Cisco Integrated Services Routers Generation 2: Environmental Benefits

Rising energy costs, environmental concerns, and new government regulations are accelerating a global effort to monitor and conserve the power required to create and operate networks. At the same time, we are expanding the capacity and functions of those same networks, expecting to do more with less.

Building in Efficiency from Cradle to Cradle

How a product affects the environment varies. Resources in the form of raw materials and energy are required to manufacture and deploy the systems. Operating the network requires power, which not only consumes natural resources but also results in operational expenses for electricity. At the end of life of a product, capturing its residual value and properly disposing of the product must be considered when evaluating the overall cost and lifecycle of the network.

The Cisco® Integrated Services Routers Generation 2 (ISR G2) platforms were designed with a holistic approach to reduce their environmental effect throughout the product lifecycle.

Efficiency in Manufacturing and Deployment

The Cisco ISR G2 platforms enable industry-leading capabilities in security, voice and video, WAN optimization, and other application services. With the broad set of networking and application services that these routers offer, you can consolidate several standalone network appliances and servers onto a single platform. The result is a significantly lower consumption of raw materials, including sheet metal, electronic components, and the energy required to build multiple systems.

Optimizing the next lifecycle stage, the Cisco ISR G2 platforms offer streamlined packaging and accessories. The shipping volume of the systems has been reduced significantly, and the packaging material used is nearly 100-percent recyclable. The smaller shipping volume results in lower shipping costs for partners and customers when deploying the platforms to branch-office locations. Additionally, the cables, documentation, and other items shipped with the routers have been minimized in order to prevent post-installation waste. The items not included by default are available with a free download or at a small additional cost to reflect the materials required to manufacture and ship these products. E-delivery of Cisco IOS® Software licenses is yet another innovative and environmentally friendly deployment strategy.

Operational Efficiencies

Operationally, the Cisco Integrated Services Routers Generation 2 platform continues to lead the industry in environmental efficiencies. The new power supplies operate at 85-percent efficiency under typical power load, representing an improvement of approximately 30 percent over previous designs. This savings is multiplied when one Cisco ISR G2 platform is used to consolidate several standalone systems. For example, you can reduce the power associated with your applications deployment by up to 75 percent by replacing a server with the Cisco Services-Ready Engine (SRE) Module.

The Integrated Services Routers Generation 2 systems fully support the EnergyWise system. EnergyWise is an energy management architecture that allows system administrators to measure and fine-tune power usage to realize significant cost and environmental benefits. The ISR G2 EnergyWise implementation is discussed in detail later in this paper.

Environmentally, the Cisco ISR G2 routers offer indirect savings: Web 3.0 tools ranging from Cisco WebEx™ to Cisco TelePresence® conferencing applications have a well-proven record of reducing travel. The higher performance and expanded functions position the Cisco ISR G2 routers in collaborative networks at all levels. By reducing commuter and long-distance travel, Cisco network solutions can lower the environmental cost of running your business.

End of Life: Reduce, Reuse, and Recycle

The Cisco ISR G2 system is designed for backward compatibility with high-speed WAN interface cards (HWICs), packet voice/fax DSP module 2 modules (PVDM2s), and network modules currently in production networks. Reusing modules and consolidating peripheral appliances conserve materials and save costs when compared to designs that require that you replace an entire system when you want to significantly increase network or product performance, functions, or the number of users supported.

The Cisco Technology Migration Program (TMP) enables you to trade in Cisco or a competitor's networking products in exchange for credit toward the purchase of new Cisco products. This global program extends the investment made in previous networking equipment while implementing new Cisco ISR G2 borderless network functions.

Electronic waste is an important environmental concern that has been the focus of increased regulation over the past several years. The new platforms have lead-free mainboards, and other system components will be converted to lead-free designs in the future. Additionally, product take-back and recycling allow you to return Cisco equipment for environmentally responsible reuse, recycling, or disposal. Cisco works with waste-recovery partners to reduce the quantity of nonrecyclable material that ends up in landfill-and less than two percent of Cisco's returned electronic equipment goes to landfills. All Cisco products are eligible for this streamlined recycling program.

Cisco EnergyWise and the Cisco ISR G2

Starting with IOS release 15.0(1)M2, the Integrated Services Routers Generation 2 support EnergyWise at the platform level. The Cisco ISR G2 is the first series of routers to take advantage of the full Cisco EnergyWise capabilities natively. In brief, the Cisco EnergyWise system extends the ability to evaluate, monitor, and control devices throughout a network in order to reduce operational expenses and greenhouse gas emissions (refer to Figure 1).

Figure 1. Cisco EnergyWise Technology Benefits

With Cisco EnergyWise, evaluation, monitoring, and controlling network power consumption is accomplished by using a unique domain-naming method to group endpoints at an enterprise scale. Using this domain structure, the

Cisco EnergyWise software accesses the individual entities within that domain for a top-level view and control of these endpoints.

In addition to this top-level control, Cisco EnergyWise endpoints are grouped using attributes such as importance, role, and keywords. This granularity in endpoint definition allows the network administrator to manipulate and classify endpoints with the flexibility required to properly manage the wide range of profiles required for the enterprise scale.

The Cisco EnergyWise design goes beyond the control of PoE based-endpoints. With Cisco EnergyWise, you can instruct servers and PCs to enter a low-power state in a similar manner as PoE devices. The Cisco EnergyWise system is also designed to control facilities such as lighting, heating, ventilation, and air conditioning (HVAC).

For more information about Cisco EnergyWise, please visit http://cisco.com/go/energywise.

Additional information related to the ISR G2 EnergyWise implementation can be found in the System Configuration Guide: http://www.cisco.com/en/US/docs/routers/access/1900/software/configuration/guide/enrgyz_artg.html

System Power: Monitoring and Control

Valuable knowledge of network traffic has been collected for some time using NetFlow. In-depth knowledge of the power characteristics of the network can be collected using EnergyWise in a similar manner. This power consumption detail provides valued insight while optimizing the power profile.

At the device-level, the Cisco Integrated Services Routers Generation 2 provide the ability to monitor the power the platform consumes through the command-line interface (CLI) using the "`show environment`" command. The information is also available with Simple Network Management Protocol (SNMP) and IP-based protocols. The output of these reporting methods provides full system power in addition to component-level power of service-module interfaces, the motherboard, and its components.

This detailed view of the power profile allows the network administrator to evaluate the potential savings if one or a combination of modules is selectively powered off.

Sample wattage information from the "`show environment`" command:

```
SYSTEM WATTAGE
==============
Motherboard, EHWIC, PVDM and Fan Power consumption = 67.535 W
NM/SM slot 1 Power consumption = 31.342 W
NM/SM slot 2 Power consumption = 24.566 W
NM/SM slot 4 Power consumption = 33.062 W
Total System Power consumption is: 156.505 W
```

System Power: Control

Analysis of the platform power profile may reveal that a system component - a wireless LAN controller, for instance—is not needed when an office is closed. The Cisco ISR G2 system provides the capability to turn this wireless LAN controller off when not needed.

You can fully remove system power from services modules and integrated services modules (ISMs). The new PVDM3s are placed in a low power state when configured to conserve power. As in monitoring, you can control the system power using EnergyWise, CLI, SNMP, or IP-based interfaces. The control of module power is accomplished either on demand or with a recurring day-of-the-week, hour-of-day schedule. Each module can be tagged with relevant EnergyWise priority and keywords to tailor specific behavior.

Supported Modules and Systems

Table 1. Modules and Systems that Can Be Controlled by EnergyWise on Cisco ISR G2 Routers

Module	Power Savings (Watts)	Module	Power Savings (Watts)
SM-D-ES3G-48-P	84.00	**SM-SRE-900-K9**	50.0
SM-D-ES3-48-P	84.00	**SM-SRE-700-K9**	40.0
SM-D-ES2-48	84.00	**ISM-SRE-300-k9**	20.0
SM-ES3G-24-P	41.00	**PVDM3-256**	4.6
SM-ES3-24-P	41.00	**PVDM3-192**	4.1
SM-ES2-24-P	41.00	**PVDM3-128**	2.1
SM-ES2-24	41.00	**PVDM3-64**	1.2
SM-ES3G-16-P	38.00	**PVDM3-32**	1.0
SM-ES3-16-P	38.00	**PVDM3-16**	1.7
SM-ES2-16-P	38.00		

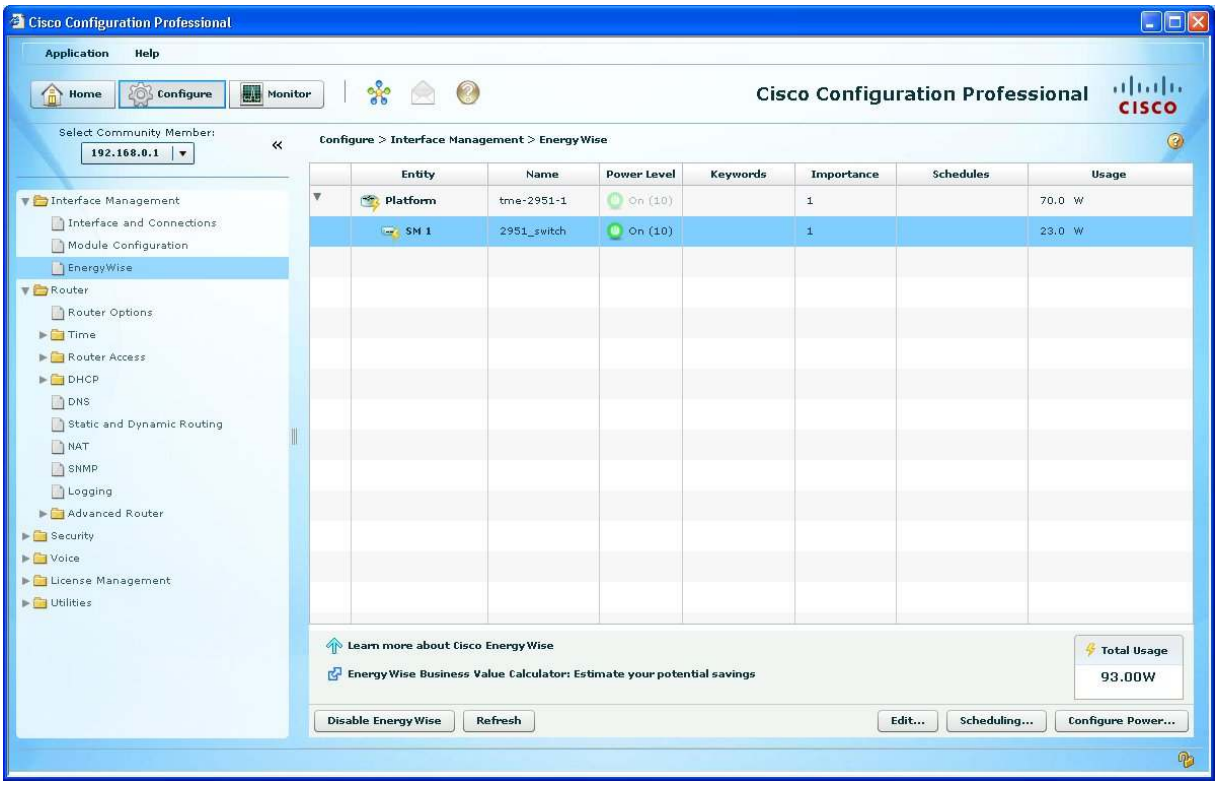
EnergyWise was already available in the Enhanced EtherSwitch modules and is now available on all Cisco 1900, 2900, and 3900 Integrated Services Routers Generation 2 platforms. Because this function requires a new hardware design, network modules and earlier digital-signal-processor (DSP) (PVDM2) modules requiring a carrier card do not support power control. Table 1 lists the modules supported at initial system release along with the expected power savings with the system invoked.

Configuring and Scheduling the System Power

Cisco Configuration Professional is a GUI-based device manager used to configure and monitor the ISR G2 system interfaces, traffic management, security, and voice features. Configuration of the system is streamlined using a collection of easy-to-use wizards. The Cisco Configuration Professional Version 2.3 extends its functionality to support EnergyWise.

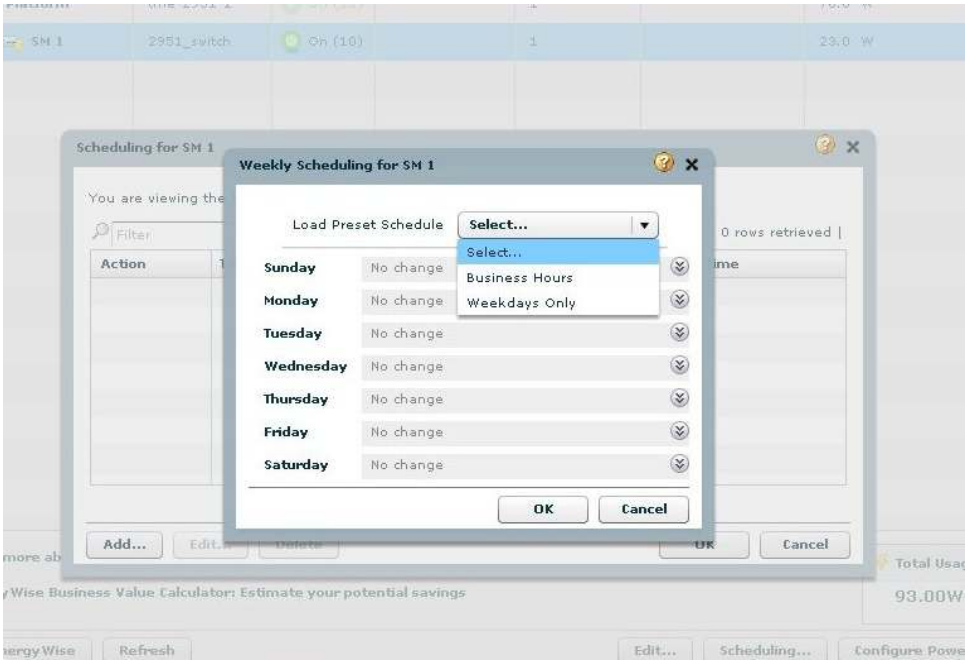
The Cisco Configuration Professional EnergyWise panel (Figure 2) provides a view of the components that support the Cisco ISR G2 EnergyWise. From this panel, the network manager can view and modify the configuration of the system.

Figure 2. Cisco Configuration Professional Power Management Panel



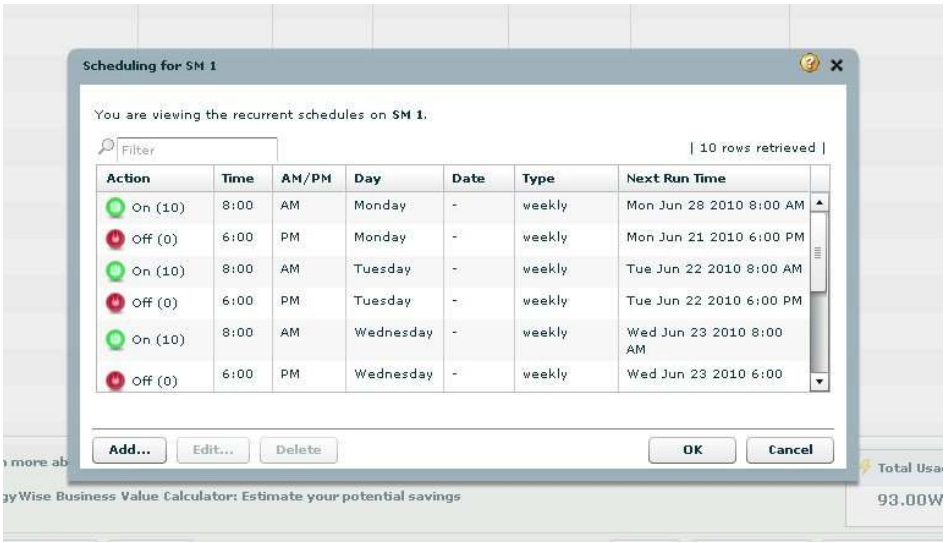
Using the Configure button in the EnergyWise panel, the network administrator can toggle the operational status of a device on or off. The Schedule button prompts the user to create a recurring schedule that is applied to the selected device. You can program each device to be turned on or off based on the time of day and day of week, and apply common preset schedules to the interface (refer to Figure 3).

Figure 3. Scheduling



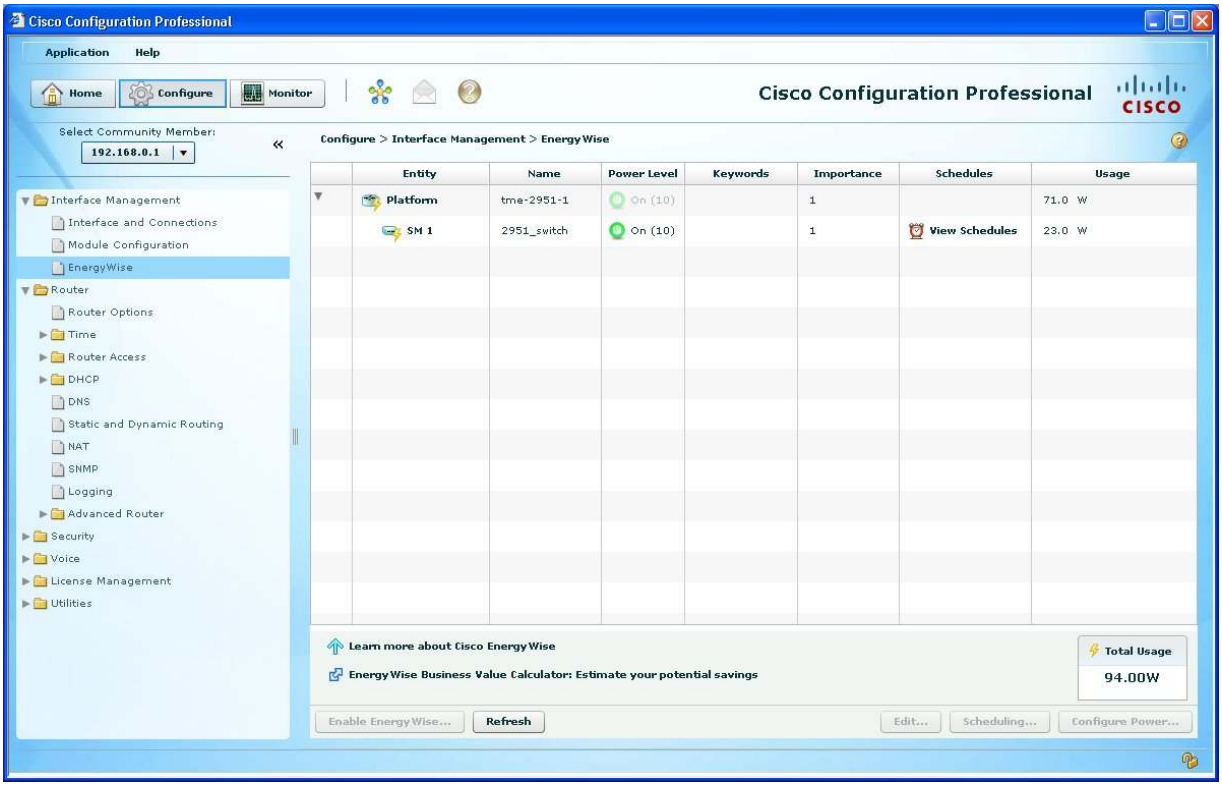
After applying a configuration to the system, Cisco Configuration Professional shows you the programmed schedule associated with the device when the View Schedule link is selected in addition to the EnergyWise panel (refer to Figure 4).

Figure 4. Programmed Schedules



With Cisco Configuration Professional you can see power monitoring at the module level. From the EnergyWise panel you can see the details of the environment such as expected power used by the module, current status, location of the interface, interface type with a link for the programmed schedule (refer to Figure 5).

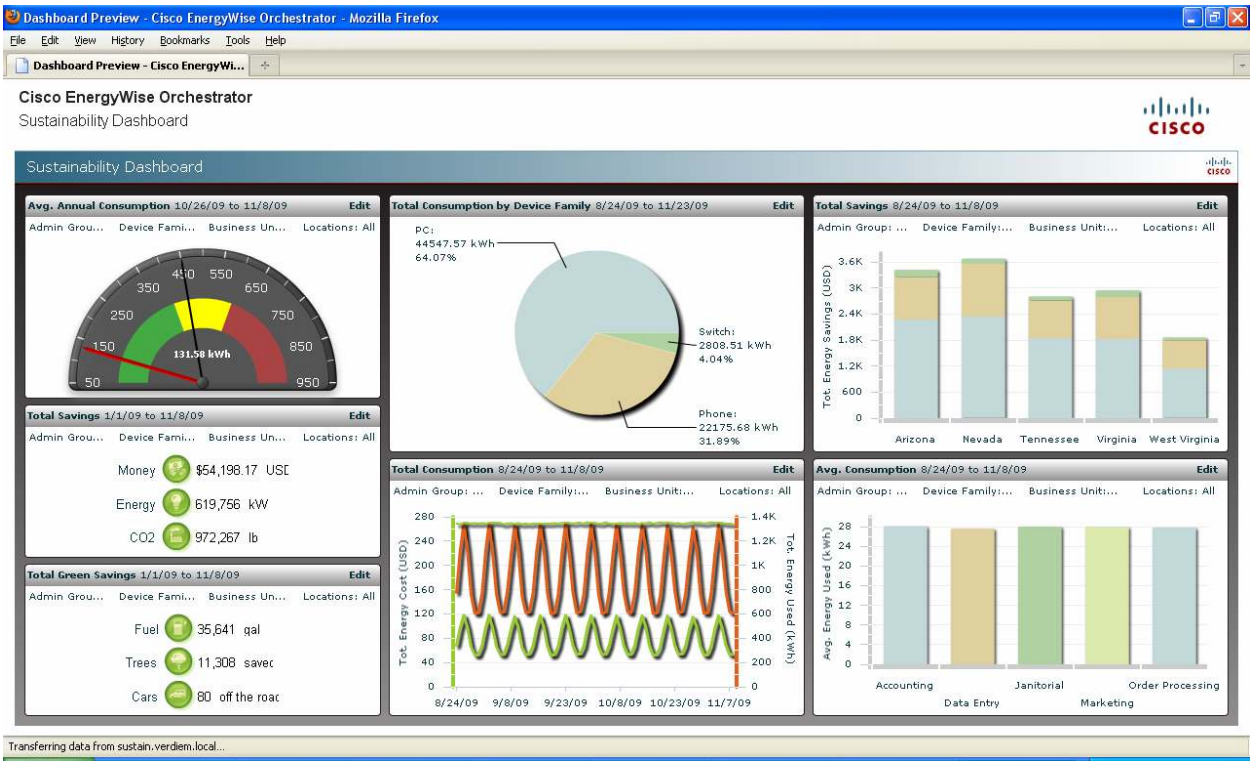
Figure 5. Power Management Panel



Cisco Configuration Professional is a tool specifically targeted to aid in configuring the ISR G2 systems. For a broader look on the network the EnergyWise Orchestrator application can be used. The Orchestrator application gives the system administrator control of the network power profile at the enterprise level.

The Orchestrator application provides centralized control of the EnergyWise switches, routers, IP phones, and access points along with desktop and laptop PCs through a single administrative console. The application is highly configurable allowing administrators to view their network based on date range, device type, administrative group, location, and business unit. The primary interface for the Orchestrator application is the Cisco EnergyWise Orchestrator Sustainability Dashboard (refer to Figure 6).

Figure 6. Cisco EnergyWise Orchestrator Sustainability Dashboard



For more detail on the Cisco EnergyWise Orchestrator application please refer to the product datasheet at this URL: http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps10195/data_sheet_c78-577722.html

Using the Command-Line Interface

The Cisco EnergyWise CLI implementation is very straightforward associating the scheduling and specific interface attributes to the hardware module. The Cisco Configuration Professional example discussed earlier is implemented on the ISR G2 router using the EnergyWise CLI as follows.

Scheduling of power to the system components is accomplished by associating the scheduling command to the "`hw-module`" CLI interface. The power to the module can then be controlled to either toggle the power on/off at any given time using the "`energywise level [0-10]`" command, with a level of 0 tuning the component off and 10 turning on. To extend this control for a reoccurring environment, the "`recurrence`" keyword is used.

When programming a reoccurring schedule, additional control is defined using the mandatory "`importance`" variable. The importance value of the module is defined under the hw-module section using the "`energywise importance [1-100]`" command; importance is set to 1 by default. When the importance variable is designated in

the reoccurring schedule command to be higher than the assigned importance of the interface, the command will take effect.

The scheduling of the power is the last component of the command. The modules schedule is defined using a numeric and wildcard method with the format—"`Minute, Hour, Day of Month, Month and weekday`". Users familiar with Cisco KRON will recognize that the scheduling mechanisms are similar.

The Cisco Configuration Professional example above generates the below configuration for the Service Module located in slot 1. Taking the first two EnergyWise lines for example, the Service Module will turn on every Monday at 8:00 AM and turned off at 6:00 PM. This cycle is repeated throughout the work week with the system remaining off on Friday evening until the Monday 8:00 AM timer is executed.

```
hw-module sm 1
 energywise level 0 recurrence importance 100 at 0 18 * * 1
 energywise level 10 recurrence importance 100 at 0 8 * * 1
 energywise level 0 recurrence importance 100 at 0 18 * * 2
 energywise level 10 recurrence importance 100 at 0 8 * * 2
 energywise level 0 recurrence importance 100 at 0 18 * * 3
 energywise level 10 recurrence importance 100 at 0 8 * * 3
 energywise level 0 recurrence importance 100 at 0 18 * * 4
 energywise level 10 recurrence importance 100 at 0 8 * * 4
 energywise level 0 recurrence importance 100 at 0 18 * * 5
 energywise level 10 recurrence importance 100 at 0 8 * * 5
 energywise importance 50
```

Example

Applying the configuration methods discussed previously to a real-world example might look like the following.

During normal operation, a platform supports business operations by providing the following functions:

- The platform supports 24 users with IP phone and PC connectivity using the Cisco Enhanced Layer 2, Layer 3 EtherSwitch® Service Module (SM-ES3-24-P).
- Voicemail is provided to the 24 users using the Cisco Services Ready Engine (ISM-SRE-300-K9).
- Power over Ethernet (PoE) is supplied to the 24 IP phones through the Cisco 3945 PoE Power Supply (PWR-3900-POE).
- Cisco Wide Area Applications Services (WAAS) functions are provided by the SM-SRE-900-K9) (supported in H1CY2010).
- Wireless LAN control is provided using a second Cisco SRE 700 Services Module (SM-SRE-700-K9) (supported in H2CY2010)
- A lobby phone implemented with the foreign-exchange-station (FXS) EHWIC along with the Cisco 16-Channel High-Density Packet Voice Digital Signal Processor Module (PVDM3-16).
- The WAN interface is connected to the onboard Gigabit Ethernet interface using a 100-Mb Small Form-Factor Pluggable (SFP) adaptor.
- The server room is connected using a second onboard Gigabit Ethernet interface.

Although most of the services configured on this router are user-based, some system components are used during off hours for business-related transactions. With the Cisco 3945 Integrated Services Router, the network manager uses EnergyWise to turn off nonessential system components during off hours while at the same time meeting the requirements for the off-hours network.

The enhanced Cisco EtherSwitch Services Modules supporting the 24 employees' voice and PC connectivity is not in use while the office is not open. The additional services the router supplies, such as voicemail and WAN optimization, are also not required; voicemail service can be transferred to a centralized offsite location and the WAAS functions can be turned off.

There is still network activity during the off hours. The HWIC routed Ethernet ports remain active for backup and data transactions. There is also an off-hours maintenance crew that will require E911 services using the HWIC FXS port, and a fax machine will also remain active using the second port.

Applying this example to a branch-office bank profile, normal operating hours are 7 a.m. to 7 p.m. Monday through Friday, and there are 500 locations. Using this profile and EnergyWise, the system administrator can place the Cisco 3945 Integrated Service Router systems in reduced power mode for 108 hours a week, or approximately 5616 hours per year (Table 2).

Table 2. Example of Energy Savings

Module	Function	Operational Power Consumption	Reduced-Power Consumption and Savings
SM-ES2-16-P	Data and voice	38.0W	0 - **38.0W**
16 phones	PoE: Telephone	240.0W	0 - **240.0W**
SM-SRE-900-K9	Cisco WAAS	50.0W	0 - **50.0W**
SM-SRE-700-K9	Wireless controller	40.0W	0 - **40.0W**
ISM-SRE-300-k9	Cisco Unity™ Express	20.0W	0 - **20.0W**
		Total Power Savings	**388W**

The 388-watts of power savings per location translates to more than 1.3 million pounds of CO2 not introduced into the environment over one year. An operating-expense perspective shows that the implementation of EnergyWise on the Cisco ISR G2 Power results in an annual savings of $119,845 (€79.541):

```
388W/Branch office x 500 branch offices = 194,000W
194,000W/1000 = 194.0 kW
194.0 kW x 5616 hr = 1,089,504 kW-hr
1,089,504 kW-hr x 1.25 lb CO2/kW-hr = 1,361,880 lb CO2 saved
1,089,504 kW-hr x $0.11/kW-hr = $119,845(€79.541) Annual Savings
```

This example illustrates the typical savings possible with the Cisco EnergyWise system.

Summary and Future of the Cisco ISR G2 Environmental Vision

As demonstrated throughout the product lifecycle, Cisco is committed to developing technologies that reduce the effect of the network on the environment. From the nonoperational perspective, minimized, clean manufacturing processes and product recycling programs frame the product lifecycle in an environmentally responsible manner.

Operationally, the Cisco ISR G2 EnergyWise system provides a platform that supports the ability to not only dynamically monitor and control the power consumption of the network's edge systems but also enables the same level of control to the connected endpoint PoE devices.

As part of Cisco's commitment to the environment, continued advances in these operational and nonoperational technologies can be expected to continue. For additional information about Cisco's commitment to environmental sustainability, please refer to the corporate efforts for environmental sustainability at http://www.cisco.com/go/green.

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