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312 Rising Sun Rd.  
Bordentown, NJ 08505

phone: 800-742-5695  
fax: 609-298-1982

e-mail: [sales.caps@nwl.com](mailto:sales.caps@nwl.com)  
[www.nwl.com](http://www.nwl.com)

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# **Switch Mode Power Supplies for Electrostatic Precipitators Technology and Supplier Capabilities**

**David Seitz and Helmut Herder  
NWL Inc. Bordentown, NJ**

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## Introduction

Switch Mode Power Supplies (SMPS) have shown considerable promises in many electrostatic precipitator applications. SMPS has been applied to many different ESP applications, including coal-fired boilers producing low and high resistivity fly ash, wood fired boilers, and Wet ESP's. Many installations have shown significant improvements in Precipitator performance.

SMPS units also offer a smaller; lighter, integrated package that reduces installation and support costs. In addition, the improved power factor means that less KVA must be provided to a SMPS than a conventional (50/60Hertz) power supply in order to put the same power into a precipitator field.

The reliability standard for ESP power systems is very high. The conventional (50/ 60 Hertz) technology is robust and well proven, and the industry expects the same from the advanced switch mode technology. Some of the early SMPS units have come up short in this respect, and have not performed as reliably as desired.

Because of this early experience ESP suppliers and users are raising legitimate questions concerning the expected long-term reliability of switch mode power supplies.

Two questions need to be answered.

- 1) Is the underlying technology of SMPS well proven and capable of performing reliably in ESP applications?
- 2) What capabilities should a manufacturer have in order to design and manufacture reliable and cost effective units?

### Is the technology up to the task?

For many years linear 50/60 Hertz power supplies below 20kW, have no longer been available; only switch mode units are offered in that power range. A number of different circuit topologies-hard switched, resonant, current fed- are all commonly used, with the choice being determined by the application.

In recent years SMPS units have been moving into higher power (>20kW) applications, as cost effective Integrated Gate Bipolar Transistors (IGBT) have now become available at higher current ratings. Major motor drive manufacturers are now using IGBTs with ratings as high as 6500 Volts @ 1200 Amps, which is substantially higher than the power requirements for ESP power supplies.

In addition high power high voltage switch mode power supplies have been developed for specialized applications for the military and government research organizations.

Based on the wide range of use, it is safe to say that switch mode technology is widely accepted, and very capable of performing reliably in almost any industrial application. The challenge then is for manufacturers to develop cost effective products for ESP applications.

**Based on the number of vendors offering switch mode power supply products, for all types of applications, it is safe to say that the underlying technology is well proven.**

### What capabilities does a manufacturer need?

There are numerous examples of innovative companies that can bring new products to the market, but lack the necessary competencies to be a long-term supplier of a reliable and cost effective product. Under these circumstances what criteria should be used to evaluate the true capabilities of a SMPS supplier?

Since the earliest days of the industry the ESP power supply system was split into major components – Transformer/Rectifier, Current Limiting Reactor, Voltage Control and Switch Gear Cabinet. These were purchased from individual vendors who specialized in one or perhaps two of the components, as very few suppliers were competent and price competitive in supplying all of the major power system components.

In this environment the integration of the complete power system was the responsibility of the ESP supplier. For upgrades and support, users could and did purchase individual components, and thus took on the systems integration role for themselves. This approach is still the standard mode of operation.

Switch mode power supplies introduce a much different situation. The power supply is now one integrated system incorporating all of the required elements from incoming switch-gear to the high voltage output bushing. The power supply control must now be an integrated part of the system.

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It is well accepted within the power supply industry that successful power supply manufacturing companies must be competent at the design and production of the key components listed below.

#### Power Electronics Circuitry

The manufacturer must have knowledge of and experience with various circuit topologies as well as an understanding of the proper application and sizing of power semiconductor devices including the required capacitors and inductors. The company must have good sources for parts that are commonly required in the power supply.

#### Magnetics

The high frequency transformers required in SMPS units are much more sophisticated than their 50/60-Hertz equivalents. The high voltage step-up transformer is the largest and most expensive component in a SMPS unit for ESP applications. It is a significant technical challenge to design and build cost effective and reliable transformers for high frequency, high voltage applications. Competency and experience in this area is essential.

#### Enclosures and Packaging

High power outdoor power supply applications require creative industrial packaging solutions to fit many critical components into a small envelope and still properly dissipate the heat losses. The enclosures will need to be specially engineered to tightly integrate with the overall system design and to protect all components from dirt and moisture. To do this effectively, the supplier must have advanced in-house design and manufacturing capabilities.

#### Controls

Since the controls are now an integral part of the power supply the manufacture must have experience with and knowledge of the control functions needed to optimize ESP performance.

#### Conclusion

Electrostatic precipitator suppliers and users should recognize that the switchmode power supply technology offers many advantages in the operation of ESP's. They should however make sure that they work with a qualified supplier that possesses most of the necessary elements as internal core competencies. If too many of the key elements are out sourced, cost and reliability will likely suffer.