Appendix B-2
DETAILS ON INDUSTRIAL SECTOR POLICIES

Category	Policy/Program
Voluntary Industrial Sector Agreements	Voluntary Industrial Sector Agreements

Voluntary Programs	Expanded Challenge programs
	    Motor Challenge and Compressed Air Challenge
	    Steam Challenge
	    CHP Challenge
	Expanded ENERGY STAR Buildings and Green Lights
	Expanded ENERGY STAR and Climate Wise program
	Expanded Pollution Prevention Programs

Information Programs	Expanded assessment programs Expanded labeling and procurement programs

Investment Enabling Programs	Expanded state programs
	    State industrial energy efficiency programs
	    Clean Air Partnership Fund
	Expanded ESCO/utility programs
	    Standard performance contracting (public benefit charges)
	Financial incentives
	    Tax incentives for energy managers
	    Tax rebates for specific industrial technologies
	    Investment tax credit for CHP systems

Regulations	Motors Standards and Certification SIPs/Clean Air Partnership Fund

Research & Development Programs	Expanded demonstration programs
	    NICE3
	Expanded R&D programs
	    Industries of the Future
	    Other OIT R&D programs

	Domestic carbon dioxide emissions cap and trade system

Category: Voluntary Industrial Sector Agreements
Policy: Voluntary Industrial Sector Agreements

Voluntary industrial sector agreements are agreements between government and industry to facilitate voluntary actions with desirable social outcomes, which are encouraged by the government, to be undertaken by the participants, based on the participants self-interest (Story, 1996). A voluntary agreement can be formulated in various ways; two common methods are those based on specified energy efficiency improvement targets and those based on specific energy use or carbon emissions reduction commitments. Either an individual company or an industrial subsector, as represented by a party such as an industry association, can enter into such voluntary industrial sector agreements.

In this study, the voluntary industrial sector agreements are defined as a commitment for an industrial partner to achieve a specified energy efficiency improvement potential over a defined period. The level of commitment, and hence specified goal, varies with the moderate and advanced scenario. The number and degree of supporting measures also varies with the two scenarios, where we expect the increased industrial commitment to be met with a similar increased support effort by the federal and state government. The effectiveness of voluntary agreements is still difficult to assess, due to the wide variety and as many are still underway. Ex-poste evaluations are therefore not yet available. We estimate the effect on the basis of various efforts undertaken. Voluntary industrial agreements in Japan and Germany are examples of self-commitments, without specific support measures provided by the government. Industries promised to improve energy efficiency by 0.6% to 1.5% per year in those countries (IEA, 1997a; Stein and Strobel, 1997). As the targets are set by sub-sector, only intra-sector structural changes are included in the targets, while inter-sector structure changes are excluded. The voluntary industrial sector agreements in The Netherlands have set an efficiency improvement goal of 2% per year (Nuijen, 1998; IEA, 1997b), excluding intra- and inter-sector structural change. Industries participating in the voluntary agreements in The Netherlands receive support by the government, in the form of subsidies for demonstration projects and other programs (Rietbergen et al., 1998). For more details on voluntary industrial sector agreements, see Newman (1998); Rietbergen et al., (1998); Nuijen (1998); Mazurek et al. (1999).

Experience with industrial sector voluntary agreements exists in the U.S. for the abatement of CFC and non-CO2 GHG emissions through the EPA Environmental Stewardship programs. For example, eleven of twelve primary aluminum smelting industries in the U.S. have signed the Voluntary Aluminum Industrial Partnership (VAIP) with EPA to reduce PFC emissions from the electrolysis process by almost 40% by the year 2000 (U.S. EPA, 1999b). Similar programs exist with the chemical, magnesium and semi-conductor industries, as well as voluntary methane emission abatement programs with the coal, oil and natural gas industry. New voluntary efforts include landfill operators and agriculture.

Based on the literature we expect that voluntary industrial sector agreements without support measures are able to achieve energy efficiency improvements of 0.6% to 1.5% per year, excluding the effects of structural change in the economy. AEO 99 assumes energy intensity reductions of 1.0% per year, of which 80%, or 0.2% per year, are due to inter-sector structural change (U.S. DOE-EIA, 1998). Hence, voluntary industrial sector agreements can contribute between 0.4% and 1.3% per year to industrial efficiency improvement. Current voluntary programs in the U.S. cover many areas of industrial energy use. However, no comprehensive programs have been implemented yet, which have a wide coverage of industrial energy users, as well as a definition of commitments by industry and the (federal) government.

Business-As-Usual Scenario:

Current Policy/Program:
No comprehensive industrial voluntary agreements are assumed in the BAU scenario, beyond the existing programs and initiatives.

Current Funding Level:
No comprehensive industrial voluntary agreements are assumed in the BAU scenario, beyond the existing programs and initiatives.

Business-As-Usual Scenario Assumptions:
No comprehensive industrial voluntary agreements are assumed in the BAU scenario, beyond the existing programs and initiatives.

Moderate Scenario:

Timing and Funding Level:
In the moderate scenario we assume the implementation of voluntary industrial sector agreements to reduce industrial sector energy intensity. The voluntary agreements are primarily directed to energy intensive industries, and are made between the government (or government agency) and mainly individual companies, although some sector industrial associations are expected to be active in the discussion and the implementation of voluntary agreements.

Description of Program Expansion:
The voluntary industrial sector agreements are expected to be implemented by 2003, for the period until 2020. In the moderate scenario we assume a contribution equal to an energy efficiency improvement of 0.5% per year over the baseline scenario. Most of the improvements will be found in the energy intensive sectors, and energy intensive energy users in the other sectors (e.g. sugar mills in the food industry).

Modeled in CEF-NEMS?
The voluntary industrial sector agreements will lead to increased TPCs in existing equipment, increased TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, increased use of recycled materials, improved building energy efficiency, and increased use of cogeneration in all sectors in the CEF-NEMS model.

Advanced Scenario:

Timing and Funding Level:
In the advanced scenario we assume the implementation of more aggressive voluntary industrial sector agreements to reduce it s energy intensity. The voluntary agreements will cover most industrial sub-sectors (including mining, construction and parts of agriculture), and are made between the government (or government agency) and individual companies (in the energy intensive sectors), and industrial associations for the non-energy intensive industries, or those industries with a large number of companies. The voluntary industrial sector agreements are assumed to cover most of industrial energy use in the U.S. The energy intensive industries are expected to take part in the program in the first years of the scenario, followed by the other sectors throughout the period until 2005.

Description of Program Expansion:
The program is a significant expansion of the program defined under the moderate scenario. The participation of light industries, through their associations and large companies, will increase the coverage to about 80% of industrial energy use. The program will give investors the opportunity to time investments, reducing opportunity costs, and provide a flexible approach to address GHG emissions. The program will be evaluated in 2010 to estimate the contribution to GHG emission control. Based on

available experiences the program is expected to result in energy efficiency improvements of 1.0%/year in the advanced scenario over the baseline scenario

Modeled in CEF-NEMS?
The voluntary industrial sector agreements will lead to increased TPCs in existing equipment, increased TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, increased use of recycled materials, improved building energy efficiency, and increased use of cogeneration in all sectors in the CEF-NEMS model.

References
IEA, 1997a. Voluntary Actions for Energy-Related CO2 Abatement, International Energy Agency, Paris, France.

IEA, 1997b. Energy Efficiency Initiatives (Volume 1 and 2), International Energy Agency, Paris, France.

Mazurek, J. and Lehman, B., 1999. Monitoring and Verification of Long-Term Voluntary Approaches in the Industrial Sector: An Initial Survey, in *Proceedings of the 1999 ACEEE Summer Study on Energy Efficiency in Industry*. Washington, DC: American Council for an Energy-Efficient Economy.

Newman, J., 1998. Evaluation of Energy-Related Voluntary Agreements, in *Industrial Energy Efficiency Policies: Understanding Success and Failure*. Workshop Organized by the International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June 11-12, 1998.

Nuijen, W., 1998. Long Term Agreements on Energy Efficiency in Industry, in *Industrial Energy Efficiency Policies: Understanding Success and Failure*. Workshop Organized by the International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June 11-12, 1998.

Rietbergen, M., Farla, J., and Blok, K., 1998. Quantitative Evaluation of Voluntary Agreements on Energy Efficiency, in *Industrial Energy Efficiency Policies: Understanding Success and Failure*. Workshop Organized by the International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June 11-12, 1998.

Stein, G. and B. Strobel (eds.), 1997. *Policy Scenarios for Climate Protection: Volume 1: Scenarios and Measures for Reduction of CO2 Emissions in Germany Until the Year 2005*, (in German) Juelich, Germany: Forschungszentrum Juelich.

Story, M., 1996. *Demand Side Efficiency: Voluntary Agreements with Industry, Policy and Measures for Common Action*. Paris: Organization for Economic Cooperation and Development (Working Paper 8).

U.S. Department of Energy, Energy Information Administration, 1998. Annual Energy Outlook 1999: With Projections to 2020. (DOE/EIA-0383(99)). Washington, DC: US DOE.

Category: Voluntary Programs
Policy: Expanded Challenge Programs — Motors and Compressed Air Challenge

Business-As-Usual Scenario:
Current Policy/Program:
DOE s Motor Challenge program was created in 1993 to promote voluntary industry/government partnerships to improve energy efficiency, economic competitiveness, and the environment. The program is designed to help industry capture 2 billion kilowatt-hours per year of electricity savings by the year 2000 (U.S. DOE, OIT, 1999) and 9 TWh/yr of electricity savings by the year 2010; these savings will lead to potential energy savings of 82 TWh/yr within industry (65 TWh/year manufacturing, 17 TWh/year non-manufacturing) (Scheihing et al., 1998). The main goal of the program is to work in partnership with industry to increase the market penetration of energy-efficient industrial electric motor-driven systems. The program focuses its resources on the key industrial sectors that are participating in DOE s Industries of the Future (IOF) strategy, as well as the water supply and wastewater sectors. The current Motor Challenge program focuses on eight energy- and waste-intensive sectors: forest products, steel, aluminum, metal casting, chemicals, glass, mining, and agriculture, and is targeting large plants in these industries (Scheihing et al., 1998). Starting in 1999, the Motor Challenge program has been expanded to include provision of enhanced technical assistance on steam and compressed air systems (U.S. DOE, 1999).

A key element in the Motor Challenge strategy is to encourage a "systems approach" to industry s selection, engineering, and maintenance of motors, drives, pumps, fans, and other motor-driven equipment (Scheihing et al., 1998). This approach seeks to increase the efficiency of electric motor systems by shifting the focus from individual components and functions to total system performance. Industry partnership activities being pursued include developing practical guidebooks for pumps, fans/blowers, and air compressors; developing plant application energy management guidelines; and supporting technology-specific design-decision tools that will provide reliable cost/performance data for end-users.

The Compressed Air Challenge, initiated in 1998, is a voluntary collaboration of industrial users; manufacturers, distributors and their associations; facility operating personnel and their associations; consultants; state research and development agencies; energy efficiency organizations; and utilities (U.S. DOE, OIT, 1999). The program aims to stimulate industry to reduce the inefficiencies in the use of compressed air, achieving an overall efficiency improvement of 10% by the year 2002 (STAPPA/ALAPCO, 1999). Compressed air is used extensively as a source of power for tools, equipment, and industrial processes in the chemicals, plastics, glass, pulp and paper, electricity generation, textiles, petroleum, machinery, and metal manufacturing industries. Compressed air systems are often inefficient, modified over time, frequently oversized, and poorly maintained. Optimization of these systems using existing technology could achieve savings of 20—50% of energy use in current systems. Compressed air system improvements can be achieved by eliminating air supply leaks, lowering air supply pressures, and properly maintaining components, supply lines, and filters. Improving system control strategies and operating compressors to match process demands can achieve further savings. The Compressed Air Challenge will develop and deliver information and training, and work to transform the market so that high-efficiency is the norm (U.S. DOE, OIT, 1999).

Current Funding Level:
The budget for Motor Challenge was $6.1M in 1998. In 1999, funding for Motors and Compressed Air Challenge increased to $8M, with associated administrative costs of $0.5M. The requested funding for 2000 is $9M (U.S. DOE, 1999).

Business-As-Usual Scenario Assumptions:
Under the business-as-usual scenario, we assume that funding remains at $8M per year through 2020, with administrative costs of $0.5M. Based on a 2010 ratio of energy savings attributed to the program to national energy savings of 9 TWh/82 TWh, or 11% (Scheihing et al., 1998), we assume energy savings of 2 TWh (6.8 TBtu) in 2000, increasing to 8.3 TWh (28.2 TBtu) in 2010[1] and remaining at that level through 2020. As a result, total energy savings from this program for the 2000 to 2020 period are 139 TWh (474 TBtu) for an average annual savings of 6.6 TWh (22.6 TBtu).

Moderate Scenario:
Timing and Funding Level:
The Motor and Compressed Air Challenge program effort would be fully integrated by 2000, with an increased budget during the period 2000-2020. Beginning in 2000, we assume that the budget is increased by 50% to $12.8M/year including associated administrative costs, remaining at that level through 2020.

Description of Program Expansion:
Under this scenario, the Motor and Compressed Air Challenge program will assist in implementation of overall motor system optimization measures through increased educational efforts and technical assistance and providing training and tools to end users to help achieve potential savings. The program will increase use of adjustable speed drives (ASDs) to ~10% of all manufacturers motor systems by increasing R&D funding for fundamental research (resulting in decreased costs of ASDs), offering financial incentives, offering rebates through utilities based on hp class ($75/hp rebate), and by promoting ESCOs. Under this scenario, the annual energy savings from the Motor and Compressed Air Challenge program is increased by 50% in 2000, growing to 12.5 TWh/year by 2010 and stabilizing at that level through 2020. This results in average annual savings of 10 TWh/year (34.2 TBtu/year) over the 2000-2020 period.

Modeled in CEF-NEMS?
Motors are a cross-cutting technology and are present in all NEMS subsectors. Under the moderate scenario, we assume that the impacts are largest in the industrial sectors that the Motor Challenge program is currently targeting, although savings are spread throughout the manufacturing and non-manufacturing sectors. In CEF-NEMS, expanded Motor and Compressed Air Challenge programs lead to improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

Advanced Scenario:
Timing and Funding Level:
The Motor and Compressed Air Challenge program effort would be fully integrated by 2000, with an increased budget during the period 2000-2020. Beginning in 2000, the budget increases by 100% to $17M /year including associated administrative costs, remaining at that level through 2020.

Description of Program Expansion:
Under the advanced scenario, the Motor and Compressed Air Challenge program will increase ASD use to 18-25% of all manufacturers motor systems using the same policies as in the moderate scenario, except offering greater financial incentives and implementing penalties for non-implementation. Incentives will be promoted and distributed through ESCOs. In addition, overall motor system optimization measures will be implemented using the same policies as the moderate scenario and by providing attractive financial incentives or costly penalties for non-assessment and non-implementation. Under this scenario, the annual energy savings in 2000 are doubled to 4 TWh/year in 2000, growing to 21

[1] Based on assessment by Philip Jallouk at ORNL.

TWh/year by 2010 and stabilizing at that level through 2020. This results in average annual savings of 16.4 TWh/year (56.1 TBtu/year) over the 2000-2020 period.

Modeled in CEF-NEMS?
Under the advanced scenario, we assume that the program is extended to cover the food, cement, construction, and petroleum refining industries. In CEF-NEMS, expanded Motor and Compressed Air Challenge programs lead to improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

References:

Scheihing, P. E., Rosenberg, M., Olszewski, M., Cockrill, C. and Oliver, J. 1998. United States Industrial Motor-Driven Systems Market Assessment, *Industrial Energy Efficiency Policies: Understanding Success and Failure: Workshop Organized by International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June 1998*. Also available on the U.S. DOE, OIT Web Site (http://www.motor.doe.gov/docs/utrecht.shtml).

U.S. Department of Energy, 1999. *FY 2000 Congressional Budget Request: Energy Efficiency and Renewable Energy*. (http://*www*.doe.gov).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *Compressed Air Challenge Web Site*, 15 March 1999 (http://www.knowpressure.org/).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *OIT Motor Challenge Web Site*, 15 March 1999 (http://www.motor.doe.gov/mchal.shtml).

Xenergy, Inc., 1998. *United States Industrial Motor Systems Market Opportunities Assessment*. Prepared for the U.S. Department of Energy s Office of Industrial Technologies and Oak Ridge National Laboratory. Burlington, MA: Xenergy, Inc.

Category: Voluntary Programs
Policy: Expanded Challenge Programs — Steam Challenge

<u>Business-As-Usual Scenario:</u>
Current Policy/Program:
The Steam Challenge program, a public-private initiative launched in April of 1998, was developed by DOE-OIT in partnership with the Alliance to Save Energy (ASE) and leading providers of energy-efficient steam technologies. The goal of Steam Challenge is to provide targeted information and technical assistance to help industrial customers retrofit, maintain, and operate their steam systems more efficiently and more profitably. Steam Challenge helps companies implement a systems approach in designing, purchasing, installing, and managing boilers, distribution systems, and steam applications. The program also helps identify and implement projects that will enhance safety, save money, improve productivity, and reduce emissions. Participation in Steam Challenge is open to steam system operators and managers, developers and distributors of steam systems equipment, and steam trade and membership organizations (U.S. DOE, OIT, 1999).

The tools used in the program include fact sheets, brochures, checklists, guidebooks, software, and case studies. Steam Challenge services include demonstrations, seminars, training, workshops, conferences, access to steam efficiency experts, answers to steam-related questions, and referrals. A Steam Team will enable providers of steam products and services to provide input into the program and help promote "total steam system efficiency". DOE, ASE, and a technical advisory committee review all material before recommending it for use by industry (U.S. DOE, OIT, 1999).

The program aims to reduce overall energy consumption in steam systems by 20% by 2010 (Hart, 1999). A systems approach to improving efficiency taking basic measures to improve efficiency in the generation, distribution, application, operation, and maintenance of systems could achieve efficiency improvements of 30—40% in a typical industrial plant (Jones and Jaber, 1998).

Current Funding Level:
Steam Challenge was funded for $300,000 in FY 1998 and $1.5 million in FY 1999 (Jones, 1999; Hart, 1999). Funding in the near future is expected to remain fairly level (Hart, 1999). The 2000 budget request is for $2M (U.S. DOE, 1999).

Business-As-Usual Scenario Assumptions:
We assume that Steam Challenge is funded at $2M in 2000 and funding remains at this level through 2020. Based on these assumptions, the average annual savings for this program are 5.7 TBtu per year between 2000 and 2020.

<u>Moderate Scenario:</u>
Timing and Funding Level:
In the moderate scenario we assume an increased activity level for the Steam Challenge Program, increasing outreach, training and the development of assessment tools. Starting 2000 the annual budget is $2 million, and will grow to $3 million by 2002, and will be maintained at this level throughout the scenario period.

Description of Program Expansion:
Energy savings in steam use and boilers are important in the moderate scenario and we assume that Steam Challenge plays a catalytic role in this improvement. However, it is difficult to estimate the direct impact of the program. We assume that the energy savings per dollar invested in the program are similar to those seen in the Motor and Compressed Air Challenge program. Based on these assumptions, the average

annual cost of this program is $2.9M per year with associated energy savings of 7.9 TBtu per year between 2000 and 2020.

Modeled in CEF-NEMS?
Steam is used throughout the industry, with an emphasis on the pulp and paper, chemical and food industries, as well as petroleum refining. Steam use is modeled separately in the NEMS model, as is the boiler and cogeneration unit. In CEF-NEMS, expanded Steam Challenge programs lead to increased boiler efficiency and increased use of cogeneration in all sectors.

Advanced Scenario:
Timing and Funding Level:
In the moderate scenario we assume an increased activity level for the Steam Challenge Program, increasing outreach, training and the development of assessment tools. Starting 2000 the annual budget is $2 million, and will grow to $4 million by 2002, and will be maintained at this level throughout the scenario period.

Description of Program Expansion:
In the advanced scenario, the program is expanded to include outreach to smaller boiler users, as well as development of automated monitoring and controls. The development of improved analytic, monitoring and process control tools for boilers and steam distribution will start to pay off after the year 2010, leading to an increased impact by 2020. As with the moderate scenario, we assume that the savings from this program are similar to those seen in the Motor and Compressed Air Challenge program. Based on these assumptions, the average annual cost of this program is $3.8M per year with associated energy savings of 13.0 TBtu per year between 2000 and 2020.

Modeled in CEF-NEMS?
Steam is used throughout the industry, with an emphasis on the pulp and paper, chemical and food industries, as well as petroleum refining. Steam use is modeled separately in the NEMS model, as is the boiler and cogeneration unit. In CEF-NEMS, expanded Steam Challenge programs lead to increased boiler efficiency and increased use of cogeneration in all sectors.

References:
Hart, F., 1999. *Personal communication with Fred Hart*, U.S Department of Energy, Office of Industrial Technologies, Office of Technology Access, 15 March, 1999.

Jones, T. and Jaber, D., 1998. Steaming Ahead, *Energy Manager* (July/August): pp. 61-64

Jones, T., 1999. Personal communication with Ted Jones, Alliance to Save Energy (ASE), 11 March, 1999.

U.S. Department of Energy, 1999. *FY 2000 Congressional Budget Request: Energy Efficiency and Renewable Energy*. (http://www.doe.gov).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *Steam Challenge Web Site*, (http://www.oit.doe.gov/steam/).

Category: Voluntary Programs
Policy: Expanded Challenge Programs — CHP Challenge and Related Activities

Reference Scenario:

Current Policy/Program:

DOE recently announced a target of doubling CHP capacity (including industrial, commercial, and federal facilities) in the United States by 2010, creating an additional 46 GW of capacity. The Department also seeks to open a national dialogue on CHP technologies to raise awareness of the energy, environmental, and economic benefits of CHP, and to promote innovative thinking about ways to accelerate the use of CHP. State and regional officials will be key participants in this CHP Challenge; DOE already has awarded grants for CHP efforts in California, Indiana, Vermont, and Washington. Future plans include a series of seminars with state officials, regional workshops, and a national CHP conference for policymakers and CHP practitioners to promote collaborative solutions (U.S. DOE, OIT, 1999). Educational materials also are being prepared for state legislators and environmental groups (Hoffman, 1999).

The CHP Challenge will coordinate with other government and industry programs to leverage ongoing activities relevant to CHP for example, by working with the Federal Energy Management Program (FEMP) and facilities management agencies to expand the use of CHP technologies in government facilities. The Challenge also will assess related DOE technology demonstrations in advanced turbines, fuel cells, and combustion and heat recovery equipment (U.S., DOE, OIT, 1999). The CCCTI-activities are described later.

Achieving the CHP Challenge Target of 46 additional GW of CHP by 2010 would displace approximately 244 TWh of utility generation, yielding net energy savings of about 1280 Tbtu and reducing carbon emissions by about 37 MMT from current levels (Elliot, 1999). Analyses completed as part of this study indicate that additional market penetration of CHP in the industrial sector by 2020 will range from 30 to 50 GW, depending upon the timing and impact of the CHP policies discussed below.

Current Funding Level:

The CHP Challenge is funded for $1.0 million in FY 1999 and $1.5 million for FY 2000. Anticipated funding levels over the next four years are $2 million annually (Hoffman, 1999).

Moderate Scenario:

Timing:

Private CHP activities have been ongoing for several years. CHP Challenge has been started in 1999, and is assumed to be fully operational by the year 2001. CHP Challenge and related activities over the time frame of the study will emphasize the following policy goals: 1) CHP financing and labeling; 2)˚expanding the CHP and distributed generation R&D portfolio; 3)˚increasing CHP capacity in Federal facilities; 4) removing financial barriers to CHP development; 5)˚expedited siting and permitting for CHP projects; 6) removing utility barriers; and 7) reducing emissions. Together, these policies are expected to increase awareness of the benefits of CHP and provide the main financial stimuli for CHP development. The timing and content of each individual policy goal is discussed in more detail below.

Funding Level:

It is assumed that the funding level will increase to $3 million by the year 2001, and will be maintained at this level throughout the modeling period. Additional assumptions include CHP targeting of grants under the Clean Air Partnership Fund, expanded R&D for CHP technology development and demonstration, and government support of interconnection technology to reduce costs to a ***moderate*** level, as described below. Furthermore, while the investment tax credit requires no direct funding, it is expected to result in revenue loss currently estimated at over $300 million over five years.

Modeled in CEF-NEMS?
Cogeneration is modeled as part of the BSC Module in NEMS. However, the current design of the model does not allow progressive penetration of CHP units to replace existing boilers. To overcome this limitation in NEMS for this study, the potential for CHP generating capacity additions has been estimated based on detailed modeling using a model that is better equipped to estimate development of CHP. The model selected for this purpose was DISPERSE, the Distributed Power Economic Rationale Selection model developed by the Resource Dynamics Corporation. A detailed description of the DISPERSE methodology is included as Attachment A2 to this memorandum.

Detailed Description of Policy Goals
A variety of barriers hamper the implementation of industrial CHP, making barrier removal an important instrument to increase implementation rate. Removal of barriers associated with each of the CHP policy goals is discussed below.

<u>CHP Financing and Labeling</u>. Under this modeling scenario, CHP awareness is encouraged by opening a national dialogue that highlights the efficiency, economic and environmental benefits of CHP. An information dissemination program will include seminars, a national CHP conference, and educational materials for legislators, regulators and environmental groups.

Additional incentives will be provided under the Clean Air Partnership Fund, reserving $100 million annually for 5 years for financial support of CHP projects. This financial support will be in the form of 1)˚buying down the end-user cost of CHP project installation, 2) making available a CHP loan fund at market or better rates, or 3) establishing an indemnification fund for CHP projects determined to be economic but not able to proceed because of liability concerns.

Government technology demonstration programs will be examined for CHP opportunities, with appropriate information transfer to the responsible Government office in charge of the demonstration program.

Under an expanded EPA Energy Star Labeling Program, CHP/DG packaged power generation sets will be labeled as meeting emissions and efficiency criteria. This is expected to remove a great deal of the uncertainty associated with the local and state approval of certain types of power generation equipment.

<u>Expand CHP and Distributed Generation R&D Portfolio</u>. CHP and distributed generation government technology development funding will increase by 50 percent, mostly related to market and technology assessments. Encouragement and acceleration of private commercialization activities will be included in the scope of government technology development projects.

<u>Increase CHP Capacity in Federal Facilities</u>. CHP Program activities will leverage on existing government programs such as FEMP to encourage CHP use in government facilities.

<u>Remove Financial Barriers to CHP Development</u>. This scenario contemplates the implementation of the 8% investment tax credit included in the Administration s FY2000 Budget Proposal. In addition, the CHP equipment asset life will by shortened, beginning in 2002, allowing for faster recovery of project equity investment (see below).

Streamlining eligibility for tax incentives, an expedited certification process will be established for CHP projects meeting efficiency and heat/power share criteria for the incentives. End-user self-qualification of a facility for financial incentives, potentially bypassing a lengthy and potentially costly third-party or government certification process, will also be allowed.

Expedited Siting and Permitting for CHP Projects. By 2002 provide guidance to state agencies on establishing faster CHP permitting processes, encouraging arrival of new capacity online earlier. This activity will leverage on development of a handbook and conduct of workshops for states by the EPA. Incentives include establishment of a public benefits fund which would be available to states on a cost-sharing basis to support the implementation of streamlined CHP siting and permitting practices.

Remove Utility Barriers. By 2002, enactment of a national interconnection standard for CHP and other distributed generation projects, easing the interconnection process. Additionally, the FERC shall be positioned as the final arbiter for interconnection disputes. While a national interconnection standard will simplify the interconnection, additional government support will focus on development of advanced interconnection packages and technologies, leveraging on industrial R&D to realize a ***moderate*** installed cost of the interconnection (25 percent less than cost of the interconnection today).

Additionally, the mandated availability of backup power at reduced cost, or allow customer shopping for competitively-priced backup power.

Reduce Emissions. No activities under the Moderate Scenario.

Advanced Scenario:

Timing:

In the advanced scenario, CHP Challenge efforts are expected to be doubled over the baseline scenario. It is assumed that this doubling will start at the beginning of the modeling period (2000-2001), and will be maintained throughout the period until 2020. CHP Challenge and related activities over the time frame of the study will emphasize the following policy goals: 1) CHP financing and labeling; 2) expanding the CHP and distributed generation R&D portfolio; 3)˚increasing CHP capacity in Federal facilities; 4)˚removing financial barriers to CHP development; 5)˚expedited siting and permitting for CHP projects; 6)˚removing utility barriers; and 7) reducing emissions. These policies, expected to increase awareness of the benefits of CHP and provide the main financial stimuli for CHP development, are discussed in more detail below.

Funding Level:

It is assumed that the funding level will increase to $4 million by the year 2001, and will be maintained at this level throughout the modeling period. This is effectively a doubling of the effort under the baseline scenario. Additional assumptions include expanded CHP targeting of grants under the Clean Air Partnership Fund, a doubling of R&D for CHP technology development and demonstration, and government support of interconnection technology to reduce costs to a very low level, as described below. The investment tax credit revenue, if extended beyond year 2003, will result in a cumulative revenue loss in excess of the $300 million currently estimated.

Modeled in CEF-NEMS?

Cogeneration is modeled as part of the BSC Module in NEMS. However, the current design of the model does not allow progressive penetration of CHP units to replace existing boilers. To overcome this limitation in NEMS for this study, the potential for CHP generating capacity additions has been estimated based on detailed modeling using a model that is better equipped to estimate development of CHP. The model selected for this purpose was DISPERSE, the Distributed Power Economic Rationale Selection model developed by the Resource Dynamics Corporation. A detailed description of the DISPERSE methodology is included as Attachment A2 to this memorandum. In the advanced scenario, a relatively larger penetration of small CHP systems is expected, using technology advances which improve the performance of microturbines, some gas turbine designs, as well as fuel cells and modern reciprocating engines.

Detailed Description of Policy Goals

A variety of barriers hamper the implementation of industrial CHP, making barrier removal an important instrument to increase implementation rate. Removal of barriers associated with each of the CHP policy goals is discussed below.

CHP Financing and Labeling. Under this modeling scenario, CHP awareness is encouraged by opening a national dialogue that highlights the efficiency, economic and environmental benefits of CHP. An information dissemination program will include seminars, a national CHP conference, and educational materials for legislators, regulators and environmental groups.

Additional incentives will be provided under the Clean Air Partnership Fund, reserving $200 million annually expanding beyond 2005 for financial support of CHP projects. This financial support will be in the form of 1)˚buying down the end-user cost of CHP project installation, 2) making available a CHP loan fund at market or better rates, or 3) establishing an indemnification fund for CHP projects determined to be economic but not able to proceed because of liability concerns.

Government technology demonstration programs will be examined for CHP opportunities, with appropriate information transfer to the responsible Government office in charge of the demonstration program.

Under an expanded EPA Energy Star Labeling Program, CHP/DG packaged power generation sets will be labeled as meeting emissions and efficiency criteria. As a further incentive under the Advanced Scenario, high efficiency, low emissions packaged generation sets will be qualified as presumptive BACT.

Expand CHP and Distributed Generation R&D Portfolio. CHP and distributed generation government technology development funding will double, focusing on increased efficiency, reliability improvement, and cost reduction, all at levels beyond current anticipated 2010 performance goals.

Increase CHP Capacity in Federal Facilities. The use of CHP in government facilities will be mandated when technically and economically feasible, during new construction or facility upgrades.

Remove Financial Barriers to CHP Development. In this scenario, the investment tax credits included in the Administration s FY2000 Budget Proposal will be extended beyond 2003, and accelerated depreciation allowed on the remaining basis of property (see below).

Streamlining eligibility for tax incentives, an expedited certification process will be established for CHP projects meeting efficiency and heat/power share criteria for the incentives. End-user self-qualification of a facility for financial incentives, potentially bypassing a lengthy and potentially costly third-party or government certification process, will also be allowed.

Expedited Siting and Permitting for CHP Projects. Through the Clean Air Partnership Fund, 1) increase state grants to encourage streamlined CHP siting and permitting, and 2) favor grants to states with accelerated CHP siting and permitting. The goal will be to harmonize the siting and permitting processes across the states to remove the uncertainty associated with widely varying requirements and procedures.

Remove Utility Barriers. Exempt CHP projects from any exit fees and other charges applicable when becoming a self-generator. Allow recovery of costs associated with conversion of stranded generation assets to CHP.

By 2002, enactment of a national interconnection standard for CHP and other distributed generation projects, easing the interconnection process. Additionally, the FERC shall be positioned as the final arbiter for interconnection disputes. While a national interconnection standard will simplify the interconnection, additional government support will focus on development of advanced interconnection packages and technologies, leveraging on industrial R&D to realize a ***very low*** installed cost of the interconnection (50 percent less than cost of the interconnection today).

Additionally, the mandated availability of backup power at reduced cost, or allow customer shopping for competitively-priced backup power.

Reduce Emissions. Establishment of robust Carbon Cap and Trading System, with assumed consequent permit price of $50 per metric ton of carbon. The CHP end-user will benefit from reduced capital cost and/or sales of permit credits. As an additional incentive, the allowance of a greater level of emissions based on the higher CHP efficiency, or the introduction of emissions per BTU input criteria (or some other recognition of greater efficiency levels).

References:

Blok, K., 1993. The Development of Industrial CHP in The Netherlands, *Energy Policy 221* pp. 158-175 (1993)

Elliott, N., 1999. Personal communication with Neal Elliott, American Council for an Energy-Efficient Economy, 15 March 1999 (Spreadsheet: *ACEEE Projected CHP Impacts,* December 22, 1998).

Hoffman, P., 1999. Personal communication with Pat Hoffman, U.S. Department of Energy, Office of Industrial Technologies, Office of Industrial Crosscut Technologies. 12 March 1999.

U.S. Department of Energy, Office of Industrial Technologies, 1999. *CHP Challenge Web Site,* http://www.oit.doe.gov/chpchallenge/).

Category: Voluntary Programs
Policy: Expanded ENERGY STAR Buildings and Green Lights

Business-As-Usual Scenario:
Current Policy/Program:
US EPA s ENERGY STAR labeling programs reduce information barriers and improve willingness to invest in the buildings component (especially important in light industries) of industrial energy use. Energy Star programs are voluntary partnerships between DOE, EPA, product manufacturers, local utilities, and retailers to develop and market energy-efficient products. Partners help promote energy-efficient products by labeling with the ENERGY STAR logo, which may be used as a marketing tool, and educating consumers about the benefits of energy efficiency. The program covers a wide array of domestic appliances, home electronics, windows, lighting, office equipment (computers, monitors, printers, copiers, fax machines, and scanners), and heating and cooling equipment (U.S. EPA, 1999a). Energy Star also has programs for transformers aiming especially at utilities and small businesses. 1600 small businesses participated in the ENERGY STAR Small Business Program in 1998 (U.S. EPA, 1999b). Participating companies are provided with access to information on products and practices to improve their efficiency. EPA will continue to add products to the list of those that qualify for the ENERGY STAR label (U.S. EPA, 1999b).

The Green Lights program, a voluntary pollution prevention program sponsored by EPA and part of the ENERGY STAR program, aims at improving the efficiency of lighting systems. Green Lights partners agree to install energy efficient lighting where profitable as long as lighting quality is maintained or improved. Nearly 1,400 companies have signed up with the Green Lights program, with partners as diverse as 3M, ALCOA, Chevron and Hoechst Celanese.

Annual greenhouse gas emission reductions for these programs are estimated to be 0.00056 MMTCE/square foot of industrial building space. In 1998, 1.44 billion square feet of industrial building space was included in the ENERGY STAR Buildings and Green Lights programs (Lupinacci-Rausch, 1999).

Current Funding Level:
The industrial buildings portion of the ENERGY STAR Buildings program is currently funded at approximately $0.5M per year (Lupinacci-Rausch, 1999).

Business-As-Usual Scenario Assumptions:
We assume that the industrial buildings funding remains at the same level, $0.5M per year, from 2000 to 2020. Beginning in 2000, program costs for the business-as-usual scenario are assumed to total $10.5 M ($0.5M/year) for a total program savings (2000-2020) of 1045 TBtu or an average of 50 TBtu per year.

Moderate Scenario:
Timing and Funding Level:
Under the moderate scenario, we assume that funding is increased by 50%, to $0.75 M per year, maintained at that level through 2020.

Description of Program Expansion:
Future expansion of ENERGY STAR will focus on initiatives that are more valuable to the industrial sector for example, providing best practices management tools to industrial facilities and, if possible, developing and providing benchmarking information to help industries assess and compare their energy usage, and ultimately save energy (Lupinacci-Rausch, 1999). We assume that industrial building floorspace included in the ENERGY STAR Buildings and Green Lights programs increases by 50% under the moderate scenario. Energy savings and carbon dioxide emissions reductions per $ invested are

assumed to be the same as under the business-as-usual scenario. Thus, beginning in 2000, program costs for the moderate scenario are assumed to total $15.8M ($0.8M/year) for a total program savings (2000-2020) of 1567 TBtu or an average of 75 TBtu per year.

Modeled in CEF-NEMS?
Expanded ENERGY STAR Buildings and Green Lights Programs leads to improved building efficiency in CEF-NEMS in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

Advanced Scenario:
Timing and Funding Level:
Under the advanced scenario, we assume that funding is increased by 100%, to $1M per year, in 2000 and maintained at that level through 2020.

Description of Program Expansion:
We assume that the best practice management tools and benchmarking information developed under the moderate scenario are expanded and more extensively marketed to industrial building managers. In addition, industrial building floorspace included in the ENERGY STAR Buildings and Green Lights programs increases by 100% under the advanced scenario. Energy savings and carbon dioxide emissions reductions per $ invested are assumed to be the same as under the business-as-usual scenario. Thus, beginning in 2000, program costs for the moderate scenario are assumed to total $21M ($1M/year) for a total program savings (2000-2020) of 2089 TBtu or an average of 100 TBtu per year.

Modeled in CEF-NEMS?
Expanded ENERGY STAR Buildings and Green Lights Programs leads to improved building efficiency in CEF-NEMS in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

References:
Lupinacci-Rausch, J., 1999. Personal communication with Jean Lupinacci-Rausch, U.S. Environmental Protection Agency, 16 March, 1999 and 16 April , 1999.

U.S. Environmental Protection Agency, 1999a. *Energy Star Web Site*, (http://www.epa.gov/energystar/).

U.S. Environmental Protection Agency, 1999b. *FY 2000 Annual Performance Plan and Congressional Justification*. Washington, DC: U.S. EPA.

Category: Voluntary Programs
Policy: Expanded ENERGY STAR and Climate Wise Programs

Business-As-Usual Scenario:

Current Policy/Program:

U.S. Environmental Protection Agency sponsors various government-industry partnership initiatives, e.g. ENERGY STAR and Climate Wise, designed to stimulate the voluntary reduction of greenhouse gas emissions among participating manufacturing companies by providing technical assistance and helping organizations identify the most cost-effective ways to reduce greenhouse gas emissions. Climate Wise works with individual partner companies that represent almost 12% of U.S. energy use and more than 15% of U.S. manufacturing energy use (EPA, 1999a), including companies of all sizes from diverse industries e.g., Johnson & Johnson, Lockheed Martin, Coors, and Quad/Graphics. In 1998, the Climate Wise partners identified more than 2500 actions to improve efficiency and prevent pollution, which are expected to reduce emissions by nearly 10 million metric tons of CO_2 equivalent and to save $400 million. By the year 2000, Climate Wise partners are expected to comprise half of the cement, pharmaceuticals, food processing, and steel industries (EPA, 1999a).

Within six months of joining the program, companies submit an Action Plan that identifies specific cost-effective energy efficiency and pollution prevention measures. Companies then quantify and report their energy savings and emission reduction numbers annually. In return, participants in the Climate Wise program receive DOE and EPA assistance in identifying actions that both save energy and reduce costs, have access to technical and financial assistance, and receive public recognition for their efforts (e.g., through signing ceremonies, media briefings, articles in business journals). Participating companies also are eligible for energy and waste assessment audits through the Industrial Assessment Centers; consultation with DOE's national laboratories; use of regional resources through state, city, and county pilot programs (e.g., in California, Colorado, New Jersey, and Texas); participation in workshops; and participation in other programs, such as Green Lights, Waste Wi$e, and Motor Challenge (EPA, 1999b).

Climate Wise partners represent most of the manufacturing sectors, as shown in this recent breakdown: cement (3%), printing (5%), pharmaceuticals (5%), lumber and paper (6%), chemicals (6%), metals (8%), food (16%), electrical equipment (19%), and other (32%) (U.S. EPA, 1998).

Current Funding Level:

EPA funding for this program (there is no direct DOE funding) was $1.5 million in FY 1998 and $1.6 million in FY 1999. Funding levels are expected to remain stable in the near future (James, 1999). Estimated annual GHG emissions reductions for 1998 and 1999 are 2.0 MMTCE and 3.0 MMTCE, respectively (U.S. EPA, 1999c).

Business-As-Usual Scenario Assumptions:

We assume that funding levels remain at $1.6M per year from 2000 to 2020, with associate carbon savings of 3.0 MMTCE per year for a total savings of 63 MMTCE for the 2000 to 2020 period.

Moderate Scenario:

Timing and Funding Level:

Under the moderate scenario, Climate Wise programs are increased by 50%, beginning in 2000 and maintained at that level through 2020. A doubling of the Climate Wise programs leads to an annual budget of $2.4M per year beginning in 2000 and continuing at that level through 2020.

Description of Program Expansion:

With increased funding, Climate Wise will continue its state and local government outreach program, and work with the private sector to develop a market for climate neutral products whose emissions are offset through domestic energy efficiency or renewable energy projects (James, 1999). Climate Wise will also encourage the incorporation of renewable power purchase/generation into key partners Action Plans over the next five years (EPA, 1999a), develop a Green Power Initiative to help companies build demand for new green power sources, and work with companies to develop applications for their international facilities (James, 1999). We assume that the budget increase results in carbon savings attributable to this program, of a total of 95 MMTCE, or 4.5 MMTCE per year, for the 2000 to 2020 period.

Modeled in CEF-NEMS?
All of the Climate Wise partner manufacturing sectors are included in the NEMS model, although the mapping between the Climate Wise and NEMS subsectors is not exact. Since Climate Wise efforts are focused on near term GHG emissions reduction actions in these industries, we consider that this program contributes to the savings in both existing equipment and new plant equipment in the NEMS model. In the moderate scenario, we project that Climate Wise partners are expanded in the currently represented manufacturing sectors while additional partners are added in the steel, aluminum, and glass sectors. Expanded Climate Wise programs will lead to increased TPCs in existing equipment and increased TPCs in new equipment in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in the CEF-NEMS model.

<u>Advanced Scenario:</u>
Timing and Funding Level:
Under the advanced scenario, Climate Wise programs are doubled beginning in 2000 and maintained at that level through 2020. A doubling of the Climate Wise programs would lead to an annual budget of $3.2M per year beginning in 2000 and continuing at that level through 2020.

Description of Program Expansion:
In the advanced scenario, we project that Climate Wise partners are expanded in the manufacturing sectors beyond those in the moderate scenario while additional partners are added in the agriculture, construction, and mining sectors. We assume that a doubling of the budget results in equivalent increases in carbon savings attributable to this program, resulting in total savings of 126 MMTCE, or 6 MMTCE per year, for the 2000 to 2020 period.

Modeled in CEF-NEMS?
All of the Climate Wise partner manufacturing sectors are included in the NEMS model, although the mapping between the Climate Wise and NEMS subsectors is not exact. Since Climate Wise efforts are focused on near term GHG emissions reduction actions in these industries, we consider that this program contributes to the savings in both existing equipment and new plant equipment in the NEMS model. Expanded Climate Wise programs will lead to increased TPCs in existing equipment and increased TPCs in new equipment in all sectors in the CEF-NEMS model.

References:
James, K., 1999. *Personal communication with Kevin James*, U.S. EPA, 16 March, 1999.

U.S. Environmental Protection Agency, 1998. *Climate Wise Progress Report*, (231-R-98-015). Washington, DC: U.S. EPA.

U.S. Environmental Protection Agency, 1999a. *FY 2000 Annual Performance Plan and Congressional Justification*. Washington, DC: U.S. EPA.

U.S. Environmental Protection Agency, 1999b. *Climate Wise Website*, (http://www.epa.gov/climatewise/)

U.S. Environmental Protection Agency, 1999c. *1999 Annual Plan*, (http://www.epa.gov/ocfopage).

Category: Voluntary Programs
Policy: Expanded Pollution Prevention Programs

Business-As-Usual Scenario:

Current Policy/Program:

Although not directly aimed at energy use or GHG emissions, the WasteWi$e program may reduce energy use and GHG emissions through pollution prevention and increased recycling of energy intensive materials. The WasteWise program targets the reduction of municipal solid waste, such as corrugated containers, office paper, yard trimmings, packaging, and wood pallets. Participants, range from small local to large corporations, sign on to the program for a 3-year period and commit to waste reduction, establish goals, monitor progress of the activities. Building on their successes during 1997 WasteWise partners conserved nearly 816,000 tons of materials through waste prevention activities in 1996, increasing materials collected for recycling to 7,669,000 tons. Cost savings in the order of $270 million were achieved through avoided disposal tipping fees alone. The reduction in GHG emissions due to reduce material needs and waste management was estimated at 5.2 MtC in 1997 (EPA, 1998). Partners include a large number of manufacturing industries, from nearly all sub-sectors. In 1997 around 700 companies and institutes were a member of the voluntary program, spread across the U.S. EPA has also created the Design for the Environment (DfE) Program to build on the "design for the environment" concept pioneered by industry. Under this program, EPA encourages businesses to incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems, as well as environmentally procurement programs. Note that the Industrial Assessment Centers now also advise on pollution prevention as part of the auditing program (see *expanded assessment programs*).

Current Funding Level:

The total pollution prevention effort by EPA is funded at $25 million in FY1998 and $27 million in FY 1999 (EPA-OCFO, 1999), which includes a variety of voluntary programs. The implementation costs for specific projects of the program partners are not known, and not included in the above estimate.

Business-As-Usual Scenario Assumptions:

We assume that funding for pollution prevention programs grows to $30M in 2000 and remains at that level through 2020. We further assume that 35% of the GHG emissions reductions are due to decreased energy use and the remainder are due to decreased use of materials. Based on these assumptions, total energy savings of 2780 TBtu are realized over the 2000 to 2020 period, for an average of 132 TBtu/year.

Moderate Scenario:

Timing and Funding Level:

The funding level is expected to start growing by the year 2000 by $1.6 million a year until 2010 and remain at $43 million after 2010, resulting in average annual funding of $39.6M for the 2000 to 2020 period.

Description of Program Expansion:

We assume that the funding for pollution prevention programs will increase, and that the number of partners will increase annually. The increased effort of the program is expected to keep pace with the growth over the past years, although slower than the current annual increase of number of partners by 15%. Pollution prevention programs are assumed to achieve this fast implementation rate due to the embedded cost savings for industry (Pye, 1998). Pollution prevention is expected to be implemented throughout industry, following the current initiatives. Especially industries processing materials to produce products are expected to achieve reductions in materials demand by more efficient processing, increased diversion of wastes to recycling instead of landfilling, and process changes leading to reduced processing material needs. This will lead to changing consumption and production patterns in the primary materials industries. Based on the increased funding, total energy savings over the 2000 to 2020 period grows to 3670 TBtu, for an average of 175 TBtu/year.

Modeled in CEF-NEMS?
Pollution prevention programs are expected to be implemented throughout industry, including energy intensive and small industries. The savings will lead to increased recycling rates of materials in the energy-intensive industries, especially in the steel, aluminum, paper and glass industries in the CEF-NEMS model. Pollution prevention may also lead to lower material demand in the processing industries, but this has not been modeled due to the relative small impact yet.

Advanced Scenario:
Timing and Funding Level:
The funding level is expected to start growing by the year 2000 by $1.6 million a year until 2020, and will achieve a total annual budget of $60 million by 2020, resulting in average annual funding of $45M in the 2000 to 2020 period.

Description of Program Expansion:
We assume that the funding for pollution prevention programs will increase, and that the number of partners will increase annually, growing to about 1600 companies by 2020. The increased effort of the program is expected to keep pace with the growth over the past years. We expected an annual growth of 40 new partners in the program. As more smaller companies will join in the future, the cost-effectiveness may somewhat reduce, although this may be offset by learning by doing, and enhanced information exchange within the program. Pollution prevention programs are assumed to achieve this fast implementation rate due to the embedded cost savings for industry (Pye, 1998). Pollution prevention is expected to be implemented throughout industry, following the current initiatives. Especially industries processing materials to produce products are expected to achieve reductions in materials demand by more efficient processing, increased diversion of wastes to recycling instead of landfilling, and process changes leading to reduced processing material needs. This will lead to changing consumption and production patterns in the primary materials industries. Based on the increased funding, total energy savings over the 2000 to 2020 period grows to 4170 TBtu, for an average of 200 TBtu/year.

Modeled in CEF-NEMS?
Pollution prevention programs are expected to be implemented throughout industry, including energy intensive and small industries. The savings will show up as increased recycling rates of materials in the energy-intensive industries, especially in the steel, aluminum, paper and glass industries in the CEF-NEMS model. Pollution prevention may also lead to lower material demand in the processing industries (showing up as lower production or imports of raw materials), but this has not been modeled due to the relative small impact yet.

References
EPA, 1998. Fourth Year Waste Wise Progress Report, Preserving Resources, Preventing Wastes, U.S. EPA, Washington, DC, September 1998.

EPA, OCFO, 1999. Environmental Protection Agency 1999 Annual Plan, Office of the Chief Financial Officer, U.S. EPA (http://www.epa.gov/ocfopage/toc.htm, accessed March 22nd, 1999).

Pye, M., 1998. *Making Business Sense of Energy Efficiency and Pollution Prevention*, ACEEE, Washington, DC, April 1998.

Category: Information Programs
Policy: Expanded Assessment Programs

Business-As-Usual Scenario:
Current Policy/Program:
DOE-OIT s Industrial Assessment Center (IAC) program is an energy efficiency improvement initiative that also supports waste reduction and improvements in productivity for small and medium sized manufacturing firms. There are now 30 universities operating IACs across the country. Since its inception in 1976, these centers have performed more than 7,700 assessments and provided 53,000 recommendations since 1976; about 42% of the suggested investments have been implemented (STAPPA/ALAPCO, 1999).

The energy audits and assessments are performed by teams from engineering schools at Universities across the country, who help manufacturers identify opportunities to improve productivity, reduce waste, and save energy. The IAC recommendations, which provide for anticipated savings, implementation costs, and simple payback, are provided to the manufacturer at no cost and have averaged about $55,000 in potential annual savings for each manufacturer (U.S. DOE, OIT, 1999). The IAC program also has produced manuals for self-assessment and auditing. IAC programs may help to reduce the information gaps for small and medium enterprises (SMEs) and improve their willingness to invest.

Facilities that qualify for this service are manufacturing facilities that generate a product (SIC codes 20-39), and meet at least three of the following criteria:

- Fewer than 500 employees at a given plant;
- Less than $75 million gross sales per year;
- Maximum energy bill of $1.75 million per year;
- No in-house energy expertise.

Most clients of the IAC centers are currently in food processing and metals manufacturing, due to the higher presence of small and medium sized enterprises in these sectors. Historically, IAC assessments have identified the most retrofit opportunities in lighting, HVAC and building envelopes, heat recovery and containment, compressors, and motors in small and medium sized enterprises. The largest energy savings have typically been found in the food processing (SIC 20), textiles (SIC 22), and fabricated metals (SIC 34) industries. Significant energy savings have also been realized in the lumber and wood products (SIC 24), paper and allied products (SIC 26), stone, clay, and glass products (SIC 32), primary metals industries (SIC33), industrial machinery and equipment (SIC 35), rubber and miscellaneous plastics products (SIC 30), and chemicals and allied products (SIC 28). An analysis of the 3914 assessments conducted between 1981 and 1992 showed total energy savings of 9.45 TBtu, averaging just under 2500 MBtu per assessment. Currently, the 30 IACs perform approximately 30 assessments annually (new centers only perform 15 the first year) for an average of 750 assessments per year. On average, the annual energy savings are calculated to be approximately 1.8 TBtu.

Current Funding Level:
The IAC Program receives approximately $8.2 million annually (an average of $11,000 for each of the 750 assessments performed each year). Administrative charges associated with this program are $0.53M.

Business-As-Usual Scenario Assumptions:
No substantial changes in funding levels are expected under the business-as-usual scenario (Muller, 1999). Under the business-as-usual scenario, we assume that the current funding level and current program effort and associated energy savings levels remain constant between 2000 and 2020.

Moderate Scenario:

Timing and Funding Level:
IAC programs will be increased in 2000, with programs remaining at the same level throughout the analysis period (2000-2020). Funding for the IACs increases to $14 million annually (averaging $11,000 per assessment), with additional administrative costs of $0.89M.

Description of Program Expansion:
Under the moderate scenario, we assume that the number of IACs increases to 35 (allowing new centers to be established in under-served cities) and that, due to integration with both business schools and local community colleges, the number of assessments increases to approximately 36 per year per center, leading to 1265 assessments per year. There would also be a focus on increased follow-up with industrial clients to improve the rate of implementation of the IAC centers recommendations and on the implementation of emerging technologies, which we estimate would increase the energy savings per assessment to 3000 MBtu, leading to annual energy savings of 3.8 TBtu per year.

Modeled in CEF-NEMS?
Energy savings from IAC assessments are accounted for in NEMS in the existing plant UECs. These UECs are reduced slightly in the moderate scenario to incorporate the savings that result from implementation of energy-saving measures identified by these assessments. The reductions are reflected in all subsectors, with the largest savings in the following NEMS sectors: food, metals-based durables, other manufacturing, glass, steel, primary aluminum, and chemicals. In CEF-NEMS, expanded assessment programs lead to improved TPCs in existing equipment in all sectors.

Advanced Scenario:

Timing and Funding Level:
IAC programs will be increased in 2000, with programs remaining at the same level throughout the analysis period (2000-2020). Funding for IACs is increased to $22 million per year (averaging $11,000 per assessment), with additional administrative costs of $1.4M.

Description of Program Expansion:
Under the advanced scenario, we assume that the number of IACs further increases to 50 and that the number of assessments increases to 40 per year per center, for a total of about 2000 audits per year. In addition, the work of the centers is expanded to include development of comprehensive energy plans for the audited industries. Developing such corporate energy plans to implement and maintain energy-efficient practices will focus industries on sustained efforts, modeled after programs run at various companies. The IACs also develop workshop programs for specific industries within their region. We assume that each assessment will now lead to an average savings of 4000 MBtu due to the increased desire on the part of industries to save energy now that the cost of carbon is $50/ton. Under this scenario, we estimate annual energy savings of 8 TBtu/year.

Modeled in CEF-NEMS?
Existing plant UECs are further reduced in the advanced scenario to incorporate the savings that result from implementation of energy-saving measures identified by these assessments. In CEF-NEMS, expanded assessment programs lead to improved TPCs in existing equipment.

References:

Muller, M.R.1999. Personal communication with Michael Muller, Rutgers University, 11 March, 1999.

Muller, M.R. and Barnish, T.J., 1998. Evaluation of the Former EADC Program, *Industrial Energy Efficiency Policies: Understanding Success and Failure,* Workshop organized by the International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands.

STAPPA/ALAPCO, 1999. *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options*, Washington, DC: State and Territorial Air Pollution Program Administrators (STAPPA)/Association of Local Air Pollution Control Officials (ALAPCO), October 1999.

U.S. Department of Energy, Office of Industrial Technologies, 1999. Industrial Assessment Centers Web Site, 15 March 1999 (http://www.oit.doe.gov/iac/).

U.S. Department of Energy, Office of Policy and Office of Energy Efficiency and Renewable Energy, 1996. *Analysis of Energy-Efficiency Investment Decisions by Small and Medium-Sized Manufacturers*. Washington, DC: U.S. DOE.

Category: Information Programs
Policy: Expanded Labeling and Procurement Programs

Consumer information to encourage demand for environmentally benign products, e.g. eco-labelling, is a step towards more sustainable production that is taken in many countries. For example, the Blue Angel program has been in existence since 1977 in Germany, and is used for a wide array of products. The Blue Angel program labels products like unbleached, recycled paper, as well as many other common products (e.g. computers, paint). The labelled products generally have a lower environmental impact than competing products, and often result in energy savings due to the use of less energy-intensive materials or recycled materials. To maintain objectivity standardized and independent procedures are needed. The design of the testing procedures may take a couple of years. Corporate and governmental procurement programs of labelled products are also established as 'market-pull' instruments. The federal government has established procurement programs for energy consuming equipment (FEMP). The described effort would expand the program to other products, e.g. cement for public construction projects.

<u>**Business-As-Usual Scenario:**</u>

Current Policy/Program:

There are currently no federal labeling programs, other than the Energy Star program which is an example of labeling products for energy efficiency, that label environmentally friendly products.

Current Funding Level:

There are currently no federal labeling programs. Hence, current funding levels are set at zero.

Business-As-Usual Scenario Assumptions:

Under the business-as-usual scenario we assume that no industrial product labeling or procurement programs are developed and implemented other than the already existing programs and products.

<u>**Moderate Scenario:**</u>

Timing and Funding Level:

We assume the development of a federal eco-labeling program in the U.S., starting in 1999 and implemented by the year 2002. The program may be based on the experiences in the Energy Star program, which would reduce the start-up time of the program. The program will be slowly expanded to various products. Funding is needed for testing and evaluation procedures, as well as marketing. Development and initial public support for a product label is estimated to cost approximately $0.5M per product, including technical research, meetings and negotiations, and public outreach efforts (Thigpen, 1999). We assume this funding level for development of a label for unbleached, recycled paper. For cement we assume a total funding package of $2.0M, to establish a practice of performance based cement standards, and active information dissemination to public and private agencies, responsible for cement procurement and specification, on the environmental advantages of blended cements.

Description of Program Expansion:

In the moderate scenario, we assume labeling of recycled/non-bleached paper, as well a change in practice of public procurement or specification policies. In both instances energy gains are achieved, and show environmental advantages. Thus, beginning in 2000, program costs for the moderate scenario are assumed to total $2.5M ($0.1M/year) for a total program savings of 53 TBtu in 2020 or an average of 26.4 TBtu per year for the modeled period.

Modeled in CEF-NEMS?

Product labeling and procurement programs lead to increased use of waste or recycled materials. This has been implemented in CEF-NEMS through adjusting the throughputs of the process steps that are replaced by the use of these materials in CEF-NEMS in the paper and cement sectors. Clinker production is reduced relative to the cement production volume. In the paper industry the throughput for waste paper is increased, decreasing the need for virgin pulp and wood. The throughput of the bleaching is reduced. Product Labeling Programs lead to increased use of recycled materials (adjustments in throughputs) in CEF-NEMS in the paper and cement sectors.

<u>Advanced Scenario:</u>
Timing and Funding Level:
We assume that funding level double over the moderate scenario for the 2000-2020 period.

Description of Program Expansion:
In the advanced scenario, labeling will be expanded to other products containing relatively large amounts of recycled material (e.g. glass bottles). More active marketing will increase the visibility of labeled products, and increase demand. The program will also include enhanced procurement policies for federal, state, and municipal agencies, e.g. DOT, for labeled products. Thus, beginning in 2000, program costs for the moderate scenario are assumed to total $5M ($0.2M/year) for a total program savings of 119 TBtu in 2020 or an average of 59 TBtu per year for the modeled period.

Modeled in CEF-NEMS?
Product labeling and procurement programs lead to increased use of waste or recycled materials. This has been implemented in NEMS through adjusting the throughputs of the process steps that are replaced by the use of these materials in CEF-NEMS in the paper and cement sectors. Clinker production is reduced relative to the cement production volume. In the paper industry is the throughput for waste paper increased, decreasing the need for virgin pulp and wood. The throughput of the bleaching is reduced. Product Labeling Programs lead to increased use of recycled materials (adjustments in throughputs) in CEF-NEMS in the paper and cement sectors.

References:
Thigpen, S., 1999. *Personal communication with Scott Thigpen*, U.S. EPA, 16 April 1999.

Catetory: Investment Enabling Programs
Policy: Expanded State Programs - State Industrial Energy Efficiency Programs

<u>Business-As-Usual Scenario:</u>

Current Policy/Program:

Currently many states and regional bodies have local industrial innovation and competitiveness programs (NIMAP, 1999), of which a number specifically aim at industrial energy efficiency improvement. In this description we excluded utility or ESCO programs (see description under expanded ESCO/utility programs). The NIMAP database identified 300 regional or state programs. Successful examples of energy programs can be found in Iowa, New York, Wisconsin, and other states. The Energy Center of Wisconsin focuses on demonstration projects. The NYSERDA program in New York focuses more on industrial R&D, while the LoanSTAR program in Texas focuses on demonstrating energy retrofit technologies. The Iowa Energy center focuses on agriculture and audits. The programs are active in information dissemination, auditing, demonstration, and R&D of industrial technologies. Recently, OIT has also started an effort to expand the IOF program to the state level. States Industries of the Future (SIOF) has activities in 50 states in various stages of development, and focus points (depending on the interests of local industries). There are no estimates of evaluations of estimated energy savings in the industrial sector available, making an estimate of the impact difficult. Generally, OIT projects have shown an investment of 0.71-1.42 $/MBtu saved annually (Quinn and Reed, 1997). Assuming a total budget of $85M, we estimate the industrial energy savings due to state programs at 60 TBtu. Currently less than half of the states participate in the OIT state activities, and the levels of activities vary as well. For example, Louisiana with a large chemical industry does not receive any funding for state projects.

Current Funding Level:

The current total funding level is difficult to estimate due to the scattered character and large number of programs. The Energy Center in Wisconsin had an 1998 operating budget of $4.5 million, of which 12% was specifically spent on industrial demonstration projects and 3% on industrial R&D (ECW, 1999). Other states run similar programs with varying budgets and emphases. The budgets for industrial activities in the state activities are often not published, making an analysis difficult. The budget for OIT funded state programs is $82.6 million for FY 1997 (OIT, 1999). A breakdown of the funding sources is not given. We estimate the total state expenditures in the U.S. on industrial energy efficiency programs at $85 million.

Business-As-Usual Scenario Assumptions:

Under the business-as-usual scenario we assume that current funding levels will remain at the 1997 level, and that the cost-effectiveness of the savings is similar to that of OIT-funded technology projects. Assuming a life-time of 10 years of the investments and technology developments, every dollar spent will save 7 to 14 MBtu over the lifetime of the investment. By 2020 total annual savings will be 600 TBtu/year, assuming a budget of $85 million/year. These savings exclude ripple effects to other sectors, and productivity increases (Quinn and Reed, 1997).

<u>Moderate Scenario:</u>

Timing and Funding Level:

We assume that the funding of the programs at the state level is increased to a total level of $138 million starting in 2000, which represents a 50% increase over the business-as-usual scenario activities coordinated with OIT and additional state level funding of $10 million. This funding level is maintained throughout the scenario period.

Description of Program Expansion:

We assume that the efforts at the state level will be increased over the current levels so that most state programs include information dissemination, audits, demonstration, and R&D components and that 30 states fully participate in the program. This increase is maintained at the higher level throughout the scenario period. Annual funding of $130 million will result in annual energy savings of 93 TBtu (or 32 TBtu over savings in the business-as-usual scenario). This is a conservative estimate based on the cost-effectiveness of historical OIT technology projects. This excludes ripple effects of spin-off technologies to other sectors, and the costs and potential energy savings from increased productivity (Quinn and Reed, 1997).

Modeled in CEF-NEMS?
The current state efforts are able to focus on industries that are not necessarily part of the IOF industries or the energy-intensive industries. Efforts will vary by state, based on the relative importance of the various industrial sub-sector in each state. States are better equipped to build relationships with light manufacturing industries, as well as energy-intensive industries. We expect that a relative large part of the savings will be achieved in the light industry sectors in NEMS (e.g. food, metal durables, other manufacturing, and agriculture), as well in some energy-intensive industries (e.g. aluminum, glass, steel, some bulk chemicals). In the CEF-NEMS model, expanded State Industrial Energy Efficiency Programs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, and increased boiler efficiency in all sectors as well as improved building energy efficiency in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

Advanced Scenario:
Timing and Funding Level:
In the advanced scenario state programs are further expanded, aiming to be more comprehensive with demonstration of technologies and practices across sub-sectors, auditing, active dissemination, and integration with other industrial innovation and environmental policies. The state programs aim especially with those sectors that have less easily access to federal funding and programs. The program is expected to increase in activity level from the year 2000 and 50 states will now be included in the program.

In the advanced scenario the funding for state programs is further expanded, and doubled over the business-as-usual funding levels. We assume that the programs coordinated with OIT are doubled to $170 million per year, and that independent state activities are increased by 50%, reflecting a serious public attention for and commitment to environmental policy. These increased funding levels are independent of revenues from public benefit charges, which are assumed to be used for standard performance contracting. Some of the revenues may be used for increased R&D, and some overlap with increased state spending may exist. In the advanced scenario we also expect the states currently without activities to develop programs. Total annual budget for industrial energy efficiency is estimated at $180 million.

Description of Program Expansion:
Annual funding of $190 million, will result in annual energy savings of 144 TBtu. The larger sizes of the programs and comprehensiveness will increase the cost-effectiveness slightly, from 1.4$/MBtu to 1.25$/MBtu. We assume that these implemented measures have an average lifetime of 10 years. The estimate is based on the cost-effectiveness of historical OIT technology projects. This excludes ripple effects of spin-off technologies to other sectors, and the costs and potential energy savings from increased productivity (Quinn and Reed, 1997).

Modeled in CEF-NEMS?
We increase the expected energy savings from state programs, especially in those sectors that have less access to federal programs, e.g. food, light manufacturing, agriculture and mining, and industries that receive relative low levels of funding in the federal IOF program, e.g. petroleum refining, forest products. In the CEF-NEMS model, expanded State Industrial Energy Efficiency Programs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, and increased

boiler efficiency in all sectors as well as improved building energy efficiency in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

References

Energy Center of Wisconsin, 1999. Annual Report *E2, Energy Efficiency* 1 **4** (Winter 1999).

National Inventory of Manufacturing Assistance Programs (NIMAP), 1999. Database of NIMAP developed by ASE, OIT and PNNL. The Database can be accessed at: http://www.oit.doe.gov/nimap.

Office of Industrial Technologies, 1999. Information provided on the website of DOE-OIT, March 1999.

Quinn, J.E. and J.E. Reed, 1997. Energy, Economic and Environmental Impacts of Advanced Industrial Process Innovations, 1976-1996 Proc. ACEEE Summer Study on Energy Efficiency in Industry 1997 pp.417-428.

Catetory: Investment Enabling Programs
Policy: Expanded State Programs — Clean Air Partnership Fund
(see also Category: Regulations)

Business-As-Usual Scenario:

Current Policy/Program:

There are various ways to comply with the provisions of the Clean Air Act. Harmonized strategies to reduce air pollutant emissions and GHG emissions can be developed in all sectors and in the industrial sector (STAPPA/ALAPCO, 1999). Air pollution control measures are developed by state and local regulators and are described in a so-called State Implementation Plan (SIP). A SIP contains plans for inventories of emissions, modeling of efforts needed to attain or maintain a specified emission level, and a list of control measures and regulations to adopt and enforce the control strategies. While not all pollutant control measures may reduce GHG emissions, many GHG emission reduction measures will reduce pollutant emissions, especially of those processes combusting fuels. EPA has recently announced the *Energy Efficiency and Renewable Energy Set-Aside Guidance* (EPA, 1999), which will give regulators guidance in reducing pollutant emissions through energy efficiency measures.

We expect the largest impact of the SIPs in non-attainment areas. Industrial energy use in non-attainment areas in industrial boilers is estimated at 28% of total industrial energy use in boilers (Bailey, 1999). We assume the same distribution for total industrial energy use. The GHG emission reduction will depend strongly on the measures that are implemented to reduce pollutant emissions, and are likely to vary by region (STAPPA/ALAPCO, 1999). This makes it difficult to estimate the energy efficiency improvement and GHG emission reduction potential.

Current Funding Level:

Implementation of SIPs is independent of funding levels for technology procurement or development, but is rather a re-orientation of means to reduce pollutant emissions in a more cost-effective way, reducing the need for expensive add-on control equipment. Cogeneration is an example of a technology that would be more attractive under such a re-orientation, reducing NOx-emissions (and other emissions depending on the fuels used), GHG emissions and energy costs for industries. The federal government is also developing the Clean Air Partnership Fund that would distribute funds to state and local regulators to reduce pollutant and GHG emissions in an integrated way. Current plans assume a five year program with funding levels of 200 M$/year. Distribution of the budget is unclear, as it depends on local initiatives and needs. We will assume that 25% of the budget is spend on industrial projects (assuming a total fund of $100 million/year). For modeling purposes we assume an annual budget of $25 million/year for industry for the total modeling period, of which $20 million/year is considered investment enabling and $5 million/year is considered regulations .

Business-As-Usual Scenario Assumptions:

The development and implementation of integrated pollutant reduction strategies is currently under way. The plans for the Clean Air Partnership Fund are also being developed. We assume that the modified SIPs can be implemented starting in the year 2000, followed soon by the availability of the Fund to local regulators.

Moderate Scenario:

Timing and Funding Level:

In the moderate scenario we assume the same timing as in the business-as-usual scenario, i.e. start of implementation of the measures by the year 2000.

The funding of the Clean Air Partnership Fund will increase to \$150 million/year, of which \$37.5 million/year is allocated to industrial projects (\$30 million/year as investment enabling and \$7.5 million/year as regulations).

Description of Program Expansion:
It is expected that under this scenario integrated approaches will increase in popularity under state and local regulators as a cost-effective way to reduce emissions. The increased funding level will make this approach also more attractive for industries. Integrated approaches will also allow industries to demonstrate new technologies to reduce emissions, without the current dangers of non-compliance. Black-liquor gasification is an example of a technology that needs to demonstration, but emission characteristics at a commercial scale are yet to be determined.

Modeled in CEF-NEMS?
The energy and GHG emission reductions will strongly depend on the nature of the measures taken, and on the local characteristics of the industrial air pollutant emissions. Based on model calculations reductions in CO2 emissions may vary between 0.2% to 3% per percent reduction in NOx emissions in the industrial sector (STAPPA/ALAPCO, 1999). The specific emission reductions in other criteria pollutants (ozone, PM) depend strongly on the mix of industrial activities in the non-attainment areas. These are model assessments based on a very limited data set for the industrial sector. Based on the model analysis we assume an average energy efficiency improvement rate of 1% per percent NOx emission reduction, or a 1.5% reduction in CO2 emissions per percent NOx emission reduction. In the CEF-NEMS model, expanded Clean Air/SIPs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, and increased use of cogeneration in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

<u>**Advanced Scenario:**</u>
Timing and Funding Level:
In the advanced scenario we assume the same timing as in the business-as-usual scenario, i.e. start of implementation of the measures by the year 2000. Increased funding and increased attention for environmental issues will enhance the effectiveness of the program, by increased emphasis on GHG emission reductions in achieving criteria pollutant emission reductions. The funding level of the program is maintained at \$200 million/year, of which 25%, or \$50 million/year (\$40 million/year as investment enabling and \$10 million/year as regulations) is spent on industrial emission reduction project implementation.

Description of Program Expansion:
Increased attention on GHG emissions will increase the attractiveness of projects that have higher GHG emission reduction as a co-benefit, and increased funding will be directed towards these projects. This will result in a stronger specific GHG emission reduction, while attaining the criteria pollutant emission levels in the current non-attainment areas. The specific GHG emission reduction per unit of criteria pollutant emission reduction depends strongly on the various criteria pollutants, the needed reduction level of each of the pollutants, mix of industrial activities in the non-attainment area. Hence, the results will vary by area (STAPPA/ALAPCO, 1999), as will the GHG emission reduction. This is even more true for energy savings, as it depends on the measures implemented to reduce the pollutant emissions. A detailed study would be needed to assess all SIPs and SIP revisions, and regional opportunities for GHG emission reduction, which is outside the scope of this study. The savings will mainly be achieved in the manufacturing sector, due to the location of these industries in non-attainment areas.

Modeled in CEF-NEMS?

The increased GHG emission reduction per unit of criteria pollutant emission is expected to result in an energy saving of 1.2% per percent criteria pollutant emission reduction. In the CEF-NEMS model, expanded Clean Air/SIPs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, and increased use of cogeneration in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

References

Bailey, A., 1999. NSR Triggering Analysis for Combined Heat and Power, Washington, DC: U.S. EPA (presentation).

STAPPA/ALAPCO, 1999. *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options*, Washington, DC: State and Territorial Air Pollution Program Administrators (STAPPA)/Association of Local Air Pollution Control Officials (ALAPCO), October 1999.

U.S. Environmental Protection Agency, 1999. *Guidance on Establishing an Energy Efficiency and Renewable Energy (EE/RE) Set-Aside in the NOx Budget Trading Program*, Washington, DC: U.S. EPA, APPD.

Category: Investment Enabling Programs
Policy: Expanded ESCO/Utility Programs

<u>Business-As-Usual Scenario:</u>

Current Policy/Program:

Currently many utilities have reduced the size of DSM programs in order to reduce operation costs in light of deregulation. Currently 19 states have introduced public benefit charges (or line charges). The revenue of the public benefit charge will be used to fund projects in energy efficiency, R&D, renewable energy sources, as well as for low income households. The public benefit charge and the spending pattern will vary by state (Kushler, 1998; Kushler, 1999). We assume that the revenues will mainly be used to expand the work of ESCOs through standard performance contracting (Eto et al., 1998).

Current Funding Level:

Currently 19 states have plans to enforce public benefit charges, which in total will generate over $1.4 Billion annually (Kushler, 1999). Some of the states have allocated the funding to different uses, spending 53% on energy efficiency and 6% on R&D. In this study we assume that 50% is spend of the revenues is spend on energy efficiency programs, and of this half is spend on programs in the industrial sector. This is equal to $350 million/year. Energy savings are difficult to estimate. A dated analysis of 58 utility DSM programs has shown average costs of $0.04/kWh saved (Nadel,1990). The costs and achieved savings vary widely. A more recent analysis of bidding programs for commercial/industrial energy savings showed typical costs from $0.054 to $0.08 per kWh-saved (Goldman and Kito, 1994).

Business-As-Usual Scenario Assumptions:

The actual energy savings that can be achieved depend strongly on the design of the program, as well as the cost-effectiveness of the savings. Historically, DSM program performance has varied widely, and depends on factors like marketing, targeting of approaches, program procedures, level of financial incentives, and availability of technical assistance (Nadel, 1990). The future, types and effectiveness of these services and programs is unclear, and the next years will show how these programs will develop (Nadel et al., 1997). This will also allow an improved analysis of the cost-effectiveness of the bidding programs. For this assessment we will use a typical cost of $0.06/kWh-saved. The ESCO programs could result in savings of 5.8 TWh/year in electricity or equivalent in primary fuels. The cost data are often inaccurate, and it is unclear what costs are included in the analysis, making a reliable estimate of prospective savings of ESCO bidding programs difficult.

<u>Moderate Scenario:</u>

Timing and Funding Level:

The public benefit charges are expected to be used in 20 states by the year 2000 and expanded to 30 states by 2005. We assume that the public benefit charges will be maintained at a level of 3 mills/kWh throughout the period until 2020. This will result in a total annual funding level of $600 million for industrial energy efficiency programs by the year 2005.

Description of Program Expansion:

The actual energy savings that can be achieved depend strongly on the design of the program, as well as the cost-effectiveness of the savings. We assume that the typical costs in the moderate scenario will slightly increase to $0.065 per kWh-saved, due to increased efforts targeting small industrial consumers. By the year 2005 this will result in approximate power savings of 9.2 TWh/year which is then maintained through 2020. For the 2000 to 2020 period, total funding for this program would be $1.19B ($564M/year) and energy savings would be just about 4800 TBtu (230 TBtu/year).

Modeled in CEF-NEMS?
The funds will mainly be used for ESCO/utility programs targeting small and medium sized enterprises. We expect that most of the funding will be used to generate power savings (e.g. in buildings and some in processes), although some will also achieve fuel savings (e.g. building retrofits, CHP), as ESCOs are expected to have an integrated approach to energy efficiency improvement. Expanded ESCO/utility programs lead to improved TPCs in existing equipment and increased use of cogeneration in the agriculture, mining, food, paper, chemicals, glass, cement, steel, metals-based durables, and other manufacturing sectors in the CEF-NEMS model. In addition, these programs lead to improved buildings energy efficiency in the food, paper, chemicals, glass, cement, steel, metals-based durables, and other manufacturing sectors.

Advanced Scenario:
Timing and Funding Level:
We assume that the public benefit charges are used throughout the U.S. by 2010. Public benefit charges will be charged from the year 2000 for 20 states, and expanding to all U.S. electricity consumption by 2010. The public benefit charges are assumed to be 3 mills/kWh on average. This will result in a total annual funding level of $350 million in 2000 for industrial energy efficiency programs. This will increase to over $2 billion for industrial energy efficiency projects alone (assuming that 25% is spent on industrial projects) by 2020.

Description of Program Expansion:
Higher typical costs, as it is more difficult to reach a larger group of customers. We will assume $0.07/kWh-saved. Energy savings increase to 28 TWh/year by 2010 and beyond. For the 2000 to 2020 period, total funding for this program would be $30.2B ($1.4B/year) and energy savings would be just about 7010 TBtu (334 TBtu/year).

Modeled in CEF-NEMS?
The funds will mainly be used for ESCO/utility programs targeting small and medium sized enterprises. We expect that most of the funding will be used to generate power savings (e.g. in buildings and some in processes), although some will also achieve fuel savings (e.g. building retrofits, CHP), as ESCOs are expected to have an integrated approach to energy efficiency improvement. In the advanced scenario there will be a stronger emphasis on small companies, a more difficult group of industries to reach. This will lead to higher typical costs. Expanded ESCO/utility programs lead to improved TPCs in existing equipment and increased use of cogeneration in the agriculture, mining, food, paper, chemicals, glass, cement, steel, metals-based durables, and other manufacturing sectors in the CEF-NEMS model. In addition, these programs lead to improved buildings energy efficiency in the food, paper, chemicals, glass, cement, steel, metals-based durables, and other manufacturing sectors.

References
Eto. J., C. Goldman, and S. Nadel, 1998. Ratepayer-Funded Energy-Efficiency Programs in a Restructured Electricity Industry: Issues and Options for Regulators and Legislators, Lawrence Berkeley National Laboratory, Berkeley, CA, May 1998 (LBNL-41479).

Goldman, C and S. Kito, 1994. Review of Demand-Side Bidding Programs: Impacts, Costs, and Cost-Effectiveness, Lawrence Berkeley National Laboratory, Berkeley, CA, 1994 (LBNL-35021).

Kushler, M., 1998. An Updated Status Report of Public Benefit Programs in an Evolving Electric Utility Industry, American Council for an Energy Efficient Economy, Washington, DC.

Kushler, M., 1999. Summary Table of Public Benefit Programs and Electric Utility Restructuring, ACEEE-website, updated February 1999.

Nadel, S., 1990. Lessons Learned: A Review of Utility Experience with Conservation and Load Management Programs for Commercial and Industrial Customers, NYSERDA, Albany, NY, October 1990.

Nadel, S., N. Elliott, and M. Pye, 1997. Serving the Industrial Customer: Emerging Directions for Utilitty related Energy Efficiency Services, *Proc. 1997 ACEEE Summer Study Energy Efficiency in Industry*, ACEEE, Washington, DC, 1997 (pp.395-407).

Category: Investment Enabling Programs
Policy: Financial Incentives - Tax Incentives for Energy Managers

<u>Business-As-Usual Scenario:</u>

Current Policy/Program:

Programs to promote energy managers have been advocated in the U.S. as a potentially important policy (Elliott et al., 1996), based on the experiences in various industries (e.g Nelson, 1994). However, no active policy has been pursued in the U.S. Various countries have experience with such programs, including Korea, Japan, Thailand, Finland and Portugal (Elliott et al., 1996), as well as Denmark and Italy. In Italy large industrial energy consumers were required to appoint an energy manager within the company (Rega and Mebane, 1994). This was enforced by law in 1982, and extended to other sectors in 1991. The energy manager was to identify energy efficiency measures, monitor energy use, and prepare energy reporting to the government. The energy managers were supported by regional energy centers, set up by the national energy agency. Evaluation of the program showed that approximately 34% of the suggested measures were implemented within one year. In Denmark in 1996 a policy has been introduced that funds employment of energy managers in small and medium sized enterprises (Elm-Larsen, 1997). The energy manager may either have an advisory role, or be involved with the practical aspects of energy use in companies. Small and medium-sized enterprises (SMEs) often have limited resources, and lack staff to actively assess energy efficiency opportunities (see also the U.S. IAC program). The program subsidies can be up to 50% of the project costs, involving at least employing one energy manager. The funds for the subsidy are collected through a small energy and carbon tax levied in Denmark to all energy users. SMEs with less than 250 employees, and with a turnover less than the equivalent of $40 Million can participate in the project. Based on previous experiences, the energy managers are expected to save 5-10% of the company s energy consumption. The program could build on the experiences in the IAC program, and provide employment opportunities for students trained in the IAC program.

Current Funding Level:

No programs exist today.

Business-As-Usual Scenario Assumptions:

No program is implemented in the baseline scenario.

<u>Moderate Scenario:</u>

Timing and Funding Level:

The program is assumed to start in 2000 with a pilot program, with 5 industries per state. This is assumed to increase to a total of 5,000 companies. The program assumes a tax rebate of 50% of the salary of an energy manager (e.g. $ 40,000/year per site). The funding level starts with $10 M in 2000 and is maintained at this level for 5 years. After 2005 the program is expected to grow to the participation level of 5,000 companies in 2020. Participation of 5,000 companies in 2020 will lead to a budget of $200 M by 2020. Average annual costs are $87M for the 2000 to 2020 period.

Description of Program Expansion:

We assume that medium to large energy using industries will be most likely to use the tax rebate program, and hire and train new energy managers. Assuming average annual energy use of 60,000 MBtu per company or site (derived from the average energy use per site in the IAC program (IAC,1998)), and achieved energy savings of 7%, the total energy savings are estimated at 1.05 TBtu/year in 2000 — 2005. This will increase to 21 TBtu/year by 2020.

Modeled in CEF-NEMS?
Tax incentives for energy managers will lead to increased TPCs in existing equipment in the agriculture, mining, food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS. In addition, this program will lead to improved building energy efficiency in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS.

Advanced Scenario:
Timing and Funding Level:
The program is assumed to start in 2000 with a pilot program, with 5 industries per state. This is assumed to increase to a total of 5,000 companies. The program assumes a tax rebate of 50% of the salary of an energy manager (e.g. $ 40,000/year per site). The funding level starts with $10 M in 2000 and is maintained at this level for 5 years. After 2005 the program is expected to grow to the participation level of 10,000 companies in 2020. This will lead to a budget of $400 M by 2020. Average annual costs are $168 M for the 2000 to 2020 period.

Description of Program Expansion:
We assume that medium to large energy using industries will be most likely to use the tax rebate program, and hire and train new energy managers. Assuming average annual energy use of 60,000 MBtu per company or site, and achieved energy savings of 7%, the total energy savings are estimated at 1.05 TBtu/year in 2000 — 2005, increasing to 42 TBtu/year by 2020.

Modeled in CEF-NEMS?
Tax incentives for energy managers will lead to increased TPCs in existing equipment in the agriculture, mining, food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS. In addition, this program will lead to improved building energy efficiency in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS.

References:
Elliott, N., M. Pye and S. Nadel, 1996. Partnerships: A Path for the Design of Utility/Industrial Energy Efficiency Programs, ACEEE, Washington, DC, February 1996.

Elm-Larsen, U., 1997. Subsidy Scheme for Employment of Energy Staff Members in Enterprises *Proceedings ECEEE 1997 Summer Study The Energy Efficiency Challenge* . Splinderuv Mlyn , Czech Republic, 9-14 June 1997.

Industrial Assessment Centers, 1998. US DOE IAC Annual Report — 1996 . The annual reports can be found on: http://oipea-www.rutgers.edu/documents/IAC_DOC.html.

Nelson, K., 1994. Finding and Implementing Projects that Reduce Waste, in: R. Socolow, C. Andrews, F. Berkhout, and V. Thomas (eds.) Industrial Ecology and Global Change, Cambridge University Press, Cambridge, UK.

Rega, A., and Mebane, W.M., Energy Manager Legislation in Italy in: *Proceedings International Workshop on Industrial Energy Efficiency: Policies and Programmes* OECD/IEA/US DOE, Paris, 1994.

Category: Investment Enabling Programs
Policy: Financial Incentives - Tax Rebates for Specific Industrial Technologies

Business-As-Usual Scenario:

Current Policy/Program:

As part of his climate change proposal, President Clinton announced support for $5 billion over 5 years in additional R&D efforts and tax cuts to stimulate energy efficiency and other technologies that reduce greenhouse gas emissions. The financial incentives and R&D expenditures would spur development and commercialization of advanced technologies and leverage larger private sector investments. If appropriated, this funding would help consumers and businesses reduce GHG emissions and bring about technology improvements that would benefit the economy (Geller et al., 1997). No decision has yet been made about the balance of proposed spending between additional R&D expenditures and tax incentives (Elliott, 1999).

Tax rebates typically are based on a share of the cost of purchasing highly efficient products and are intended to lower required capital recovery rates. By covering a large fraction of the incremental cost of technologies, they reduce commercialization risk, increase the efficiency of new purchases and accelerate the turnover of capital stock. Investment-based incentives can be given to individual technologies (e.g., insulation for steam pipes) or for implementing audits recommendations. Tax rebate programs can suffer from free-rider problems, but may still achieve substantial energy savings (Farla and Blok, 1998).

Current Proposed Funding Level:

Specific technologies that have been discussed for the tax rebate program include:

Black liquor gasification. Black liquor gasification is a leapfrogging technology under development for the pulp and paper industry. Proposed funding level: Tax credits of about $750,000,000. (Geller et al., 1997; Elliott, 1999)

Advanced steel-making. Direct steelmaking technologies (i.e., smelt reduction: replacing the blast furnace and coke ovens with a coal-based smelter and direct reduction of iron oxides) could benefit from accelerated deployment techniques. At least seven direct steelmaking processes are under development worldwide. Incentives could be paid per tonne of steel, up to a maximum amount. Proposed funding level: Tax credits of about $500,000,000. (Geller et al., 1997; Elliott, 1999)

Advanced aluminum cells. Work is currently being carried out on the development of new anodes and cathodes for electrolytic cells for aluminum production; the advanced cells would consume less electricity per unit of aluminum produced, and would have lower direct emissions of carbon and other greenhouse gases. Financial incentives for early adopters could spur the commercialization and diffusion of these technologies in the United States. Proposed funding level: Tax credits of about $500,000,000. (Geller et al., 1997; Elliott, 1999)

Other potential tax incentive initiatives in the industrial sector could include improved aluminum smelting technologies and major chemical production processes. These incentives could be made available for up to ten years, assuming that they are initiated in 1999 or 2000 (Elliott, 1999).

Business-As-Usual Scenario Assumptions:

Under the BAU-scenario we assume that the tax credit program will be approximately $1 Billion/year. Industrial projects (including cogeneration) are assumed to receive 25% of the tax rebates, or equivalent to $250 million/year. It is assumed that a select set of technologies is eligible for the tax rebate, e.g. industrial cogeneration, advanced control systems, black liqour gasification, near net shape casting, and other select advanced technologies.

Moderate Scenario:

Timing and Funding Level:

In the moderate scenario we assume that the tax rebate program as proposed by the Clinton government will expand from its original level of $1 billion/year to $1.5 billion/year by 2005, and remain at this level until 2020.

Description of Program Expansion:

The expanded program will be aimed at the implementation of advanced technologies. In the early years this will include industrial cogeneration, roller kilns, autothermal reforming, black liqour gasification, near net shape casting. After 2005 it will also include advanced technologies, now under demonstration or development, e.g. smelt reduction, advanced (catalytic) membrane applications, and impulse drying. Similar to cogeneration, the program is expected to give a tax rebate approximately equal to 8-10% of the investments.

Modeled in CEF-NEMS?

Tax rebates for specific industrial technologies will lead to increased TPCs in new equipment and accelerated retirement rates in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS.

Advanced Scenario:

Timing and Funding Level:

In the moderate scenario we assume that the tax rebate program as proposed by the Clinton government will expand from its original level of $1 billion/year to $2.0 billion/year by 2005, and remain at this level until 2020.

Description of Program Expansion:

The expanded program will be aimed at the implementation of advanced technologies. In the early years this will include industrial cogeneration, roller kilns, autothermal reforming, black liquor gasification, near net shape casting. After 2005 it will also include advanced technologies, now under demonstration or development, e.g. smelt reduction, advanced (catalytic) membrane applications, and impulse drying. The higher funding level is expected to accelerate adoption of these technologies within the analysis period of the study. Like for cogeneration the program is expected to give a tax rebate approximately equal to 8-10% of the investments.

Modeled in CEF-NEMS?

Tax rebates for specific industrial technologies will lead to increased TPCs in new equipment and accelerated retirement rates in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors in CEF-NEMS.

References:

Elliott, N., 1999. Personal communication with Neal Elliott, American Council for an Energy-Efficient Economy, 11 March, 1999.

Farla, J. and K. Blok, 1998. Energy Conservation Investments of Firms: Evaluation of the Energy Bonus in The Netherlands in the 1980 s, in: Industrial Energy Efficiency Policies: Understanding Success and Failure Proceedings of a workshop organized by the International Network of Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June, 11-12th, 1998.

Geller, H., Nadel, S. and Elliott, N., 1997. *Recommendations Concerning Tax Incentives for Energy Efficiency Measures*. Washington, DC: American Council for an Energy-Efficient Economy.

Category: Investment Enabling Programs
Policy: Financial Incentives — Investment Tax Credit for Combined Heat and Power (CHP) Systems

<u>Business-As-Usual Scenario:</u>
Current Policy/Program:
This policy would establish an 8% investment credit for qualified CHP systems with an electrical capacity in excess of 50 kilowatts or with a capacity to produce mechanical power in excess of 67 horsepower (or equivalent combination of electrical and mechanical energy capacities). A qualified CHP system would be required to produce at least 20 percent of its total useful energy in the form of thermal energy and at least 20 percent of its total useful energy in the form of electrical or mechanical power (or a combination thereof).

For CHP systems with an electrical capacity of 50 megawatts (or a mechanical energy capacity in excess of 67,000 horsepower), the total energy efficiency of the system would have to exceed 70 percent. For smaller systems, the total energy efficiency would have to exceed 60 percent. For this purpose, total energy efficiency would be calculated as the sum of the useful electrical, thermal, and mechanical power produced by the system at normal operating rates, measured on a Btu basis, divided by the lower heating value of the primary fuel source for the system supplied.

Current Funding Level:
This tax credit would start in 2000 and be terminated in 2003. The program would give an 8% investment credit for qualifying CHP units. This funding level in this period is expected to be around $100 Million. In the BAU scenario we assume that the program is not extended after 2003.

Business-As-Usual Scenario Assumptions:
The CHP tax credit scheme is assumed to be in place from 2000 till 2003. The program is expected to contribute to the expansion of industrial CHP and result in estimated CO2 emission reduction of 0.15 MtC by 2010 (EIA, 1999).

<u>Moderate Scenario:</u>
Timing and Funding Level:
In the moderate scenario it is expected that the tax credit scheme is maintained at the 2000-2003 level, until 2002, followed by an accelerated depreciation scheme for qualifying CHP units. The annual costs are estimated at $100 Million, and assumed to result in similar energy savings as the tax credit scheme.

Description of Program Expansion:
The program is maintained throughout the modeled period, and is expected to contribute to the expansion of CHP in industry, as well as third party (merchant) producers at industrial sites. The program is expected to contribute to the expansion of industrial CHP.

Modeled in CEF-NEMS?
Investment tax credits for CHP systems will lead to increased use of cogeneration in all sectors where steam is used in CEF-NEMS.

<u>Advanced Scenario:</u>
Timing and Funding Level:
In the advanced scenario it is expected that the tax credit scheme is maintained at a level of $100 Million for the period 2000-2020, and is augmented with a scheme for accelerated depreciation of qualifying CHP untis. The investment credit remains at 8% for qualifying CHP units. After 2005, higher credit levels are

available for advanced cogeneration systems, including advanced turbines, gas turbines for industrial furnaces, high efficiency systems using waste gases, and for industrial applications of fuel cells.

Description of Program Expansion:
The program is maintained throughout the modeled period, and is expected to contribute to the expansion of CHP in industry, as well as third party (merchant) producers at industrial sites. The program is expected to contribute to the expansion of industrial CHP.

Modeled in CEF-NEMS?
Investment tax credits for CHP systems will lead to increased use of cogeneration in all sectors where steam is used in CEF-NEMS.

References:
Energy Information Administration, 1999. Analysis of the Climate Change Technology Initiative , EIA, U.S. Department of Energy, Washington, DC. The report can also be found on: http://www.eia.doe.gov/oiaf/climate99/climaterpt.html.

Category: Regulations
Policy: Motors Standards and Certification

Business-As-Usual Scenario:

Current Policy/Program:

The 1992 Energy Policy Act (EPACT) contains standards that apply to all integral horsepower, general purpose, AC induction motors from 1 to 200 hp. These motors constitute 50 to 70% of all motors sold in the relevant horsepower classes.

Current Funding Level:

Implementation of the motor efficiency standards under EPACT is estimated to cost $10 million/year.

Business-As-Usual Scenario Assumptions:

Under the BAU scenario, we assume that EPACT is continued through 2020. Additional energy savings from EPACT motors regulations starting in 2000 have been estimated to be 104 TBtu/year by 2010 and remain at approximately that level through 2020. This results in average annual energy savings over the 2000 to 2020 period of 77 TBtu.

Moderate Scenario:

Timing and Funding Level:

Energy-efficient motor standards and certification requirements begin in 2000 and are enforced through 2020. Annual program funding requirements are estimated to increase to about $15 million/year.

Description of Program Expansion:

The expanded regulations mandate upgrade of all motors to EPACT standards by 2020, extend standards to all motors not currently governed by EPACT, and enforce 100% compliance by 2020. In addition, rewind practices are improved by promoting a national repair standard (EASA-Q). Certification and licensing of rewind shops by 2004 is also instituted. Supplies specifications for motor purchases and increases energy-efficiency requirements to EPACT standards (by extending standards to all motors not currently governed by EPACT).

Modeled in CEF-NEMS?

Motors are a cross-cutting technology and are found in all industrial sectors in the CEF-NEMS model. Under the moderate scenario, we assume that the impacts are largest in the industrial sectors that the Motor Challenge program is currently targeting, although savings are spread throughout the manufacturing and non-manufacturing sectors. In CEF-NEMS, motors standards and certification lead to improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

Advanced Scenario:

Timing and Funding Level:

Energy-efficient motor standards and certification requirements begin in 2000 and are enforced through 2020. Annual funding requirements are estimated to increase to about $25 million/year.

Description of Program Expansion:

The expanded regulations mandate upgrade of all motors to CEE standards by 2020, extend standards to all motors not currently governed by CEE and enforce 100% compliance by 2020. Improves rewind practices and mandates national repair standard (EASA-Q) into law by 2004. In addition, certification and licensing of rewind shops is mandated by 2004.

Modeled in CEF-NEMS?
In CEF-NEMS, motors standards and certification lead to improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

References:

Scheihing, P. E., Rosenberg, M., Olszewski, M., Cockrill, C. and Oliver, J. 1998. United States Industrial Motor-Driven Systems Market Assessment, *Industrial Energy Efficiency Policies: Understanding Success and Failure: Workshop Organized by International Network for Energy Demand Analysis in the Industrial Sector, Utrecht, The Netherlands, June 1998*. Also available on the U.S. DOE, OIT Web Site (http://www.motor.doe.gov/docs/utrecht.shtml).

Xenergy, Inc., 1998. *United States Industrial Motor Systems Market Opportunities Assessment*. Prepared for the U.S. Department of Energy s Office of Industrial Technologies and Oak Ridge National Laboratory. Burlington, MA: Xenergy, Inc.

Catetory: Regulations

Policy: Expanded State Programs — SIPs/Clean Air Partnership Fund

(see also Category: Investment Enabling)

Business-As-Usual Scenario:

Current Policy/Program:

There are various ways to comply with the provisions of the Clean Air Act. Harmonized strategies to reduce air pollutant emissions and GHG emissions can be developed in all sectors and in the industrial sector (STAPPA/ALAPCO, 1999). Air pollution control measures are developed by state and local regulators and are described in a so-called State Implementation Plan (SIP). A SIP contains plans for inventories of emissions, modeling of efforts needed to attain or maintain a specified emission level, and a list of control measures and regulations to adopt and enforce the control strategies. While not all pollutant control measures may reduce GHG emissions, many GHG emission reduction measures will reduce pollutant emissions, especially of those processes combusting fuels. EPA has recently announced the *Energy Efficiency and Renewable Energy Set-Aside Guidance* (EPA, 1999), which will give regulators guidance in reducing pollutant emissions through energy efficiency measures.

We expect the largest impact of the SIPs in non-attainment areas. Industrial energy use in non-attainment areas in industrial boilers is estimated at 28% of total industrial energy use in boilers (Bailey, 1999). We assume the same distribution for total industrial energy use. The GHG emission reduction will depend strongly on the measures that are implemented to reduce pollutant emissions, and are likely to vary by region (STAPPA/ALAPCO, 1999). This makes it difficult to estimate the energy efficiency improvement and GHG emission reduction potential.

Current Funding Level:

Implementation of SIPs is independent of funding levels for technology procurement or development, but is rather a re-orientation of means to reduce pollutant emissions in a more cost-effective way, reducing the need for expensive add-on control equipment. Cogeneration is an example of a technology that would be more attractive under such a re-orientation, reducing NOx-emissions (and other emissions depending on the fuels used), GHG emissions and energy costs for industries. The federal government is also developing the Clean Air Partnership Fund that would distribute funds to state and local regulators to reduce pollutant and GHG emissions in an integrated way. Current plans assume a five year program with funding levels of 200 M$/year. Distribution of the budget is unclear, as it depends on local initiatives and needs. We will assume that 25% of the budget is spend on industrial projects (assuming a total fund of $100 million/year). For modeling purposes we assume an annual budget of $25 million/year for industry for the total modeling period, of which $20 million/year is considered investment enabling and $5 million/year is considered regulations .

Business-As-Usual Scenario Assumptions:

The development and implementation of integrated pollutant reduction strategies is currently under way. The plans for the Clean Air Partnership Fund are also being developed. We assume that the modified SIPs can be implemented starting in the year 2000, followed soon by the availability of the Fund to local regulators.

Moderate Scenario:

Timing and Funding Level:

In the moderate scenario we assume the same timing as in the business-as-usual scenario, i.e. start of implementation of the measures by the year 2000.

The funding of the Clean Air Partnership Fund will increase to $150 million/year, of which $37.5 million/year is allocated to industrial projects ($30 million/year as investment enabling and $7.5 million/year as regulations).

Description of Program Expansion:
It is expected that under this scenario integrated approaches will increase in popularity under state and local regulators as a cost-effective way to reduce emissions. The increased funding level will make this approach also more attractive for industries. Integrated approaches will also allow industries to demonstrate new technologies to reduce emissions, without the current dangers of non-compliance. Black-liquor gasification is an example of a technology that needs to demonstration, but emission characteristics at a commercial scale are yet to be determined.

Modeled in CEF-NEMS?
The energy and GHG emission reductions will strongly depend on the nature of the measures taken, and on the local characteristics of the industrial air pollutant emissions. Based on model calculations reductions in CO2 emissions may vary between 0.2% to 3% per percent reduction in NOx emissions in the industrial sector (STAPPA/ALAPCO, 1999). The specific emission reductions in other criteria pollutants (ozone, PM) depend strongly on the mix of industrial activities in the non-attainment areas. These are model assessments based on a very limited data set for the industrial sector. Based on the model analysis we assume an average energy efficiency improvement rate of 1% per percent NOx emission reduction, or a 1.5% reduction in CO2 emissions per percent NOx emission reduction. In the CEF-NEMS model, expanded Clean Air/SIPs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, and increased use of cogeneration in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

<u>Advanced Scenario:</u>
Timing and Funding Level:
In the advanced scenario we assume the same timing as in the business-as-usual scenario, i.e. start of implementation of the measures by the year 2000. Increased funding and increased attention for environmental issues will enhance the effectiveness of the program, by increased emphasis on GHG emission reductions in achieving criteria pollutant emission reductions. The funding level of the program is maintained at $200 million/year, of which 25%, or $50 million/year ($40 million/year as investment enabling and $10 million/year as regulations) is spent on industrial emission reduction project implementation.

Description of Program Expansion:
Increased attention on GHG emissions will increase the attractiveness of projects that have higher GHG emission reduction as a co-benefit, and increased funding will be directed towards these projects. This will result in a stronger specific GHG emission reduction, while attaining the criteria pollutant emission levels in the current non-attainment areas. The specific GHG emission reduction per unit of criteria pollutant emission reduction depends strongly on the various criteria pollutants, the needed reduction level of each of the pollutants, mix of industrial activities in the non-attainment area. Hence, the results will vary by area (STAPPA/ALAPCO, 1999), as will the GHG emission reduction. This is even more true for energy savings, as it depends on the measures implemented to reduce the pollutant emissions. A detailed study would be needed to assess all SIPs and SIP revisions, and regional opportunities for GHG emission reduction, which is outside the scope of this study. The savings will mainly be achieved in the manufacturing sector, due to the location of these industries in non-attainment areas.

Modeled in CEF-NEMS?

The increased GHG emission reduction per unit of criteria pollutant emission is expected to result in an energy saving of 1.2% per percent criteria pollutant emission reduction. In the CEF-NEMS model, expanded Clean Air/SIPs lead to improved TPCs in existing equipment, improved TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, and increased use of cogeneration in the food, paper, chemicals, glass, cement, steel, aluminum, metals-based durables, and other manufacturing sectors.

References

Bailey, A., 1999. NSR Triggering Analysis for Combined Heat and Power, Washington, DC: U.S. EPA (presentation).

STAPPA/ALAPCO, 1999. *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options*, Washington, DC: State and Territorial Air Pollution Program Administrators (STAPPA)/Association of Local Air Pollution Control Officials (ALAPCO), October 1999.

U.S. Environmental Protection Agency, 1999. *Guidance on Establishing an Energy Efficiency and Renewable Energy (EE/RE) Set-Aside in the NOx Budget Trading Program*, Washington, DC: U.S. EPA, APPD.

Category: Research & Development Programs
Policy: Expanded Demonstration Programs

<u>Business-As-Usual Scenario:</u>
Current Policy/Program:
Demonstration programs, such as DOE s National Industrial Competitiveness through Energy, Environment, and Economics (NICE^3), improve industry energy efficiency, reduce industry's costs, and promote clean production. Grants support innovative technology deployment that can significantly conserve energy and energy-intensive feedstocks, reduce industrial wastes, prevent pollution, and improve cost competitiveness. After the initial funding, the awardee is expected to commercialize the process or technology.

The NICE^3 grant program provides funding to state and industry partnerships for projects that develop and demonstrate advances in energy efficiency and clean production technologies. Since 1991, NICE^3 has sponsored 87 projects more than half of these with small businesses leveraging $25.3 million in federal funds and $78.5 million in state and industry funds. Industry applicants submit project proposals through a state energy, pollution prevention, or business development office. Industry/state awardees receive a one-time grant of up to $425,000 for the proposed project. Grants fund up to 50% of total project cost for up to 3 years (U.S. DOE, OIT, 1999). The existing program is expected to save 0.09 to 0.16 quads of energy in the industrial sector by 2010. We calculate that, on average, NICE3 sponsored close to 11 programs per year at a cost of $13M per year (or $1.2 M/project), with annual energy savings (between 2000 and 2010) of 12.5 TBtu.

The NICE^3 program currently focuses on the following industries (# of projects): agriculture (1), aluminum (6), chemicals (13), forest products (10), glass (2), metal casting (4), petroleum (3), steel (8), other industries: electroplating/galvanizing (4), electronics (2), food (4), general manufacturing (10), printing (1), textiles (3).

Current Funding Level:
On March 12, 1999, Secretary of Energy Bill Richardson announced the awards for 1999, totaling more than $2.1 million for six U.S. manufacturing companies. The grants from DOE/OIT range from $211,000 to $425,000, and the award recipients will contribute more than $3 million. (U.S. DOE, OIT, 1999). Total 1999 federal funding is $5.9M and administrative costs are $0.38M (U.S. DOE, 1999).

Business-As-Usual Scenario Assumptions:
Under the business-as-usual scenario, we assume that the savings projected from the 1991 to 1998 funding are realized in the 2000 to 2010 period. We further assume that the 1999 funding level of approximately $6M is continued through 2015, with associated administrative costs of $0.4M/year. Thus, annual energy savings under the business-as-usual scenario are 12.5 TBtu from 2000 through 2010. In 2005, the results of the 1999 funding of $5.9M add 0.6 TBtu per year until 2015. An additional 7 TBtu per year are also realized from 2005 to 2015 as a result of the continuation of the 1999 funding levels through 2015. Due to the assumed 5-year lag in energy savings realization from these programs, another 6.3 TBtu savings continue to be realized through 2020. Beginning in 2000, program costs for the business-as-usual scenario are assumed to total $102.4M for a total program savings (2000 through 2020) of 245 TBtu, or an average of 12.2 TBtu/year. It must be noted that about 138 TBtu of these savings are the result of pre-2000 funding.

<u>Moderate Scenario:</u>
Timing and Funding Level:
Demonstration programs will be increased in 2000 to an effort slightly above the level that occurred between 1991 and 1998, with programs remaining at the same level throughout the analysis period (2000-

2020). Federal funding for demonstration programs will be increased to about $8M project funds and $1M administrative costs, with assumed contributions from industry growing to $10M in 2000, with funding remaining at the same level throughout the analysis period (2000-2020).

Description of Program Expansion:
Annual funding of $19M will support 15 demonstration projects per year, saving roughly 17.3 TBtu/year between 2005 and 2025). Between 2005 and 2010, these savings are additional to the savings projected from the program during the 1991-1999 period. Thus, annual energy savings under the moderate scenario are 12.5 TBtu from 2000 through 2010 due to previous funding. An additional 17.3 TBtu/year are also realized from 2005 to 2020 as a result of the annual funding of $19M envisioned under this scenario. Beginning in 2000, program costs for the moderate scenario are assumed to total $402M for a total program savings (2000 through 2020) of about 415 TBtu, or an average of 20.7 TBtu/year. It must be noted that about 138 TBtu of these savings are the result of pre-2000 funding.

Modeled in CEF-NEMS?
NICE^3 demonstration programs are found in many of the industrial subsectors. The NEMS subsectors that currently have the most NICE^3 projects are chemicals, paper, other manufacturing, steel, and aluminum. Under the moderate scenario, we assume that demonstration programs are continued in these sectors, expanded in the other sectors already addressed by NICE3, and extended to include the mining and construction sectors. In CEF-NEMS, expanded demonstration programs result in improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

Advanced Scenario:
Timing and Funding Level:
The demonstration programs will be increased over the moderate scenario level beginning in 2000, with programs remaining at the same level throughout the analysis period (2000-2020). Federal funding for demonstration programs will be increased to about $10M project funds and $1.4M administrative costs, with assumed contributions from industry growing to $12M in 2000, with funding remaining at the same level throughout the analysis period (2000-2020).

Description of Program Expansion:
Demonstration programs are further expanded to federal and state programs (following the example of NYSERDA in New York and other states), aiming to be more comprehensive with demonstration across sub-sectors and involving various applications. Active dissemination and improved eligibility for tax rebate support, are added to the programs. Annual funding of $20M will support about 18 demonstration projects per year, saving roughly 21.2 TBtu/year between 2005 and 2025). Between 2005 and 2010, these savings are additional to the savings projected from the program during the 1991-1999 period. Thus, annual energy savings under the advanced scenario are 12.5 TBtu from 2000 through 2010 due to previous funding. An additional 21.2 TBtu/year are also realized from 2005 through 2020 as a result of the annual funding of $23.4M envisioned under this scenario. Beginning in 2000, program costs for the advanced scenario are assumed to total $492M for a total program savings (2000 through 2020) of 477 TBtu, or an average 24 TBtu/year. It must be noted that about 138 TBtu of these savings are the result of pre-2000 funding.

Modeled in CEF-NEMS?
The demonstration programs will have an increased impact in sectors that currently do not have a large number of demonstration programs, including agriculture, glass, petroleum refining, food, mining, and cement. In CEF-NEMS, expanded demonstration programs result in improved TPCs in existing equipment, improved TPCs in new equipment, and accelerated retirement rates in all sectors.

References

Barnett, L., 1999. *Personal communication with Lisa Barnett*, U.S. DOE, OIT, NICE3, March 1999.

U.S. Department of Energy, 1999. *FY 2000 Congressional Budget Request: Energy Efficiency and Renewable Energy*. (http://*www*.doe.gov).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *NICE3 Website*. http://www.oit.doe.gov/nice3/index.shtml.

Category: Research & Development Programs
Policy: Expanded R&D Programs — Industries of the Future

<u>Business-As-Usual Scenario:</u>
Current Policy/Program:
The DOE/OIT Industries of the Future (IOF) strategy creating partnerships among industry, government, and supporting laboratories and institutions to stimulate technology research, development, and deployment is being implemented in nine energy- and waste-intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The IOF strategy is based on the preparation of documents outlining each industry's vision for the future, along with technology roadmaps identifying the technologies that will be needed to reach that industry's goals. Potential technologies are assessed and selected for funding by DOE and the industries. The Laboratory Coordinating Council (LCC) responds to the IOF research needs by streamlining industries' access to the expertise and capabilities of DOE's national laboratories and facilities (U.S. DOE, OIT, 1999). IOF projects are expected to improve the profitability of technologies after the year 2010 (STAPPA/ALAPCO, 1999). Estimated savings from the current portfolio (based on funding to date of approximately $235M) are 0.71 quads by 2010 and 3.13 quads by 2020, resulting in reduced carbon emissions of 13.33 MtC by 2010 and 60.45 MtC by 2020 (U.S. DOE, 1999). The goal of the IOF program is to achieve annual carbon emission reductions of 29 MtC by 2010, as described in the Report to Congress on Federal Climate Change Expenditures.

Current Funding Level:
The IOF (Specific) Program was funded for $52.2M in 1998 and $57.5M in 1999. Additional costs of about 15% of the IOF (Specific) program budget are required for management and planning, leading to funding levels of $55.4 M in 1998, $60.1M in 1999. The 2000 budget request is for $74M (U.S. DOE, 1999).

Business-As-Usual Scenario Assumptions:
In the business-as-usual scenario, we assume that only $65M is actually funded (based on past budget requests and resulting funding levels), so the resulting annual spending (when funds for management and planning are added) is $78M from 2000 through 2020.

<u>Moderate Scenario:</u>
Timing and Funding Level:
The IOF (Specific) Program is increased 50% over the current effort beginning in the year 2000 and continued at that level through 2020. Doubling the IOF (Specific) Program would lead to expenditures of $117M per year beginning in 2000 and continuing at that level through 2020.

Description of Program Expansion:
The IOF program is expanded to increase R&D efforts in all industries currently in the program. Assuming the same success rate in realization of energy savings and carbon emissions reductions as has

occurred in the past, the increase in funding in this scenario will lead to total energy savings in 2020 of 6.2 quads (286 TBtu/year) and total carbon emissions reductions of 103 MtC (5.5 MtC/year).

Modeled in CEF-NEMS?
All of the IOF industries are included in the NEMS model, although the mapping between the IOF industries and NEMS subsectors is not exact. Since IOF efforts are focused on research and development of future technologies, we consider that this program leads to improved TPCs in new plant equipment, accelerated retirement rates, and in the additional R&D savings in the 2010 to 2020 period in the agriculture, mining, paper, chemicals, glass, cement, steel, aluminum, and metals-based durables sectors in CEF-NEMS model.

Advanced Scenario:

Timing and Funding Level:
The IOF (Specific) Program is doubled over the current effort beginning in the year 2000 and continued at that level through 2020. Doubling of the IOF (Specific) Program would lead to expenditures of $156M per year beginning in 2000 and continuing at that level through 2020.

Description of Program Expansion:
The IOF program is expanded to increase R&D efforts in all industries currently in the program as well as a number of smaller other manufacturing industries. Assuming the same success rate in realization of energy savings and carbon emissions reductions as has occurred in the past, the increase in funding in this scenario will lead to total energy savings in 2020 of 9.3 quads (381 TBtu/year) and total carbon emissions reductions of 154 MtC (7.3 MtC/year).

Modeled in CEF-NEMS?
All of the IOF industries are included in the NEMS model, although the mapping between the IOF industries and NEMS subsectors is not exact. Since IOF efforts are focused on research and development of future technologies, we consider that this program leads to improved TPCs in new plant equipment, accelerated retirement rates, and in the additional R&D savings in the 2010 to 2020 period in the agriculture, mining, paper, chemicals, glass, cement, steel, aluminum, and metals-based durables sectors in CEF-NEMS model.

References:

Report to Congress on Federal Climate Change Expenditures, received from Energy Information Administration, Department of Energy, April 1999.

STAPPA/ALAPCO, 1999. *Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options*, Washington, DC: State and Territorial Air Pollution Program Administrators (STAPPA)/Association of Local Air Pollution Control Officials (ALAPCO), October 1999.

U.S. Department of Energy, 1999. *FY 2000 Congressional Budget Request: Energy Efficiency and Renewable Energy*, (http://www.cfo.doe.gov/budget/00budget/ec/industry.pdf).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *Industries of the Future Web Site*, (http://www.oit.doe.gov/industries.shtml).

Category: Research & Development Programs
Policy: Expanded R&D Programs — Other OIT R&D Programs

Business-As-Usual Scenario:
Current Policy/Program:
The Office of Industrial Technologies currently funds basic research in the areas of Enabling Technologies and Distributed Generation. The Enabling Technologies include engineered ceramics/continuous fiber ceramic composites, advanced industrial materials, combustion systems, and sensors and control technologies. The Distributed Generation programs focus on industrial power generation and industrial distributed generation (U.S. DOE, 1999). In cooperation with the DOE Office of Fossil Energy, OIT supports the development and demonstration of ultra-high efficiency natural gas turbines for industry. Objectives include increasing the efficiency of industrial systems by 15% and lowering NOx emissions. Seven manufacturing industries targeted in the Industries of the Future strategy purchase about $16 billion of electricity annually; the chemical, forest products, and refining industries are particularly likely to reap significant benefits from new cogeneration technologies (U.S. DOE, OIT, 1999).

The Advanced Turbine Systems Program is a joint program with the Office of Fossil Energy to complete the development and demonstration of ultra-high efficiency natural gas turbine systems for electric utilities, independent power producers, and industrial end users. The objectives include:
- Boost system efficiency to 60% or greater for utility combined cycle systems and achieve a 15% improvement in existing industrial systems
- Reduce the cost of electricity by 10% compared to conventional systems
- Fuel flexibility
- Lower nitrogen oxide emissions to less than 10 parts per million (ppm) with less than 25 ppm carbon monoxide without the use of post-combustion emissions controls
- Offer reliability-availability-maintainability-durability (RAMD) that equals or exceeds current turbine systems

Current Funding Level:
The Enabling Technologies program had funding (including administrative costs) of $15M in 1998 and $20.4 M in 1999. The 2000 budget request for this program is for $23.4M. The Distributed Generation program had funding (including administrative costs) of $36.1M in 1998 and $54.3M in 1999. The 2000 budget request for this program is for $33.3M (U.S. DOE, 1999).

Business-As-Usual Scenario Assumptions:
Total estimated primary energy savings from all OIT Cross-Cutting programs is 0.76 Quads in 2010 and 1.37 Quads in 2020. Associated carbon reductions are 16.05 and 32.3 tonnes, respectively (U.S. DOE, 1999). Funding for the Enabling Technologies and Distributed Generation programs is 60% of the total funding for OIT Cross-cutting programs, but some of that funding is used for utility and power generation-related R&D. Thus we assume that approximately 40% of the total funding, or $36.3M/year, is for the industrial sector R&D portion of the Enabling Technologies and Distributed Generation programs. We also assume that 40% of the estimated 2010 and 2020 energy and carbon savings are attributable to these programs, resulting in total energy savings over the 2000-2020 period of 6.2 Quads or 296 TBtu/year.

Moderate Scenario:
Timing and Funding Level:
Funding for the Enabling Technologies and Distributed Generation programs are increased by 50% over the business-as-usual scenario in the moderate scenario for the period 2000-2020.

Description of Program Expansion:
Program R&D efforts are increased in all areas related to improving industrial sector energy efficiency. Increased funding leads to total energy savings over the 2000-2020 period of 9.3 Quads or 444 TBtu/year.

Modeled in CEF-NEMS?
Increased efforts in this area lead to improved TPCs in new plant equipment, increased boiler efficiency, increased use of cogeneration, and in additional R&D savings in the 2010 to 2020 period in the paper, chemicals, glass, cement, steel, aluminum, and metals-based durables sectors in CEF-NEMS model. In addition, these programs lead to increased use of cogeneration in the agriculture and mining sectors.

Advanced Scenario:
Timing and Funding Level:
Funding for the Enabling Technologies and Distributed Generation programs are increased by 100% over the business-as-usual scenario in the moderate scenario for the period 2000-2020.

Description of Program Expansion:
Program R&D efforts are further increased in all areas related to improving industrial sector energy efficiency. Increased funding leads to total energy savings over the 2000-2020 period of 12.4 Quads or 592 TBtu/year.

Modeled in CEF-NEMS?
Increased efforts in this area lead to improved TPCs in new plant equipment, increased boiler efficiency, increased use of cogeneration, and in additional R&D savings in the 2010 to 2020 period in the paper, chemicals, glass, cement, steel, aluminum, and metals-based durables sectors in CEF-NEMS model. In addition, these programs lead to increased use of cogeneration in the agriculture and mining sectors.

References:

U.S. Department of Energy, 1999. *FY 2000 Congressional Budget Request: Energy Efficiency and Renewable Energy*, (http://www.cfo.doe.gov/budget/00budget/ec/industry.pdf).

U.S. Department of Energy, Office of Industrial Technologies, 1999. *Industries of the Future Web Site*, (http://www.oit.doe.gov/industries.shtml).

Policy: Domestic Carbon Dioxide Emissions Cap and Trade System

<u>Business-As-Usual Scenario:</u>
There is no carbon cap and trade system assumed under business as usual conditions.

<u>Moderate Scenario:</u>
There is no carbon cap and trade system assumed in the moderate scenario.

<u>Advanced Scenario:</u>
Timing and Funding Level:
The cap and trade system is gradually implemented between 2002 and 2005. By 2005 the cap and trade system is assumed to result in a carbon permit cost of 50$/metric ton C. It is assumed that al industries will participate in the cap and trade system. The effects of the cap and trade system will affect energy use in all industries.

Description of Program Expansion:
The cap and trade system for GHG emissions may result in market price increases for carbon intensive fuels. This is expected to change investment behavior of firms, as well as increasing attention for energy efficiency improvement. The cap and trade system results in net energy savings of 0.9 quads/year by 2020.

Modeled in CEF-NEMS?
A GHG emissions cap and domestic trading system with an assumed carbon permit price of $50/tonne C will lead to increased TPCs in existing equipment, increased TPCs in new equipment, accelerated retirement rates, increased boiler efficiency, increased use of recycled materials, improved building energy efficiency, and increased use of cogeneration in all sectors in the CEF-NEMS model.