

## Energy Partnerships: Comprehensive U.S. Federal Programs

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*"Today, I reaffirm my personal, and announce our nation's, commitment to reducing our emissions of greenhouse gases...This must be a clarion call, not for more bureaucracy or regulation or unnecessary costs, but instead for American ingenuity and creativity, to produce the best and most energy-efficient technology."*

President Bill Clinton  
April 21, 1993 (Earth Day)

### INTRODUCTION

In 1992, two major events marked significant steps forward in terms of U.S. energy policy, marking a new direction to meet the challenges of economic and technological competitiveness in the growing markets for energy and environmental technologies. First, the U.S. Congress passed the landmark National Energy Policy Act (EPACT). EPACT focuses on efficient consumption and production of energy in the U.S., from demonstrating renewable energy sources to alternative fuel fleet purchases to integrated resource planning. Secondly, the U.S. elected President William J. Clinton who brought with him decision makers and leaders who re-directed national policy in the direction of comprehensive programs in efficiency and renewables that benefit the economy while preserving the environment and natural resources.

We are only beginning to see the effects of the current Administration's programs, many of which were initiated during President Clinton's first year in office but did not receive Federal funding until 1994 or 1995. The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's programs to be discussed here fall under one of three categories: 1) grants to retrofit the dwellings of low-income families (about \$220 M annually) and schools and hospitals; 2) Renewable energy, covering research, development and demonstration of the latest technologies; and 3) Efficiency R&D, including analysis and implementation of mandatory standards for appliances, equipment, and federal buildings. **Figure 1** provides funding levels for EERE's programs.

In this paper we summarize the Clinton/Gore administration's initiatives to improve efficiency in the buildings, industry, and utility sectors, and reduce CO<sub>2</sub> emissions back to 1990 levels by 2000. These programs were approved by Congress in the summer of 1994 under the name "Climate Change Action Plan" (CCAP). The Department of Energy's contribution to CCAP is called "Energy Partnerships for a Strong Economy" (Energy Partnerships).

The administration has also initiated a multi-million dollar collaboration (Partnership for a New Generation Vehicle) with the "Big 3" U.S. automakers -- Ford, General Motors and Chrysler -- to produce a prototype 80 mpg [3 liter/100 km] car (probably a "hybrid" with a small, constant-power generator, batteries, and electric drive), which should produce an-order-of magnitude less pollution, but which we will not discuss here.

### THE CLIMATE CHANGE ACTION PLAN (CCAP)

President Clinton's 1993 Earth Day commitment outlined the U.S. policy goal of reducing domestic greenhouse emissions to 1990 levels by the year 2000. The blueprint for this initiative was the Climate Change Action Plan -- 46 specific action items (assigned to various federal agencies) that build on existing legislative authority to partner with industry, reduce costs, and achieve measurable outcomes through comprehensive implementation efforts. Of the 46 actions, the U.S. Department of Energy carries responsibility for the majority (24, to be exact). The Office of Energy Efficiency and Renewable Energy, working closely with other agencies, businesses, industry, State and local governments, members of Congress, and with non-government organizations, undertook an extensive 11 month-long planning process to gather ideas and develop strategies to carry out 21 of these actions. Each one has been designed to reduce emissions while producing increased profits for business, increased

spendable income for taxpayers, and increased flexibility for all private and public partners.<sup>1</sup> Fourteen of the 21 partnerships are outlined in **Table 1**.

## **POLICY SHIFT**

As domestic and global environmental conditions become increasingly problematic, the policies addressing climate change have evolved. During the 1970s, lawmakers attempted to clean up pollution after it was produced -- so-called "end of pipe" treatments. As a result, U.S. has historically relied upon command-and-control measures that attempt to regulate different types of pollutants while other laws set mandates and standards affecting cleanup practices and timelines. Although public scrutiny of industrial practices increased to a large degree, the business community in general disliked the regulations for interfering with "the market" and by setting often unreachable goals laid out with strict penalties for non-compliance.<sup>2</sup>

In 1995, the United States enjoys a strong economy, low unemployment, and pressure to decrease federal expenditures. Increasingly, the federal government is being asked to be leaner, cleaner and more competitive. At the same time, the general population views the federal government as the strongest player in the environmental protection game and must therefore continue to partner with industry to meet the challenge of doing more with less.<sup>3</sup>

In short, policymakers in the United States have found themselves in the tough position of finding solutions that make businesses more competitive, keep customers happy, improve the environment, and free up capital to take care of these needs. Given all the constraints, the most effective solutions developed by the current administration have transcended the traditional, moving away from strict regulatory, command-and-control measures to economically efficient, win-win partnerships with the private sector. This is the essence of the approach taken in the Energy Partnerships for a Strong Economy.<sup>4</sup>

## **ENERGY PARTNERSHIPS FOR A STRONG ECONOMY**

One key idea in the Climate Change Action Plan effort is to create voluntary partnerships. Virtually all of DOE's actions avoid government mandates or regulations; rather the department has made itself the focal point for open dialogue allowing the private sector partners develop plans themselves -- plans to increase market penetration of new energy efficient technologies and renewable sources of energy. The initiatives have appropriately been called **Energy Partnerships for a Strong Economy**.

The second cornerstone of the Action Plan is its focus on accelerating the deployment of under-utilized but cost-effective emissions reduction opportunities as the primary mission of Energy Partnerships activities. The essence of cost-effective energy efficiency measures is the fact that investing in such measures saves more money in the long run than the cost of the measure. By emphasizing options that are cost-effective, the Energy Partnerships can simultaneously emphasize voluntary activities and programs, i.e. the "voluntary approach." While not every action strictly adheres to these two principles -- for instance, appliance standards are not voluntary, although highly cost-effective -- they remain the centerpiece of the Partnerships.<sup>5</sup> Also, one of the under-recognized benefits of energy efficiency programs can be increased productivity (see **Appendix A** for a brief discussion on this point).

We must point out, however, the remarkable success of mandatory standards when the benefit-cost ratio is good enough to generate broad acceptance. In an interesting 1995 Report from Lawrence Berkeley Laboratory, *From the Lab to the Marketplace*, Evan Mills addresses residential equipment and appliance standards in place by 1993: in 2015, these advanced products will save U.S. homes \$6 Billion (1993 dollars) and the annualized cost of the efficiency features is only 42% of that, leaving a net savings of \$3.5 Billion. The savings are mainly

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<sup>1</sup>Energy Partnerships for a Strong Economy, U.S. Department of Energy, page 1.

<sup>2</sup>National Environmental Technology Strategy. National Science and Technology Council, 1995, pg.3.

<sup>3</sup>Farhar, Barbara C. Trends in Public Perceptions and Preferences on Energy and Environmental Policy. March, 1993. pg. xii of Executive Summary. (prepared by the National Renewable Energy Laboratory for the U.S. Department of Energy)

<sup>4</sup>Fox-Penner, Peter. "Instruments and Tools in Clinton Era Policies." from 20 Years After the Energy Crisis, (Johns Hopkins University Press: 1996), Chapter 17.

<sup>5</sup>Mills, 1995. From the Lab to the Marketplace. Lawrence Berkeley Laboratory. Pg.13. [Evan Mills 1-510-486-6784; EMills@lbl.gov]

electric, and can be compared with 1995 residential electricity bills of \$80 Billion annually. Later standards, commercial and residential, will triple these net savings to over \$10 Billion per year.<sup>6</sup>

Energy Partnership activities, developed within existing federal programs, resulted in efforts to reduce greenhouse gas emissions in the commercial, industrial and utility sectors. Cross-cutting themes emerged, including financial assistance, technical assistance, cost-shared demonstration of new technologies, and shared information. The challenges for emissions reductions and the methods for achieving specific goals varies by sector, but the players involved in the action often have interests in multiple sectors. For instance, a utility will have interests in the efficiency of residential appliances as well as industrial motors. Pollution prevention, additionally, is often a problem more suitably handled through a comprehensive systems approach. Therefore many of the partners are involved in two or more actions that cut across sectors to address a wider range of opportunities for reducing emissions, avoiding the "stovepipe" mentality.

The deployment process begins with the identification of a measure, an existing, under-utilized technology or a new technology developed through public or private research or a new standard or label. The measure is then "delivered" through some combination of natural price signals, existing private or public programs, and Energy Partnership actions. Through partnerships, the actions are designed to effect maximum use of existing delivery channels. We target very specific markets characterized by large opportunities for energy and emissions savings.

Each action has specific goals, approaches to achieving results, objective measurements of benefits, extensive lists of active partners, and major milestones for each fiscal year. To illustrate, **Table 2** outlines one of the partnerships according to the characteristics mentioned.

Commercial and Residential Buildings Partnerships (Table 1, Lines 1-5)

The goals of the first action, **Rebuild America**, are to save, annually, approximately 1.6 million metric tons of carbon equivalent by the year 2000, equivalent to an annual energy savings of 100 trillion Btus. Estimates are based on increased efficiency realized through current practices with millions of private dollars stimulated to improve the energy efficiency of commercial and multifamily buildings that exist today. The major focus of Rebuild America involves encouraging decision-makers to include energy efficiency as an integral part of individual building renovation projects, requiring the interaction of architects, engineers, contractors and utility demand-side management professionals. Given the high number of organizations involved in each renovation, the general approach is to coordinate regional or community teams that can customize strategies to fit individual needs and capabilities. Shared Energy Savings for Architects, Engineers, and Operators

While discussing commercial buildings, we should mention an interesting pilot project on "performance-based compensation for building design" announced in 1995 by the California Energy Commission (CEC). The aim is to provide incentives to a currently disconnected series of professionals (architects, architectural engineers, contractors, and building operators) to form a team which will share strongly in the energy savings if a new building beats existing standards, but pay a stiff penalty if it fails to achieve its target. The project involved is a 40,000 square meter, \$73 M. administration facility in Oakland. If it merely complied with California's "Title 24" energy performance code, its annual energy bill would be \$700,000-750,000. The CEC target is a daunting 20-25% less. During the first two years of operation the CEC's project manager will oversee the commissioning and monitoring of the building, so the results for the third year will be based on real-time measurements, corrected for the weather, occupancy changes, schedules, etc. Then the dramatic awards/penalties will be assessed, at about 10 times the annual saving/losses compared to the target. A number of us, including a group within the American Association of Architects, are eager to introduce this new "Performance Based Contracting" and DOE has an action item which can help demonstrate it in other states.

Electricity is the second largest expenditure of the average home, with the fraction remaining at about 2% of household income.<sup>7</sup> Appropriately, almost half of the actions from the Climate Plan target buildings, and the largest share of comments on the implementation plans focused on the buildings sector. Energy Partnerships provides 8 program opportunities for the buildings community to improve materials, designs, and practices. Opportunities

<sup>6</sup>Mills, From the Lab to the Marketplace., pg. 20.

<sup>7</sup>National Environmental Technology Strategy, The National Science and Technology Council, 1995, pg.18.

include technical and financial assistance for energy-saving retrofits, training and certification of energy raters, information on energy-efficient building technologies and materials, incentives for communities to upgrade building codes, and effective transfer and application mechanisms to commercialize efficient building equipment and products.

The **High Efficiency Commercial Equipment** program has a strategy similar to Rebuild America, but involves appliance manufacturers and retailers to transform the traditional markets for energy-efficient products such as water heating equipment, refrigerators, lighting and appliances. By increasing market penetration in the residential sector, the annual goal of 5.8 million metric tons of emissions reductions can be attained with the added economic benefit of ensuring future market demand for more efficient technologies. Manufacturers of these products know the benefits but face market barriers such as design improvement, performance uncertainty, and lack of familiarity on the part of the end-user.

The **Affordable Homes Partnership** aims to stimulate homeowner investment in residential energy efficiency by providing consumers with the means to choose, finance, and install energy-efficient technology in new and existing homes. The approach to this pursuit of the "efficient American Dream" has four major components, beginning with a Nationwide Home Energy Rating System (HERS) to accumulate and disseminate useful new information for homebuyers and for lenders who need a basis for providing special incentives. Secondly, a four year goal has been set to facilitate over \$1 Billion in Energy Efficient Financing, special loans and mortgages that will not ignore the value and significant affect that energy efficiency has on a borrowers ability to repay. Energy efficiency financing will include loans made at competitive rates linked to a guarantee of energy savings by the firm selling the energy efficiency products.

The third and really the key component in the Affordable Homes Partnership will be to ensure that an adequate network is established to properly train builders and recognize them for their efforts. Finally, efforts to increase national awareness, through media campaigns, in-store displays, and creative marketing will help remove information barriers for the consumer.

Since most American consumers are generally unaware of the energy features available in the market today, programs to **Update Residential and Commercial Building Codes** will achieve emissions reductions and energy savings by updating existing codes and explaining the codes to designers, builders, and code officials. Since building costs are the most prominent barriers in the market for new homes and office space, the codes, coupled with the information system (HERS) and financing mechanisms mentioned above, will create a level playing field for both the builder and the buyer. In 1995, DOE is assisting 5 states in adopting energy codes that exceed the national model energy codes and will have assisted 35 states by the year 2000. This involves an intensive training program of over 3,000 seminars and workshops to raise awareness levels of over 50% of the market participants during the next five years.

**Cool Communities** is a cost-effective application of environmental science, which should save 20% of air conditioning and reduce smog by 20%.<sup>8</sup> But for the full effect, we'll have to wait about 20 years till today's roofs wear out and can then be replaced with lighter colored roofs, which stay cooler in the summer. The same is true for asphalt roads and parking lots, which can be resurfaced with cooler, less heat absorbent material. The simplest measure (and the most appealing aesthetically) is planting trees and shrubs around buildings to provide shading during the summer months of peak energy demand.

At the building scale, cool roofs reduce air conditioning load (10-50% depending on the insulation under the roof). At the community scale, by offsetting the summer heat island, they reduce smog, whose formation is extremely sensitive to temperature. Both building and heat island formation can be implemented by 1) rating and labeling roofing materials by their temperature rise on a cloudless summer day; 2) adopting relatively mild standards; and 3) offering rebates on new roofs (or re-roofs) for beating the standards.

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<sup>8</sup>Rosenfeld et al. 1995. Mitigation of Urban Heat Islands. Energy and Buildings, in press, 1995. Contact Hashem Akbari 1(510)486-4278, H\_Akbari@LBL.gov.

### Cool Communities -- History and Potential

Research on cool roofs, cool communities, and smog reduction started at Lawrence Berkeley Laboratory in 1985, under Dr. Hashem Akbari and one of us (AHR). It is finally gaining recognition, particularly in Los Angeles, where it has the potential of offsetting the emissions of 20-30% of all the present automobiles and of avoiding about \$200,000 per hour of peak power every hot afternoon.

Modern urban areas usually have dark surfaces and less vegetation than their surroundings. At the building scale, dark roofs are heated by the summer sun and thus raise the summertime cooling demands of buildings. Collectively, the dark surfaces and reduced vegetation warm the summer air over urban areas, leading to the creation of the familiar summer urban "heat island." On a clear summer afternoon, the air temperature in a typical city is about 2.5 C hotter than the surrounding rural area. Akbari et al.\* have found that peak urban electric demand in six major American cities rises by 2 - 4% for each 1C rise in daily maximum temperature above a threshold of 15 to 20 C. Thus, the additional air-conditioning use caused by this urban air temperature increase is responsible for 5-10% of urban peak electric demand.

\*Rosenfeld et al. 1995. Mitigation of Urban Heat Islands. Energy and Buildings, in press, 1995. Contact Hashem Akbari 1(510)486-4278, H\_Akbari@LBL.gov.

### Manufacturing Partnerships (Table 1, lines 6-9)

The manufacturing sector represents an important market for capturing economic benefits through increased energy efficiency. The 4 initiatives targeting the manufacturing sector under Energy Partnerships provide opportunities for education, training and technical assistance (again, this is a overarching theme of the Energy Partnerships), grants for pollution prevention partnerships, audits for small and medium sized manufacturing companies to identify and cut sources of waste, and information sharing. In 1993, over 162 individuals from the manufacturing sector attended roundtables specifically designed to gather their recommendations and comments, which further assisted the department in reducing duplication with existing programs and addressing the primary needs of U.S. firms.

**Climate Wise** is labelled a "foundation" action because its basic strategy encompasses the goals of the entire Climate Change Action Plan. Climate Wise targets the sector that consumes approximately one-third of the total energy used in the United States: industry. Climate Wise identifies large national industries, trade associations, and socially responsible businesses, representing large opportunities for energy and emissions savings, and encourages them to become Climate Wise "pledge companies." Pledge companies commit to voluntarily adopting energy efficiency, renewable energy, and pollution-prevention technologies.

The success of the fledgling Climate Wise initiative has been notable from the start. This year, 150 organizations have used technical assistance resources, and companies representing almost 3% of the energy used in the United States have pledged to reduce their emissions. The Climate Wise companies choose from any of the Energy Partnership portfolio of programs to achieve their goals, or they may develop their own programs, or devise a combination of the two.

The **Motor Challenge** promotes the benefits of energy efficient electric-motor systems by forming partnerships between manufacturers, distributors, retailers, users and others to incorporate energy efficiency considerations into the design, purchase and operation of electric motor systems. Industrial electric motor systems and the devices connected with their operation account for nearly 70 percent of all electricity used in the industry.<sup>9</sup> Through three mechanisms -- showcase demonstrations, an information clearinghouse, and technology development partnerships -- new products and systems that can cut industry electricity bills by as much as 50% (with payback in as little as two years) will find the necessary investment to build and sustain market share.

<sup>9</sup>Energy Partnerships for a Strong Economy, U.S. Department of Energy, p.93.

Due to the financial constraints smaller industries face as they attempt to capture savings from energy efficiency, **Energy Analysis and Diagnostic Centers (EADCs)** will be enlarged. EADCs offer free energy audits to businesses, a practice that will expand to include waste management and reduction, holding workshops to share state of the art practices within industry, providing manuals for easy direct access to EADC assistance and technical expertise, and recognizing individual companies that implement a majority of their assessment recommendations. Participants who follow the EADC recommendations can expect immediate energy savings that accumulate well beyond the payback years, resulting in lower production costs, improved bottom lines, increased capital for investment and, in turn, the creation of jobs.

To date, an encouraging 40-50% of EADC's recommendations have been actually implemented by firms. Since its inception in 1976, the EADC program has generated energy savings worth \$438 million and associated carbon dioxide reductions of approximately 255 MMT.<sup>10</sup> The EADC program's track record is astounding, especially when compared to the relatively small federal investment of \$27.5 million and the 800 college students that have gained valuable experience through participation in 30 hands-on audits conducted each year.

**NICE<sup>3</sup>** -- National Industrial Competitiveness through Energy, Environment, and Economics -- is a cost-sharing grant program operated by the Department of Energy in cooperation with the U.S. Environmental Protection Agency. It offers grants to industries to develop and demonstrate advances in energy efficiency and clean production and has been recently expanded to promote development of environmental technologies. State and industry invest over \$4.00 for every grant dollar, sharing the cost of reducing carbon emissions by 4.2 MMT by 2000. The industries are expected to commercialize the process or technology funded by the grant.

#### **Utility Partnerships (Table 1, Lines 10-14)**

The dynamics of the market of new electricity supply has been changing dramatically over the past decade in the U.S. Slow demand growth, low oil and gas prices, increasing environmental regulations, and moves towards a more competitive market for electricity supply have changed the nature of decision-making in the electricity sector. These have presented a whole new set of problems for introducing new technologies into the market place.

Currently the present group of decision makers in the U.S. utility sector (electric utilities, independent power producers and state regulatory officials) have a number of concerns about **renewable technology** that are impeding its introduction. First, the technologies need to show some history of commercial viability before decision makers are willing to depend on them for electricity supply. Secondly, regulators are often hesitant to approve unproven technologies in the technology mix of their regulated utilities. Thirdly, the investment community will not invest in a high risk and relatively low return technology unless it has a proven track record of technical viability. The activities undertaken under Energy Partnerships will provide this first level of technical and commercial viability to prove the technologies to the decision makers, who are interested, but hesitant to fund these demonstrations independently.

Energy Partnerships utility actions accelerate development of renewable energy. By definition, renewables lower carbon fuel use thereby decreasing greenhouse gas emissions by reducing the amount of fuel required to generate and provide electricity to customers. In addition, as the world market for electricity is growing -- particularly in developing countries -- the market for renewable electricity generation is expanding. Projections for new electric generation capacity in the United States remain flat over the next decade, the renewables commercialization programs are designed to cross domestic borders into international energy markets, where the World Bank predicts global energy investments of over \$1 trillion by the year 2000.<sup>11</sup> But again, international financing groups need some reassurance about the applicability of technologies before financing large amounts of technological development. These projects will help secure some of the fast growing markets for U.S. products and technologies. Many of the characteristics of the energy efficiency partnerships can be found in the renewable energy partnerships, including information exchange and technical assistance.

Technological advances through intense cooperative research and development with industry over the past 15 years have pushed utility scale renewable hardware to the edge of commercialization. Of the 9 utility programs, 5 are solicitations for cost-shared partnerships and joint ventures with industry to accelerate the market penetration of renewable energy technologies for power generation. These 5 market collaboratives, known as

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<sup>10</sup>Energy Partnerships for a Strong Economy. U.S. Department of Energy, 1995. pg. 107.

<sup>11</sup>World Energy Outlook. The World Bank, 1992.

**Renewable Energy Commercialization**, are broken down into the following technology areas: photovoltaics, biomass power, geothermal heat pumps, geothermal power, and wind.

Renewables market collaboratives are voluntary partnerships specifically designed to stimulate a sustainable, cost-effective industry. Reliability, technical capabilities and incremental costs relative to traditional power generating facilities exist as barriers that the partnerships address. Wind collaboratives focus on verification of turbine efficiency and reliability while photovoltaic collaboratives focus on manufacturing costs to decrease prices and increase sales. Geothermal technologies have been successfully demonstrated and geothermal power facilities provide approximately 1000 MW of electricity for the United States today. Geothermal heat pumps, while expensive to purchase and install, use 33% less energy than electric heat pumps. The challenge with geothermal power generation is to provide incentives to open new fields with proven resources and to sustain current production. The biomass collaborative promotes commercialization through cost-shared demonstrations and the development of new energy crops and photovoltaic commercialization focuses on reducing manufacturing costs as well as improving conversion efficiencies.

**Integrated Resource Planning** is designed to assist states and utilities develop plans to evaluate all available sources of power generation, including renewables and demand-side management. Through IRP, data on technology cost and performance, environmental impact, and fuel cycles can be gathered and incorporated into a cooperative decisionmaking process.<sup>12</sup>

The **Climate Challenge** introduces a unique opportunity for U.S. utilities to reduce, avoid, or sequester greenhouse gas emissions. When a utility becomes a member of the Climate Challenge program, it signs a written agreement to develop a portfolio of cost-effective initiatives that reduce emissions. To date, more than 800 utilities have signed agreements. These utilities represent over half of the electric generating capacity in the United States.

#### **U.S. Initiative on Joint Implementation (USIJI)**

As a part of the development of an international joint implementation regime for the Framework Convention on Climate Change, USIJI partners submit proposals on a broad range of projects involving energy efficiency, renewable energy supply, sustainable forestry and land use, methane emissions reduction, and advanced fossil fuel technologies. Through USIJI, private investors may find technical and financial assistance available for project development, monitoring and verification. Partner countries benefit from USIJI by receiving training, improving infrastructure and reducing local pollution.

#### **CONCLUSION**

In one short year, President Clinton's Climate Change Action Plan has evolved from a conceptual framework into a working document, and finally into partnerships with active program participants. Through the Energy Partnerships, the United States is providing low cost and profitable opportunities for businesses and local governments nationwide through comprehensive means to reduce greenhouse gas emissions in the residential, commercial, utility and transportation sectors. The U.S. Congress has given the go-ahead to proceed with the implementation plans, and EERE has secured commitments from hundreds of partners, with some initiatives already exceeding original expectations. The commitment will continue as the U.S. monitors progress and adjusts plans as necessary to achieve historic reductions in greenhouse gas emissions and other pollution while making sizable contributions to economic growth by increasing productivity, raising corporate profits and building new markets for environmental technologies.

#### **APPENDIX A. ENERGY EFFICIENCY AND PRODUCTIVITY.**

Economic growth is driven in large part by productivity. We've discussed the energy and environmental effects of the Energy Partnerships in the buildings sector, but to make the story complete we must make the transition from building efficiency to worker productivity in the buildings. To introduce this transition, we have broken down the total annual costs for operating an office building and its staff, per square meter. The estimates

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<sup>12</sup>Energy Partnerships for a Strong Economy. U.S. Department of Energy, pg. 205.

below are from Wright and Rosenfeld (1995).<sup>13</sup> Annual personnel costs -- salary, plus the social costs of health insurance, leave, retirement, etc. -- are estimated at about \$10,000 per square meter. Operating costs are only \$100 per square meter, of which only \$25 covers energy (1/4%). Energy efficiency measures, then, can produce significant savings in operating costs, but from the point of view of the building operator represent only a small fraction of the personnel costs which are related to the final productivity of the building.

By addressing the entire office "system," which usually means more efficient office equipment, ventilation, and lighting, U.S. firms are continuing to discover a surprisingly significant connection between efficiency measures and increased worker productivity. As **Figure 2** shows, productivity increased more than 6% in Reno, Nevada's post office, as discussed by DOE's Joseph Romm in his newest book (see box).<sup>14</sup> A 6% increase in productivity means more work accomplished per square meter by the same personnel. Using the \$10,000 figure above, this particular efficiency retrofit translates into an annual increase of \$600 worth of productivity per square meter, real dollar benefits above and beyond expected energy savings.

#### Energy Efficiency Increases Productivity

Companies installing energy efficiency technology have found that energy efficiency, in addition to saving money on their energy bills, also boosts productivity. Energy expert Joseph Romm, in *Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution* (Kodansha America, 1994), studies 24 cases; in each case productivity gains were completely unexpected and often overshadowed the energy savings by wide margins. For example, after the work space and office lights in the Reno, Nevada post office were redesigned in 1986 to minimize energy use, its mail sorters became the most productive in the Western United States. At the same time, operators achieved the lowest error rate. The improved performance was attributed to new, indirect, energy efficient lighting which replaced the harsh direct lighting. The energy and maintenance savings for the building came to about \$50,000 per year, enough to pay for the renovation in about 6 years. But the productivity gains were worth \$400,000 to \$500,000 per year, more than enough to pay for the retrofit in a single year.

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<sup>13</sup>Wright, RN, AH Rosenfeld, AJ Fowell, Federal Research Plan for Construction and Building, Interagency Budget Coordination for FY1997, National Institute for Science and Technology, 1995. AJ Fowell 1(301)975-6865, AFowell@enh.NIST.gov.

<sup>14</sup>Romm, Joseph J. *Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution.* (Kodansha International: New York, 1994). pg.xvi.