

WHITE PAPER

Comparative Analysis

Trane HVAC Sustainability Solutions and TransPower Company's Power Management Controls System (MPTS)

Prepared for HVAC Sustainable Solutions

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White paper comparing Trane's HVAC Sustainability Solutions with TransPower Company's Power Management Controls System (MPTS), tailored for technical and executive audiences:

Executive Summary

In an era of rising energy costs, carbon regulations, and grid instability, building operators are increasingly pursuing integrated energy solutions that address both thermal and electrical inefficiencies. Two noteworthy solutions in this space are:

- Trane HVAC Sustainability Solutions:

Comprehensive systems targeting heating, ventilation, and air conditioning performance, decarbonization, and comfort.

- TransPower Company's MPTS (Power Management Controls System):

An advanced power quality and energy optimization platform that reduces electrical waste, improves system reliability, and lowers operational costs.

This white paper compares the strengths, limitations, and integration potential of both technologies.

The goal is to inform facility managers, energy consultants, and sustainability professionals on how to make informed decisions that align with both carbon goals and ROI expectations.

2. Overview of Each System

Trane HVAC Sustainability Solutions

Trane is a global leader in HVAC innovation, offering a suite of sustainability-oriented solutions including:

- High-efficiency HVAC equipment (e.g., magnetic bearing chillers)
- Building automation systems (Tracer SC+, Ensemble)
- Thermal energy storage and demand response
- Electrification and decarbonization services
- Low-GWP refrigerants

These solutions optimize HVAC energy use, reduce environmental impact, and improve indoor environmental quality.

TransPower Company's MPTS

The MPTS (Managed Power Technology System) is a non-invasive, panel-mounted control system designed to:

- Improve power factor
- Reduce harmonic distortion
- Arrest Surges and Spikes
- Capture Transient Voltages
- Lower kW demand and reactive power
- Reduce waste heat from motors, compressors, and transformers

By continuously correcting electrical anomalies in real-time, MPTS reduces energy costs, extends equipment life, releases electrical capacity, and enhances grid compatibility.

3. Comparative Analysis

Category	Trane HVAC Solutions	TransPower MPTS
Core Focus	HVAC energy efficiency, comfort, decarbonization	Electrical system optimization, power quality, waste heat reduction
Technology Platform	HVAC systems, BAS, VAVs, chillers, refrigerant management	Real-time electrical Power Management Controls, Harmonic Mitigation, & Power Factor Improvement to 0.98
Energy Savings Potential	20–40% (HVAC-specific)	5–15% (whole-building electrical energy)
Heat Reduction	Lower compressor load and chilled water temperature	Reduces heat from motors, transformers—secondary HVAC load impact
ROI	5–10 years (depending on equipment and scope)	1–3 years (especially in motor, compressor-dense facilities)
Carbon Impact	Direct reduction via electrification and refrigerants	Minimizing wasted electrical losses due to inefficiencies and reducing generation demand
Maintenance Requirement	High (mechanical systems)	Low (no moving parts, diagnostics via dashboard)
Installation Type	Mechanical retrofits or new construction	Electrical panel retrofit (non-invasive)
Grid Support	Demand response, thermal storage	Power factor improvement, harmonics mitigation, peak demand lowering, arresting Surges, Spikes and removing transients
Investment Cost	Very High	Very Low
Life	15 to 30 years	30 plus years

4. Use Case Scenarios

Facility Type	Trane HVAC Advantage	TransPower MPTS Advantage
Hospitals	Clean air, decarbonized heating/cooling	Stabilized power for MRI, HVAC motors, elevators
Data Centers	Precise cooling control	Power quality, UPS load stabilization
Schools	Air quality, comfort during high occupancy	Reduced transformer heating, lower electrical losses
Industrial Sites	Process cooling and air quality	Heavy motor load correction, lower power bills
Commercial Buildings	Tenant comfort, energy visibility	Electrical cost reduction, grid support, billing savings

5. Integration Opportunity

While both systems can function independently, they are highly complementary:

- Trane optimizes thermal systems—chillers, coils, AHUs.
- MPTS optimizes electrical systems—motors, transformers, pumps, fans.

Combined Impact:

- Greater total building energy savings
- Lower peak demand charges
- Reduced HVAC system runtime due to reduced internal heat gain
- Enhanced system reliability and equipment lifespan

Example:

In a facility with air-cooled chillers and 40+ motors (VFDs, pumps, fans), installing MPTS can reduce waste energy from motors, thereby lowering HVAC cooling demand, leading to compound energy savings.

The power quality improvement features of the MPTS will run HVAC equipment efficiently and reliably.

The MPTS Power Management feature will also provide real time electrical diagnostics for predictive preventive maintenance and performance.

6. Financial & Sustainability Incentives

Incentive Type	Trane	TransPower
Utility Rebates	HVAC upgrades, thermal storage, BAS optimization	Power factor correction, kW demand reduction
Carbon Reduction Credits	Yes	Indirect—via energy waste reduction
Federal/ State Programs	IRA, DOE grants, refrigerant transition incentives	State/local EE incentives, industrial efficiency programs
ESCO/ Performance Contracting	Yes	Often bundled for quick-payback ECMs

7. Conclusion & Recommendation

Both Trane HVAC Sustainability Solutions and TransPower's MPTS represent powerful tools in the decarbonization and efficiency toolbox.

Trane is essential for addressing HVAC-related emissions and comfort, while TransPower MPTS delivers measurable electrical efficiency improvements with minimal disruption.

Recommended Strategy:

- Baseline assessment of HVAC and electrical inefficiencies
- Phased implementation starting with high-ROI opportunities (e.g., MPTS in motor-heavy zones)
- Monitoring & verification to capture real-time savings
- Integration with renewables or demand response programs

References

- A: Sample Case Studies
- B: Trane & TransPower Technical Specs
- C: Available Incentives by Region
- D: System Diagrams (Optional)

Additional Information

White Paper

Advanced Harmonic Mitigation

MPTS versus Passive and Active Filters

1. Executive Summary

This paper evaluates the harmonic mitigation performance of the impedance matching technology (MPTS) against conventional passive and active harmonic filters. Harmonic distortion is a growing concern in modern electrical systems, primarily due to nonlinear loads such as VFDs, LED lighting, UPS systems, inverters, electronics, and computing equipment. While traditional filters reduce distortion by targeting specific frequencies or load segments, MPTS offers a holistic, intelligent solution that dynamically suppresses harmonics in real time while simultaneously optimizing voltage, power factor, and load balance. The analysis concludes MPTS delivers superior adaptability, broader harmonic coverage, and a significantly lower total cost of ownership.

2. Introduction

Harmonics are distortions in electrical waveforms caused by nonlinear loads that draw current in abrupt pulses rather than smooth sine waves. The distortions reduce system efficiency, increase heat losses, interfere with sensitive electronics, and trigger penalties and equipment failures. Effective harmonic mitigation is essential for maintaining power quality, reliability, and energy efficiency.

This paper compares three technologies:

- MPTS: An innovative, solid-state platform with real-time harmonic suppression.
- Passive Filters: Tuned L-C networks block or absorb specific harmonic frequencies.
- Active Harmonic Filters: Power electronics-based systems inject inverse harmonics to cancel distortion.

3. Overview of Harmonic Mitigation Technologies

3.1 Maximum Power Transfer Solution (MPTS)

MPTS is a power management control system that offers dynamic harmonic mitigation using high-frequency switching and control logic. It continuously samples current and voltage waveforms, detects harmonic content, and injects counteracting signals to flatten waveform distortions. MPTS covers many harmonic orders (3rd to 55th+) and compensates in real time without needing external filter banks or bypass circuits. It also provides voltage stabilization, power factor correction, and load balancing in a single integrated platform.

3.2 Passive Harmonic Filters (PHFs)

Passive filters are inductors, capacitors, and resistors tuned to absorb specific harmonic frequencies—typically the 5th, 7th, or 11th. They are cost-effective and straightforward, but only effective for predictable, steady-state harmonic content. Their performance drops sharply in dynamic environments or if the load harmonic profile shifts.

3.3 Active Harmonic Filters (AHFs)

AHFs are intelligent electronic devices that measure harmonic content and inject corrective waveforms in real time. They are highly effective across multiple harmonic orders and can adapt to changing load conditions. However, they are expensive, complex, and typically dedicated to specific load segments, limiting their scalability and integration.

4. Feature-by-Feature Comparison: Harmonic Mitigation

Feature	MPTS	Passive Harmonic Filters	Active Harmonic Filters
Harmonic Orders Mitigated	3rd to 50th+ (adaptive)	Fixed (e.g., 5th, 7th)	Wide spectrum (3rd to 50th)
Response Time	Real-time correction	Static (no active correction)	Real-time correction
Load Adaptability	Fully dynamic, high	None	High
System-Level Coverage	Facility-wide (main/sub)	Load-segment only	Usually load-segment only
Integration with PFC/Volt	Yes –fully integrated	No	Sometimes available
Maintenance Requirement	Zero (Passive solid-state)	Moderate	High (power electronics)
Heat Generation	Minimal	Moderate	High
Space Required	Compact	Large passive L-C units	Moderate
Cost (TCO)	Low lifecycle cost	Low upfront, high hidden	High upfront/maintenance

5. Use Case Scenarios

Case 1: Data Center with Sensitive Electronics

A Tier III data center with dozens of UPS systems experienced waveform distortion, causing frequent alarms. Passive filters were ineffective due to variable harmonic content. Post MPTS installed, THD dropped from 13% to <4%, power quality indices stabilized.

Case 2: Industrial Plant with VFDs and Induction Furnaces

Heavy harmonic pollution from VFDs and furnaces led to transformer overheating and motor failures. Active filters were installed on key panels, but only mitigated partial distortion. MPTS provided system-wide mitigation, balancing harmonic content, and eliminating interference across the plant.

Case 3: Commercial Building with LED Lighting

The facility's lighting upgrades increased 3rd and 9th harmonics, reducing power factor and increasing kVA demand. Passive filters caused resonance under light load conditions. MPTS mitigated all odd harmonics without resonance or instability while correcting power factor and stabilizing voltage.

6. Performance Evaluation

THD Reduction:

MPTS reduced Total Harmonic Distortion (THD) from 10–14% to <4% in real-time operation. Active filters achieved similar results, while passive filters reduced specific harmonic peaks but had minimal impact on overall THD under variable loads.

Stability & Scalability:

MPTS showed high stability under fluctuating load conditions and could be deployed centrally to manage multiple downstream loads, unlike AHFs, which required individual load placement.

System Efficiency:

MPTS reduced apparent power demand, transformer heating, and unnecessary reactive power flows. The absence of moving parts contributed to lower cooling requirements and operating noise.

7. Benefits of MPTS Over Traditional Filters

- **Unified Solution:** Harmonic mitigation, power factor correction, voltage balancing, and surge suppression.
- **Intelligent Adaptation:** Real-time learning of load behavior and waveform distortion.
- **Resonance-Free:** MPTS does not create resonance issues with existing inductive or capacitive components.
- **Facility-Wide Impact:** Mitigates harmonics system-wide rather than at individual nodes.
- **Longer Lifecycle:** Solid-state design reduces wear-and-tear, extending service life with zero maintenance.

8. Considerations and Limitations

- **Initial Investment:**

MPTS costs more than passive filters, but avoids the need for separate systems and reduces long-term O&M.

- **Complex Load Profiles:**

Highly chaotic systems may require additional transient suppression.

- **Installation Planning:** Optimal results depend on placement at key distribution nodes or main switchboards.

9. Conclusion

MPTS is a next-generation platform for harmonic mitigation that combines real-time waveform correction, voltage control, and reactive power management in one intelligent system. Compared to traditional passive and active filters, MPTS offers superior flexibility, zero maintenance, and broader protection against harmonic distortion. For facilities aiming to protect sensitive equipment, reduce penalties, and enhance energy efficiency, MPTS represents a strategic investment.

10. Appendices

Glossary

- **THD (Total Harmonic Distortion):** A measure of waveform distortion.
- **VFD (Variable Frequency Drive):** A nonlinear load that introduces harmonics.

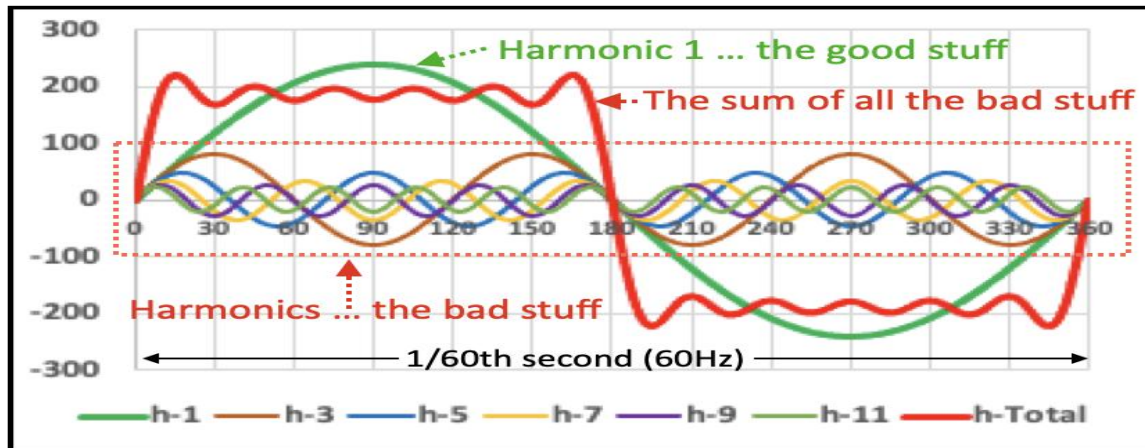
- Resonance: Harmonic interaction that amplifies voltage/current distortions.
- Passive Filter: An LC circuit designed to block specific harmonics.
- Active Filter: Inverter-based system injecting counter-harmonics.

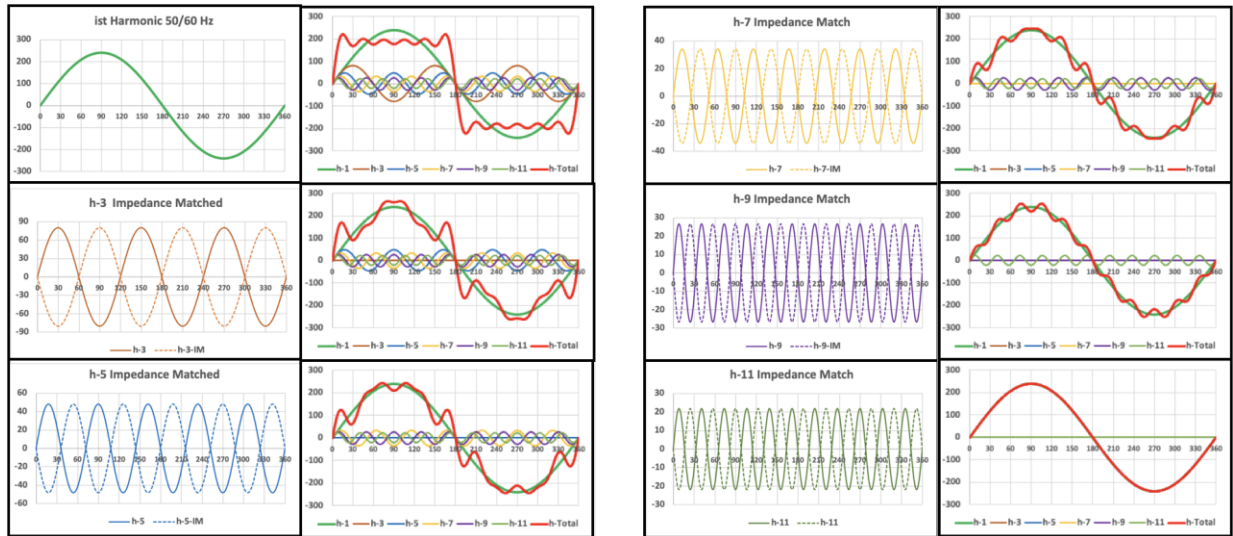
Harmonic Performance Snapshot

Time	Load Type	THD (pre-MPTS)	THD (post-MPTS)	Passive Filter THD	AHF THD
9:00 AM	VFD Cluster	13.2%	3.8%	9.1%	4.1%
12:00 PM	LED System	10.6%	3.2%	7.5%	3.9%
4:00 AM	Mixed Load	11.9%	3.6%	8.2%	4.2%

11. References

- IEEE 519-2022 – Recommended Practices for Harmonic Control
- IEC 61000-4-7 – General Guide on Harmonic Measurement
- MPTS Performance Data Sheets
- Manufacturer Case Studies and Independent Field Measurements
- Power Quality Magazine – Harmonic Filtering Trends (2023)





MPTS Impedance Matching Harmonics

- Each 360-phase degree graph = 1/50 or 1/60 of a second (50Hz/60Hz)
- Sampling and matching occur 20,000/second = $5\mu s$ = 5 microseconds
- The dotted line impedance matches the opposite solid line harmonic
- The sum of all the harmonic levels 1 - 3 - 5 - 7 - 9 - 11 THD angles = 0°

Additional Information

Power Factor Correction

Comparative Analysis of Power Factor Correction:

TransPower MPTS vs. Capacitor Banks and APFC Systems

1. Executive Summary

This white paper compares the power factor correction capabilities of three technologies: TransPower Company's MPTS (Modular Power Technology System), traditional capacitor banks, and Automatic Power Factor Correction (APFC) panels. While capacitor banks and APFC systems have long been used to correct poor powerfactor,

MPTS represents a new generation of intelligent, adaptive solutions that not only improve powerfactor but also reduce harmonics, voltage imbalance, and wasted heat energy. This analysis highlights MPTS's superior performance in dynamic environments and its potential to lower overall operational costs, energy losses, and maintenance needs.

2. Introduction

Power factor correction (PFC) is a critical aspect of efficient electrical power management. Poor power factor increases reactive power, leading to higher utility bills, increased losses, equipment overheating, and potential penalties.

Traditionally, fixed or stepped capacitor banks and APFC panels have been employed to improve powerfactor by supplying leading reactive power. However, emerging technologies like TransPower Company's MPTS provide a more responsive, intelligent alternative that adapts in real time to fluctuating load profiles.

This paper aims to assess and compare the PFC performance of these three solutions across multiple parameters.

3. Overview of Power Factor Correction Technologies

3.1 TransPower MPTS Power Management Controls System

The TransPower MPTS is a modular, intelligent, solid-state system that dynamically regulates voltage, reduces harmonic distortion, and performs power factor correction in real time. Unlike traditional capacitor banks, it doesn't rely on banks of capacitors or relays. Instead, it uses a combination of high-speed electronics and proprietary control algorithms to inject or absorb reactive power with millisecond responsiveness, resulting in a corrected power factor across a wide range of loads without switching delays or overcompensation.

3.2 Traditional Capacitor Banks

Capacitor banks are static devices connected to an electrical distribution system to supply leading reactive power. Once installed and energized, they operate continuously or in manually switched steps. While simple and cost-effective, they lack responsiveness and can be prone to overcorrection or resonance issues in varying load conditions.

3.3 Automatic Power Factor Correction (APFC) Systems

APFC systems are more sophisticated than static capacitor banks. They consist of capacitor banks switched by contactors or thyristors under the control of a microprocessor-based controller. These systems monitor power factor and switch in the appropriate capacitor steps accordingly. However, they still operate in discrete intervals and may lag in response under rapidly changing load conditions.

4. Feature-by-Feature Comparison: Power Factor Correction

Feature-by-Feature Comparison: Power Factor Correction			
Feature	MPTS	Capacitor Bank	APFC Panel
Response Time	Millisecond-level continuous correction	Static solution; no responsiveness	Seconds; step-based static solution
Control Intelligence	AI-driven real-time correction logic	None	Controller-based threshold logic
Harmonic Filtering	Built-in harmonic suppression capability	None	Optional, separate filters
Energy Efficiency	Reduces both reactive and real power waste	Reduces reactive only	Reduces reactive only
Risk of Overcorrection	None (algorithmically prevented)	High (under light loads)	Moderate (based on step settings)
Load Adaptability	Adapts dynamically to varying loads	Fixed compensation	Step-wise approximation
Maintenance Requirements	Very low (solid-state, no moving parts)	Moderate (capacitor degradation)	Higher (contactors, capacitors, controller)
Integration with EMS	Fully integrated into power monitoring system	Standalone	Standalone with optional metering
Installation Footprint	Compact, wall or panel mount	Large physical footprint	Moderate footprint
Lifecycle Cost	High initial, low total cost of ownership	Low initial, higher long-term cost	Moderate initial and ongoing cost

5. Use Case Scenarios

Case 1: Variable Load Industrial Environment

A manufacturing plant with CNC machines and variable-speed drives faced rapidly changing loads. Capacitor banks and APFC panels could not keep up with fluctuations, leading to poor correction and penalty charges. After implementing MPTS, real-time PFC maintained a power factor >0.98, eliminating penalties and reducing transformer heat.

Case 2: Office Building with HVAC Load Profile

An office complex with large HVAC loads experienced demand-based variations in power factor. Traditional PFC systems overcompensated during light load periods. MPTS adjusted continuously, improving PF without creating overvoltage issues and supporting consistent voltage regulation.

Case 3: Facility with Nonlinear Loads

A facility using significant LED lighting and VFDs suffered from poor power factor and harmonics. Capacitor banks worsened the harmonic distortion. MPTS provided both power factor correction and harmonic mitigation, improving power quality and equipment longevity.

6. Performance Evaluation

- Correction Accuracy: MPTS maintained $PF \geq 0.98$ in all measured intervals, compared to APFC's range of 0.92–0.96 and static banks at 0.90–0.94.
- Load Response: MPTS adjusted instantly to load shifts (within 20–40 ms), compared to 2–10 seconds for APFC and zero adaptability from capacitors.
- Energy Savings: MPTS demonstrated 3–5% reduction in real power losses due to lower I^2R losses, reduced transformer stress, and improved voltage profile.

7. Benefits of MPTS Over Traditional Methods

- Real-time adaptability avoids overcorrection and maintains optimal PF under all load conditions.
- Solid-state design results in longer lifespan, no wear-and-tear from mechanical switching.
- Integrated system intelligence allows facility managers to monitor, log, and trend power factor data.
- Harmonic filtration and voltage stabilization provide system-wide power quality improvement.
- Thermal load reduction due to reduced current flow and power losses, easing HVAC demands.

8. Considerations and Limitations

- Cost: MPTS requires higher upfront investment but has a faster ROI when considering energy savings and penalty avoidance.
- Compatibility: Older facilities with limited panel space may require retrofitting.
- Application-Specific Design: MPTS should be configured per site load profile for optimal results.

9. Conclusion

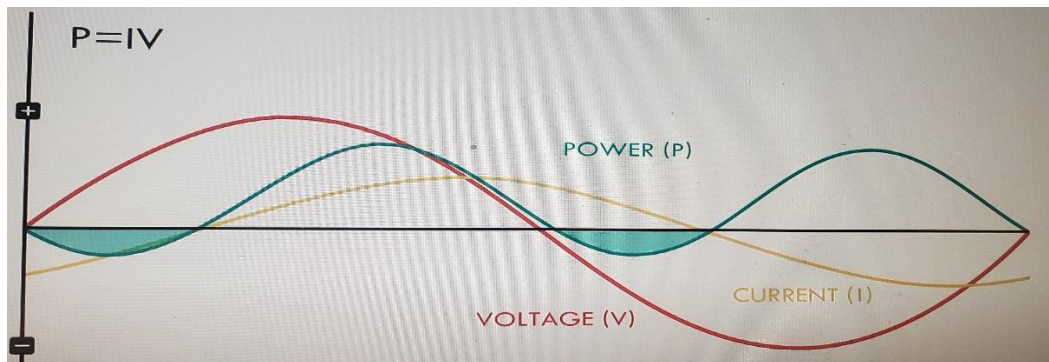
While capacitor banks and APFC panels have served well in the past, the power sector's move toward smarter, more responsive solutions makes TransPower MPTS a superior alternative.

With its millisecond response time, intelligent control, and multi-functionality, MPTS provides holistic power factor correction and system optimization in a single platform. Facilities looking for long-term savings, enhanced power quality, and reduced maintenance will benefit most from implementing MPTS.

10. Appendices- Glossary

Power Factor (PF): Ratio of real power to apparent power.

- Reactive Power: Power consumed by inductive/capacitive elements in the system.
- Harmonics: Distortions in the waveform caused by non-linear loads.
- I^2R Losses: Energy lost due to current flow through resistance (heat).



Sample PF Measurement – Industrial Load

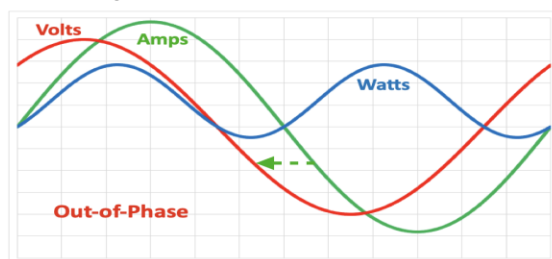
Time	Load (kW)	PF (Cap Bank)	PF (APFC)	PF (MPTS)
9:00 AM	120	0.91	0.94	0.99
12:00 PM	180	0.89	0.92	0.98
3:00 PM	90	0.88	0.91	0.99

11. References

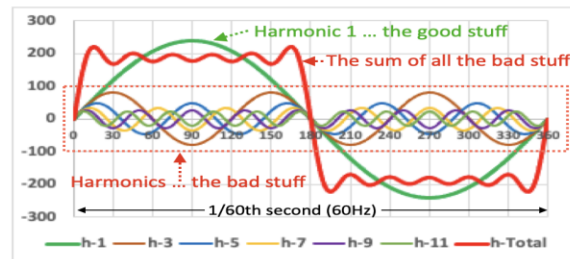
- IEEE Std. 1459-2010 – Definitions for Measurement of Electric Power Quantities
- IEC 61000-3-2 – Limits for Harmonic Current Emissions
- TransPower MPTS Technical Specifications and Performance Data
- Field Study Data from TransPower Client Sites (confidential summaries)
- Utility Billing Structures – Reactive Penalty Schedules

Total Power Factor = Real Energy Efficiency

45° Displacement Power Factor = 0.707 PFA



50% Distortion Power Factor = 0.894 PFTHD



$$\text{Total Power Factor} = \text{Displacement Power Factor} \times \text{Distortion Power Factor}$$

$$\text{PFTOT} = \text{PFA} \times \text{PFTHD}$$

$$\text{PFTOT} = 0.707 \times 0.894 = 0.632$$

This the the REAL issue!

MPTS will typically improve Total Power Factor from 0.95 to 0.99 PFTOT