Potential Energy, Cost, and CO_2 Savings from Energy-Efficient Government Purchasing[1]

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ABSTRACT

The public sector – including federal, state, and local agencies – purchases at least 10% of all energy-using products in the US. The federal government alone is the largest buyer in the world for many products. Channeling this enormous buying power toward energy-efficient products can stimulate market transformation throughout the economy. Government initiatives in the U.S. also offer a promising model for other countries with industrial, developing, or transition economies, where government leadership in energy-efficient purchasing is an important but largely overlooked policy option.

Within the federal sector, the Department of Energy's Federal Energy Management Program (FEMP) promotes energy-efficient purchasing by helping federal agencies comply with requirements of the 1992 Energy Policy Act and a 1999 Executive Order. The order directs agencies to buy ENERGY STAR® labeled products or those in the upper quartile (25^{th} percentile) of the market, with respect to energy efficiency. The EPA/DOE Energy Star Purchasing Program encourages similar policies and practices in state and local purchasing.

This paper estimates the potential energy, cost, and CO_2 savings from federal and non-federal government purchasing of energy-efficient products. For the federal sector, we present detailed results for the first 21 products analyzed by FEMP (including many ENERGY STAR® labeled products), based on an equipment stock turnover model and a series of four scenarios of federal agency compliance with energy-efficient purchasing policies. This detailed analysis covers residential appliances and equipment, office equipment, some lighting technologies, and water-saving products. A less detailed analysis of savings covers federal purchases of larger, non-residential heating and cooling equipment; this adds about 30% to the initial savings estimate. Within the federal sector, combined savings in 2010 for the two groups of products range from 11 to 42 TBtu/year (site energy[3]) for the four scenarios. This represents about $160-620 million/year in reduced federal energy costs. These savings also equal 3-12 % of current energy use in federal buildings, and a major contribution (7-28%) to the federal goal of reducing building energy intensity by 35% (from 1985 levels) as of 2010.

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[1] This work was supported in part by the Assistant Secretary for Energy Efficiency and Renewable Energy, Federal Energy Management Program, of the U.S. Department of Energy under Contract No. DE-AC03-76SF0098, and by the Stockholm Environment Institute. Portions of this paper are based on Johnson and Harris 2000 (LBNL Report 42179).

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[3] Unless otherwise noted, for consistency with current practice by FEMP and other US government agencies, energy consumption is reported in this paper in English rather than SI units (1 Btu = 1055 j.) and electricity is reported as end-use (site) energy at 3413 Btu/kWh, not including system losses of about 60-70%.

Outside the federal sector, we also projected savings in 2010 from energy-efficient purchasing by states, local governments, and schools, as a result of the Energy Star Purchasing program and related initiatives now getting started. For all products, annual savings in 2010 range from 40 to 150 TBtu (site) for the same four scenarios.

Taken together, potential energy savings from energy-efficient purchasing by at all levels of government translate into a reduction in annual greenhouse gas (CO_2) emissions of about 2.4 to 8.6 million metric tons of carbon (MMT_C) as of 2010.

Background – Energy-Efficient Purchasing in the U.S.

The Energy Policy Act of 1992 (EPAct) and Executive Order 13123 (Clinton 1999) establish federal policies on buying energy-efficient products. The Executive Order directs federal agencies to buy ENERGY STAR® labeled products or, where there is no label available, to buy products in the upper quartile (25^{th} percentile) of the market with respect to energy efficiency. The Department of Energy's Federal Energy Management Program (FEMP) assists federal agencies in complying with these requirements by publishing Energy Efficiency Recommendations[4] for those energy-using product commonly purchased by the government (DOE/FEMP 1999, on-line at www.eren.doe.gov/femp/procurement). FEMP's purchasing recommendations also contribute to the federal government's goal of reducing building energy intensity by 35% in 2010, compared to 1985 levels. A further goal of EPAct and the Executive Order is to use the buying power of the federal government to help "pull" the overall commercial market towards greater efficiency, and to serve as a model to encourage energy-efficient purchasing practices by other governmental and corporate buyers (McKane & Harris 1996).

To date, FEMP has issued energy-efficient purchasing recommendations for more than 30 product categories, ranging from exit signs and fluorescent ballasts to large chillers and boilers. Where a product category is also covered by the DOE/EPA ENERGY STAR® labeling program (www.energystar.gov), the FEMP purchasing criteria have been chosen to match the ENERGY STAR® label requirements. To increase market impact, FEMP also makes an effort to assure that its purchasing recommendations match those of other energy efficiency programs, including the utility- and state-sponsored market transformation activities coordinated by the Consortium for Energy Efficiency (CEE). However, merely publishing efficiency recommendations does not assure that federal buyers will use them. FEMP also conducts interagency outreach and training to raise awareness and help buyers incorporate these efficiency criteria, not only in their day-to-day purchasing but also in federal specifications for construction projects and other contracts (e.g., maintenance and operation, energy-saving performance contracts, etc.).

Both the FEMP efficiency recommendations and criteria for a product to receive the ENERGY STAR® label have been incorporated in an Energy Star Purchasing Toolkit prepared by the Environmental Protection Agency (EPA) with help from DOE. This publication and an accompanying Web site (www.energystar.gov) are targeted mainly to state and local

[4] For details on how these efficiency levels are set, within the overall framework of the Executive Order on federal energy-efficient purchasing, see Ware 2000 and Johnson et al. 1996.

government agencies, as well as larger corporate customers. To date, over 1100 copies of the Toolkit have been distributed through state/local government associations; the Web site also offers hot-links to and from the FEMP procurement web site.

The following sections describe the sources of data and calculation methods used to estimate energy savings from both federal and non-federal government purchasing policies, summarize our quantitative results, and discuss some policy implications for reducing energy use and costs within the government sector while also establishing public agencies as market leaders.

Data Sources and Analysis Methods

This paper estimates future energy savings from governmental purchasing at three levels of detail. We used spreadsheet models to analyze two groups of energy-using products purchased by federal government agencies (the first group was analyzed in depth; the second using a less detailed model). A separate spreadsheet analysis looked at energy and cost savings from purchases by state and local agencies, including schools.

The most detailed analysis, based on a stock turnover model for each product, covered 21 energy-using products commonly purchased by federal agencies, and for which FEMP had issued energy efficiency recommendations as of June 1999 (Johnson & Harris 2000). These included residential appliances and equipment, office equipment, and a few lighting products. The second analysis covered federal purchases of 8 additional product types: non-residential heating and cooling (HVAC) equipment, lighting products, motors, and distribution transformers, for which FEMP purchasing recommendations were issued after June 1999. For these products, our approach used more aggregated data and assumptions based on existing equipment stocks or total energy use, the assumed fraction of stock turnover by 2010, and percentage improvements in efficiency as defined by the FEMP recommendations. Even when these two estimates are combined, the total may underestimate the ultimate savings potential from federal purchasing, since a number of important energy-using products were excluded from the analysis. For some of these, FEMP is already developing energy-efficient purchasing recommendations.

The third set of products we analyzed covers purchases of both residential and non-residential equipment by non-federal (i.e., state and local) agencies who may adopt purchasing policies similar to those already in place at the federal level, in response to the Energy Star Purchasing program, initiatives by the Consortium for Energy Efficiency, or actions taken independently by these other government agencies. The spreadsheet model was more aggregated than those used for federal purchasing, beginning with an estimate of energy by end-use in state and local government buildings. This was multiplied by the fraction of the stock expected to turn over by 2010 and the percentage energy savings for efficient products that meet the Energy Star or FEMP criteria.

For all three groups, we define several scenarios to illustrate a range of possible savings, from minimal agency compliance with policies on energy-efficient purchasing to a theoretical maximum savings if all current stock were replaced with the most efficient model available today (see below for descriptions of each scenario). To help judge the reasonableness of the four scenarios, we drew upon selected reports and anecdotes of federal agencies' experience with the FEMP efficiency recommendations. For each scenario we translate the estimated energy savings into reduced energy operating costs, using the average cost paid by the government per kWh of electricity and per million Btu of fuel. Similarly, we "map" electricity and fuel savings into avoided emissions of CO_2 and air pollutants, using average annual emissions factors for the U.S. The analysis methods and data are further described in the following sections, beginning with the most detailed analysis: federal purchases of residential products, office equipment, and lighting.

Characterizing the Federal Market

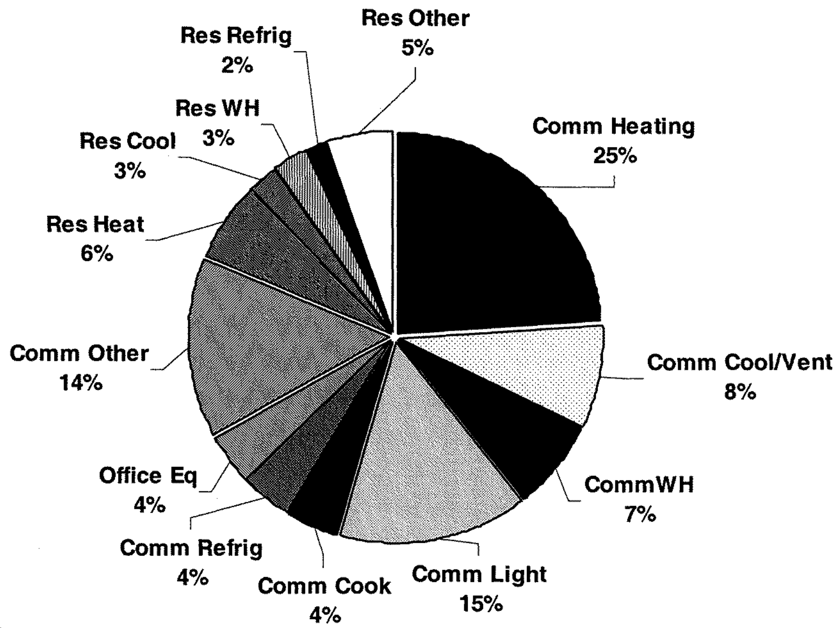
Federal purchases of energy-related products are estimated at roughly $12 billion annually, of which about one-fourth ($4 billion) are building-related equipment and appliances (Casey-McCabe 1995). Although the federal government is often the largest single customer for a given product, the federal market share is still only about 1-2% of national sales for most residential products, increasing to 3-5% for lighting and office equipment. These ratios approximate the federal shares of floorspace for all US buildings (GSA 1998, DOE/EIA 1998a). Of this $4 billion/year spent on energy-using equipment, approximately 10% is for lighting, 30% for office equipment, 15% for residential and commercial appliances, 25% for heating and cooling equipment, and the remaining 20% for building materials and miscellaneous products. However, these are only rough estimates; the diverse and highly decentralized nature of federal purchasing makes it difficult to compile hard data on purchases volume of energy-using products – except in very aggregate terms. Moreover, a significant amount of energy-using equipment is specified and acquired indirectly, through federal contracts for design, construction, and maintenance as well as energy service providers; including these totals would probably increase the dollar purchasing volume estimated above.

Detailed Analysis of 21 Energy-Using Products

Reported data on federal agency purchases are limited to aggregate dollar amounts, by broad category of purchases, and only for transactions over $25,000. Although contractors often specify and install equipment in federal facilities, there is virtually no reported information on the volume or efficiency features of these contractor purchases. Lacking reported data, to estimate energy savings we first had to estimate annual purchases of each product using a model of equipment stocks and turnover rates. We then compared our estimated sales (based on stock turnover) to other sources, such as the federal share of total U.S. sales of that product.

The 21 products fall into five groups: residential equipment, residential appliances, office equipment, lighting, and water-saving products. Although these categories together account for about one-fourth of all federal energy use in buildings (**Figure 1**), only selected products within each group are covered by the FEMP recommendations or ENERGY STAR® labels. The non-residential equipment we analyzed separately (see below) represents another 40% of federal energy use.

Figure 1: End-Use Shares in Federal Buildings (Site Energy)
Source: LBNL estimates based on CBECS 1995, RECS 1993



Equipment stocks and sales. To estimate equipment stocks and turnover for these 21 products, we began with a detailed characterization of residential, office, and other buildings in the federal stock. Total federal floorspace in FY1996 was approximately 3.6 billion square feet[5], with over 90% of this space government-owned and the rest leased. About 22% of total floorspace is residential and another 21% office space. Since lighting and office equipment densities are much higher in office space and lower in residential space, we grouped all other federal building types into a single category ("other"). The Department of Defense (DOD) accounts for about 2/3 of total federal floorspace (including overseas facilities). Civilian agencies predominate in the office category (72% of total office space) while DOD's 325,000 family housing units and 357,000 troop housing units worldwide dominate the residential stock (Morey 1997, DMDC 1997). We assumed that overall floorspace in the federal stock would remain largely unchanged over the analysis period (1998 to 2010).

Unless we had specific data to the contrary, we assumed that equipment saturations and fuel types in federal buildings were similar to their residential and non-residential counterparts in the overall U.S. building stock, as reported in national surveys by the DOE Energy Information Administration. Using the estimated equipment stocks and typical lifetimes, we then inferred annual sales for end-of-life replacement, with an added allowance for new construction and for equipment replacement when the building is renovated or

[5] (1 sq. foot = 0.093 sq. meter)

refurbished. For most residential equipment, federal purchases are projected to be fairly constant; continuing upgrades in military housing generally offset the effects of military downsizing and housing privatization. Lighting equipment purchases are also relatively constant, while office equipment purchases grow steadily (but at a slower rate than in the past). For details, see (Johnson & Harris 2000).

Our analysis focused on the year 2010, the target date for federal agencies to reduce energy intensities in their buildings by 35% compared with 1985 levels (Clinton 1999). For many of the products analyzed, a substantial fraction of today's stock will have been replaced by 2010, although projected annual savings continue to grow after that year.

Energy savings per unit. Average energy savings per unit was based on assumptions used in the cost-effectiveness section of each FEMP purchasing recommendation (DOE/FEMP 1999, on-line at www.eren.doe.gov/femp/ procurement). These published recommendations define:

- a "Base Case" model (generally the least efficient model available or allowed under national efficiency standards),
- a "FEMP Recommended" level (corresponding to the ENERGY STAR® label or the top-25th percentile of efficient products, as required by federal policy), and
- a "Best-Available" level of efficiency, for products commercially available now.

In most cases, we re-interpreted the "typical" energy use and savings values from each FEMP Energy Efficiency Recommendation to also represent an *average* savings/unit for all purchases. Choosing a single value to represent average unit savings may be useful as a simplifying assumption, but it may not reflect a realistic average for larger equipment, such as boilers or chillers. In a few cases, we used our judgment to adjust the typical values published by FEMP to come up with more realistic average savings per unit for all products purchased.[6]

Four Scenarios of Energy Savings

We defined four scenarios to indicate a range of potential program impacts from energy-efficient purchasing, as summarized in Table 1. All four scenarios start from the assumption that some federal purchasing already incorporates energy efficiency, either because equipment is purchased as part of an energy-saving retrofit project or because designers or facility managers are taking into account federal construction requirements or life-cycle costs when installing or replacing equipment. This 20% current practice is the base from which savings are calculated, for all four scenarios.

[6] Similarly, at this stage of the analysis we did not adjust the sum of energy savings for all products to account for likely interactions between heat-load-reducing measures (such as efficient lighting and office equipment) and savings from efficient heating, cooling, and ventilation (HVAC) equipment. In general, reduced loads increase heating energy and lower cooling energy to varying degrees, depending on building size and other characteristics, operating practices, and climate. These simplifying assumptions could be refined in the future, with better data and more detailed calculations.

- At one end of the range, a "Maximum Technical Potential" case (*Scenario I*), assumes that all federal purchases, beginning now, will occur at today's best available efficiency level as identified by FEMP.
- *Scenario II* assumes that all new federal purchases from 2000 on will occur at the efficiency levels recommended by FEMP or required to qualify for the ENERGY STAR® label. Both of these scenarios are included to indicate the upper bound of savings potential, not because we consider them likely to be achieved.
- The most conservative case is *Scenario III*, which assumes that energy-efficient federal purchasing – at an average efficiency that just meets the FEMP recommendations (or ENERGY STAR® label criteria) – will increase gradually to an 80% market share by 2010.
- *Scenario IV*, which we consider the most likely outcome, assumes once again that energy-efficient federal purchasing ramps up to 80% after 10 years, but with average efficiency levels higher than the minimum FEMP recommendation (i.e., halfway between the "Recommended" level and today's "Best-Available" efficiency.) This fourth scenario recognizes that some federal buyers already exceed the FEMP recommended efficiency levels, either because higher efficiency levels are cost-effective in specific cases or because, in practice, buyers often face a limited choice of FEMP-complying models.[7]

Table 1. Summary of Four Savings Scenarios

Scenario	Market Share	Efficiency Level for New Products
I. "Max Tech," Full Penetration	100%	Best-Available (as of today)
II. Recommended Efficiency, Full Penetration	100%	FEMP Recommended (or ENERGY STAR® label)
III. Recommended Efficiency, Rising Penetration	Rising from 20% in 2000 to 80% by 2010	FEMP Recommended (or ENERGY STAR® label)
IV. Above-Recommended Efficiency, Rising Penetration	Rising from 20% in 2000 to 80% by 2010	Average between FEMP (ENERGY STAR®) and Best-Available

For each of the four savings scenarios, a spreadsheet model estimates annual energy savings by product based on four variables: number of units purchased/year, eligibility, energy savings per unit, and program penetration:

Annual Savings = Purchases x Eligibility x Unit_Savings x Penetration

The number of annual purchases is calculated from stock turnover and new construction to replace older buildings, as described above. Eligibility is based on technology and market characteristics; in most cases eligibility was assumed to equal 100% although special assumptions were needed in the case of low-water-use products and some lighting products, to avoid double-counting energy savings (Johnson & Harris 2000). Unit

[7] Note that we did not explicitly increase future efficiencies of either the base case or the FEMP Recommended (or Best Available) products, between now and 2010. We assume that, if there is an increase in the baseline efficiency for some product types due to market forces and/or new DOE efficiency standards, then the FEMP or ENERGY STAR® levels will also be revised, with no net effect on energy savings (at least for the next ten years).

energy savings are based on the cost-effectiveness example in each FEMP recommendation, as noted. Penetration refers to the share of federal purchases that meet or exceed the FEMP efficiency recommendations. For all the scenarios, savings are compared the business-as-usual case that assumes 20% of all federal purchases already represent, on average, an efficiency level that meets FEMP recommendations.

Estimating Savings for Other Non-Residential Equipment

While the energy and cost savings from federal purchases of residential products, lighting, and office equipment were analyzed using a detailed approach described above, savings for an additional group of non-residential products were estimated at a more aggregate level, based on FEMP purchasing recommendations adopted since early 1999. These included electric motors, customer-owned distribution transformers, water-source chillers, commercial-scale rooftop "packaged" air conditioners and unitary heat pumps, commercial boilers, industrial high-intensity discharge (HID) lighting, and commercial downlights.

For most of these product categories, we used two methods to estimate the existing equipment stocks in federal buildings, then chose a final value (using own judgment) between the two results. One method was to estimate equipment saturations for the federal floorspace served by that equipment type, starting with data from the 1995 CBECS survey (DOE/EIA 1998a). A second method started with total US shipments of that product type according to the 1998 Economic Census (DOC 1999), and estimated the federal share of purchases using the ratios of federal to total floorspace from CBECS (i.e., floorspace served by that equipment type). In some cases, only one of these options was available. For two products (motors and transformers), we had to simplify the calculation even further, starting with estimates of total energy for that end-use, rather than stocks * unit-energy-consumption (Dieckmann et al. 1999, Easton 1996, Resource Dynamics 1994). This end-use estimate was multiplied by the fraction of today's stock that would be replaced (or added) between now and 2010 (based on typical lifetimes), and the typical percentage savings from buying more efficient new or replacement products

There are other products for which FEMP is currently developing (or planning) energy-efficient purchasing recommendations; including them would further increase the estimated program savings by 2010. Examples include additional types of HVAC equipment, building components such as architectural glazing, commercial refrigeration and food preparation equipment, and common laboratory equipment such as fume hoods. Another area for future refinement in our savings estimates would be to account explicitly for interactions among building envelope, load, and systems improvements.

Government Purchasing by State and Local Agencies

While federal purchasing of energy-related products plays an important role in the U.S. market, purchases by state and local agencies (including schools) are, in aggregate, perhaps 3-5 times larger. These non-federal government and institutional buyers are being targeted by a relatively recent initiative on Energy Star Purchasing, cosponsored by EPA and DOE with active involvement of the utility-sponsored Consortium for Energy Efficiency

(CEE 2000, Hlavac 1999). This program encourages state and local agencies to adopt purchasing policies similar to those of the federal government, based wherever possible on the same efficiency criteria (ENERGY STAR® labels and FEMP recommendations) in order to maximize the market impact of buyer demand for efficiency.

Because of the potential importance of state and local purchasing, a third stage of our analysis uses a consistent methodology (including the same four scenario definitions) to estimate future savings from energy-efficient purchasing outside the federal sector.[8] The spreadsheet model in this case starts with estimated energy by end-use for both government-owned residential buildings (mainly public housing) and non-residential buildings (state/local government offices, schools and colleges, hospitals, prisons, warehouses, and others) based on data from EIA national surveys (DOE/EIA 1995a, 1995b, 1998a). We then multiply these end-use energy estimates by: (1) the range of efficiency improvements per unit (using the same assumptions as above) for FEMP and ENERGY STAR® labeled products), (2) the fraction of equipment stock turnover expected by 2010, and (3) by the assumed market penetration rates (as defined above) for each of the four scenarios.

Energy Cost Savings

We translated annual site energy savings in the year 2010 into energy cost savings, using the current level of average domestic energy prices paid by federal agencies: \$0.06/kWh of electricity and \$0.40/therm of gas. For those products that use both gas and electricity (e.g., to heat water for clothes washers and dishwashers), we calculated the energy costs separately for each water-heating fuel. All values are expressed in 1996 dollars, with no price escalation for future prices, nor any discounting of future costs to present-value.[9] Note that the annual cost savings in 2010 refer to reductions in energy costs only, and do **not** reflect net cost savings to the agency, after taking into accounting the added purchase price of more efficient equipment.

Greenhouse Gas (CO_2) Emissions Savings

Reducing emissions of carbon dioxide (CO_2), a greenhouse gas that contributes to climate change, is an important goal for the nation and for the federal sector in particular (Clinton 1999). Energy-efficient purchasing is one of many energy-saving measures that can significantly lower atmospheric carbon emissions from electricity generation and direct fuel use. To estimate the avoided CO_2 emissions associated with buying energy-efficient products, we used DOE's standard assumptions for analyzing savings from energy efficiency programs in the buildings sector (DOE 1999). DOE uses a single, nationwide average emissions coefficient for CO_2, expressed in metric tons of carbon (MT_C): 50.34 $\times 10^3$ MT_C/TBtu (site) for electricity savings and 14.40 $\times 10^3$ MT_C/TBtu for natural gas savings. While beyond the scope of this study, a more detailed analysis might account for differences between the nationwide power generation mix and the generation sources of electricity purchased by federal agencies (on average or at the margin, either nationally or by region).

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[8] For earlier estimates of potential savings from purchases of ENERGY STAR® labeled products, see (Raynolds 1998) and (Dolin and Raynolds 1998).

[9] However, the cost-effectiveness example included in each FEMP Efficiency Recommendation does discount the stream of future energy costs and savings over the expected lifetime of each product.

Results: Energy, Cost, and CO_2 Savings from Government Purchasing

Federal Sector Savings

Estimated annual savings in 2010 for federal purchases within the first group of 21 products (residential appliances/equipment, lighting, and office equipment) range from 8.2 to 30.8 trillion Btu (TBtu, site energy) for the four scenarios (**Table 2**). The corresponding energy cost savings range from $119 million to $426 million/year. Additional savings for the second group of non-residential HVAC and lighting products increases federal savings in 2010 by nearly one-third, to a new total of 10.5-41.8 TBtu/year (site), depending on the scenario. Similarly, total federal cost savings for both groups of products amounts to $160-620 million/year.

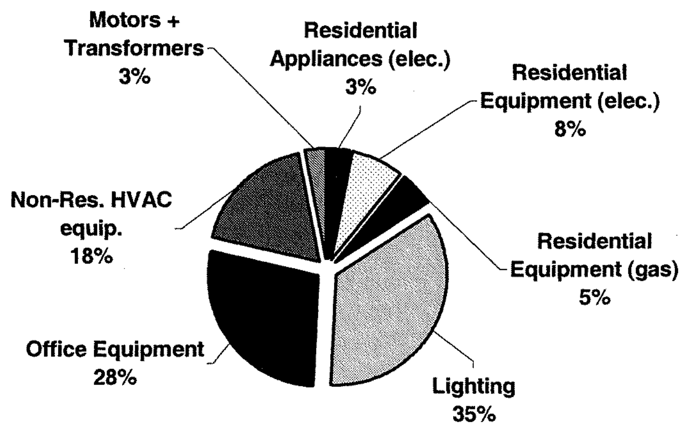
To put this in perspective, energy consumption in federal buildings was 360 TBtu (site) in FY1996 and while agencies spent about $3.6 billion to buy electricity and fuel for their facilities. Thus, the projected savings from energy-efficient purchasing represent 3% to 12% of today's energy use in federal buildings, and 4-17% of federal energy costs. Equally significant, the projected savings from federal purchases of these energy-efficient products represent 6-21% of the total energy savings that agencies must achieve between now and 2010 in order to meet the 35% savings goal for federal facilities (compared with a 1985 base), as mandated in the 1999 Executive Order.[10]

The contributions to total savings by each major category of equipment are shown in **Figure 2**. In this case, we used energy cost savings for comparison, rather than (site) energy, since the unit costs (and greenhouse gas impacts) of electricity and fuel differ dramatically when both are expressed as site Btu. Figure 2 shows that purchases of energy-efficient lighting products alone (mainly improved fluorescent luminaires and ballasts) account for about one-third of all site energy savings in 2010. As with the other product categories, these savings include some effects of other programs, such as the Federal Relighting Initiative, energy-efficient new construction, and lighting retrofit projects financed through Energy-Savings Performance Contracts (ESPCs), as well as the impact of the FEMP program on energy-efficient purchasing. ENERGY STAR® office equipment with low standby power is a second important source of total savings – provided that the equipment is properly set up, with power-saving features "enabled." Purchases of efficient non-residential HVAC equipment are a third major source of savings, as shown in Figure 2.

[10] This estimate is derived from the DOE/FEMP Annual Report (DOE/FEMP 1998). Overall, federal facilities have achieved a 15.2% savings in energy intensity (site Btu/sq.ft.) since 1985; this leaves another 20% savings in site energy/sq.ft. still to be realized, or a total of 148 TBtu to be saved in all federal facilities. To use this number for comparison, we made the simplifying assumption that both total federal floorspace and fuel mix (electricity vs. natural gas or other fuels) will remain constant, from now to 2010.

Table 2: Federal Energy Savings in 2010 by Product for 4 Scenarios (Trillion Btu/year, site)				
	Scenario I - Max. Tech., Full Penetration	**Scenario II - Recommended Efficiency, Full Penetration**	**Scenario III - Recommended Efficiency, Rising Penetration**	**Scenario IV - Above-Recommended Efficiency, Rising Penetration**
A. Detailed Analysis (stock/turnover)				
Residential Appliances (Elec.) *standard + compact refrig., room AC, dishwashers + clothes washers*	*1.3*	*0.5*	*0.2*	*0.4*
Residential Equipment (Elec.) *central AC, air-source HP, elec. WH, water-saving products*	*3.3*	*1.2*	*0.5*	*1.0*
Residential Equipment (Gas) *gas furnaces, gas WH, dishwashers + clothes washers*, water-saving products*	*8.4*	*4.9*	*1.9*	*2.7*
Office Equipment *PCs, monitors, printers, copiers, fax machines*	*6.8*	*4.2*	*2.7*	*3.5*
Basic Lighting Products** *fluorescent tubes + ballasts, fluor. luminaires, exit signs, CFLs*	*11.0*	*8.3*	*3.0*	*3.9*
Subtotal, 21 Products	**30.8**	**19.2**	**8.2**	**11.6**
B. Non-residential Bldg. Equip.				
Additional Lighting Equipment *comm'l downlights, industrial HID*	*1.9*	*0.9*	*0.3*	*0.5*
Non-Residential HVAC Equipment *chillers, rooftop AC and heat pumps, boilers*	*8.0*	*4.3*	*1.6*	*2.3*
Other Electrical Equipment *motors, distribution transformers*	*1.1*	*0.9*	*0.3*	*0.4*
Subtotal, Non-Res. Bldg. Equip.	**11.0**	**6.2**	**2.3**	**3.2**
TOTAL, ALL PRODUCTS	**41.8**	**25.4**	**10.5**	**14.8**
Savings as a Percent of All Energy Use in Federal Buildings, FY 96 (=359 TBtu, site)	*11.6 %*	*7.1 %*	*2.9 %*	*4.1 %*
Savings as a % of post-2000 Energy Reductions Needed to Meet Federal Buildings Goals for 2010 (=148 TBtu, site)	*28.2%*	*17.2 %*	*7.1 %*	*10.0 %*

Figure 2. Components of Federal Energy Cost Savings in 2010 (Scenario IV, total = $224 M/yr)



Savings from State and Local Purchasing

Estimated savings for state and local purchasing of efficient products (including ENERGY STAR® labeled products) are summarized in **Table 3**, using the same four scenarios and other assumptions comparable to our analysis of savings in the federal sector. Energy savings for energy-efficient purchasing by state and local agencies (including schools and public universities) range from 42 to 149 TBtu/year (site) in 2010. Depending on the scenario, this is 3-4 times larger than corresponding federal savings. The breakdown of savings by type of equipment differs somewhat from our results for the federal government. This is due to the differing composition of the building stock and different end-use shares (e.g., public housing vs. military family housing), as well as the importance of school buildings (with their daytime, part-year occupancy and low process loads) in the state/local sector.

Aggregate Cost Savings and Reduced Greenhouse Gas (CO_2) Emissions

A combined summary of our estimated energy cost savings in 2010 for energy-efficient purchasing by both federal agencies and state/local governments is found in **Table 4** and shown graphically in **Figure 3**. Combined savings for all government-sector purchasing range from $850 million to over $3 billion/year for the four scenarios; with state and local agencies responsible for about 80% of this total. As expected, savings from non-residential equipment purchased by government agencies are significantly greater than savings from residential products. The latter are purchased mainly for military housing (federal), public housing and college dorms (state/local), and for smaller buildings at all levels of government.

We consider Scenario IV to be the most likely case – assuming a large-scale effort to implement energy-efficient purchasing at all levels of government. For this Scenario, in 2010, annual energy cost savings to the public treasury could exceed $1 billion.

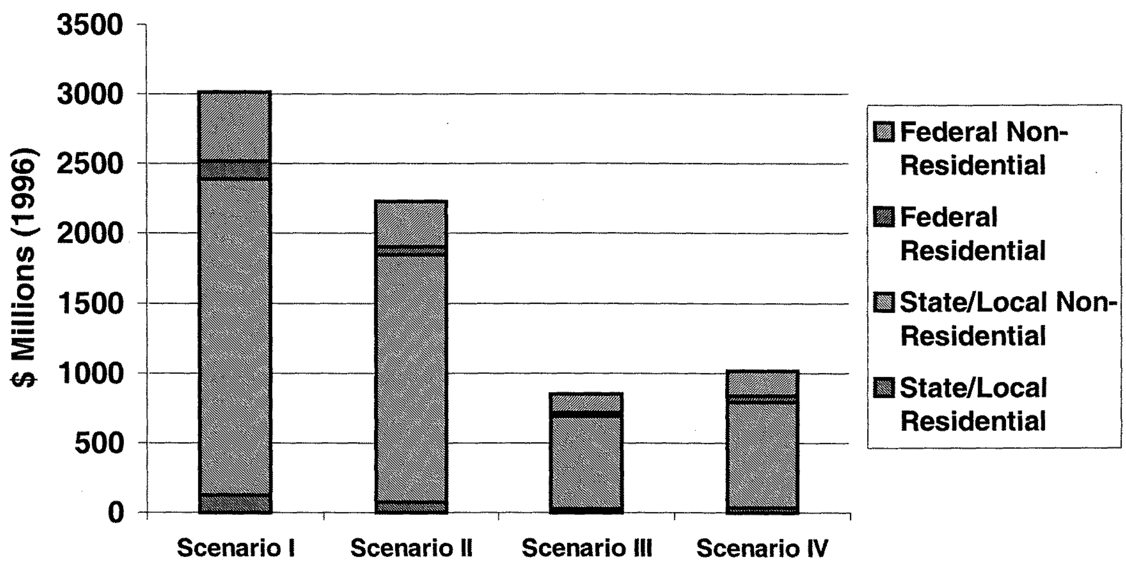
Table 3: State and Local Government Energy Savings in 2010* (Trillion Btu/year, site)				
	Scenario I - Max.Tech., Full Penetration	**Scenario II - Recommended Efficiency, Full Penetration**	**Scenario III – Recommended Efficiency, Rising Penetration**	**Scenario IV – Above-Recommended Efficiency, Rising Penetration**
A. Residential – Public Housing				
Residential Appliances (Elec.) *standard + compact refrigerators, room AC, dishwashers + clothes washers*	*1.5*	*0.8*	*0.3*	*0.4*
Residential Equipment (Elec. + Gas) *central AC, air-source HP, elec. + gas WH, water-saving products*	*6.8*	*3.8*	*1.4*	*2.0*
Residential Lighting *CFLs*	*1.4*	*1.4*	*0.5*	*0.5*
Subtotal, Residential	**9.7**	**6.0**	**2.2**	**2.9**
B. Non-Residential – Government Offices, Schools, Hospitals, Other				
Lighting Equipment *fluorescent tube luminaires, down-lights, industrial HID, exit signs*	*74.4*	*63.9*	*24.0*	*25.9*
Office Equipment *PCs, monitors, printers, copiers, fax machines*	*31.8*	*22.1*	*8.3*	*10.1*
Non-Residential HVAC Equipment *chillers, rooftop AC and heat pumps, boilers*	*30.6*	*18.8*	*7.0*	*9.3*
Other Electrical Equipment *motors, distribution transformers*	*2.6*	*2.1*	*0.8*	*0.9*
Subtotal, Non-Residential	**139.4**	**106.8**	**40.0**	**46.2**
TOTAL, ALL PRODUCTS	**149.1**	**112.8**	**42.3**	**49.1**
Savings as a % of All Energy Use in State/local Government Buildings (=1307 TBtu, site)	*11.4%*	*8.6%*	*3.2%*	*3.8%*

* Excludes non-buildings energy use in water supply and treatment, streetlights, traffic signals, etc.

Table 4. Summary of Annual Energy Cost Savings in 2010 from Energy-Efficient Government Purchasing: Federal, State, and Local ($ millions)				
	Scenario I - "Max Tech," Full Penetration	Scenario II – Recommended Efficiency, Full Penetration	Scenario III – Recommended Efficiency, Rising Penetration	Scenario IV - Above-Recommended Efficiency, Rising Penetration
A. Federal Residential *(military + civilian housing)*	$ 129	$ 57	$ 24	$ 44
B. Federal Non-residential *(offices, other)*	$ 493	$ 324	$ 135	$ 180
C. State/Local Residential *(public housing)*	$ 123	$ 77	$ 29	$ 38
D. State/Local Non-Residential *(offices, schools, hospitals, other)*	$ 2268	$ 1770	$ 664	$ 757
TOTAL GOVERNMENTAL COST SAVINGS	$ 3013	$ 2228	$ 853	$ 1019

Greenhouse gas (CO_2) emissions reductions associated with these energy savings closely follow the patterns of dollar savings in energy costs. Projected annual reductions in 2010 range from 2.4 to 8.6 million metric tons of carbon (MMT_C) for the four scenarios, for government purchasing at all levels, combined. Savings amount to 2.9 MMT_C /year for the "most likely" case (Scenario IV).

Figure 3. Energy Cost Savings in 2010: Federal + State + Local Purchasing



Discussion and Conclusion

Empirical Evidence for Scenario Assumptions

In developing these savings estimates we had to make a number of assumptions; some potential program impacts were not considered due to limited data or because they are inherently difficult to quantify. The choice of four scenarios to describe a range of possible energy saving outcomes was partly in response to the limited data available on actual purchasing practices.

While we used our judgment in defining the four savings scenarios, we also made use of some empirical evidence, including feedback from federal buyers. First, there were quantitative indicators on the dissemination and use of FEMP's energy efficiency recommendations, which are distributed to federal buyers both on-line and in printed form. Over the past three years, more than 3000 copies of the FEMP publication "Buying Energy-Efficient Products" have been distributed on request to federal employees. A much smaller number of requests have come from non-federal buyers, manufacturers or distributors, and others, including government and private sector organizations outside the U.S. Activity on the FEMP Web site quadrupled between summer 1998 and summer 1999, to a current level of about 20,000 "page views" and roughly 6,000 visitors per month. While most of these are from government agency personnel, individuals from more than 50 foreign countries have also visited the site within the past year.

FEMP continues to receive positive feedback from other federal agencies on its energy-efficient procurement program and the efficiency recommendations in particular. In late 1997, FEMP organized a series of focus groups with purchasers, specifiers, and facility energy managers from 11 federal agencies. This group endorsed the overall approach and called for FEMP to establish efficiency recommendations for additional product categories, mainly for non-residential equipment (which the program has, in fact, emphasized since that time). An interagency survey conducted for FEMP in Fall 1998 found that energy-efficient procurement accounted for well over half of all energy-saving projects or activities undertaken by agencies in response to FEMP outreach programs and services.

Perhaps most significantly, the FEMP energy efficiency criteria have started to be adopted by other agencies as part of their guide specifications for new construction and renovation projects (Coleman & Shaw 2000). Through an interagency project coordinated by the National Institute of Building Sciences, several agencies are incorporating the FEMP criteria in their guide specs as part of an effort to consolidate and update existing, diverse federal specs. Recently, the US Navy changed their guide specifications for non-residential lighting, exit signs, and distribution transformers to match the DOE efficiency criteria. Based on the volume of military construction in one year alone (1998), these Navy guide specs should save an estimated $1.2 million/year in reduced electricity use by 500,000 efficient (T-8) fluorescent lamps, 200,000 electronic ballasts, and 20,000 LED exit signs. Similarly, the Army Corps of Engineers, which designs and specifies up to $1.5 billion of construction work annually, has updated its guide spec to incorporate the FEMP criteria for energy-efficient chillers. These same chiller efficiency criteria are being included, along with other energy and environmental features, in a new guide spec developed jointly by Arcom

MasterSpec and Green Seal, a non-profit environmental group. The MasterSpec documents are used extensively in GSA construction, and are also in widespread use by private architecture and engineering firms. Finally, GSA and DOE recently used the FEMP efficiency recommendation for chillers in issuing a Basic Ordering Agreement, a streamlined procurement process designed for use by any government agency.

Given these specific examples, as well as the renewed emphasis on energy-efficient purchasing in Executive Order 13123 (June 1999), we believe that the assumptions used in the four scenarios cover a plausible range of implementation rates for the FEMP purchasing recommendations, and that Scenario IV represents the most likely path for implementation and results in the next few years.

Purchasing Policies Interact with Other Programs

We found that there was no credible way to separate the impact of other energy efficiency policies and programs from those of the FEMP purchasing program. One notable example is the EPA/DOE ENERGY STAR® labeling program. FEMP has made every effort to assure that the same efficiency levels are used for both ENERGY STAR® labeling and energy-efficient federal purchasing, in order to send the strongest possible market signal to other buyers and to suppliers. As a result, there is no practical way to separate out the effects on federal purchasing decisions of FEMP's efficiency recommendations *vs.* the ENERGY STAR® product labels themselves. The two reinforce each other: labels make it easier for federal (and other) buyers to identify and select efficient products, while government policies in support of energy-efficient purchasing make it more attractive for manufacturers and retailers to upgrade their products' energy efficiency and to join the Energy Star program.

Energy savings performance contracts (ESPCs) are another important contributor to the increased efficiency of federal equipment. Moreover, under federally negotiated "area-wide agreements," many government facilities can obtain energy efficiency financing and other services from the utilities that deliver their gas and electricity. Federal agencies' use of both ESPC and utility-based project financing is on the increase, especially for non-residential lighting. FEMP expects both ESPC and utility programs to make significant contributions to federal energy savings by 2010 (DOE/FEMP 1998). In some cases, the savings we attribute to federal purchases of efficient equipment may actually be implemented through ESPCs and utility area-wide programs. However, at the present time a typical ESPC project involves at least $1 million of capital investment, and the great majority of federal equipment purchases probably occur at a much smaller scale.

The FEMP program for energy-efficient procurement represents an opportunity not only to save energy and money within the federal sector, but also to significantly influence the broader U.S. market because of the high profile of the federal government as a purchaser. Manufacturers, distributors, retailers, vendors, and other commercial actors are likely to keep an eye on important trends in demand by their largest customer – especially if this is closely coupled with similar policies and purchasing criteria at the state and local levels. Finally, several other countries are starting to take notice of the market-leadership role and the opportunity for direct energy and costs savings represented by the FEMP program government purchasing initiatives in the U.S. A survey of purchasing and other public sector energy efficiency programs in many industrial and developing countries suggests that, up to now, little attention has been paid to these opportunities for energy savings and market leadership by the public sector itself (Borg et al. 1997).

Conclusion

This paper has developed a consistent and comprehensive framework for estimating the energy, cost, and carbon saving impacts of energy-efficient purchasing at the federal, state, and local levels. The first level of detailed analysis included twenty-one products commonly purchased by federal agencies, representing energy end-use categories that account for about one-fourth of (site) energy consumption in federal buildings. Additional products (non-residential equipment and lighting) were analyzed in less detail. Combined, the estimated annual savings in 2010 for these products represent about 3-12% of current federal energy use in buildings, and 7-28% of the total savings that remain to be achieved in order to meet the targeted goals for federal facilities in 2010. Extending similar purchasing policies and practices throughout the state and local government sector would increase savings by a factor of three or four, depending on the scenario. Of the four savings scenarios we analyzed, the most likely case represents annual energy cost savings, for all three levels of government, worth over $1 billion/year in 2010 along with reduced CO_2 emissions of about 2.9 MMT_C/year. Clearly, energy-efficient purchasing program can make a major contribution to energy and environmental goals at all three levels of government, while saving taxpayer dollars in the process.

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