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Online APC monitoring and Guidance software

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Abstract:

Power plants designed for base load service increasingly are being required to operate in a cyclic mode due to new ***CERC*** *norms; today's energy market is imposing changes in conventional steam power plant units load curve and expects to run machines below technical minimum load. This Cyclic loading has imposed Great challenge to optimize our Auxiliary power . For this some innovative idea like* ***Online APC monitoring and Guidance software*** are required, *which can monitor APC unit wise as well as station wise and also the same time help desk operator for Guidance, how he can optimize Auxiliary power consumption (APC)*

Key word: *APC, Energy management system, online guidance software, PI, Cyclic loading, Regression analysis*

Introduction:

The utility electricity sector in India had an installed capacity of 307.28 GW as of 31 October 2016[1]. Renewable power plants constituted 28.9% of total installed capacity. The gross electricity generated by utilities is 1,106 TWh and 166 TWh by captive power plants during the 2014–15 fiscal. The gross electricity generation includes auxiliary power consumption of power generation plants. India is the world's third largest producer and fourth largest consumer of electricity.[1]

Auxiliary power consumption in a thermal power plant is a major source of energy consumption. During the financial year 2007-08, total generation by coal plants was 488157.46 Mus with a PLF of 78.75 %. Auxiliary power consumption was 8.17 %. If this APC gets reduced only by 0.17 %, fresh capacity addition of about 120 MW can be achieved without any investment. APC reduction initiatives not only reduces energy intensity but also ensures more revenues because of increase in energy export [5].

Cyclic schedule and load below technical minimum has become stark reality of today in all thermal power plants of India. New duty cycles force base load plants and equipment to operate closer to or beyond nominal design limits and through more thermal cycles than originally anticipated. The operational impacts of flexible operation cited earlier resulted into increased Auxiliary power consumption . This new regime imposed bigger challenges to operate, control, strategise, more flexibly, steam power plants.

Genesis: Auxiliary power is defined as power consumed in power generation in a plant and it is generally referred as % of power consumed to generate a unit power. The auxiliary power consumed will be more if the equipment and system performance deteriorated over a period of time due to poor operation and maintenance practices. The more will be aux power consumption more will be the loss. Generally energy audit is carried out system wise as well as gap between the desired performance and actual performance is measured and suggested action plan are initiated henceforth to plug these gaps. Thus real time opportunity losses can not be plugged through this process ,.whatever improvement takes place , it happens after a certain period of time.

Scope- If innovative tools are available to the operators (24*7)in real time to give the feedback related to gap between actual and desired performance to optimize consumption through different O&M practices, then opportunity will not be lost as corrective action can be there in real time basis. Moreover the requirement of traditional energy auditing after a time interval will no more be required, saving precious resources of energy auditing.

Idea framework - Infrastructural support like energy management system (energy meters installed in feeders powering 100 KW and above)exists in stage#1, 2 and st#3 and smart meters installed in stage#4 to have a data base of a system showing amperages, power factors and power consumed feeder wise. The same data is transferred to plant information software for common access of data across organization for valuable input to all stakeholders. These critical information can be tagged to a software showing system wise power consumption like draft power, pump power, condensate power, ash handling power and so on.

Further, mere knowing intensity of power consumption will be of no use unless the information like gap analysis, performance of associated lead indicators are mapped. Thus system wise lead indicators are to be identified and clubbed with its parent system and brought to the same platform for simultaneous demonstration indicating root cause of deviation with conditioning formatting. Finally a single pager will be a guide to the operators providing quantitative input for real time correction and optimization. Online

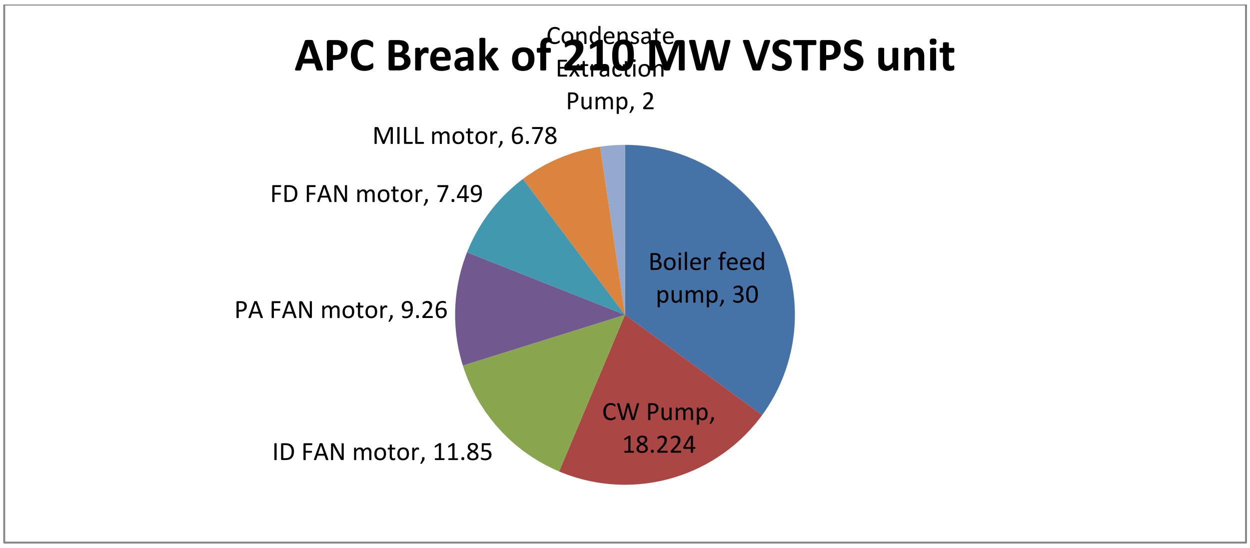
Optimization and Guidance software need to be developed which can not only keep a regular check on our operating Power consumption but can also guide operator what can be best operating mode and which of its equipment can help achieve its ideal power consumption at part load. Part load operation is a present reality of thermal power plant operation . With “green energy and sustainable energy for all” motto of our government . NTPC has to develop innovative idea to keep a regular check on our present energy consumption and ways to optimizes its.

Auxiliary Power Consumption (APC) norms Indian Scenario [5] :

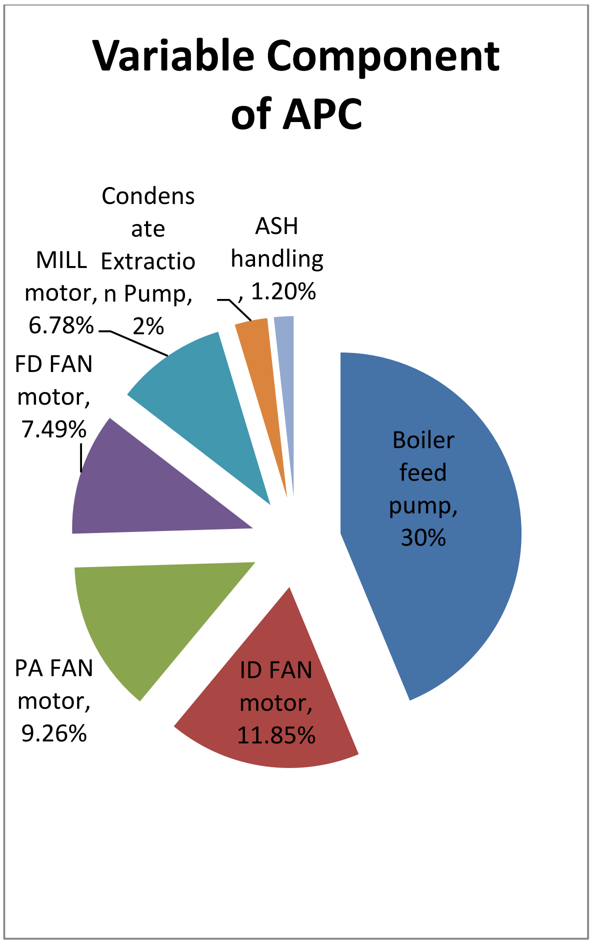
Auxiliary Power Consumption capacity wise **Capacity group in MW**	**Auxiliary power consumption in %**
500	**5.75**
250	**9.0**
210	**9.0**
195-200	**9.0**
100-150	**10.32**
<100	**10.31**

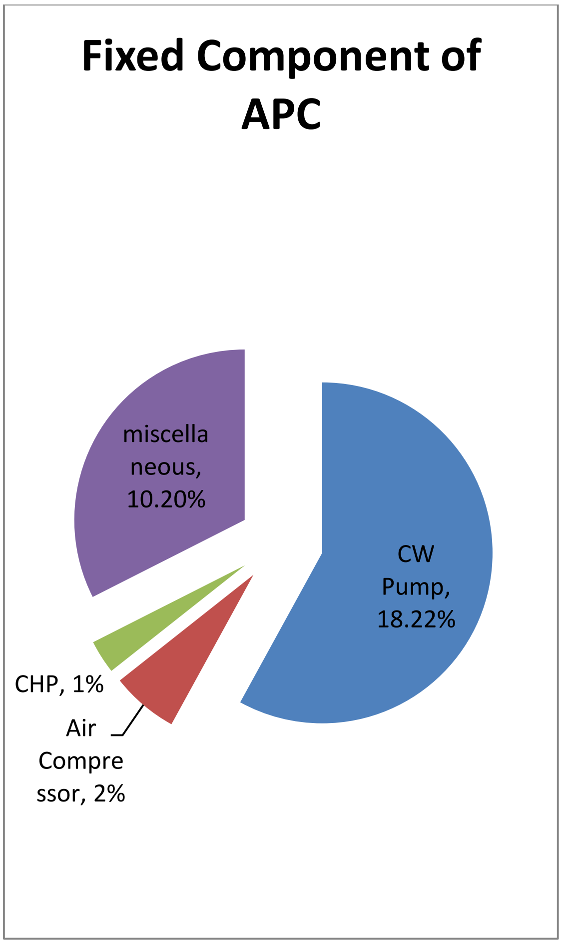
Table 1.1

Auxiliary Power Consumption (APC) Breakup:



APC can be categorize as Variable and fixed components . Variable components are those components which vary with load and fixed components are those which remain constant irrespective of Load variation. Variable components include Draft power , BFP power , Mill power , CEP power . Fixed components include Air Compressor power, CW power , Ash handling power , CHP power





Variable Component of APC is a function of load . When Load Reduces Variable component also reduces. Mapping of all the unit of VSTPS APC was done at different load condition as shown in Table 1.2

Load MM	210	189	157.5	136.5	115.5	Load Mw	500	375	275
Unit -1	9.29	9.49	9.5	10.5	11.2	**Unit -7**	5.7	6.4	7.5
Unit -2	8.2	8.65	9.0	9.5	10.5	**Unit -8**	5.7	6.5	7.5
Unit -3	9.45	9.79	10.2	11.3	12.2	**Unit -9**	5.1	6.2	6.4
Unit -4	8.93	9.20	9.2	10.7	11.8	**Unit -10**	5.1	6.2	6.4
Unit -5	9.53	9.56	9.5	10.7	11.6	**Unit -11**	5.1	6.5	6.6
Unit -6	9.26	9.58	10.0	10.8	11.6	**Unit -12**	4.7	6.2	6.8
						Unit -13	4.3	4.7	6.0

Table 1.2

Power Consumption at Low load condition reduces but Specific power consumption increases.

Factors Affecting Auxiliary Power Consumption (APC):

Cyclic operation has high impact on APC as shown in Fig 1.4. VSTPS having a loading factor 84% in which part loading is high during nights and morning. Major factors effecting APC at part load are

- At Low load below 40% Power factor of motor increases
- No of mills in service
- Primary header pressure
- Part loading of Fans
- Operation of BFP in DP mode rather than three element mode

Optimization of Variable component of APC through Mathematical Modelling Using MINITAB

Methodology

APC data of individual units was collected of last 6 Months at different load conditions, with different equipment combination. Like Different Mill combination and Coal condition. Various parameter of unit are taken and Polynomial Regression was created. [Annexure 2]

These regression equation was used as best possible power consumption at different Load condition .

Example:

Polynomial Regression Analysis: Draft Power (KW) versus load

The regression equation is
Draft Power (KW) = 8023 - 51.59 load + 0.2037 load**2
S = 141.416   R-Sq = 97.4%   R-Sq(adj) = 94.7%

Polynomial Regression Analysis: BFP (KW) versus load

The regression equation is
BFP (KW) = 1842 + 15.24 load + 0.002298 load**2
S = 3.95909   R-Sq = 100.0%   R-Sq(adj) = 100.0%

Polynomial Regression Analysis: Mill (KW) versus Load of unit 3

The regression equation is
Mill (KW) = - 459.1 + 15.29 Load - 0.03631 Load**2
S = 26.4559   R-Sq = 98.2%   R-Sq(adj) = 96.3%

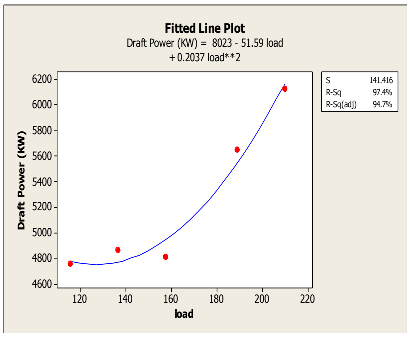


Fig 1.1

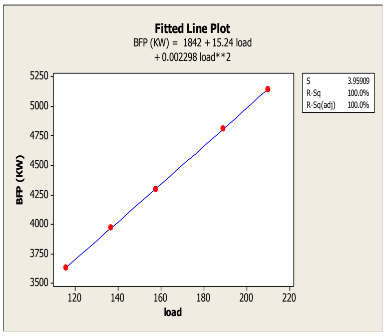


Fig 1.2

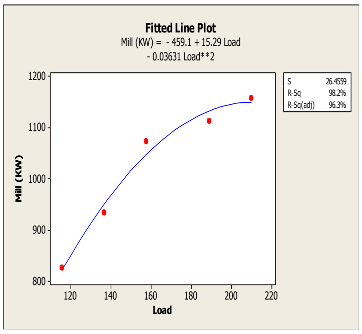


Fig 1.3

As Regression equation gives R2 value greater than 95% . this model can widely be accepted and can be replicated in other units

Power consumed is under best optimized condition. Using this as bench mark comparison is made with actual running power of BFP , Draft and mill. And it the same time key parameter through which it can further be optimized is also shown

Unit 2 APC mapping at different loading condition is shown in Fig 1.4 , which shows trend how our APC vary with load

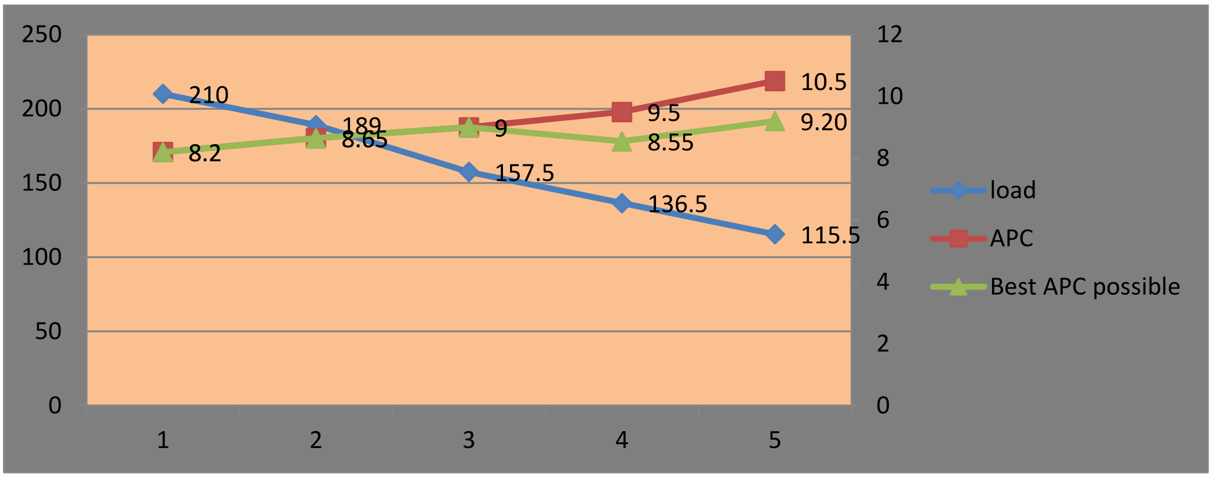


Fig1.4

Graph clearly shows that at reduced load APC can further be improved, only guidance is required. That Guidance is in the form of Mill stopping, PA header reduction, O2 optimization, Mill combination, BFP Optimization, and Stopping of Mill, FD and BFP where ever possible. At the same time it also shows operator the bench mark which can be achieved

APC Monitoring and Guidance Software

Operator Guidance software is developed with detail of APC instantaneous , past one hour APC, Specific power of mill, FD, ID, PA FAN and BFP . One page shows only the deviation which is shown below fig 1.3. Deviation from benchmark APC at particular load and current operating load . Like details of Power consumption of mills and other equipment are shown for detail analysis with there key Parameter through which operator can optimize it.

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OPERATOR GUIDENCE PARAMETER FOR APC OPTIMIZATION

STAGE 1	LOAD	Mill Power actual	Predicted	Draft Power actual	Predicted	BFP power Actual	Predicted	APC	LAST 1 HR APC	LAST 1 HR STAGE APC
Unit-1	219.9	1444.6	1289.5	5835.0	5892.8	6277.9	6609.3	8.5	8.4	8.7
Unit-2	217.9	1338.2	1147.9	5931.9	6081.0	5688.2	5269.7	8.3	8.2	
Unit-3	202.5	1325.6	1160.4	5931.7	5893.1	6200.1	6031.4	9.8	9.4	
Unit-4	217.8	1535.1	1313.8	5914.3	5839.4	5487.3	5440.6	8.3	8.1	
Unit-5	195.3	1425.1	1116.5	6088.8	5777.1	5164.4	4932.2	9.4	9.3	
Unit-6	218.7	1427.4	1111.6	6245.0	6320.0	5840.8	5472.6	9.0	8.8	

STAGE 2	LOAD	Mill Power actual	Predicted	PA Power Actual	Predicted	FD Power Actual	Predicted	ID Power actual	Predicted	APC	LAST 1 HR APC	LAST 1 HR STAGE APC
Unit-7	506.3	6645.3	6251.1	2088.1	2356.3	1018.3	1071.6	4450.5	4681.0	5.72	5.6	5.8
Unit-8	497.8	6631.1	6575.2	2357.2	2194.5	989.6	1030.1	4670.2	5028.9	6.02	6.0	

STAGE 3	LOAD	Mill Power actual	Predicted	PA Power Actual	Predicted	FD Power Actual	Predicted	ID Power actual	Predicted	APC	LAST 1 HR APC	LAST 1 HR STAGE APC
Unit-9	508.4	2589.7	2520.6	2965.7	3418.3	857.4	950.6	3980.5	5157.7	4.74	4.8	4.9
Unit-10	495.3	2313.0	2853.6	2370.4	2367.2	890.0	951.8	4231.9	4728.3	5.04	5.0	

STAGE 4	LOAD	Mill Power actual	Predicted	PA Power Actual	Predicted	FD Power Actual	Predicted	ID Power actual	Predicted	APC	LAST 1 HR APC	LAST 1 HR STAGE APC
Unit-11	515.7	1767.9	1548.8	2468.1	2676.7	391.0	422.6	4848.9	4914.9	4.55	4.5	4.6
Unit-12	510.9	2682.0	2932.5	2370.4	2315.7	380.7	469.8	4366.4	4454.6	4.71	4.5	

STAGE 5	LOAD	Mill Power actual	Predicted	PA Power Actual	Predicted	FD Power Actual	Predicted	ID Power actual	Predicted	APC	LAST 1 HR APC	LAST 1 HR STAGE APC
Unit-13	518.5	2161.5	1735.3	2963.5	2401.0	361.4	394.8	4336.3	4263.0	4.72	4.8	4.8

Fig 1.3

This sheet Gives deviation of power , which is highlighted through Condition Formatting. In addition to this different pages is created showing specific mill power consumption, Mill specific power , past history of mill specific power

Mill Power :

MILL SPECIFIC POWER CALCULATION KW /ton

	Load	Mill-A	Mill-B	Mill-C	Mill-D	Mill-E	Mill-F	Mill-G	Mill-H	Mill-J	Mill-K	APC
Unit-1	214.76	10.44	9.15	10.12	10.40	0.00	9.47	*	*	*	*	9.25673978
Unit-2	209.09	0.42	9.43	7.41	10.12	9.91	8.67	*	*	*	*	8.77506003
Unit-3	89.68	0.00	0.43	2.30	10.81	12.41	10.62	*	*	*	*	16.3406584
Unit-4	202.38	8.36	0.00	10.58	10.29	9.83	9.50	*	*	*	*	8.55109389
Unit-5	196.30	12.04	2.17	9.09	9.00	9.35	8.43	*	*	*	*	9.05903075
Unit-6	216.18	11.11	10.20	0.00	9.24	10.57	7.66	*	*	*	*	8.89802181
Unit-7	505.37	12.36		11.12		10.95		11.69		0.00		5.74368695
Unit-8	501.27	14.92		13.30		0.00		13.67		13.93		5.7676764
Unit-9	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	UNIT DOWN
Unit-10	436.56	10.37	10.85	10.52	0.00	10.60	11.10	0.00	10.95	0.00	0.00	5.03959143
Unit-11	491.38	0.00	8.41	9.39	4.15	8.48	12.69	0.00	8.16	22.02	0.00	5.21795913
Unit-12	519.20	1.62	5.13	9.98	10.28	11.34	11.95	0.00	10.73	0.00	0.00	4.62104701
UNIT13	502.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	5.00832088

Reduction in even 5% of energy consumption of the pulverizes would bring significant benefit to the plant. The operations of coal mills can be optimized by maintaining proper air-fuel ratio, periodic testing of coal particles and size and roller pressure with grind ability of the coal. Mill performance can be analyzed with regression analysis of previous and present consumption pattern. Break-even point for replaced must be identified so as to avoid excess energy consumption in coal mill

Draft Power :

Draft system includes forced draft fan, primary air fan and induced draft fan. It has been observed that excess air or air ingress tends to increase the flow of ID fan. The condition of excess air in draft air draft system and ingress is due to FD pan and PA fan respectively. Since there is a increased air flow in the draft system the energy consumption increases substantially resulting in higher APC consumption.

The performance of fans (ID, PA & FD fans) can be analyzed through the sheet , comparing it with actual power consumption pattern. It has been observed that a reduction of 10% air can result of 15% ID fan power consumption. Sheet also displays Key parameters like PA header , O2 and specific coal through which Operator can optimize Draft power

Draft Power (KW) PI

	Load	PA FAN	FD FAN	ID FAN	MILL POWER	DRAFT POWER	Dft+ MILL pwr	DRAFT+ MILL kw/mw	APC UNIT WISE
Unit-1	213.75	1365.31	1404.75	2482.56	1006.22	5252.62	6258.84	29.28	8.25
Unit-2	212.17	1766.24	1487.95	2703.09	1154.05	5957.28	7111.34	33.52	8.41
Unit-3	208.09	1460.66	1337.12	2677.39	1007.97	5475.18	6483.15	31.16	8.87
Unit-4	213.01	1525.86	1432.93	2682.75	1168.80	5641.54	6810.34	31.97	7.86
Unit-5	207.36	1474.81	1529.59	2744.09	1116.89	5748.48	6865.36	33.11	8.50
Unit-6	216.10	1527.47	1547.04	2717.66	1156.65	5792.17	6948.82	32.15	8.22
Unit-7	500.39	1976.40	1076.65	4182.93	6678.53	7235.98	13914.51	27.81	5.57
Unit-8	493.65	1958.65	1019.04	4349.45	6537.78	7327.14	13864.92	28.09	5.43
Unit-9	503.60	2693.29	988.55	4140.03	2217.19	7821.87	10039.06	19.93	3.76
Unit-10	500.26	2575.76	1084.91	5135.21	2174.25	8795.88	10970.13	21.93	6.03
Unit-11	518.66	2697.58	399.29	5003.96	2141.90	8100.83	10242.73	19.75	5.52
Unit-12	522.25	2575.76	379.29	4495.84	3528.36	7450.89	10979.25	21.02	4.52
Unit-13	521.59	2616.18	404.28	4481.88	31.94	7502.34	7534.28	14.44	4.37
average	371.61	2016.46	1083.95	3676.68	2301.58		9078.67	26.47	6.56
total	4830.89	26213.97	14091.40	47796.82	29920.53		118022.73	344.16	

BFP power :

Boiler Feed Pump is one of the largest auxiliaries of the power plant in terms of energy consumption. It nearly consumes 30 % of the APC in Stage 1 unit of VSTPS. Any reduction in the energy consumption using asset optimization will greatly increase the efficiency of the plant. The various measures which can be taken to optimize the BFP are described below.

Energy consumption can be saved in boiler feed pump (BFP) by controlling the speed of the pump by using Scoop instead of valve control methods. There

are two method of operating units at DP mode across FRS valve and Three element mode.
BY seeing BFP Sheet operator can come to upto which load three element mode can be operated to give best result and like wise Optimization can be done
BFP can further be optimized by replacing cartridge and Retrofitting it .

By avoiding recirculation of feed there can be saving of as much as 15 % of the energy consumption of BFP

Instant Data		21-11-2016 10:13								
STAGE 1 BFP POWER CALCULATION KW/MW							BFP POWER			
UNIT	Load	BFP-A	BFP-B	BFP-C	FRS DP		BFP-A	BFP-B	BFP-C	Total BFP Power
Unit-1	213.37	9.44	0.00	7.91	18.06		3066.81	-0.29	3070.54	6137.06
Unit-2	211.76	7.85	0.00	8.81	13.27		2916.20	0.00	2995.11	5911.31
Unit-3	208.47	8.53	0.76	7.88	4.70		3195.26	37.82	3008.01	6241.09
Unit-4	213.17	0.00	7.67	7.87	8.64		0.44	2799.98	2850.06	5650.48
Unit-5	207.34	0.00	7.37	8.21	6.33		4.53	2860.02	2550.14	5414.69
Unit-6	217.17	7.75	0.49	8.68	7.38		3247.30	4.23	2532.31	5783.84

Financial gain through APC Monitoring and Guidance Software

On an average if 210 MW unit is operated from 115 MW to 210 MW in a day average APC comes out to be 9.2%

If generation is 4.41 MU per unit per day

Aux Power consumption is = 4.41x9.2% = 0.405 Mu

By operating unit as according to APC predicted software APC could have been 8.8 %

Aux Power = 4.41x8.8% = 0.388 Mu

Which means in one day 0.405-0.388 = 0.017 MU can be saved

Which accounts to Rs= 0.017 x 1.86 x 10^6

= 31620 per day per unit

For stage I units 6 x 210 MW

= 31620 x 6

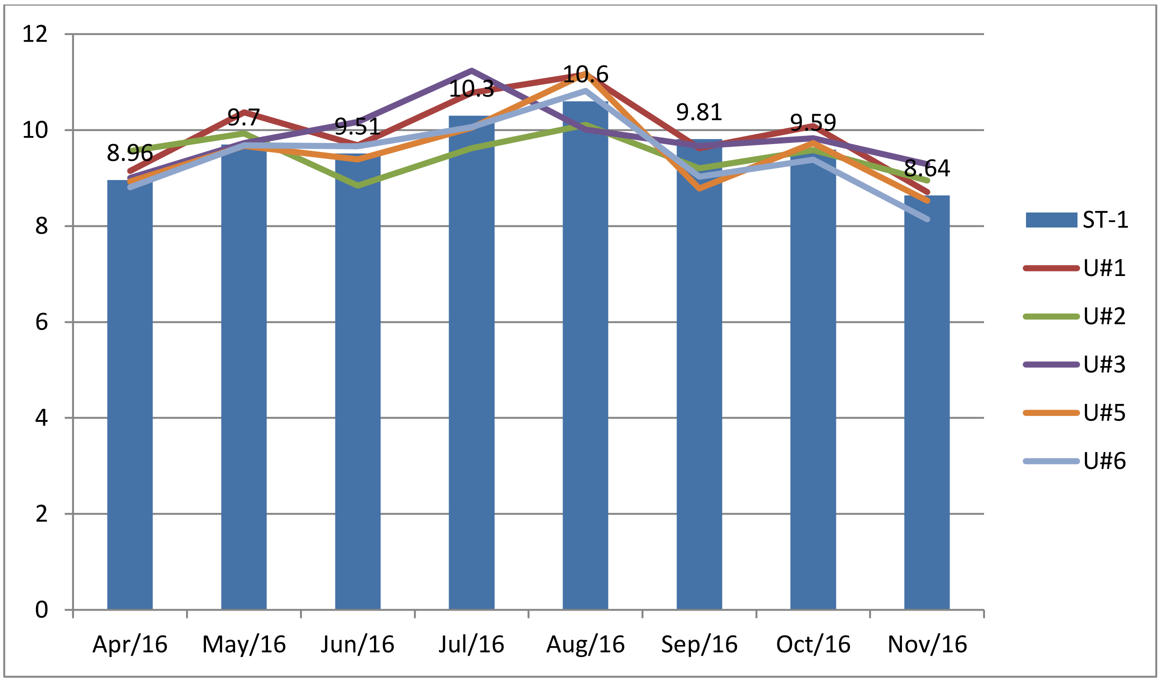
= 189720 Rs / day

On yearly basis ~ 5.81 crore

Current Operating scenario of VSTPS

Past 6 month trend of APC of Stage I unit s are taken as example to show how this soft ware has helped station .

APC(%)							
VSTPS	ST-1	U#1	U#2	U#3	U#4	U#5	U#6
Apr-16	8.96	9.15	9.56	9.00	8.93	8.93	8.81
May-16	9.70	10.37	9.93	9.73	9.30	9.67	9.68
Jun-16	9.51	9.68	8.84	10.17	9.42	9.39	9.66
Jul-16	10.30	10.78	9.62	11.24	9.91	10.05	10.06
Aug-16	10.60	11.16	10.11	10.01	9.48	11.18	10.82
Sep-16	9.81	9.62	9.20	9.67	12.14	8.78	9.03
Oct-16	9.59	10.08	9.58	9.83	8.71	9.73	9.38
Nov-16	8.64	8.71	8.95	9.29	8.14	8.53	8.14



APC has reduced in past three months but our Loading factor and climatic condition has also improved. But by monitoring APC on day to day basis significant gain has been achieved . in terms of our auxiliary power consumption. Operator has better view is our current APC and which sector of unit is contributing maximum. What is the optimization measure and whether equipment is healthy or some maintenance is required. Even Maintenance person is in better position to predict its equipment health. Predictive maintenance planning is also monitoring it so that he can plan its maintenance so that availability of plant is not hindered

This Software is implement in all stages of VSTPS and it is available on site also so that operator can access it from any where. APC optimization is a long journey and in coming future it can not only be improved through operation practices but some design modification is also needed. But this small step can be a stepping stone for power optimization technique which can still be further improved .

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5. **Energy Management Approach To Improve Performance Of Thermal Power Plant** A G Vinchurkar1, Dr. R R Lakhe2, Dr. R L Shrivastava3 *1Principal Director National Power Training Institute (Ministry of Power, Govt. of India) Gopal Nagar, Nagpur-22 2Dr. R R*

Lakhe Director SQMS, Nagpur 3Dr. R L Shrivastava Professor YCCE, Nagpur

6. ***Efficiency Improvement by Asset Optimization Program and Strengthening Operation and Maintenance Practices of Captive Power Plant*** by ***Ms. Rachna Vats,*** *Senior Fellow, NPTI, Faridabad* & ***Mr. Bimalendu Mohapatra*** *AGM, Asset Optimization* Sterlite Energy Limited, Jharsugda

Annexure 2

Average data of 6 month under different head and different load condition

load	210	189	157.5	136.5	115.5
Unit -1	**100%**	**90%**	**75%**	**65%**	**55%**
APC	9.29	9.4901	9.54	10.49285	11.15
Mill (KW)	1251	1167.66	1041	960.81	879
Draft Power (KW)	5878	5395.9	4589	4550.65	4387
BFP (KW)	6204	5474.3	4400	3547.55	2728

load	210	189	157.5	136.5	115.5
Unit -2	**100%**	**90%**	**75%**	**65%**	**55%**
APC	8.2	8.65	9	9.5	10.5
Mill (KW)	1124	1085.13	1032	971.205	917
Draft Power (KW)	6130	5650.1	4812	4867.85	4762
BFP (KW)	5142	4807	4295	3967	3632

load	210	189	157.5	136.5	115.5
Unit -3	**100%**	**90%**	**75%**	**65%**	**55%**
APC	9.45	9.7891	10.19	11.26435	12.16
Mill (KW)	1158	1114.27	1074	934.195	826
Draft Power (KW)	5886	5699.7	5476	4948.95	4513
BFP (KW)	6275	5509.1	4407	3466.85	2584

Unit -4	**100%**	**90%**	**75%**	**65%**	**55%**
APC	8.93	9.2001	9.21	10.72785	11.78
Mill (KW)	1256	1191.25	1109	968.125	849
Draft Power (KW)	5825	5526.1	5044	4953.85	4808
BFP (KW)	4957	4661	4393	3243.5	2344

load	210	189	157.5	136.5	115.5
Unit -5	**100%**	**90%**	**75%**	**65%**	**55%**
APC	9.53	9.5554	9.46	10.6789	11.64
Mill (KW)	1180	1090.13	956	871.205	786
Draft Power (KW)	6063	5685.5	5047	4924.25	4715
BFP (KW)	5268	4747.8	4026	3214.8	2488

load	210	189	157.5	136.5	115.5
Unit -6	**100%**	**90%**	**75%**	**65%**	**55%**
APC	9.26	9.5829	9.96	10.83765	11.56
Mill (KW)	1081	1028.09	953	880.565	814
Draft Power (KW)	6112	5804.7	5356	4896.45	4470
BFP (KW)	5306	4925.6	4355	3959.6	3567

Unit -7	500	375	275
APC	5.66	6.43	7.5
Mill (KW)	6399.495	4864.107	4826.963
PA POWER (KW)	2302.549	2025.668	1601.953
FD POWER (KW)	1094.363	864.6711	863.755
ID POWER (KW)	4760.327	3544.988	3315.212

	500	375	275
Unit -8	500	375	275
APC	5.67	6.48	7.49
Mill (KW)	6751.771	4862.109	4193.091
PA POWER (KW)	2237.267	1708.838	1491.029
FD POWER (KW)	1047.433	942.8759	960.6845
ID POWER (KW)	5263.378	3498.184	3405.61

Unit -9	500	375	275

APC	5.06	6.24	6.4
Mill (KW)	2495.536	2055.34	1732.167
PA POWER (KW)	3490.022	2243.307	2015.399
FD POWER (KW)	976.8285	739.2192	755.1294
ID POWER (KW)	5305.929	3345.942	3180.843

Unit -10	500	375	275
APC	5.06	6.24	6.4
Mill (KW)	2704.312	2055.34	1732.167
PA POWER (KW)	2349.207	2243.307	2015.399
FD POWER (KW)	993.9756	739.2192	755.1294
ID POWER (KW)	4947.927	3345.942	3180.843

Unit -11	500	375	275
APC	5.1	6.5	6.6
Mill (KW)	1548.403	1446.064	1418.08
PA POWER (KW)	2739.152	2131.141	2238.42
FD POWER (KW)	423.6662	359.0419	345.5647
ID POWER (KW)	4905.168	4338.197	4161.596

Unit -12	500	375	275
APC	4.71	6.2	6.8
Mill (KW)	2964.697	2314.068	2227.362
PA POWER (KW)	2341.199	2047.65	2045.931
FD POWER (KW)	467.3674	384.0704	338.3134
ID POWER (KW)	4439.523	4398.017	4310.162

Unit -13	500	375	275
APC	4.3	4.65	6
Mill (KW)	1583.83	2277.448	1794.327
PA POWER (KW)	2772.252	2423.706	2302.977
FD POWER (KW)	397.5595	359.2139	364.9038
ID POWER (KW)	4295.381	3795.07	3839.794