# POWER-ONE, INC.

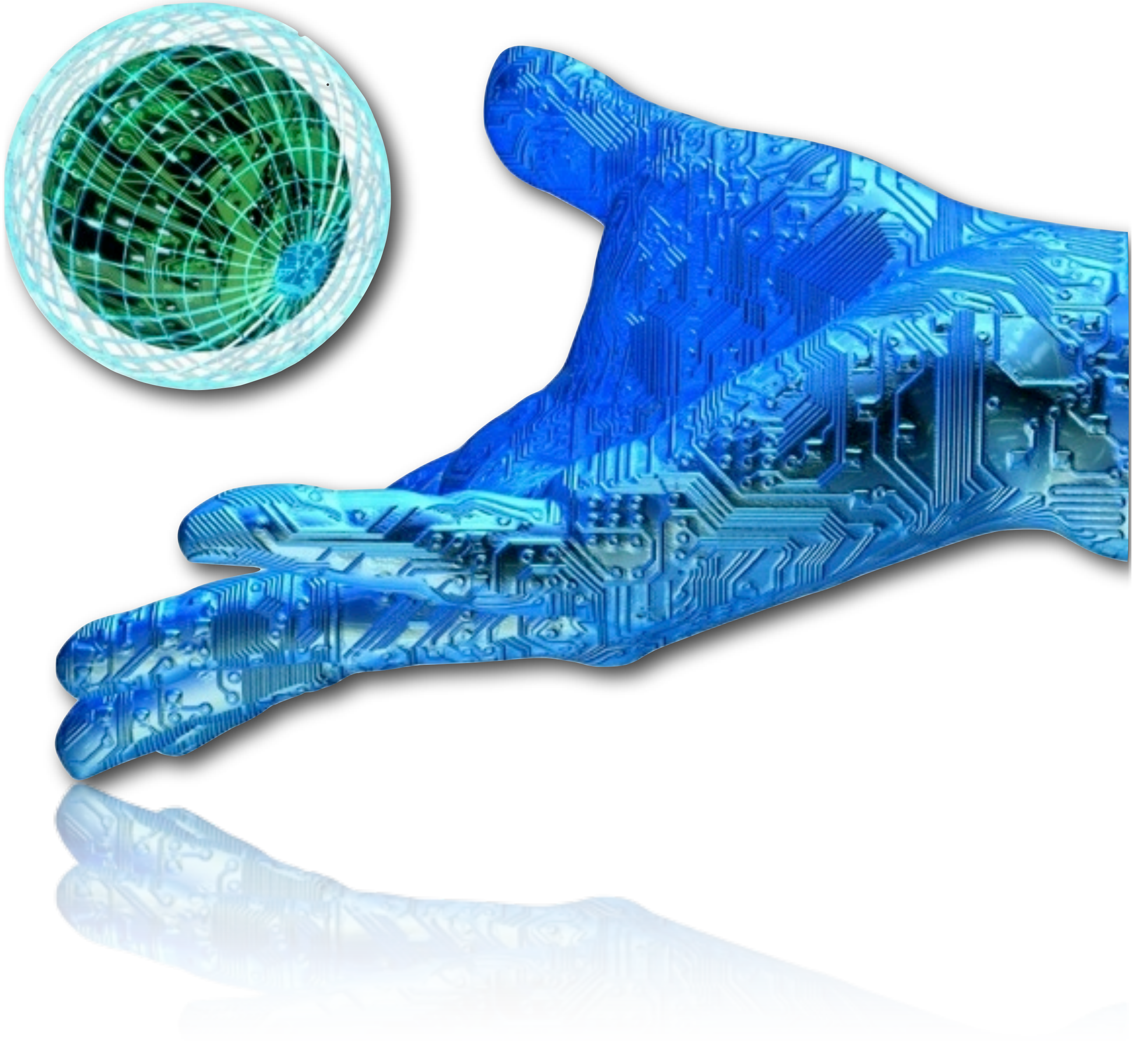
# *PFE1100-12-054NA*

# 54 MM 1U PSU

# IN

# THE SERVER ENVIRONMENT

PERITUS POWER



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# Platinum PFE1100-12-054NA Overview.

The PFE1100-12-054NA shown on the right is a 1U form factor, 54 mm wide power supply capable of 1100 watts at high line and de-rates in a low line condition.


This is an AC to DC power-factor-corrected (PFC) power supply that converts standard AC mains power into a main output of 12 VDC for powering intermediate bus architectures, (IBA) in high performance and reliability servers, routers, and network switches.

The power supply meets international safety standards and displays the CE-Mark for the European Low Voltage Directive (LVD).

Applications for this power supply would typically include servers, routers and general networking, although there is no reason for it not to find its way into any equipment requiring small form factor high efficiency 12 V bus characteristics.

A basic block diagram of the power supply is shown in Figure 1.

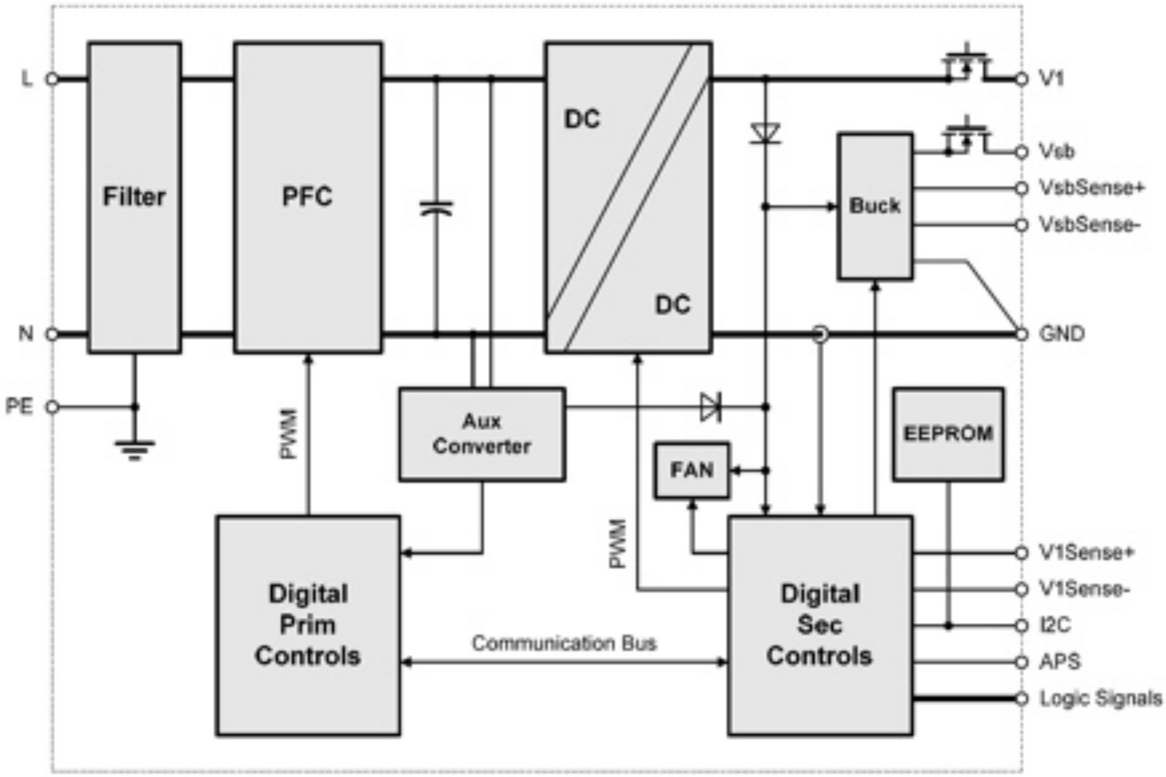



Figure 1:

## PFE1100-12-054NA Features

•Best-in-class "Platinum" graded efficiency

• Wide input voltage range: 90-264 VAC

• AC input with power factor correction

• Always-On 15 W programmable standby. 5V or 3.3V, pin selectable

• Hot-plug capable

• Parallel operation with active digital current sharing

• Full digital controls for improved performance

• High density design: 25.6 W/in$^3$.

• Small form factor: 54.5 (w) x 40.0 (h) x 322 (l) mm

• I$^2$C communication interface for control, programming and monitoring with PSMI bus or PMBus™

• Over-temperature, output over-voltage and over-current protection

• 2 kBytes of EEPROM for user information

• 2 Status LEDs: AC OK and DC OK with fault signaling

The PFE1100-12-054NA AC-DC power supply is a fully DSP controlled, highly efficient front-end. It incorporates resonance-soft-switching technology and interleaved power trains to reduce component stresses, providing increased system reliability and very high efficiency. With a wide input operating voltage range and minimal linear derating of output power with input voltage and temperature, the PFE1100-12-054NA maximizes power availability in demanding server, switch, and router applications while keeping power dissipation to a minimum.

The front-end is fan cooled and ideally suited for server integration with a matching airflow path.

The fan control proved to be very effective at adjusting the speed of the fan as the output current demand increases or decreases, keeping ambient noise to a minimum and helping ensure power is not wasted through inefficient fan control.

Cooling is managed by a fan controlled by the DSP controller. The fan speed is adjusted automatically depending on the actual power demand and supply temperature and can be overridden through the I$^2$C bus.

The PFC stage is digitally controlled using a state-of-the-art digital signal processing algorithm to guarantee best efficiency and unity power factor over a wide operating range.

The DC-DC stage uses soft switching resonant techniques in conjunction with synchronous front-ends. An active ORing device on the output ensures no reverse load current and renders the supply ideally suited for operation in redundant power systems.

The Always On standby output with selectable voltage level (3.3/5V) provides power to external power distribution and management controllers. Selection is straightforward and is set by a pin on the output connector. Its protection with an active ORing device provides for maximum reliability.

Status information is provided with front-panel LEDs. In addition, the power supply can be controlled via the I$^2$C bus and programmed for output voltage, current limitation, and fan speed. In addition, it allows full monitoring of the supply, including input and output voltage, current, power, and inside temperatures.

# Expected Server Growth Through 2010.

This power supply is primarily aimed at the server industry, so it makes sense to take a snapshot of that industry to gauge the demand.

The server industry took a distinctive downward trend throughout 2009 as OEM's and IT customers reduced budgets quarter by quarter to reduce costs. Roadmaps were halted, major programs postponed, and for a while innovation and new designs either slowed down or stopped. Industry experts at IDC and Gartner do expect 2010 to herald the return to a recovery throughout 2010 and into 2011, particularly in the X86 space, where demand for blade and volume servers is expected to accelerate, as infrastructures consolidate and to satisfy a pent up demand in the corporate space taking hold.

The financial markets are expecting growth in volume servers and blades from 3Q10 with positive growth around 2Q10. Mid-to-high range servers will have to wait until 1Q11 to see any real growth.

It is not all good news, although growth is expected we are coming out of a deep and extended recession. The industry has changed, and that change is set to remain for some time; the bubble truly burst. EMEA is expected to recover slower than the U.S. with IDC predictions of 2.4% increases for 2010 in Europe compared to the 27% decline throughout 2009. Due to the downward trend, customers of mid-to-high end servers began considering x86 solutions and server virtualization for increasing workloads across fewer servers.

In reality, industry is preparing for a four-year recovery to reverse the decline seen throughout 2009, and maybe even six years to see the peaks of 2007 return.

Server sales dropped six quarters in a row. Table 1 below shows the 4Q09 revenues from the main OEM's.

**Table 1. 4Q09 OEM sales revenues.**

| OEM | REVENUE | SALES DOWN % |
|---|---|---|
| Dell | $337.5 million | -16% |
| HP | $1.4 billion | -9.6% |
| Sun/Oracle | $387 million | -18.6% |
| IBM | $1.29 billion | -10.1% |
| Fujitsu | $201 million | -4.7% |

The Darnell Group forecasts are shown in Table 2 below, starting from 2008 to 2011.

**Table 2. Darnell 2008-2011 forecasts.**

*North America AC-DC Server Power Supply Market (millions of units)*

| SERVER | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Enterprise Servers | 0.2 | 0.2 | 0.2 | 0.2 |
| Servers | 3.1 | 3.6 | 4.0 | 4.6 |
| Blade Servers | 1.2 | 1.6 | 2.0 | 2.4 |
| Totals | **4.5** | **5.4** | **6.2** | **7.2** |

As the server industry begins a slow recovery the two main points that will affect sales will be:

- Efficiency and utility cost reductions for end users.
- Lower power consumption, benefiting PUE for data centers.

Another interesting data point is in cloud computing. As this technology takes hold the servers employed in this sector are increasingly making use of one AC/DC power supply. Forgoing the redundant supply maximizes efficiency, and with redundancy built in at the server level, the redundant PSU is truly redundant.

At first look, cloud computing could be seen to affect power supply sales, especially if servers are deployed requiring half the quantity of front ends due to the redundancy criteria. In reality, that may not be the case. In order to support cloud computing, new data centers are being built, these are typically more efficient to run from an infrastructure point of view, and the servers employed are most likely to be the lowest power consuming servers available. Cloud computing has to be seen as “green”, and with more devices using mobile internet, cell phones, net-books, iPads, etc., this is a growing industry.

# Efficiency in the Data Center.

In 2006, Larry Page, Google's cofounder, stated "running out of power" as the biggest potential threat to Google, and the electricity needed to run its "server farms" - tens of thousands of power-hungry computers storing billions of internet pages - could soon cost more than the hardware. Now in 2010 that statement carries more truth than could ever have been imagined.

The cost of energy is higher than ever before, considering over half the energy cost to run a server goes towards cooling. The cost of running a typical volume server over five years can exceed the original product cost.

There is some data from Microsoft to support that for every watt saved, between $4 to $5 can be saved over a five-year period, depending on cost per kWh from the utility company. It may not sound very high, but for data centers with thousands of servers it is a considerable savings.

## PUE and DCIE

All data centers refer to PUE (Power Usage Effectiveness), or DCIE (Data Center Infrastructure Efficiency). Both are metrics to determine a data center's efficiency. With a PUE of 2.0, for every 1 watt used, 1 watt is also consumed in distributing the power and cooling the data center.

With constantly varying server loads, storage and virtual server load balancing, the PUE is a constantly changing entity. PUE is affected by everything in the data center, chillers, cooling towers, pumps, humidifiers, lighting, PDU's and air conditioning. The IT equipment in the equation consists of servers, storage and network switchers, routers , etc.

Assuming a data center used 100,000 kWh of power of which 80,000 kWh is used to power the IT equipment. 100,000 kWh / 80,000 kWh gives a PUE of 1.25. Likewise, DCIE takes 80,000 kWh / 100,000 kWh = 0.8. Table 3 defines the PUE efficiency.

**Table 3. PUE and DCIE Criteria**

| PUE | DCIE | EFFICIENCY |
|---|---|---|
| 3.0 | 33% | Very Inefficient |
| 2.5 | 40% | Inefficient |
| 2.0 | 50% | Average |
| 1.5 | 67% | Efficient |
| 1.2 | 83% | Very Efficient |

The goal of course is to meet the lowest possible PUE. The larger companies in this industry, Microsoft and Google for example, will all have PUE's between 1.13 and 1.21, but as with all data centers this parameter is constantly monitored and adjustments made to the infrastructure to be efficient. High efficiency AC/DC power supplies provide an opportunity to reduce input power and increase PUE performance at the same time, with further gains that can be made in actual infrastructure changes. The EPA's estimated PUE values for 2011 are optimistic and are shown in Table 4.

| SCENARIO | PUE |
|---|---|
| Current Trend | 1.9 |
| Improved Operations | 1.7 |
| Best Practices | 1.3 |
| State of the Art | 1.2 |

**Table 4. EPA PUE Estimated Targets.**

All businesses are now focused on reducing the utility bill, maximizing the efficiency right through the data center, taking the next logical step in reporting their C02 savings, and reporting eco-responsibilities.

Users of high power servers consist of a large spectrum of businesses,

- Server farms and data centers
- Corporate campuses
- Banks and government offices
- Telecommunication businesses
- Government buildings
- Universities and public schools

# How Many Servers In A Data Center?

To assess the total market penetration of high efficiency power supplies in the data center the question asked is, "How many servers are there in a data center?" To answer this let us look at a growing server business user, Facebook.

Facebook began in April 2008. From inception to the end of 2009 the number of servers in the Facebook data center rose to 30,000, as confirmed by Jeff Rothschild, Facebook's VP of Technology. This number continues to grow as the company grows capacity each day.

Facebook is now amongst the largest internet companies, as far as comparing those who have revealed their infrastructure.

Table 5 provides an insight into the number of servers in the top companies who have disclosed their usage. This data does not include official unpublished companies, or Google, HP, and Microsoft whose estimated servers amount to an unconfirmed or out-of-date record of 65,000, 380,000 and 500,000, respectively.

**Table 5. Number of servers declared.**

| COMPANY | NUMBER OF SERVERS | CONFIRMED BY |
|---|---|---|
| Intel | 100,000 | Intel Feb. 2010 |
| 1 & 1 Internet | 70,000 | 1 & 1 Feb. 2010 |
| OVH | 65,000 | OVH Feb. 2010 |
| Rackspace | 56,671 | Rackspace Feb 2010 |
| The Planet | 48,500 | The Planet Feb 2010 |
| Akami | 48,000 | Akami Feb. 2010 |
| Facebook | 30,000 | Facebook Feb. 2010 |
| SBC Communications | 29,193 | Netcraft |
| Verizon | 25,788 | Netcraft |
| Time Warner Cable | 24,817 | Netcraft |
| SoftLayer | 21,000 | Softlayer |
| AT & T | 20,268 | Netcraft |
| Peer 1 | 10,277 | Peer 1 |
| iWeb | 10,000 | iWeb |

Over time all these servers will make use of Platinum or better than Platinum power supplies, dramatically reducing C02 emissions, reducing customers utility bills, and improving the PUE for the data centers.

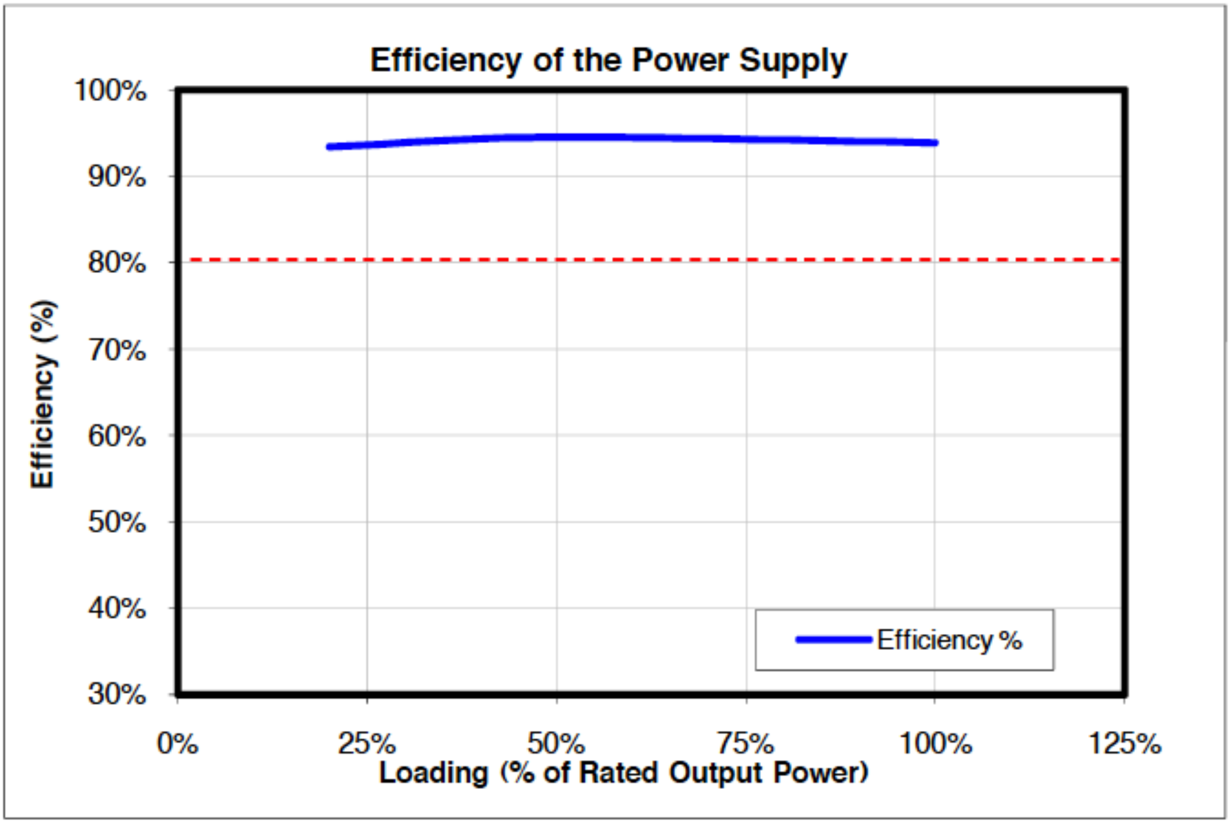
# PFE1100-12-054NA Efficiency

With energy consumption, cost and availability of traditional power generation, the importance of energy efficient designs and reduced power consumption has never been more important. The 80 Plus and Climate Savers organizations strived to improve the usage of power by implementing worldwide standards that became known as Bronze, Silver, Gold and now Platinum power levels.

The PFE1100-12-054NA power supply not only surpasses Platinum requirements but achieves it in a dense form factor. Of the different 54 mm power supplies tested from different power vendors, the PFE1100-12-054NA
exceeds all others in power capabilities by 250 W

When tested by EPRI, the performance of the PFE power supply demonstrates an almost flat efficiency curve across the load range. The data provided by EPRI is shown in Figure 2.

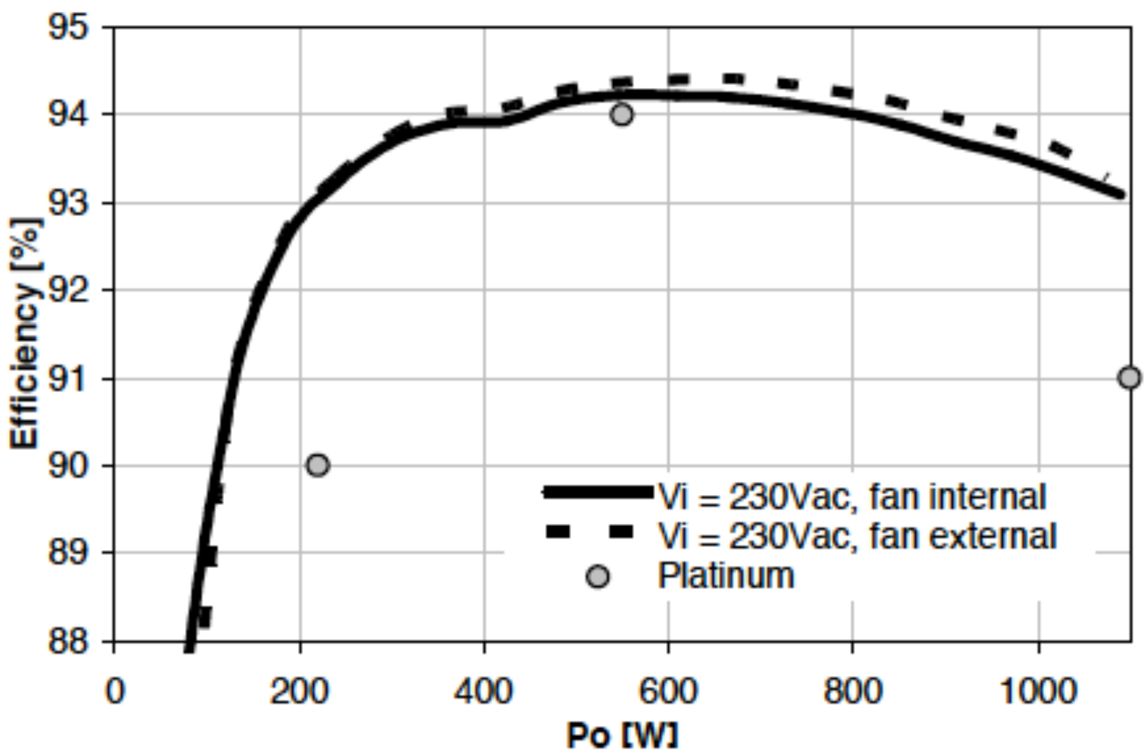
**Figure 2. EPRI Efficiency Curve of PFE1100-12-054NA**




| PF | ITHD | LOAD | I/P W | FAN W | 12V/I | 5V/I | O/P W | EFF. |
|---|---|---|---|---|---|---|---|---|
| 0.83 | 18.92 | 10% | 122 | 0.72 | 12.02/9.06 | 5.01/0.32 | 110 | 90.33% |
| 0.96 | 13.38 | 20% | 236 | 0.84 | 12.01/18.11 | 5.01/0.65 | 221 | 93.38% |
| 1.00 | 5.70 | 50% | 582 | 2.16 | 11.99/45.2 | 4.99/1.63 | 550 | 94.50% |

| PF | ITHD | LOAD | I/P W | FAN W | 12V/I | 5V/I | O/P W | EFF. |
|---|---|---|---|---|---|---|---|---|
| 1.00 | 4.51 | 100% | 1168 | 5.52 | 11.95/90.36 | 4.96/3.26 | 1096 | 93.86% |

The importance of structured efficiency, in that power supplies efficiency curves are as flat as possible is paramount to meeting the load issues that servers represent; this helps address load variables as the servers respond to peak and idle power demands.




Some more recent data points indicate a 10-degree thermal reduction doubles mean time between hardware failures, add this to power savings to run the servers and air-conditioning-costs to cool the server farms and the cost in kWh begins to become significant. As the PFE1100-12-054NA dissipates less heat, it contributes to the continuing cause in driving data centers to a higher ambient to reduce air-conditioning-costs.

# Energy Savings Using PFE1100-12-054NA

The following section details the energy effects using the PFE1100-12-054NA in a data center environment. Table 5 detailed the server count for key companies. A rack of servers using 1100 W power supplies would not be a typical x86 server; the power in these servers is more typically between 450 W to 850 W

This paper will demonstrate how much energy and carbon emissions are reduced in a single-rack configuration and a 10-rack configuration, with both examples using the PFE power supply.

This example details systems requiring 1U redundant 1100 W front ends. The system power budget for this example is set at 850 W maximum per server and the rack contains 40 x 1U servers.

Data center PUE for this example is set at 1.9, (defined as current trend by the EPA as shown in Table 4), with the cost of electricity at 11 cents per kWh. Workload for each server has been set as a variable load between 20% and 50% load of a single 1100 W supply, with the load shared 50:50 by the redundant PSU.

Power and climate comparison data is shown for each product across the Climate Saver specifications, Silver, Gold, Platinum, and PFE1100-12-054NA. The baseline for all calculations is the Silver requirement as defined in Table 6.

**Table 6. Overview for power and climate example.**

| Power Supply Detail | |
|---|---|
| Power Supplies In Rack (1100 W each) | 80 |
| Servers in Rack | 40 x 1U |
| Number of Racks | 10 |
| Efficiency @20% Load Each PSU | 93.6% |
| Efficiency @50% Load Each PSU | 94.7% |
| Efficiency @100% Load Each PSU | 94.2% |
| Product Life (Years) | 5 |
| PUE | 1.5 |
| **System Rack Detail** | |
| Design Load (PSU Capability) | 34,000 W per rack |
| Actual Power required based on load | 11,900 W per rack |
| Redundancy | Yes |
| Load | Average (20-50%) |
| **Environmental Data** | |
| Electricity Cost ($/kWh) | $0.11 |
| CO2 kg/kWh (EPA Data Point) | 7.18 x 10-4 metric tons CO2 / kWh |

## PFE1000-12G and Climate Savers Comparisons per Standalone Rack.

Table 7, and Figure's 3 and 4 detail the standalone rack differences when comparing different efficiency grade power supplies. One rack of 40 x 1U servers, total power supplies = 80.

**Table 7. One Rack of 40 servers.**

| | SILVER (BENCHMARK) | GOLD | PLATINUM | PFE1100-12-054NA |
|---|---|---|---|---|
| Rack Load Power Budget | 34 kW | 34 kW | 34 kW | 34 kW |
| Server Rack Loading. Average 20% to 50% Load | 11,900 W | 11,900 W | 11,900 W | 11,900 W |
| Total C02 Emissions over 5 Years | 430 Tons | 416 Tons | 407 Tons | 397 Tons |
| C02 Saved over 5 Years | | 14 Tons | 23.38 Tons | 32.67 Tons |
| Energy Used over 5 Years | 599.1 Megawatts | 579.1 Megawatts | 566.5 Megawatts | 553.6 Megawatts |
| Energy Saved over 5 Years | | 19.97 Megawatts | 32.56 Megawatts | 45.50 Megawatts |
| Utility Savings over 5 Years (OPEX) | | $2197 | $3582 | $5005 |

**Figure 3**

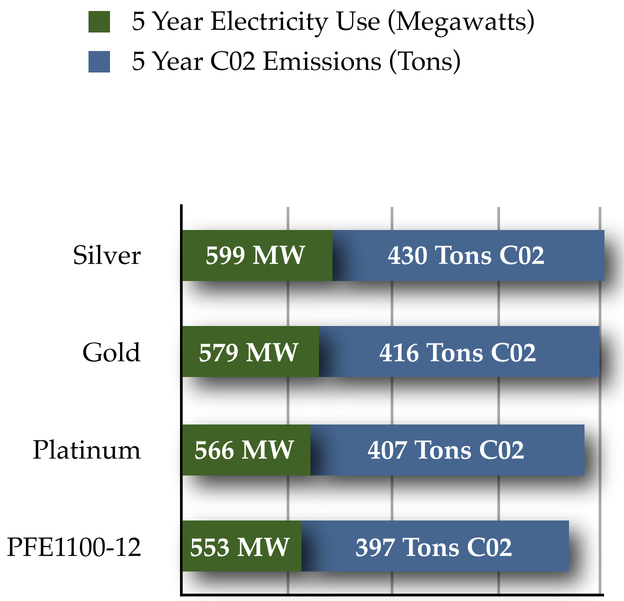
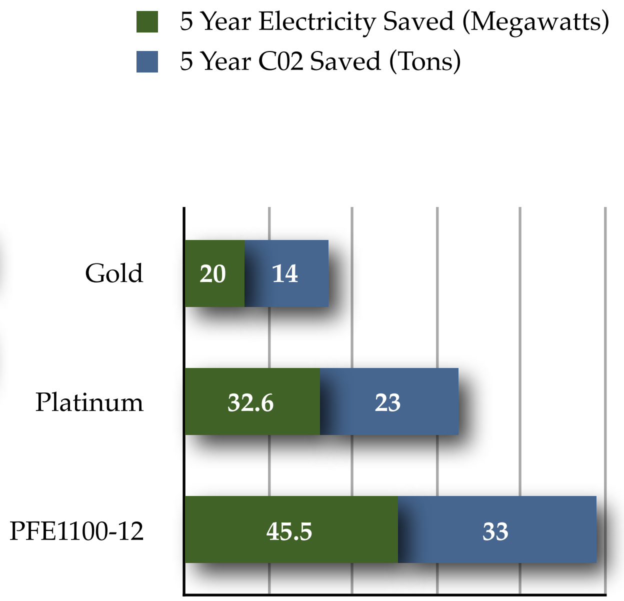



**Figure 4**



## PFE1000-12G and Climate Savers Comparisons per 10 Rack Upgrade.

Table 8, and Figure's 5 and 6 detail the standalone rack differences when comparing different efficiency grade power supplies. Ten racks of 40 x 1U servers, total servers 400, total power supplies = 800.

**Table 8. CSCI comparisons per 10 standalone racks.**

| | SILVER (BENCHMARK) | GOLD | PLATINUM | PFE1100-12-054NA |
|---|---|---|---|---|
| Total IT Load Power Budget | 340 kW | 340 kW | 340 kW | 340 kW |
| Total IT Loading. Average 20% to 50% Load | 119 kW | 119 kW | 119 kW | 119 kW |
| Total C02 Emissions over 5 Years | 4,302 Tons | 4,158 Tons | 4,068 Tons | 3,975 Tons |
| C02 Saved over 5 Years | | 143 Tons | 234 Tons | 327 Tons |
| Energy Used over 5 Years | 5991 MW | 5791 MW | 5665 MW | 5536 MW |
| Energy Saved over 5 Years | | 199 Megawatts | 325 Megawatts | 455 Megawatts |
| Utility Savings over 5 Years (OPEX) | | $21,967 | $35,816 | $50,047 |

**Figure 5**

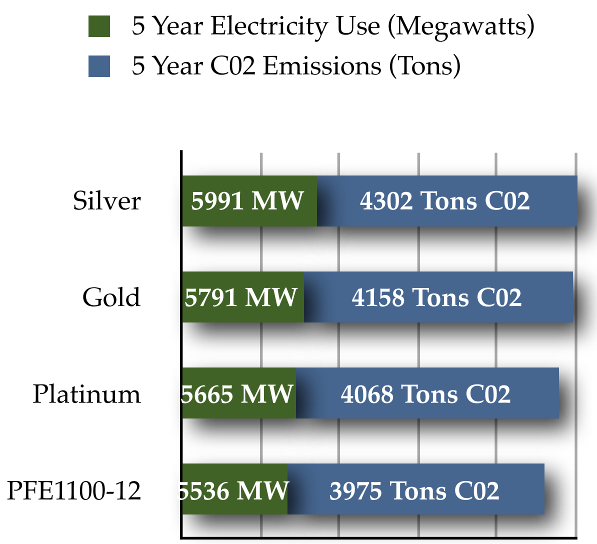
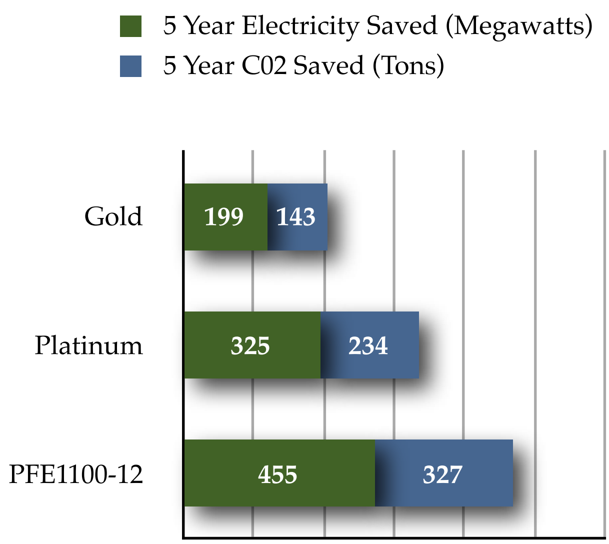



**Figure 6**




As the lower power variants of the PFE1100-12-054NA become available, when implemented in standard x64 racks, the expected cumulative savings would be significant, both from a C02 perspective, as well as the dollar cost perspective.

# Power Savings in the Data Center.

Data center PUE for this example is set at 1.9 (refer to Table 9 for EPA 2011 target details), with the cost of electricity at 11 cents per kWh. Calculations refer to the full set of 10 upgraded racks (defined on page 13) to run with the PFE1100-12-054NA.

Data centers take steps to maximize efficiency in the application of fans, chillers, UPS, PDU's , etc. Sometimes selecting the best hardware can provide better energy, carbon and cost savings. The mechanical cooling systems are left to remove the heat from a data center. The Coefficient of Performance (CoP) defines the efficiency of these criteria. If it takes 400 W to remove 1000 W of heat, then the CoP is 0.4 or 40%.

A data center has to allocate the worst case power draw from a rack of servers. From the IT load a facility load is calculated, this changes relative to the PUE.

High efficiency server power supplies will reduce the IT load, also then reducing the facility and assisting with the other infrastructure changes throughout the ongoing process of PUE reduction.

**Table 9. EPA PUE Estimated Targets.**

| SCENARIO | PUE |
|---|---|
| Current Trend | 1.9 |
| Improved Operations | 1.7 |
| Best Practices | 1.3 |
| State of the Art | 1.2 |

Taking the example from Table 7 and applying a 100 rack data center example would provide the following data shown in Table 10.

**Table 10. Power loading for 100 racks.**

| | SILVER (BENCHMARK) | GOLD | PLATINUM | PFE1100-12-054NA |
|---|---|---|---|---|
| Individual Rack Load | 34 kW | 34 kW | 34 kW | 34 kW |
| Worst case load from 100 racks | 3400 kW | 3400 kW | 3400 kW | 3400 kW |
| Number of Power Supplies | 8000 | 8000 | 8000 | 8000 |
| Input Power 100 Racks. | 3908 kW | 3777 kW | 3695 kW | 3611 kW |

The data center C02 and utility costs applicable to the data in Table 10, and running with a current PUE of 1.9 would translate as shown in Table 11. As the efficiency of the power supplies increases, the input power required is lower. This in turn leads to a lower facility power requirement to cool the servers.

**Table 11. Energy and C02 calculations for 100 racks.**

| PUE 1.9 | SILVER (BENCHMARK) | GOLD | PLATINUM | PFE1100-12-054NA |
|---|---|---|---|---|
| Individual Rack Load | 34 kW | 34 kW | 34 kW | 34 kW |
| Worst case load from 100 racks | 3,400 kW | 3,400 kW | 3,400 kW | 3,400 kW |
| Number of PSU's | 8000 | 8000 | 8000 | 8000 |
| Total IT Load Input Power | 3908 kW | 3,777 kW | 3695 kW | 3611 kW |
| Total Facility Load | 7,425 kW | 7,176 kW | 7,021 kW | 6861 kW |
| Electricity kW Per Year | 65,044,752 kW | 62,864,388 kW | 61,499,580 kW | 60,101,484 kW |
| Electricity Costs Per Year | $7,154,923 | $6,915,083 | $6,764,954 | $6,611,163 |
| Electricity Cost Savings | | $239,840 | $389,969 | $543,760 |
| C02 Footprint | 39,221 Tons | 37,907 Tons | 37,084 Tons | 36,241 Tons |
| C02 Savings | | 1,314 Tons | 2,137 Tons | 2,980 Tons |

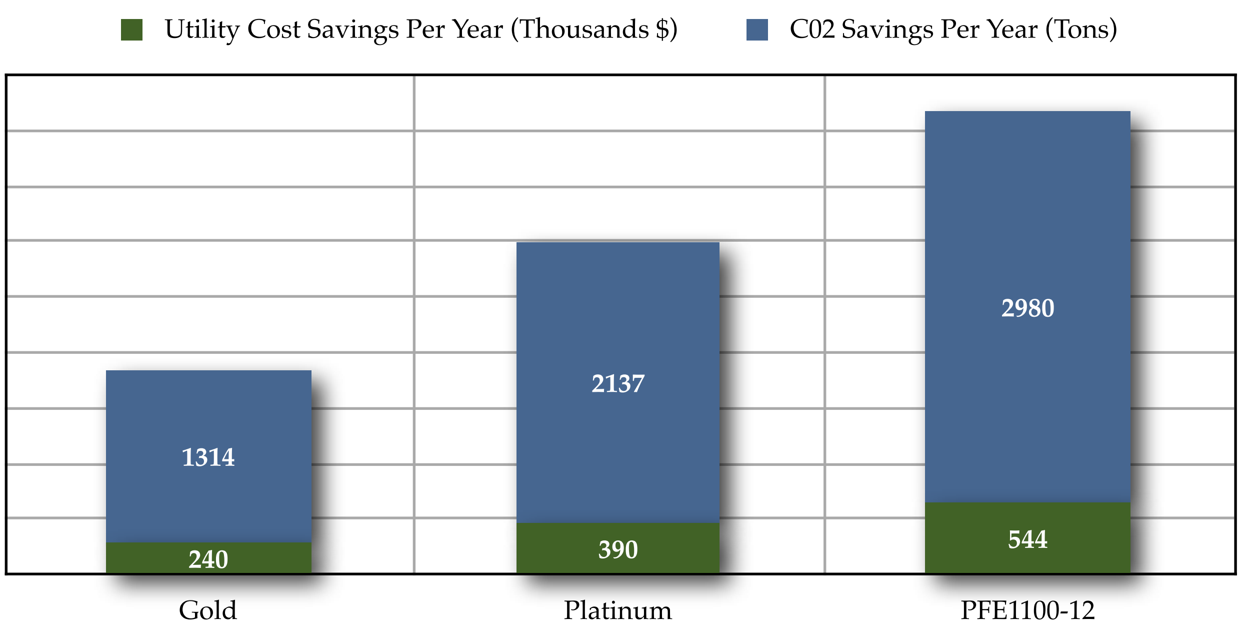



**Figure 7. Graphical data of C02 and Utility cost savings from Table 11.**

Figure 7 demonstrates the considerable environmental and utility cost savings using high efficiency power conversion.

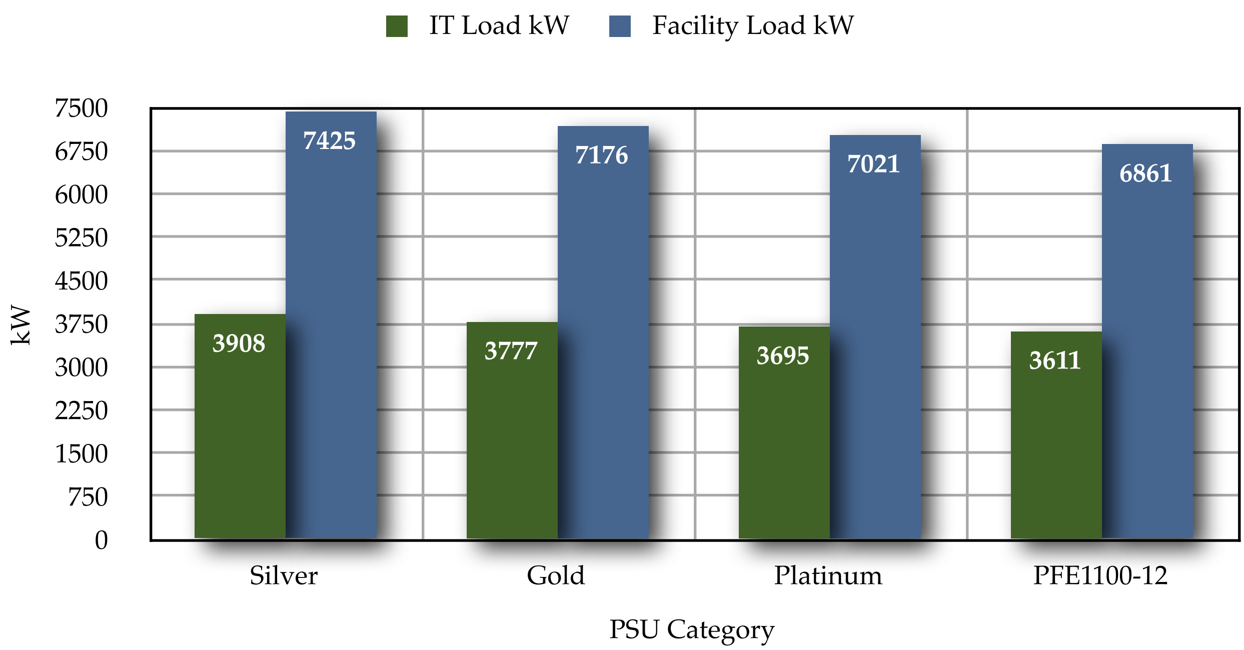



**Figure 8. Graphical data of IT Loads and Facility Loads from Table 11.**

Figure 8 demonstrates the IT load versus the facility load. As PSU efficiency increases, IT load and Facility loads both drop.

# Using the PFE1100-12-054NA to reduce PUE.

Data centers are working toward the same goals of reducing PUE and increasing operating efficiencies. To some extent the PFE1100-12-054NA has a positive effect to reducing PUE. The following data shows what is required in order for a data center currently using Silver category front ends to drive to a PUE of 1.2 from 1.9, and how this translates to energy and C02 over time.

Table 12 shows the energy and carbon improvements that have to be met in driving this 100-rack example data center from a PUE of 1.9 to a respectable 1.2

**Table 12. Energy and PUE savings to be met to move from a PUE of 1.9 to 1.2**

| | SILVER (PUE 1.9) | EFFICIENCY GOAL PUE 1.2 |
|---|---|---|
| Total IT Load Input Power | 3908 kW | 3908 kW |
| Total Facility Load | 7,425 kW | 4690 kW |
| Electricity kW Per Year | 65,044,752 kW | 41,080,896 kW |
| Electricity Costs Per Year | $7,154,923 | $4,518.899 |
| C02 Footprint | 39,221 Tons | 24,771 Tons |

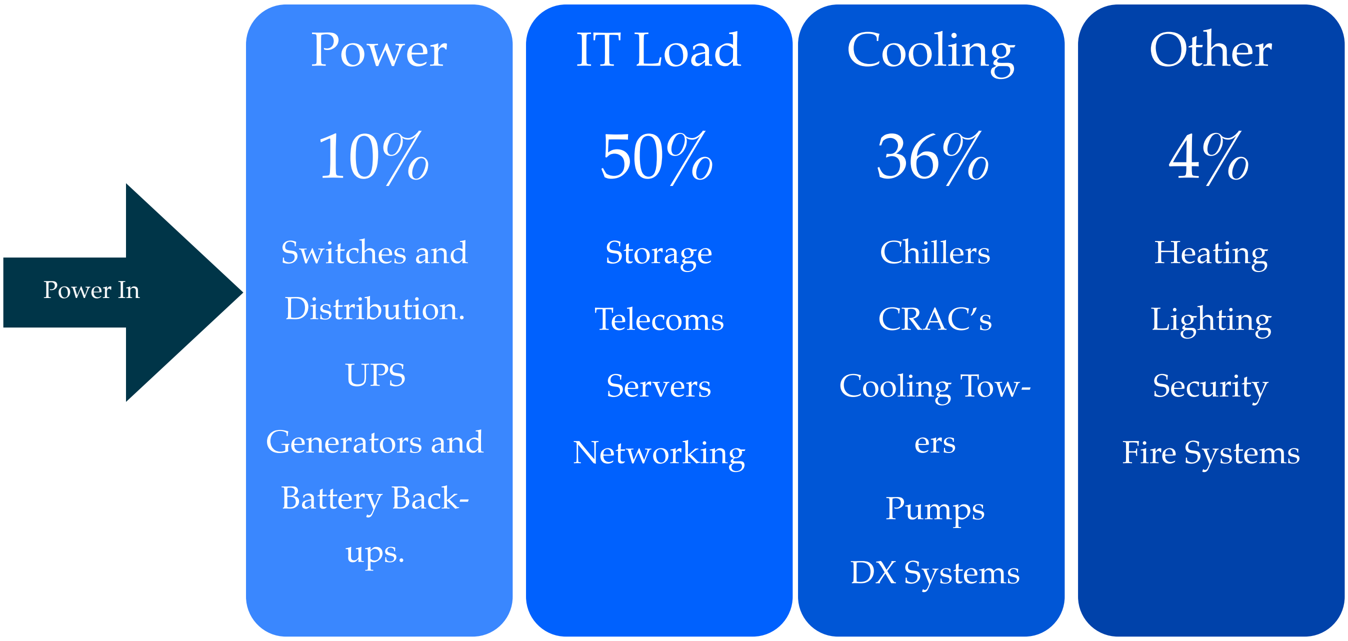
Improving PUE involves changes throughout the data center. Improving the efficiency of everything that consumes power, right down to the lighting is taken into account. Energy plans have to be continually monitored and tweaked, making sure system stability and uptime is not affected.

Data center efficiency is not optimized once then left alone; these are dynamic environments. Thermal probes, sensors and power meters are installed in great numbers to control the power usage and understand carbon emissions.

Changes are also achieved with the replacement of older technology, but modern blades and high power volume servers can present a challenge when densely packed in the data center.

The sequence of power consuming equipment is shown in Figure 9.

**Figure 9. Data Center Losses**




Each of the items will be adjusted or replaced in the effort to gain higher PUE.

The PFE1100-12-054NA plays an important part. In this 100 server rack example, replacing all 8000 power supplies from a silver grade is equivalent to increasing the PUE performance from 1.9 to 1.76, (defined as improved operations by EPA), and a 7.36% improvement.

The power supply enables data center managers to make an instant gain in the drive towards higher efficiency power.

**Table 13. Replacing the 100 rack example with PFE1100-12-054NA power supplies.**

| | SILVER PUE 1.9 | PFE1100-12-054NA UPGRADE<br>PUE 1.76 | EFFICIENCY GOAL PUE 1.2 |
|---|---|---|---|
| Total IT Load Input Power | 3908 kW | 3908 kW | 3908 kW |
| Total Facility Load | 7,425 kW | 6861 kW | 4690 kW |
| Electricity kW Per Year | 65,044,752 kW | 60,101,484 kW | 41,080,896 kW |
| Electricity Costs Per Year | $7,154,923 | $6,611,163 | $4,518.899 |
| C02 Footprint | 39,221 Tons | 36,241 Tons | 24,771 Tons |

Table 14 details the data center center efficiency savings derived from Table 13.

**Table 14. Data center efficiency savings in replacing 100 racks with Silver Grades to PFE1100-12-054NA power supplies.**

| REDUCTION IN | KILOWATTS | UTILITY COSTS | C02 EMISSIONS | EQUIVALENT TO |
|---|---|---|---|---|
| 1 Year | 4,792,771 kW | $527,205 | 2,890 Tons | 545 Fewer Cars |
| 5 Years | 23,963,856 kW | $2,636,024 | 14,450 Tons | 2,726 Fewer Cars |
| 10 Years | 47,927,712 kW | $5,272,048 | 28,900 Tons | 5,453 Fewer Cars |

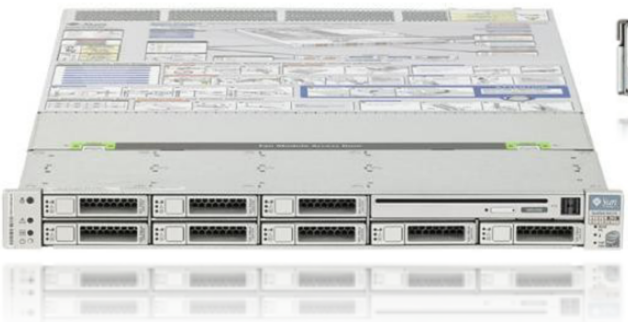
# 1U 54 mm Mechanical Form Factor

The form factor for this power supply is 54 mm (w) x 322 mm (l) x 40 mm (h). The length is traditionally longer than the majority of server power supplies, but this frees up space for larger motherboards and more I/O functionality. At 54mm wide, side by side in a redundant configuration, they fit into a 19-inch rack mounted server and allow a 12-inch motherboard to be fitted.

Three servers are evaluated for power supply size and server feature sets in order to evaluate the possible benefits of a 54mm wide power supply.

### Sun Microsystems X4170

**PSU 54 mm x 322 mm x 40 mm. PSU plugs into PDB.**



### HP ProLiant DL360 G6

**PSU 86 mm x 196 mm x 40 mm. PSU plugs directly into motherboard.**

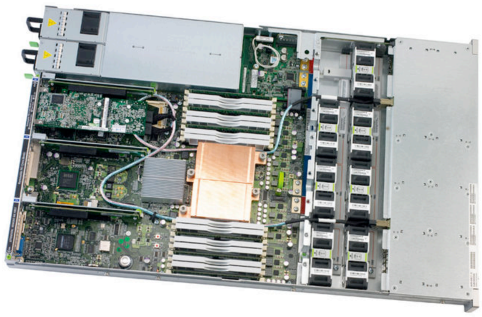
### Dell Power Edge R610

**PSU 65 mm x 250 mm x 40 mm. PSU plugs directly into motherboard.**

Narrower power supplies pave the way for wider motherboards and increased functionality, providing more functionality into each server. The Sun X4170, for example has one extra PCI-E slot, this equates to 4000 extra slots in the 100 server example in this document. The X4170 clearly demonstrates a wider motherboard. Table 15 provides comparisons of the servers' specifications.

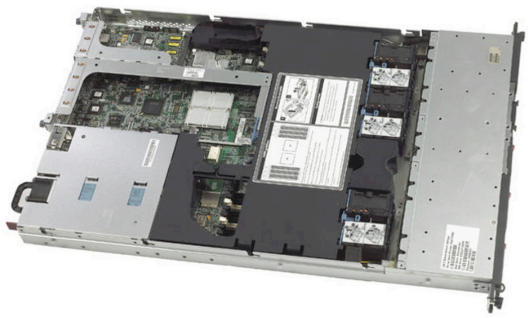
**Sun Microsystems X4170**

**650W /760W 54mm wide.**



**HP ProLiant DL360 G6**

**460W, 750W and 1200W 86mm wide.**



**Dell Power Edge R610**

**502W and 717W 65mm wide.**

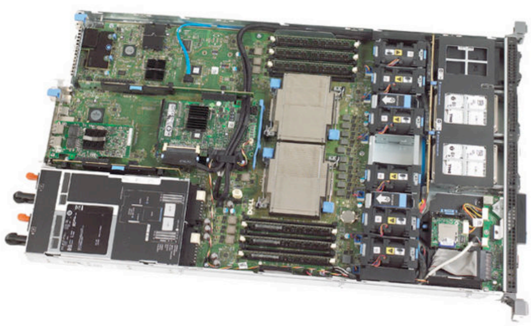


**Table 15. Side by side server comparisons.**

| | HP DL360 | DELL R610 | SUN X4170 |
|---|---|---|---|
| CPU | 2 | 2 | 2 |
| DDR MAX | 144 Gb | 96 Gb | 144 Gb |
| DDR Slots | 18 | 12 | 18 |
| Hard Drives | SATA/SAS | SAS/SSD | SAS/SSD |
| Hard Drive Bays | 8 | 6 | 8 |
| Raid | 3 Types | 2 Types | 9 Types |
| Hot Swap Disks | Yes | Yes | Yes |
| DVD | Yes | Yes | Yes |
| I/O | 1 x 16 PCI-e<br>1 x 8 PCI-e | 2 x 8 PCI-e | 1 x 16 PCI-e<br>2 x 8 PCI-e |
| Networking | 1 x Dual Gigabit | 2 x Dual Gigabit | 4 x Gigabit |
| Hot Swap Fans | No | No | Yes |
| Hot Swap PSU | Yes | Yes | Yes |

# Conclusions

This paper demonstrates the benefits of implementing the PFE1100-12-054NA in the server environment. Table 16 shows the data for Climate Savers Silver, Gold and Platinum. It demonstrates the PFE1100-12-054NA's
achievement in exceeding the Platinum specification. The efficiency data in Table 16 is the actual data recorded by EPRI when this power supply was submitted for 80 Plus, Energy Star and CSCI compliance.

The design is optimized where the load really counts, between 10% and 50% of the load. As the majority of servers operate in this area this is the most sensible load range to optimize a power supply. Having said that, the difference in efficiency across the entire load range from 20% to 100% load is within 1.12%, and from 10% load to 100% is just over 4%.

**Table 16. PFE1100-12-054NA efficiency compared to CSCI requirements.**

| LOAD | SILVER | GOLD | PLATINUM | PFE1100-12-054NA | EXCEEDS PLATINUM BY |
|---|---|---|---|---|---|
| 10% | 75% | 80% | 82% | 90.33% | 8.33% |
| 20% | 85% | 88% | 90% | 93.38% | 3.38% |
| 50% | 89% | 92% | 94% | 94.50% | 0.5% |
| 100% | 85% | 88% | 91% | 93.86% | 2.86% |

The benefits of the 54mm dimension have been shown to increase system I/O capabilities , (the limit in that form factor, has up to now, been down to the maximum power density that could be achieved), as the motherboard width can increase to 12 inches.

54mm wide designs have been in the marketplace at power ranges from 500W to 850W, but that remained the limit, as the primary drive in designing for higher power was the efficiency. Server power supplies as narrow as 54mm require optimum efficiency as the airflow will never be optimum. Typically the PSU fan has to draw air from the output connector toward the AC inlet connector, with heat sinks, electrolytics, and magnetics restricting that airflow throughout the enclosure.

OEM's embracing this design, can, in turn develop energy efficient hardware, and with expected models being available in 600W, 850W and 1100W outputs, with identical connectors and pinouts, the ability to scale up and down in power levels while retaining form fit and function is invaluable.

The implementation of this power supply is a good solution for the entire supply chain, from the manufacturers, to the OEM's and in turn the end users. The efficiency of the unit enables utility and C02 reductions to be realized, the mechanical dimensions allow for more flexibility with the motherboard design, and the data center managers can realize improvements towards system performance and feature sets while achieving invaluable PUE reductions.