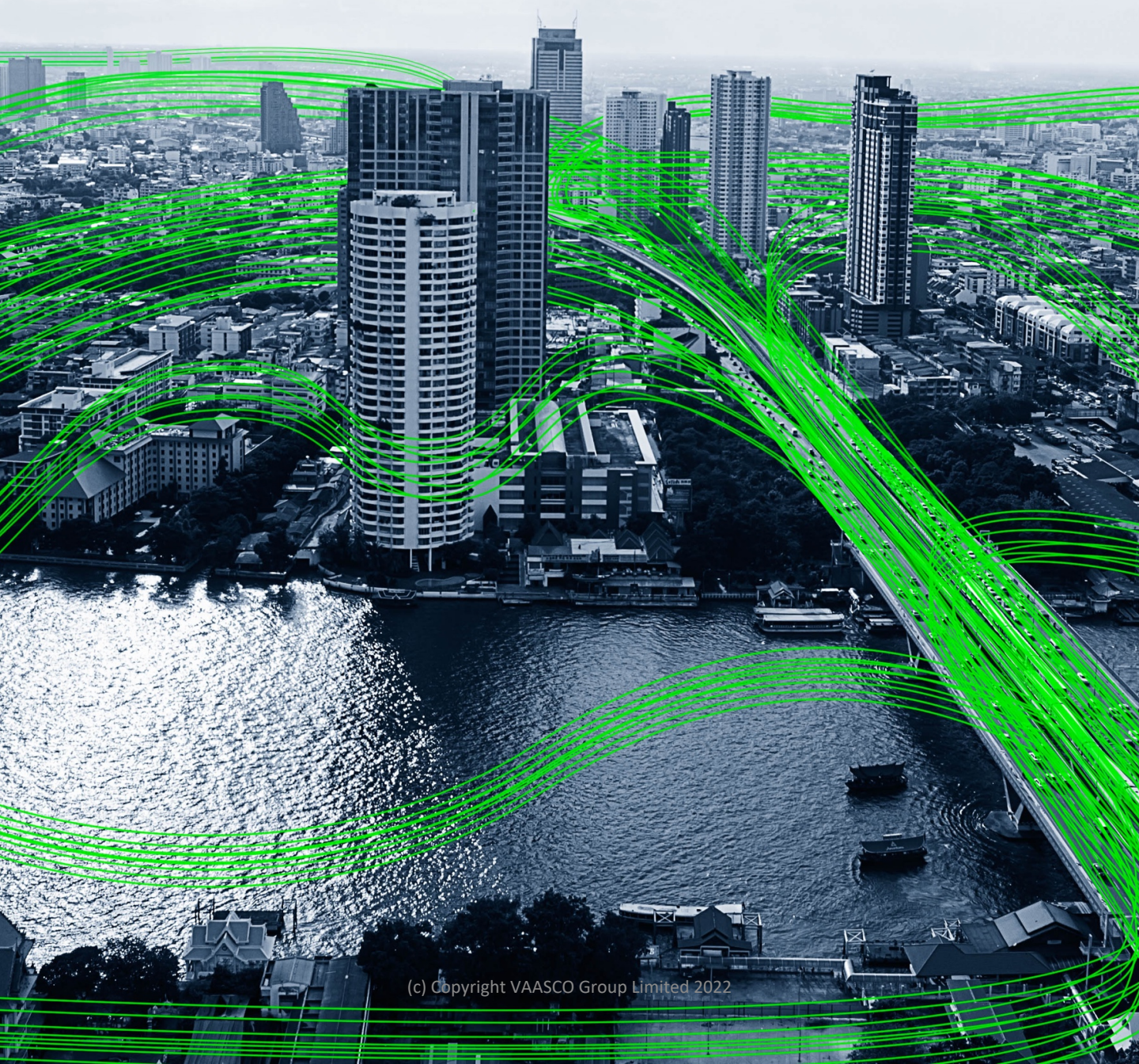


20<sup>th</sup> May 2022

# grid voltage control for commercial, industrial & government

an effective step towards net zero energy

## savings verification - introduction



## Measurement and Verification of savings from Voltage Optimisation

This can be referred to as a “dark art” only because too many suppliers cannot conclusively prove savings to their clients due to the variability of load, footfall, equipment change, voltage, 3 phase balance, etc and, of course - weather.

To overcome the “imaginative reporting” by suppliers back in 2005 IPMVP was adopted as a protocol that was accepted as the “most accurate” methodology available – the drawback was cost; due to the complexity of collecting all that data in an almost infinitely variable environment and then weighting its impact with regression analysis, noting at the same time the building’s continuing variability mentioned above. However this expensive, but quite accurate, methodology did give our clients and Finance Directors confidence to push the buy button.

Evolution means improvement and powerPerfector’s “pPPlus” Automatic Voltage Controller (AVC) paralleled onto the Voltage Power Optimiser (VPO) unit which allowed Voltage control to be turned off and on to show our clients the impact that change made to kW, kWh or kVA in their building/site.

A step forward in cost reduction and illustrating savings but not perfect because we ended up searching for stable loads in an unstable environment so any comparative period of on/off, whether it was 1 hour, 6 hours or even a day or week still would not precisely show savings.

BUT now we have completed our 5 year R & D of our revolutionary, rather than evolutionary, “iQ” voltage controller which precisely stabilises and balances 3 phase grid supply - we can introduce you to “**Responsive Power Optimisation**” or “**RPO**” – a new technology sector that has everyone talking.

So how does “**RPO**” change the M & V landscape?

After installation of the new **pPiQ** we, or our clients, can select any 5 minute time period when we program the iQ controller to stabilise and balance the grid voltage for 15 seconds and then come out of circuit and revert to grid supply to the building/site. During its operation we measure the change that takes place at the switching point within a 200ms time frame to capture the decrease and increase in kW, Amperage and kVA. We recommend selecting 6 different periods during the working day to capture the load variation to produce an definitive average saving.

The graphs from Test 1 below illustrate the value of this responsive and precise granularity and clearly identify the immediate and continuing change on the downstream load and consumption.

As interesting, in Test 2 and 3 graphs below, you can see the impact of inrush current from motors switching on and their stabilising with little or no impact on the base line in that 15 second period.

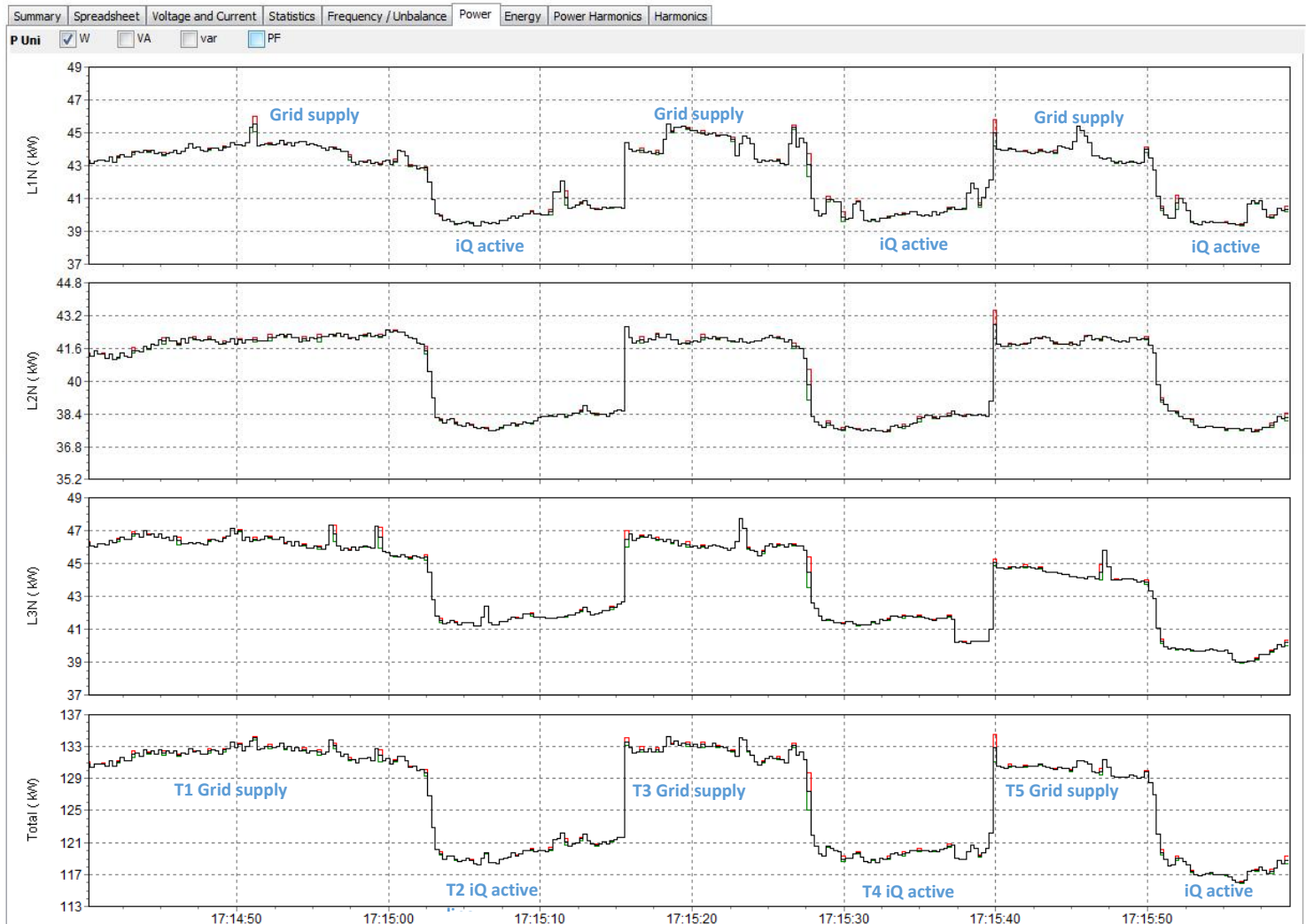
The value of this precision measurement has set us on the path of designing a software upgrade for our Graphical User Interface that will give you Power Quality Analyser (PQA) grade information of certain power quality characteristics on your supply that would have induced equipment failure in your motors, electronics and/or lighting circuits before your installation of the pPiQ.

Good technology comes with future proofing so having “designed to manufacture” the iQ, which we know cannot be improved upon as its operational parameters are so precise, we are now focused on developing Artificial Intelligence (AI) that allows the iQ to adjust voltage prior to predictable load changes – which will reduce stress on equipment and increase efficiency even further.

But for now, immediately after an installation, you can prove to yourselves, and at any time in the future – that your most valuable asset – the pPiQ is saving money, protecting your electrical equipment and reducing your maintenance and capital replacement costs.

## Test 1: kW per phase and Total kW

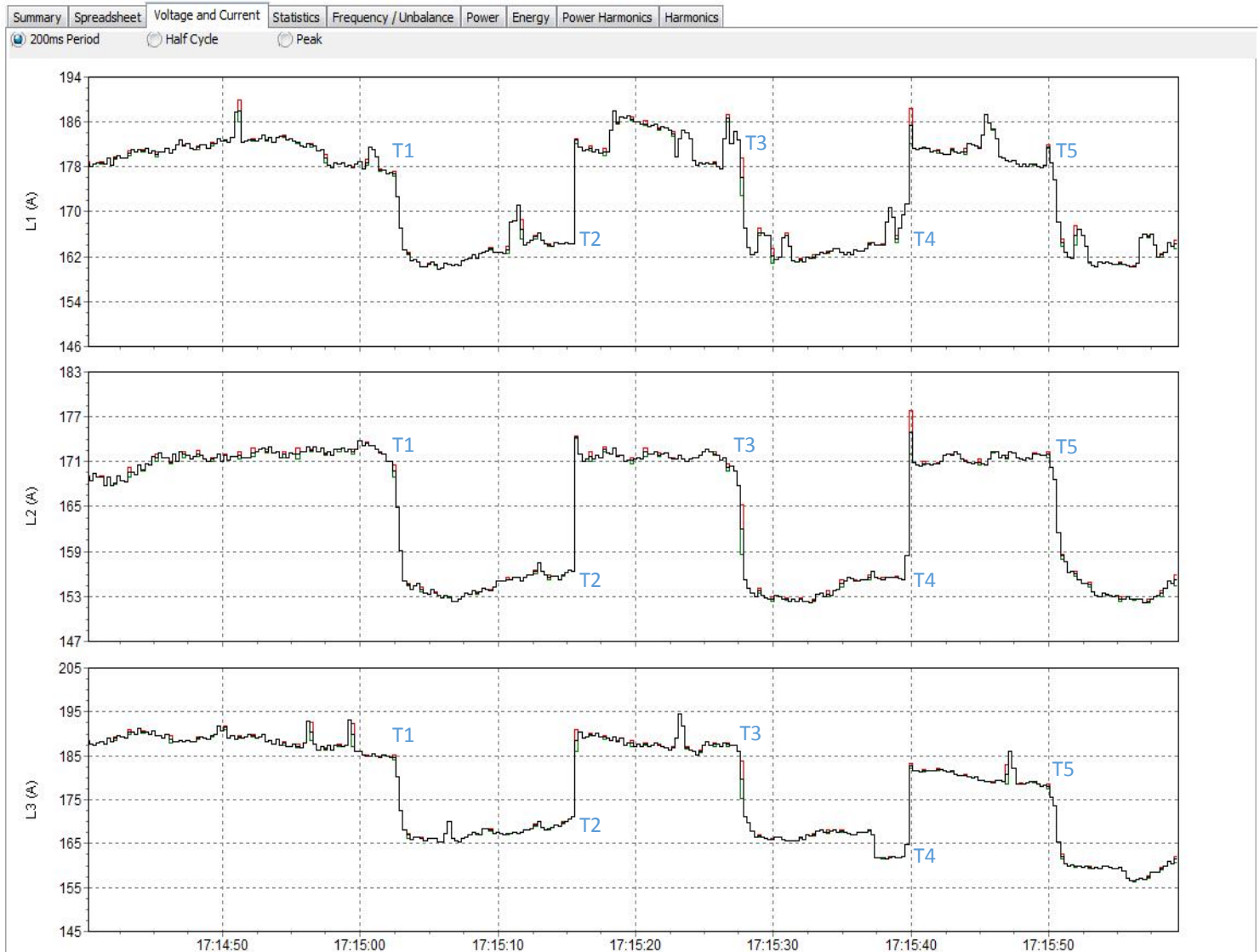
The charts below show the change in real power (kW) between the incoming Grid supply and the powerPerfector Active iQ supply when it is precisely stabilising and balancing the Grid supply. The graphs show a clear 9% saving from reducing the 6% - 9% overvoltage of ~235V to 220V (+/-0.5V) with the pPiQ.



| Test                                     | Total kW change |        |
|------------------------------------------|-----------------|--------|
| T1 = Grid supply to Active pPiQ savings  | 130.53          | 120    |
|                                          | <b>-8.08%</b>   |        |
| T2 = Active pPiQ to Grid supply increase | 121.2           | 133    |
|                                          | <b>+9.74%</b>   |        |
| T3 = Grid supply to Active pPiQ savings  | 132.33          | 119.97 |
|                                          | <b>-9.34%</b>   |        |
| T4 = Active pPiQ to Grid supply increase | 119.67          | 130.29 |
|                                          | <b>+8.87%</b>   |        |
| T5 = Grid supply to Active pPiQ savings  | 129             | 117    |
|                                          | <b>-9.30%</b>   |        |

## Test 2: Current per phase

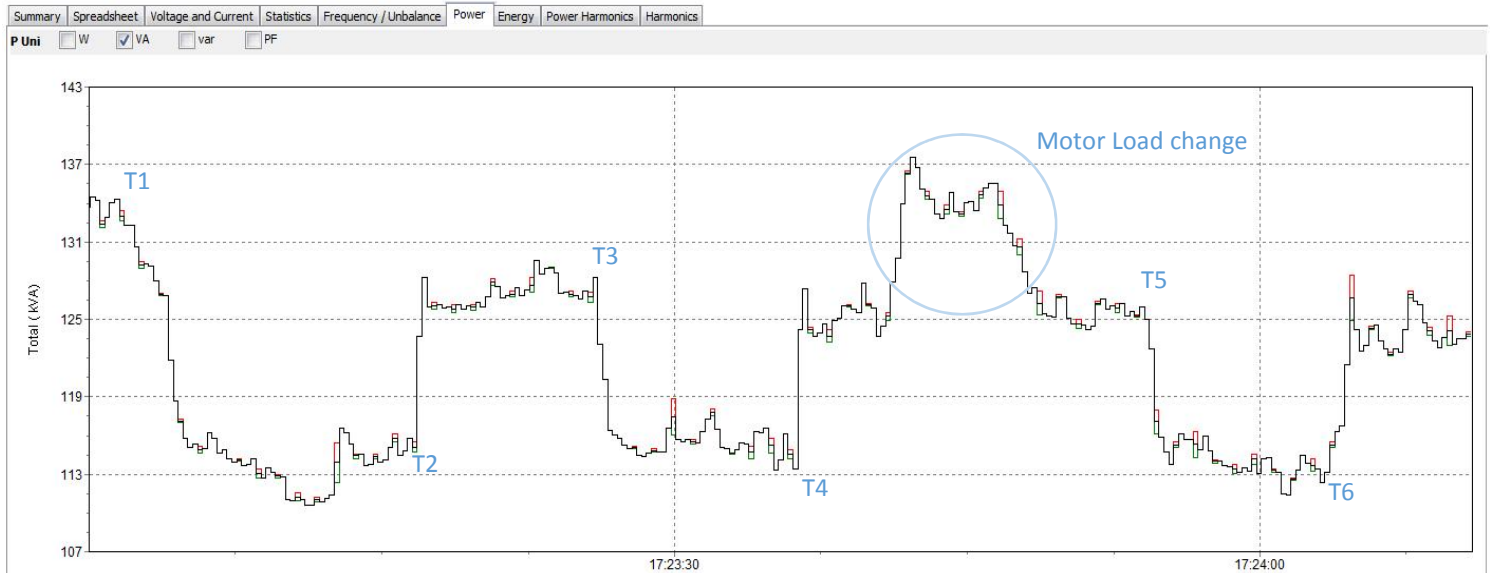
Each phase shows a reduction in current (amps) of approximately 10% as the voltage is stabilised and balanced precisely by the powerPerfector iQ.



| Test                            | L1 Amps       | L2 Amps        | L3 Amps        | Average change in Amps |
|---------------------------------|---------------|----------------|----------------|------------------------|
| T1 = Grid supply to Active pPiQ | 178           | 172.7          | 185            |                        |
|                                 | 161.3         | 153.4          | 166.5          |                        |
|                                 | <b>-9.38%</b> | <b>-11.17%</b> | <b>-10%</b>    | <b>-10.18%</b>         |
| T2 = Active pPiQ to Grid supply | 164.3         | 156.2          | 168            |                        |
|                                 | 184.6         | 172.1          | 187.1          |                        |
|                                 | <b>+12.35</b> | <b>+10.18</b>  | <b>+11.37%</b> | <b>+11.3%</b>          |
| T3 = Grid supply to Active pPiQ | 178.6         | 172.4          | 187            |                        |
|                                 | 161.3         | 152.7          | 166.3          |                        |
|                                 | <b>-9.69%</b> | <b>-11.43%</b> | <b>-11.07%</b> | <b>-10.73%</b>         |
| T4 = Active pPiQ to Grid supply | 169.1         | 155.7          | 161.9          |                        |
|                                 | 178.4         | 172.2          | 182.1          |                        |
|                                 | <b>+5.5%</b>  | <b>+10.6%</b>  | <b>+12.48%</b> | <b>+9.53%</b>          |
| T5 = Grid supply to Active pPiQ | 178.4         | 172.2          | 182.1          |                        |
|                                 | 162           | 152.1          | 157.1          |                        |
|                                 | <b>-9.19%</b> | <b>-11.67%</b> | <b>-13.73%</b> | <b>-11.53%</b>         |

## Test 3: Total kVA

The chart below (from data at a different time of the day) shows the change in apparent power kVA (real power plus re-active power) as the powerPerfector iQ is activated. This demonstrates the ability of the unit to reduce maximum demand and reactive power and associated KVA charges.



| Test                            | Total kVA change |     |
|---------------------------------|------------------|-----|
| T1 = Grid supply to Active pPiQ | 131              | 113 |
|                                 | <b>-13.74%</b>   |     |
| T2 = Active pPiQ to Grid supply | 114              | 127 |
|                                 | <b>+11.4%</b>    |     |
| T3 = Grid supply to Active pPiQ | 127              | 114 |
|                                 | <b>-10.23%</b>   |     |
| T4 = Active pPiQ to Grid supply | 114              | 126 |
|                                 | <b>+10.52%</b>   |     |
| T5 = Grid supply to Active pPiQ | 125              | 113 |
|                                 | <b>-9.6%</b>     |     |
| T6 = Active pPiQ to Grid supply | 113              | 124 |
|                                 | <b>+9.73%</b>    |     |

Our clients, who have reviewed this methodology, have said that this gives them absolute confidence in the operation and proof of value of the pPiQ's application to reduce consumption and both direct and associated costs – along with matched carbon reduction of course.

The reduction in KVA is a substantial benefit so that UK uses can reduce their capacity charges whilst International can reduce high variable usage charges which calculate the monthly cost on the highest KVA demand.



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