INFOGRAPHIC

ADVANCING HYBRID POWER FACTOR CORRECTION

PEAK NANOPLEX FILM INTEGRATED CAPACITORS ENABLE MODERN HYBRID PFC

HIGHER
EFFICIENCY

MODULAR
SCALABILITY

POWER FACTOR CORRECTION (PFC)

IMPROVING ENERGY SYSTEM EFFICIENCY AND STABILITY

Power factor (PF) measures how efficiently electrical power is used and Power Factor Correction (PFC) is a technique used in electrical systems to improve energy efficiency and stability.

POWER FACTOR (PF)

- **Real Power (kW):** Power actually used by equipment.
- **Reactive Power (kVAR):** Power drawn by equipment but not actually consumed.
- **Apparent Power (kVA):** Combination of real and reactive power.

$$\text{Power Factor} = \frac{(\text{Real Power (kW)})}{(\text{Apparent Power (kVA)})}$$

POWER FACTOR CORRECTION (PFC)

- **Adjusting and minimizing the difference between the apparent power** (the total power supplied to a circuit) and the **real power** (the actual power consumed by the circuit).
- Commonly **implemented using capacitors.**

OUTCOMES

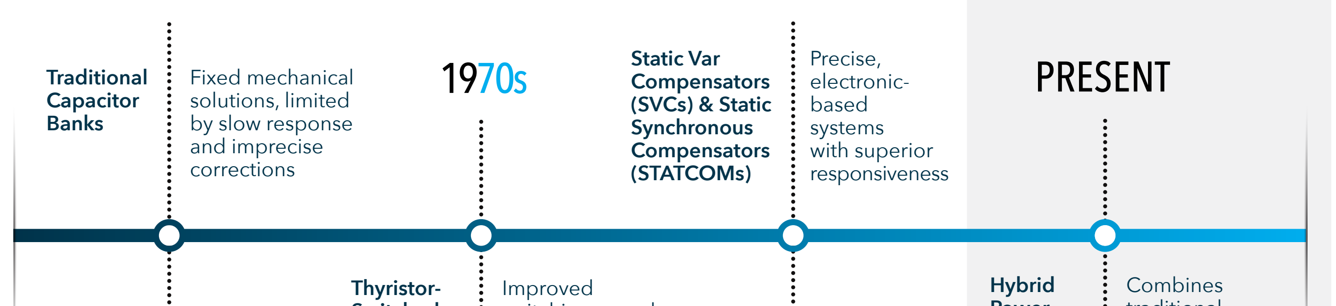
- **Reduced electricity bills** due to fewer reactive power charges.
- **Improved system capacity,** allowing more equipment to run without upgrading infrastructure.
- **Lower system losses,** enhancing efficiency and reducing wear on equipment.
- **Stable voltage levels,** improving equipment lifespan and reliability.
- **Enhanced environmental sustainability,** decreasing overall energy consumption.

79%
SURGE
IN POWER DEMAND

HYBRID POWER FACTORING SYSTEMS

THE LATEST EVOLUTION OF POWER FACTORING TECHNOLOGY

Power factoring technology has evolved to support increasingly complex and dynamic power systems, and must continue to evolve to address the 79% surge in power demand driven by AI, EVs, expanding populations, and economic growth.



Hybrid systems represent the latest evolution of Power Factoring technology. These systems rely on a combination of two main components to manage load conditions, **reduce harmonic distortion, and improve voltage stability:**

THYRISTOR SWITCHED CAPACITORS (TSCs)	STATIC VAR GENERATOR (SVGs)
Provides large-scale, step-wise reactive power compensation.	Handles smaller, continuous adjustments and harmonic filtering.

Hybrid power factoring systems improve energy efficiency, power quality, and equipment protection by minimizing reactive power, leading to reduced costs and increased system capacity.

These systems are relied on to maintain power quality, and are fundamental for integrating renewable and distributed energy resources while adhering to evolving interconnection standards.

RELIABLE
SYSTEM
PERFORMANCE

CAPACITORS AND HYBRID POWER FACTORING SYSTEMS

ESSENTIAL FOR RELIABLE SYSTEM PERFORMANCE

Capacitors play an indispensable role in hybrid power factoring systems by combining the strengths of traditional passive power factor correction methods with advanced active compensation capabilities.

CAPACITOR ENABLED CAPABILITIES

Reactive Power Compensation
Supplies necessary reactive power for optimal grid efficiency

Energy Efficiency
Minimizes energy losses by reducing unnecessary reactive power flow

System Capacity Enhancement
Free up capacity in the electrical system by reducing reactive power flow

Renewable Energy
Helps manage variability and fluctuations inherent in renewable sources

Voltage Stability
Maintains stable and consistent voltage, protecting equipment from fluctuations

Cost-Effectiveness
Cost-effective solution for large-scale reactive power compensation

Capacitors are critical to enabling hybrid power factoring systems to adapt to growing demands from renewable energy, energy storage, and smart grid technologies–demands intensified by increasing electrification, decentralization, decarbonization, digitalization, and AI.

Next-generation capacitor technologies are essential to support grid modernization efforts.

MEET
PERFORMANCE
DEMANDS

CHALLENGES WITH TRADITIONAL CAPACITORS (BOPP)

TRADITIONAL CAPACITORS HINDER HYBRID PFC MODERNIZATION

BOPP film limitations suggest that future hybrid power factoring systems may increasingly rely on advanced materials and technologies to meet performance demands.

BOPP LIMITATIONS

Temperature Constraints
BOPP films struggle above 105°C due to increased conduction losses

Permittivity Constraints
Higher permittivity demands extensive fillers, weakening electric and mechanical performance

Emerging Competition
Advanced hybrid systems using SVGs and thyristor capacitors increasingly outperform traditional BOPP solutions

Structural Integrity Issues
Silica agglomerates cause weak points, reducing reliability under stress

Energy Density Needs
Advanced applications require materials exceeding BOPP's limited energy storage capabilities

Regulatory Pressures
Stricter regulations could drive up production costs for improved BOPP materials

Hybrid PFC advancement requires high-voltage capacitors that last longer and store more energy at higher temperatures.

By integrating advanced, next-generation films into capacitors, capacitor manufacturers can address the urgent market demand for modern hybrid PFC.

UP TO
50%
SMALLER
AND LIGHTER

HYBRID PFC REQUIRES NEXT-GENERATION CAPACITORS

PEAK NANOPLEX FILMS SIGNIFICANTLY ENHANCE CAPACITOR PERFORMANCE FOR MODERN HYBRID PFC

Peak NanoPlex films enable breakthroughs in capacitor technology, providing enhanced thermal stability, superior energy density, and greater durability compared to traditional BOPP capacitors.

ADVANTAGES OF NANOPLEX FILM VS. BOPP

Higher Energy Storage	Nanolayered technology enables up to **4x more energy storage**
Reduced Footprint	Capacitors up to 50% smaller and lighter, **enhancing efficiency** and **reducing impedance**
Longer Lifespan	High durability enables capacitor **lifespan up to 5x longer**
Higher Duty Cycles	**3-5x higher duty cycles,** ideal for high-performance applications
Superior Temperature Tolerance	Withstands **temperatures up to 135 °C, exceeding BOPP by 30°C+**
Bill of Materials (BOM) Savings	Significant cost advantages, enabling capacitor manufacturers to **cut BOM costs in half**
US-made, 20+ global patents	Manufacturers exposed to **supply chain vulnerabilities** with ~80% of BOPP film production concentrated in China

Capacitors featuring NanoPlex film technologies enable Hybrid PFC systems to address the stringent requirements of grid modernization.

ADVANTAGES OF NANOPLEX INTEGRATED HYBRID PFC

Switching Reliability
Consistent performance in high-frequency environments

Thermal Resilience
Extended life in dynamic operating conditions

Compact Performance
High energy density with low ESR

Load Responsiveness
Fast reaction to shifting power demands

Power Factor Control
Sustains high power factor in real time

System Flexibility
Adapts to compact & passive PFC configurations

NanoPlex film integrated capacitors enable hybrid PFC systems with greater energy in a compact footprint, reducing installation costs, enhancing reliability, extending lifespan, and delivering consistent performance in demanding grid conditions.

By integrating NanoPlex film enabled capacitors, grid operators can support the delivery of smaller, more efficient, and more reliable correction systems with extended operational life, even in rapidly changing conditions.

Peak NanoPlex film empowers Hybrid PFC systems to meet the demands of tomorrow's energy systems.

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