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Energy Efficiency in U.S. Forest Service Facilities: a Multiregion Review

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Cover Photographs

Clockwise from top left: (1) Workers install energy-efficient windows at the U.S. Forest Service Forestry Sciences Laboratory in Olympia, Washington. Photo by Rob Avila. (2) Sitka Ranger District, Tongass National Forest, Sitka, Alaska. Photo by Dave Nicholls. (3) In 2011, the Tongass National Forest equipped its Steelhead Barge, which it uses as a floating bunkhouse, with solar arrays. Photo by Michele Parker. (4) The Forest Service's Southeast Alaska Discovery Center in Ketchikan, Alaska, switched to this new biomass boiler. Photo by Michele Parker.

Abstract

Meyer, Rachelle S.; Nicholls, David L.; Patterson, Trista M.; White, Rachel E. 2013. Energy efficiency in U.S. Forest Service facilities: a multiregion review. Gen. Tech. Rep. PNW-GTR-886. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 28 p.

We reviewed energy efficiency measures in facilities across the U.S. Department of Agriculture Forest Service, examining opportunities and obstacles, and identifying factors of project success. The adoption of energy efficiency measures at Forest Service sites was seen to be most likely when decision control was local to the site and when budget timing and structures were familiar to decisionmakers and planned for in advance. The role of information diffusion is an important factor in both the planning and demonstration phases of energy efficient projects. The findings presented can help other Forest Service units and other governmental agencies reach the ambitious energy reduction goals stated in Executive Orders 13423 and 13514. Higher returns on investment and more informed decisionmaking can be supported by better data documentation (pre- and postinvestment) and research into life-cycle analyses of project benefits. Much of the work summarized in this paper addresses minor purchasing decisions and energy saving equipment; however, future developments will likely include larger-scale projects, including new construction of Leadership in Energy and Environmental Design-certified buildings and new renewable energy projects. Resources to aid Forest Service personnel in making energy use decisions are summarized.

Keywords: Energy efficiency, federal government, energy conservation, life-cycle analysis, carbon emission reductions.

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Introduction

Greening Up Government

American taxpayers have more than just their own utility bills to worry about. Energy use by the federal government, the single largest consumer of energy products and services in the United States, carries a substantial price tag. Collectively, federal agencies purchase more than 10 percent of all energy-using products nationwide (Gillingham et al. 2006). Efforts by the federal government to increase energy efficiency therefore benefit the whole Nation by lowering costs, minimizing the government's carbon footprint, and reducing resource depletion.

To encourage effective energy management, the U.S. Department of Energy established the Federal Energy Management Program in 1973 to provide technical assistance and oversee energy efficiency investments and energy audits. Since then, significant strides have been made, as energy use in government buildings has decreased by 23 percent between fiscal years 1985 and 2001 (Gillingham et al. 2006). Total federal government energy use—which includes electricity, fuel oil, propane, gasoline, and diesel—dropped from 1,565,000 billion site-delivered British thermal units (Btu) in 1975 to 1,085,000 in 2007 (US DOE 2010). However, by using more energy-efficient products, federal agencies could still save more than $200 million per year (US DOE 2008) and reduce carbon emissions by up to 8.6 million metric tons per year (Gillingham et al. 2006). To increase the pace of progress, President George W. Bush signed two federal policies that mandate curbing costs and resource use. Executive Orders 13423 (E. O. 13423 2007) and 13514 (E. O. 13514 2009) have necessitated large-scale changes to the status quo. Executive Order 13423 requires all federal agencies to lead by example in reducing energy consumption by 30 percent (from a baseline year of 2003) by the year 2015, while Executive Order 13514 has longer term and more stringent ramifications for buildings starting in 2020.

It is particularly appropriate for federal agencies with a natural resource conservation mission to demonstrate environmental leadership by not wasting energy. The U.S. Department of Agriculture (USDA) Forest Service mission is to "sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" (USDA FS 2012a). As part of its mission, the Forest Service has set goals for resolving energy resource challenges through its Strategic Energy Framework. The framework defines the key Forest Service energy role as follows:

> …to effectively contribute to the sustainable development and use of energy resources for present and future generations through land management, technical and financial assistance, research and development, and energy conservation (USDA FS 2011).

Strategy goals relate to supporting renewable energy production, facilitating a low fossil-fuel energy future, and reducing the Forest Service footprint via reduced energy consumption in agency buildings, operations, and infrastructure. Specific targets for energy reductions include office facilities, the motor vehicle fleet, water use, green purchasing, and recycling (USDA Forest Service 2012b).

Many savings can accrue from very simple behavioral or low-cost infrastructure changes (e.g., shifting from incandescent to fluorescent lighting, installing powerstrips, powering down computers, and installing insulation). Federal agencies are required to purchase either ENERGY STAR[1] products, or if ENERGY STAR labels do not apply, to purchase products in the upper 25-percent range of energy efficiency (Gillingham et al. 2006). These policies can directly influence markets for these products, as the scale of federal expenditure is so large. For example, in 2007, the USDA invested $9.67 million in energy efficiency and renewable energy projects (US DOE 2010).

The Forest Service also aims to proactively mitigate climate change impacts, which led the agency to create its Climate Change Performance Scorecard (USDA FS 2010). Using the scorecard approach, all national forests work toward attainment measures in 10 different elements within four broader themes (see sidebar). Performance areas include integrating climate change into program work, assessing vulnerability of key resources, performing a baseline assessment of carbon stocks and flows, and making progress toward targeted reductions in resource use. The agency anticipates that the performance scorecard will inform a broader range of planning decisions as familiarity with the scorecard grows, because it includes elements for carbon assessment and management as well as sustainable operations.

In coming decades, energy efficiency measures within the Forest Service will reap benefits far beyond cost savings. Nonmonetary benefits will be high, and as certain ecosystem services enter the marketplace, these may also receive financial translation. For example, the environmental benefits associated with carbon footprint reductions, although having little value in today's carbon markets, could someday yield significant economic benefits if and when carbon is valued higher.

[1] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture, Forest Service of any product or service.

Sidebar

Ten elements of the Forest Service Climate Change Performance Scorecard (2010)

Organizational Capacity

1. Employee education
2. Designated climate change coordinators
3. Guidance, training, and plans of work

Partnerships, Engagement and Education

4. Integrate science and management
5. External partnerships

Adaptation

6. Vulnerability assessment
7. Adaptation activities
8. Monitoring

Mitigation and Sustainable Consumption

9. Carbon assessment and management
10. Sustainable operations

In many locations, the low-hanging fruit of simple and immediate behavioral changes (e.g., light bulbs and recycling) is already being implemented (table 1). Longer term measures (and those which account for the life cycle of products) include purchasing energy efficient hardware and whole-building installation of renewable energy systems. These types of changes are more challenging, and may require better coordination and development of supportive policy and institutional changes. As the Forest Service explores potential avenues toward broader long-term energy efficiency goals, it is working to create an organizational structure that facilitates coordination and sharing of lessons learned and benefits from these efforts.

Research Objectives

This study focused on eliciting and synthesizing insights from managers who are closely involved with energy efficiency measures. Specific objectives of this report include:

- Identification of barriers common to energy efficiency investment. If a specific logistical barrier was not easily identified, we looked for underlying patterns and root causes that might hinder projects.

Table 1—Energy efficiency measures implemented on western national forests

Project title	Region	Footprint areas		
New heater for helibase shop	Intermountain	Energy	Green purchasing	
Hand-crank flashlights	Intermountain	Energy	Green purchasing	Fleet and transportation
Energy-efficient office improvements	Intermountain	Energy	Green purchasing	
Camp can crusher	Intermountain	Energy	Green purchasing	Waste reduction
Rechargeable lithium batteries	Intermountain	Energy	Green purchasing	Fleet and transportation
Green transportation	Intermountain	Energy	Fleet and transportation	
Water bottle reduction	Intermountain	Energy	Water	Waste reduction
Solar upgrade	Rocky Mountain	Energy	Green purchasing	Sustainability leadership
"Kiwi" project	Pacific Northwest	Green purchasing	Fleet and transportation	Waste reduction
Air compressor installations	Intermountain	Fleet and transportation		
Battery recycling program	Intermountain	Green purchasing	Waste reduction	
Waterwise landscaping	Intermountain	Green purchasing	Water	Waste reduction
Recycling bins	Intermountain	Waste reduction		
Recycling at remote sites	Alaska	Waste reduction		

Source: USDA FS 2012c.

- Identification of a strategy for success. We wanted to find out what approaches and actions have worked well for specific projects, particularly if they could be replicated in other locations. We used these success factors to identify a set of recommendations for future energy efficiency projects.

Getting to an Energy-Efficient Forest Service

The U.S. Forest Service has worked to transform its agency culture in the face of several large and persistent organizational challenges, such as safety, diversity, and, currently, sustainable operations (Apple 2000, Dialogos International 2007, Jones-Crabtree et al. 2010). These changes will need to occur at all levels of the agency for it to truly chart a new course. Cultural transformation will also be more meaningful and likely to succeed when communication is clear and based on adequate information. For example, understanding the dynamics of the various processes, personnel, and institutional structures involved in decisionmaking about energy efficiency can help the Forest Service become more aware of barriers and missed opportunities.

By pointing out the bottlenecks in our approach to implementing energy efficiency projects, we help advance the goal of becoming a learning organization, where an agency self-assesses its management practices, policies, and mission, and continually adapts them as new challenges arise.

As we view energy conservation and efficiency through this lens, we hope to identify behaviors or planning processes where small changes could produce big improvements. Through doing so, we anticipate that the Forest Service will realize broad-based energy and environmental benefits, underscoring its leadership and fiscal accountability. Here, we first review available literature and policy relevant to improvement of energy efficiency in federal agencies.

Other Studies of Energy Efficiency Projects

Although energy efficiency policies can be wide ranging, they may be generally categorized into four areas: appliance standards, financial incentive programs, voluntary conservation programs, and government energy management programs (Gillingham et al. 2006). Nearly 200 energy conservation provisions across many sectors, including government buildings, were outlined in the Energy Independence and Security Act of 2007 and the Energy Policy Act of 2005 (Dixon et al. 2010).

Despite an extensive body of literature on energy efficiency and green building practices, relatively little research has been done specifically on government buildings. Proper insulation, materials, and building design are widely recognized as important determinants of energy efficiency. However, accurately modeling energy efficiency in buildings can be complex because numerous variables can influence energy use. For example, Buck and Young (2007) modeled energy efficiency for commercial buildings in Canada using a stochastic approach. They evaluated 23 variables, including year of construction, number of floors, heating and cooling degree-days per year; presence of insulation retrofits; presence of lighting retrofits, presence of reflective glass on windows; building area; and the heating, ventilation, and air conditioning maintenance and repair schedule.

Alternatively, energy efficiency can be modeled less precisely by recognizing basic and immediate actions that can affect energy use. Escrivá-Escrivá (2011) identified seven easily implemented changes that could reduce energy in commercial buildings. Among them are automatically monitoring energy consumption, making one or more individuals responsible for energy use within their building, and improving communications between managers and users. Other researchers (Tzikopoulos et al. 2005) have considered bioclimatic principles, including environmental conditions, building characteristics, and use of renewable energy to model energy efficiency.

New building construction has been identified as a prime opportunity to improve energy efficiency. Often, energy-efficient designs can be included in the initial construction much less expensively than retrofitting existing buildings. Kneifel (2010) simulated energy consumption for 12 prototypical buildings, and found that, even when conventional energy technologies are used, energy consumption can be decreased 20 to 30 percent through new building construction.

These studies and others demonstrate some of the approaches possible for energy conservation and successful applications in the private sector. Forest Service energy efficiency planning motivations can differ from those of the commercial or residential sectors, which tend to be more profit oriented. The Forest Service's challenge will be to develop effective strategies that work within the federal government system and also meet mandated energy conservation requirements.

Methods

Resources and strategies for implementing energy efficiency measures at Forest Service locations were evaluated by conducting 22 open-ended interviews with employees involved with energy-improvement projects or knowledgeable of other local and regional initiatives (apps. 1 and 2). Interviewees spanned a broad range of job descriptions, and their projects varied in timing (currently in progress, recently completed, or far in the past); extent (one or several small projects to large construction projects); and technological diversity (numerous efficiency measures and green technologies versus a specific one).

All nine Forest Service regions (fig. 1) and two research stations were represented. Of these, the Northern Region and Rocky Mountain Region were represented more than other regions, with five employees each. Employees included engineers, facility managers, building managers, architects, and green team members. The range of responsibilities represented suggests that their viewpoints were close to the "front-lines," but their insights might complement that of upper level management, where budgetary or investment decisions are often otherwise made.

The discussions were conducted by phone and ranged from 20 to 120 minutes in length, with most lasting about an hour. Discussions focused on the nature of energy efficiency measures, funding sources, obstacles encountered, decisionmaking processes, key motivations, and success strategies (app. 2). The energy efficiency measures covered ranged from multimillion dollar Leadership in Energy and Environmental Design (LEED) building construction to the installation of several "vending misers" (external devices that reduce power consumption of vending

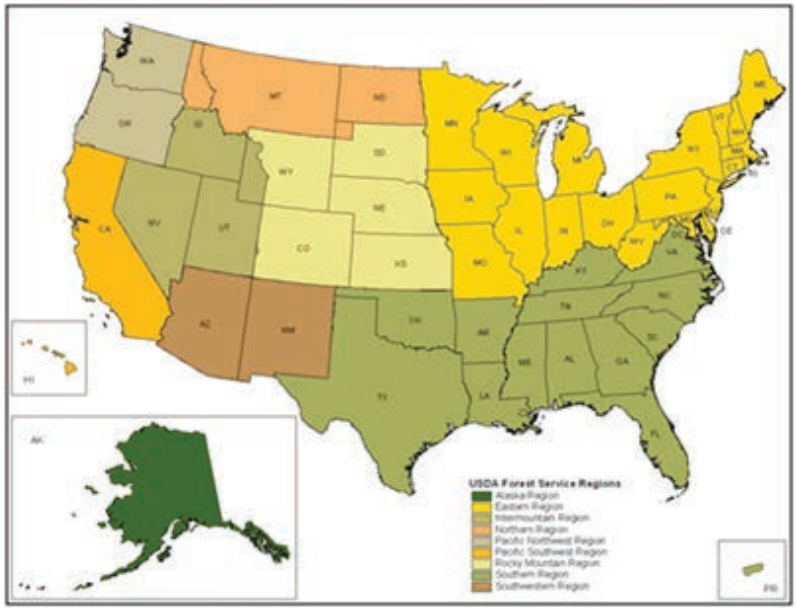

Figure 1—Map indicating the 9 regions of the U.S. Department of Agriculture Forest Service National Forest System.

machines) in an employee break room. The interviews were evaluated against prior respondent answers, which helped to accurately record and discern certain relationships, timing, and feedbacks among elements that promoted or presented a barrier to the proposed energy efficiency measure.

Findings

This section presents a synthesis of insights from respondents. The path varied, but most respondents identified a series of steps in conceiving, funding, implementing, and reflecting upon each project. Improvements can be made in each step of the cycle.

Forest Service employees want to save energy—
The desire to lead by example or to "walk the talk" was a nearly universal sentiment among those interviewed. Many felt that, as employees of a conservation agency, their day-to-day activities should reflect the Forest Service's motto of "caring for the land and serving people." The most common phrase encapsulating this vision was that "it's just the right thing to do." The root of this desire may differ; for some interviewees, it was about reducing carbon emissions, while for many more it was motivated by efficient use of available funds. Either way, this suggests a shared vision of the Forest Service conserving resources and leading by example.

Corrine Kegel

Figure 2—Forest Service nursery at Coeur D'Alene, Idaho Panhandle National Forest. By modernizing refrigeration, lighting, and heating, ventilation, and cooling systems, the nursery cut energy usage by 80 percent.

Institutional barriers present challenges to adoption of energy efficiency measures—

Our interviews revealed three institutional barriers to implementation of energy efficiency projects: (1) site-specific information on energy use is not easily accessible, (2) centralized funding allocation does not incentivize energy saving, and (3) annual budgeting leads to short-sighted decisions.

Site-specific information on energy use is not easily accessible—

Employees at most Forest Service sites are likely unaware of how much energy they use. The creation of a feedback loop that provides timely information on resource use could provide motivation for reductions in use (Meadows 2008). In residential settings, immediate feedback on energy use typically results in savings of 5 to 15 percent (Darby 2006). Thus, a centralized clearinghouse for information on energy efficiency and use could provide the feedback needed to streamline the planning process, better inform local decisionmakers, and reduce the likelihood of confusing or contradictory records. If every site reviewed and reconciled their own billing statements, errors would be found much more quickly, and true energy use could be verified. Further, up-to-date utility records will be essential for local managers to gauge progress in reaching agencywide energy use mandates.

Although the Telephone, Utilities, and Maintenance System (TUMS) used by the Forest Sevice was mentioned as a resource for obtaining this information, it is not often used, possibly because getting access can be difficult. When TUMS is not accessible, there are other ways to get this information. For example, one employee learned accidentally that it was possible for workers in Forest Service Region 1 to get copies of utility bills through the Administrative Center of Excellence. Others mentioned getting a copy of the bill by speaking with their utility providers. However, another employee found that their utility would not mail bills to two separate addresses. Currently, most Forest Service utility bills are sent to the National Finance Center (NFC).

Centralized funding allocation does not incentivize energy saving—In most regions and stations, at least some utilities are paid through the NFC, meaning that these funds come from centralized (and not local) sources. In these cases, savings generated by an individual unit are not retained locally, often leading to counterproductive decisionmaking. For example, one engineer reported that a greenhouse was currently running on electricity, yet could be more cost-effective if run on natural gas. Because electricity bills were paid through the NFC, and natural gas was paid by the unit, the decision was made to stay with electricity. That is, because this unit did not want to pay the bill out of their own budget, they went with a more expensive, less efficient option (using centralized funding).

Rachelle Meyer

Figure 3—A new “smart” meter at the Missoula Fire Sciences Laboratory. Advanced meters like this one make real-time electrical usage readings available on a website, making them extremely useful for tracking energy use. Before installing these meters, staff at the Missoula lab had no way to determine energy usage in their buildings.

The inability of Forest Service units to take local ownership for local energy use is perhaps one of the most important barriers we identified. If all units were given the funds to pay their own utilities with any savings being retained for the unit or project, this could provide a strong local motivation for increased energy efficiency. However, this change is unlikely under the current finance structure, and would require a high-level policy solution.

There is hope, however, that local units can devise creative strategies that allow for new budgeting structures. At least one research station has taken steps to address this issue. Also, in at least one lab, money saved from utilities and other operating costs was made available for deferred maintenance or research. This policy was shown to motivate staff to reduce energy consumption and become amenable to policy changes. As a specific example, two or more programs may decide to share a freezer, so the money saved could be used to purchase other equipment. A potential downside of this arrangement is the additional time needed to track payments and to ensure that payments are applied to the correct accounts.

Annual budgeting leads to short-sighted decisions—
Currently, the operating and maintenance costs over the course of a Forest Service building's lifetime are not included in the design process. Incorporating long-term costs into the planning process could clarify the differences between available options, justify higher initial construction costs, save money over the long term, and improve the durability and efficiency of Forest Service buildings. Several quantitative methods have been developed to address these and other resource use questions including life-cycle analysis, carbon footprinting, and greenhouse gas inventories. Obtaining such information specific to Forest Service projects is difficult. Even more discouraging is that such information is then unavailable to help inform spending decisions. Incorporating this type of information into purchasing decisions would result in better support for proposed actions as well as accounting for short- and long-term impacts and benefits.

Annual budgeting also creates the "end-of-year" spending phenomenon. The desire to spend all allocated money stems from the potential loss of at least a portion of remaining money and the perception that unit budgets may be reduced if they do not use the money they are allocated. Because it can incentivize wasteful spending and restrict the ability to save money across fiscal years, many interviewees viewed this structure negatively, despite its use for funding many energy-efficiency measures.

Incorporating long-term costs will require a major cultural shift and a budgeting structure in which decisionmakers can respond to this information. This could extend to high levels of government. For example, mechanisms for saving money between fiscal years would create a monetary incentive for further cost savings and efficiency improvements, but would literally require an act of Congress. Meanwhile, there are mechanisms already used in the Forest Service that allow for saving money and long-term budgets. Programs such as the Forest Service Facility Realignment and Enhancement Act (FSFREA) is a notable example. Providing information to decisionmakers in the Forest Service has been addressed by the Western Collective Sustainability Science team, whose efforts help managers use the most relevant research information to make science-based decisions on their units.

Key people can make or break a project—
The interviews revealed several cases of changes occurring because of a specific person having the motivation and power to make a change. This includes the sustainable operations coordinator, who was largely responsible for the creation of the Western Collective, and the individuals who have set up microgrants in their regions, providing a previously unavailable funding source. The effect a motivated individual (or "project champion") can exert on the success of a project can be substantial.

Conversely, a single person (or small group of vocal opponents) strongly opposed to a given project can also exert strong influence on the outcome. For example, one respondent indicated that a proposed wind turbine that had received categorical exclusion status through the National Environmental Policy Act, and seemed to have broad-based public support, was stalled by one local citizen making objections to the city council. All these individuals are examples of "the law of the few" described by Gladwell (2002), where the actions of a handful of people have large effects on the spread of an epidemic, be it an illness, a fashion trend, or the adoption of a new technology.

Also important is the effect of individual hires, retirements, and transfers on implementing energy efficiency measures. For instance, Region 6 seemed uninterested in joining Region 1 in partnership with the Bonneville Power Administration until a new architect was hired. In another case, a Utility Energy Service Contract was stalled because important project work remained uncompleted after someone retired. In yet another case, the favored biomass heating project of a district ranger fell out of favor after his departure, because no one else was interested in maintaining the system. This factor can be especially important in multiyear projects

because the continued presence of a project champion, familiar with a specific project, is usually essential. Incorporating these projects into the facilities' Environmental Management System could help ensure that a project continues even if a key team member or project champion leaves.

Nearly all of the respondents had generally favorable remarks about the role of leadership in the success of their project. Although it may be a coincidence, two of three interviewees who had unsuccessful projects were the only ones who listed leadership as an obstacle. In the third case, high cost was a barrier. This suggests that the level of motivation by decisionmakers in leadership positions may be a key factor in the success or failure of projects. This makes intuitive sense, as it would be quite difficult for a project to move forward without the support of supervisors, even if all other factors were favorable. Leadership has a critical role in facilitating the change from the status quo to meeting mandated and desired energy goals (Jones-Crabtree et al. 2010).

People learn by example—
We found that energy-efficiency measures and funding mechanisms, when successful at one location, can often be replicated at other locations. A notable example is the microgrant program in Region 1. It provides $100,000 a year (with a $25,000 project maximum) for energy efficiency and renewable energy projects (table 2). This program came about because the regional engineer learned of a similar, successful microgrant program in Region 2 at a Sustainable Operations Summit.

Table 2—Available Forest Service "green" microgrant

Region or station	Annual microgrant amount	Years offered
	Dollars	
Region 1	100,000	2009–2011
Region 2	50,000	2005–2009, 2011
Region 3	55,000	2009, 2010
Region 4	25,000–35,000	2008–2011
Region 5	20,000–28,500	2007, 2008, 2011
Region 6	50,000	2011
Region 10	5,000	2010
Rocky Mountain Research Station	5,000	2010–2011

Seeing the potential for a similar program in his region, he successfully presented the idea to his station leadership. The new Region 1 program has resulted in many energy-saving projects, leveraging over $100,000 in matching funds from utilities and other sources. Several of these projects have achieved outstanding payback periods, as short as one to two years. Only one of the five employees from Region 1 listed budget constraints as an obstacle to implementing energy efficiency measures, and that individual mentioned a need to prioritize available funds, not a lack of funding.

Interviewees noted that several other project successes were based on effective information diffusion. These examples include the adoption of vending misers and smart power strips on the Tongass National Forest, cooperation between regions to participate in common Energy Savings Performance Contracts, and successful LEED designation for a building on the White Mountain National Forest in New Hampshire. Lessons learned from other, non-Forest Service LEED building projects in New Hampshire were incorporated into designing and constructing the White Mountain LEED building. In addition, tours of the LEED facilities help communicate their success within and outside the Forest Service, furthering information diffusion while demonstrating successful agency projects.

Corrine Kegel

Figure 4—A new energy-efficient furnace at the Forest Service's Coeur D'Alene nursery was part of an Energy Savings Performance Contract with Honeywell. The success of this project led to inquiries from the Eldorado National Forest about energy upgrades for its Placerville nursery.

Interviewee Observations

The interviews revealed several tactics for getting energy efficiency measures in place, which can be summarized as:

- Be ready
- Try it in pieces
- Get and give information

Most facilities managers are already aware of the benefits of being prepared, especially with regard to purchasing new equipment.

Be prepared for opportunities—
Thoroughly research energy efficiency choices in advance, and make sure that purchase sources and locations are well known, even if funding is not yet available. Maintain relationships with key partners, including local cooperators and utility company personnel, to help them be prepared when opportunities arise. Until systemic changes are made regarding funding across multiple fiscal years, employees attempting energy efficiency measures at their locations can improve their chances of success by being ready to mobilize efforts quickly once a funding opportunity arises. In addition to having the information to justify the expense of some of these options, a mechanism for paying for them would likely be necessary.

Take a piece-meal approach—
If necessary, do things piece-meal. In many circumstances, this may be the only way to successfully complete projects. For example, the LEED building on the White Mountain National Forest in New Hampshire was completed in four phases (Mainville 2012). Because it was an expensive project, full funding could not be provided in a single fiscal year. Completion took 4 years and four contracts, but the result was a well-built, energy-efficient building. On a smaller scale, when completing projects in existing buildings (e.g., upgrading office lights), a piece-meal approach can also lead to successful results while building the support of cooperators. For example, if one floor of a building is completed and the successful results are demonstrated, this may pave the way for future support to complete other floors. The measurement and verification of energy savings could themselves become success strategies.

Be patient and persistent—
Overcoming bureaucratic hurdles and delays is one of the key elements of successful energy efficiency measures. Full funding for projects can often take several years to secure, followed by years of purchasing and construction. Managing multiyear projects can become even more challenging when key personnel retire

or move to new positions. Over shorter timeframes, focusing on local, easily implemented changes requiring little or no funding can produce tangible results. Examples include promoting alternative transportation for commuting to work, turning off computers, and reducing office lighting. These examples not only can reduce energy use, but can improve employee morale, which in turn can encourage participation in future projects. The role of local Forest Service "green teams" in similar activities should not be overlooked.

Adopt a slogan—
Despite having a simple motto that is likely to resonate with the majority of Forest Service employees, there has been no organized attempt to use it to mobilize the agency to increase efficiency. A slogan or motto that captures Forest Service goals and plans for reaching energy efficiency objectives could help connect the personal convictions of all employees, not just those involved in sustainable operations, to these large-scale efforts. Use of the word "save" in this catch phrase would be congruent with all interviewees' responses, as it addresses all aspects of the issue including monetary, natural resources, and mitigating the impacts of climate change.

Adapt energy projects to end-users—
Models for energy efficiency measures across sectors have shown that policies including both mandatory and voluntary components can be effective (Lee and Yik 2004). Although many of these elements could be transferrable to national forest

Jamey Lowdermilk

Figure 5—A bulletin board at the Helena Ranger District office, Helena National Forest, helps keep employees inspired to reach sustainability objectives. This study found that even without an organized, agencywide effort to increase efficiency, most employees want to save energy.

units, successful private sector models may need to be modified before being used at government facilities. For example, as a natural resource management agency, the Forest Service has some unique considerations to deal with, including remote, fragmented districts and forests, the safety needs of field-going employees, the need to address urgent issues (such as wildfire suppression), and other concerns that may supersede energy efficiency. Ultimately, however, the motivation of individual Forest Service employees and their attitudes regarding cost savings, environmental awareness, and other factors could play a determining role in how agencywide energy efficiency benefits are realized.

Take the "low-hanging fruit"—
These projects require little effort to implement, yet bring about tangible benefits quickly. Examples include turning off computers at night, recycling, and using energy-efficient light bulbs. A key element in moving forward will be the need to distinguish between the motivation needed to tackle simple measures versus the complexity of implementing larger scale projects. For example, new building construction with LEED certification represents a complex, expensive, and time-consuming project that could require a phased approach (in contrast to simple projects where benefits can usually be quickly realized). It is important to distinguish between the scale of these two types of projects, and the financial returns. For example, large-scale projects can sometimes have very attractive economic returns, yet not be undertaken because of administrative, logistical, or other barriers.

Strive for clear information flow and diffusion—
Easy access to good-quality information, including quantitative estimates of reductions in resource use and cost savings, improves decisionmaking ability, increases opportunities, and can create positive incentives for change. Encouraging pilot projects and spreading information regarding their results would likely be an effective strategy to implement new technologies. This was the case with vending misers and smart power strips and the Region 1 microgrant program. Results of these "experiments" should be widely distributed. Similarly, pilot programs can justify further action. If replacing a small sample of lights in a building with more efficient bulbs results in noticeable reductions, this could pave the way toward replacing the remaining bulbs and realizing these added benefits. A structural change that could streamline this process would be to provide stronger linkages between the planning decisions and their economic outcomes. The recent development of the Leadership

in Sustainable Operations website addresses this by providing a searchable repository of sustainable operations projects. By ensuring that all employees are aware of this resource, Forest Service managers can help facilitate the spread of information between regions and stations.

Support project champions—
Having motivated people with vested interests in project outcomes can provide substantial contributions to energy efficiency measures. Educating supervisors on the critical nature of the project champion's leadership role may also assist in increasing successful project outcomes. The ability for project champions to provide local oversight in monitoring and controlling routine expenses (rather than a centralized spending authority) will further help managers to become true stakeholders in their projects.

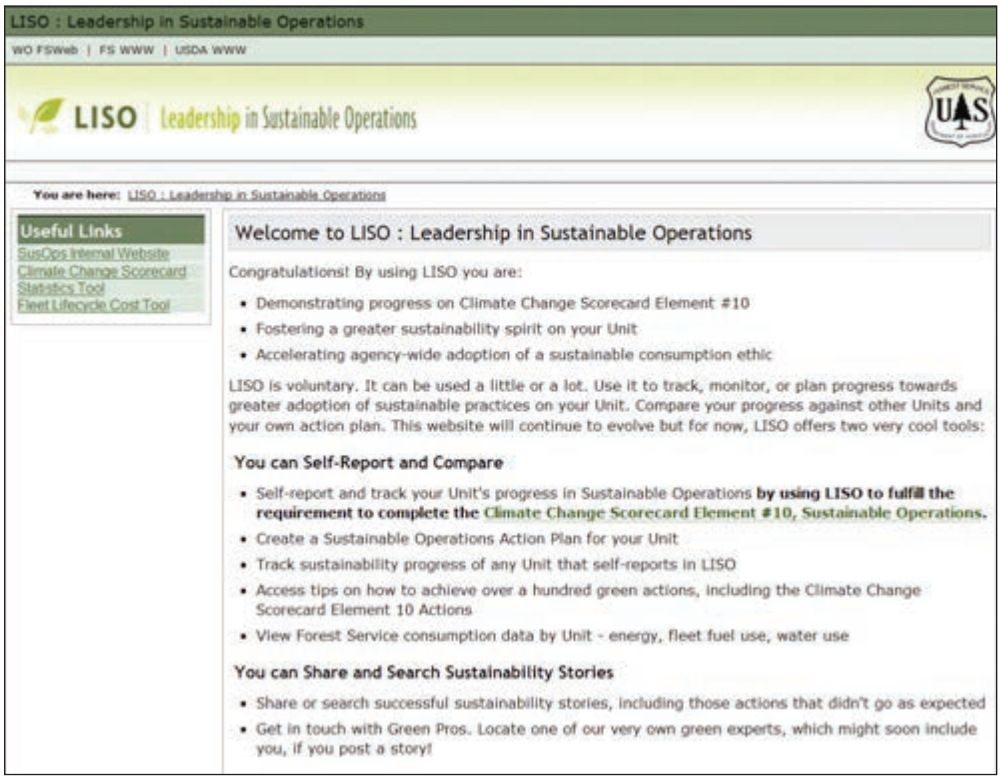

Figure 6—The Leadership in Sustainable Operations webpage is a great resource for assessing our progress toward becoming more energy efficient. Users can share information about energy consumption, access the Climate Change Scorecard, and learn about successful sustainability measures across the Forest Service.

Embrace technological change—
New technologies will drive implementation of many energy efficiency measures in the years to come. One only has to consider how quickly new light bulb technologies, smart grids, and other integrated energy management strategies are reducing energy consumption. As technological innovation changes the range of energy efficiency measures available, the Forest Service will need to be responsive and proactive in adopting these new products.

Future Research Directions

The potential for increased energy efficiency throughout the Forest Service is substantial, and the associated environmental and economic benefits great. The barriers associated with implementing new practices and procedures across a large agency will also need to be addressed. These barriers are already being overcome as learning experiences within the Forest Service provide feedback into the most effective and appropriate energy efficiency measures. Energy efficiency measures in Forest Service buildings will require ongoing monitoring, documentation, and analysis in order to provide feedback for future efforts.

In addition to energy efficiency measures, future work could include evaluations of renewable energy projects. For example, several wood energy facilities have recently come online at Forest Service buildings (Groom and Elder 2009, SitNews 2012) and are making positive contributions toward energy savings. Thus, the combined effect of energy efficiency measures and renewable energy generation could paint a more complete picture of the Forest Service's commitment to environmental measures such as reducing greenhouse gas emissions. Combined, these actions will help assess progress toward reaching the goals from Executive Orders 13423 and 13514.

A key part of successful monitoring efforts will be for common measurement and analysis procedures to be established to ensure consistency across Forest Service units and regions. Forest Service research units could address topics as diverse as energy-use modeling, greenhouse gas emissions analysis, economic analysis, or life-cycle inventory and assessment. For example, the National Renewable Energy Laboratory (NREL) has built a 222,000 square foot (20 239 square meters) "net-zero" facility in Golden, Colorado (Raabe 2010). Life-cycle analysis research on this building and others could help document energy-saving innovations. New research on federal buildings could complement similar research already completed for private-sector buildings. As more and more LEED-certified Forest Service buildings are constructed, research could also play a role in shaping these decisions and feedback loops. Ultimately, the Forest Service's actions and success stories could serve as an example to catalyze projects at other federal facilities.

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Figure 7—In 2011, the Tongass National Forest equipped its Steelhead Barge, which it uses as a floating bunkhouse, with solar arrays. The solar panels eliminate the use of 4,000 gallons (15,141 liters) of fuel oil a year, saving $60,000 and reducing greenhouse gas emissions.

Resources

Capital Improvement Program (CIP)—

The CIP is a national-level funding mechanism for construction, in which funding selection is based on several criteria including health and safety. Federal agencies across the Nation compete for a common funding pool, allocated annually by Congress. Criteria for the CIP are developed by different administrative levels within the Forest Service, and there is typically strong competition among the many applicants for these funds. This is the primary, and, in many circumstances, the only mechanism for funding new construction.

Project maintenance—

Energy efficiency measures in Forest Service facilities can often be intertwined with maintenance programs and budgets. This funding source is often used to implement site-level energy efficiency measures. Several managers gave the impression that the true cost of maintaining buildings is not adequately reflected in their budgets, thus limiting their efforts to secure funding for energy efficiency measures. Because resources are often spent on reactive issues and emergency repairs to other types of infrastructure, it is not uncommon for these funds to be used on

crisis abatement items rather than on projects or equipment having longer benefits for improving energy efficiency. Nonetheless, incorporation of energy efficiency into maintenance planning and budgets represents a viable avenue for energy efficiency measures.

End-of-year dollars—
Opportunities for energy efficiency measures can sometimes appear unexpectedly in the form of "end-of-year dollars" (i.e., funding allocated in a given fiscal year that will be lost if not spent by the end of the fiscal year). Employees planning to implement energy efficiency measures often take advantage of funds remaining near the end of the fiscal year. However, the window of opportunity can be narrow and planning must occur quickly or funds will be lost. Thus it is helpful for units to have projects "shelved" and ready to implement, especially when considering that other projects deemed higher priorities could outcompete energy efficiency measures for funding.

Rental income from Forest Service residences (quarters funds)—
Many Forest Service locations maintain temporary residences for seasonal employees and for employees who are starting new assignments. Often, a portion of these receipts can be used for energy efficiency measures. So-called "quarters funds" can be used on upgrades to Forest Service residences and cannot be spent for other purposes. An advantage of using these funds is that they do not need to be spent by the end of the fiscal year.

Conveyance funds—
Conveyance funds are funds from the sale of Forest Service land. The Forest Service Facilities Realignment and Enhancement Act of 2005 allows forests to save proceeds from sales of Forest Service properties through September 2011; the funds can be designated for other uses. Forests are given budget authority on a certain funding amount every year, based on their property sales (USDA FS 2005). About 160 forests have conveyance funds available through this program. However, the White River National Forest near Aspen, Colorado, holds about half of all conveyance funds, owing to the high value of their land sales.

Regional "green" microgrant programs—
Forest Service "green" microgrants are modest funds that are awarded to help stimulate grassroots sustainable efforts having local impacts for units (table 2). Typically, microgrants are less than $2,000 and enable employees to take local actions to promote sustainability. Here, projects are selected based on criteria that

differ among programs, but all include requirements for reduced resource use, and for reporting following the project to share lessons learned and resources saved. More than 19 successful sustainability efforts have been funded by microgrants in western national forests alone.

Western Collective—
The Western Collective is an organization within the Forest Service dedicated to sustainable management practices in Western regions. It is designed to "facilitate overall coordination and collaboration of Sustainable Operations practices throughout Regions 1, 2, 3, 4, 5, 6, 10 and the Rocky Mountain Research Station while providing the management and leadership climate to ensure such activities and practices are successful" (USDA FS 2012b). Funds from each Western region and the Rocky Mountain Research Station are pooled every year for projects having strong potential to reduce energy consumption along with other sustainability initiatives. Several avenues are considered, including effective information exchange and technology transfer, reducing duplication of efforts, and sustainable operations training for Forest Service employees.

Mass conservation purchases—
Bulk purchases of smaller, lower budget energy efficiency measures can often allow for cost savings versus purchasing individually. Some examples include lights, recycling bins, vending misers, smart power strips, occupancy sensors, and faucet aerators. Often, these items can be assembled into kits and sent to all units within a national forest or research station. Because many items are purchased at once, bulk purchase and shipping discounts can help reduce unit costs.

Energy savings performance contracts (ESPCs)—
Third-party financers and contractors collaborate with the Forest Service to develop large-scale (greater than $1 million) energy efficiency measures. Savings are guaranteed, and more than one utility may be involved. The U.S. Department of Energy provides information on these contracts (NREL 2010, US DOE 2012a), while the Federal Acquisition Regulations (FAR 2012: Part 41) includes rules regarding acquisition of utility services for federal facilities.

Because Forest Service facilities are often at remote locations, and can include many smaller buildings, energy efficiency economics are often unfavorable. This generally reduces the incentive for private-sector involvement. To help remedy this, many locations, including more than one region or station, can be combined into one ESPC. It is important to set up ESPCs so that monthly cashflows to the financer come out of the same funds normally used to pay utility bills.

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Figure 8—The Forest Service's Southeast Alaska Discovery Center in Ketchikan, Alaska, switched to this new biomass boiler for heating, eliminating the use of 12,000 gallons of fuel oil a year. Eventually, all remote sites on the Tongass National Forest could be powered through a combination of energy conservation and renewable energy systems, freeing them from reliance on expensive fuel oil.

Agreements with utilities—

There are several opportunities to work with local utilities on energy efficiency measures. Utility Energy Service Contracts (UESCs) are similar to ESPCs as funding mechanisms but are administered through a single utility. Here, a third-party financer may or may not be involved. General information on this topic is available at the Department of Energy's UESCs website (USDOE 2012b) and detailed information regarding implementation is provided by an NREL (2009) publication. In addition, utilities often offer rebates and other incentives that can reduce costs and streamline funding. These incentives can be used concurrently with other financing mechanisms, including UESCs and ESPCs (NREL 2010).

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English Equivalents

When you know:	Multiply by:	To find:
Metric tons or tonnes	1.102	Tons or short tons
British thermal units (BTU)	1,050	Joules (J)

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Appendix 1: Summary of Energy Efficiency Discussions With Forest Service Employees

Table 1—Region, employees, title, and primary discussion topic

Forest Service region or station	Name	Title	Primary discussion topic
Northern	Steve Oravetz	Engineer	Microgrant implementation; local facilities work
	Jane Kipp	Architect	ESPC
	Bruce Crockett	Architect	Local facilities work
	Mark Libby	District ranger	Photovoltaic installation
	Frank Castillo	Facility manager	Lighting, new appliances, solar hot water heater
Rocky Mountain	Anna Jones-Crabtree	Sustainable Operations	Creation of the Western Collective
	Mike Ross	Civil engineer	Aspen construction project
	Lexie Carroll	INFRA database	Microgrants, mass energy purchase
	Todd Michael	Engineer	ESPC
	Jerry Stevenson	Forest engineer	Multiple
Southwest Intermountain	Pat Leyba	Facilities manager	ESPC
	Shelly Worthington	Architect	ESPC
Pacific Southwest	Jeff Sheahan	Building manager	Maintenance updates, lighting
	Renee Jewell	Commercial program management	ESPC and UESC
Pacific Northwest	Tim Dedrick	Engineer	UESC
Southern	Randy Warbington	Engineer	Ground-source heat pumps, local facilities work
Eastern	Bill Dauer	Forest engineer	LEED-certified building
Alaska	Michelle Putz	Tongass National Forest, green team member	Vending misers
	Jason Anderson	Tongass National Forest, Thorne Bay district ranger	Renewable energy/wood pellets
Rocky Mountain Research Station	John Howard	Facilities manager	Boiler/new windows/general
	Frank McArthur	Facilities manager	Local facilities work
Northern Research Station	Jean Holland	Facilities operations manager	Local facilities work

ESPC = Energy Savings Performance Contract, UESC = United Energy Savings Contract, LEED = Leadership in Energy and Environmental Design.

Appendix 2: Energy Efficiency Discussion Questions

Part I: Classification information

1. Interviewee name
2. Forest Service region

Part II: Energy efficiency questions

1. What energy efficiency upgrade(s) have you considered/attempted?
2. Who or what got you inspired to do this?
3. Why did you want to implement this change?
4. Did you have references or mandates for these changes?
5. What criteria are commonly considered in the decisionmaking process for energy efficiency upgrades?
6. What criteria did you use for making this change (time to payback, environmental concerns, etc.)?
7. What other indicators would you like to use?
8. How did you obtain funding?
9. What other funding options were you aware of?
10. Why did you select the option you did?
11. What obstacles did you face?
12. Why do you think the energy efficiency project was successful? (Why was it not successful?)
13. What savings have you or do you expect to realize ($, emissions, etc.)? at local, regional, national scales short term, long term)?
14. Do you feel you inspired spin-off benefits or actions outside this effort?
15. Who or what inspired you to get started?

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