Technical Guide
Benefits of Power Factor Improvement

Small and Medium Enterprises Development Authority

Ministry of Industries & Production
Government of Pakistan

www.smeda.org.pk

HEAD OFFICE
4th Floor, Building No. 3, Aiwan-e-Iqbal Complex, Egerton Road,Lahore
Tel:(92 42)111 111 456, Fax:(92 42) 36304926-7
helpdesk@smeda.org.pk

REGIONAL OFFICE PUNJAB	REGIONAL OFFICE SINDH	REGIONAL OFFICE KHYBER PAKHTUNKHWA	REGIONAL OFFICE BALOCHISTAN
3rdFloor, Building No. 3, Aiwan-e-Iqbal Complex, Egerton Road Lahore, Tel: (042) 111-111-456 Fax: (042) 36304926-7 helpdesk.punjab@smeda.org.pk	5TH Floor, Bahria Complex II, M.T. Khan Road, Karachi. Tel: (021) 111-111-456 Fax: (021) 5610572 helpdesk-khi@smeda.org.pk	Ground Floor State Life Building The Mall, Peshawar. Tel: (091) 9213046-47 Fax: (091) 286908 helpdesk-pew@smeda.org.pk	Bungalow No. 15-A Chaman Housing Scheme Airport Road, Quetta. Tel: (081) 831623, 831702 Fax: (081) 831922 helpdesk-qta@smeda.org.pk

Table of Contents

1 Disclaimer

This information memorandum is to introduce the subject matter and provide a general idea and information on the said matter. Although, the material included in this document is based on data/information gathered from various reliable sources; however, it is based upon certain assumptions, which may differ from case to case. The information has been provided on AS IS WHERE IS basis without any warranties or assertions as to the correctness or soundness thereof. Although, due care and diligence has been taken to compile this document, the contained information may vary due to any change in any of the concerned factors, and the actual results may differ substantially from the presented information. SMEDA, its employees or agents do not assume any liability for any financial or other loss resulting from this memorandum in consequence of undertaking this activity. The contained information does not preclude any further professional advice. The prospective user of this memorandum is encouraged to carry out additional diligence and gather any information which is necessary for making an informed decision, including taking professional advice from a qualified consultant/technical expert before taking any decision to act upon the information.

For more information on services offered by SMEDA, please contact our website: www.smeda.org

2 Introduction to SMEDA

The Small and Medium Enterprises Development Authority (SMEDA) was established in October 1998 with an objective to provide fresh impetus to the economy through development of Small and Medium Enterprises (SMEs).

With a mission "to assist in Employment Generation and Value Addition to the national income, through development of SME sectors, by helping increase the number, scale and competitiveness of SMEs", SMEDA has carried out 'sectoral research' to identify Policy, Access to Finance, Business Development Services, strategic initiatives and institutional collaboration & networking initiatives.

Preparation and dissemination of prefeasibility studies in key areas of investment has been a successful hallmark of SME facilitation by SMEDA.

Concurrent to the prefeasibility studies, a broad spectrum of Business Development Services is also offered to the SMEs by SMEDA. These services include identification of experts and consultants and delivery of need-based capacity building programs of different types in addition to business guidance through help desk services.

2.1 Industry Support Program

In order to enhance competitiveness of SMEs and achieve operational excellence, SMEDA established an Industry Support Cell (ISC) for provision of foreign technical support and knowledge transfer in collaboration with International Development Organizations. SMEDA's Industry Support Program (ISP) initially launched with Japan International Cooperation Agency (JICA) and actively engaged in reducing energy inefficiencies and improving production and quality of products with the support of Japanese Experts. Later on, similar activities with other international partner organizations like German Corporation for International Cooperation (GIZ), Training and Development Centers of the Bavarian Employers' Association (bfz), Germany, and United Nations Industrial Development Organization (UNIDO) were also successfully implemented.

3 Power Factor Improvement

Power factor improvement can be defined as

"The Techniques/Methods to improve the power factor of the electrical system"

Power factor improvement is done in order to avoid low power factor penalty from utility (WAPDA in our case). Low power factor penalty is charged when the power factor of the system is less than 90 % (0.90).

4 Benefits of Power Factor Improvement

Electrical distribution systems are designed to carry a certain amount of current without overloading. Too much current causes excessive resistive losses in electric elements and can result in overheating and voltage drop. If the reactive power of a load with poor power factor is not compensated locally, the reactive power needs to be supplied from the power source. To maximize the capacity of power network, transfer of reactive power should be kept at the minimum.

Power Factor should be improved for a number of reasons. Some of these reasons are financial while others are related to system efficiency. We will discuss some of these reasons below

4.1 Lower Utility Bills

4.1.1 Reducing Peak kW Billing Demand

As we know that low power factor is due to higher inductive loads (Transformers, induction motors, induction generators, high intensity discharge (HID) lighting etc) and high inductive loads require higher reactive power (kVAR). This increase in kVAR results in higher apparent power (KVA) demand which is supplied by the utility.

A low power factor facility causes the utility to increase its generation and transmission capacity in order to handle the extra demand due to high inductive loads

By increasing your power factor, you use less kVAR and this results in less kW, which equates to money savings from the utility

4.1.2 Eliminating Low Power Factor Penalty

Utilities usually charge customers an additional fee / penalty when their power factor is less than 90% (0.90). Thus by improving power factor this additional penalty can be avoided and money can be saved

4.2 Increased system capacity and reduced system losses

By improving power factor, the kVAR value of the system is decreased which results in increased kW capacity of the system

As we know that

$$Apparent\ Power = \sqrt{ActivePower^2 + ReactivePower^2}$$

Simply

$$kVA = \sqrt{kW^2 + kVAR^2}$$

For Example, a 1000 kVA transformer with an 80% power factor provides 800 kW. Now the kVAR value can be calculated with the help of above equation

$$1000\ kVA = \sqrt{(800kW)^2 + (?\,kVAR)^2}$$

$$kVAR = 600$$

Now if the power factor is improved to 90%, more kW (900 kW) can be supplied for the same amount of kVA as calculated below

$$1000\ kVA = \sqrt{(900kW)^2 + (?\,kVAR)^2}$$

$$kVAR = 436$$

The kW value of the system increases to 900 kW and the utility supplies only 436 kVAR

In short we can say that lower power factor causes power losses in the electrical distribution system. By improving the power factor, these losses can be reduced and we can add more load to the existing system and system efficiency can be improved

4.3 Improved voltage level

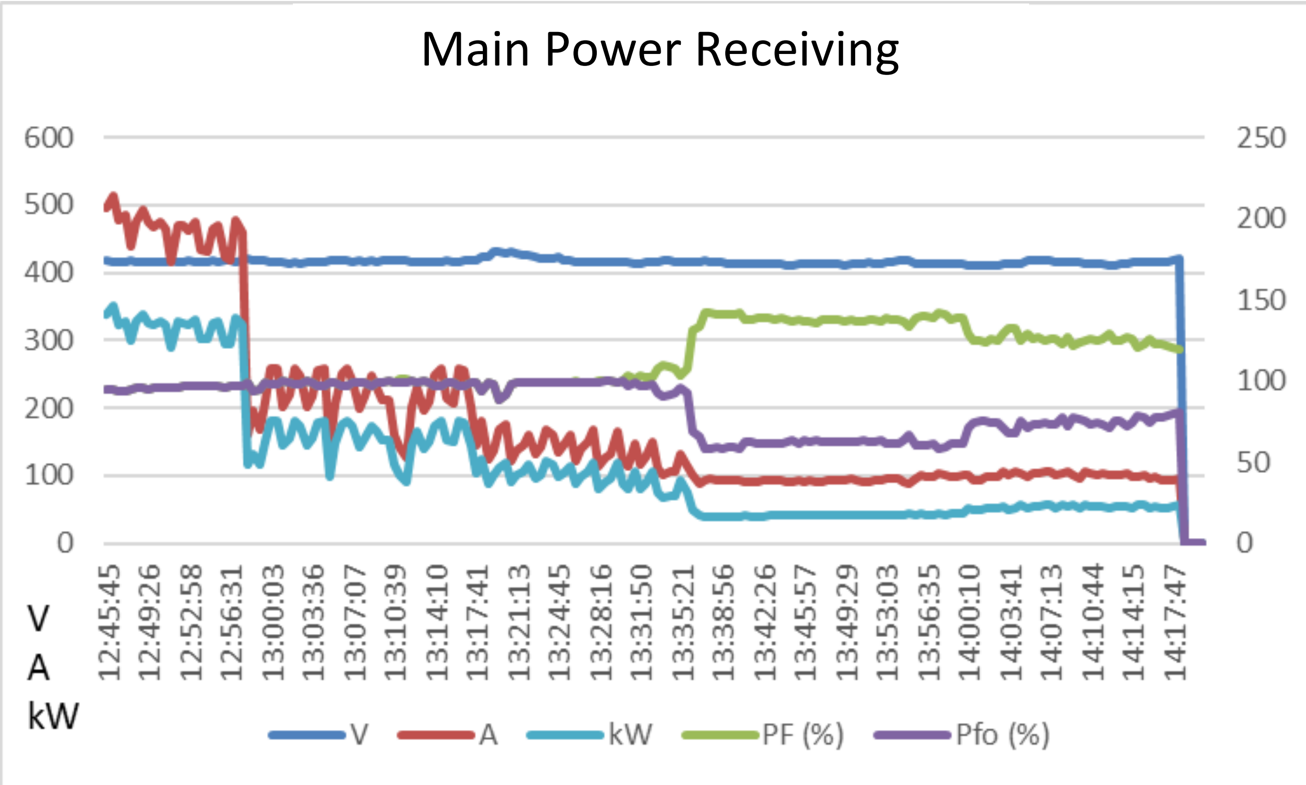
A low power factor causes a higher current flow for a given load. As the line current increases, the voltage drop in the conductor increases, which may result in lower voltage at the equipment. With improved power factor, the voltage drop in the conductor is reduced, improving the voltage at the equipment.

As mentioned above, lower power factor causes system losses. As power losses increase, you may experience voltage drops. Excessive voltage drops can cause overheating and premature failure of motors and other equipment.

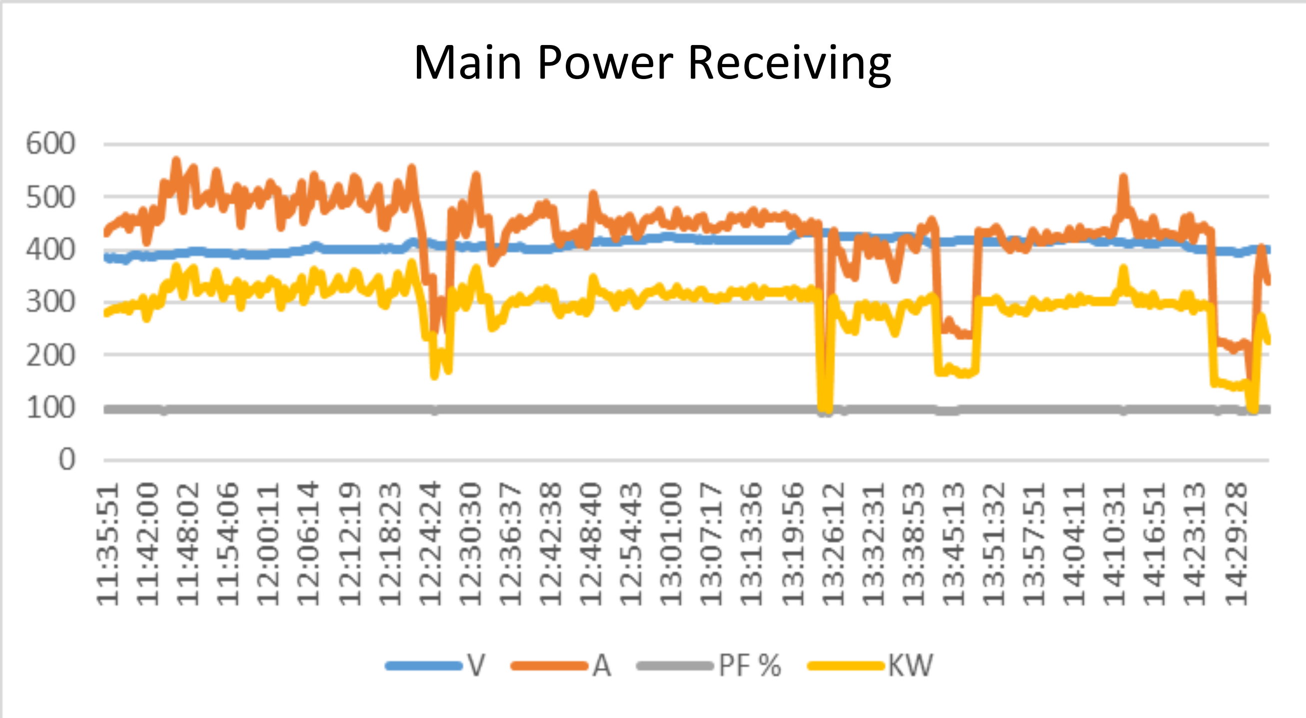
Thus, by improving the power factor, these voltage drops can be minimized and motors will run cooler and will be more efficient, with a slight increase in capacity and starting torque.

5 Case Study

In Base Line Energy Audit of a factory, power factor was leading on low load since automatic power factor controller was not working properly. (PF is shown more than 100 % (Highlighted in yellow)) Average power factor (Pfo) was 83.7%, low. The factory replaced the controller and set parameters properly. Power factor value was confirmed appropriate later on



Data until 14:18:17					Sampling time :30se	
	V	A	PF (%)	Pfo (%)	kW	ThdV L3 (%)
MAX	431.6	513.6	142.1	100.0	350.1	5.4
MIN	410.5	89.4	88.7	57.9	39.1	2.0
AVERAGE	416.3	178.4	114.1	83.7	115.5	3.5



	V	A	PF %	KW	Thd%V L3
MAX	433	571.1	97.4	377.2	4.98
MIN	380.2	144.5	90.1	97.5	1.73
AVG	409.1	430.5	96.1	292.8	3.66

6 Conclusion

CEO / Owner of every factory should check PF value and Low Power Factor Penalty in electricity bill of each month because most of them are unaware of the fact that they are paying extra rupees in terms of low power factor penalty. If they find any low power factor penalty in their electricity bills then either their PF improvement panel is not working properly or they have an undersized PF improvement panel.

Furthermore, a factory CEO / Owner can enjoy following benefits by power factor improvement and continuous monitoring of power factor

- ✓ Lower utility bill by reducing peak kW billing demand
- ✓ Lower utility bill by eliminating low power factor penalty

- ✓ Improved system capacity
- ✓ Reduced system losses
- ✓ Improved system voltage