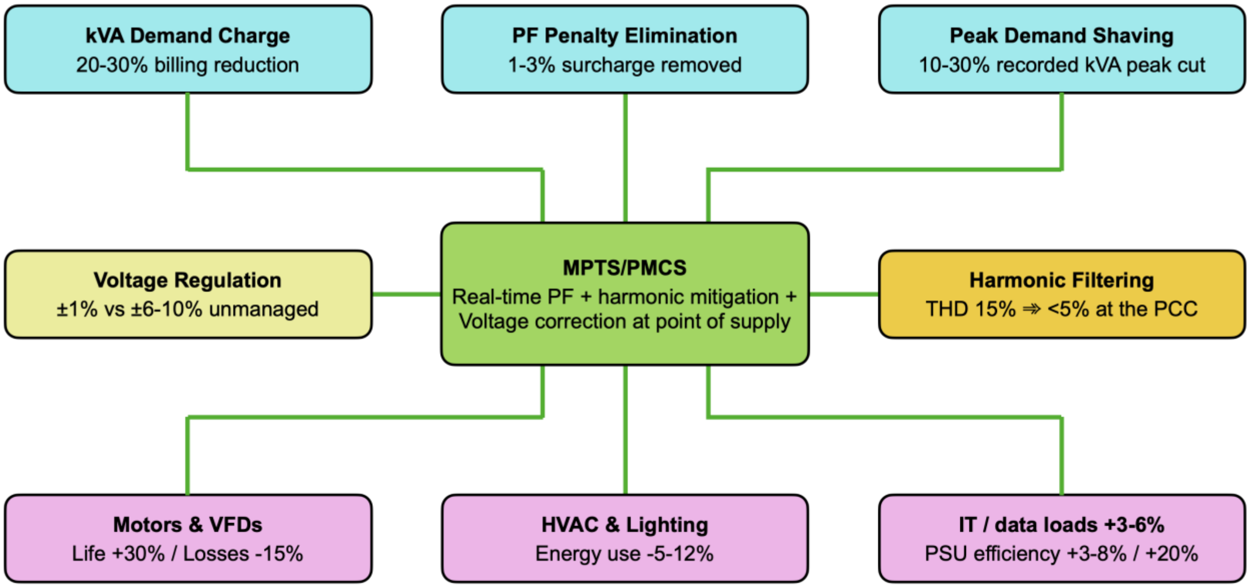
How MPTS/PMCS Justifies Its Investment from an Electrical Utility Billing Perspective

A load analysis is where the MPTS value proposition becomes most tangible for the client, because it touches every line item on the utility bill simultaneously.



MPTS/PMCS Net Annual Savings - representative 500 kW site
$60,000-$120,000 (R1,020,000-R2,040,000) / year in billing + equipment savings combined

Let’s review this across each mechanism with the underlying mathematics, using a consistent reference site: a commercial/industrial client with a 500-kW average real power demand, billed on a two-part tariff (energy in kWh + demand in kVA), with a baseline uncorrected power factor of 0.76 and input THD of 14%. (**US$1 = SAR17**)

1. kVA Demand Charge Reduction

This is the single largest line item. Most medium-voltage commercial and industrial tariffs bill peak demand in kVA recorded over a 15 or 30-minute integration window each month. The client pays for the worst window of the month, regardless of how long it lasted.

At PF = 0.76, a 500 kW load demands S = P / PF = 500 / 0.76 = 657.9 kVA. MPTS correcting to PF = 0.97 reduces this to S = 500 / 0.97 = 515.5 kVA - a reduction of 142.4 kVA, or 21.6%.

At a typical demand tariff of $14/kVA/month, that reduction is worth:
142.4 kVA × $14 × 12 months = $23,923 (R406,691)/year saved on demand charges alone, for no change whatsoever in the real work the client's processes perform.

On larger sites (2–5 MW), this single mechanism routinely delivers $100,000–$400,000 (R1,700,000-R6,800,000) per year.

2. Power Factor Penalty Clause Elimination

Many utility tariffs embed a PF penalty separate from the demand charge structure. A common formulation is a 1% surcharge on the total monthly bill for every 0.01 that the recorded PF falls below a threshold - typically 0.90 or 0.95.

At PF = 0.76 against a 0.90 threshold, the client is 14 penalty steps below the threshold: 14 × 1% = 14% surcharge applied to the total energy bill.

On a 500-kW site running 6,000 hours/year at an average energy rate of $0.11/kWh:

Energy consumption = 500 kW × 6,000 h = 3,000,000 kWh Energy bill before penalty = 3,000,000 × $0.11 (R1.87) = $330,000 (R5,610,000) ... Penalty = 14% × $330,000 (R561,000) = $46,200 (785,400)/year.

MPTS correction to PF 0.97 eliminates this penalty entirely. This is often the highest single recoverable cost for clients with legacy motor-heavy plant operating without correction.

3. Peak Demand Shaving and Load Smoothing

Beyond correcting steady-state power factor, an active MPTS with energy storage capability (or fast reactive power injection) suppresses demand spikes during motor start-up, transformer energization, or process step changes, events that would otherwise set a new monthly demand peak and lock in a higher demand charge for the entire billing month.

A 250-kW motor starting direct-on-line draws 6 × full-load current for 2-5 seconds - a 1,500-kW spike on the demand meter's integration window. If this occurs in the last minute of a 15-minute demand window, it can push the recorded demand by 100+ kVA above what the running load would have registered. MPTS soft-start support (via reactive power compensation or BESS discharge) limits this spike to 10-15% of the running current.

Quantified: if one such event per month is suppressed, preventing a 100 kVA demand uplift at $14 (R238)/kVA/month, the saving is $1,680 (R28,560) /year from a single motor start. Sites with multiple large motors starting under process control can see $10,000 (R170,000)-$30,000 (R510,000)/year in demand-spike suppression alone.

4. Motors and Variable Frequency Drives (VFDs)

Electric motors account for 60-70% of global industrial electricity consumption. They are also the load type most harmed by voltage distortion and poor power factor, and most benefited by MPTS correction.

Under dirty supply conditions (THD = 14%, voltage unbalance 2%), a three-phase induction motor suffers:

- Negative-sequence harmonic currents (5th, 11th, 17th) create counter-rotating magnetic fields in the stator, producing braking torque and additional rotor heating. This increases rotor losses by 8–15% and raises rotor temperature by 10–20°C above rated.
- Stator winding insulation life, governed by the IEEE 117 thermal model, halves for every 10°C above rated temperature. A motor running 15°C hot has roughly one-quarter of its design insulation life remaining.
- NEMA MG-1 and IEC 60034-26 both require motors to be de-rated when supplied with distorted voltage. At 14% THD and 2% unbalance, the de-rating factor is approximately 0.88 - meaning a 100-kW motor can only safely develop 88 kW, forcing the client to run a larger frame motor than the process actually requires.

MPTS correction to THD < 5% and voltage unbalance < 0.5% removes the de-rating requirement, recovers the full nameplate output, and cuts rotor losses by 10-15%. On a site with 300 kW of installed motor load running 6,000 hours/year:

Recovered efficiency = 300 kW × 3% efficiency improvement × 6,000 h × $0.11 (R1.87)/kWh = $5,940 (R100,980)/ year

Motor replacement interval extended from 12 years to 16 years (30% life extension) on a fleet of 10 motors averaging $8,000 (R136,000) each: deferred replacement value = $80,000 (R1,360,000)/ 4 years = $20,000 (R340,000)/year equivalent.

VFDs similarly benefit: the DC-link capacitors in a VFD are rated for a defined ripple current. Grid harmonic content adds ripple current directly, reducing capacitor life. Industry data from ABB and Danfoss indicates DC bus capacitor life at 14% input THD is approximately 60% of the life achievable at 5% THD - a 40% reduction in the most expensive VFD component.

5. HVAC and Lighting Loads

HVAC systems combine compressors (motor loads, addressed above), fans, pumps, and, in modern installations, electronically commutated motors (ECMs) and variable refrigerant flow (VRF) systems. These inverter-driven loads are acutely sensitive to supply voltage quality:

- Compressor motors running on a harmonically distorted supply draw 5-10% more current for the same refrigeration output, increasing energy cost proportionally.
- Electronic expansion valve controllers and building automation system (BAS) controllers experience nuisance trips and watchdog resets under high-THD conditions, generating service call costs of $300 (R5,100)-$800 (R13,600) per event.
- LED driver power supplies, now ubiquitous in commercial lighting, have internal power-factor-correction circuits that mitigate upstream harmonic distortion. Poor supply quality reduces LED driver power factor from a nameplate 0.95 to 0.75-0.80 in practice, negating the energy saving that justified the LED retrofit.

Quantified on a 500-kW site where HVAC represents 35% of the load (175 kW) and lighting 10% (50 kW):

HVAC energy saving at 7% improvement = 175 kW × 6,000 h × 7% × $0.11 (R1.87) = $8,085 (R137,445)/year. Lighting efficiency recovery = 50 kW × 6,000 h × 5% × $0.11 (R1.87)= $1,650 (R28,050)/year. Avoided BAS/controller service calls (estimated 6/year) = 6 × $500 (R8,500) = $3,000 (R51,000)/year

6. IT and Data Benter Loads

Server power supply units (PSUs) are switch-mode power supplies (SMPS) - they are themselves harmonic generators, but they are also harmonic victims. A server PSU operating from a supply at 10% THD sees its internal power factor correction (APFC) circuit working against external distortion, reducing its conversion efficiency by 2-4 percentage points compared to operation from a clean sinusoidal supply.

For a data hall drawing 200 kW of IT load at $0.12 (R2.04)/kWh running continuously (8,760 h/year):

PSU efficiency recovery of 3% = 200 kW × 8,760 h × 3% × $0.12 (2.04) = $63,072 (R1,072,224)/year

Additionally, harmonic-induced neutral current overloading in IT distribution panels (a well-documented phenomenon in three-phase PDU environments) causes premature tripping of neutral conductors and overheating of panels. Avoiding a single neutral conductor failure and associated downtime event - conservatively valued at $50,000 (R850,000) in a production data environment - represents significant annual risk reduction.

7. Consolidated Demand-Load Benefit Table

Benefit Mechanism	Annual Financial Value	Basis
kVA demand charge reduction (PF 0.76 → 0.97)	$23,923 (R406,691)	142 kVA × $14 (R238) × 12
PF penalty clause elimination	$46,200 (R785,400)	14% surcharge on $330k energy bill
Peak demand spike suppression	$10,000 (R170,000)-$30,000 (510,000)	Motor starts, process steps
Motor efficiency and life extension	$25,940 (R440,980)	Efficiency + deferred replacement
VFD capacitor life extension	$8,000 (R136,000)-$15,000 (R255,000)	40% longer DC bus cap life
HVAC energy and service savings	$12,735 (R216,495)	Energy + avoided service calls
IT/data PSU efficiency	$63,072 (R1,072,224)	3% on 200 kW IT load
Total Annual Benefit	**$190,000 (R3,230,000) -$216,000 (R3,672,000)**	500 kW reference site

The payback arithmetic is clear: at a fully installed MPTS cost of **$200,000 (R3,400,000)** for a 500-kW site, simple payback is 10-12 months. The IT load efficiency savings alone - driven by 24/7 continuous operation - frequently cover the entire system cost within the first year on data-center-heavy installations.

What makes these numbers durable is that they do not depend on any single mechanism. Even if a conservative auditor discounts the savings from the penalty clauses (because the tariff is being renegotiated) or the motor life extension (because the fleet is newer), the kVA demand charge reduction and IT efficiency savings alone justify the investment.