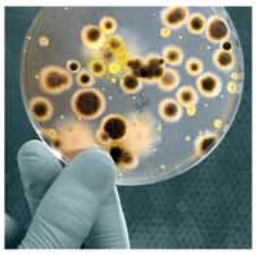
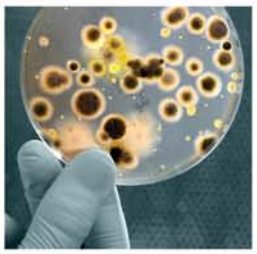


GREENING CORRECTIONS TECHNOLOGY
GUIDEBOOK

NIJ NLECTC National Law Enforcement and Corrections Technology Center NLECTC Corrections Technology Center of Excellence



GREENING CORRECTIONS TECHNOLOGY
GUIDEBOOK

Prepared for
National Law Enforcement and Corrections Technology Center

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This publication was prepared by the National Law Enforcement and Corrections Technology Center's Corrections Technology Center of Excellence, supported by Cooperative Agreement 2010-IJ-CX-K003 awarded by the U.S. Department of Justice, National Institute of Justice (NIJ). Points of view or opinions contained within this document are those of the authors and do not necessarily represent the official position or policies of the U.S. Department of Justice. Please note that providing information on law enforcement and corrections technology or the mention of specific manufacturers, products or resources does not constitute the endorsement of the U.S. Department of Justice or its component parts. Agencies are encouraged to gather as much information as possible, from multiple sources, and make their own determinations regarding solutions that best fit their particular needs.

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FOREWORD

This guidebook was developed by the National Law Enforcement and Corrections Technology Center's (NLECTC) Corrections Technology Center of Excellence (CoE).

Operated by the University of Denver, the Corrections Technology CoE serves as the authoritative resource within the NLECTC System for both practitioners and developers with respect to technologies that support institutional and community corrections. The Center's position within DU allows it to leverage a wide array of multidisciplinary research units to accomplish its mission.

In its primary role, this CoE assists in the transition of technology from the laboratory into practice by first adopters within the correctional community. Specifically, the Corrections Technology CoE supports NIJ's research, development, test and evaluation activities within the corrections portfolio by:

- Assisting NIJ in identifying practitioner technology requirements by coordinating and conducting Technology Working Groups (TWGs).

- Supporting NIJ research and development programs by assisting with program objective definition and refinement, assessing ongoing NIJ projects, scouting relevant technology efforts and participating in national and regional groups.

- Testing, evaluating and demonstrating technologies by conducting and coordinating operational evaluations and conducting, facilitating and coordinating demonstrations with corrections agencies.

- Supporting the adoption of new technologies by introducing these tools to practitioners, providing practitioner requirements to developers, assisting developers in commercialization and providing support to first agencies for effectiveness evaluation.

- Coordinating and developing technology guidelines for planning, selecting and implementing technology solutions.

- Providing technology assistance and support to corrections agencies on a national basis, including providing science and engineering advice and assisting first adopters with new tools and methods.

To facilitate the development of this guidebook, the Corrections Technology CoE entered into a contract with Paul Sheldon, senior adviser with Natural Capitalism Solutions to act as primary author. Mr. Sheldon was assisted by Eugene Atherton, Institutional Corrections Program Manager with the Corrections Technology CoE.

Natural Capitalism Solutions is a Colorado-based, nonprofit organization that advises communities, agencies, companies and countries on cost-effective 'green' technologies and strategies, and on cost-saving, revenue-producing implementation of sustainable technologies and the principles of sustainability.

A number of subject matter experts assisted with the preparation of this guidebook, including Joe Russo, Jerry Elmblad, Kara Sperle, John Daugherty, John Gillogley, Diana Dean, Beth Waitkus, Tommy Norris, Todd Gundlach, John Rees, Jeff Hohensee, Sylvia Stone, Lorraine Marks and Terry Yergenson.

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EXECUTIVE SUMMARY

Greening Corrections Technology Guidebook was developed for the National Institute of Justice (NIJ) based on a recommendation from its Institutional Corrections Technology Working Group (TWG). The TWG, which consists of leaders from correctional agencies across the country, has recognized the growing importance of greening initiatives.

This guidebook provides correctional administrators with a brief, yet comprehensive and informative, view of sustainability-oriented green technologies. It reviews green technologies' evolving role in correctional institutions and presents issues to consider when acquiring and implementing green technologies to reduce costs and increase the efficiency of resource use. It also addresses the opportunities and challenges involved in selecting and implementing green technologies in correctional settings.

The guidebook has seven chapters that provide information and insight into specific types of green technologies. The authors selected these seven topical areas because they include most — although not all — of the green technologies in use in corrections in 2011. Subsections on future trends indicate possible additions and enhancements to the field.

Each chapter contains lists of specific technologies, including well-established and more traditional examples, as well as emerging technologies that have proven effective in saving money and increasing the efficiency of resource use while protecting public safety and staff security.

Appendix 1 provides additional information on financing and Appendix 2 presents a thorough case study of waterless urinals as an example of a green technology.

Planning for, Selecting and Implementing Technology Solutions

Each chapter contains information on planning for, selecting and implementing various technologies. Correctional settings include unique opportunities and challenges related to the safety of staff, the general public and inmates, as well as to administration and funding. Each technology must be carefully evaluated for appropriateness and affordability within a correctional setting.

To facilitate planning, selection and implementation of green technologies, many institutions start by forming a "Green Team" with representatives from operations and maintenance, custody, administration, community relations and legislative liaison. In some locations, adding members of the surrounding community to the Green Team can provide additional resources and functionality as well as fostering goodwill (see Chapter 1).

Each chapter also contains links, references and contact information (as available) for correctional institutions that have experience with the technologies described. Proper project planning should include gathering comparative data on successes and challenges encountered by other institutions. Many correctional institutions

have been able to adapt technologies used in hospitals, schools and other community institutions. When no correctional examples are available, links to other institutions have been provided.

Some institutions, such as the three state of Washington institutions: Stafford Creek Corrections Center, Coyote Ridge Corrections Center and Cedar Creek Corrections Center (http://www.doc.wa.gov/facilities/prison/cccc/default.asp), as well as El Dorado Correctional Facility in Kansas (http://www.doc.ks.gov/facilities/edcf), the Boulder County Jail in Colorado (http://www.justnet.org/Documents/2011_ITCC/NLECTC_2011_Sheldon_Atherton_Greening_Corrections.pdf) and Marcy Correctional Facility in New York (http://www.mjinc.com/bldgProject4.html) have opted to invest in multiple programs to save energy, water and waste; provide green jobs training for inmates; and capitalize on other green opportunities. The U.S. Green Building Council offers Leading Energy and Environmental Design (LEED) certification for correctional institutions (both new construction and retrofit), of which Coyote Ridge was the first to receive "Gold" level certification, followed by Marcy and others. Other institutions, such as the Alameda County (Calif.) Juvenile Justice Center have opted to invest in one technology, such as solar photovoltaic electricity (www.acgov.org/sustain/what/greenbuilding/jjc.htm).

For institutions and programs focused primarily on energy efficiency, the U.S. Department of Energy and the Environmental Protection Agency (EPA) have joined together to offer the ENERGY STAR® program, which certifies a wide variety of technologies and provides resources and referrals to partners (http://www.energystar.gov/index.cfm?c=pt_univ.pt_univ).

How fast and how broadly to invest in reducing waste and saving costs through green technologies depends on an institution's budget, resources, mandates, priorities and a wide variety of other factors.

Guiding Principles and Topics

This guidebook uses the basic principles of public safety, staff security and economic stability as the basis for its review and guidance.

Methodologies

Methodologies used in preparing this guidebook included literature reviews of primary and secondary sources, site visits, focus groups and interviews of corrections practitioners. Every attempt has been made to provide references and citations to sources used. URLs are provided as "hot links" when available. This guidebook does not represent original research, but rather, a review of existing resources.

Chapter Review

Greening Corrections Technology Guidebook contains the following seven technology chapters.

Integrating Technology and People

Knowledge and abilities to implement green technologies within correctional institutions and programs reside with people: staff, inmates, support agencies and surrounding communities. This knowledge and the related abilities can be considered a form of capital. Integrating technology and people by training staff and inmates and by developing relationships with agency and community resources provides many ways to receive long-term returns and dividends from savings, innovative technologies and the relationships required to implement technologies effectively. When paired with job training and skills development programs, traditional education programs such as general education degrees can be more effective in reducing recidivism and increasing successful reintegration into communities than merely providing basic literacy education or informational programs (Feldbaum, Mindy, Frank Greene, Sarah Kirschenbaum, et al. March 2011. The *Greening of Corrections: Creating a Sustainable System*. National Institute of Corrections, NIC Accession Number 024914, http://nicic.gov/Library/024914, p. 19). If correctional institutions use inmate labor to implement the technologies described in this guidebook, they will also teach skills that can be integrated with job skills for transitioning inmates back into communities.

Lighting

Almost all institutions use artificial lighting of some kind. Because 20th-century lighting used inefficient, incandescent bulbs and early fluorescent technologies, many opportunities exist to reduce waste of money

and resources by using more efficient lighting technologies. This chapter describes the leading technologies for saving money and improving lighting efficiency.

HVAC Systems

Heating, ventilation and air conditioning (HVAC), which includes cooling, filtration and circulation systems, as well as roofs, ceilings, walls, floors, windows and other elements of the building envelope, provides significant opportunities to reduce waste. HVAC also plays a critical role in the health and safety of an institution. Properly maintained HVAC systems can mitigate the risk of the spread of infectious diseases by improving indoor air quality and preventing the spread of allergens, spores, bacteria and viruses. Because most correctional institutions were built at a time when the coal, oil, gas or electricity used to heat, cool and ventilate buildings was relatively inexpensive, little thought was given to alternatives at the time of construction. This guidebook explores technologies to improve the efficiency, health and safety of heating, cooling, ventilation and air conditioning in correctional institutions.

Plug-in Appliances (Including Pumps and Motors)

If it plugs into the wall or uses electricity in any form, then improving the efficiency with which the technology uses electricity can probably save an institution money. Using less electricity means spending less money to pay for the electricity. Many such solutions are as simple as turning off unnecessary lights or using "smart" power strips for computer workstations. Other solutions include re-engineering of systems such as sewage or water treatment facilities, or prison industries that use large amounts of electricity for pumps or motors. Requiring more efficient, ENERGY STAR appliances is another simple cost-saving measure, along with requiring procurement officers to calculate "life cycle" electricity costs over the expected lifetime of any device.

Materials Flow (Including Recycling and Toxics)

Any material not put to use in an institution is wasted. Waste equals money and time. Thus, examining the technologies related to the flow of materials through an institution can lead to important savings of money and time. In addition, particularly with regard to cleaning and sanitation, many traditional materials have been shown to be toxic to humans. Reducing the use of toxic materials or reducing levels of toxicity in materials used and treating the indoor environment with safer, less-toxic solutions that act as deterrents to mold, viruses, bacteria and allergens can produce important health and safety improvements as well as substantial monetary savings.

Water

Because most areas of the United States (except for the dry Southwest) historically had access to abundant supplies of fresh water, early planners of correctional institutions did not need to consider water as a significant expense. Because historical supplies of surface and ground water were uncontaminated, more recent costs of water purification and sanitation were also not considered significant. However, more recently the costs of obtaining, treating and distributing water have increased. Many larger correctional institutions have been required to construct and maintain their own water purification and wastewater treatment plants, some of which provide additional services to surrounding communities. The technology cost associated with pumping water using large, electric pumps also adds to overall institutional costs. Any savings in water use or related energy use reduces waste and provides institutional savings.

Energy (Including Transportation)

Saving energy saves money — as long as the cost of saving energy remains below the cost of acquiring new energy. This applies to heating and cooling buildings, lighting, pumps, motors, appliances, computers, transportation, water treatment, water transport, wastewater treatment and a host of other energy uses. Similarly, long-term investments in producing energy locally can increase security and reliability while reducing costs (as long as the investment can be properly financed by using monthly cash flow below existing levels of energy costs).

Appendixes

This guidebook contains an appendix on financing options (Appendix 1), which details several financing mechanisms that various institutions and agencies have used to provide funding for implementing training as part of the different technology strategies discussed in the guidebook. An extended case study (Appendix 2) presents the complex issues involved in selecting and implementing one particular green technology (waterless urinals).

INTRODUCTION

Technologies for the design, engineering, construction and maintenance of prisons and jails in the United States have evolved significantly over recent decades. *Greening Corrections Technology Guidebook* has been prompted by the emerging public mandate to use resources wisely and plan for a more sustainable future in the areas of energy, water, materials, health and related resources in correctional institutions. For many correctional institutions, this mandate has been clearly expressed in legislative requirements, in organizational policy and in staff training. Other institutions are just getting started. These greening efforts have included a broad range of topics, most of which are included in this guidebook.

What Do the Terms *Green* and *Sustainable* Mean?

The terms *green* and *sustainable* are often used interchangeably. The World Commission on Environment and Development first defined the phrase *sustainable development* in 1987: "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet the needs of future generations." (Gro Bruntland (ed.). 1987. *Our common future: The World Commission on Environment and Development.* Oxford, United Kingdom: Oxford University Press.) Since 1987, the term sustainability has acquired common usage to refer to all technologies that improve efficiency of natural resource use, reduce negative impacts on natural environments and social systems, mimic natural processes and systems, and restore the balance between human systems and natural resources. Early concerns about the natural, non-human environment have been expanded to integrate economic issues, jobs, economics, social equity and ethical considerations. More recently, because of the priority placed on reducing impacts on natural environments, sustainability-oriented practices have come to be known as green. This guidebook uses the term green to refer to all sustainability-oriented technologies and practices.

Green also means efficient; however, efficient does not mean freezing in the dark. *Efficient* means meeting end-use needs in convenient, appropriate and cost-effective ways to produce service and comfort with as few resources as possible. In times of tight budgets, green means using scarce budget allocations more efficiently.

Historical Background

In the United States, with the advent of the federal environmental laws of the 1960s and 1970s, (http://www.fema.gov/plan/ehp/regionviii/laws.shtm includes the Clean Water Act, Clean Air Act, Endangered Species Act, Wilderness Act, Wild and Scenic Rivers Act, Marine Protection, Research and Sanctuaries Act and National Environmental Protection Act) national, state and local jurisdictions began requiring correctional institutions to comply with environmental standards. The earliest such requirements related to health, safety, water and air quality, followed in the 1970s by the broader, more comprehensive environmental impact reviews required by national and regional environmental protection acts. These acts also mandated consideration of impacts on

the economy, jobs, cultural heritage and archaeological resources.

Current Mandates and Requirements

Current mandates for green technologies include a Federal Executive Order to "increase energy efficiency; reduce fleet petroleum consumption; conserve water; reduce waste; support sustainable communities; and leverage Federal purchasing power to promote environmentally-responsible products and technologies," (http://www.whitehouse.gov/the_press_office/President-Obama-signs-an-Executive-Order-Focused-on-Federal-Leadership-in-Environmental-Energy-and-Economic-Performance) as well as a wide variety of state and local requirements for everything from resource efficiency to reducing toxics and providing green jobs training (http://www.epa.gov/statelocalclimate/state/topics/energy-efficiency.html, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1779.) No comprehensive list of mandates and requirements exists so correctional institutions must check with local and regional utilities, cities, counties, states and agencies to determine all applicable requirements.

In 2010 and 2011, the American Correctional Association (ACA) adopted both a standard and a policy on "clean and green" practices, instituting an audit requirement for accredited institutions to demonstrate progress toward consideration and implementation of cost-effective and appropriate green technologies. ACA specifically cited issues such as recycling, water and energy conservation, pollution reduction, renewable energy and training (*Corrections Today,* April/May 2011, pp. 84, 92).

CHAPTER 1

INTEGRATING TECHNOLOGY AND PEOPLE

What Is a Green Technology Program?

As institutions make the decision to go green, it is important to understand the available supporting technologies. Many of these technologies will be addressed in later chapters, but before discussing them in detail, it is important to provide a framework for the implementation of an overall green technology program.

Implementing a green technology program includes planning, selecting, implementing and evaluating sustainability strategies. A green technology program may include a training component designed to teach staff and/or inmates to implement green technologies. This chapter describes how an institution can get started, general benefits and how to involve staff and inmates in a way that is advantageous to each group and also contributes to safety, security and re-entry.

Why Go Green?

As stated in the Introduction, the mandate for correctional institutions to use resources wisely and plan for a more sustainable future is expressed in a variety of forms, including legislative requirements. With that said, green technology initiatives are also clearly in alignment with the corrections mission of providing a critical public service in the most cost-effective manner possible without compromising security. In fact, some forward-thinking agencies recognized this and instituted their own initiatives as part of their basic mission.

As energy costs increase, institutions must move as rapidly as possible to adopt alternative strategies. Those institutions bold enough to take steps now can usually achieve return on their investment in a relatively short period of time. Further discussion regarding the cost effectiveness of various individual approaches is contained in the chapters to follow; through metering and other advanced analytics the impact can be fairly easy to quantify. However, the financial implications of long-term sustainability are only one consideration. There are several other benefits to be reaped through a green technology program that are less readily quantifiable but no less important. Institutions have a unique opportunity to leverage these efforts to support inmate re-entry efforts. A vocational training and certification component can be built into a green technology program that provides inmates with the skills necessary to manufacture, install and/or maintain these technologies. The chances of an inmate's successful transition to the community are greatly enhanced when the inmate possesses relevant job skills. Teaching inmates skills in a relevant and growing field such as green technologies may help them successfully transition back into the community. In fact, the successful transition of inmates to the civilian job force is likely to be an important solution to the problem of the shortage of people with required skills in the job market in the next decade (McDonald, Stephen and Carl Nink. *Green Certifications and Training*. June 2010. Centerville, UT: MTC Institute.) The potential impact on human lives that can result cannot be overstated, and any reduction in recidivism simply adds to the return on investment.

Institutions that invest in training staff to implement green technologies can save money, increase safety and security, and reduce risk of injury and illness. Providing proper training to staff communicates that the institution cares enough to help people improve. When staff members receive training to, for example, become LEED-accredited professional auditors or enhance skills in the areas of carpentry, electrical, sanitation, or heating and ventilation work, it makes them more capable of fulfilling performance requirements related to green technology. This training can also lead to advancement opportunities, which in turn correlates to greater job satisfaction, reduces absenteeism and decreases staff turnover, all of which indirectly save the institution money. Training and development opportunities lead to greater job satisfaction and lower turnover (http://www.mtctrains.com/institute/publications/CO%20Retention%2010-04.pdf).

A green program can also help an institution create a positive impression with the general public, the legislature and the media. Particularly in these tough economic times, it is critical that the prevailing perception is that corrections is doing its fair share in reducing costs of resources and being creative in achieving new sources of energy. It is even better when the cost savings can actually be expressed in clearly defined financial terms. When the vast majority of media stories are about riots, fires or escapes, having a story to tell about installation of solar panels or inmate job training programs can attract positive attention (http://ecozome.com/more-than-just-green-correctional-industries%E2%80%99-sustainability-efforts-transform-prisons-into-centers-of-social-benefits/). Positive publicity creates a "buzz." People tell their families, and legislators and other regulators gain a sense of hope about the institutions' potential to demonstrate success. Investing in a green technology program can lead to positive stories and improved goodwill in the community and with funders and regulators.

How to Get Started

Most efforts are driven by official mandates such as legislation, governor's administrative direction or direction from county commissioners, the mayor, the sheriff, the president, a legislative body or a correctional director. In many cases mandates are followed by the creation of policy directives and program goals with some degree of performance measurement. As a result, many correctional agencies have to some extent organized themselves to identify and implement green technologies. These efforts range from providing additional training for a single plant supervisor at the local county jail to deploying an entire team of highly trained staff to create programs and implement complicated strategies across major correctional organizations.

Regardless of the size of the system or institution, some common elements contribute to an initiative's success. As with any other initiative, support and commitment from senior management are essential to success. Success is greatest when leaders are sincerely interested and invested in the program, attend the early planning meetings, and provide budgetary and other resources.

Important Features of a Successful Green Correctional Technologies Program

The following are common elements found in most successful programs:

- Clearly defined mission to guide staff efforts.
- Rewards and recognition for significant contributors to the greening effort both statewide and at the facility level.
- Obtainable performance objectives.
- Standards that drive efforts and allow for measurement of accomplishments.
- Successful mobilization of inmates and staff toward accomplishments in greening technology and implementation strategies.

Forming a "Green Team"

For many institutions the most successful way to begin the implementation of a green technology initiative is to form a Green Team. Typically the Green Team consists of a group of correctional staff created among existing positions. They can be administrators, accountants, engineers, architects, project managers, officers or supervisors. They still retain their regular responsibilities, but have been directed or allowed to assume a central responsibility for leading greening initiatives in the institution. Community representatives, volunteers, vendors or other interested parties may also be

REAL WORLD EXAMPLES

Michigan Department of Corrections. The Michigan corrections system is subject to an executive directive for the entire state that mandates performance in areas of resource conservation and searches for alternative energy sources. The policy mandates staff support at all levels, including the existence of green committees in each facility to create and implement new ideas at the line level of correctional operations (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MI05R&re=0&ee=1). The important first step was the interest and commitment of department personnel, led by the director. The department began with simple things such as turning off lights and shutting down unused computers. Then, seeing the dramatic savings, department personnel expanded their efforts to include such green strategies as recycling and alternative energy (http://blog.mlive.com/cns/2009/03/low_energy_bill_inspires_corre.html_).

Colorado Department of Corrections (CDOC). In addition to implementing green physical plant changes and enhancements in all institutions across the state, CDOC also entered into a cooperative agreement with Northern Colorado Community College in Sterling to provide inmate training, resulting in a certificate for inmates who complete accredited training programs. Main Street Power, a third-party finance and implementation company, included a training component in the response to CDOC's request for proposals for solar photovoltaic installations with inmates included as trainee labor. (Providing inmate training was a credit criterion in proposal evaluation.) Inmate laborers performed site preparation work and other designated tasks. CDOC is also evaluating small wind and small hydroelectricity projects to determine if a third-party developer can provide these in cost-effective ways that would also include an inmate training component.

CDOC has also worked in collaboration with the Colorado Department of Labor to develop training programs related to greening technologies and deliver them to inmates. Members of the Department of Labor team specialize in innovative projects, focusing on four areas: green jobs, information technology, bioscience and construction. In the past, the department has delivered courses in the areas of asbestos abatement and weatherization construction, producing certified graduates who achieved job placement when paroled (http://coloradoenergycareers.blogspot.com/).

Putnamville, Ind. Putnamville Correctional Facility, like many other institutions, offers apprenticeships. Putnamville's recycling apprenticeship program began when a correctional officer downloaded helpful hints for recycling from a government website and it grew into an accredited program in collaboration with the U.S. Department of Labor and labor unions (http://www.in.gov/idoc/2403.htm). According to Indiana Commissioner Bruce Lemmon, Putnamville's recycling program has also produced net revenue of more than $300,000, including savings and income from sales of recycled materials.

Green Entrepreneur Program. A nonprofit organization established this program in 2010 using funding from the Bluegrass Workforce Investment Board, which offers workforce support in central Kentucky. This program serves at-risk youth and ex-offenders and is seeking funding for expansion to include job training and business plan development for green businesses and green industries (Clark, Bobby and Kim Potter-Bair. "Entrepreneurship: Catalyst for Successful Reentry," *Corrections Today*, April 2011).

The Re-entry/Universal Customer Access Center. This organization provides training and services as well as core and intensive services to the re-entry population, their families and the at-risk, dislocated community at large. This service opened in April 2011 in Columbus, Ohio, with support from partnerships with both for-profit and nonprofit organizations. Recycling industries are major employers of released former inmates (Ibid).

U.S. Department of Labor Job Corps. The Job Corps is a federally funded program with an annual budget of $1.7 billion. It serves approximately 60,000 youth each year with 123 centers throughout the United States. The Job Corps provides specially designed academic and job skills training to those who have dropped out or in other ways have been left behind by the mainstream process of education, job training and placement. Many Job Corps employment projects focus on green jobs such as urban cleanup, tree planting, habitat restoration, urban beautification and trails maintenance (Nink, Carl, Stephen McDonald and Lucy Hood. March 2010. *Reengaging Dropouts: JOB CORP WORKS.* Centerville, UT: MTC Institute).

California Department of Corrections and Rehabilitation. Innovative educational opportunities in development in the green arena include a recent Green Career Fair at San Quentin State Prison, hosted by the Insight Garden and California Re-entry Programs. In addition, public/private partnerships might also offer the chance for inmates to develop pre-release relationships with employers that use certificates and educational credit programs.

Remote College Courses. Montana's Department of Corrections has contracted with community colleges and the state university colleges to do online college-level learning. Offering the courses online saves energy, travel time, expense and carbon emissions for teachers, and enables institutions to offer green education programs without having an instructor onsite.

considered for participation. The Green Team takes the mandate from leadership and formulates a program to evaluate, select and implement strategies for physical plant changes and enhancements. The team also identifies methods of tracking achievements in the form of dollars, time savings and other benefits.

Considerations and Implementation Issues

Budget Issues. Operational budgets often are the single greatest concern when greening programs include investment in technology and associated training for staff and inmates. Decision makers may say they fully understand the cost benefits; however, they may find securing funding for the start-up phase to be daunting and perhaps require innovative approaches. More information on creative ways to secure funding can be found in Appendix 1: Financing Mechanisms.

Funding for training programs for staff and inmates can be as difficult to find. Institutions should develop relationships with state and federal labor departments, which often provide funding for innovative programs that support staff and/or inmate training and job placement. Some skills development for inmates could be modifications of existing programs, for example adding solar panel construction and installation to existing vocational training for electricians or water conservation strategies to general maintenance services. Staff training is often associated with increased cost savings, so the expense can be considered an investment or an offset (http://www.informaworld.com/smpp/content~db=all~content=a718869560).

Community partnerships should also be explored as another strategy that could provide resources to the institution. Developing relationships with community organizations and community leaders can provide resources, goodwill and creative opportunities.

Implementation Strategy: "All In" or "One Step At A Time"? Different institutions choose different approaches based on budget, interest and opportunities. Some institutions, such as the Stafford Creek Corrections Center in Washington State, the Deer Ridge Correctional Institution in Oregon or the Boulder County Jail in Colorado, take a comprehensive institutional approach, implementing a wide range of green technologies all at the same time. This has the advantage of gaining maximum savings, which can be combined to finance more resource-intensive strategies. Other institutions prefer to take it one technology at a time, replacing light bulbs, recycling, instituting composting, or growing organic vegetables or ornamental flowers near a visitor area. Which strategy is best will vary according to local conditions.

Fitting the Population. To put it simply, inmates in higher security settings are not trusted with many of the tools and instruments necessary for some training programs. However, those in higher security settings may qualify for a version of green technology training that involves the initial classroom or paperwork rendition of programs until such time as they qualify for less-restricted options. Also, moving inmates to participate in any program carries its own set of security and safety issues that must be addressed prior to implementation and that must be carefully monitored and adjusted to prevent unforeseen risks. Inmate training programs also require proper use of the classification system to ensure appropriate participation, certification and accreditation.

In addition, when selecting and implementing green technology solutions, it is critical to consider whether the solution will be viable in a correctional setting. For example, is the solution vulnerable to inmate misuse? (See Appendix 2: Waterless Urinals.)

Job Readiness. Almost all employers want their employees to have a basic level of literacy, as well as basic job-readiness skills such as showing up on time, a cooperative attitude and the ability to work with others as a team. Thus, any pre-release job training will help inmates be more qualified for green jobs. For green jobs, specifically, some degree of *environmental literacy* is also required: that is, basic knowledge of what distinguishes green technologies and why they matter, as well as the ability to describe this to clients or customers (Feldbaum, Mindy, Frank Greene and Sherry Carroll. 2011. *The Greening of Corrections: Creating a Sustainable System*. http://nicic.gov/Library/024914, pp. 20-30).

Future Performance Accountability for Energy, Water and Materials Management. Institutions are beginning to include accountability for the efficient use of energy, water and materials as part of employee evaluations. This has been shown to bring quick improvements and cost savings as well as creative ideas for enhanced efficiency (http://www.financeproject.org/Publications/measures.html).

Resources

Training resources for staff and inmates abound. Examples include:

Staff Training

- U.S. Green Building Council Training and Education
  http://www.usgbc.org/DisplayPage.aspx?CMSPageID=283
- ENERGY STAR Training
  http://www.energystar.gov/index.cfm?c=business.bus_internet_presentations
- Green Building Certification Institute (LEED)
  http://www.gbci.org/homepage.aspx
- American Correctional Association
  http://www.aca.org/development/products.asp
- Construction Management Institute for Criminal Justice Agencies
  http://www.cmi-cja.org/Home_Page.php
- Community Colleges
  http://www.aacc.nche.edu/pages/ccfinder.aspx
- Correctional Management Institute
  http://www.cmitonline.org/
- New England College
  http://sustainability.nec.edu/masters-in-sustainability-nc/
- Sustainability Executive Education
  http://www.sustainabilityexeced.com/

Inmate Training

- Community Colleges
  http://www.aacc.nche.edu/pages/ccfinder.aspx
- Insight Prison Garden Program at San Quentin State Prison
  http://www.insightgardenprogram.org/overview.html
- Women's Prison Gardens
  http://capstone.unst.pdx.edu/courses/womens-prison-gardens
- Ohio Green Prisons Project
  http://www.vera.org/project/ohio-green-prison-project
- Green Collar Jobs
  http://www.ellabakercenter.org/downloads/gcjc/making-green-work.pdf

Conclusion

Many institutions are implementing green technology programs in response to mandates, whereas others are proactive and choose to explore this approach because it makes sense on a variety of levels. Institutions must have a strong commitment from their leadership and formal mechanisms in place to select, implement and evaluate the impact of green technologies, and should strongly consider developing an inmate vocational training component as part of their program. Such an initiative can provide the labor necessary to manufacture, install and/or maintain green technologies, and also transfer a marketable skill.

Institutions should also invest in training their staff to implement green technologies. America's correctional institutions are among the safest and most professional in the world. They have achieved this level of excellence due to the high level of investment made in staff training as well as the care and guidance provided to inmates. These investments, along with core technology investments, will pay off in a variety of ways.

CHAPTER 2
LIGHTING

Background

Lighting has been shown to be one of the most cost-effective ways to save energy and money. Incandescent bulbs and early fluorescent technologies use two to five times more electricity than newer, more efficient technologies. The investment required to replace lighting technology with more cost-effective options is usually repaid quickly (http://www.correctionsone.com/facility-design-and-operation/articles/2473021-7-steps-to-save-1-000-per-inmate-by-going-green/).

As with most greening efforts, improving lighting starts with forming a Green Team (see previous chapter), surveying users and obtaining competitive bids for larger projects. For simple tasks such as replacing screw bulbs with compact fluorescent lights (CFLs), implementation can begin immediately as part of a *deemed and calculated* savings plan. That is, since savings have been calculated so many times by other institutions and have always been deemed to be cost-effective, the cost savings can be measured retroactively after implementation.

Existing Technology Review

Applications of energy-efficient lighting include indoor lighting in cells, corridors, offices, clinics, dining areas, gymnasiums and dormitories, as well as outdoor lighting of yards, perimeters, walkways, roadways and parking areas. Green technologies most commonly included to improve the efficiency of lighting for correctional institutions include the following.

Fluorescents (Including Induction)

Fluorescent bulbs and fixtures use electricity to excite gases to glow, producing light. *Induction* is a technology in a fluorescent-type lamp without the metal electrical contacts used to conduct electricity from the fixture to the light-emitting gas inside the bulb. Induction lamps are capable of efficiency levels 40 percent better than their fluorescent counterparts and some models boast a life expectancy of up to 100,000 hours (http://www.energystar.gov/index.cfm?c=cfls.pr_crit_cfls).

When the bulb has metal contacts, as a lamp heats up, the metal and glass components expand and contract by different amounts, shortening lamp life. After many on/off cycles, a fluorescent lamp's glass becomes stressed by the pulling and pushing from repeated heating and cooling, and the contact area between the glass and metal can become compromised. Eventually, air leaks in and the lamp will not produce light.

Daylighting (Windows, Skylights and *Sun Tubes*)

Techniques to allow natural light into the institution reduce electrical consumption. Windows and skylights are common methods that allow daylight to enter interior spaces. *Sun tubes* are a more recent innovation that use a simple system of reflectors, mirrors and light-conducting fibers to distribute sunlight into interior spaces (http://www.greenerbuilding.org/category_list.php?cid=13).

Daylighting at Boulder County Jail (CO)

Movement and Occupancy Sensors

Automatic sensors can be installed to detect occupancy of an area through infrared, sound or other technology, then automatically turn lights on or off, saving significant amounts of electricity over leaving lights on all the time. These sensors can also improve security by causing an increase in lighting when movement or occupancy is detected. Manual overrides and 24-hour security lighting are important components of an effective sensor system in a correctional setting (http://www.energystar.gov/index.cfm?c=business.EPA_BUM_CH6_Lighting).

High-Intensity Discharge (HID) Lamps

There are three types of HID lamps, including mercury vapor, metal halide and high-pressure sodium, that produce more intense light using less electricity than traditional incandescent fixtures. Typical applications for these lamps are street and roadway lighting; area lighting such as parking lots and athletic fields; industrial and commercial building interior lighting; commercial, industrial and residential security lighting; and landscape lighting and fixtures (http://www1.eere.energy.gov/buildings/appliance_standards/commercial/high_intensity_discharge_lamps.html).

Solid-State Lighting (Including Light-Emitting Diode, or LED, and Organic Light-Emitting Diode, or OLED, Lights)

LEDs are small light sources that become illuminated by the movement of electrons through a semiconductor material. LEDs produce very intense light and use much less electricity than other forms of lighting. LEDs have proven to be cost-effective in areas such as outdoor walkways, indoor parking garages, under office counters and rooms. Because LEDs are just entering commercial applications, they can have inconsistent quality, depending on conditions and manufacturer. Organic Light-Emitting Diodes (OLEDs) are light-emitting diodes (LEDs) that consist of sheets of carbon-based compounds that glow when an electrical current is applied. OLEDs are not yet market ready, but they are more efficient than other LEDs and are being tested as highly efficient light sources for walls, ceilings, TV screens and other uses (http://www.energystar.gov/index.cfm?c=lighting.pr_what_are).

Solar and Wind Technology for Outdoor Lighting

Various systems provide small-scale, local electricity from solar and/or wind sources, which charge small batteries to provide secure outdoor lighting for parking lots, walkways, roadways and other outdoor spaces. Combining both solar photovoltaic and wind generators to charge the batteries increases reliability and can be cost-effective, especially when combined with incentives and rebates.

Costs/Benefits

Most correctional institutions have undertaken some kinds of lighting improvements, even if just by installing more efficient bulbs. In nearly all instances, replacing incandescent bulbs with more efficient technologies has proven cost-effective, with the benefit of saving money while maintaining safety and effectiveness. LED lighting in correctional institutions is not yet cost-effective, but fluorescent, induction, high-intensity discharge and occupancy sensor technologies of many types are available to save money with no reduction in security or convenience. Advanced occupancy and movement sensor technologies provide reliability by switching to "on" if the sensor fails. The costs and benefits of more efficient lighting technologies have been calculated so many times that an institution no longer needs to do so. Institutions can move directly to issuing requests for proposals and can include comparative cost/benefit analysis as a component of the submitted proposals.

Considerations and Implementation Issues

According to correctional administrators and facilities managers interviewed by the authors of this Guidebook, once a project has been approved, implementation issues for lighting technologies are relatively straightforward. Safety issues must be resolved and careful monitoring of the quality of technologies such as CFLs and LEDs must be addressed. Cheap units often fail early, but more expensive units may do the same, so it is important to obtain manufacturer's, installer's and/or retailer's guarantees.

For major retrofits, qualified licensed contractors must be used to perform difficult tasks. Installation and replacement of CFLs requires minimal training. Certain safety requirements must be observed to ensure no toxic exposure to the tiny amount of mercury contained in each CFL occurs in the event that a new CFL breaks during installation or transit (http://www.epa.gov/mercury/consumerinfo.htm#cfl). With regard to mercury in CFLs, extensive studies by the EPA have determined that the technology is safe (http://www.epa.gov/mercury/consumerinfo.htm#cfl)

Future Trends

Sun tubes that channel sunlight into interior spaces using fiber optics and reflective technologies will soon provide inexpensive, cost-effective ways to provide daylighting to interior spaces. LED, OLED and other solid state (no filament and no tube) lighting technologies are emerging fast (http://www.energystar.gov/ia/partners/downloads/meetings/EmergingLighting Techologies_Brodrick.pdf). Many LED retrofits for "can light" fixtures and "down light" fixtures are currently cost effective. Additional improvements in LED technology are likely to make outdoor flood lighting much more cost effective within the next few years. In addition to the lighting fixtures themselves, several innovative technologies are emerging to combine solar photovoltaics, battery storage and LED lighting to provide safe, inexpensive outdoor lighting for walkways, roadways and parking lots. The long-term durability of LEDs, which are supposed to last 10 times longer than incandescents and at least twice as long as fluorescents, makes LEDs and other solid-state lighting (SSL) technologies the most important emerging lighting technology (http://www.netl.doe.gov/redirect/).

REAL WORLD EXAMPLES

Kansas Department of Corrections. The El Dorado Correctional Facility's comprehensive retrofit program, which includes a comprehensive lighting program, provides a good example of savings. With an investment of $2.1 million, the department projects annual savings of $247,517, producing a 16-percent per year reduction in utility costs, an eight-year payback and an overall project return on investment rate of 12.2 percent over 10 years (http://www.kcc.state.ks.us/energy/fcip/eldorado_correctional_profile.pdf).

Boulder County Jail. Colorado's Boulder County Jail has also conducted a comprehensive retrofit, starting with lighting, which is producing a positive rate of return in its second year.

LED Projects. Sample LEDs have been installed for testing in some correctional institutions in Michigan and Wisconsin, which will provide important verification of the company's offer to provide turnkey financing and positive cash flow for correctional lighting retrofit projects.

As mentioned above, the SSL family of lighting technologies also includes OLEDs (pronounced "OH-leds"), which consist of sheets of carbon-based compounds that glow when a current is applied through transparent electrodes. While not yet ready for market, OLEDs will function like a thin film on a wall or ceiling that illuminates a room. Like LEDs, OLED technology is advancing rapidly. SSL has the potential to revolutionize the efficiency, appearance and quality of lighting as we know it.

The U.S. Department of Energy estimates that rapid adoption of LED lighting in the United States over the next 20 years can:

- Deliver savings of about $265 billion.
- Avoid 40 new power plants.
- Reduce lighting electricity demand by 33 percent in 2027.

Using GIS mapping technology to identify locations requiring intense lighting can reduce lighting expense by placing increased-intensity lighting only in the areas where it is most needed (http://www.iaca.net/Resources/Articles/drjaishankarmaparticle.pdf).

Lighting will always remain a critical need for maintaining public and institutional safety in corrections institutions. The most prominent needs for improved

efficiency are outdoor flood lighting on high poles and ways to get daylighting into interior spaces. Portable, easily rechargeable, handheld lights will increase safety in emergency situations.

Being able to see at night, indoors and in underground institutions has long been the most critical component of maintaining perimeter integrity, internal security and public safety at night. Because lighting uses such a significant portion of any institutional electricity supply (estimated to be 15 percent of all electricity use), the future need for more efficient and cost-effective lighting remains high.

Resources

The National Council on Qualifications for the Lighting Professions refers to professionals as *lighting certified.*

- Using licensed personnel and a lighting certified professional will ensure proper planning and implementation for lighting retrofits
  www.ncqlp.org/

- The U.S. Department of Energy maintains a website for referrals and information on solid-state lighting (LEDs)
  http://www1.eere.energy.gov/buildings/ssl/index.html

- Washington State Department of Corrections offers specific suggestions for correctional lighting.
  http://www.doc.wa.gov/sustainability/docs/HowToEfficientLighting.pdf

- American Council for an Energy Efficiency Economy
  http://www.aceee.org/topics/public-buildings

- U.S. Department of Energy
  http://www1.eere.energy.gov/buildings/ssl/

Conclusion

Most correctional institutions have undertaken some kind of lighting improvement, if only installing more efficient bulbs. In nearly all instances, replacing incandescent bulbs with more efficient technologies has proven cost effective, with the benefit of saving money while maintaining safety and effectiveness of lighting. LED lighting in correctional institutions is not yet cost-effective, but fluorescent, induction, high-intensity discharge and occupancy sensor technologies of many types are available to save money with no reduction in security or convenience. Advanced occupancy and movement sensor technologies provide reliability by switching to "on" if the sensor fails. The costs and benefits of more efficient lighting technologies have been calculated so many times that an institution no longer needs to do so. Institutions can move directly to issuing requests for proposals and can include comparative cost/benefit analysis as a component of the submitted proposals.

CHAPTER 3
HVAC SYSTEMS

Background

For the purpose of this guidebook, *heating, ventilation and cooling (HVAC)* includes all aspects of building heating and cooling, as well as various health considerations associated with HVAC systems. In addition to the familiar energy technologies associated with HVAC equipment and systems, this chapter also addresses the impact HVAC systems have on the spread of airborne infectious diseases, allergens, pathogens and other toxins.

The original purpose of buildings was to provide shelter from rain, snow, wind, cold, heat, sun, attack and so on. They were not built with resource efficiency in mind. Early prisons were made from stone or adobe with very thick walls and tiny or no windows, which made them sturdy, but often cold, dark and dank. More recently, correctional institutions have been designed to provide greater comfort and dignity for inmates and staff. With the advent of mechanical HVAC systems, the maintenance associated with keeping buildings warm in the winter and cool in the summer has become a major design criterion as well as a significant operating expense. Air, heat and moisture naturally transfer through the windows, doors, ceilings, walls and floors of all buildings. HVAC systems are designed to control these flows of heat and air to provide comfortable, safe and healthful living conditions.

Many correctional systems have recognized the value of reducing costs and increasing comfort by heating and cooling buildings more efficiently. California's Title 24 of the Non-Residential Energy Efficiency Standards requires that "provisions shall be made to maintain a comfortable environment" (http://www.cdcr.ca.gov/csa/FSO/Docs/2001-04-17_400-01-010_Detention_Facility_Energy_Design.PDF p. 3). The U.S. Environmental Protection Agency has also found that, "Enhanced indoor air quality … can improve employee comfort and reduce fatigue, accidents, absenteeism, turnover and health costs, all of which can contribute to better employee morale and improved productivity in energy-efficient buildings" (http://www.epa.gov/statelocalclimate/documents/pdf/ee_municipal_operations.pdf p. 4). Correctional institutions worldwide have recognized the value of reducing costs and increasing comfort by heating and cooling buildings more efficiently. The sections below outline some of the basic technologies available to accomplish this straightforward task.

- Insulation in walls, attics and floors.
- Plugging leaks and sealing ducts.
- Conducting periodic maintenance and tune-ups.
- Variable Air Valve (VAV) and multi-zone heating and cooling systems.
- Upgrading HVAC equipment.
- Better-insulated windows and window coverings/shades.
- Combined heat and power.

- Heat storage.
- Installing more efficient or tankless "demand" water heaters.
- Reducing heat islands in parking lots.

Health

Unfortunately, if not properly attended to, HVAC systems can become major pathways for the distribution of diseases, germs, viruses, mold, mites, toxins and other health risks (http://www.cdc.gov/niosh/topics/indoorenv/mold.html). Keeping systems clean and sanitary is an important aspect of HVAC maintenance. According to the U.S. Centers for Disease Control, airborne infectious disease transmission can be reduced using dilution, ventilation, specific in-room flow regimes, room pressure differentials, personalized and source capture ventilation, filtration and ultraviolet germicidal irradiation (UVGI) (www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf).

By addressing the HVAC system in all of its facets, planners and maintenance personnel can reduce operating costs and increase the healthfulness of indoor spaces.

WHAT CAUSES POOR INDOOR AIR QUALITY?

- Asbestos.
- Raw sewage.
- Insufficient air circulation.
- Tobacco smoke.
- Airborne particles from cooking and frying.
- Mold.
- Volatile organic compounds (VOCs) from paint, flooring and adhesives.
- Toxic cleaning chemicals and paints that contain VOCs and phenols.
- Construction debris.
- Fiberglass insulation.
- Lead paint.
- Asbestos
- Raw sewage
- Smoke and fire damage.
- Auto and truck exhaust.
- Animal waste from service animals or birds.
- Untreated water damage and standing water.
- Allergens, bacteria and viruses.

HVAC is all about heat. When there is too much heat outside, HVAC keeps heat out of the buildings or moves it out. When it's too cold outside, HVAC puts heat in and keeps it in. Because heat transfer is the essence of HVAC, the most effective programs begin with adding insulation, sealing leaks and implementing other forms of heat transfer barriers.

Proper HVAC maintenance also includes reducing the spread of allergens, toxins and pathogens. With proper HVAC design, installation and maintenance, correctional institutions can take restorative, preventative and cost-effective measures to save money, prevent future expense, maximize comfort and mitigate the risk of the spread of infectious diseases.

Existing Technology Review

Insulating Attics, Walls and Floors

The knowledge and application of insulation technologies is advancing rapidly. Insulation is traditionally measured by *R-value,* expressed as the thickness of the insulation material divided by the thermal conductivity — in other words, how difficult it is for heat to pass through it. The higher the R-value, the better the insulating properties of the material. In addition to traditional technologies rated via R-value including asbestos, fiberglass, foam, cellulose, structurally insulated panels (http://www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11740) and more, there are new reflective technologies that lack R-value. Often referred to as *radiant barriers,* these materials reflect heat in one or both directions. Some are as thin as a sheet of plastic or a coat of paint (http://www.bootheglobalperspectives.com/article.asp?id=383).

The amount and type of insulation or reflective coating required to reduce heat transfer in or out of buildings must be balanced with cost-effective return on investment. At a certain point, the cost of insulating the building exceeds the cost of the energy required to heat or cool the space.

According to correctional administrators and facilities managers interviewed by the authors of this Guidebook, the diversity of situations and technologies makes it difficult to provide comprehensive cost/benefit information, but in almost all cases, insulation is cost-effective (almost always paying for itself within the first year) and the benefits of reduced monthly charges and increased comfort are nearly immediate.

Plugging Leaks and Sealing Ducts

Checking ducts for leaks and repairing them to peak efficiency improves heating and cooling and prevents outside particulates and pathogens such as dust, dirt, fiberglass and asbestos insulation from entering the ductwork. Plugging leaks and sealing ducts are among the most cost-effective improvements any facility manager can make. Caulking guns and duct tape aren't glamorous, but they do save money. When added up, the little leaks around windows, doors, ducts and joints amount to a heat loss similar to having gaping holes. If asbestos tape, toxic mold or other risks are present, necessary precautions must be taken to protect the health of workers and occupants.

Plugging leaks and sealing ducts are among the most cost-effective improvements any institution can make. Especially in institutions with the capacity to provide inmate labor, this task provides immediate return on investment with a minimum amount of training.

HVAC Tuneups

This simple maintenance includes removing dust, dirt and detritus, and treating equipment with environmentally safe and non-toxic solutions that reduce or eliminate mold, bacteria, virus and allergens (see sidebar *ENERGY STAR Tuneup*).

When using coil cleaners, it is important to use non-toxic, environmentally safe solutions (see Chapter 5 for further discussion of non-toxic cleaning technologies).

Many jurisdictions and utility companies periodically offer free or reduced-cost HVAC tuneups to tighten belts, clean ducts, lubricate moving parts, clean jets and manifolds, check thermostats, replace refrigerant and so on. Such tuneups can be done with minimal training and generally save three to 10 percent of the cost of operating HVAC systems (http://www.seattle.gov/light/conserve/tips/cv6tip_27.htm).

Plugging leaks, tuning furnaces by tightening belts, lubricating bearings, cleaning jets and other simple maintenance tasks provide immediate return for minimal investment. At a cost of $50 to $500 per furnace depending on the size, there is an opportunity to save on the total heating and cooling bill. The benefits are obvious.

ENERGY STAR TUNEUP

The ENERGY STAR program maintains a very informative website on HVAC tune-ups at http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac. According to this program, maintenance tuneups for the HVAC system include:

- Check thermostat settings to ensure the HVAC system keeps the space comfortable when occupied and saves energy when not occupied.
- Tighten all electrical connections and measure voltage and current on motors. Faulty electrical connections can cause unsafe operation of the system and reduce the life of major components.
- Lubricate all moving parts; parts that lack lubrication cause friction in motors, increasing the amount of electricity use and shortening equipment life.
- Check and inspect the condensate drain in the central air conditioner, furnace and/or heat pump (when in cooling mode). A plugged drain can cause water damage and affect indoor humidity levels.
- Check system controls to ensure proper and safe operation. Check to ensure the system starts, operates and shuts off properly.

Cooling-Specific Maintenance

- Clean evaporator and condenser air conditioning coils. Dirty coils reduce the system's ability to cool a building and cause the system to run longer, increasing energy costs and reducing equipment life.
- Check the central air conditioner's refrigerant level and adjust if necessary. Too much or too little refrigerant will make the system less efficient, increasing energy costs and reducing equipment life.
- Clean and adjust blower components to provide proper system airflow for greater comfort levels. Airflow problems can reduce the system's efficiency by up to 15 percent.

Heating-Specific Maintenance

- Check all gas (or oil) connections, gas pressure, burner combustion and heat exchange. Improperly operating gas (or oil) connections are a fire hazard and can contribute to health problems. A dirty burner or cracked heat exchanger causes improper burner operation and can cause equipment to operate less safely and efficiently.

Additional Actions Inmates Can Do With Minimal Training

- Inspect, clean or change air filters once a month in the central air conditioner, furnace and/or heat pump. A trained staff member or contractor can demonstrate how to do this task. A dirty filter can increase energy costs and damage equipment, leading to early failure.

Duct Cleaning

Most HVAC systems use air filters on return vents and at the air handler. Gaps and leaks around existing ducts and inefficient air filters allow heat to escape or penetrate and do not effectively trap pathogens, allergens and so on. Sealing leaks, cleaning the surfaces surrounding the ducts, repairing or replacing bent or broken filter receptacles and implementing the use of superior filters can efficiently trap pathogens and other particulate matter.

Preparing ducts for treatment with non-toxic, environmentally safe, antimicrobial, antibacterial, antiviral, antifungal, long-lasting disinfectant will also reduce health risks and prevent future health-related absenteeism and claims (see http://www.cdc.gov/niosh/topics/mrsa/, http://www.centervbhm.com/pdf/workset/MCF094_risk_reduction_booklet.pdf, or http://www.epa.gov/iaq/schools/district.html).

As an example, the patented National Institute for Occupational Safety and Health (NIOSH)-rated Sander's System allows for high-efficiency particulate air (HEPA) or near-HEPA filtration of the entire facility's air handling system, trapping and holding suspended pathogens as they enter the HVAC system. This installation requires no retrofit to the air handling system and will filter the air, trapping and holding (and thereby eliminating) particles as small as 0.3 submicrons to include asbestos, fiberglass, allergens, mites and pathogens.

Duct cleaning removes dust, dirt and allergens that may impede air flow and contribute to poor indoor air quality as well as respiratory discomfort, increased incidence of asthma attacks and the spread of nosocomial infections. Mold, bacteria and viruses thrive in areas where there is minimal light, high humidity and enough organic material on which to colonize.

Antimicrobial/Antibacterial/Antifungal/Antiviral Treatment

Advanced cleaning and sanitation solutions are non-toxic phenols or volatile organic compounds (VOCs) and are environmentally safe, contain no phenols or VOCs and are intended for use in occupied settings. These solutions eliminate up to 99.99999 percent of bacteria, viruses and mold on contact. Once applied, the surface treatment remains indefinitely and provides continuous protection in all but the busiest traffic areas. Applying surface treatment to condensate pans in HVAC closets, around water heaters and dishwashers, and in laundry areas inhibits mold growth. One-time treatment and periodic cleaning would reduce the incidence of illness, reduce absenteeism and save substantial money currently being spent on medical care.

High-efficiency Air Filters and Personal Protective Filtration Masks

Masks made of patented, non-woven fabric can filter particles as small as 0.3 microns and virtually all medically related pathogens are larger than 0.3 microns. Proper masks are one-size-fits-all and adhere directly to the skin with a non-allergic adhesive that forms an airtight seal around the face, eliminating leakage. Masks with straps or bands have been shown to leak up to 10 percent and thereby are not effective.

In medical areas, wearing respiratory masks can prevent exposure to, and spread of, hospital/clinic-related pathogens and particulates that can be transmitted through airborne transmission or drawn into return vents and circulated through the HVAC system to and from caregivers, medical staff, cleaning staff, infected patients and the general population.

The cost of superior HEPA or near-HEPA grade air filters is similar and equivalent to the cost of inferior, less efficient, less effective filters currently in use. Improved filtration materials that capture allergens and pathogens reduce the cost of medical care by mitigating the risk of the spread of infectious illness originating in hospital or clinic areas. This can save substantial sums of money while providing a healthier, safer environment for staff and residents. Personal protective masks and air filters for HVAC made of superior filtration media reduce the risk of the spread of infectious diseases via nosocomial transmission from direct person-to-person contact and through HVAC systems.

Variable Air Valve and Multizone HVAC Systems

Variable Air Valve (VAV) and multizone HVAC systems provide a means of varying the amount of conditioned air to a space. A variable air volume system maintains

the air flow at a constant temperature and supplies varying quantities of conditioned air in different parts of the building according to heating and cooling needs and occupancy of the space. These systems provide enough air flow and circulation for health while minimizing the amount of energy used for heating and cooling.

The most common problems with VAV systems include moisture, air flow and distribution of pathogens, allergens and so on. It is important to ensure that there is enough air, that it is properly filtered and sanitized to reduce particulates and other toxins, and that moisture does not accumulate and cause mold growth. Dividing HVAC systems into individually controlled zones can increase the levels of control and efficiency.

Due to the diversity and complexity of HVAC systems, it is not possible to give a generic assessment of costs and benefits of implementing this technology; however, this can be included in any standard institutional energy audit/assessment.

Upgrading Equipment

When upgrading HVAC equipment, two factors are important: timing and life-cycle costs. Often, extended operational savings associated with a more efficient system will reduce the monthly costs by more than the amortized cost of purchasing a new system. If a system costing $100,000 lasts for 20 years and reduces the monthly heating bill by $1,000, it will pay for itself in nine years (without taking into consideration the additional savings associated with rising energy prices). If third-party financing is available, then what matters is not the total cost, but rather, the monthly and annual operating cost: as long as operating costs go down, then the system saves money. (See Appendix 1 for additional ways of obtaining third-party financing for large capital upgrades.)

Automating thermostats and providing variable speed fans that aren't just "on" or "off" will further increase the efficiency of an upgraded system.

In addition, providing variable-speed fans and more even-flow duct pathways (with curved, rather than square, corners) can reduce the cost of operating HVAC systems. A simple technology to recirculate air vertically can be installed in the ceiling areas of common rooms and atrium spaces (as demonstrated at the County Jail in Boulder, Colo.) to circulate air and prevent stratification while reducing the cost of heating and cooling high-ceiling areas by as much as 40 percent (http://www.Airius.us).

Increasing efficiency of circulation systems is difficult to estimate on a generic basis, but it is fairly straightforward to include in the cost estimate of any comprehensive energy upgrade. A vertical air circulation device costs $40 to $400 per unit and can save as much as 40 percent of the energy used to heat and cool areas with high ceilings.

Better-Insulated Windows and Window Coverings/Shades

The rationale for investing in better-insulated windows and window coverings/shades (including exterior shade trees in locations where line-of-sight is not a security issue) is the same as for HVAC equipment upgrades. As long as the monthly bill for heating and cooling goes down by more than the amortized cost, then it saves money to make the investment (especially if third-party financing is available).

Windows can be expensive, and in correctional settings, they must be properly secure. Skylights have been known to leak and provide their own issues with security. However, poorly insulated and poorly sealed windows and skylights are among the most expensive liabilities of older buildings with regard to HVAC. Stopping the passage of heat out of or into buildings should be taken care of before considering any other measures.

Because of the relatively high upfront cost of replacing windows and skylights ($100 to $3,000 per window) as well as the unique security needs of correctional institutions, window replacement generally requires third-party financing or careful planning. Nonetheless, at an estimated savings of $126 to $465 per window

per year, it is not difficult to recognize the benefits once the upfront cost has been provided.

High-efficiency Furnaces

As with so many other HVAC opportunities, installation of high-efficiency furnaces can quickly reduce the cost of heating (usually by more than the cost of installation when amortized over the life of the furnace or boiler). Replacement generally must coincide with the usual replacement schedule, although retiring inefficient equipment often saves more than the replacement cost. A capable energy auditor or energy service company can calculate comparative costs quickly (see Appendix 1).

Because of the diversity of types of furnaces, as well as the variable prices of oil, coal, natural gas, electricity and biomass fuels, it is difficult to estimate the cost and benefit of high-efficiency furnaces. However, this can be included in the assessment provided by an energy audit. It is most likely to be cost-effective to replace a furnace at or near the end of its useful life, although depending on the existing technology, the energy savings associated with a more efficient furnace combined with other cost-eliminating measures may make it beneficial to do so sooner. At Indiana's Putnamville Correctional Facility,

conversion to a high-efficiency boiler using wood as biomass is a central part of the green retrofit program that will save $1.25 million over two years.

Biomass Conversion

With the cost of fossil fuels continually rising and considering the potential carbon costs associated with their use, many institutions have begun converting to heat provided by biomass such as wood chips, pellets, agricultural wastes, organic waste from garbage or construction or specific, non-food crops grown on marginal land. The County Jail in Boulder and the Indiana Department of Corrections are among the leaders demonstrating the cost effectiveness of using biomass (http://www.correctionsone.com/facility-design-and-operation/articles/2473021-7-steps-to-save-1-000-per-inmate-by-going-green/, http://www.in.gov/idoc/files/Pendleton_Boiler_Ceremony_Media_Release.pdf). Indiana Department of Corrections will save $36 million over the next 10 years as a result of green initiatives, including investment in conversion to biomass heat using waste wood.

Heat Storage

As a general rule, the more thermal mass contained in a building and its contents, the less expensive it is to heat and cool the building. If temperature can be maintained at a relatively constant level because of the presence of thermal masses such as rocks or water, there is less need to heat and cool the air. Retaining heat or preventing its transfer makes it more cost-effective and less resource-intensive to change the temperature. Properly designed heat storage systems, such as rock storage in underground chambers where heat coils pass through the storage area, can store heat for up to eight months and eliminate the need for anything more than small back-up heating systems. Conversely, subterranean mass protected from heating can be used to discharge heat during hotter weather. Properly insulating buildings can also make heat storage much more most cost-effective. Because of the tendency for warm air to rise, it is often more convenient and cost-effective to include sub-floor heat storage as part of the construction of a building rather than as a retrofit project. (See additional discussion under Geothermal Systems in the chapter on energy.)

Combined Heat and Power

Combining heat generation with electricity generation to create combined heat and power (CHP) is a technology that is more than 100 years old. It is cost-effective and reliable, especially in larger complexes where it can be combined with district or multi-building heating and cooling. Examples of this include the 1MW fuel cell system at Santa Rita County Jail in California (http://www.pacificcleanenergy.org/PROJECTPROFILES/pdf/SantaRitaJail.pdf) and the boilers at Bridgewater Correctional Complex in Massachusetts (http://www.mass.gov/anf/property-mgmt-and-construction/facilities-mgmt-and-maintenance/energy-and-sustainability/bridgewater-correctional-complex-performance.html). The CHP system at

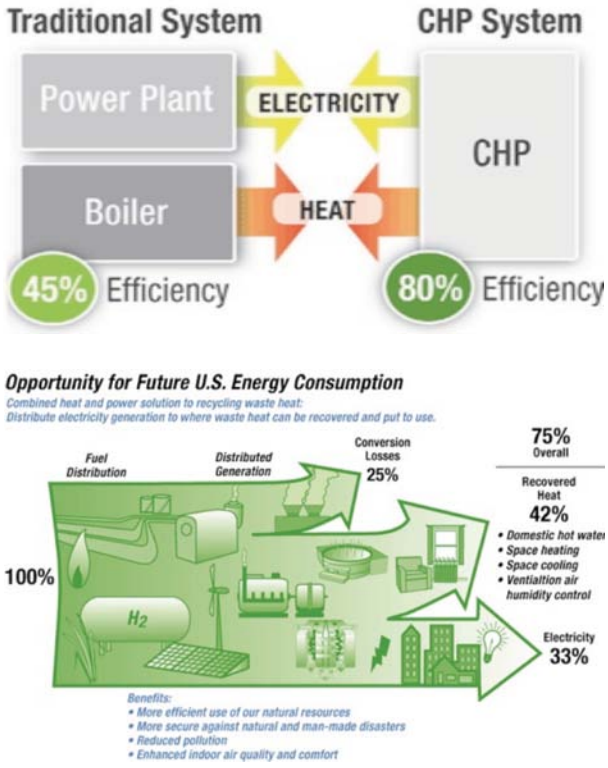
Bridgewater is projected to save more than $27 million over its life.

Because of the maturity of CHP technologies, most major engineering firms can provide capable oversight of applications and considerations associated with installing and maintaining CHP systems.

Energy service companies will generally provide useful estimates of CHP potential as part of their standard audit and proposal. Many engineering companies will also deduct the cost of the feasibility assessment for such systems from the purchase and installation price. And a well-written RFP can include assessment of applications and concerns as part of the request for information and qualifications.

As an example, the CHP fuel cell project at Alameda County's Santa Rita Jail in Dublin, Calif., cost $6.1 million, but after incentives, an annual energy savings of $264,000 will provide simple payback in 14 years (http://www.pacificcleanenergy.org/PROJECTPROFILES/pdf/SantaRitaJail.pdf).

Combining Heat and Power



Wood-burning boiler at Putnamville (Ind.) Correctional Facility

Bridgewater (Mass.) Corrections Complex

Installing More Efficient or Tankless "Demand" Water Heaters

By comparison with windows, pipes and buildings, water heaters have a relatively short lifetime, making them ideal candidates for upgrade to more efficient technologies when it's time to replace them. For larger systems in which the water heating is combined with space heating in the boiler system, this requires careful planning and possible third-party financing (see Appendix 1). Tankless "demand" water heaters that heat water very rapidly as it passes through a manifold without keeping a tank of water hot all the time are discussed in more detail later in this section. Their affordability depends on purchase and installation costs, use and local prices for the gas, electricity or oil used to heat the water.

Much of the energy used to heat water is wasted in keeping a tank of water hot at all times. Tankless demand water heaters provide hot water almost instantly without keeping a tank of water hot. Although they can be very efficient to operate, they are sometimes difficult and expensive (including the cost of removing the prior technologies) to install.

Tankless demand water heaters carry a high upfront cost for the technology as well as installation. Though they use less energy, the higher upfront cost often stretches payback to a period longer than the anticipated life of the water heater. A test by *Consumer Reports*® indicated $1,200 purchase and installation costs for tankless, compared to $300 for regular tank heaters, in a residential setting. Although the *Consumer Reports* estimate for purchase and installation of traditional water heaters seems low, at an estimated savings of $70 to $80 per year, it would take more than 10 years to reap savings. Unless water use is high enough to

Reducing heat islands

return greater savings, it is likely that simply replacing older, less efficient traditional water heaters with more efficient models will be more cost-effective than switching to tankless demand heaters (http://www.consumerreports.org/cro/appliances/heating-cooling-and-air/water-heaters/tankless-water-heaters/overview/tankless-water-heaters-ov.htm).

Reducing Heat Islands in Parking Lots and on Non-reflective Roofs

Especially in hotter climates, parking lots can generate enough heat to create a need for additional cooling in surrounding buildings. In locations where line-of-sight is not a security concern, planting and maintaining trees can reduce these heat islands and provide aesthetic value as well (http://okplanttrees.okstate.edu/resources/educational/pdr/section6.html).

The most common way to reduce heat islands is to provide shade, usually through planting and maintaining trees. However, this can cause security problems if line-of-sight is necessary. Another strategy is to install solar carports that generate electricity and provide shade and shelter. However, the cost of building the frames for solar carports adds to the cost of the system, which generally requires aggressive rebates or subsidies such as feed-in tariffs to make them cost-effective.

The diversity of technologies used for reducing heat islands makes it difficult to calculate the costs and benefits because they are usually combined with other factors such as storm water runoff, aesthetic value and solar photovoltaic energy generation.

General Considerations

Sealing buildings more efficiently has sometimes resulted in sealing contaminants into buildings by limiting the exchange of outside air and recirculating dust, dirt, allergens and pathogens through HVAC systems, resulting in respiratory irritation and an increased risk of the spread of infectious diseases (http://www.ahrq.gov/qual/haicusp.pdf).

When done effectively, HVAC-related energy-efficiency improvements to buildings also include implementing an environmental cleaning protocol, remediation with new environmentally safe, non-toxic treatment solutions, adding superior air filters and using personal protective filtration masks in medical areas. In combination, these cost-effective changes will provide improved indoor air quality, reduce employee absenteeism and provide a more healthful indoor environment while mitigating the risk of the spread of infectious diseases and saving significant financial resources currently devoted to medical care (http://www.cdc.gov/niosh/topics/mrsa/).

HVAC systems are complex. Particularly when automation, computers, wireless monitoring and various forms of "smart metering" are involved, benefits can be difficult to achieve. For example, an $800,000 upgrade in the county prison system in Hillsdale, Mich., designed to save money on heating has not been able to reduce gas usage after three years due to complexities with

the wireless control systems and other issues, according to attendees at the 2010 Construction Maintenance Institute for Criminal Justice Agencies Conference in Dearborn, Michigan in 2010. (Personal interview between Jerry Elmblad, Administrative Manager, Michigan DOC, and Guidebook co-author, Paul Sheldon, Oct. 6, 2010).

Investments in solving health issues related to HVAC systems are difficult to justify because the expenses caused by health claims occur in the future. The investment in preventing health claims cannot be justified by direct cost savings, but rather, requires a commitment to preventing future costs by investing a reasonable amount of money in the present. In times of tight budgets, this type of investment is difficult to fund, even though the significant potential liabilities are much larger than the investment required (see report of U.S. Surgeon General's Workshop on Healthy Indoor Environment, at http://www.surgeongeneral.gov/topics/indoorenv/ p. 10-18).

Lastly, HVAC systems have long life cycles, much longer than a light bulb or faucet washer, so it is often necessary to balance potential savings with already existing capital replacement schedules in order to achieve direct savings.

Future Trends

Preventing the transfer of heat from inside or outside a building remains the greatest challenge in HVAC. Reflective/radiant barrier technologies continue to innovate in the area of heat reflection, including advanced windows (http://ies.lbl.gov/iespubs/46990.pdf).

Resources

- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) http://www.ashrae.org/
- Local ASHRAE chapters http://www.ashrae.org/members/page/607
- U.S. Department of Energy http://www1.eere.energy.gov/buildings/appliance_standards/information_resources.html

REAL WORLD EXAMPLES

The combined heat and power program at Bridgewater Correctional Complex in Massachusetts (http://www.mass.gov/eopss/agencies/doc/massachusetts-department-of-correction-2.html) provides an excellent example of a comprehensive HVAC retrofit. Another comprehensive HVAC retrofit has been conducted at the County Jail in Boulder, including improved circulation, reflective roof, a photovoltaic electricity system and a biomass boiler (http://www.coloradodaily.com/cu-boulder/ci_13455774#axzz1ZmAvRAES). As mentioned previously, the Indiana Department of Corrections will save $36 million over the next 10 years as a result of their green initiatives, including investment in conversion to biomass heat using waste wood. And El Dorado Correctional Facility (www.kcc.state.ks.us/energy/fcip/eldorado_correctional_profile.pdf) in Kansas has also completed a cost-saving HVAC retrofit as part of an institutional overhaul: with an investment of $2.2 million, the facility projects annual savings of $247,517, producing a 16-percent annual reduction in utility costs, an eight-year payback and an overall project return on investment rate of 12.2 percent over 10 years.

Many energy service companies (ESCOs) provide recommendations and referrals to experienced HVAC providers as part of their comprehensive retrofits (see Appendix 1). Also, most state energy offices also provide referrals to licensed, reputable HVAC practitioners.

Conclusion

HVAC and related efficiency improvements to buildings can save money and promote the health of residents and staff. The diverse technologies described in this chapter are intended to offer an introduction to what is possible. The most important step in realizing the cost savings and waste elimination in HVAC systems is to schedule an energy audit by a competent inspector. Simple changes to HVAC can save money, improve indoor air quality and mitigate the spread of infectious diseases. When added to a comprehensive program of environmental cleaning of all surfaces, clothing and food preparation areas, institutions have noted significant benefits in health, comfort and reduced employee absenteeism. The reduction in health care costs will result in immediate and long-term significant savings (http://www.epa.gov/nhsrc/pubs/600r05083.pdf).

CHAPTER 4

PLUG-IN APPLIANCES

(Including Pumps and Motors)

Background

Vending machines, office equipment, televisions, computers, communications equipment, refrigerators, freezers, pumps, motors, fans — the list of technologies that plug into the wall seems nearly endless. For many years, the electricity used by these devices was considered negligible. And in comparison with salaries, benefits, transportation, food and other essential costs, electricity is still a relatively minor expense. However, with electricity costs rising, it has become more significant. Prison industries and related activities have been given free electricity as have inmates who plug in "stingers," TVs, radios, hair dryers and appliances without any thought for how much it costs the institution to supply this electricity.

Large electricity uses, such as pumps, motors, wastewater treatment facilities, wood shops, metal shops and so on also have remained relatively unexamined in the overall budget. Any efficiency improvements in those areas will save money.

Look around—are the lights on? Listen—is there any noise? Is any of the noise generated by electrical equipment such as fans, motors, TVs, printers, copiers, radios, communications equipment, computer servers or anything else that plugs into the wall or is connected to electricity? New advances in consumer electronics products and growing awareness of the expense associated with unnecessary use of electricity have made it possible to save significant amounts of money for relatively little — sometimes no — investment. These savings are relatively easy to measure: did the electricity bill go up or down? For institutions that do not pay or see their electricity bill, the directly identifiable benefits may be minimal, but for any institution that pays an electricity bill, this information in this chapter could provide a new source of cost avoidance and waste elimination.

Existing Technology Review

ENERGY STAR Appliances and Equipment

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that helps save money and protect the environment through energy-efficient products and practices. Many corrections institutions, following guidance or mandates from regulatory and funding agencies, have implemented policies requiring that ENERGY STAR-compliant appliances and devices must be purchased when procuring any and all appliances and devices covered by the ENERGY STAR program (http://www.energystar.gov/index.cfm?c=about.ab_index). The ENERGY STAR website at http://www.EnergyStar.gov provides lists of technologies that qualify for ENERGY STAR ratings, along with comparative statistics to calculate life cycle costs and savings. The ENERGY STAR logo and specifications can be found on most plug-in appliances available for purchase. ENERGY STAR appliances and devices typically save 25 percent or more of the energy used by non-compliant devices.

Office Equipment

Office equipment can be among the most voracious energy vampires in an institution, including computers, monitors, printers, copiers, coffee makers, water heaters, water coolers, microwave ovens, computer servers, personal foot heaters and floor lamps. The latest ENERGY STAR-rated computers use liquid crystal display (LCD) technology and are moving towards LED or Organic Light-Emitting Diode (OLED) monitors, which do not require backlights and which use minimal amounts of electricity, sometimes as little as 15 percent of that used by older monitors (http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=MO).

Computer Servers

Because they operate 24 hours a day, 365 days per year, computer servers can use a very large amount of electricity for both operation and cooling. Some systems may choose to virtualize all desktops by replacing PCs and moving to "thin client" desktop client computers (which use minimal electricity) and also possibly moving to web-based operations (although web-based dependency carries security risks). The monitor could thus become the biggest power draw. With web-based applications, desktop machines need only provide access to the server through the Internet browser or other direct-access software. This virtualization would mean no hard drive on the desk, just a programmed chip in the keyboard. However, if the Internet connection goes down, so does the computer system. More localized systems are less vulnerable. (Based on interviews by this Guidebook's authors with personnel at Montana and Colorado Departments of Corrections. See also http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Version5.0_Computer_Spec.pdf. For more information on "thin client" computing, see the State of Michigan's Strategic Plan at http://www.michigan.gov/documents/itstrategicplan/2010_Strategic_Plan_Full_Version_071410_327731_7.pdf Appendices I, J, & M).

In some agencies, functions such as offender management, accounting and time entry systems are already web-based. Agencies such as Montana Department of Corrections (DOC) are also experimenting with using tablet computers to connect to offender management systems. Parole and probation officers may not need desktops in that case, just tablets or netbooks.

Computer servers use large amounts of electricity and generate a lot of heat, and usually require more electricity to cool the servers and/or the server rooms. Installing and using virtual machine software (VMware), which detects and eliminates unused server space, can reduce the number of servers and the amount of electricity required to run them by 50 percent or more. The Montana DOC has implemented this process as well. Using innovative cooling technologies can also reduce the cost of purchasing or generating electricity to cool the servers.

Refrigerators and Freezers

Like most other consumer electronic products, refrigerators and freezers are rated by ENERGY STAR for their efficiency. Super-efficient products, even more efficient than ENERGY STAR, are also available. These products use 10 percent of the electricity of other devices. However, simply purchasing ENERGY STAR-labeled products will increase efficiency by up to 25 percent.

Vending Machines

Most vending machines are not yet ENERGY STAR-rated, so it is important to measure electricity consumption using a simple meter. Do the machines need to be on all the time or could they be turned off at times? Could a timer be installed that would regulate when they are on or off? Is it necessary for the machine to be lighted all the time or could the lights be disconnected to save electricity? Asking these simple questions and taking simple steps can save 25 percent or more of the electricity used for vending machines.

Inmate TVs

How much electricity does a TV set draw? Older, less-efficient CRT TVs, even small ones, draw 35-50 watts (http://www.efficientproducts.org/reports/tvs/NRDC_TV-efficiency_2004.pdf). More efficient TVs use 15 to 25 watts (http://www.toptenusa.org/Top-Ten-Televisions/Top-Ten-Small-Televisions/(view)/list/(sort)/rank). Assuming inmates watch TV for eight hours/day, 365 days/year, and further assuming a cost of $0.10/kWh for electricity, a facility with 1,000 inmate TVs could be spending $15,000 per year to pay for the electricity. Requiring more efficient, ENERGY STAR TVs could save $5,000 or more per year.

Pumps

More information on pumps is provided in Chapter 6. Pumps tend to use a lot of electricity. Properly sizing pumps, replacing single-speed motors with computer-controlled variable-speed capacity and replacing right-angle piping with curved transitions can save significant amounts of energy and money.

Electric Motors

Correctional institutions require hundreds of electric motors to operate everything from doors to cooling towers to wastewater treatment facilities. Many institutions pay the electricity costs for older, less-efficient motors in prison industries and manufacturing operations. Federal Executive Order 13514 requires that all new technologies be energy efficient (http://www1.eere.energy.gov/femp/regulations/eo13514.html). Many large engineering companies have special divisions to assist correctional institutions in becoming more energy efficient, with particular attention paid to improving the efficiency and reliability of electric motors (http://www.emersonmotors.com).

Battery Chargers

Battery chargers are among the most taken-for-granted consumers of electricity. Used to charge everything from communication devices to cell phones, forklifts to golf carts, battery chargers can use very large amounts of electricity even when not in use or when the device is already charged. Ensuring that battery chargers are efficient and programmed to shut down when no device is present or switch to "trickle charge" when the device is fully charged can reduce the total amount of electricity used to run an institution (http://www.efficientproducts.org/reports/bchargers/NRDC_Battery_Charger_Final.pdf).

"Smart" Plug Strips

"Smart" plug strips look like normal plug strips but also incorporate additional technologies to automatically disconnect power to certain equipment when not in use. Most smart plug strips have one "master" control outlet, four to six controlled outlets that will automatically power down designated devices and one or two uncontrolled outlets that are always on. Smart plug strips vary by design, but typically employ occupancy sensors, load sensors, remote controls, timers or USB interfaces to automatically power down plug loads when they are not in use (http://www.efficientproducts.org/product.php?productID=24).

Costs/Benefits

Because of the diversity of electrical uses for plug-in appliances, pumps and motors, it is not possible to give a comprehensive cost/benefit analysis. However, a capable energy audit will provide immediate estimates and comparisons for the amount of electricity that could be saved by improving efficiency.

Considerations and Implementation Issues

The ENERGY STAR program has very rigorous testing and compliance protocols, so there are few complications with using ENERGY STAR-labeled appliances. Some tested technologies are much more efficient than what ENERGY STAR requires. ENERGY STAR generally ranks in the top 25 percent of more efficient technologies, but is not necessarily the most efficient.

Energy retrofit programs recommended by ESCOs and other providers often neglect plug-in appliances such as vending machines or office equipment. The expense and complexity of measuring the actual electricity usage of devices plugged into wall sockets or hard-wired into electrical circuits must be considered when calculating opportunities for increasing efficiency. Sometimes it is easier and more cost-effective to rely on known solutions, such as ENERGY STAR or the recommendations of a LEED-accredited professional.

The most common problem is no statistics, because energy is often billed to state general services and the department or agency doesn't see the bills and can't calculate the overall savings.

The second most common problem is that the expense of replacing plug-in appliances comes from a different budget than does the monthly utility bill, so correlating the replacement cost with long-term operating costs requires both calculation and collaboration among different managers.

Future Trends

More efficient plug-in technologies are emerging almost daily. In particular, advances in computerized monitoring and control allow significant savings over older technologies.

Resources

- ENERGY STAR
  http://www.energystar.gov/
- Efficient products
  http://www.efficientproducts.org/product.php?productID=24
- Computer server optimization using VMware
  http://www.vmware.com/

Conclusion

Measuring how much electricity plug-in devices and hard-wired motors, pumps and other electrical equipment use, then implementing measures to increase efficiency, can lead to significant savings of electricity and money systemwide.

REAL WORLD EXAMPLES

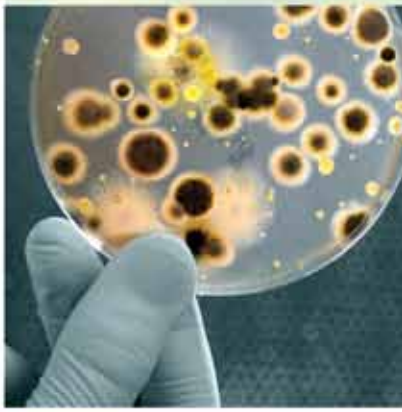
Under a 2008 requirement that all state agencies reduce energy use by at least 20 percent by 2010, the Montana DOC mandated that no desktop printers may be purchased unless their business need is justified (http://missoulian.com/news/state-and-regional/article_7a0b35f9-9c3a-53b7-9547-2bcc954b24cd.html). All printers must be networked so that multiple users have access. This increases energy efficiency by eliminating "phantom" standby loads. Purchasing a monitor with a screen size larger than 22-inch diagonal requires division administrator approval because larger monitors use more energy and using smaller monitors is more energy efficient. Montana DOC has also replaced power strips with smart strips that power down all devices plugged into them when a key device is turned off. This inexpensive smart strip technology eliminates phantom loads from devices at a workstation inadvertently left on or in standby mode. Also, when uninterruptible power supplies fail, Montana DOC is replacing them with power supplies that include these smart strip features for minimal additional cost. Savings from reduced electricity use offset any additional costs.

Montana DOC has done server virtualization, eliminating 17 computer servers by combining via virtualization using VMware. Montana DOC has also consolidated the outlying server functions of probation and parole offices to reduce bandwidth use of transmission lines. An additional nine servers are being consolidated with no impact on end users, resulting in a 50-percent reduction in server use, including related energy costs for operation, cooling and space. These improvements caused no impact on budget due to reallocation of capital replacement funds. All of Montana DOC's IT-related energy-efficiency improvements have been accomplished with no impact on end users or their abilities to do their jobs.

CHAPTER 5

MATERIALS FLOW

(Including Recycling and Toxics)



Background

Although many people think recycling began with Earth Day in 1970, correctional institutions had been leading this movement for many decades before anyone talked about "healing the earth." Correctional institutions have composted food wastes; managed organic gardens, farms and dairies; recycled and reprocessed junk from surrounding communities; and provided important job training for inmates for more than 100 years.

With the advent of recycling as a way of dealing with the mountains of trash generated by urban areas and other communities worldwide, correctional institutions have begun to recognize unique opportunities to position themselves as important processors of more than just people.

In addition to reuse, repurposing, composting and other forms of recycling, the focus on materials flow includes the types of chemicals and substances used for cleaning, painting and maintaining equipment. Correctional institutions must be very careful about toxic substances. Some inmates have been found to drink anything with any type of alcohol in it, and other toxic chemicals can cause injuries to inmates and staff. Material safety data sheets (MSDs) are required at nearly all institutions to provide details about any toxic substances as well as environmental cleaning protocols, remediation recommendations and less-toxic, safe cleaning product information (http://www.osha.gov/html/faq-hazcom.html).

To address this aspect, correctional institutions can implement a green cleaning program. This approach requires minimal investment and can also prevent future health-related claims. The best environmentally safe, non-toxic products clean well and do not promote the development of resistant strains of bacteria, germs and viruses. The methods and technologies described here are cost-comparable to traditional methods and technologies (http://www.green.ca.gov/EPP/building/cleaning.htm).

Monitoring and improving the efficiency and safety of the flow of materials through an institution can save money and resources and prevent or reduce future illnesses and risks.

Existing Technology Review

Recycling

Practically everything can be recycled. Correctional institutions nationwide are recycling food waste, garbage, computers, bicycles, wood, cardboard, ferrous metals, nonferrous metals, tires, batteries and a host of other materials. Recycling reduces costs and can be the focus of vocational training opportunities for inmates.

In many instances, institutions are providing recycled goods such as bicycles, computers and compost to needy individuals and organizations in the surrounding community (www.greenprisons.org/Uploads/files/1310404146.pdf).

Composting and Vermiculture

In Louisiana, the State Penitentiary at Angola has been composting kitchen scraps for more than 100 years. What used to be known as a backyard mulch pile has evolved to become the science of composting. Composting food scraps, coffee grounds and landscape/garden/lawn/yard trimmings through traditional methods or vermiculture (worm composting) can save institutional costs for waste disposal and reduce landfill volume.

An added benefit is that the compost can be used to fertilize and revitalize prison landscaping and garden areas. Reducing chemical fertilizers and pesticides protects soil, groundwater and human health. Additionally, learning about the composting process can raise awareness about waste issues and be incorporated into prison vocational recycling, waste processing, landscaping and gardening programs to provide inmates with new skills for post-release employment.

Various composting methods have similar outcomes including wire composting, plastic bin composting, sheet composting, hedgerow composting and vermiculture.

One notable advantage to the vermiculture approach is that it breaks down food scraps and other organic matter very quickly, and provides valuable soil amendment for use in landscape and gardening.

Industrial and institutional composting and vermiculture operations often involve the following steps:

- Collection.
- Mixing and shredding.
- Pre-composting.
- Digester loading or spreading.
- Turning and mixing.
- Harvesting.
- Spreading.
- Storage.

(Fleming, Ganett. 2002. *Feasibility of a Vermicomposting Operation For Food Waste at the Clearfield County Prison.* Clearfield, PA: Clearfield County. http://www.portal.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_505397_0_0_18/Clearfield_Prison.pdf.)

Worm composting facility at Stafford Creek (Wash.) Corrections Center

Organic Gardens and Farms

In light of current trends to grow, harvest and distribute locally produced, organic food, prison gardening and farming can save enormously on food costs and provide constructive time for inmates to learn new skills for potential employment opportunities when they leave prison (Atherton, Eugene and Paul Sheldon. 2010. *Low Lying Fruit: Implementing Green Technologies in Corrections. Workshop C-1,* http://www.justnet.org/Pages/corr2010_presentations.aspx; "Save $1,000 per Inmate," *Corrections Today,* April/May 2011, p. 52).

In the realm of rehabilitation, prison gardens are also used as experiential learning labs for inmates to get the education, skills training and transformational behavioral tools to get meaningful employment and stay out of prison. Garden programs that incorporate a multifaceted approach to rehabilitation can ultimately help reduce recidivism rates and increase public safety (http://www.dosomething.org/project/cultivating-dreams-organic-garden-women-prison-ciw).

Prison gardens have sprouted up from coast to coast from food farms in correctional institutions in Washington State and Rikers Island in New York to a rehabilitative gardening program at San Quentin State Prison in California. These programs often integrate their garden projects with other prison recycling and composting programs.

Gardens are generally low in cost to implement and maintain, and the harvested food can be used in prison kitchens, sold back to prison food vendors or at farmer's markets, and/or donated to local charities and food banks as part of prison community service programs. Collaborations have also developed between in-prison service providers and community-based food, farming and urban agriculture programs to integrate in-prison skills training with direct linkages to employers who can hire the formerly incarcerated.

Green Cleaning

Green cleaning includes efficient, effective and non-toxic solutions and products designed to improve sanitation and provide a safer, more healthful working

REDUCING MOLD

HEPA Vacuums. It is important to replace regular vacuums, which generally serve to distribute dust, dust mites and infection, with HEPA vacuums. Removing the maximum amount of particulate and preventing fine particles from re-entering the environment through the vacuum exhaust will improve indoor air quality.

General Cleaning. Cleaning off heavy soil by blotting and using soap and water or environmentally safe cleaning products, microfiber cleaning cloths, mops and so on is an important first step.

Applying Surface Treatment. Environmentally safe, non-toxic products can mitigate the risk of mold and/or antibiotic-resistant strains such as MRSA, and can prevent disease and the spread of pests, infections and mold. These green products can be used on walls, floors, ceilings, furniture, doors, handles, sinks and showers; in closets; by water heaters, HVAC air handlers and ducts; and are approved for use on hard and soft, porous and non-porous surfaces including walls, floors, doors, locks, carpets, wood, metal, rubber, plastic, mattresses, pillows, glass and tile.

Surface Treatment for Frequent Touch Points. Use environmentally safe, long-lasting, non-toxic, broad-spectrum disinfectant surface treatment to sanitize surfaces as part of routine maintenance protocols. Ready-to-use formula or solution from concentrate can be sprayed, fogged or applied with a cleaning cloth or mop.

This will protect frequent touch points by remaining on surfaces to provide continuous protection, thus mitigating the risk of the spread of infectious diseases via surface contact.

Areas of High Humidity. Mold is likely to occur in areas with high humidity or a history of water intrusion. Leaks must be repaired and moist structural materials, ceiling tiles, carpet, padding, fabrics or other wood or organic elements may need to be removed and replaced. Areas and furnishings must be completely dried, followed by the application of antimicrobial surface treatment.

Food Preparation Areas. Special EPA-approved antimicrobial and antibacterial solutions can be used to treat mold, viruses and foodborne bacteria and do not create antibiotic resistant strains. Use of National Science Foundation food safety-rated surface treatments that remain on surfaces until mechanically removed can provide continuous protection against salmonella, E. coli, norovirus, MRSA, mironorovirus, Listeria monocytogenes and more (http://www.ncsu.edu/research/results/vol10n1/results.pdf). Repeated wiping of surfaces with less toxic germicidal cleaners also maintains sanitary conditions. Adding antimicrobial solution to floor washing and carpet cleaning machines sanitizes carpets and floors.

Treat Upholstered Furniture. Vacuuming dry dirt, spot-treating stains, adding an antimicrobial solution to a steam cleaner and applying fabric-safe antimicrobial treatment for continuous, long-lasting protection against pathogens, microorganisms and odors can prevent the spread of disease, the presence of pests and the growth of mold.

HVAC System. HVAC is discussed in detail in Chapter 3.

Laundry. Use of antimicrobial laundry additives to provide long-lasting protection to clothing, uniforms, bedding, towels and so on can prevent the spread of mold. The best products continuously protect washables for 25-50 washes. This will reduce the odor from perspiration by killing the bacteria that cause odor. By using an antimicrobial, disinfectant laundry treatment, fabrics remain protected against transfer of pathogens and assist in preventing the spread of viruses and bacteria from person-to-person contact via clothing, linens and towels. The most immediate and noticeable benefit is the reduction in odor from perspiration. These treatments can be used on patient gowns, medical personnel uniforms, curtains, bed linens, pillows, inmate uniforms, towels and any other washable items. Many institutions use unscented anti-allergen laundry detergent, which is designed especially for those with sensitive skin who wish to eliminate allergic reactions to clothing, bedding and other washables.

Floor and Carpet Cleaning. Add antimicrobial solution to floor washing and steam carpet cleaning machines. Repeated wiping of surfaces with less toxic germicidal cleaners also maintains sanitary conditions. Adding antimicrobial solution to floor washing and carpet cleaning machines sanitizes carpets and floors.

Dust Mites and Fleas. Dust mites and fleas can be controlled by adding special non-toxic, borate-based treatment to floor washing machines or buckets and to steam-cleaning equipment for cleaning carpets and upholstery.

and living environment for staff and inmates. Federal institutions are required to provide non-toxic cleaning protocols (Executive Order #13148, Section 205, http://ceq.hss.doe.gov/nepa/regs/eos/eo13148.html), as are all state institutions in California (http://www.pia.ca.gov/Public_Affairs/pdfs/CALPIA%20Report%20to%20the%20California%20Legislature.pdf).

New, innovative biotechnology has changed the way institutions look at cleaning, which now includes killing and preventing mold, bacteria and viruses using compounds and liquids that are non-toxic to humans. In addition to cleaning, these germicidal, anti-microbial cleaners and surface treatments interfere with the ability of mold, bacteria and viruses to reside and grow. If they cannot colonize and grow, most such organisms die.

Many manufacturers of green cleaning products still recommend "elbow grease," because frequent wiping reduces the growth of mold, bacteria and viruses. Other manufacturers say the most effective antimicrobial surface treatment products remain on surfaces, are continuously active and effective for long periods of time and eliminate any pathogen that comes into contact with treated surfaces. The EPA recommends both.

Using non-toxic cleaning solutions, paints and finishes reduces health risks from phenols, VOCs and toxic chemicals.

Antimicrobial surface treatments are applied via spray or fog to treat hard-to-reach areas that are missed by wiping or mopping, or are inaccessible (behind baseboards, in cracks and crevices, etc.). This mitigates the risk of the spread of infectious diseases by surface contact.

Frequent touch points such as bed rails, telephones, hand rails, elevator buttons, door knobs, light switches, gym equipment and other surfaces where treatment may be mechanically removed will require re-cleaning or reapplication as part of a regular cleaning routine.

Ozonators, chlorination and ultraviolet treatments sanitize water. Antimicrobial laundry solutions can be added to the wash cycles of any commercial or residential washing machine and will mitigate the risk of the spread of infectious diseases by killing organisms that transfer to clothing. Antimicrobial laundry solutions remain on fabrics for up to 50 washes and control odor-causing bacteria from perspiration.

As described above, pest control solutions are easily incorporated into carpet and floor maintenance routines.

New, innovative germicidal, antimicrobial, antiviral, antibacterial disinfectants and surface treatments do not use poisons or harmful chemicals that can lead to the development of resistant strains. These products and techniques eliminate 99.999 percent of microbes, spores and pathogens in minutes, remain on surfaces, are long lasting, provide continuous protection and interfere with the ability of microbes and pathogens to attach to surfaces.

Recycling, Gardens, Farms, Composting and Vermiculture

Considerations with regard to recycling, composting, vermiculture, organic gardens and farms in correctional settings generally involve issues of inmate movement and security regarding tools and equipment (http://www.antiochne.edu/ssj/CompostingCaseStudy.pdf). Planning priorities for such programs can include:

- Gaining buy-in from institutional leadership and prison custody staff including recycling program design, garden design and implementation.
- Determining the goals and objectives of the program (vocational, rehabilitative, waste reduction, revenue generation and so on).
- Performing in-depth security reviews (equipment location, inventory, etc.): Objective classification analysis to project the number of inmates and type of supervision needed to support the necessary inmate participation provides an important tool for matching inmates and program opportunities appropriately (http://www.northpointeinc.com/pdf/michigan_classification_project.pdf).
- Conducting a waste audit in order to have a benchmark for measurable success.
- Developing a recycling and/or composting plan (what can be recycled/composted, how much, by whom, distribution area, and staffing and inmate participation).

- If part of a community service program, conducting research on potential charities to receive donated materials, food, equipment and so on.
- Determining viability of integrating recycling and composting plans with other prison vocational or other rehabilitative equipment, gardening, landscaping and green programs.
- Determining resources needed for the project, including other linkages with community-based organizations that can provide planning expertise, supplies, donated equipment and materials.
- Planning for ongoing maintenance and classes (depends on program goals).
- Determining size and type of recycling/compost containers needed (if onsite). A recycling program can start with labeled or color-coded trash cans in convenient locations. Closed-lid containers for compost will reduce rodent and/or odor problems.
- If recycling or composting offsite or outside the fence, determining how materials and food scraps can be removed and delivered.

REAL WORLD EXAMPLES

Recycling. Counties such as Marion, Ky., and Boulder, Colo., have provided inmate labor and job training through their local recycling centers (http://www.epa.gov/region4/rcra/mgtoolkit/).

In regions that allow it, such as Boulder, fees received from inmate labor at the regional recycling center have been used to cover the costs associated with other programs such as establishing the Boulder County Jail's organic garden, which now provides all the vegetables used by the jail during the growing season.

In Virginia, an innovative partnership with Verizon allowed recycling of used cell phones to support formerly incarcerated women in preventing domestic violence during their transition process back into their communities (http://www.publicsafety.virginia.gov/News/viewRelease.cfm?id=375).

At Putnamville in Indiana, the Department of Corrections has installed water boilers that run on recycled waste wood chips from their pallet recycling operation (http://www.bionomicfuel.com/biomass-boilers-used-in-indiana-prisons/; http://planetsave.com/2008/11/03/eco-carceration-inmates-recycling-reusing-and-rehabbing/). The Putnamville Correctional Facility's recycling program in Indiana recycles nearly 10 tons of cans, bottles, paper, plastic wrappers and other waste material in a month. Sales of recyclables have earned the prison as much as $150,000 in a year. The bicycle recycling program provides more than 700 bicycles to needy children each year, supported by local government impoundment programs and regional bicycle businesses. Correctional officers have led a program to provide formal training and certification of inmate participants in the recycling program in collaboration with the Indiana Department of Labor (http://www.greendiary.com/entry/indiana-prison-takes-green-initiatives-to-save-environment-and-money/).

Many, many more examples of correctional institutions engaged in recycling programs are emerging on a daily basis from nearly every jurisdiction in the country.

Bicycle recycling shop at Putnamville (Ind.) Correctional Facility

Composting and Gardening. Composting in the Cedar Creek Corrections Center, 25 miles from the Washington state capitol, "… reduces cost, reduces our damaging impact on the environment and engages inmates as students (http://www.usatoday.com/news/nation/2008-11-01-3438466893_x.htm)."

Instead of hauling food scraps to landfills, state prisons in Nashville, Tenn., haul more than 13,000 pounds of food scraps to another facility, where they are mixed with wood chips and then spread back onto the prison's gardens. Officials there estimate that the impact of the composting and recycling programs totals approximately a half-million dollars in savings and revenue (http://www.nowpublic.com/environment/nashville-prison-composting-saves-money-and-earth).

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REAL WORLD EXAMPLES *(Continued From pg. 39)*

Various projects exist within the Washington State Department of Corrections (WDOC), including:

- As of 2011, Larch Corrections Center in Yacolt has achieved a 70-percent reduction in their trash bill from composting (www.doc.wa.gov/sustainability/docs/FactSheetLCC.pdf).
- The State Penitentiary in Walla Walla is a regional composting facility that processed 800 tons of food waste in 2006.
- The Olympic Correction Center composts 300 tons of food waste and biosolids annually.

Since the baseline year of 2004, the total amount of waste generated by WDOC institutions has decreased 8.6 percent. The amount of waste has decreased 23 percent. At an average cost of $150 per ton to send solid waste to a landfill, diverting waste to recycling or composting represents significant cost savings or cost avoidance. Yearly savings have ranged from $212,100 to $326,250 since waste reduction programs were initiated in 2004 (http://www.doc.wa.gov/news/stories/2011/071311sustainabilitycosts.asp).

California Institution for Women in Chino features a 7,200-square-foot organic garden funded by outside sources from private foundations (http://www.greenrightnow.com/denver-boulder/2009/05/08/gardens-within-prison-walls-how-to-escape-bad-prison-food/).

At the Mississippi Department of Corrections, a massive food production system generated cash revenues of $3 million whereas expenditures were about $3.1 million, almost net zero expenses in food service. The project employed 374 inmates for 774,000 work hours. Twenty-three different varieties of vegetables, corn, soybeans, wheat, rice, 7,300 hogs, 36,000 chickens and fruit were grown for inmate consumption, livestock feed and outside sale (http://www.mdoc.state.ms.us/agricultural_enterprises.htm).

Brown Creek Correctional Institution's materials flow program in North Carolina includes the following (http://www.bae.ncsu.edu/topic/vermicomposting/vermiculture/worm-prison.html):

- Switched from half-pint milk cartons to a bladder dispenser system.
- Switched from buying processed eggs in cartons to using real eggs and composting the shells.
- Switched from purchasing cleaning detergents in five-gallon containers to 55-gallon drums, which are then reused on prison farms.
- Changed from paper hand towels to electric hand dryers.
- Eliminated take-out polystyrene trays.

The Greenhouse Project on New York's Rikers Island has seen tremendous success (and inspired a book, *Doing Time in the Garden*), while in Wisconsin, 28 adult correctional institutions started onsite gardening projects in 2008. Each Wisconsin facility is producing thousands of pounds of vegetables per year, the highest yield being 75,000 pounds of produce, a quarter of which is donated to local food banks (http://www.slowfoodusa.org/index.php/slow_food/blogpost/beyond_the_corniness_of_prison_gardens/).

The Lettuce Grow Garden Foundation in Oregon is building organic vegetable gardens in six prisons with classes for inmates and has developed linkages with the local university's gardening program. Their dedicated garden areas will donate to food banks as well as supply food to the prison kitchens' gardens. They are also initiating a study of recycling programs in prisons.

At San Quentin State Prison in California, the community-based Insight Garden Program offers vocational skills training to inmates on a 1,200-square-foot organic flower garden on an open prison yard. Their curriculum includes cognitive and behavioral change processes, education on sustainability issues and green jobs, and links with organizations with landscaping, gardening and green jobs that can be filled by former inmates on release.

- Determining safety and movement issues if inmates participate in sorting, processing, composting of food scraps (which should not include meat, dairy or citrus) or programs that include classes or hands-on work.
- Using onsite maintenance crews to transport recyclables, or landscaping and gardening crews to distribute compost at regular intervals on institutional gardens and grounds.
- Monitoring current waste, materials and food usage to measure against later output.
- Proper storage of recyclables, and mixing and monitoring of compost, to reduce odors from anaerobic processes.
- Determining whether to grow vegetables in the ground or in raised beds on asphalt, based on soil toxicity.

- Selecting the proper materials for recycling. Bottles, cans, paper, cardboard, pallets, plastics, bicycles and food wastes are standard, but some e-waste recycling programs have encountered difficulties with toxics (http://www.yourlawyer.com/topics/overview/Unicor-Federal-Prison-Toxic-Electronic-Waste-Recycling).

Future Trends

The cost-saving and health-improving features of enhanced, green materials management will continue to improve in the future. Recycling, composting, gardens and farms continue to improve their contributions to correctional institutions. In addition, reducing toxics and providing safer, healthier working and living conditions within institutions will continue to reduce the risk of lawsuits and insurance claims. Although this latter aspect — lawsuits and insurance claims — has not yet become a problem for many institutions, the "tail" on such liability is long. The illnesses associated with the materials released from buildings after 9/11 did not manifest for a decade. Toxic mold and other pathogens are the subject of numerous alerts from the Centers for Disease Control and Prevention. Although their associated liabilities are often not recognized immediately, such lawsuits are becoming more popular and may become more prominent as more claims result from employees and residents (http://www.moldnews.org/mold_in%20_the_news.htm, http://toxic-torts.lawyers.com/mold-litigation/Toxic-Mold-Lawsuits.html).

Resources

- Washington State DOC Sustainability Programs
  http://www.doc.wa.gov/sustainability/links.asp
  http://www.doc.wa.gov/sustainability/docs/2009SustainabilityReport.pdf

Recycling

- Washington State DOC recycling programs
  http://www.doc.wa.gov/search/results.asp?search=recycling&x=0&y=0

- EPA
  http://www.epa.gov/osw/conserve/rrr/recycle.htm
  http://www.epa.gov/osw/partnerships/wastewise/pubs/howtopdf.pdf

- Electronic waste recycling programs
  http://www.justice.gov/oig/reports/BOP/o1010.pdf

- NIC study on greening prisons
  http://nicic.gov/Library/024914

- Gardening, composting, vermiculture, apiculture, and horticulture
  http://insightgardenprogram.org
  http://gardenproject.org
  http://lettucegrow.org
  http://plantingjustice.org
  http://www.doc.state.nc.us/NEWS/1998/9811news/index.htm

Sanitation

- Committee to Reduce Infection Deaths
  http://www.hospitalinfection.org

- Consumers Union
  http://www.stophospitalinfections.org/learn.html

- HHS Action Plan to Prevent Healthcare-Associated Infections
  http://www.hhs.gov/ophs/initiatives/hai/infection.html

- Centers for Disease Control and Prevention
  http://www.cdc.gov/ncidod/dhqp/healthdis.html
  http://www.cdc.gov/niosh/topics/mrsa/

- Ozonated laundry systems
  http://www.p2sustainabilitylibrary.mil/P2_Opportunity_Handbook/2_II_9.html

Less Toxic Paints and Finishes

- EPA
  http://www.epa.gov/epp/pubs/case/paint.pdf

- California
  http://www.green.ca.gov/EPP/building/paint.htm

- GreenSeal
  http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=StandardCategory&cid=13

Conclusion

Recycling, composting, gardening and using less toxic cleaning and finishing products can reduce waste, save

money, provide services to surrounding communities and transfer valuable job and entrepreneurial skills to inmates.

Many traditional practices to mitigate the risk of toxicity and the spread of infectious diseases are not working, and in fact may be contributing to the problem of toxicity and infection in correctional institutions (https://litigation-essentials.lexisnexis.com/webcd/app?action=DocumentDisplay&crawlid=1&doctype=cite&docid=20+Fordham+Urb.+L.J.+467&srctype=smi&srcid=3B15&key=2d3e3457c3ded726eb52b17c43818bb2). This has led to the development of toxic conditions and superbugs in institutions as well among the general public. The costs associated with the treatment of toxic conditions and infectious diseases are mounting.

New green methodologies, protocols and products can be implemented to increase success in mitigating the risk of toxicity and the spread of infectious diseases. When implemented properly, there will be significant, substantial savings to the institution or program related to medical costs for treatment and employee absenteeism. Improvement of environmental health will increase the health of inmates and employees and increase the comfort of all those who are obligated to spend time in correctional institutions.

CHAPTER 6
WATER

Background

Water costs vary widely across correctional institutions. Older and more rural institutions may have "free" water from wells, for which the only costs are pumping and disposal. Urban and recently constructed institutions may pay high costs for water based on utility charges per thousand gallons or per acre foot. In all instances, the hidden costs of pumping and treatment add to the cost of using water, regardless of whether or not the facility pays for the water itself.

Maximizing water efficiency not only helps to conserve natural resources, it can also result in significant cost savings over the life of any building. Even within the first several years in the life of a building, water efficiency strategies are among the shortest payback periods of any green design feature.

In the arid West, water efficiency can be implemented cost effectively. And in wetter climates, such as Washington State, excess rainwater can also be managed cost-effectively through such technologies as rain barrels, swales and porous pavement in parking areas.

As an illustrative example, Appendix 2 describes the pros and cons of waterless urinals in great detail. Other water-saving opportunities are described in lesser detail in this section.

Existing Technology Review

Low-flow Toilets, Shower Heads and Other Low-flow Technologies

Most plumbing suppliers can provide a wide range of low-flow shower heads, toilets, urinals, dishwashers, lawn sprinklers, drip-irrigation systems and other water-use technologies. Cost savings from water efficiency measures can be dramatic.

Capturing Rainwater in Barrels and Cisterns

Collecting water, especially in dryer climates, provides extra water for landscape and other non-potable uses.

Rain Gardens and Soft Curbs

In areas where storm water runoff is a problem, rain gardens and swales, which cleanse and slow run-off water and encourage filtration, provide aesthetic and useful ways to recharge groundwater (http://www.mass.gov/dcr/watersupply/ipswichriver/definitions.htm). Soft curbs that offer gradual transitions between streets, gutters, walkways and vehicle traffic areas increase safety and assist with runoff management.

Green Roofs

The 7,500-square-foot green roof at Onondaga County Correctional Facility in Jamesville, N.Y., provides storm water runoff control. Green roofs can also provide additional HVAC benefits for the buildings on which they sit. Although the green roof at the Cold Climate Housing Center, in Fairbanks, Alaska, only provides greenery for a few months each year, it provides important insulation the rest of the year (http://www.cchrc.org/green-roof).

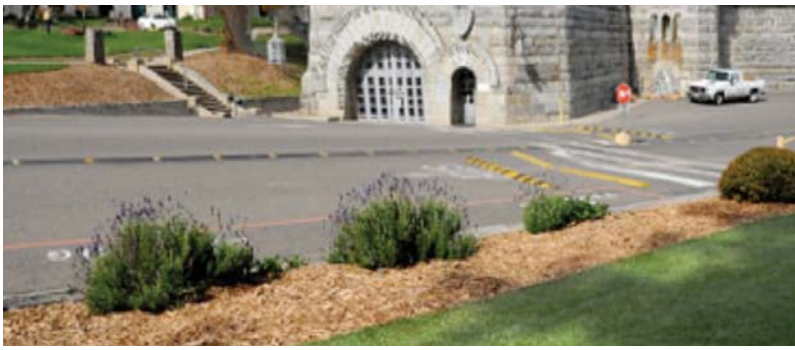
Green Roof at Onondaga County (N.Y.) Correctional Facility

Links Between Water and Energy Use

All built environments must treat, pump and dispose of water. Almost all water use carries hidden energy uses as well. In California, for example, 30 percent of all electricity used in the state is used for pumping water. Using water more efficiently reduces the cost of energy, especially if pumping and treatment facilities are onsite (http://www.epa.gov/region9/waterinfrastructure/municipalities.html).

Managing Runoff

Naturally, most storm water soaks into the ground, especially in forested areas. However, in built-up areas, this natural groundwater percolation has been replaced by storm water runoff technologies. Many jurisdictions are now mandating that storm water runoff be redirected into spreading basins (such as rain gardens and swales, described above) to allow for recharge of groundwater.



Low-water landscape at Folsom (Calif.) State Prison

Considerations and Implementation Issues

Problems with low-flow water technologies often emerge around the volume of water required to provide proper flushing or draining of a system, not only within the plumbing of a particular building area, but also in a municipal system.

Colorado Department of Corrections has looked at the possibility of enhanced algal systems to reduce pumped air into lagoon systems, but these aren't cost-effective yet because of the amount of staff time needed to maintain the systems. The systems require 24/7 attendance and offenders are not authorized to be outside custody in non-daylight hours. Colorado hasn't had much success with water conservation. Low-flow showers, low-flow toilets and waterless urinals all were not well-received. Other difficulties with waterless urinals are discussed in Appendix 2.

Even in institutions that do not pay for water, the costs of pumping and treating water add up. Wastewater from institutions is often subject to the same regulations as normal residential wastewater, even though it can provide a very different profile, requiring different kinds of treatment. For example, offenders in cells often dispose of other products into the waste system.

Traditionally wet areas such as the southeastern United States have experienced periodic droughts, which make water-efficiency investments monetarily feasible.

When considering green roofs, security concerns such as safety, access and supervision during construction and maintenance must be addressed appropriately.

Future Trends

Water technologies have been researched and developed by human cultures for thousands of years. Thus, there are not many new technologies on the horizon.

REAL WORLD EXAMPLES

In Georgia, Reidsville State Prison's water efficiency programs have increased efficiency by 57 percent, saving 25 million gallons per year. Officials estimate another 35 million gallons could be saved, representing total cost savings of more than $300,000 per year (http://www.gasustainability.org/sites/uploads/sustain/pdf/spring2003.pdf).

In Colorado, an engineered wetland at one facility provides mitigation of seasonal algae blooms near Delta Correctional Center. Rifle Correctional Facility supports a hay crop using biosolids that have caused the hay to overgrow. If the facility grows too much hay too fast, it may have to supplement this method of disposing of biosolids with a traditional wastewater treatment facility. Some institutions use tertiary lagoon systems and CDOC maintains two types of wastewater treatment plants, oxidation ditch and mechanical treatment.

The city of Arcata, Calif., treats all its municipal sewage in a sewage treatment marsh, which is also a public wildlife sanctuary (http://www.humboldt.edu/arcatamarsh/). A scenic wetland provides sewage treatment for the Adam Lewis Center at Oberlin College (http://new.oberlin.edu/arts-and-sciences/facilities/detail.dot?id=305168&buildingId=30236).

The Women's Garden Project at Evergreen Corrections Center, in British Columbia, Canada, includes rain barrels and a swale to increase the efficiency of water use (http://www.corrections.com/performa/?p=155).

Most of the emerging technologies have to do with the links between using water more efficiently and saving the energy associated with pumping and treating water — more efficient pumps, biogas collection and distribution systems, and various recycling and water re-use technologies. Another related overlap is the wastewater treatment improvements that result from composting food scraps instead of using a sink-installed garbage disposal. The resulting reduction in suspended solids can reduce sewage treatment costs, sometimes dramatically, if the reductions defer capital improvements to wastewater plants.

As potable water continues to become scarcer and in greater demand, the cost of water will continue to rise. Even for those few remaining jurisdictions with free water, the energy costs associated with pumping and treating water will continue to increase the cost of using water. Therefore, the future need to, and benefits associated with, investing in water-efficiency measures will continue to increase as well.

Resources

- EPA water efficiency websites
  http://www.epa.gov/owm/water-efficiency/product_search.html
  http://www.epa.gov/WaterSense/

Water Conservation Organizations

- Water Conserve
  http://www.waterconserve.org/links/Organizations/Government/welcome.asp

- American Water Works Association
  http://www.awwa.org/Resources/PartnershipMain.cfm?ItemNumber=51227&navItemNumber=51231

- National Association of Conservation Districts
  http://www.nacdnet.org/policy/environment/water/quality/

- Corrections examples
  http://www.sloanvalve.com/Project_Portfolio/Corcoran_Prison.aspx

  http://www.correctionalnews.com/articles/2009/12/9/pipe-down

- Drainage, swales, rain barrels, and rain gardens
  http://www.epa.gov/greeningepa/stormwater/best_practices.htm

In addition to the links shown above, most local water utility districts offer significant resources for assisting institutions in promoting water efficiency.

Conclusion

Using water efficiently saves money and reduces the costs of energy and labor associated with pumping, distributing and treating water, both for sanitation and wastewater treatment. Institutions that invest in water efficiency measures continue to find benefit and savings when the investment is made prudently, with proper planning and verification of the technologies involved.

CHAPTER 7
ENERGY
(Including Transportation)

Background

Many states have been exploring ways to reduce energy costs and provide secure, reliable energy since the first Arab oil embargo caused nationwide energy shortages in 1973. This situation created a need not only to identify new sources of energy, but also to become more efficient in the use of energy. Money saved from increased efficiency can be invested in alternative sources of local energy.

As a historical example, CDOC implemented a program to manage utility costs in the 1990s, funding one employee to implement a program that became self-supporting. CDOC saved enough money by managing utilities to fund the position beginning in 1997. Like many other states, Colorado's program started with no records, no database and no plan: nothing but a dedicated employee. There was merely a footnote authorization to a long bill in the state legislature. The energy program was required to provide a report to the state Joint Budget Committee each year, which in turn required CDOC to create a database. This led to development of a process whereby invoices were transmitted to the facilities manager, who could record data, authorize payment, dispute invoices and so on. Procurement efficiencies, such as purchasing market-rate natural gas as another way to reduce costs, came next. Headnotes and related footnotes for institutions to provide guidelines to manage utilities indicated legislative intent; public agencies must follow legislative intent. That is, if the legislature gives language that says, "Using energy more efficiently and generating it from renewable sources is required," then a manager in a facility can put efforts toward that.

Even without such a legislative mandate, managing energy use wisely saves money. Institutions need a funding source to justify many efficiency improvements, and one of Colorado's important lessons learned was that managing utilities saves money. A utilities program can fund itself unless there is a need for a large capital expense, such as a solar farm or wind generation, that would require outside capital, often from a third party. If a utility savings program can eliminate $2 million per year in wasted energy costs, this "cost avoidance" can authorize additional expenditures to gain similar benefits.

Providing affordable energy from local and renewable sources increases independence and security, and keeping the money that is saved is important, especially in these days of shortfalls and tight budgets. Without a plan that ensures savings will be reinvested in additional efficiency programs, administrators may simply appropriate the savings for other uses. Many people in government have expressed frustration around budget issues, since everything seems to be underfunded and it is difficult to make ends meet. With shortfalls, administrators might be more motivated to manage costs, but other problems tend to dominate the conversation, and other urgent needs are easily identified for money saved from resource efficiency programs. However, working with third-party partners can provide additional funding for renewable energy sources.

Existing Technology Review

Correctional institutions from New York to California are adding renewable energy facilities at a breakneck pace. Technologies such as solar, wind, biomass and geothermal are providing cost-effective, clean, renewable electricity and heat to a wide variety of institutions (http://www.azocleantech.com/Details.asp?newsID=2392, http://tinygreenbubble.com/eco/environmental/item/414-wind-power-in-prisons-texas-is-leading-the-way, http://www.insideprison.com/indiana-state-prison.asp, http://www.alternative-energy-news.info/renewable-energy-prison-nevada/).

Solar, Wind and Geothermal Electricity

For these technologies, the primary concerns are financial and site-specific suitability. Financial options are included in Appendix 1. Site-specific feasibility assessments can be provided as part of a comprehensive energy audit.

Solar Energy

Solar energy uses the sun's rays to generate heat (solar thermal) or electricity (photovoltaic or concentrating solar thermal). Solar thermal can be used to heat water or buildings, via solar panels or direct heat gain. Dark-colored surfaces absorb solar heat. Lighter-colored or reflective surfaces reflect solar heat. Solar photovoltaic cells arranged into panels create electricity from the sun's light rays. Parabolic-shaped mirrors can also be used to concentrate the sun's heat onto pipes carrying mineral oil or other conductive liquids, which can then heat water to create steam to turn turbines that generate electricity.

Wind Energy

The force of wind has been used to turn windmills to pump water for centuries. Windmills simply create shaft power, which can be used for many purposes, most commonly pumping water or turning turbines to generate electricity. Early windmills used to generate electricity were inefficient. They turned fast and caused some problems, such as killing birds and bats that flew into them by accident. More modern turbines are much larger, turn more slowly and do not have these same problems. The towers that hold commercial-scale wind turbines are hundreds of yards high, with huge blades more than 100 yards long turning very slowly but with tremendous torque that is used to generate electricity. With government incentives, the cost of wind-generated electricity in good sites is often the same as or less than the current cost of electricity.

Geothermal Electricity

In some locations the heat of the earth's crust is close enough to the surface that it can be captured to create steam to turn turbines to generate electricity. In other locations, the difference in temperature in pipes sunk into the ground between surface and relatively shallow depths can be used to move liquid through pipes in ways such that the flow can turn shafts to power generators that create electricity. As with wind, in areas with good government incentives, the cost of geothermal electricity can be the same as or less than the current cost of utility-grid electricity.

Geothermal Heat Pumps

Warner Creek Correctional Facility in Oregon warms its water with geothermal heat (http://www.oregon.gov/DOC/OPS/PRISON/wccf.shtml). As with other renewable technologies, the applicability of geothermal heat pumps depends on the site conditions and government incentives. A high water table is more useful than solid rock. Initial feasibility can be determined by a comprehensive energy audit.

Passive Cooling Systems

The simplest and most cost-effective passive cooling systems are materials such as trees and thick stone or earth walls. If line of sight can be protected, deciduous trees can reduce the cost of heating and cooling buildings. More complex systems involve thermal mass and convection-based circulation systems. Initial feasibility can be determined by a comprehensive energy audit.

Efficient Vehicles

Many jurisdictions mandate purchase of efficient vehicles for new acquisitions and conversion for older vehicles to natural gas, biogas or diesel. Any diesel engine will run on biodiesel with a very few minor adjustments to prevent corrosion and ensure compatibility.

Biofuels Technologies

Cellulosic ethanol shows great promise as fuel (as do other forms of alcohol), provided sufficient feedstocks can be obtained from non-food agricultural, forest or waste sources.

Proper Tire Inflation

Inflating tires to the maximum tire pressure, rather than the minimum, can increase fuel mileage by five to 10 percent (http://tires.lifetips.com/cat/63618/tires-and-fuel-efficiency/index.html).

Low-rolling Resistance Tires

Tire treads were designed for traction. However, many tread designs impact the road in ways that create resistance to the smooth rolling of the vehicle. Much of the noise of cars, trucks and buses passing by comes from their tires. Installing properly designed, low-rolling resistance tires can increase fuel mileage by 10 to 15 percent.

Alternative Fuels

Alternative fuels such as hydrogen are not yet cost-effective.

Employee and Inmate Transit

One of the quickest ways to save money is to install video conferencing facilities. GPS and other route and speed management technology can improve fuel efficiency for fleet vehicles (http://www.smartplanet.com/business/blog/business-brains/ups-steers-toward-new-us-fuel-efficiency-destination/8820/).

Costs/Benefits

Energy-efficiency technologies generally pay for themselves from savings. Depending on the technology, some approaches require capital financing as described in Appendix 1. However, even those projects that require large, upfront capital investments tend to produce significant return on investment in the range of 10 to 70 percent or more over their lifetime.

Considerations and Implementation Issues

Large correctional institutions often only have one master meter at the large campus, making it difficult to calculate savings possibilities or existing use. Demonstrating savings and obtaining funding for upfront costs are prerequisites for larger-scale energy projects. With more revenue meters, the data could perhaps be used to calculate savings to install more energy-efficient generation systems. The upfront cost of installing solar is prohibitive without outside financing. Institutions can't spend capital on renewable energy systems such as solar or wind turbine arrays when capital dollars are limited and prioritized for safety and other concerns. Also, institutions can't compromise reliability or security. The first priority is always security, then reliability, which must be satisfied before evaluating costs. Funding usually requires a third-party performance contract or a capital reserve fund. Grants have been problematic due to strings attached, such as offenders not being paid prevailing wage being perceived as either illegal or viewed as unfair competition with licensed businesses.

And if, as in Colorado, utility cost avoidance program savings are looked at as discretionary funds, it can be a problem for the program when the savings are diverted to other uses.

It is optimal if a program can have a fund to roll the value of energy savings into at the end of the year to be carried forward to future years. It can be difficult to spend every penny on an annual basis, while accumulating savings over several years allows for more effective use of budget resources. A fund to roll savings over year to year and build savings to fund larger projects can benefit taxpayers and institutions.

If a self-sustaining program tracks efficiency measures; has the cooperation of the institution; works on projects to implement lighting, HVAC, roofing, filters or other maintenance projects; and gives the facility 100 percent of the benefits to manage in any way that meets legislative intent, then it can achieve greater benefit.

Future Trends

CDOC is investigating garbage incineration, anaerobic digestion, woody biomass and manure gasification to generate steam heat. If the dollars work, CDOC will move forward, but it is a long-term process.

Additional emerging energy technologies include crystalline and thin film solar photovoltaics; small-scale wind turbines; small-scale hydroelectric generation (where available); various batteries, capacitors, compressed air and flywheels; and other technologies for storing intermittent energy from renewable sources.

Combining small-scale solar and wind with battery storage may soon become cost-effective, particularly for exterior lighting.

Fuel cells continue to hover on the horizon of affordability, especially using hydrogen, natural gas or biogas as a fuel, but it has proven difficult to provide fuel for

REAL WORLD EXAMPLES

Montana Department of Corrections. In 2007, the governor of Montana set a state mandate for a 20-percent energy reduction by 2010 (http://www.epa.gov/statelocalclimate/state/state-examples/case-studies.html#mt), and the Montana DOC made it to 18 percent, according to John Daugherty, Montana Department of Corrections. Other states have also mandated energy efficiency, the most aggressive of which is Alaska, where 2010 legislation mandated that Alaska obtain 50 percent of its energy from renewable sources by 2025 (http://www.akenergyauthority.org/railbeltlargehydro.html).

Among their many technology strategies, Montana DOC installed video conferencing in parole and probation, central and all other institutions, which, according to Montana DOC staff, is better than conference calling because it allows people to see each other's faces, display whiteboard notes, see gestures and so on. Montana DOC uses conference calling units over a State T1 network using HD512 protocol, converged so that video runs on a proprietary data network. Administrators monitor the system closely and prioritize video signals over data. Despite this prioritization, Montana DOC has had no issues with data. Montana's courts use video for some court appearances, and Montana DOC uses video conferencing for many parole hearings, which has reduced offender transport, lead and chase vehicles, and related staff time. Doing court appearances by video also saves energy, staff time and security risks. Montana DOC has contracted with colleges to do online learning for college-level courses. Offering the courses online saves energy and also travel time, expense and carbon emissions for teachers. Montana DOC also uses video conferencing for youth corrections, which saves energy and time for families of youth who come to the local parole office and link to youth in institutions via video. And Montana DOC also conducts psychiatric consultations with youth via video. This in turn saves staff time for psychiatrists as a result of reduced transport, energy use and mileage while also reducing carbon emissions.

Colorado Department of Corrections. Installation of solar photovoltaic electricity generation projects at Colorado's correctional institutions has been a big success with savings at small, 100 kW installations producing enough electricity to power eight to 12 homes at a cost of $.068 per kWh. The projects are developer based; CDOC has no ownership. The site for a solar installation is made available to the vendor who negotiates terms with the local qualified utility. CDOC is not bound by the agreements but does enter into a multi-year "Power Purchase Agreement" with the electricity provider. CDOC opted after the contract period to purchase the system at a pre-negotiated price.

The solar facilities are usually out of the way — outside the fence — so there are no security issues. CDOC now has solar installations at San Carlos Correctional Facility, Colorado Health Institute at Pueblo, Arkansas Valley Correctional Facility, Crowley (Ordway) and the Old Colorado Territorial Correctional Facility in Canyon City. A fourth installation will be added at East Cañon City Prison Complex (4,600 acres, holding eight institutions). In Colorado, qualified retail utilities only have to provide standard rebate programs up to 500 kW. Everything else is competitively bid, although it may not be an objective bidding process because CDOC has submitted some "nothing more than cost" bids that still have not been chosen.

CDOC also participates in the regional utility's Demand Side Management (DSM) program, which helps with calculating savings that can be applied to additional purchases of more energy-efficient technologies. This participation is atypical and is due to an internal policy at occupancy level that requires 100-percent emergency backup power. Because of the economics of first costs, this is diesel with a closed-transmission switching operation allowing equipment to be brought online with no power interruption (even for computers). Colorado's DSM has included dispatch through a utility support company, which calls institutions to go off grid and onto diesel generation. Dispatching is done on a very limited basis due to cost (prices are proprietary). Equipment failures and other factors impact costs in the availability of standby power, so the institutions get paid by the support company to do essentially maintenance-level standby runs whenever the need arises. This often occurs more frequently than usual quarterly maintenance. Capacity and maintenance agreements allow for dispatch and maintenance without spending money to run the system for maintenance, since the dispatch provides the maintenance runs. This provides peak generation to the grid, which might otherwise be filled by the dirtiest, oldest institutions.

New Jersey. New Jersey's Fairton Federal Correctional Institution recently installed solar panels manufactured by inmates at the Federal Correctional Institution in Otisville, N.Y. (http://www.nj.com/business/index.ssf/2010/07/cumberland_county_federal_pris.html). The Federal Correctional Complex at Petersburg has also received solar panels and a geothermal heat pump system (http://www.energyboom.com/solar/fairton-and-petersburg-federal-prisons-go-green)/.

California. California's Ironwood and Chuckawalla Valley State Prisons have also installed successful, large solar projects (http://www.azocleantech.com/Details.asp?newsID=2392)

the fuel cell without increasing the cost to the point that it would be more effective to use other sources.

Some jurisdictions are also experimenting with proposals to build small-scale (30MW or smaller) "micro-nuke" nuclear power plants that could provide electricity to a building or complex. However, the cost, safety and security issues surrounding these proposals continue to keep them on the distant horizon, and they are probably not appropriate for correctional institutions.

Security, cost and other factors dictate that the future holds renewable, distributed energy generation for electricity, heat, cooling and other energy needs. Institutions' energy and security needs will be best served in the medium and longer terms by planning for a carefully orchestrated, affordable transition to distributed, small-scale, renewable energy generation.

Resources

- American Solar Energy Society
  http://www.ases.org/index.php?option=com_content&view=article&id=882&Itemid=2

- Solar Energy Industry Association
  http://www.seia.org/cs/solar_technology_and_products

- Wind Energy Industry Association
  http://www.windustry.org/your-wind-project/wind-energy-companies/wind-energy-companies

- American Wind Energy Association
  http://www.awea.org/learnabout/smallwind/equipment_providers.cfm

- Geothermal Energy Association
  http://www.geo-energy.org/

- Video conferencing
  http://web-conferencing-association.com/webconferencing/zeropanel.php?base=red&left=70light30dark.php&content1=marketing/video_conferencing_software.php&title0=Video%20Conferencing%20Software&titlepic=2&title1=WHAT%20YOU%20MUST%20KNOW

Conclusion

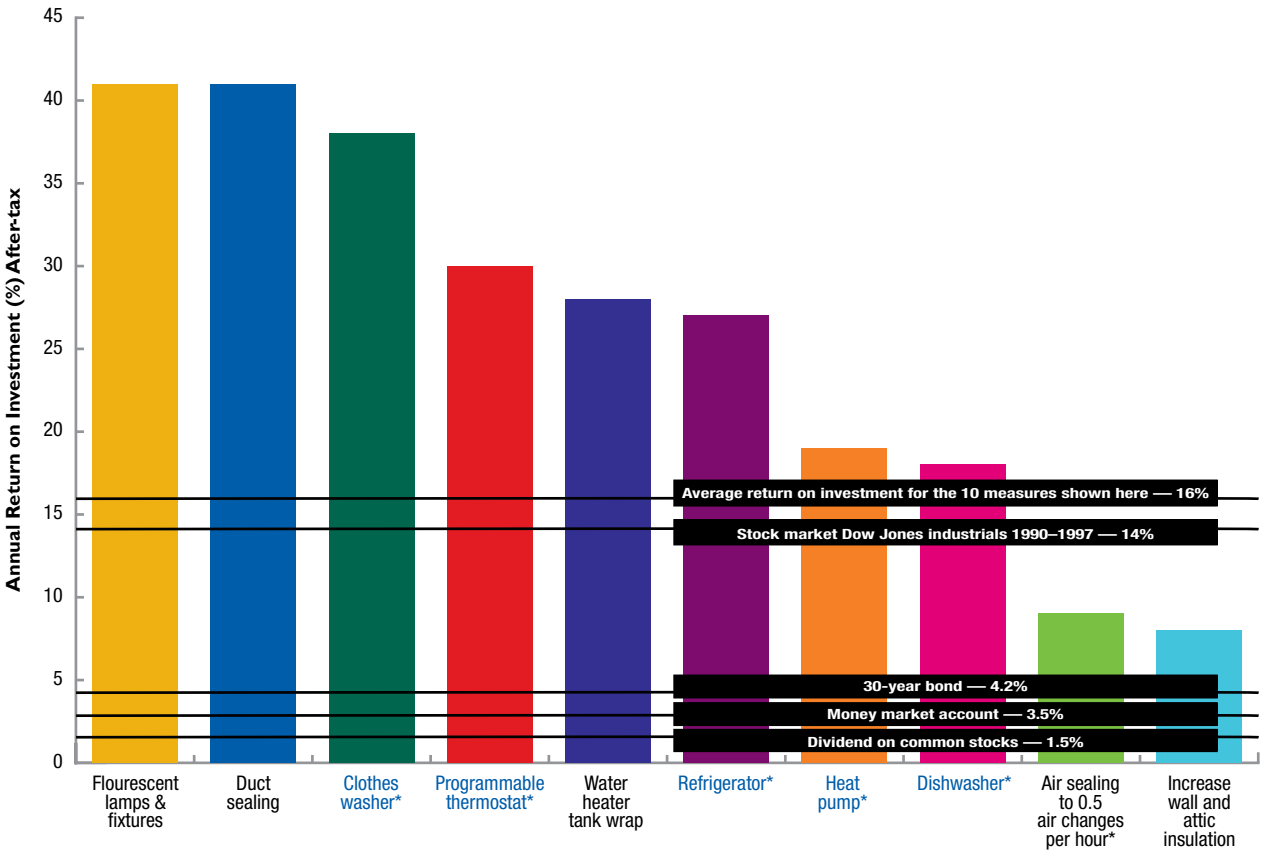
Energy systems are complex but necessary. From the simple "passive" systems of storing or reflecting heat from the sun to the elaborate, hybrid cogeneration and biogas conversion systems coming into use with innovative financing programs, the field of providing energy to correctional systems will remain a wide open opportunity for saving money while increasing the security, stability and public safety of America's correctional institutions for the foreseeable future.

Due to the many emerging finance opportunities and arrangements, correctional institutions will continue to have significant possibilities to use creative strategies to save money and time while increasing security and safety related to the ways that energy is used to meet facility needs.

APPENDIX I
FINANCING MECHANISMS

This section on financial strategies includes information on ESCOs, loan financing and utility financing.

The Lawrence Berkeley National Laboratory has prepared a very useful comparison of the return on investment from various technologies. As can be seen from the chart below and the table following, investing in energy efficiency provides an excellent rate of return in almost every instance (http://hes.lbl.gov/consumer/profitable).



*Energy Star appliances

Energy Efficiency Upgrade	Purchase Price[1] (US$)	Annual Bill Savings[2] (US$)	Simple Payback (yrs)	Rate of Return (%)
Fluorescent lamps & fixtures	200	80	2.5	41
Duct sealing	250	95	2.6	41
ENERGY STAR clothes washer	194	66	2.9	37
ENERGY STAR programmable thermostat	107	29	3.7	30
Water heater tank wrap (R-12)	85	23	3.7	28
ENERGY STAR refrigerator	97	23	4.2	27
ENERGY STAR heat pump	692	126	5.5	19
ENERGY STAR dishwasher	29	5	5.5	18
Air sealing to 0.5 air changes per hour	522	38	13.7	9
Increase wall and attic insulation	1,784	111	16.1	8
Total	3,960	597	6.6	16
Total bill savings as % of baseline bill		36%		

Financing Strategies

On-Bill Financing

The simplest way to finance electricity, natural gas, water and materials use improvements is through financing from a utility or service provider that is repaid by applying savings on utility bills. Many utilities offer variations of these programs, and some states, such as Vermont and Oregon, sponsor "efficiency utilities" to provide efficiency improvements as a separate utility.

Energy Service Companies

An ESCO offers energy services and assists with financing for institutions and businesses within the public, commercial and industrial sectors. Funding supports site assessments, energy-efficiency and renewable-energy project installations, maintenance-energy management and building control (Musser, Phil. 2003. *Utility-Affiliated ESCOs: Is the Honeymoon Over?*. http://tdworld.com/business/power_utilityaffiliated_escos_honeymoon/). Contractual agreements range from seven to 20 years, where the institution pays the ESCO back with savings earned from improved energy performance. These contracts are sometimes known as performance contracts, pay-for-performance contracts (PPCs) or power purchase agreements (PPAs). Examples of costs and benefits from ESCOs are shown in the table below.

Many state energy offices offer lists of ESCOs operating within their states (http://rechargecolorado.com/index.php/commercial_and_public/public_buildings/performance_contracting/pre-approved_escos). The Energy Services Coalition is a national, nonprofit association of energy experts focused on pay-for-performance contracting (http://www.energyservicescoalition.org).

The Michigan Department of Corrections realized an annual savings of $495,916 from a seven-year performance contract at their Muskegon and Marquette prisons negotiated with an ESCO (http://www.michigan.gov/documents/State_of_MI_Correctional_Facility_Case_Study_01-0026_121538_7.pdf), and the HVAC and CHP improvements at Massachusetts' Bridgewater Correctional Complex that will save more than $27 million were also made possible by working with an ESCO (http://archive.constantcontact.com/fs028/1101869578131/archive/1102921588491.html#LETTER.BLOCK9).

CDOC has completed multiple solar installations funded entirely through a third-party provider, energy performance contracts and PPAs (http://www.free-press-release.com/news-main-street-power-starts-construction-of-solar-systems-at-denver-public-schools-city-and-county-of-denver-colorado-department-of-corrections-and-pue-1283313373.html).

It is important to note that ESCO programs typically improve efficiency by only around 10 to 15 percent when they could increase efficiency by up to 75 percent. The 10 to 15 percent reduction in energy usage that ESCOs typically invest in provides the quickest and highest-margin return on investment (ROI). Thus, ESCOs are often accused of "cream skimming," while

EXAMPLE COST AND BENEFITS FOR INSTITUTIONAL ESCO PROJECTS

Market Segment	#	Total project costs (10^6 US$)	7 discount rate					10% discount rate				
			Direct economic benefits (10^6 US$)		Benefit/cost ratio			Direct economic benefits (10^6 US$)		Benefit/cost ratio		
			Gross	Net	25 Val	Median	75 Val	Gross	Net	25 Val	Median	75 Val
K-12 schools	289	714	803	88	0.7	1.0	1.7	633	-81	0.5	0.8	1.3
State/local gov't	159	276	581	305	1.0	1.7	3.0	471	195	0.9	1.4	2.4
Univ./colleges	100	301	809	508	1.2	1.7	3.1	637	336	0.9	1.4	2.4
Federal gov't	58	153	280	126	0.9	1.7	3.2	225	72	0.8	1.4	2.6
Health/hospital	134	136	365	229	1.6	2.3	3.8	295	159	1.3	1.9	3.3
Public housing	31	96	140	45	0.7	1.5	1.8	114	18	0.6	1.2	1.4
Institutional sector	771	1,677	2,978	1,301	0.9	1.6	2.5	2,375	698	0.7	1.3	2.0

Source: Goldman, Charles, Nicole Hopper, Julie Osborn and LBNL. January 2005. *Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data.* http://eetd.lbl.gov/EA/EMP/reports/52320.pdf. Accessed Nov. 8, 2010).

EXAMPLE COSTS AND BENEFITS FOR PRIVATE SECTOR ESCO PROJECTS

Market Segment	#	Total project costs (10^6 US$)	10% discount rate					15% discount rate				
			Direct economic benefits (10^6 US$)		Benefit/cost ratio			Direct economic benefits (10^6 US$)		Benefit/cost ratio		
			Gross	Net	25 Val	Median	75 Val	Gross	Net	25 Val	Median	75 Val
Commercial	192	137	349	212	1.7	2.2	3.7	265	128	1.3	1.7	2.8
Industrial	76	95	181	86	1.3	1.8	2.7	136	41	1.0	1.4	2.2
Other	41	28	47	18	0.8	1.8	2.7	34	6.3	0.7	1.3	2.0
Private sector	309	260	576	317	1.4	2.1	3.2	435	176	1.1	1.6	2.6

[a] Includes hotels/hospitality, retail space and commercial offices.
[b] Includes residential and projects classified as "other" by ESCO.
Source: Goldman, Charles, Nicole Hopper, Julie Osborn and LBNL. January 2005. *Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data.* http://eetd.lbl.gov/EA/EMP/reports/52320.pdf. Accessed Nov. 8, 2010.

neglecting more comprehensive, less lucrative improvements. Consequently, it is possible to require ESCOs to make improvements that cut closer to 75 percent in order to provide maximum benefit to the institutions, not just profit for the ESCO. By cutting closer to 75 percent, it is possible to balance the improvements that provide a large ROI, like lighting, insulation and replacing boilers near the end of their useful life, with those that may have a longer payback such as new windows, renewable energy technologies or upgraded wastewater treatment.

Siemens, a large energy service company, performed a large performance contract for Eastern Kentucky University to help the school meet its goal of a 40-percent increase in energy efficiency. Rather than get taxpayers to fund energy improvements, Siemens provided the university with a loan, and the university paid Siemens back from the savings incurred. At no time will the university's monthly payments exceed current payments. According to associate vice president for Capital Planning and Facilities Services for the University, James Street, "We have seen very tangible results and have had a great deal of success with this project." As

Mr. Street further explains, "…the guaranteed energy savings performance project focuses on upgrades and retrofits to energy-intensive building systems across the campus including heating, ventilation [and air conditioning] systems, lighting and other systems that consume water and fossil-fuel based energy resources like electricity and natural gas. … Eastern's utility bill is approximately $6.4 million annually … With Siemens' help we will be saving nearly $8,000 a day in energy expenses and when you add that up, we're going to be cutting our on-campus utility consumption roughly in two." (Shannon, Ronica. November 2009. "EKU sustainability project already showing savings," *Richmond Register.* http://www.richmondregister.com/localnews/local_story_321081653.htm. Accessed Nov. 8, 2010).

Net Metering

Required in most states, net metering is a method of encouraging investment in renewable energy technologies. Under net metering, customers who generate their own energy are required to use the power they produce first, but are also allowed to sell any excess electricity greater than what they use by transmitting it to the grid.

Under net metering, utility companies measure the net amount of energy generated by a local producer by running the meter forward and backward. When a consumer has used all the energy they need but continues to generate additional energy, the utility pays that customer for the excess.

EXAMPLES OF ESCO-FUNDED PROJECTS IN CORRECTIONS

Facility	Project Investment	Project Scope
SCI Camp Hill, Pa.	$3.8 million	Lighting retrofit, domestic water conservation, I-Con System plumbing controls, boiler tuneups, energy management system upgrade, variable frequency drives, new electric condensate pumps, steam trap repair and replacement, new water treatment plant and new insulation.
John O. Pastore Center, R.I.	$27.5 million	New central steam plant, including 6MW gas turbine, 4MW steam turbine and 300,000-pph steam plant serving correctional, medical and administrative buildings. Developed, designed, constructed and operated by NORESCO.
Westmoreland County Jail, Pa.	$6.5 million	New central boiler plant with two 200 HP boilers, I-Con Systems Plumbing Controls, domestic water conservation, lighting retrofit, variable frequency drives, energy management system upgrades, cooling tower repairs and new gas-fired clothes dryers.
Allegheny County Jail, Pa.	$10.3 million	Lighting retrofit, new Lexan windows, cooling tower deduct meter, I-Con Systems Plumbing Controls, VAV air-handling unit conversion, EMS upgrades, repair condensate system and addition of chemical feed system for district steam supply.
Hunterdon Center, N.J.	$7.2 million	4MW gas turbine cogeneration plant developed, constructed, financed, owned and operated by NORESCO. Includes a 60,000-pph steam plant serving correctional and mental health facilities.
California Correctional Center and High Desert State Prison, Calif.	$1.4 million	Central boiler plant upgrades of three 700 HP boilers, stack economizers and associated controls, and 1.25-mile natural gas distribution system. Propane to natural gas conversion of ancillary equipment including thermal fluid heaters.
Kern County Lerdo Correctional Facility, Calif.	$3.6 million	1,000-ton central chilled water plant with new piping to 48 package units, conversion of those units from DX to chilled water, lighting retrofit and peak load reduction via direct digital controls. Installation of a 200,000-gallon water storage tank with all high horsepower pumping moved to off-peak hours. Water conservation via automated flush valve system.
FCI Victorville, Calif.	$5.9 million	1MW wind turbine installation, solar electric system, energy management system and HVAC upgrade.
Fairfax County Adult Detention Center, Va.	$2.3 million (construction)	Lighting retrofit, replacement and repair of air handling units, energy-efficient motors, energy management system upgrade, variable frequency drives, exhaust system modifications, cooling tower deduct meters and other HVAC modifications.
Kentucky Department of Corrections	$5 million	Facilities include Kentucky State Reformatory, Luther Luckett Correctional Complex and Roederer Correctional Complex. ECMs include a lighting retrofit, upgrade energy management systems, boiler plant controls, I-Con systems plumbing controls, domestic water conservation, ozone laundry system, pipe insulation, steam trap replacement program, new kitchen equipment, new ice machines and instantaneous domestic hot water heaters.
Bridgewater Correctional Complex, Mass.	$16.5 million (DEA Phase)	Lighting retrofit, energy management system, I-Con Systems plumbing controls, steam traps, new windows, cogeneration, centralization of laundry, new kitchen equipment, motors, variable frequency drives, vending misers and submetering.

As of August 2010, more than 35 states offer, allow or require net metering.

In most states, third-party production — that is, producing electricity to sell to other parties — is not permitted except through a contract with a utility. A more balanced way to finance the program would be through an advanced renewable tariff (ART) or Feed-in Tariff (FIT), supported by a system benefit charge as described below.

Advanced Renewable Tariffs

Electricity "feed laws" and ARTs/FITs are used in a few states (e.g., Washington, Florida, California), Canada and a number of European countries, and are considered by many to be the world's most successful policy mechanism for stimulating rapid renewable energy development. They give renewable energy producers guaranteed access to the electric grid at a price set by the regulatory authority, providing the contractual certainty needed to finance renewable energy projects. They also enable utility corrections institutions, ratepayers, farmers, cooperatives and others to participate on an equal footing with large commercial developers of renewable energy.

As of August 2010, 16 countries in the European Union use some form of feed-in law. ARTs are the modern version of feed-in laws. They differ from the simpler feed-in laws in several important ways. Tariffs are differentiated by technology, project size or, in the case of wind energy, by the productivity of the resource. Tariffs for new projects are also subject to periodic review to determine if the program is sufficiently robust. For example, programs are reviewed every two years in France and every three years in Germany.

In 2006, the Canadian province of Ontario enacted a type of ART called a standard offer contract, which offers 20-year contracts at 11¢/kWh (Canadian) to producers of wind, biomass and small hydro energy, and 42¢/kWh for solar photovoltaic energy. The contracts are available to anyone with a project under 10MW, including utility ratepayers, businesses and commercial energy producers. Ontario's policy could become a model that other North American jurisdictions will follow. In 2010, Ontario became the third largest market for solar photovoltaics with more than 300MW of installed capacity (Sherwood, Larry. July 2010. *U.S. Solar Market Trends 2009*. http://t.ymlp3.com/jujaiamjwaoambyuarauuhu/click.php. Accessed Nov. 8, 2010).

Recently the state of Washington passed a modest version of a feed-in law for small solar projects. It gives businesses and homes with solar photovoltaics a credit of 15¢/kWh for electricity generated by the photovoltaic (PV) system. The credit is capped at $2,000 annually and runs until 2015. The law also combines economic multipliers to increase the system owner's credit up to 54¢/kWh if the project's components are manufactured in Washington. In 2008, California enacted the United States' first ART, which allows for 10-, 15- or 20-year contracts between utility companies and small (less than 1.5 MW) renewable energy producers. The price paid for renewable energy varies depending on the California Public Utilities Commission's determined market price and the time of day, with higher prices paid during times of peak demand. Legislation for feed-in tariffs is also being drafted in several other states including Florida, Michigan and Colorado.

Providing Capital

In order to implement financing programs such as these, it is necessary to have a source of funding for the initial investment. Fortunately, there are a variety of sources available to provide such funding. A study done by the Southwest Energy Efficiency Project states: "One of the innovations in recent clean energy finance programs has been to access new sources of public and private capital, including bank capital (through a loan), federal funds, and state treasury funding (Brown, Mathew H., and Beth Conover. *Recent Innovations in Financing Clean Energy.* Southwest Energy Efficiency Project. 2009. http://www.swenergy.org/publications/documents/Recent_Innovations_in_Financing_for_Clean_Energy.pdf (accessed Nov. 8, 2010).

Loans

Loans from private investors such as Bank of America and Wells Fargo Bank are available for funding energy-efficiency programs.

Green Loans. If coming up with immediate capital is an issue, green loans have the advantage of requiring little or no down payment. Green loans are specifically designed for efficient and sustainable investments, and can be supplied by a bank, the government or a private party. Typically, they have a lower interest rate, lower minimum loan amount or longer terms than standard loans. Sometimes the incremental payments are designed so they can be made with the savings generated by the investment.

Entering into a loan situation that uses an institution's credit will decrease the amount of credit available for other projects. As with any investment, cash flow will decrease, but in most cases, it will be minimal and the savings from utility bills should cover the cost of the project. Also, since green loans were created to promote efficiency, they may be limited to specific projects. Institutions would be well-advised to shop around to find a loan that meets their needs.

Standard Loans. If an institution cannot set up a green loan, standard loans can be used. Like green loans, they involve incremental payments that reduce up-front costs. However, standard loans involve higher interest rates and have down payment requirements, which substantially increase the initial investment. Although savings should compensate for cash flow, the incremental loan payments will encumber available credit and decrease the ability to qualify for other investments within the loan's timeframe. Institutions must meet the loan qualifications. If regulations allow, institutions can apply for a loan through their current banking institution or they can shop around for a loan that best fits their situation.

Federal Funds

Various federal funds can be used to support energy-efficiency loan programs and renewable energy investments.

Ratepayer-supported Energy Efficiency Funds. According to the Consortium for Energy Efficiency, in 2009 approximately $3.1 billion from ratepayers was used to support energy-efficiency projects (Brown, Mathew. 2010. *Funding Mechanisms for Energy Efficiency.* http://ase.org/content/article/detail/5057 Accessed Nov. 8, 2010). This money was either used by states or was directed by them for use by local entities.

Utility companies, state agencies and private administers typically operate these programs through the use of tariffs (authorized by the state regulatory agency) that put a fee on electric and/or gas ratepayers. Ratepayer programs have the advantage of not having to be paid back to the funding source. Instead, various agencies are able to use these funds for a variety of energy-efficiency projects.

Innovative Financing

Clean Energy Deployment Administration (The Green Bank). The Green Bank is essentially an independent, government-sponsored enterprise to support, via loan guarantees, debt instruments and equity, the emergence of the U.S. clean-energy industry. The bank would provide capital for a variety of renewable energy and efficiency programs.

The Clean Energy Deployment Administration starts with seed money provided by the government. The underwriting and financing is then shared with the private sector. The final step is an investment in energy-efficient technologies and projects, renewable energy technologies and projects, and other low-carbon technologies and projects. The idea is that these investments will then pay back the government's initial investment and will provide an ROI on the investment made by the private sector (Pernick, Ron and Clint Wilder. 2009. *Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation.* Clean Edge, Inc. and Green America. http://www.greenamericatoday.org/PDF/FiveEmerging_US_PublicFinanceModels.pdf. Accessed Oct. 27, 2009).

Clean Energy Victory Bonds (Green Bonds). Green bonds are currently being implemented on the national level, but they might shift to a municipal or state level. Green bonds are funded by private individuals, loaned to the federal government and issued to those pursuing renewable energy and efficiency programs (Ibid).

Tax Credit Bond Options. Supported by the federal stimulus program, the IRS issues federal tax credits as payments to bond buyers (Ibid). The bonding authority is provided with options to raise money for any renewable energy and efficiency projects.

City, County or State Funds. Public institutions can sometimes borrow money at low interest from the city, county or state to fund a renewable energy or efficiency. These arrangements are generally negotiated individually through the usual capital reserve resources.

Peak Load Pricing. Xcel Energy is proposing a peak load pricing system to be used in conjunction with the smart grid currently being developed in Boulder, Colo. For these customers, electricity prices would be higher between the hours of 2 and 8 p.m. in order to reduce demand when it is at its highest (Environmental Leader. 2009. *Pilot Utility Pricing To Charge More During Peak Hours.* http://www.environmentalleader.com/2009/11/09/pilot-utility-pricing-to-charge-more-during-peak-hours/. Accessed Nov. 8, 2010).

APPENDIX 2

CASE STUDY: WATERLESS URINALS

Introduction

The example below provides extensive detail about waterless urinals, a technology with both conspicuous benefits and conspicuous problems. Not all green technologies are appropriate for correctional institutions. Some institutions have had notable successes; others have seen notable failures. Because both the successes and failures have been well documented, this guidebook presents both as an example of how important it can be to plan diligently and to gather as much information as possible about the experiences of other institutions before making a large commitment to any particular technology.

Background

Waterless urinals, when properly selected, installed and maintained, can reduce costs, environmental burden, and sewage and maintenance expenses (e.g., for water supply, emergency repairs of flush urinals, treatment of wastewater). The use of waterless urinals earns LEED credits. Moreover, waterless urinals are strongly encouraged in drought-prone locations. Arizona, for example, has gone so far as to require the use of this technology in all state buildings.

Waterless urinals available in the United States typically have a either replaceable or permanent trap and/or liquid sealant that floats on top of the urine to form a barrier to keep sewer vapor from escaping. Other alternatives include a trapless "airflush" urinal made in Sweden, which uses a small exhaust fan to extract odors instead of the replaceable trap and/or sealant, and an Australian design that simply turns off the water and replaces it with a small block of microbes each week.

In waterless urinals that use a trap insert filled with a sealant liquid instead of water, the lighter-than-water sealant floats on top of the urine collected in the U-bend, preventing odors from being released into the air. Although the cartridge and sealant must be periodically replaced, the system saves anywhere from 15,000 to 45,000 gallons (approx. 55,000 and 170,000 liters) of water per urinal per year.

Other urinals use an outlet system that traps the odor, preventing the smell often present in toilet blocks. They can be installed in high-traffic institutions and in situations where providing a water supply may be difficult or where water conservation is desired.

Existing Technology Review

Water conservation involves two distinct areas: technical and human resources. The technical side includes collecting data from water audits and installing water-efficient fixtures and procedures. The human side involves changing behaviors and expectations about water usage and "the way things should be done." Both areas must be addressed for a water efficiency program to succeed.

Many water efficiency retrofits that appear to be prohibitively expensive are actually very cost-effective when the upfront costs can be distributed over the life of the equipment.

The true cost of water is the amount on the water bill plus the expense to heat, cool, treat, pump and dispose of/discharge the water. Most of the eight to nine million flush urinals and toilets in the United States average three to five gallons per flush (gpf), although newer models use 1.6 or even one gpf or less. Therefore, most waterless urinals save one to three gallons of water per use, depending on the flush urinal model being replaced, and low-flush or dual-flush toilets can save nearly that much. Water savings by building will vary depending on use.

The comparative savings of waterless urinals, for example, can be as high as $3,000 per year if maintenance issues (discussed below) can be resolved.

An overview of the costs and savings associated with waterless urinals is presented below. The overview is followed by sample figures for costs and savings associated with waterless urinals.

Costs

Initial costs for waterless urinals vary in the range of $300 to $1,000, depending on the price of fixtures and installation. Annual costs vary depending on the need for, price of and longevity of replaceable cartridge traps as well as the need for, quantity required and price of liquid sealant and cleaning products.

Potential Savings

In new construction, savings can result from the elimination of water supply lines, flush valves, sensors and, in some jurisdictions, drainage fixture hook-up charges. However, plumbing code in some states will require water supply piping to be installed in new construction, even in instances where waterless urinals are specified. Although water supply piping is not used for waterless urinals, it is anticipated that it will be required in case a facility chooses to replace waterless urinals with flush urinals at a future date.

Units may be less expensive to purchase and easier to install than conventional urinals due to the lack of a flushing mechanism. Installation labor is typically limited to approximately 20 minutes to install the bowl and insert the cartridge.

Several cities and water systems offer rebate incentives for the installation of urinals that don't use water. Initial installation cost and annual recurring costs vary by vendor, but in general, simple payback time typically ranges between six months and three years for new installation and retrofit. Annual savings vary depending on the flush volume of the replaced urinals, the number of uses per day per fixture and the cost of water and sewer. Each waterless urinal that replaces a one-gallon per flush (gpf) unit with 75 uses per day at typical water and sewer costs ($6.83 per 748 gallons) could save between $250 and $875 per year. This reflects the deferred cost of 27,375 gallons of water and sewer per year used by a newer one-gpf urinal, or 95,812 gallons per year for an older 3.5-gpf urinal. Including maintenance costs for replacement fluid and/or cartridges (between $45 and $120/urinal annually), the waterless alternative would yield a net savings between $130 and $830 each.

According to the U.S. Army Engineer Research and Development Center, savings vary depending on the flush volume of the replaced urinals, the number of urinal uses per day, and water and sewer rates. Additional savings can come from the elimination of parts and labor costs for repair and/or replacement of flush valves and sensors, because waterless urinals:

- Reduce water and sewer costs (each unit can save up to 45,000 gallons of water and sewage per year per urinal).
- Eliminate infrastructure costs to provide fresh water or collect and treat sewage.
- Require no freeze protection.
- Lower electricity costs (to pump water and sewage).
- Have no installation, maintenance or repair costs for flush valves, handles, sensors or water supply piping.
- Reduce the need to manage clogged sewer pipes and vandalism.
- Reduce septic system load and treatment time. When cities and other water supply agencies do not have to pump and treat as much water and sewage, energy use is reduced. If the use of waterless urinals is scaled up, that use can reduce the amount of affluent flowing to sewer systems, thereby preventing water pollution by reducing the incidence of combined sewer overflows.

- Require no batteries, transformers or other electronics sometimes associated with pumping water to traditional urinals.

- Are environmentally friendly from unnecessary waste of water.

Many new construction projects underway are becoming certified as "green buildings" under the LEED program developed by the U.S. Green Building Council; installing waterless urinals can help garner points towards LEED certification by reducing potable water use for sewer conveyance and maximizing water efficiency within buildings.

Daily Cleaning

Some waterless urinal manufacturers recommend use of their proprietary surface cleaner for daily wipedown of the fixture. Pouring a bucket of water down the drain is often part of the daily cleaning procedures for flush urinals, but will lead to odor problems and higher replacement costs for trap cartridges and/or liquid sealant for most brands of waterless urinals. Proper training of custodial staff is critical to the viability of waterless urinals.

Odor Prevention

For most liquid sealant systems, replacing the cartridge or adding liquid sealant before the sealant is fully depleted is important to prevent odor problems. Once again, proper training of maintenance staff is critical. For some liquid sealant traps, slow urine flow and/or liquid sealant appearing in the urinal bowl signal that the cartridge/insert is overdue for replacement, rather than indicating odor problems. This makes it easier to pinpoint which urinals need maintenance.

The escape of sewer gas into the restroom when cartridges/inserts are removed from waterless urinals for replacement or cleaning can make this task unpleasant. Flushing with water immediately on cartridge removal or the application of deodorizers/cleaners to the open trapway may reduce sewer gas odor.

Management/Policy Issues

Even though conventional urinals offer many maintenance challenges, waterless urinals can be more of a challenge to maintain. Some institutions using waterless urinals have recommended that management require staff operations and maintenance teams to monitor and change urinal cartridges, rather than standard custodial or inmate workers, depending on turnover and training capacity.

Considerations and Implementation Issues

The most frequent complaints about waterless urinals include maintenance issues (e.g., too-frequent need to change cartridges, odor, backup) and associated costs. Although waterless urinals initially showed great promise (http://www.epa.gov/WaterSense/products/urinals.html), the EPA, charged with developing water savings recommendations for consumer products, is delaying action on this approach and no longer features them on the WaterSense website. The EPA's WaterSense Website previously cited concerns about, among other things, "their long-term cost-effectiveness as a result of increased maintenance requirements and life expectancy of (their) liquid seal or cartridge."

Institutions with well-trained, well-managed and low-turnover maintenance staffs tend to agree that the cartridges are not a problem if they are maintained properly. Urinal drain cartridges require changing after 7,000 uses. But rather than counting urinal uses, maintenance staffs tend to change cartridges whenever urinals back up, which can be far more often. Changing cartridges or the urinal trap oil that some systems require at regular intervals is not necessarily the best solution since rates of use in banks of urinals vary widely. Given a three-urinal option, the one closest to the door gets 60 percent of the traffic, according to Roger van Gelder, a Seattle environmental and plumbing consultant (http://www.pugetsoundashrae.org/EV2030_2008/PerformanceandApplicationsofLowFlowFixtures-VanGelder.pdf). The urinal farthest from the door, which provides the most privacy, gets most of the rest. Moreover, a sudden surge of water can destroy a no-flush urinal's oil seal by literally flushing the trap. This can happen if a housekeeper empties a mop bucket into a no-flush urinal, a practice customary when cleaning restrooms with conventional urinals.

Checking and changing waterless urinal cartridges often leads to escape of sewer gas in the bathroom, causing a temporary but significant odor problem. To avoid unpleasantness of sewer gas escape during cartridge changes, vendors recommend that maintenance personnel use a flushing maintenance protocol.

Installing Waterless Urinals: New Construction and Proper Retrofits

Institutions that installed waterless urinals as part of new construction had uniformly positive experiences with waterless urinals, reporting only isolated problems. In contrast, retrofit projects have posed additional challenges that need to be addressed at installation to ensure proper functioning.

Two issues in particular appear to plague retrofits: the need to assess drain slope and the need to clean drain lines prior to installation. It appears that problems experienced at these institutions are exacerbated by the relatively high, constant use that these urinals receive, the potential for misuse and ignoring the need for more frequent cartridge changes. Follow vendor maintenance instructions exactly, including specific cleaning materials, maintenance procedures and maintenance intervals.

Correct Drainpipe Height

Some waterless urinals may require a lower drainpipe height than the flush urinal being replaced. In this case, options are to lower the drainpipe in the wall (adding expense) or select another brand or model that can be installed at the existing drain height.

Proper Slope and Drainpipe Material

Existing drain lines must slope at least ¼-inch per foot to ensure sufficient flow and cannot be made of copper pipe, which corrodes. Some manufacturers can install a tube within the existing drainpipe to create the proper pitch if necessary. Existing drain lines must not have a reverse slope and drain lines must be clean before urinal installation.

Drain Pipe Maintenance

Waterless urinals with a drainpipe connection diameter of two inches can make it easier for the drainpipe to be snaked without removing the fixture from the wall.

Eliminate Drain Pipe Obstructions

Studies on the corrosive effects of urine on drainpipes have proven that encrustation is due more to the mineral content of water than to urine. While several waterless urinal users report that they rout their drain lines annually to keep them clear, other users have reported no buildup problems. For retrofit projects, the sewage lines should be cleaned out with a power sewer snake with a rotating cutter head before installation of waterless urinals.

Keep a Urinal Maintenance Log

Keep a log of cartridge replacement dates or trap service dates to guard against premature or overly frequent cartridge replacements or trap servicing. Keep a record of all sealant and cartridge purchases to determine average sealant costs per urinal. Monitor high-use institutions during peak usage periods.

Resources

The U.S. EPA maintains a website featuring comparisons of water efficiency technologies (http://www.epa.gov/owm/water-efficiency/product_search.html). In addition, several manufacturers' websites feature worksheets for calculating the costs, savings and payback times associated with waterless urinals.

Conclusion

Installation of waterless urinals is more straightforward during new construction. Retrofitting waterless urinals in existing bathrooms without renovation poses some challenges but can be accomplished successfully. Prior to a retrofit project, it is imperative that institutions 1) ensure that the slope of the drain line is ample, 2) route drain lines to avoid problems such as sediment buildup and 3) check that drain heights are appropriate to the brand to be purchased. Institutions are far less likely to encounter problems with retrofit projects if they make these preparations.

Waterless urinals are being used successfully at stadiums, airports, offices, academic buildings, gyms and in a wide variety of other settings. However, it is too early in the development of the technology to recommend widespread adoption in correctional institutions. Problems in correctional institutions appear to be due in part to inmate misuse and limited availability of maintenance. Availability of maintenance staff is important for both daily cleaning and frequent cartridge changes/refills at institutions with high user loads.

Institutions exploring the installation of waterless urinals should conduct cost, savings, payback and maintenance calculations. These calculations should include: unit cost, installation cost, cartridge replacement cost,

REAL WORLD EXAMPLES

February 2010. Waterless urinals installed in the public men's room outside the Chicago City Council chambers are being ripped out and replaced. Environment Department spokesman Larry Merritt said copper pipe was used in the February 2006 installation of waterless urinals donated to the city "to take advantage of existing infrastructure and minimize the cost." (Chicago's building code requires commercial buildings to use copper pipes in indoor plumbing) The U.S. Army Corps of Engineers specifically states that drain pipes for waterless urinals "cannot be made of copper pipe, which corrodes."

2008. The 900-bed Alachua County Jail in Florida initiated a water conservation program that included the replacement of existing 3.5-gpf pneumatically controlled toilets with new controlled 1.6-gpf toilets containing security lock-out controls, the installation of waterless urinals and the replacement of lavatory and shower controls and valves throughout the facility with tamper-resistant, automatic-shutoff timer controls. The initiative reduced the facility's annual water usage by more than 50 percent from 36 million gallons per year to approximately 17 million gallons per year, an impressive 62-percent reduction in overall water usage.

2008. The Massachusetts Department of Correction encountered an excess of "salt buildup" around the top of the cartridge and in the drain lines on its waterless urinals. This buildup has led to drain flow problems and difficulty removing the cartridges. However, the correctional facility did not route the drain line with a sewer snake prior to installation or assess the slope of the drain line towards the main line. Therefore, the drain lines may have had previous buildup prior to installation or the slope of the drain line may have been too gradual to move urine towards the main line. Either of these scenarios leads to increased sediment buildup in the pipes.

2005. Five waterless urinals were installed in O'Hare Airport's Terminal 2 only to be removed three months later. "The pipes clogged with fluids," Aviation Department spokesperson Karen Pride said. "The cartridges placed in the urinals to abate odor failed prematurely as people poured coffee and chemicals in the urinals and destroyed the plastic." The cost of the failed O'Hare experiment was pegged at $20,000. Every time a cartridge was blown by dumping extraneous liquids, it cost the city $75.

cleaning supply cost and water savings, as well as a careful assessment of the vulnerability to vandalism. These calculations should be based on facility-specific information, including the number of conventional urinals to be replaced, the number of men at the facility, water prices and costs associated with pumping and treating of water. In addition, calculations should be based on brand-specific information because cleaning supply and cartridge costs vary significantly by brand.