KIS Power Quality and System Stability.

Introduction:

KIS power system is run on 1.6MW Solar-Thermal Hybrid power generation station; Since commencement of operations in 2015, the generation facility has a challenge of: -

- Low power factor (p.f.); leading to unstable power supply, that depends on threshold loading/ base demand of 500kW; short of the base demand results into intermittent outages;

Power Factor: -

a) Problem Statement

The dominant capacitive low p.f on KIS power system has the following effects: **-**

- Causes overvoltage on the medium voltage (33kV) network; predominately at the receiving end the feeders;
- Generally, reduces power system efficiency;
- Un realistic overload on the power system, due to disproportion between apparent power (kVA) and active power (KW), leading to nonsequential operation of the Hybrid power plant components; (Solar – Battery bank – Diesel generator sets 220kVA, 315kVA & 500kVA)
- High current drain from the power system, (Overload on generation equipment)
- Unstable power supply, that depends on base demand,
- High cost of operation (Over dependence on the diesel generators, rather than the Solar component);

b) ***Technical approach to problem***;

Procedures, data log, tests and Observations: -

Procedures:

- Generation plant was isolated from the network, at the feeder points;
- Generation step up substation kept on;
- Power system parameter recorded (Voltage, Power, and p.f)
- Feeders were switched on and voltage, Power, p.f, and current readings taken at generation station and on distribution transformers at the remote location;
- 24Hourly data log was done;
- Further tests are ongoing using Power Quality analyzer (PQA)

Observations:

- Output voltage with no feeders is 33kV;
- Power factor (p.f) was at about 99%;
- Upon closing the feeders, the voltage increases to 34.6kV;
- P.f was capacitive at about 50%;
- When the base demand area of the network was isolated;
    - The p.f. dropped further to about 30% and inverter synchronizing circuit breakers opened;
    - The generators took over the load, but triggered overload alarm and the plant tripped at a capacitive p.f of 29%;

Above observation is consistent with unstable power system, owing to high reactive power component;

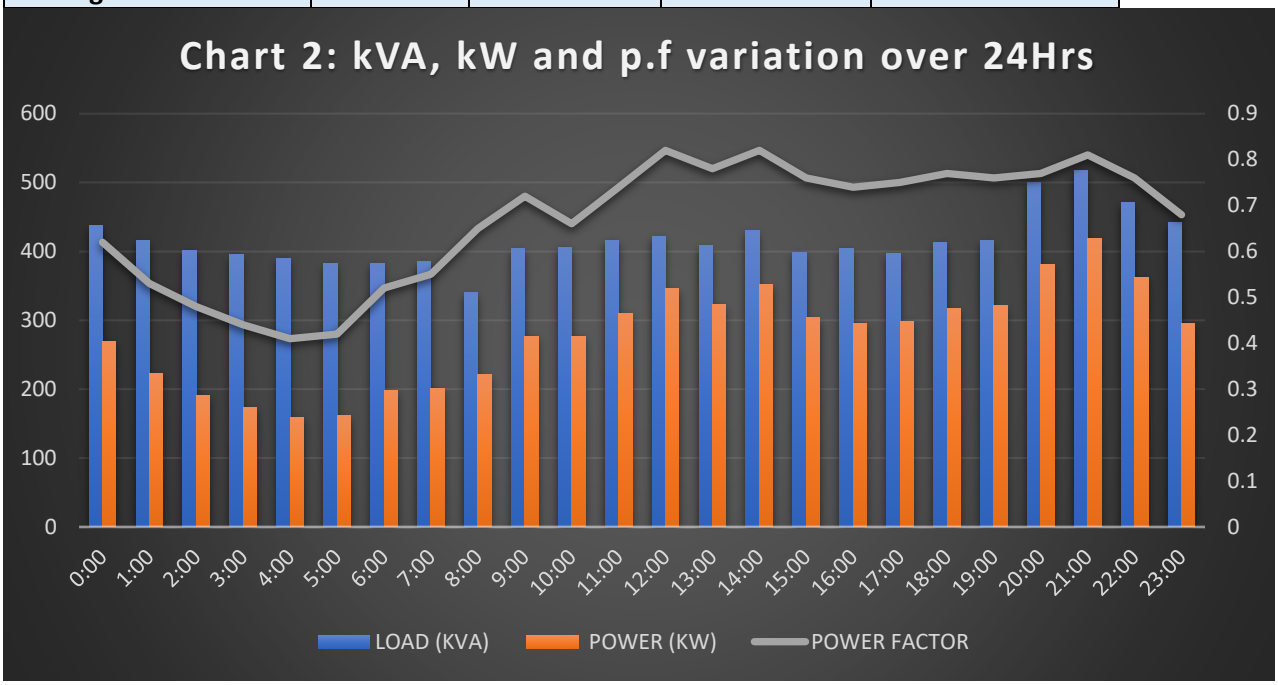
Furthermore, the table 1, is a typical power system data log over 24hour cycle, the trend is indicative of: -.

- p.f that improves with increase on demand;
- the average load is always above 300kVA; the load beyond the (200&320kVA) rating of KIS smaller generators, and thus, causes overdependence on the biggest generator, (500kVA).

Table 1: Power Plant 24Hr Operations Data Log

DATE	TIME (HRS)	LOAD (A)	LOAD (KVA)	POWER (KW)	POWER FACTOR
1-Jan-19	0:00	651	437	269.4	0.62
1-Jan-19	1:00	584.6	415.8	222.9	0.53
1-Jan-19	2:00	566.3	401.8	191	0.48
1-Jan-19	3:00	554.8	395.2	173	0.44
1-Jan-19	4:00	547.3	390.2	159.3	0.41
1-Jan-19	5:00	536.8	382.5	161.1	0.42
1-Jan-19	6:00	538.1	382.7	198.8	0.52
1-Jan-19	7:00	536.8	385.1	200.5	0.55
1-Jan-19	8:00	538	340	221.0	0.65
1-Jan-19	9:00	567	404	277	0.72
1-Jan-19	10:00	571	406	277	0.66
1-Jan-19	11:00	582	416	310.3	0.74
1-Jan-19	*12:00*	*595.6*	*421*	*346*	*0.82*
1-Jan-19	*13:00*	*561*	*408.2*	*323*	*0.78*
1-Jan-19	*14:00*	*589.2*	*430*	*351.9*	*0.82*
1-Jan-19	*15:00*	*566.5*	*399*	*303.4*	*0.76*
1-Jan-19	*16:00*	*566.6*	*403.9*	*295.3*	*0.74*
1-Jan-19	*17:00*	*552.9*	*396.4*	*298.5*	*0.75*
1-Jan-19	18:00	578.3	412.6	316.7	0.77
1-Jan-19	19:00	613.2	415.8	320.9	0.76
1-Jan-19	20:00	679.8	500	381.1	0.77
1-Jan-19	21:00	716.5	517.7	418.2	0.81
1-Jan-19	22:00	678.4	470.6	362.2	0.76

1-Jan-19	23:00	622.6	442.2	294.9	0.68
Average		**587.3**	**415.6**	**278.1**	**0.67**



c) Recommendations

❖ Engage a consultant/contractor to install reactive power compensator on the power network to correct the p.f and stabilize the power system especially at conditions of light load or no load, when the low p.f. effect is more dominant.

d) Scope

❖ The scope of contractor's engagement will include but not limited to;

- Conducting relevant study/analysis deemed necessary in providing the solution;

- Provide a hybrid (Inductive & capacitive) reactive power compensator with auto monitoring and switching to improve the p.f. to about 98/99%;

- The percentage regulation (switch in and out compensator block fractions), and the ratio of Inductive to Capacitive components, shall be determined by the contractor upon conclusive study of the power system.

e) ***KIS intends to improve the p.f. for: -***

- Better efficiency of the power system;
- Sequential running of the generators, in the order 220, 320 and 500kVA
- Reduced cost of operation; (low fuel consumption & better equipment loading);
- Improved compliance levels on power quality, and system reliability;
- Eliminating losses associated with power quality, and thus, pave way for, Segregation of losses, expansion of generation plant, and making other improvements as stipulated in KIS 2018 – 2020 strategic plan.