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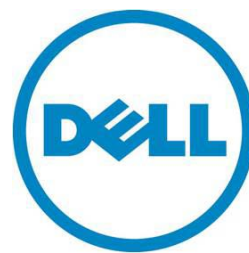
# Power Consumption Reduction: Hot Spare

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*A Dell technical white paper*

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Contents

Executive summary ..... 3

Introduction ..... 3

Traditional power solutions ..... 3

Hot spare..... 5

Hot spare solution ..... 6

Emphasis on power reduction ..... 8

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## Executive summary

As the cost of energy continues to rise, there is an increased need to employ energy efficient solutions in the data center. This paper presents the traditional approach of power management for a 1+1 redundant power supply system and an energy efficient approach we call *Hot Spare*. Hot Spare is an energy efficient solution which operates the power supplies at a more efficient operating condition thus reducing the energy cost of operating the system.

## Introduction

The IT industry continues to grow, and with it is an increased emphasis on methods to reduce energy consumption of server deployments. With data processing, communication and applications continuing to expand, many data centers are forced to grow and deploy higher density solutions to keep up with the demands of the market. The amount of existing power available to support larger scale deployments can become a limiting factor. By decreasing the amount of power consumption for given applications, more servers can be applied to the existing infrastructure. One way of reducing power consumption is by reducing the amount of power dissipation in the front end power conversion block, which is often configured with redundant AC-DC power supplies.

Dell has implemented a number of methods in reducing the power dissipation associated with the front-end conversion blocks. Methods include, but are not limited to, improving PSU efficiency, right-sized power solutions and enhanced power management techniques. The intent of this paper is to discuss Dell's Hot Spare technology, which is one of the many power management techniques targeted at reducing the power consumption of Dell™ PowerEdge™ 12<sup>th</sup> generation servers. We will start off with addressing the challenges associated with traditional redundant PSU deployments, followed by a review of Hot Spare and how it addresses some of those concerns.

## Traditional power solutions

Many server configurations are deployed with redundant power supplies to assist with maintaining server operation in the event of input power loss or PSU servicing. As illustrated in the Dell white paper, "High Efficiency Power Supplies" (found on [Dell.com](http://Dell.com)), redundant power supplies usually share the output load of the server, which places each power supply at less than 50% load. It should be noted that many agency standards, such as 80 PLUS, require peak PSU efficiency when the power supply is operating at 50% of its rating. These types of requirements have design related impacts, such as:

- 1) Reducing the fixed PSU losses that are made up of control and supervisory functions.
- 2) Reducing switching losses associated with many switch mode power supply designs.
- 3) Maintaining sufficient conduction losses, without jeopardizing the switching losses mentioned above.

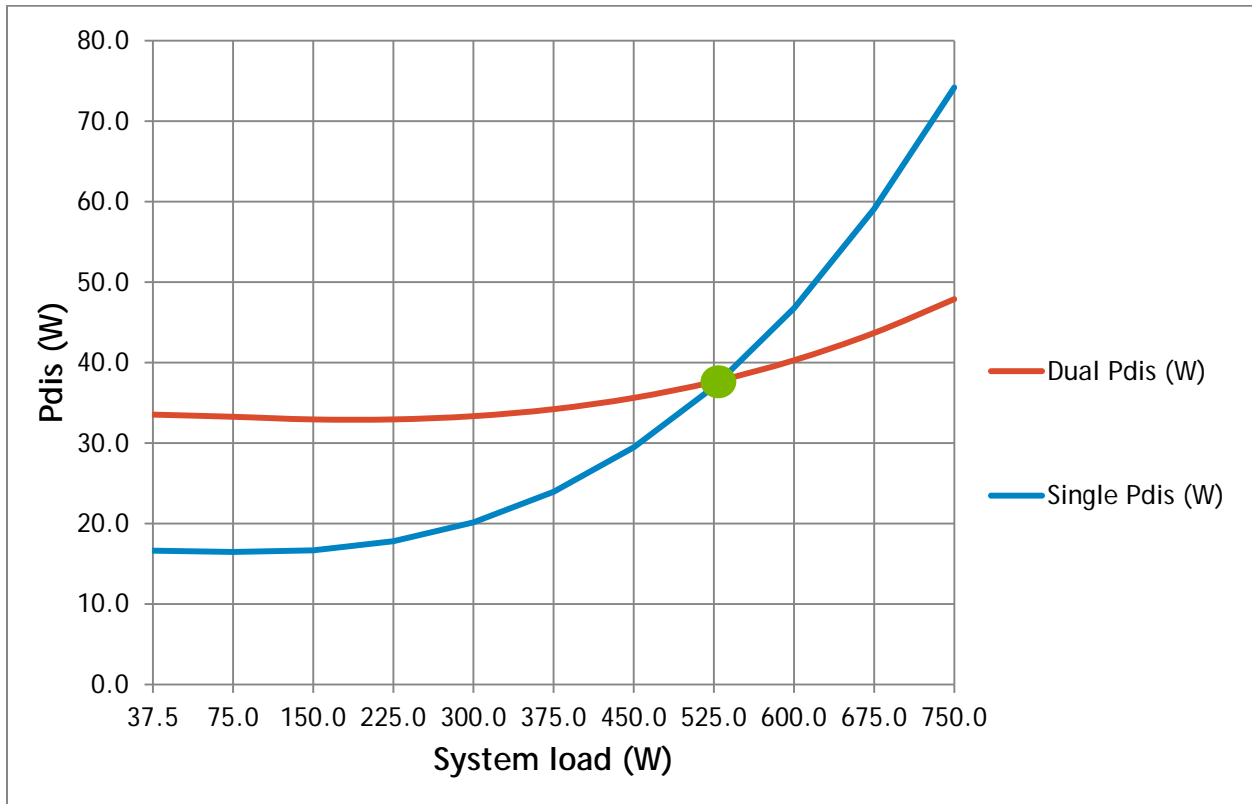
However, even with light load PSU efficiency improvements, there are loading conditions which would be more efficient if a single power supply were operating as opposed to dual PSUs operating. Figure 1 illustrates PSU power dissipation vs. load based on operating one PSU vs. dual redundant PSUs across the load spectrum. The Platinum efficiency levels, which are specified by 80 PLUS, are listed in Table 1.

Table 1. Platinum efficiency levels

% Load	% Efficiency
20	90.0
50	94.0
100	91.0

Throughout the paper, we will be referring to these efficiency specifications as a baseline for our discussion. We have derived the efficiency vs. load curves used in this paper by means of applying a curve fitting function to these efficiency points. These points are taken under specific test conditions, such as 230VAC input and at a specific ambient temperature. For more information on these requirements, please refer to the 80 PLUS website: <http://www.pluginloadsolutions.com/80PlusPowerSupplies.aspx>.

Figure 1. PSU power dissipation vs. load (single vs. dual PSU), 750 Platinum level efficiency



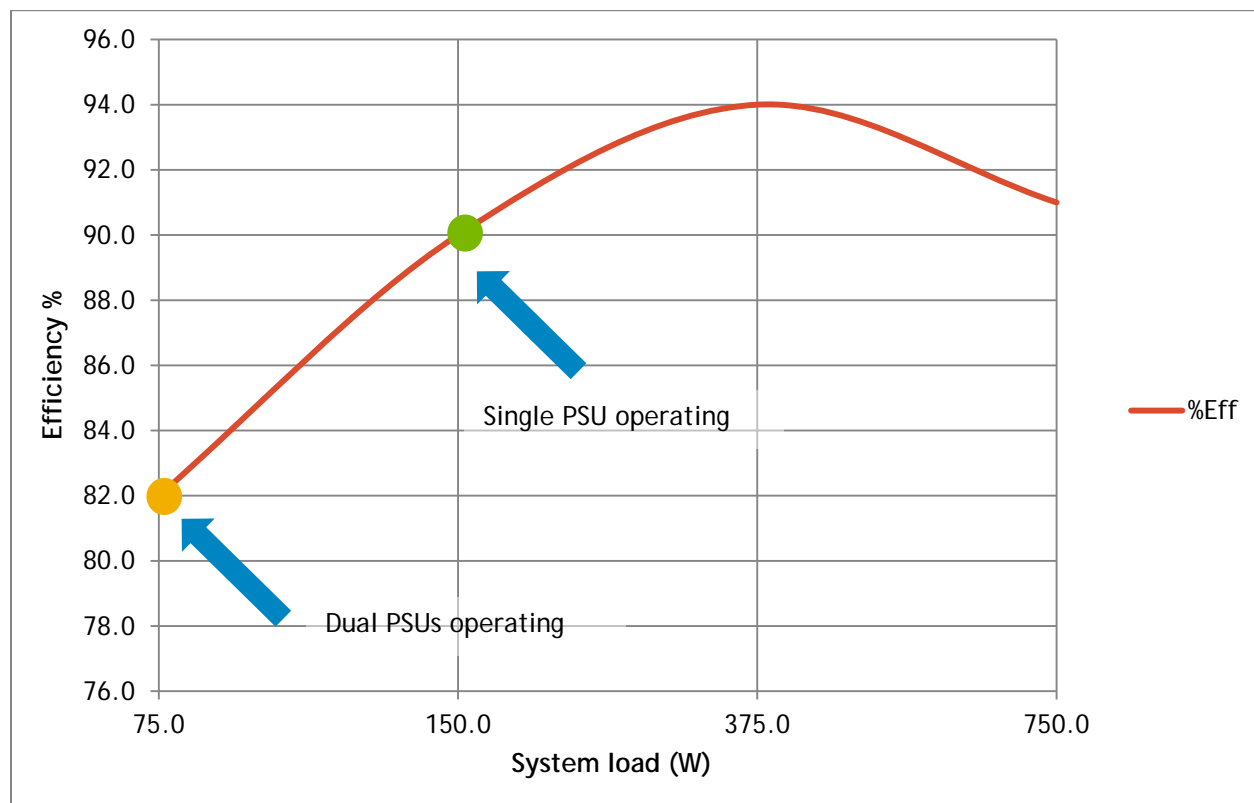
In Figure 1, it can be observed that at load levels less than 525W (~70% of this PSUs rating), there is less power being dissipated by operating a single PSU vs. dual PSUs. At a system load of greater than 525W, it can be observed that operating dual PSUs is more efficient compared to operating in a single

PSU configuration. It would seem apparent, that if the system were to allow a single power supply to operate up to 525W and then transition to dual PSUs above 525W, power could be saved compared to operating dual supplies under all conditions. This is where Hot Spare steps in.

### Hot spare

To address the situation discussed above, Dell has derived a power management feature which reduces power consumption while maintaining redundancy and availability. To keep things simple, we will refer to the 1x1 PSU configuration using 750W Platinum level efficiency PSUs. The basic premise of the feature is to have one power supply active and one PSU in a suspended state, during light load conditions. As a result, the active supply is forced to deliver the entire system load thus pushing it to operate at a higher part of the efficiency curve. As the system load increases beyond the threshold of power consumption benefit from operating one power supply, dual PSUs become active. For example, the graph below illustrates the efficiency of the AC-DC power conversion block. If we assume the system load is ~150W (20% of a single PSUs output capability), the efficiency for a single supply operating is ~90% (~16.7 Watts dissipated). With dual power supplies operating, each power supply would share ½ of the 150W load at 75W/PSU (10% of a single PSUs output capability). The power supply efficiency at 75W is ~82% (~16.5 Watts dissipated). With dual power supplies delivering the load, the total loss would be 33W compared to 16.7W when operating a single PSU. It is observed that the calculated overall savings is ~16.3W when operating a single PSU vs. dual in this load range. The best case condition would be for only one power supply to be operating during this time; however, that would void PSU redundancy. The problem is how to operate the system as if it were operating from a single PSU, but both PSU present and operational. Dell's *Hot Spare* solution addresses this concern.

Figure 2. Efficiency vs. load, 750W Platinum level spec values



## Hot spare solution

The ability to reduce power consumption, for this type of solution, relies on the ability for a PSU to suspend power delivery at light load conditions and thus force the load to be provided by the remaining active PSU. Dell's solution utilizes a sleep mode state of operation to force the load shift. Loading conditions that warrant a single PSU to operate force one power supply to actively supply the load, while the remaining PSU suspends power delivery. A suspended PSU remains prepared to support the redundant bus in case the active PSU becomes void of operation. The suspended PSU remains ready to respond, while minimizing power consumption. Since the suspended PSU voids load delivery, the amount of suspended PSU power dissipation becomes a fixed loss. The following equation summarizes the total Hot Spare dissipation of both power supplies:

$$\text{Front End Power Block Power Dissipation} = \text{Operating PSU Power Dissipation} + \text{Suspended PSU Power Dissipation}.$$

By means of advanced power management techniques, the suspended PSU power consumption is kept to a minimum to maximize power savings. It will be the loading conditions of the system and efficiency of the PSUs that will dictate when it is appropriate to enter and exit suspended modes of operation. Since the power supplies have the ability to monitor their output loading condition, action can be taken to enter and exit sleep states accordingly. To illustrate this, we will continue to refer to a 1+1 application using the 750W Platinum compliant PSUs.

Figure 3. Power dissipation vs. system load, single PSU compared to dual power dissipation, 750W Platinum PSU

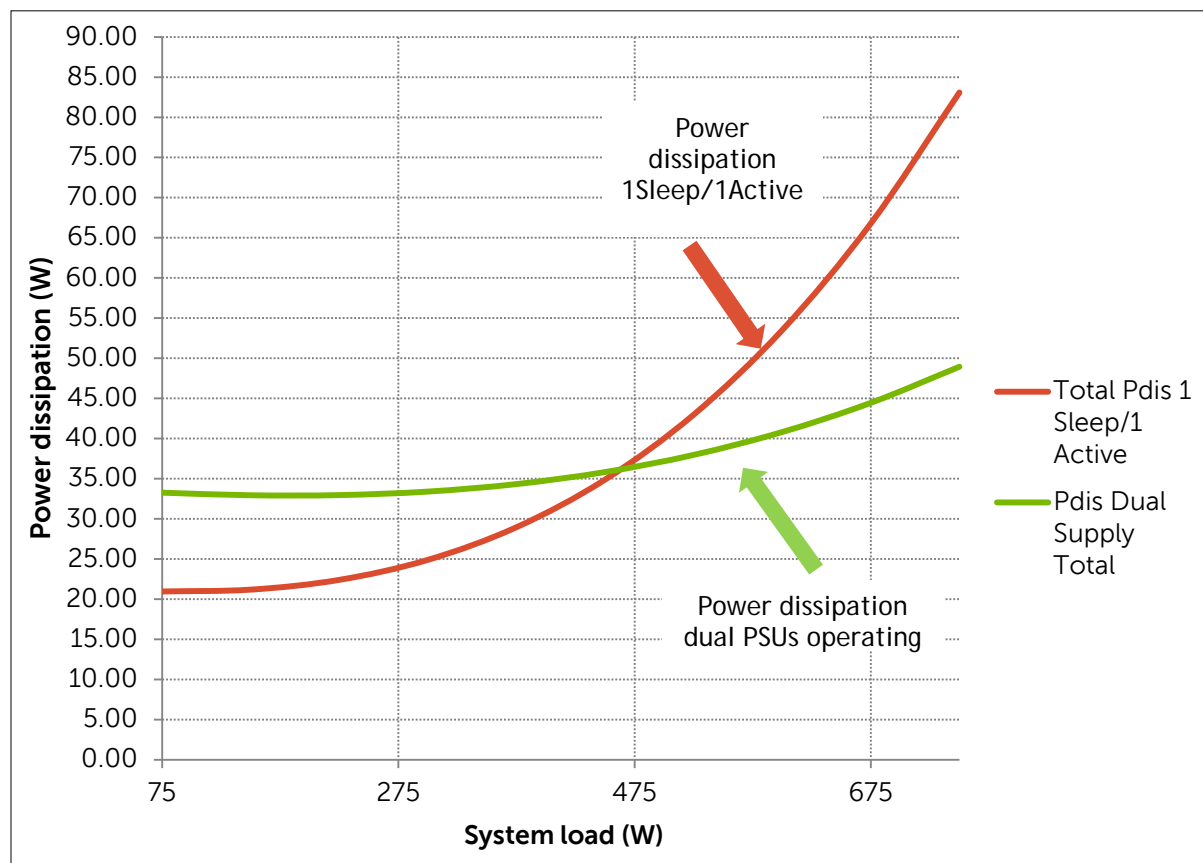


Figure 3 illustrates total calculated power block power dissipation vs. system load when operating a server type application with a single PSU versus dual PSU operation. It is observed that below ~450W of system power draw, less power is dissipated by operating a single PSU compared with running dual PSUs. Conversely, at power levels above ~450W, it is more efficient to have both PSUs active. With these power dissipation regions understood, the power system can make decisions on when to enter and exit sleep states. Figure 4 illustrates what the calculated power dissipation vs. system load would look like with Hot Spare enabled.

Figure 4. Power dissipation vs. system load, 750W PSU with hot spare algorithm, 1+1 PSU configuration

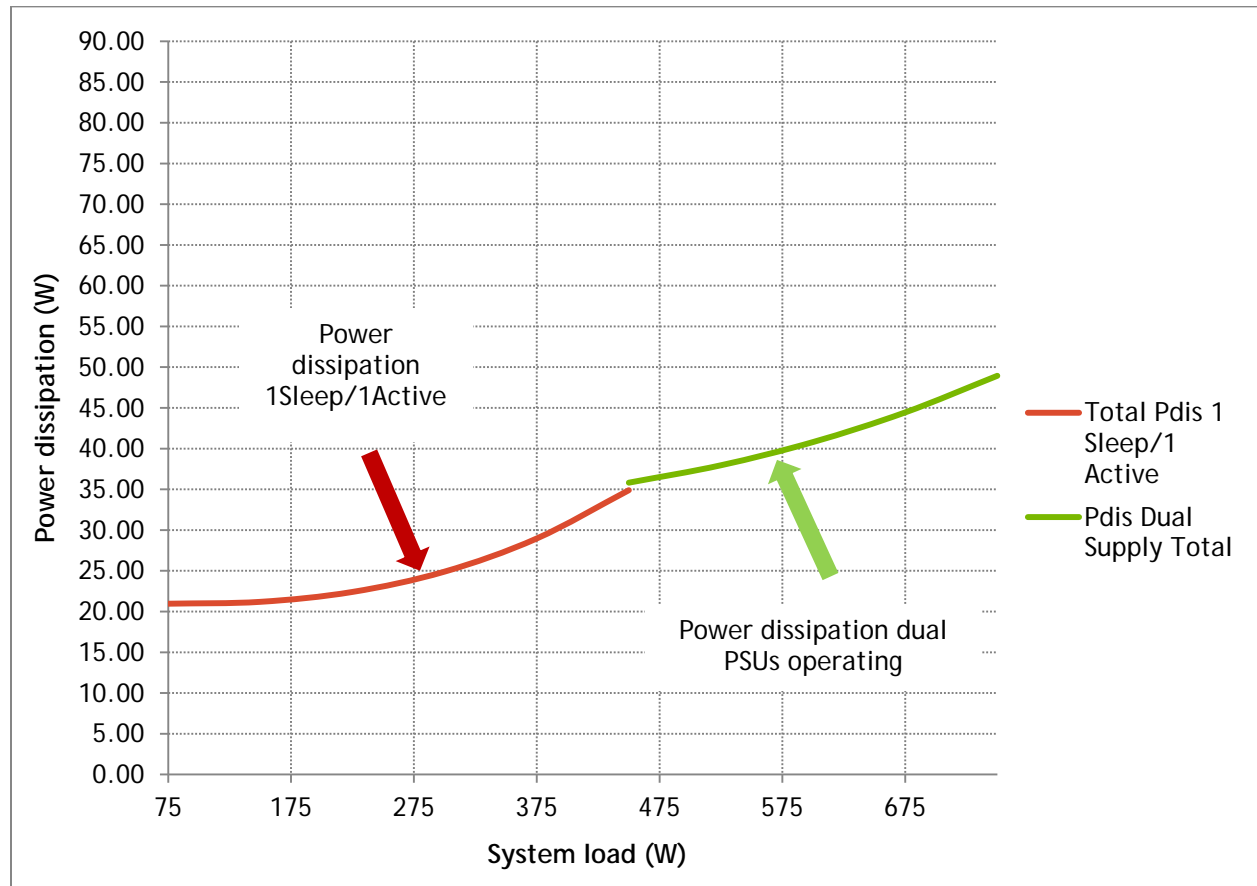
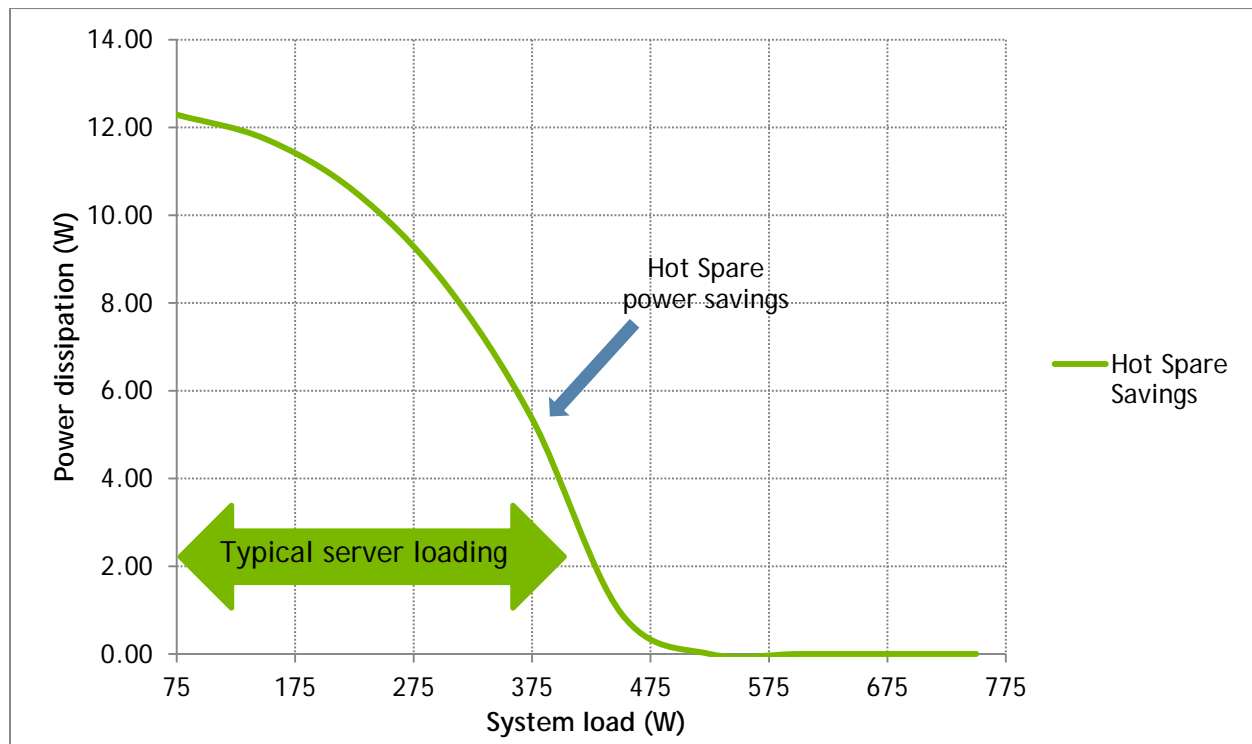


Figure 5 illustrates the calculated total power dissipation with the Hot Spare algorithm implemented. We observed that the savings are most pronounced in the region that is deemed "typical operation." In end systems, power savings will vary based on a wide variety of conditions. As an example, PSU efficiency variations will vary based on design differences. Other factors such as input voltage conditions and environmental differences may also change results.

Figure 5. Power savings vs. system load, 750W PSU with hot spare 1+1 PSU configuration



## Emphasis on power reduction

With the data center environment continuing to emphasize the need for lower power consumption, the drive to reduce power consumption at the server and PSU level is very apparent. Dell has responded with a power strategy that includes higher efficiency PSUs, right-sized solutions and features such as Hot Spare. By utilizing this new intelligent power management feature, you can now further reduce power consumption without sacrificing availability or redundancy. By employing the monitoring and management capabilities of the PSU, the Hot Spare feature can dynamically shift the load between redundant power supplies, and therefore manipulate the front end power block efficiency vs. load characteristics. Benefits include reducing PSU and server operational expenditures by means of lowering utility consumption and cooling.

[Learn more](#)

For more information on Dell power and cooling, visit [Dell.com/PowerandCooling](https://Dell.com/PowerandCooling).