
بسم الله الرحمن الرحيم

PRESENTATION ON

STUDY OF POWER QUALITY, HARMONICS ANALYSIS AND IMPROVEMENT TECHNIQUES IN SUGAR INDUSTRY

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ABSTRACT

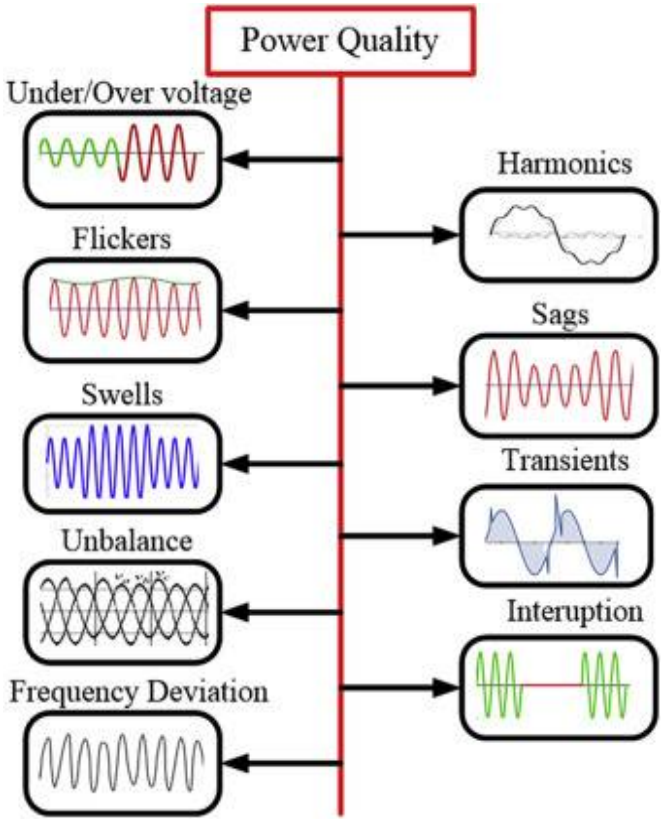
Power quality is a set of parameters that define the characteristics of the power supply. Power quality is not only a technical problem but also a problem that leads to financial issues. The power system quality is compromised due to voltage disturbances in the system and frequent load variation caused by the non-linear loads, increase in the number of electronic devices and switching/tripping of heavy loads. Power quality measures the efficiency of electric power transmitted from generation to the Load. This paper presents the power quality analysis, Harmonics analysis, IR Scan/Thermography of Motors, Short circuit current Analysis, Power quality improvement techniques & developments applied in Sheikhoo sugar Mills regarding power quality, reliability, efficiency and economy. In the end I will also discuss about the scope of solar power generation during OFF SEASON in sugar industries.

POWER QUALITY

- Power quality is the ability to supply power from Generation to the Load efficiently and it also expresses the ability of equipment to consume the power being supplied to it.

PARAMETERS OF POWER QUALITY

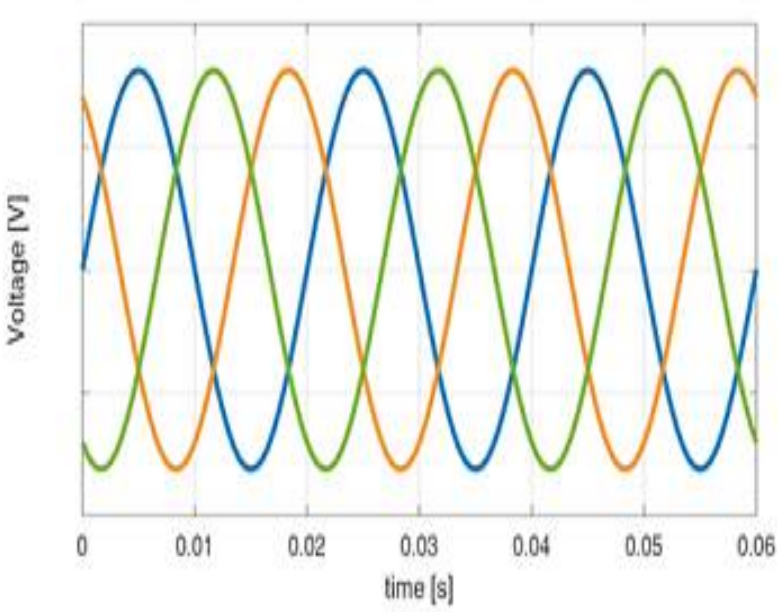
- **UNBALANCED VOLTAGE**
- **HARMONICS**
- **VOLTAGE SAG & SWELL**
- **TRANSIENTS**
- **POWER FACTOR**

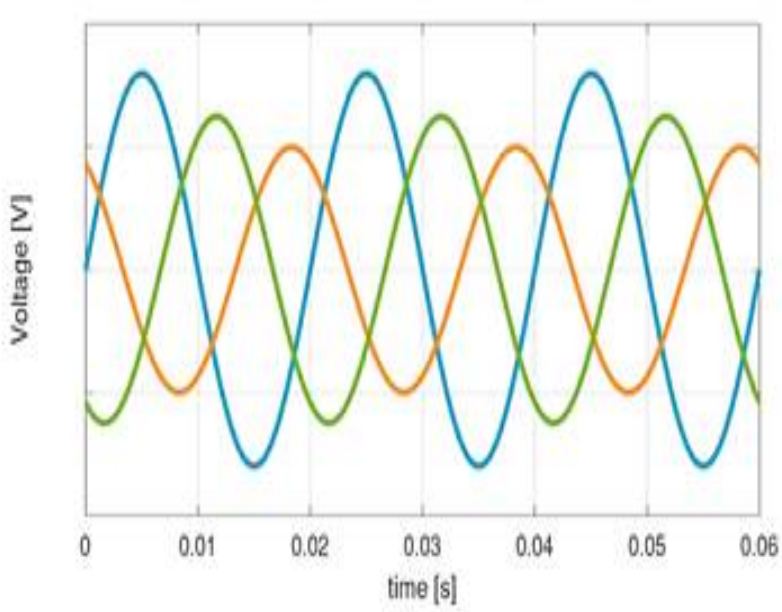


PARAMETERS OF POWER QUALITY

UNBALANCED VOLTAGE

The voltages of a 3 phase system are different in either magnitude or phase difference between each of two phases is not same i.e. other than 120 degrees. The voltage imbalance should not exceed the limit of 1%.





POWER QUALITY ANALYSIS OF SHEIKHOO SUGAR MILLS

VOLTAGE IMBALANCE ANALYSIS

Voltage imbalance analysis was performed at different motors at SSML.

Table-1 Voltage Imbalance of Different Motors at SSML

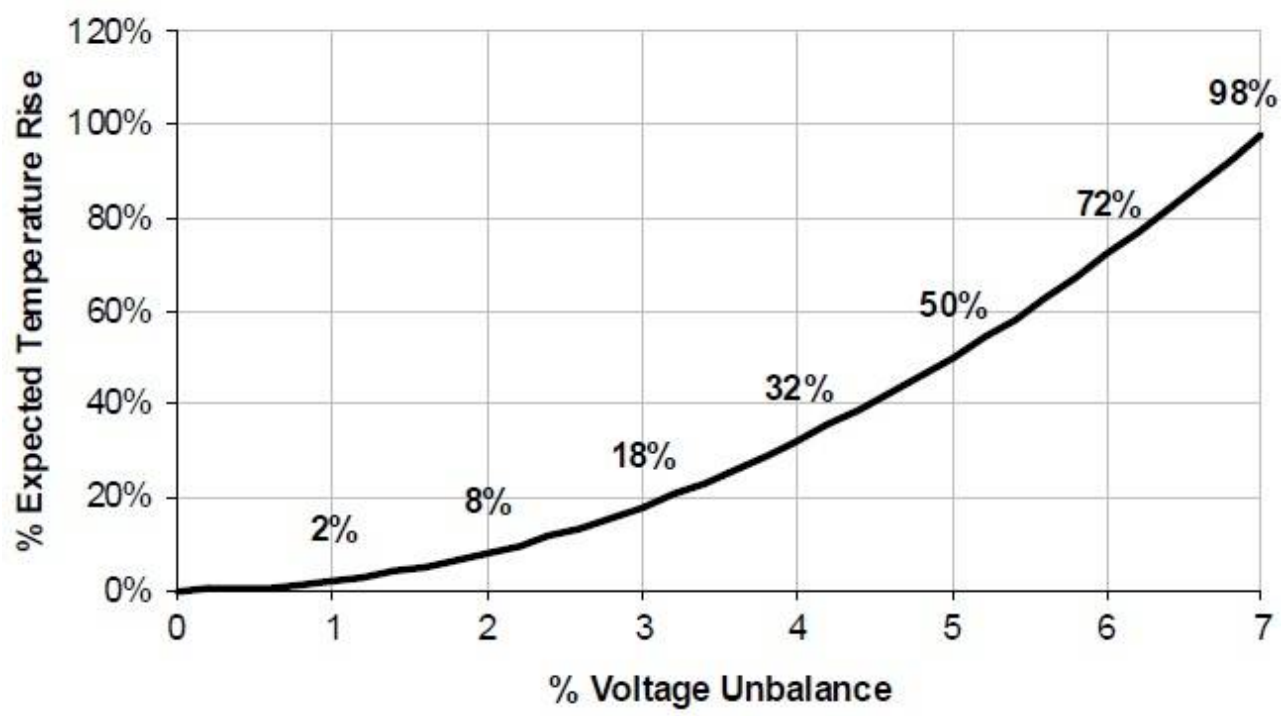
Sr. No.	Description	Running Voltage			Average Voltage	Voltage Imbalance %
		Phase-I	Phase-II	Phase-III		
1	Main Bagasse Carrier	402.0	402.0	403.0	402.3	0.17
2	Return Bagasse Carrier	410.0	401.0	402.0	404.3	1.40
3	Feed Water Pump No. 01	401.0	401.0	403.0	401.7	0.33
4	Secondary Fan Boiler No. 01	419.0	420.0	420.0	419.7	0.08
5	Condensate Pump	409.0	409.0	406.0	408.0	0.25
6	Inter Carrier No. 03	394.0	395.0	396.0	395.0	0.25
7	Conti-Centrifugal No. 05	390.0	393.0	392.0	391.7	0.34
8	Conti-Centrifugal No. 06	392.0	390.0	393.0	391.7	0.34
9	Conti-Centrifugal No. 08	388.0	388.0	387.5	387.8	0.04
10	Conti-Centrifugal No. 46	387.0	390.0	388.0	388.3	0.43

POWER QUALITY ANALYSIS OF SHEIKHOO SUGAR MILLS

VOLTAGE IMBALANCE GRAPHICAL REPRESENTATION

The graph shows the relationship between voltage imbalance and temperature rise, which approximately increases by twice the square of the percent of voltage imbalance.

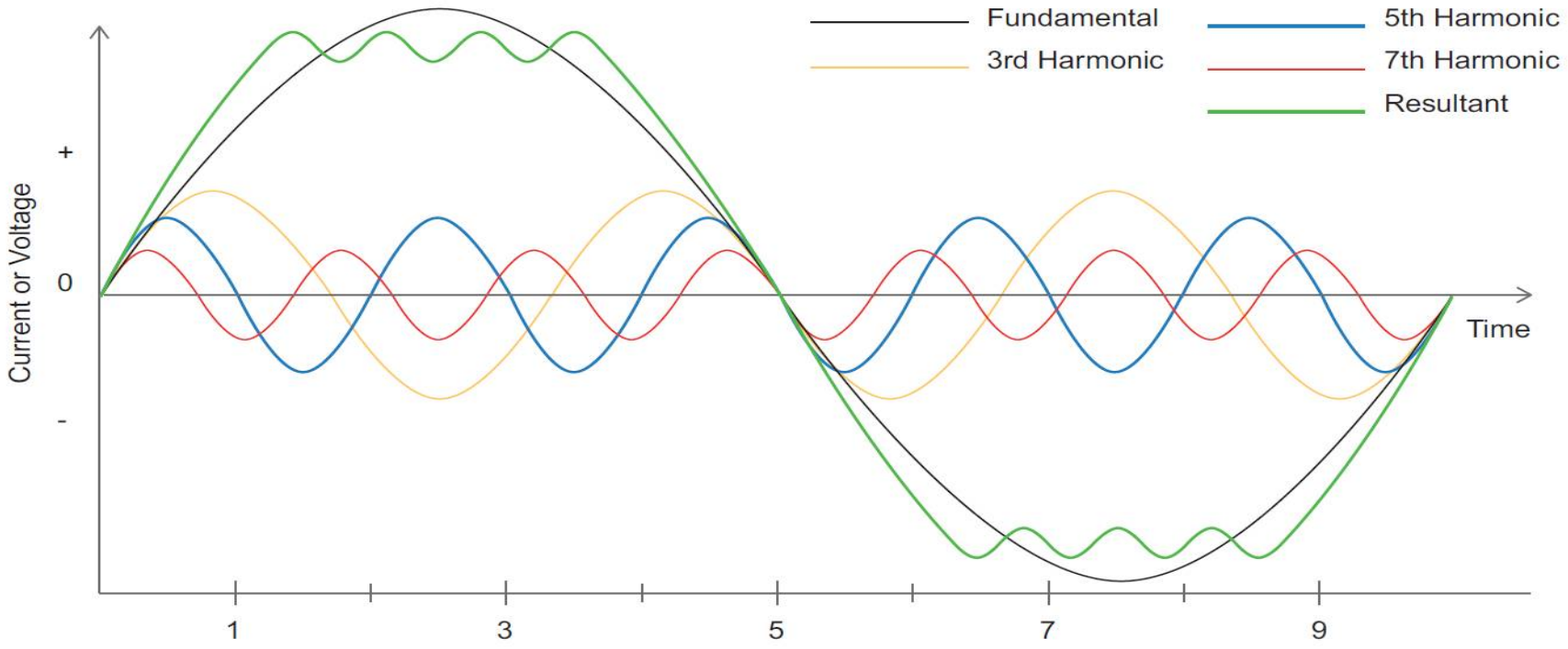
% Temp. rise = 2 x (% Voltage Imbalance)^2



PARAMETERS OF POWER QUALITY

HARMONICS

The Sinusoidal waveforms having frequencies as integral multiple of the fundamental frequency are known as harmonics. The %THD V should not exceed **8%** and the %THD I should not exceed **15%.**



POWER QUALITY ANALYSIS OF SHEIKHOO SUGAR MILLS

HARMONICS ANALYSIS

The harmonics Analysis was performed at selected Motors of SSML, According to IEEE, The harmonics Analysis of Mill No. 02 Motor (1800 KW) is given in the below Table:

Baisc Parameters Values Mill Motor No. 02 Star Side					
Sr. No	Display Variables	L1	L2	L3	L111
1	Phase-Neutral Voltage	404.81	404.74	404.31	404.62
2	Phase-Phase Voltage	693.20	692.95	693.36	693.17
3	Current	301	298	303	301
4	KW	111	110	112	333
5	KVARL	20	19	18	58
6	KVARC	0	0	0	0
7	KVA	121	120	122	363
8	Consumed Power Factor	0.92	0.92	0.92	0.92
9	Frequency	-	-	-	49.64
10	THD V	14.92	14.91	14.91	-
11	THD I	34.93	35.36	35.29	-

POWER QUALITY ANALYSIS OF SHEIKHOO SUGAR MILLS

HARMONICS ANALYSIS

The harmonics Analysis of Turbine Generator No. 07 (22 MW) is given in the below Table:

Baisc Parameters Values Turbine Generator 7					
Sr. No	Display Variables	L1	L2	L3	L111
1	Phase-Neutral Voltage	6700.61	6385.47	5959.91	6348.66
2	Phase-Phase Voltage	10964.1	10961.2	10954.1	10959.8
3	Current	545	549	555	550
4	KW	3544	3306	3219	10070
5	KVARL	843	1125	709	2678
6	KVARC	0	0	0	0
7	KVA	3651	3505	3307	10463
8	Consumed Power Factor	0.97	0.94	0.97	0.96
9	Frequency	-	-	-	50.13
10	THD V	6.60	7.12	7.25	-
11	THD I	5.62	5.80	5.83	-

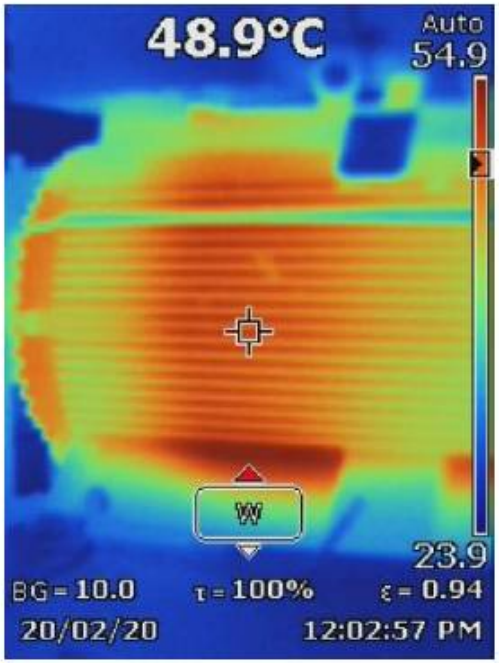
POWER QUALITY ANALYSIS OF SHEIKHOO SUGAR MILLS

Sr. No.	Description	Amp	THDI %			THDV %		
		Avg	L1	L2	L3	L1	L2	L3
1	Mill house LV Panel	2324	7	7	7	5	5	5
2	Process House 3 LV Panel	1779	10	10	11	6	7	5
3	Process House 4 LV Panel	2321	2.8	2	2.8	4.5	4.7	4
4	Conti-Centrifugal 5 LV Panel	2740	4.6	5	4.6	4	3	3.7
5	Refine 5-A LV Panel	639	6.5	6.4	6.3	4.6	4.4	4.4
6	Conti-Centrifugal 5B LV Panel	2231	5	5.4	5	4.4	4.6	4.5
7	Furnace Feeder	769	1.7	1.7	1.7	8.6	10	11
8	Turbine Generator No.1	243	5	5	5	9	10	8
9	Turbine Generator No.2	257	5	5	5	8	8	7
10	Turbine Generator No.3	247	5	5	5	8	8	7
11	Turbine Generator No.4	517	4	4	4	9	10	8
12	Turbine Generator No.5	527	4	4	4	9	10	8
13	Turbine Generator No.6	511	3	3	3	4	3.6	3.3
14	Turbine Generator No.7	550	5.6	5.8	5.8	6	7	7

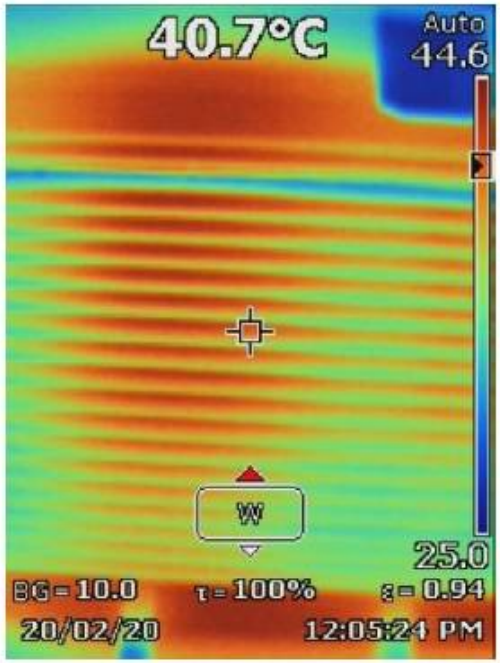
THERMOGRAPHY OF ELECTRIC MOTORS AT SHEIKHOO SUGAR MILLS

IR SCAN OF SELECTED MOTORS

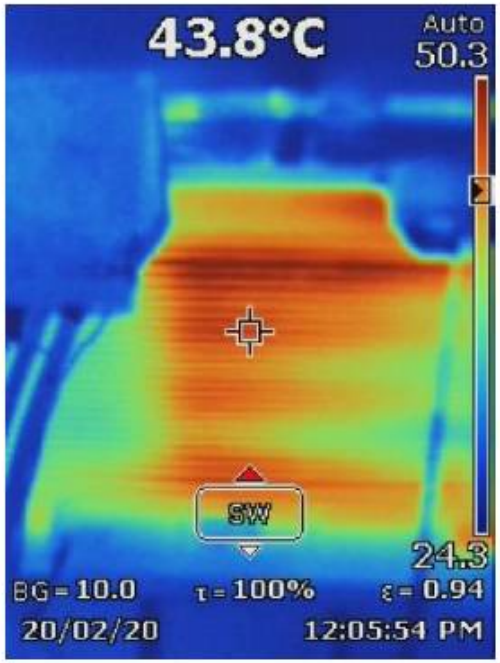
Infrared (IR) scanning is an effective method of determining the condition of insulation and connection. As a rule, a 10° C increase in the operating temperature above the allowed maximum can cut the motor's insulation life expectancy in half.



Mill Motor No.4



Mill Motor No.6



Mill Motor No.7

SHORT CIRCUIT CURRENT ANALYSIS OF SHEIKHOO SUGAR MILLS

SHORT CIRCUIT CURRENT ANALYSIS OF TRANSFORMERS

A Short Circuit current analysis is used to determine the magnitude of the short circuit current which the system is capable of producing and compares the magnitude of the short circuit current with the interrupting rating of the over current protective devices. The short Circuit fault current of transformers can be calculated from the relation given below:

$$I_{(fault)} = S_{(kVA)} \times 100 / (1.732 \times V_{(sec)} \times \%Z)$$

OR

$$I_{(fault)} = (100 / \%Z) * I_{(sec)} / (1000)$$

Where

$I_{(fault)}$ = Short Circuit Current in KA

$S_{(kVA)}$ = Transformer Rating in KVA

$V_{(sec)}$ = Transformer Secondary Voltage

$I_{(sec)}$ = Transformer Secondary Current

%Z = Percentage Impedance

SHORT CIRCUIT CURRENT ANALYSIS OF SHEIKHOO SUGAR MILLS

SHORT CIRCUIT FAULT CURRENT OF TRANSFORMERS

Sr. No.	TRANSFORMER	Rating	Pri. Rated Current	Sec. Rated Current	Pri. Rated Voltage	Sec. Rated Voltage	Impedance	S.C. Fault Current	Breaking Cap.
		KVA	A	A	V	V	%	KA	KA
1	Mill House	2500	219	3478	6600	415	6	**57.969**	**85**
2	Conti- Centrifugal SS No. 05	4000	350	5565	6600	415	7	**79.500**	**100**
3	Refine Centrifugal SS No. 05A	2000	175	2782	6600	415	6	**46.375**	**85**
4	Mill Motor No. 01 1500 KW	2500	219	2092	6600	690	6	**34.865**	**70**
5	Mill Motor No. 03 1350 KW	2200	192	1841	6600	690	6	**30.681**	**70**
6	Mill Motor No. 07 1800 KW	3000	262	2510	6600	690	7	**35.861**	**70**
7	Transformer Imp / Exp	5000	262	437	11000	6600	7	**6.249**	**25**
8	**Transformer Imp / Exp**	40000	2100	3499	11000	6600	10	**34.992**	**40**

SHORT CIRCUIT CURRENT ANALYSIS OF SHEIKHOO SUGAR MILLS

SHORT CIRCUIT CURRENT ANALYSIS OF ALTERNATORS

The short Circuit fault current of Alternators can be calculated from the relation given below:

$I_{(fault)}$ = Rated Current of Alternator / Sub-transient Reactance

SHORT CIRCUIT FAULT CURRENT OF ALTERNATORS

Sr. No.	ALTERNATOR	Rating	Rated Current	Rated Voltage	XD"	S.C. Fault Current	Breaking Cap.
		KVA	A	V	%	KA	KA
1	T G No. 01	3750	328	6600	10	**3.280**	**25**
2	T G No. 04	7500	656	6600	10	**6.560**	**25**
3	T G No. 07	27500	1443	11000	10	**14.430**	**40**
4	T G No. 08	37500	1968	11000	10	**19.680**	**40**

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

AUTO POWER SHARING & SYNC. OF ALTERNATORS

- Auto Power sharing & Synchronizing of all the Alternators is done through power sharing Controllers.

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

AUTO POWER SHARING & SYNC. OF ALTERNATORS

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

AUTO POWER SHARING & SYNC. OF ALTERNATORS

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

40 MVA 11/6.6 KV POWER TRANSFORMER

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

40 MVA 11/6.6 KV POWER TRANSFORMER

- This Transformer is used because the voltage level of HP & LP Power House is 11KV and 6.6 KV respectively.
- The vector Group of the Transformer is YNyn0.
- This Transformer is specially designed to Import Power from HP Power House to LP Power House, Export Power from LP Power House to HP Power House and also Synchronize both Power House
- The 11 KV Star point and also the 6.6 KV star point are Grounded through their dedicated NGR.
- The MV BTD (Duct Material SS) is used instead of Power Cables at 6.6 KV side of the Transformer
- The MV BTD is also used for the Distribution of Load across the out going feeders

DEVELOPMENT IN POWER SYSTEM OF SHEIKHOO SUGAR MILLS

BTD FOR LOAD DISTRIBUTION AT OUTGOING FEEDERS

IMPROVEMENT TECHNIQUES

- The Voltage unbalance should not exceed the limit of **1%**
- According to NEC recommendation, The combined Voltage drop of Feeder and branch circuit should not exceed **5%** of the source voltage.
- According to IEEE, The %THD V should not exceed **8%** and the %THD I should not exceed **15%.** The harmonic filters should be installed in case of higher harmonics level.
- Motors performance analysis should be performed to ensure that the running load of motor is with in **50% ~ 100%** of the rated power.
- A rewound motor consumes more energy as compared to the normal motor. Each rewinding decreases the motor efficiency from **2% ~ 5%.**
- The damaged motor should be replaced with the new efficient motor if the rewinding cost is more than the **40%** cost of new motor. But the calculation of cost and saving must be done before replacing such motors.

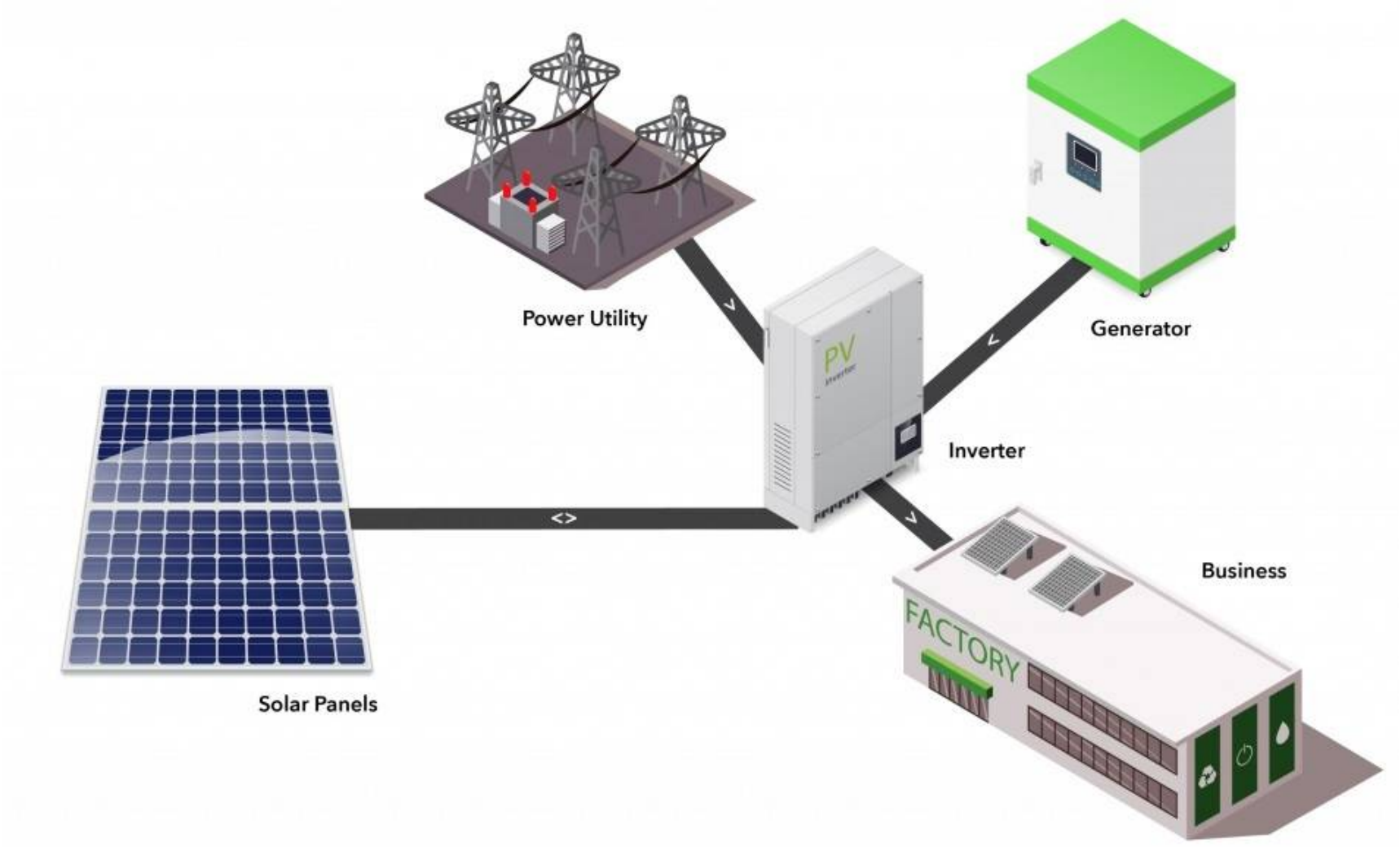
SOLAR POWER GENERATION

TYPES OF SOLAR POWER GENERATION SYSTEM

- ON GRID / GRID TIED SOLAR SYSTEM
- OFF GRID SOLAR SYSTEM
- HYBRID SOLAR SYSTEM

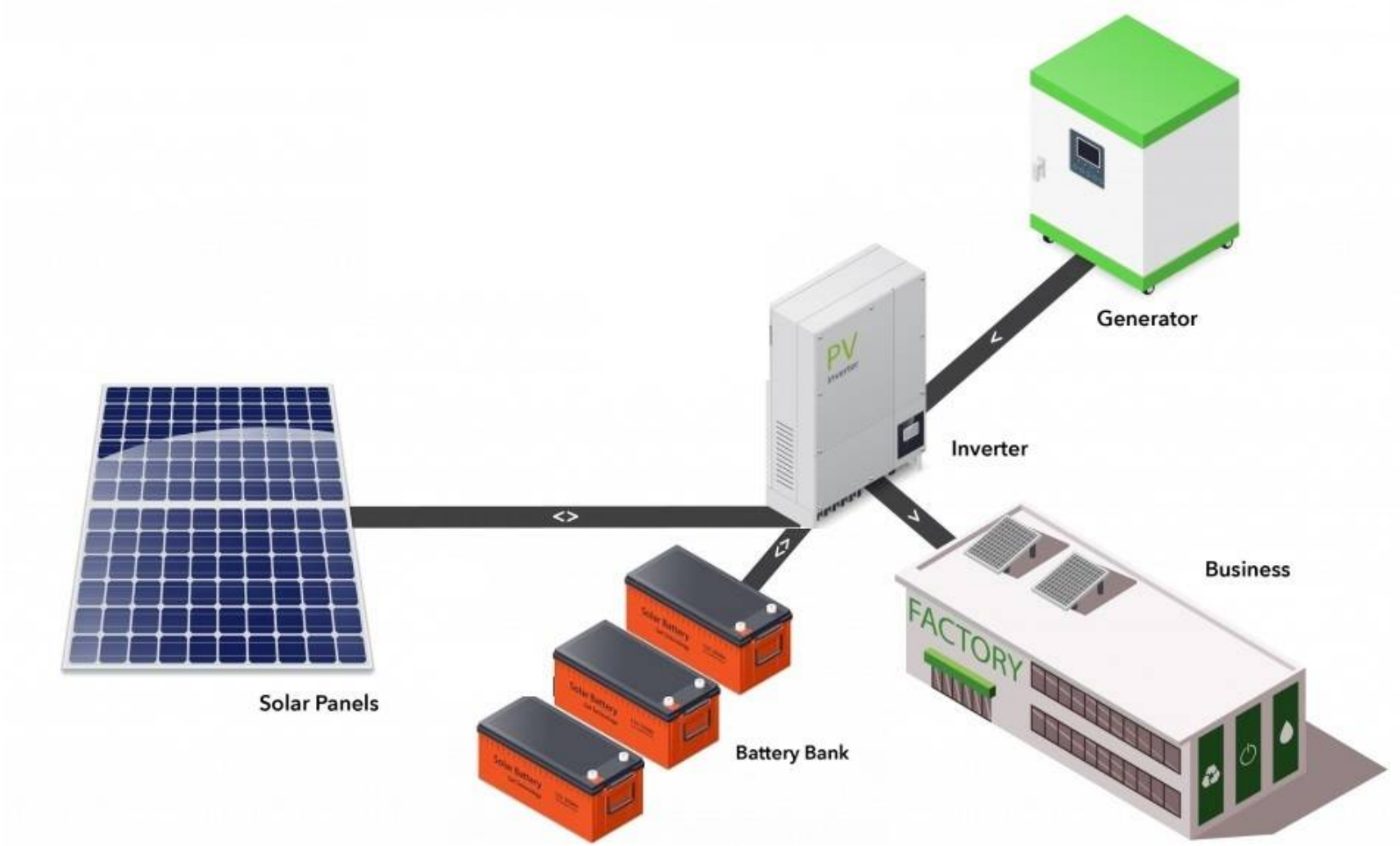
TYPES OF SOLAR POWER SYSTEMS

ON GRID / GRID TIED SOLAR SYSTEM



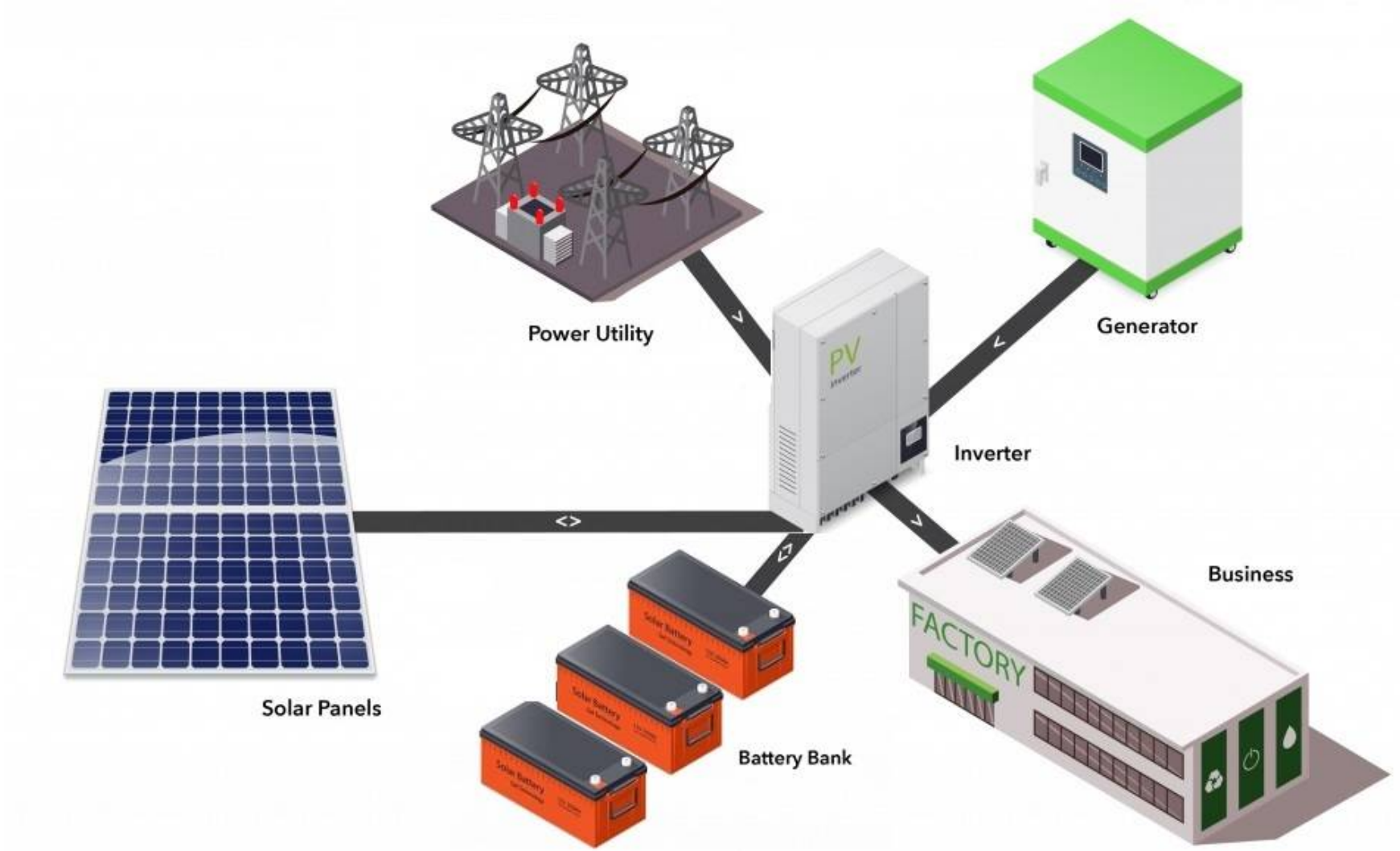
TYPES OF SOLAR POWER SYSTEMS

OFF GRID SOLAR SYSTEM



TYPES OF SOLAR POWER SYSTEMS

HYBRID SOLAR SYSTEM



DETAIL OF MEPCO BILLING

MEPCO TARIFF FOR INDUSTRIAL CONSUMERS & BILL FOR THE MONTH OF AUGUST 2022

Total KWH	Rate of OFF Peak KWH (PKR)	Rate of Peak KWH (PKR)	Total Cost incl. Tax without FPA (PKR)	Avg. Per Unit cost without FPA (PKR)	Total Cost of FPA @ 9.8972+2.3830= 12.2802/KWH (PKR)	Avg. Per Unit cost with FPA @ 12.2802 (PKR)
163,836	23.5875	29.2975	5,915,436.00	36.11	2,011,938.85	48.39

COST OF ON GRID SOLAR SYSTEM AND PAYBACK PERIOD

COST OF ON GRID SOLAR SYSTEM WITH AVG. GENERATION & PAY BACK PERIOD

Sr. No.	Per WATT Cost of ON GRID Soalr System PKR.	Cost of 500 KW ON GRID Soalr System	Avg. KWH per Year	Rate of Per Unit PKR	Avg. Saving per Year PKR	Pay back Period Years
1	110	55,000,000	675,250	45.00	27,386,250	2.01
2	110	55,000,000	675,250	36.11	21,383,278	2.57
3			670,523	37.92	22,423,224	
4			665,830	39.81	23,507,525	
5			661,169	41.80	24,638,071	
6			656,541	43.89	25,816,834	

BENEFITS AND LIMITATIONS OF SOLAR POWER GENERATION

BENEFITS	LIMITATIONS
RENEWABLE ENERGY SOURCE	HIGH INITIAL COST
REDUCE ELECTRICITY BILL	WEATHER DEPENDANT
DIVERSE APPLICATION	SOLAR ENERGY STORAGE IS EXPENSIVE
LOW MAINTENANCE COST	REQUIRED LOT OF SPACE
INDEPENDENCY FROM UTILITY	

CONCLUSION

- The Auto power sharing of Alternators gives the flexibility to share the power among alternators as per our requirement. The real time monitoring of parameters and trends give the complete information about the behavior of system.
- The continuous, Safe & reliable electrical power is ensured at all time by maintaining the power quality.
- The use of advanced techniques, efficient equipment, optimized utilization of energy can further improves & Saves the Power system.
- The Solar Power is the source of green & clean power which has no carbon emission and reduce the electricity bill from utility during the off season of sugar mills.

SHEIKHOO SUGAR

PSST

IN SERVICE OF THE NATION

PAKISTAN SOCIETY OF SUGAR TECHNOLOGISTS

Thank You