HP Power Advisor utility: a tool for estimating power requirements for HP ProLiant server systems

technology brief

Abstract 2

Introduction 2
- Key power parameters 2
  - Input line voltage 2
  - Device VA rating 2
  - Device input power 3
  - BTUs required for cooling 3
  - Input/inrush current 3
  - Leakage current 3
- Determining power needs and achieving power efficiency 3

HP Power Advisor 5
- Calculator development 5
- Calculator functionality 5

Example power calculations 10
- Rack configuration with HP DL160 G6 servers 10
- Rack configuration with HP DL380 G6 servers 13
- Rack configuration with the HP c-Class BladeSystem 16

Conclusion 21
  - Do use the Power Advisor for: 21
  - Do not use the Power Advisor for: 21

For more information 22

Call to action 22

Abstract

With power requirements of computing equipment increasing and the cost of energy rising, IT organizations need accurate estimates of power and cooling requirements for designing and expanding data centers. HP has created the HP Power Advisor utility to provide more accurate and meaningful estimates of power needs for HP ProLiant BL, DL, and SL systems so that IT infrastructure designers can determine the most efficient hardware configuration. This technology brief identifies factors affecting power requirements, explains how the Power Advisor works, and provides an example of how it can be used.

Introduction

As information technology evolves and system density increases, systems housed in a single rack can now consume the amount of power once required for several racks. Effective sizing of a compute infrastructure while managing IT costs requires realistic estimates of current and future power and cooling requirements. Accurately estimating the power consumption of a server rack can define power distribution requirements at the rack level and can be the starting point for estimating the total power consumption and cooling needs for a data center.

The HP Power Advisor utility is a tool for calculating power use of the major components within a rack to determine power distribution, power redundancy, and battery backup requirements for computer facilities.

This document assumes that readers are familiar with basic power concepts and HP ProLiant servers.

Key power parameters

Determining total power needs for a data center requires consideration of the key parameters described in this section. More details about these parameters are available in the white paper titled "Power Basics for IT Professionals" downloadable at http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01234421/c01234421.pdf . This paper does not discuss other signification parameters such as system serviceability and scalability.

Input line voltage

Input voltage may be low-line or high-line voltage depending on what is available at the data facility. Low-line voltage [100 – 120 volts alternating current (VAC)] is the standard for AC wall outlets in North America. High-line voltage (200 – 240 VAC) is used in other parts of the world but is also increasingly common in North American data centers. Most HP ProLiant servers accept a line voltage in the 100- to 240-VAC range.

IT equipment designed to use either low-line or high-line voltage typically consumes less power and generates less heat when operating off high-line voltage, which reduces the strain on cooling systems. Some systems may actually require high-line voltage to meet maximum performance specifications. Facilities may distribute AC power as single- or three-phase. Three-phase high-line power (such as 3-phase 208 VAC) is more efficient and recommended for systems requiring three kilowatts of power or more.

Device VA rating

Apparent power is the total amount of power a device requires from the facility AC feed and is measured in volt-amperes (VA). Knowing the total amount of VA for all active components in a system helps data center planners determine the types and quantities of power distribution units (PDU) and uninterruptible power supplies (UPS) needed for a given rack configuration.

Device input power

The amount of power a device turns into work and dissipates as heat is known as real (or true) power and is measured in watts (W). Since any heat created by electrical equipment must be extracted, knowing the total amount of watts dissipated by systems in a data center helps determine the cooling capacity needed in the facility.

BTUs required for cooling

The British Thermal Unit (BTU) is the standard for measuring the capacity of cooling systems. The amount of power (watts) consumed by equipment determines the number of BTUs/hr required for component cooling, based on this formula:

BTUs/hr = watts x 3.41.

For example: 399 watts x 3.41 = 1360 BTUs/hr

Air conditioning equipment is typically rated in terms of tons of cooling, an old measurement based on the cooling ability of tons of ice (1 ton of cooling = 12000 BTUs/hr).

Input/inrush current

Input current is the amount of amperes a system draws during normal operation. However, when AC voltage is first applied (power cord is plugged in and/or a circuit breaker is switched on), power supplies of electrical components can momentarily draw several times more current than they will draw while operating. This inrush current is cumulative across devices within a common power circuit, and it must be considered when building a rack. Power supplies in HP servers include circuitry that minimizes inrush current. Staggering activation of segmented circuits can further reduce the effects of inrush current.

Leakage current

Leakage current (typically measured in milliamps) is residual current that originates in power supply filters and flows from chassis ground to the phase and neutral power conductors. Leakage current is cumulative across components within a power distribution circuit and can become a hazard if proper grounding procedures are not used.

Determining power needs and achieving power efficiency

Power supplies for ProLiant servers include a chassis nameplate that typically includes the following information:

- Input requirement—the AC input voltages (or ranges) and associated maximum current draw
- Output power—the DC voltage, maximum current (amperage), and maximum power (wattage)

Nameplate ratings, therefore, define the input requirements of a power supply operating at full power. Since power supplies rarely operate at their rated capacity, using nameplate ratings for estimating system power requirements could yield inflated numbers that result in excessive power infrastructure costs.

Figure 1 illustrates how the use of nameplate ratings can distort power distribution planning. The ProLiant DL380 G6 implements the HP Common Slot Power Supply bay. This bay design, used across several ProLiant platforms, can accommodate 460W, 750W, and 1200W power supplies.

Factory configurations of the DL380 G6 include models equipped with 460W and 750W, and customers can build or specify custom configurations. Customers building a system with custom-configured DL380 G6 servers might choose the 750W power supply to ensure headroom for server needs and use the associated nameplate ratings as a guide for power distribution needs. This approach yields nameplate ratings-based figures that will likely be unrealistically high. As indicated in

the table of Figure 1, the total amperage and VA figures based on the nameplate ratings of the 750W power supply suggest that substantial power distribution components would be necessary, particularly if power redundancy is required.

Figure 1. Rack loading with 20 ProLiant DL380 G6 servers using 750W power supplies (PSs)

	Nameplate ratings-based	**Actual operating needs**
Wattage per PS unit	750 W	300 W
AC input current per PS unit (@ 208VAC)	4.5 A	1.38 A
Total rack wattage	15kW	6kW
Total rack current	90 A	27.6 A
Total input VA (estimated)	15 – 17kVA	6 – 7kVA

However, measurements of test configurations reveal that the actual operating needs of a given DL380 G6 configuration can be less than half the power that nameplate ratings of the 750W power supply indicate. This means fewer power distribution components are needed, and it reveals the possibility of a better power supply solution.

The efficiency of a power supply is determined by how much AC input power is needed to produce a given amount of output power. A power supply requiring 300 watts input to produce 250 watts of output is operating at approximately 83 percent efficiency (250 / 300 = .83). The 50-watt energy delta between the input and output is lost as heat, which must be removed by the cooling equipment.

Power supply efficiency is not linear or flat across the output range, and most power supplies achieve maximum efficiency when they operate in the mid to upper range of their rated capacity. A 750-watt power supply providing 300 watts (40 percent capacity) is less efficient than a 460-watt power supply providing the same 300 watts of power (65 percent capacity). In choosing the most efficient (right-sized) power supply for a server, an accurate power consumption estimate for that server is important, particularly for a large (enterprise) data center where cumulative energy losses from a number of servers can be significant.

The most accurate power consumption predictions are those obtained by pre-configuring and measuring actual systems under load. This method of obtaining data is usually impractical for customers since it would require purchasing, setting up, configuring, and running of each component to acquire the measurements. HP has tested server products under various configurations and loads to determine actual power requirements. The results of these tests are the foundation in creating the HP Power Advisor.

HP Power Advisor

The HP Power Advisor utility reduces the research and guesswork normally involved in determining power requirements for ProLiant-based systems. Using the HP Power Advisor, an IT administrator can build a complete system, component-by-component and rack-by-rack, assembling a complete infrastructure.

NOTE:
HP Power Advisor is intended to be a conservative estimator of power. No two applications will consume exactly the same amount of power. Even programs that report the same CPU utilization will have different power consumption characteristics, based on the exact mix and sequence of instructions being executed. The programs used as the measurement reference for the HP Power Advisor are intended to consume more power than typical user applications.

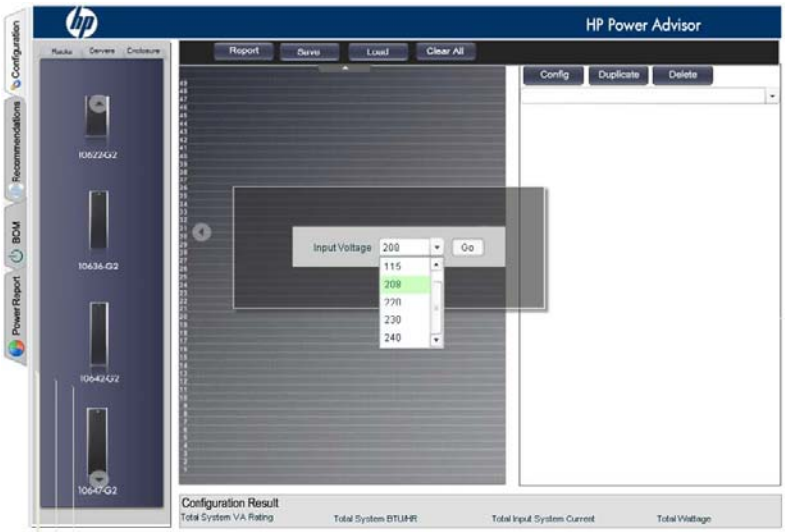
Calculator development

HP developed the HP Power Advisor using data collected from testing HP ProLiant servers. Each test starts with a system fully configured with the maximum number of processors, memory, hard drives, expansion cards, and power supplies. Proprietary software exercises the processors to the highest possible power level and operates all peripherals while taking voltage and current measurements. Testing continues for all levels of processor support at all speeds, with different memory amounts and hard drive sizes. During development cycles, HP retests revised or updated servers to ensure calculator integrity.

Calculator functionality

The calculator is a simple drag-and-drop tool. Figure 2 shows the main screen of the HP Power Advisor. A drop-down menu in the center of the screen lists the choices of AC input voltage to be used by the server systems.

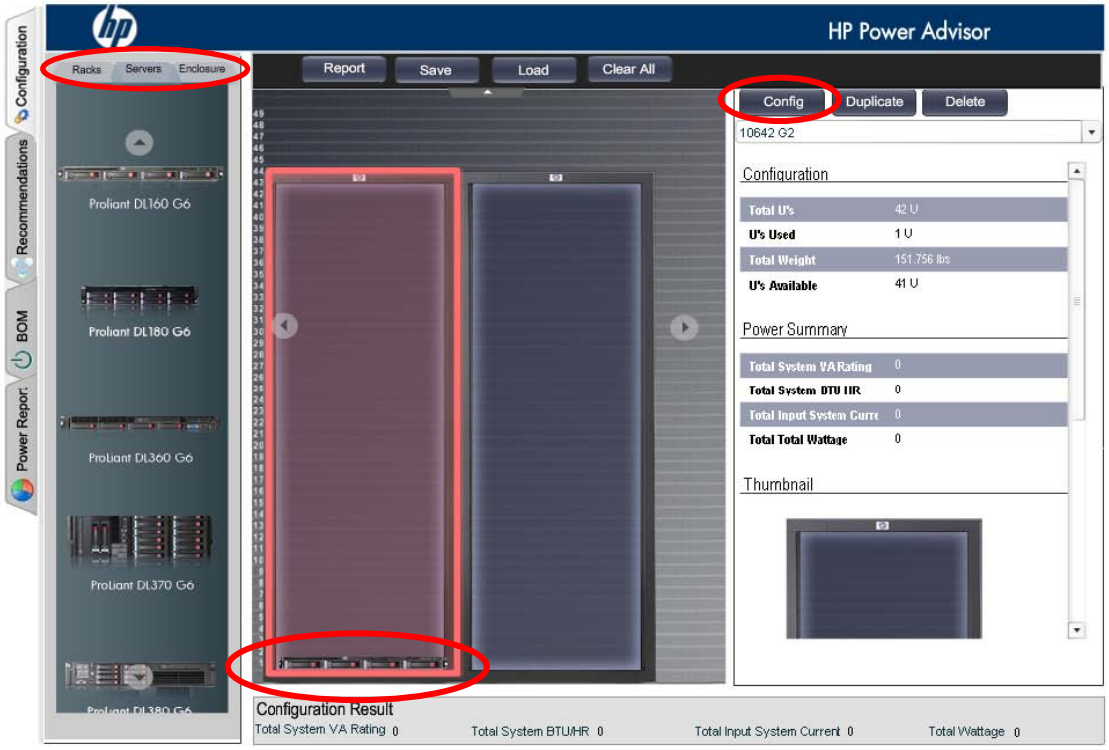
Figure 2. HP Power Advisor main screen



After selecting the line voltage, the user drags and drops the desired type of rack from the left pane (Figure 2) to the center area of the screen (Figure 3). This simple process is repeated for building a complete row of the same type of rack or a row of mixed rack types.

Next, the racks are ready to populate with components. After highlighting a rack, the user selects the **Servers** or **Enclosures** tab in the left pane area, selects the desired components, and adds them to the highlighted rack. HP ProLiant DL, SL, and some ML server chassis mount directly into the racks. For HP ProLiant BL (BladeSystem) components, the user must select a BladeSystem c-Class enclosure and then configure each enclosure with the desired components. Figure 3 shows a ProLiant DL160 G6 placed in the bottom of the first rack. A power calculation begins with selecting (highlighting) a component in a rack and clicking the **Config** tab.

Figure 3. HP Power Advisor, component selection

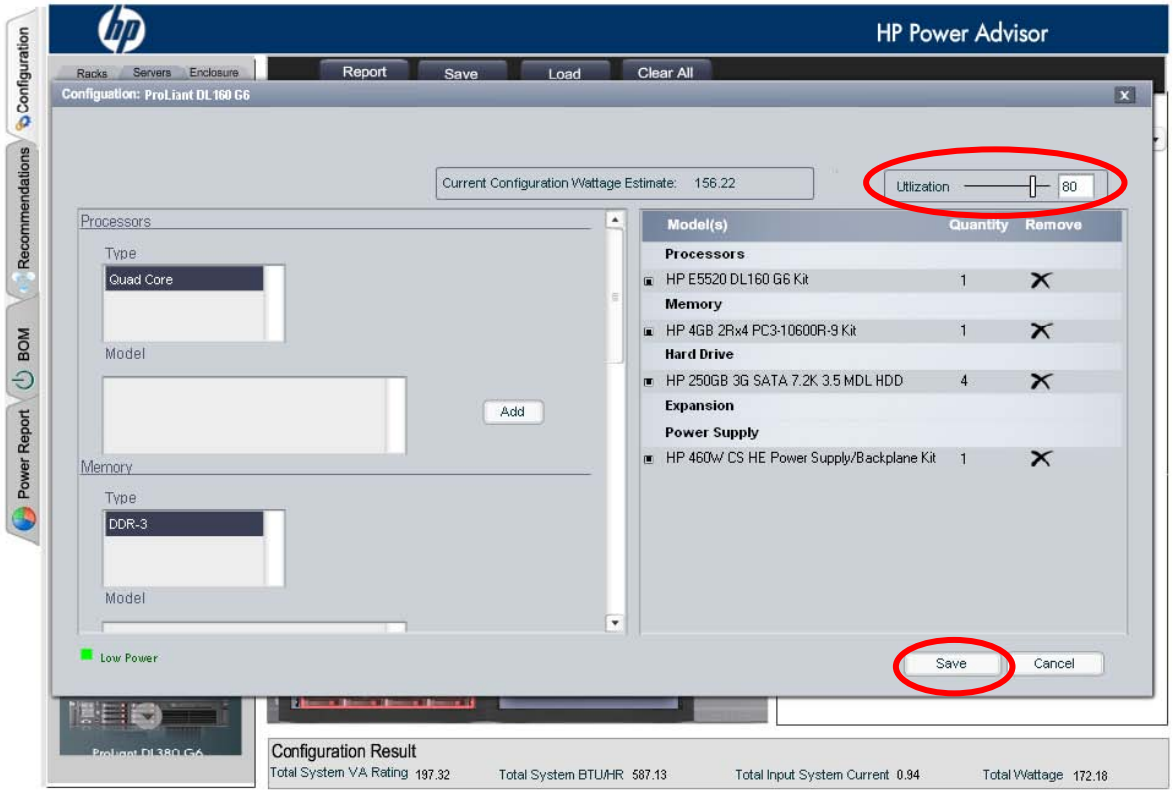


As shown in Figure 4, the HP Power Advisor allows the user to select the following components to configure each server individually:

- Processor type and number
- Amount of memory
- Drive type and number
- PCI expansion cards and/or RAID controllers (if applicable)
- Power supply type

The Power Advisor also informs the user if the selected server supports power supply redundancy.

Figure 4. HP Power Advisor, component configuration



For servers that offer a choice of power supply nameplate ratings, the Power Advisor will automatically include a power supply capable of supporting 100 percent utilization, which is the default setting for any given server configuration. As discussed earlier in the "Achieving maximum efficiency" section, a power supply with less output may be sufficient and provide higher efficiency for a configuration with an adjusted (lowered) **Utilization** setting. Once the final wattage has been determined, the user can re-configure the server for a lower capacity power supply if appropriate.

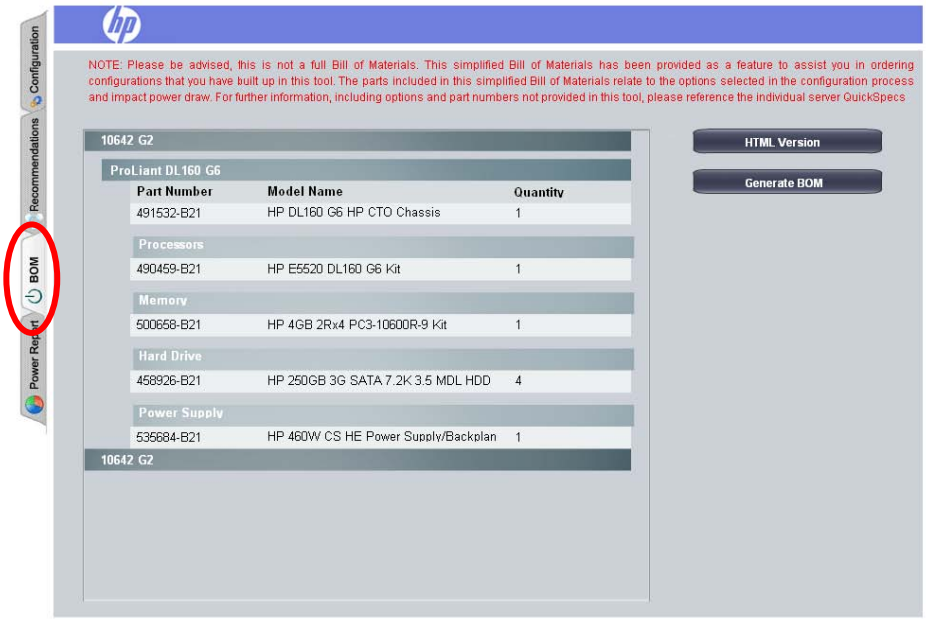
The calculator maintains a real-time estimate of the power consumption and BTU generation during the configuration of each server. When the server configuration is complete, the user clicks the **Save** button to accept the configuration and return to the rack view.

The user can generate a bill of material (BOM) report (Figure 5) for a server configuration by clicking on the **BOM** tab on the left of the screen.

NOTE

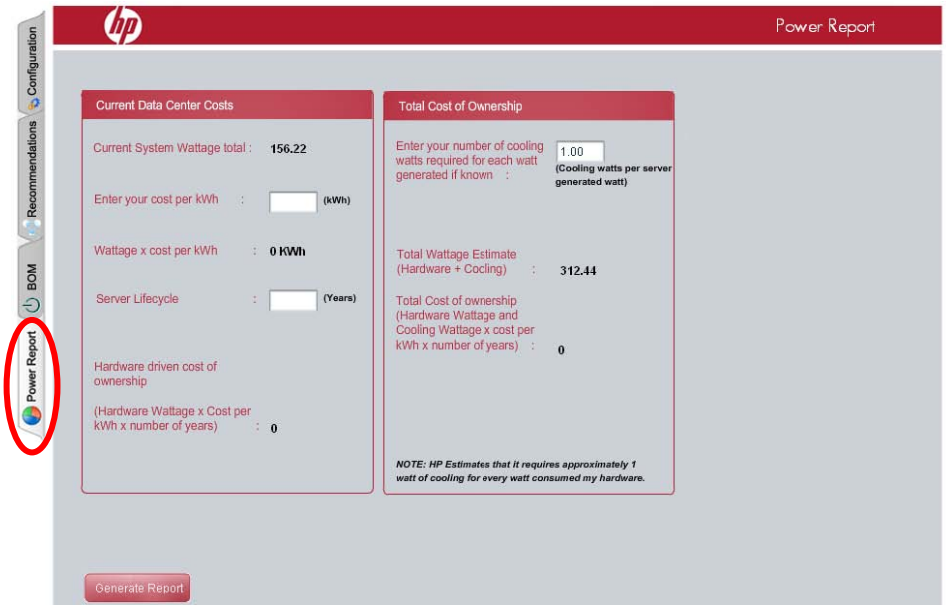
The Power Advisor BOM report only includes data for system components that affect power consumption. Refer to the individual server QuickSpecs for part numbers of optional components that may be required but are not included in the Power Advisor BOM report.

Figure 5. HP Power Advisor, BOM report



The Power Advisor makes it possible to pre-calculate the running costs (cost of ownership) of the hardware based on the rate paid per kWh. By selecting the **Power Report** tab, the user can generate a Power Report (Figure 6) for a single server or a complete rack.

Figure 6. HP Power Advisor, Power report

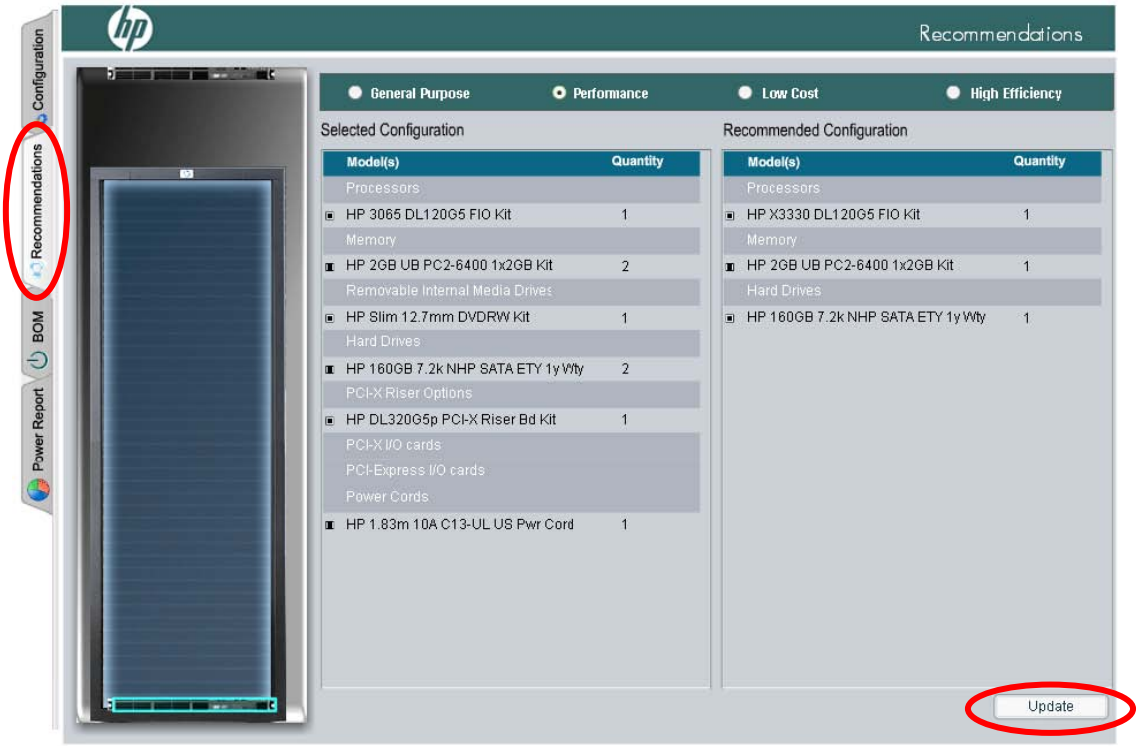


A Recommendations Report (Figure 7) is also available for each component. Based on the user-selected configuration for the highlighted server, the Power Advisor offers four types of recommendations:

- General Purpose—configuration with best balance of performance, cost, and efficiency
- Performance—enhanced configuration for maximum performance
- Low Cost—economical configuration achieving similar performance
- High Efficiency—configuration using less power with possible sacrifice in performance

The user selects a recommended configuration in the top bar of the screen and clicks **Update**. The tool then displays the Configuration screen showing the updated power calculations.

Figure 7. HP Power Advisor, Recommendations report



After selecting a unit server, the user can quickly load a rack of identically configured servers by highlighting the configured server and clicking on the **Duplicate** button. The **Delete** button removes highlighted servers from the configuration.

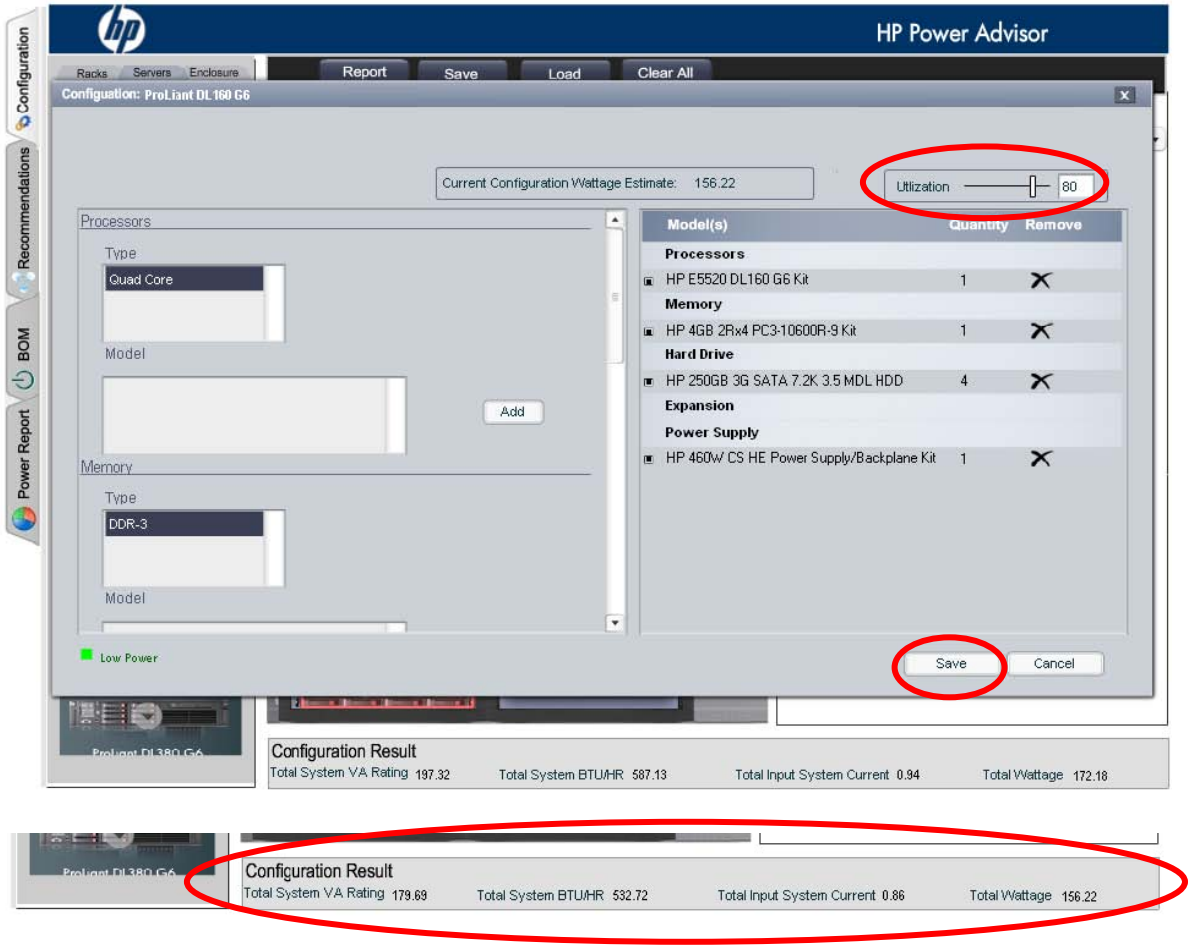
Example power calculations

The HP Power Advisor utility provides accurate calculations that planners can use to predetermine power requirements of a populated rack. This section includes three examples of a rack calculation: one for a standard 42U rack populated with HP ProLiant DL160 G6 servers, one for a standard 42U rack populated with HP ProLiant DL380 G6 servers, and one for a standard 42U rack populated with an HP c-Class BladeSystem.

Rack configuration with HP DL160 G6 servers

This example consists of a standard 42U rack configured with 24 HP DL160 G6 servers. For this calculation, each DL160 G6 server is configured with an Inte®l Xeon® E5520 processor, four gigabytes of DDR3 memory, four 250-GB SATA hard drives, and one 460-watt power supply set to run off 208 VAC (Figure 8).

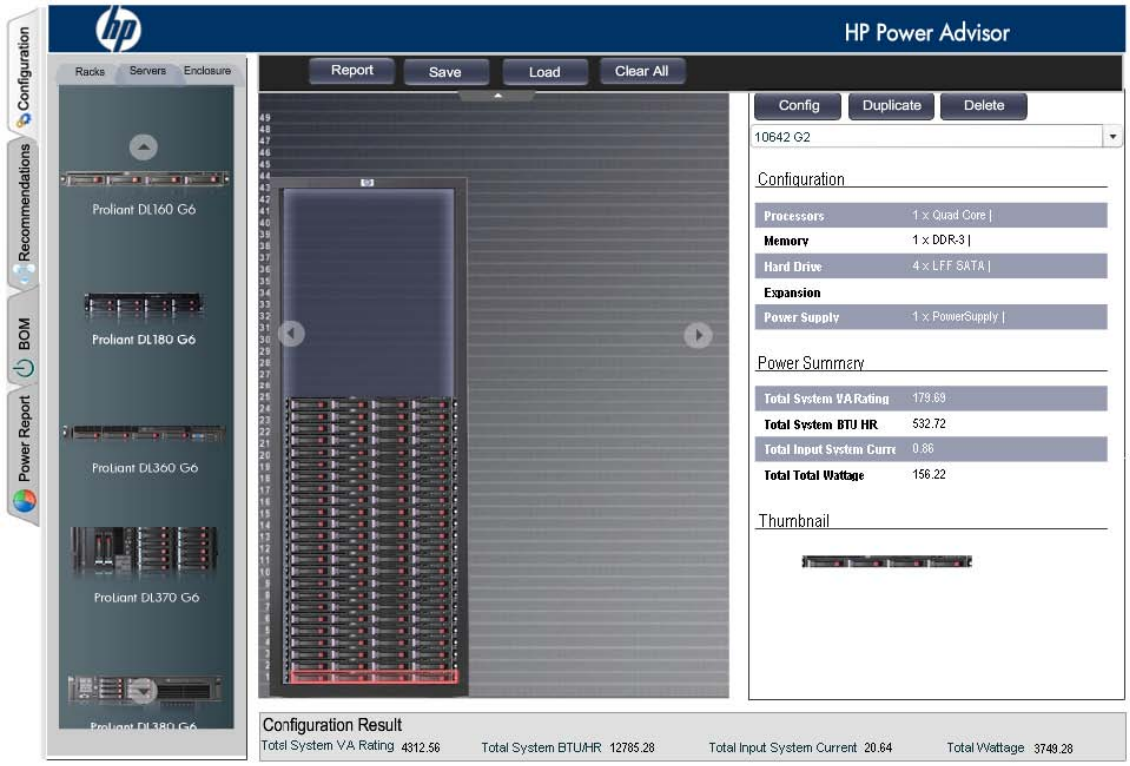
Figure 8. Power calculation for single HP DL160 G6 server



With the **Utilization** slider control set at 80 percent and the configuration saved, the Power Advisor indicates that the system input requirement will be 179.69 VA, the system will draw approximately 0.86 amperes of current, and it will dissipate 156.22 watts.

While a standard 42U rack can physically accommodate 42 ProLiant DL160 G6 servers, it is advisable to allow space for server expansion, power distribution components, keyboard/video/mouse (KVM) equipment, or networking components. In Figure 9, Power Advisor calculates a single rack configured with 24 DL160 G6 servers.

Figure 9. Power calculation for 24 HP DL160 G6 servers



The Power Advisor determines that a rack configuration of 24 DL160 G6 servers would require the following:

- 4312.56 VA total apparent power (24 x 179.69 VA) that the power distribution components must transfer
- 12785.28 total BTU/hr that will need to be removed by the cooling system
- 20.64 amperes total current (24 x 0.86 A) drawn by the 24 servers
- 3749.28 total watts dissipated by the equipment

Since the ProLiant DL160 G6 accommodates only one power supply, power redundancy will have to be provided upstream of the server's single AC connection. Figure 10 shows a rack-level power redundancy scheme using an uninterruptable power supply (UPS). With four 7-outlet PDUs and a total input current capability of 5000 VA, the HP R5500 UPS would be a good fit and would provide adequate VA and outlet headroom for server expansion or peripheral devices. Using the Power Advisor calculations indicated in Figures 8 and 9, the total heat produced by 24 servers would be 12785.28 BTU/hr., an amount that can be cooled using conventional means in most data center environments.

Figure 10. 42U rack configuration of 24 HP ProLiant DL160 G6 servers with battery backup power

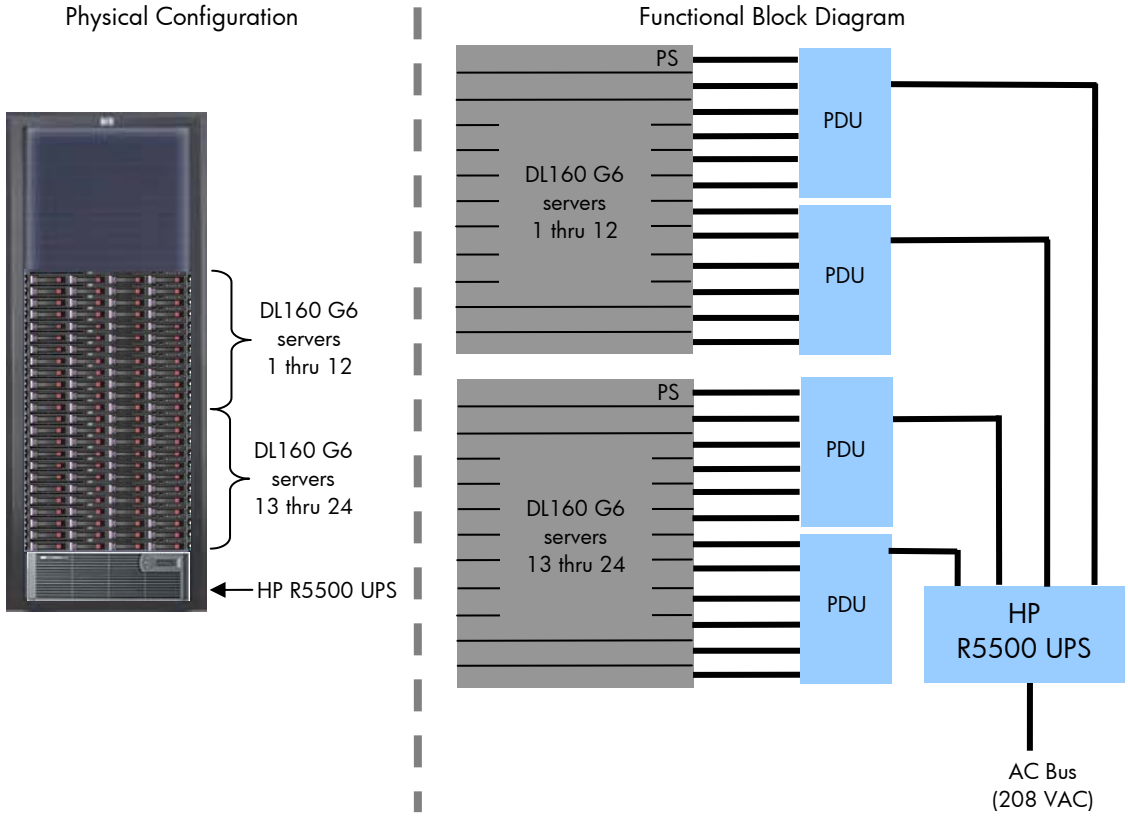
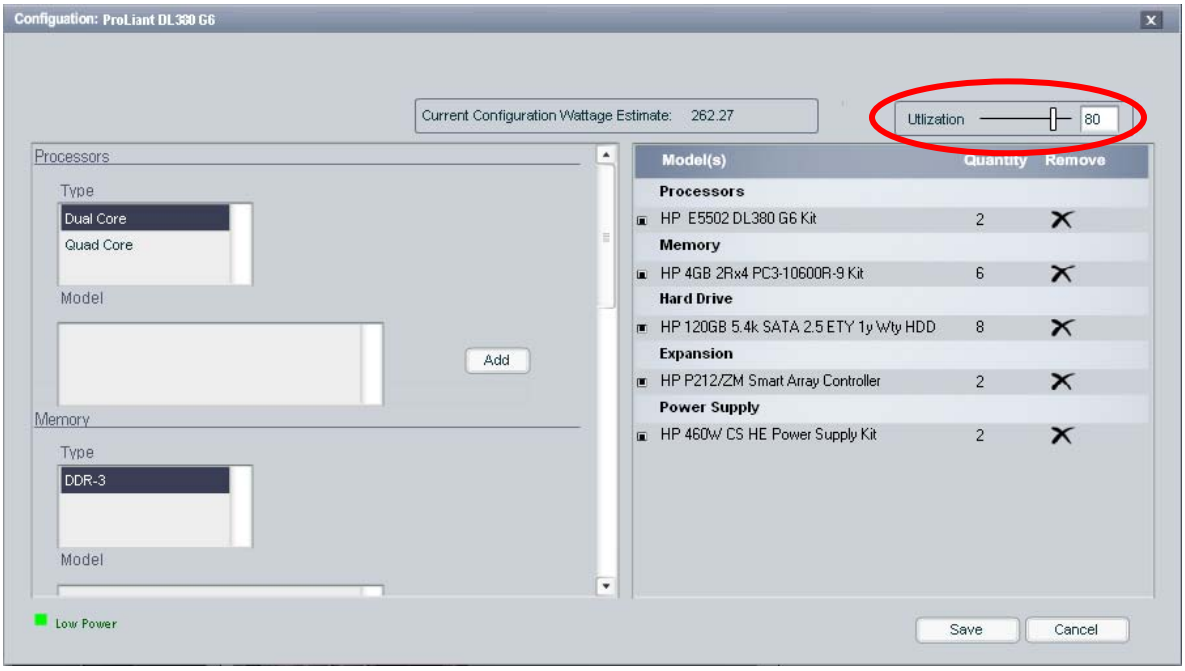


Figure 10 shows only one example—a number of configurations are possible. By using row-level power redundancy and consolidating server management with a remote console, users can achieve a maximum density configuration (42 DL160 servers).

Rack configuration with HP DL380 G6 servers

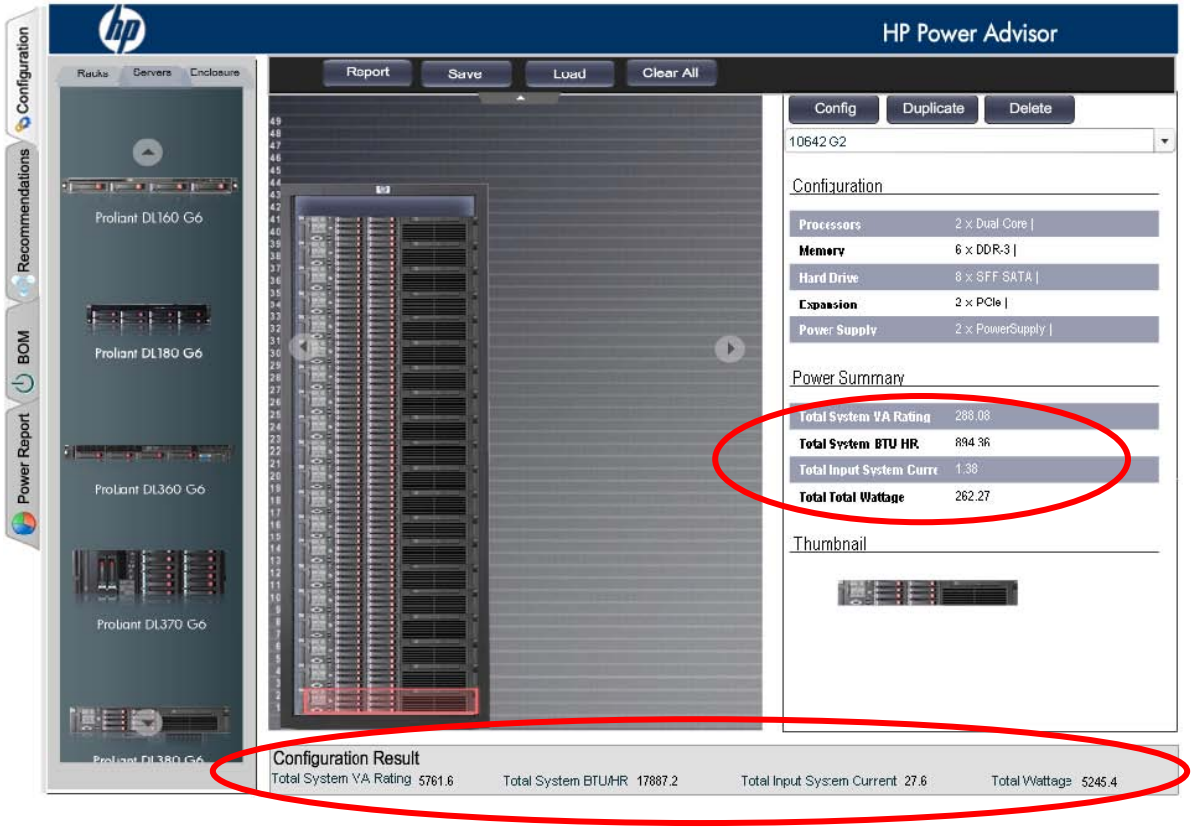
This example describes a standard 42U rack configured with 20 HP DL380 G6 servers. For this calculation, each DL380 G6 server is configured with two Intel Xeon E5502 processors, 24 gigabytes of DDR3 memory, eight 120-GB SATA hard drives and two Smart Array Controller cards (Figure 11). Two 460-watt power supplies (set to run off 208 VAC) provide 1+1 power redundancy.

Figure 11. Power calculation for a single HP DL380 G6 server



With the **Utilization** slider control set at 80 percent and the configuration saved, the Power Advisor calculates (Figure 12) that the system input requirement will be 288.08 VA, the system will draw approximately 1.38 amperes of current, and it will dissipate 262.27 watts.

Figure 12. Power calculation for 20 HP DL380 G6 servers



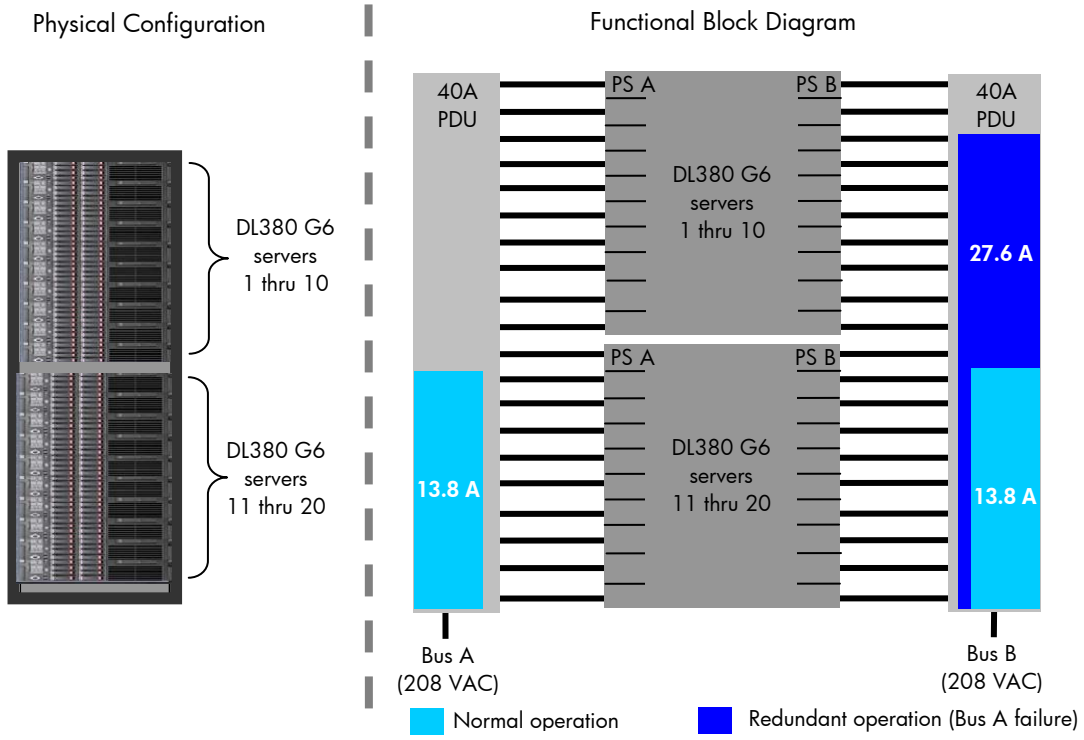
The Power Advisor determines that a rack configuration of 20 DL380 G6 servers would require the following:

- 5761.6 VA total apparent power (20 x 288.08 VA) that the power distribution components must transfer
- 17887.2 total BTU/hr that will need to be removed by the cooling system
- 27.6 amperes total current (20 x 2.38 A) drawn by the 24 servers
- 5245 total watts dissipated by the equipment

Figure 13 shows a rack configuration of twenty HP DL380 G6 servers receiving power through redundant power buses. This example is based on the Power Advisor calculations indicated in Figures 11 and 12. The power supplies (PS A and PS B) of each server connect through PDUs to the separate power buses.

With both power buses active, the power supplies and PDUs evenly share the server load (approximately 13.8 A per bus). While a 24-amp PDU could handle the load during normal conditions, a PDU would need to distribute 27.6 amps required by all the servers if one bus should fail. For this reason, a PDU on a redundant power bus should never provide more than 50 percent of its rated capacity in normal operation. In the example shown in Figure 13, the 40-amp PDUs are required and provide headroom for additional equipment upgrades.

Figure 13. 42U rack configuration of HP ProLiant DL380 G6 servers with redundant power buses



The Power Advisor indicates that the cooling requirement for the rack configuration shown in Figure 13 would be 17887.2 BTUs/hr (894.36 x 20). This level of BTU generation may require special cooling considerations such as controlled air, forced air, or chilled-water systems.

NOTE
For more information on power distribution strategies and three-phase power refer to the white paper "Power Basics for IT Professionals" at
http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01234421/c01234421.pdf

Rack configuration with the HP c-Class BladeSystem

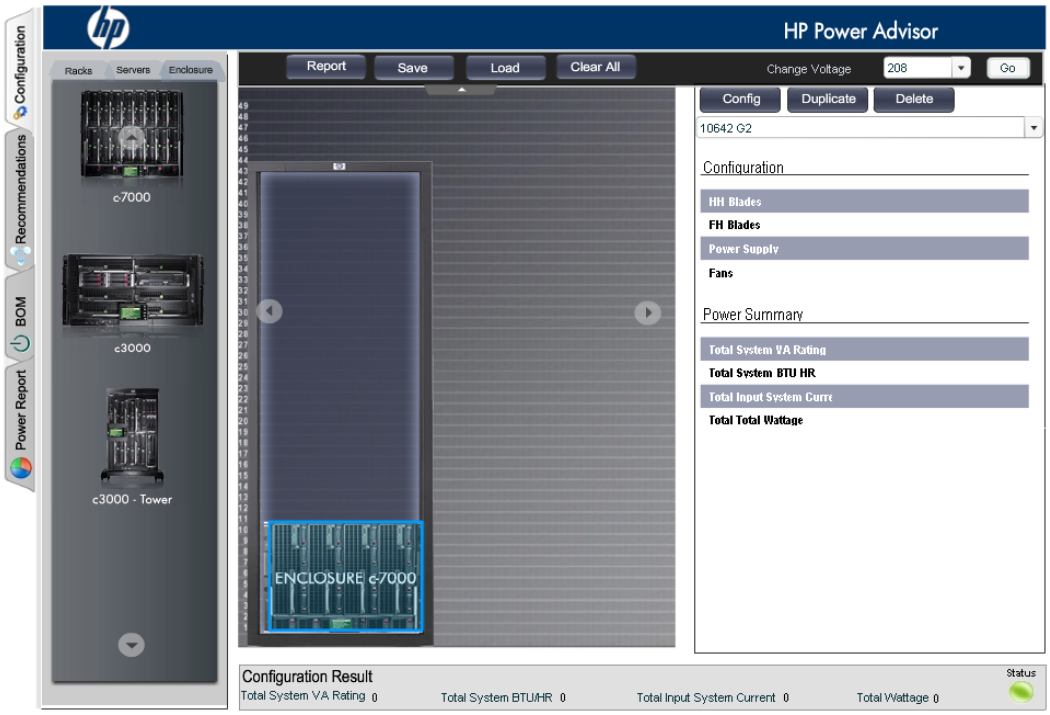
The HP c-Class BladeSystem is a modular-based design that offers very flexible configuration possibilities. Therefore, the method for calculating BladeSystem installations is more involved than for DL systems. This example describes a standard 42U rack configured with four c7000 enclosures each loaded with 16 BL460c G6 server blades.

NOTE
Prior familiarization with the HP c-Class BladeSystem is strongly recommended in avoiding Power Advisor error indications and inaccurate calculations.

To calculate the power for an HP BladeSystem based on the c-7000 enclosure, perform the following steps:

1. Open the Power Advisor and select the power input (for this example, 208).
2. Select the rack type using the drag and drop method (for this example, 10642 G2).
3. Select the **Enclosure** tab and click on the c7000 enclosure. The enclosure will appear in the rack as shown in Figure 14.

Figure 14. c7000 enclosure selection



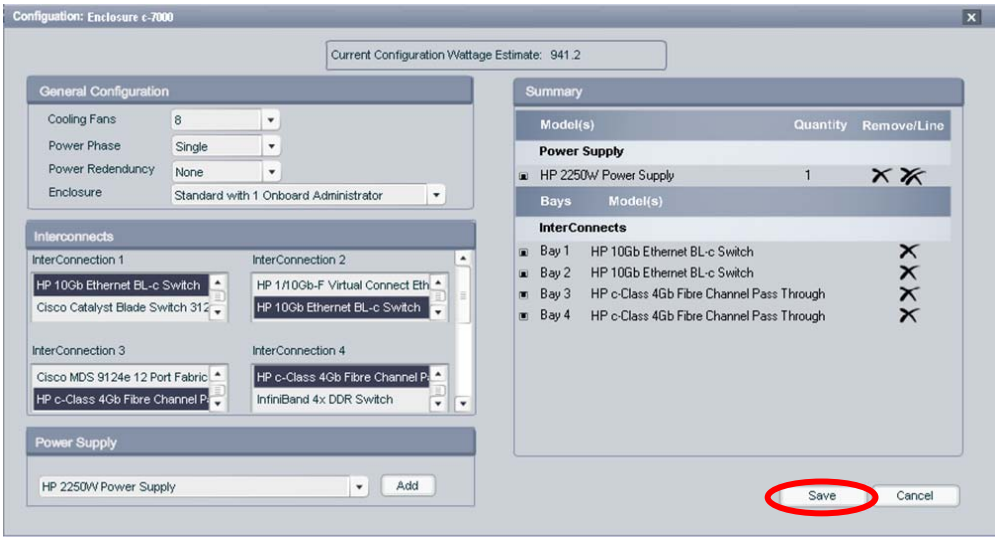
4. Highlight the enclosure in the rack and click **Config**. The enclosure configuration page appears as shown in Figure 15.

Figure 15. Initial c7000 enclosure configuration screen

NOTE
The enclosure must be configured with a power supply and interconnect modules BEFORE adding and configuring the blades.

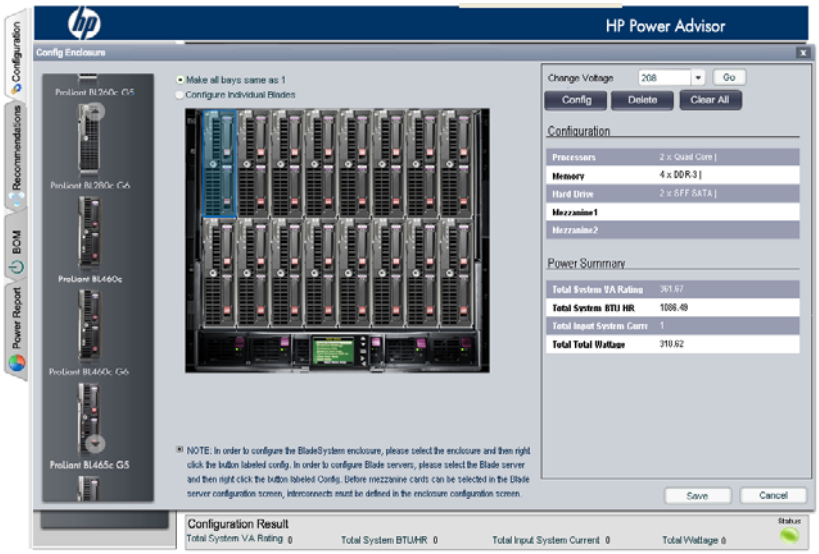
5. Click the **Config** button. The enclosure configuration screen appears. Configure the enclosure as to power supply type and quantity, number of cooling fans, and interconnect modules as shown in Figure 16. When finished, click **Save**.

Figure 16. c7000 enclosure configuration screen



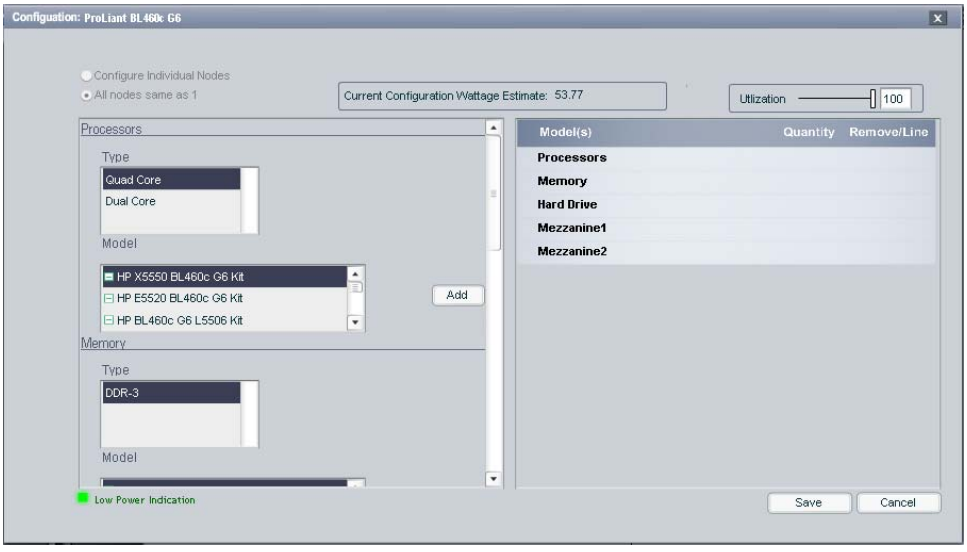
6. In the left pane, click **Servers** and select a server blade. If the "Make all bays same as 1" option is selected (default), the Power Advisor will populate all blade slots of the enclosure with the selected blade (in this example, the BL460c G6 blade) as shown in Figure 17.

Figure 17. Populating a c7000 enclosure with BL460c G6 server blades



7. Highlight the blade in slot 1 and click **Config**. The configuration screen for the BL460c G6 appears as shown in Figure 18.

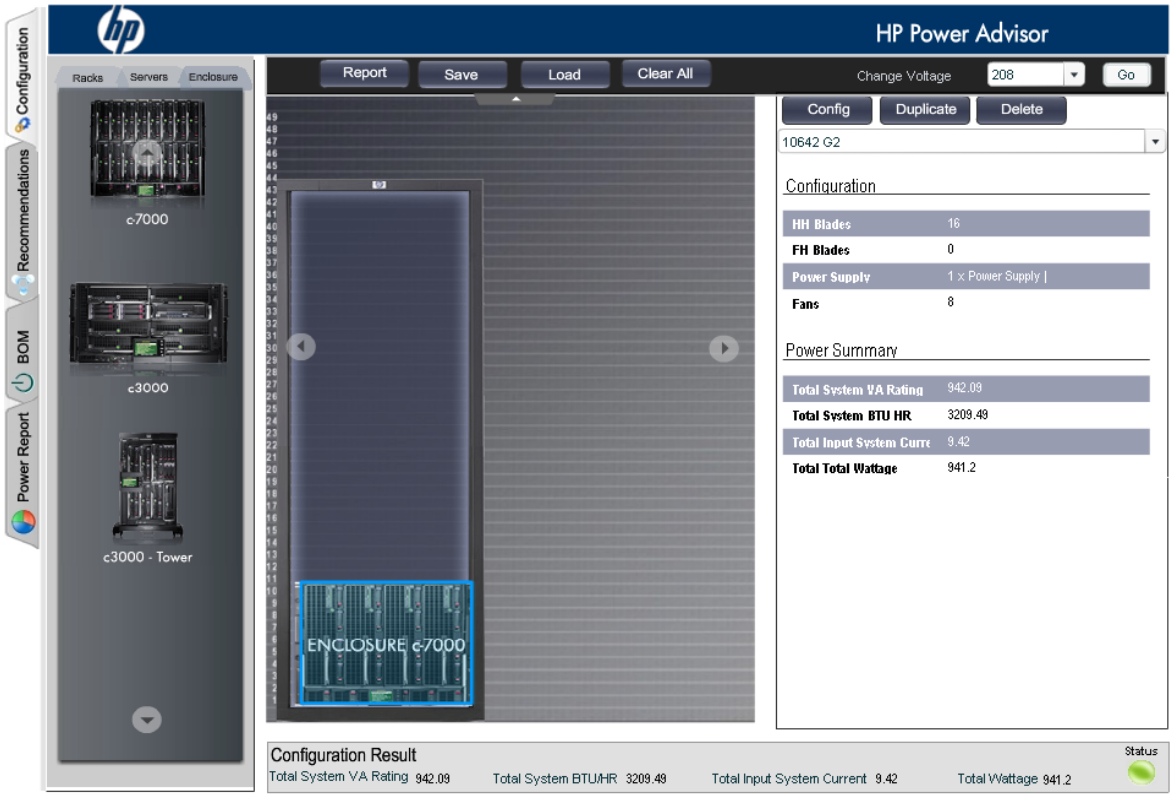
Figure 18. Initial BL460c G6 blade configuration screen



Configure the blade for processor type and quantity, memory amount, hard drive(s), and mezzanine card(s). Also, set the **Utilization** slider control at the projected level. When finished, click **Save**.

8. Check the voltage level indicated by the Power Advisor, reselect or change to 208 if necessary, and click **Go**. The Power Advisor will display the calculated power requirements for the rack with a single enclosure (Figure 19).

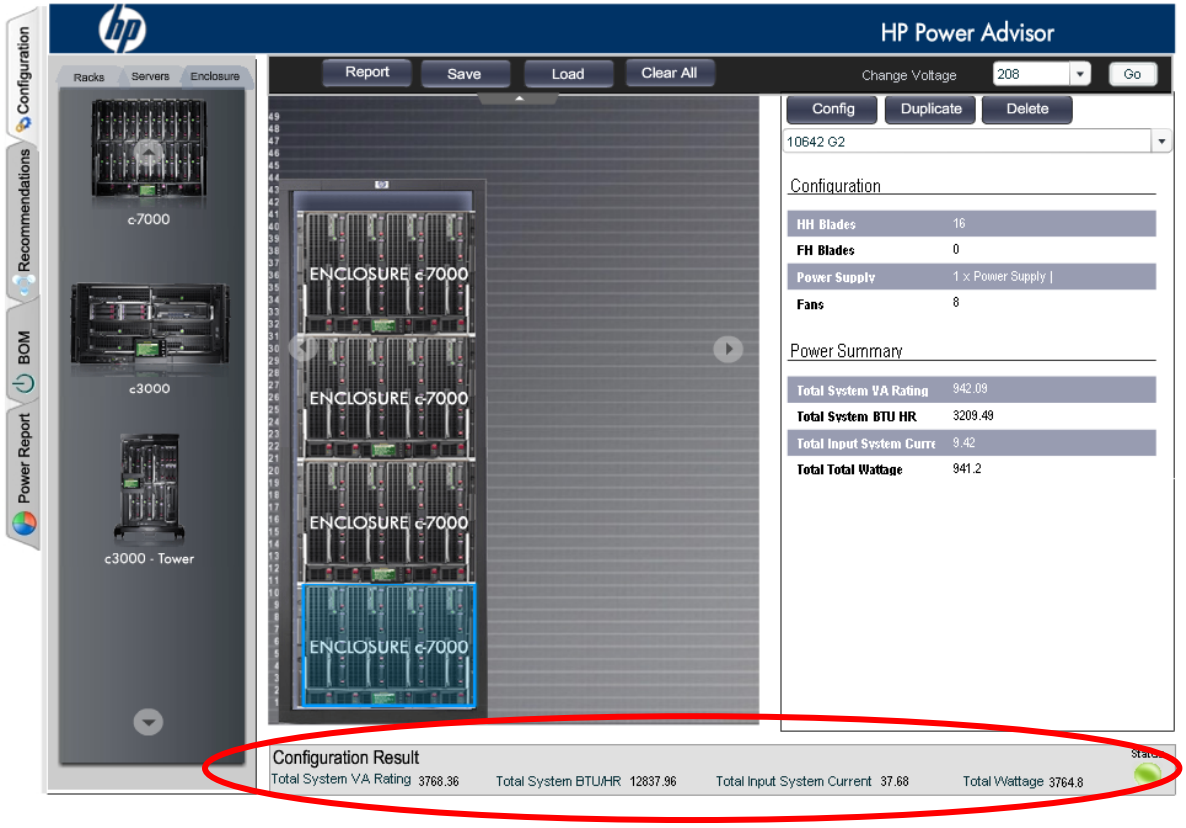
Figure 19. Power calculation for a single c7000 enclosure with BL460c G6 server blades



Additional enclosures are added to the rack by either duplicating a configured enclosure as described in the next step (9) or by selecting a new enclosure and configuring it as previously described in steps 3 through 8.

9. To duplicate an enclosure configuration, select the enclosure in the rack and click **Duplicate**. In the pop up window requesting for the number of copies, enter the desired value (for this example, enter 3). The Power Advisor will populate the rack with three additional enclosures of the same configuration as the first and calculate the total power requirements for the rack (Figure 20).

Figure 20. Populating the rack with four configured c7000 enclosures



The Power Advisor determines that a rack configuration of four c7000 enclosures as configured in the previous procedure would require the following:

- 3768.36 VA total apparent power (4 x 942.09 VA) that the power distribution components must transfer
- 12837.96 total BTU/hr that will need to be removed by the cooling system
- 37.68 amperes total current (4 x 9.42 A) drawn by the four enclosures
- 3764.8 total watts dissipated by the equipment

NOTE

The configuration flexibility of the HP c-Class BladeSystem can result in a wide range of power requirements. Depending on components and quantities selected, c-Class configuration results provided by the Power Advisor may vary considerably.

Conclusion

The HP Power Advisor is a valuable utility for planning systems based on HP ProLiant products. The calculator provides meaningful estimates of power for use in sizing an infrastructure. It is important to note, however, that actual power consumption of an installed system running certain applications may vary. To use the Power Advisor effectively, IT organizations must observe the following caveats:

Do use the Power Advisor for:

- Estimating requirements only for HP systems
- Determining maximum equipment power and cooling needs at the unit (chassis) and rack levels

Do not use the Power Advisor for:

- Estimating requirements of systems from other vendors
- Direct comparisons with other vendors' products
- Precisely predicting the power consumption of a single instance of a server running a particular application. Actual power consumption can be less than the power and cooling needs indicated by the Power Advisor.
- Estimating power consumption of individual components (memory, hard drives, cards, etc.)

NOTICE

The HP Power Advisor is provided "as is" without any warranty of any kind. The entire risk arising out of the use of the Power Calculator remains with the customer. In no event shall HP be liable for any direct, consequential, incidental, special, punitive, or other damages whatsoever (including without limitation, damages for loss of business profits, business interruption or loss of business information) even if HP has been advised of the possibility of such damages. Refer to the HP Power Advisor program license terms for more information.

NOTE:

HP Power Advisor is intended to be a conservative estimator of power. No two applications will consume exactly the same amount of power. Even programs that report the same CPU utilization will have different power consumption characteristics, based on the exact mix and sequence of instructions being executed. The programs used as the measurement reference for the HP Power Advisor were intended to consume as much or more power than actual user applications.

HP offers IT administrators post-installation support with the following power management solutions designed to maximize server efficiency and reduce power consumption to maintain the data center power budget:

- HP Insight Power Manager—included as part of HP Insight Control Suite, a monitoring and management application providing centralized control of server power consumption and thermal output
- Dynamic Power Capping—a part of the HP Thermal Logic Technology initiative allowing IT administrators to reclaim data center capacity by monitoring and capping server power without impacting performance

For more information

For additional information, refer to the resources listed below.

Resource	Hyperlink
HP Power Advisor	http://www.hp.com/go/hppoweradvisor
"Power Basics for IT Professionals" technology brief	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01234421/c01234421.pdf
Other industry standard technology papers from HP	http://h18004.www1.hp.com/products/servers/technology/whitepapers/index.html
HP energy efficiency solutions information	http://www.hp.com/go/proliant-energy-efficient

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