ORNL/TM-2007/022

STATE-LEVEL BENEFITS OF ENERGY EFFICIENCY

Bruce E. Tonn

ORNL/TM-2007/022

STATE-LEVEL BENEFITS OF ENERGY EFFICIENCY

Bruce E. Tonn

Date Published: February 2007

Prepared for
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Internal Activity Number 619080101

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
Managed by
UT-BATTELLE
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

CONTENTS

LIST OF TABLES

Table **Page**

ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ACEEE	American Council for an Energy Efficient Economy
ATDC	Advanced Technology Development Center
BTU	British Thermal Unit
CCEF	Connecticut Clean Energy Fund
CEC	California Energy Commission
CERTS	Consortium for Electric Reliability Solutions
CFL	Compact Fluorescent Lights
CHP	Combined Heat and Power
CO	Carbon Monoxide
DOE	Department of Energy
EISG	Energy Innovations Small Grant
ESCO	Energy Service Company
GWh	Gigawatt Hours
kWh	Kilowatt Hours
MW	Megawatts
NO_x	Nitrogen Oxide
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
ORNL	Oak Ridge National Laboratory
PIER	Public Interest Energy Research Program
RE	Renewable Energy
RFP	Request for Proposals
RGGI	Regional Greenhouse Gas Initiative
SBC	Systems Benefits Charge
SEP	State Energy Program
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
TBtu	Total British Thermal Unit
VAR	Volts Amps Reaction
VC	Venture Capital

STATE-LEVEL BENEFITS OF ENERGY EFFICIENCY

Abstract

This report describes benefits attributable to state-level energy efficiency programs. Nationwide, state-level energy efficiency programs have targeted all sectors of the economy and have employed a wide range of methods to promote energy efficiency. Standard residential and industrial programs typically identify between 20 to 30% energy savings in homes and plants, respectively. Over a 20 year period of time, an average state that aggressively pursues even a limited array of energy efficiency programs can potentially reduce total state energy use by as much as 20%. Benefit-cost ratios of effective energy efficiency programs typically exceed 3 to 1 and are much higher when non-energy and macroeconomic benefits are included. Indeed, energy efficiency and associated programs and investments can create significant numbers of new jobs and enhance state tax revenues. Several states have incorporated energy efficiency into their economic development programs. It should also be noted that increasing amounts of venture capital are being invested in the energy sector in general and in specific technologies like solar power in particular. Well-designed energy efficiency programs can be expected to help overcome numerous barriers to the market penetration of energy efficient technologies and accelerate the market penetration of the technologies.

1. INTRODUCTION

The purpose of this report is to describe the benefits of energy efficiency programs to decision makers in the state of North Carolina. This is a vitally important topic given recent increases in energy prices, concerns over the availability of energy in the longer-term, and constraints in expanding electric power generation, transmission, and distribution systems. Energy efficiency is a term that covers a broad range of technologies, processes, and even changes in behavior. It is defined herein to include energy efficiency technologies such as compact fluorescent lights and renewable energy technologies. Energy efficiency programs are also quite diverse. For example, some energy efficiency programs provide incentives for households to purchase energy efficient appliances whereas others provide education to residents to help them remember to adjust thermostats when no one is home. Numerous programs focus on assisting manufacturers improve the energy efficiency of their industrial processes and on cities and counties to improve the energy efficiency of their transportation systems. There are a large number of ways to save energy and the benefits to North Carolina can be substantial.

Section 2.0 provides a high-level overview of the potential energy savings that could result from state-level energy efficiency programs. Section 3.0 describes model programs run by the states of New York and Wisconsin. Section 4.0 explores the substantial economic development benefits of state-level energy efficiency programs and documents opportunities for supporting energy efficiency entrepreneurs. Section 5.0 summarizes significant non-energy benefits that result from these programs. Section 6.0 addresses the types of market barriers that constrain the market penetration of energy efficient technologies and discusses how government programs can help overcome these barriers.

2. ENERGY EFFICIENCY AND STATE-LEVEL ENERGY SAVINGS

This section presents general overviews of state-level energy efficiency programs. It is found that effective programs are decidedly cost effective. It is also found that the energy savings potential in a typical state like North Carolina probably exceeds 20% of total energy use and could be much higher.

All states have at least a few energy efficiency programs that are funded by the U.S. Department of Energy's (DOE) State Energy Program (SEP). As reported by Schweitzer and Tonn (2005), funds provided to states by SEP are used in over 18 project areas, including: energy audits, codes and standards, loans and grants, retrofits, and workshops and training. These project areas are implemented in all sectors of the economy, including residential, commercial, industrial, agriculture, and institutional. Of those programs examined in the study, DOE provided $46 million in funding and the total expenditure on those programs, including non-DOE leveraged funds, was $541 million. These investments resulted in an estimated energy savings of 48 trillion source BTUs and an estimated annual energy costs savings of $334 million dollars. Because energy costs from the year 2002 were used in this study, the estimated annual energy costs savings are most certainly underestimated. Additionally, the study did not estimate non-energy benefits associated with the SEP, although it was estimated that annually the SEP reduced carbon emissions by 826,000 metric tons, SO_2 emissions by 8,500 metric tons, NOx emissions by 6,200 tons, and carbon monoxide by 1,000 metric tons.

In a report by the ACEEE, Prindle *et al.* (2003) found that numerous states have implemented innovative and active energy-efficiency programs. The categories of energy policies found to be most effective are (examples of leading states are in parentheses):

- "Appliance and equipment standards – Several states have been active in setting regulations mandating minimum efficiencies for a range of residential and commercial products. In some cases these state initiatives have paved the way for national standards (California, Maryland);
- Building energy codes – Half or more of the states have modern energy codes for new homes and commercial buildings that require minimum energy efficiency standards to be met (Minnesota, Texas);
- Combined heat and power (CHP) – Several states support policies that encourage CHP technologies that put otherwise-wasted heat from power generation to productive use, in both large power plants and smaller applications at manufacturing plants and commercial buildings (New Jersey, New York);
- Facility management – Many states own and/or operate a lot of buildings, from universities to office buildings and prisons. Substantial innovation has been utilized in reducing energy use in these facilities (Arizona, Illinois);
- Tax incentives – Several states offer income tax credits or deductions, sales tax exemptions, and other tax-related incentives for energy-efficient products and practices (New York, Oregon);
- Transportation – States have pioneered in transportation efficiency, from encouraging efficient vehicle purchases to reducing transport demand through growth policy (Georgia, North Carolina); and
- Utility programs – Almost half of the states tap utility revenue systems in various ways to pay for efficiency program. These efforts currently top $1 billion annually (California, Massachusetts)."

Prindle *et al.* (2003) estimated the typical state energy savings potential that could be achieved annually in the year 2020 through aggressive application of just these seven policies. Their results are presented in the table below. Prindle *et al.* (2003) estimate that the savings are equivalent to 20% of current total energy use in a typical state.

Table 1. Typical State Savings Potential (from Prindle *et al*. 2003)

Policy	**Savings Potential** (TBtu in 2020)
Appliance Standards	21.4
Building Codes	4.8
Combined Heat and Power	57.2
State Facilities	23.0
Tax Incentives	10.0
Transportation	200.0
Utilities	74.2
Total	390.7

Work done by ORNL over the years has indicated that on average with a modest amount of investment energy consumption can be reduced in low-income homes by about 23% (Schweitzer 2005). Additionally, a similar level of savings can be expected to be found in the typical small to medium size manufacturing plant (Martin *et al.* 2000). ORNL has also found that numerous plant-wide assessments and corporate targeted assessments for plants owned by large companies identified similar levels of savings (Jones *et al*. 2002). These studies support the ACEEE estimate presented above that energy savings potential in a typical state like North Carolina is at least 20%. It can be strongly argued, however, that even more energy can be saved as newer advanced energy efficiency technologies become available.

3. MODEL STATE-LEVEL ENERGY EFFICIENCY PROGRAMS

This section presents an overview of two major state-level energy efficiency programs, one from New York and the other from Wisconsin.

NEW YORK ENERGY $MART℠ PROGRAM

New York has been one of the states that has aggressively pursued the restructuring of its electric power industry. However, it was realized early-on that restructuring may put at risk numerous social benefit programs that had been administered by individual utilities throughout the state at the behest of the New York Public Service Commission. In response, it was decided to consolidate the administration of energy-related public benefits programs within the responsibilities of the New York State Energy Research and Development Authority (NYSERDA) and fund the programs through a state-wide Systems Benefits Charge (SBC). The resulting New York Energy $mart℠ Program was initiated in 1998.

New York Energy $mart℠ consists of over 40 programs that fall into four major program areas: business/institutional, residential, low-income, and research and development. Through the end of calendar year 2004, just over $800 million has been committed to New York Energy $mart℠ (NYSERDA 2005). Overall, through the end of 2004, the program's annual electricity savings are estimated to be 1,400 GWh. Peak demand has been reduced by 860 MW. Annually, state energy customers are saving $195 million on their energy bills. The number of jobs created and retained per year is estimated to be 4,200. As reported above with respect to the SEP, substantial reductions in carbon dioxide, SO2 and NOX have also been achieved. The benefit-cost ratio for the portfolio of New York Energy $mart℠ programs was calculated under several different assumptions and ranges from between 5.9 to 7.2 and 13.5 to 16.4.

What has the New York Energy $mart℠ Program done specifically to accomplish these results? Here are a few examples of specific program outputs. The ENERGY STAR® Products program has resulted in the sales of more than 800,000 energy efficient appliances and almost 1.4 million efficient lighting products. More than 18% of new residential homes are being built to ENERGY STAR® specifications. People from all walks of life report being more aware of energy efficiency technologies and issues, including residents, small business owners, motor vendors, architecture and engineering firms, home construction firms, and commercial construction firms. One important consequence of increased awareness has been a significant increase in energy service company (ESCO) activity during the past five years.

WISCONSIN FOCUS ON ENERGY

According to a recent report prepared by PA Consulting Group (2006), Wisconsin's "Focus on Energy (Focus) is a public-private partnership offering energy information and services to residential, business, agricultural, and industrial customers throughout Wisconsin." Focus was initiated in 1999 with funding from the Wisconsin Utility Public Benefits fund. Annual funding for Focus approaches $100 million. The program supports energy efficiency programs in four major areas: business, which includes new and existing industrial, commercial, agricultural and government buildings; residential; renewable energy; and environmental research.

From June 1, 2001 to December 31, 2005, it is estimated that Focus has saved over 800 million kWh of electricity annually and over 40 million therms of natural gas annually, with annual costs savings of $60 million and $38 million, respectively. Over the lifetime of installed measures it is estimated that the total electricity cost savings will exceed $450 million and total natural gas cost savings will approach $280 million. Almost 600 thousand residential customers have participated in Focus programs and over 30 thousand businesses have been touched. Energy efficient lighting accounts for most electricity savings in both the business and residential sectors. Natural gas savings in homes are mostly attributable to increased efficiency of heating and the adoption of ENERGY STAR® appliances. Natural gas savings in the business sector are spread across a large array of end uses (e.g., boilers, steam traps, dryers).

The benefit-cost ratio for Focus is estimated to range from 3 to 1 and 5.7 to 1. It is estimated that over a ten-year period Focus will generate almost 2,000 new jobs, $1.4 billion in new sales, and $779 million in new personal income. During the first four years of the program, it is estimated that Focus reduced emissions of carbon dioxide by over 2 billion pounds, SO_X by 10 million pounds, and NO_X by 5 million pounds.

OTHER NOTABLE PROGRAMS

The Texas LoanSTAR (Saving Taxes and Resources) Program, implemented in 1989, has funded a total of 184 loans that have resulted in total cumulative energy savings of $165 million (Texas State Energy Conservation Office 2006). Interest rates for the $95 million loan pool are set at 3% APR. It is estimated that the program will save Texas taxpayers over $500 million over the next twenty years. The state of Ohio has a similar revolving loan fund.

4. ECONOMIC DEVELOPMENT BENEFITS OF STATE-LEVEL ENERGY EFFICIENCY-RELATED INITIATIVES

Energy efficiency programs can produce direct economic benefits for states such as North Carolina. A study conducted by Rand Corporation for the state of California found that utility energy efficiency programs administered from 1977 to 1995 increased state gross domestic product by 3% by 1995 (Bernstein *et al*. 2000). Each and every resident and business benefited economically from the programs and the state's environment was substantially less impacted from emissions from energy consumption.

A recent report by the American Council for an Energy-Efficient Economy (Prindle *et al.* 2006) found that the Northeastern eight-state Regional Greenhouse Gas Initiative (RGGI) would have a positive impact on the region's economy if energy efficiency investments were central to policies designed to reduce greenhouse gas emissions. Specifically, the report concludes that a doubling of the current investments in energy efficiency in the region would:

- "Reduce growth in electricity consumption by two-thirds;
- Keep electricity prices virtually flat;
- Cut carbon allowance prices by one-third;
- Increase economic growth in the region by almost 1% beyond the reference case; and
- Reduce average energy bills for residential, commercial, and industrial customers by 5% -- 12% in 2021."

According to a report prepared by the University of Massachusetts, Boston, numerous states are aggressively pursuing clean energy economic development programs (Renewable Energy Trust 2006). These states include California, Connecticut, New York, New Mexico, New Jersey, Florida, and New Mexico (probably associated with its two national laboratories, Los Alamos and Sandia). It was found that the state of Massachusetts has a growing 'cluster' of energy efficiency companies and ample knowledge industries to support this economic development initiative. It was estimated that the state of Massachusetts already has about 8,000 jobs in energy efficiency and 2000 jobs in renewable energy.

The California Energy Commission (CEC) administers the prototype of an aggressive research, development, and commercialization program, the Public Interest Energy Research (PIER) program, with respect to new energy efficiency and renewable energy technologies. From its inception in 1998 through 2003, 33 energy efficiency products have been commercialized, which are expected to produce ratepayer benefits of $320 million to $822 million over the products lifetimes (CEC 2005a). Commercialized products include: PowerGuard® Solar PV System for flat roofs; hotel bathroom motion sensor nightlight; and CERTS volts amps reaction (VAR) voltage management tool. PIER has distributed approximately $200 million through 2003. The program is estimated to have a benefit-to-cost ratio of 1.6 to 1 and 4.1 to 1.

The CEC also administers the Energy Technologies Export Program. This program has produced documented sales of over $400 million and has a benefit-cost ratio of 37 to 1 (CEC 2005b). Lastly, the CEC administers the Energy Innovations Small Grant (EISG) Program. It provides up to $95,000 for hardware projects and $50,000 for modeling projects to small businesses, individuals, and academic institutions to conduct research that establishes the feasibility of new, innovative energy concepts. Overall, the energy efficiency sector has contributed $6 billion annually to California's economy, supported 36,000 jobs, and has added over $10 million to state and local revenues.

The state of Illinois has developed a Clean Energy Development Plan to bolster the market penetration of energy efficient technologies and aggressively develop renewable energy resources (Repowering the Midwest 2006). It is expected to produce positive economic impacts that will be enjoyed by a wide range of sectors. Overall, it is estimated that by the year 2020, the program will generate 57,000 new jobs and increase economic output by $6.2 billion.

The state of Connecticut administers the Connecticut Clean Energy Fund to foster innovative strategic initiatives and investments in clean energy (CCEF 2006). The Fund focuses primarily on breakthrough developments in the core renewable energy areas, which include: solar energy, wind, fuel cells, biomass conversion, and emerging non-fossil technologies.

To illustrate the growing competition for energy efficiency businesses, Sustainable Business (2006) reported that NYSERDA recently requested proposals from "companies located or wishing to locate in New York that will result in new or expanded business in the State to assemble, install, distribute, manufacture, sell and/or service electric renewable energy (RE) technologies including: photovoltaics, wind power, hydro power, electric energy from waste heat, biomass and biogas, and associated enabling technologies such as storage batteries, ultra capacitors, inverters and power conversion devices." Two million dollars was available under this RFP.

States are not the only entities that support companies developing new energy efficiency technologies. Business incubators are playing an increasingly influential role. The National Alliance of Clean Energy Business Incubators "is an alliance of leading business incubators dedicated to providing business and financial services tailored to the needs of the clean energy community." Among the top eleven business incubators that belong to the alliance are BizTech and Business Innovation Center in Alabama and the Advanced Technology Development Center (ATDC) at the Georgia Institute of Technology in Atlanta, Georgia. With an investment from DOE of $2.5 million over a three-year period, 99 clean energy companies obtained services from the incubators, with 38 'graduating' to operate on their own. The Alliance reports that these companies created 1,158 jobs, raised $67 million in capital, generated $122 million in revenues, and generated over $6 million in state money. The nation's first incubator for environmental businesses in the United States, the Environmental Business Cluster in San Jose, CA, has assisted more than 85 companies over a ten-year period.

Venture capital firms are also an important force in the economic development arena both nationally and regionally. Global Insight (2004), using a database of over 26,000 venture capital-backed companies, compiled a report on the performance of venture-backed companies. In the year 2003, venture backed companies employed over 10 million and had sales of almost $2 trillion, about 9.4% of the workforce and 9.6% of total national sales, respectively. Total employment growth in venture-backed companies was higher in most industries than the national average.

In the industrial/energy category, which includes clean tech and energy efficiency, employment rose in VC backed firms about 1% from 2000 to 2003 but declined 9% nationally. Sales grew by 6% for those firms versus no sales growth for the sector as a whole. States with the most employees in venture-backed firms are California, Texas and Massachusetts, with over 2 million, 800 thousand, and 650,000 employees, respectively. North Carolina ranked 15th among states in sales by venture capital backed firms headquartered in the state, with approximately $27 billion in sales in 2003.

The amount of venture capital being invested in the industrial/energy sector is substantial. According to PriceWaterhouseCoopers (2006), this sector attracted $786 million, $653 million, and $769 million in the years 2003, 2004 and 2005, respectively. The number of ‘deals’ reported ranged from 127 to 132 during these years. Over the past decade, the most venture capital attracted to this sector was $2.5 billion in the year 2000 involving 231 deals.

FuturePundit (2005) reported that the National Venture Capital Association estimated that the venture capital investments in solar firms was more than one third of the $195 million invested in the entire energy sector in the first three quarters of 2005. This is more than twice the amount invested in all of 2004 and 30 times the amount invested ten years ago. For example, NanoSolar announced it received $6.5 million in venture capital from two leading Silicon Valley firms, Benchmark Capital and US Venture Partners. Additionally, another leading California venture capital firm, Draper Fisher Jurvetson, invested $6.5 million in Konarka Technologies, also a solar panel manufacturer (Cortese 2006).

American Venture Magazine (2006) reported that Advanced Technology Ventures, a bi-coastal venture capital firm with more than $1.4 billion in capital under management, is supporting the California Clean Tech Open, a business plan competition to spur innovation in the clean tech industry. The winners in five categories will be awarded more than $500,000 in cash and services at a September 29, 2006 event in San Francisco, CA.

The National Renewable Energy Laboratory (NREL) maintains a program to assist clean tech entrepreneurs. NREL also maintains an extensive list of venture capital firms that invest in clean tech (NREL 2006). In the Southeast, Oak Ridge National Laboratory administers a very active technology transfer program that promotes economic development, start-up firms, and licensing of energy and other related technologies to the private sector.

5. OTHER NON-ENERGY BENEFITS

Energy efficiency programs offer more than economic non-energy benefits. Schweizter and Tonn (2001) document myriad other non-energy benefits associated with low-income weatherization. These include benefits accruable to utilities from lower rates of cut-offs and lower amounts of late payments. The households accrue a wide range of non-energy benefits, from living in safer homes (e.g., furnace tune-ups may end up preventing fires) and healthier homes (e.g., weatherization activities may reduce unhealthy drafts in the winter, reduce indoor emissions of CO from furnaces) to being less prone to becoming homeless. They found that when these types of non-energy benefits are added to the local economic benefits (e.g., increased local employment, increased property values) and environmental benefits (i.e., same as those attributable to the SEP mentioned above), the non-energy benefits at the very least equal the energy benefits of low-income weatherization.

Much less formal work has been conducted to estimate the non-energy benefits of other energy-efficiency programs. However, even with limited consideration, one could argue that the benefits are probably substantial. For example, ORNL has documented cases where manufacturing plants that had energy assessments conducted by Industrial Assessment Centers were consequently able to reduce their energy costs enough to avoid certain closure, thereby retaining jobs and tax base and avoiding unemployment and other social program costs (Tonn *et al*. 2004). Insulating steam pipes and hot cauldrons not only saves energy but also reduces the chances that workers will burn themselves. Installing high quality energy efficient lights in plants may increase luminosity in the plants, thereby making the plants safer. Green buildings not only save energy but also can increase worker moral and improve worker health (Hawkins, Lovins and Lovins 1999).

6. MARKET BARRIERS TO ENERGY EFFICIENCY

There are numerous market barriers to energy efficiency. Before describing many of these barriers, it must be noted that the penetration of markets by energy efficient technologies takes time even in the best of cases. Studies of the growth of market share of new technologies have shown that on average it takes between two to three decades for successful new technologies to move from low levels of market penetration (i.e., less than 10%) to robust levels of market penetration in the 90% range (Mansfield 1963, 1989; Mansfield *et al.* 1977; Gruber 1997; Valente 1995). Oftentimes a market threshold of around 10% must be reached before market penetration begins to increase appreciably.

It is recognized that in general government programs can accelerate the penetration of new technologies in the marketplace by helping to overcome many of the barriers mentioned below (Horowitz *et al*. 2000). With respect to the commercialization of new energy technologies, the National Academy of Sciences makes the assumption that DOE energy efficiency R&D programs accelerate commercialization of new energy efficiency technologies by five to seven years (NAS 2001). Tonn (2003), in a study of this question for NYSERDA, estimated that well designed government programs can accelerate the market penetration of new energy efficiency technologies by approximately ten years.

What factors prevent new energy efficient technologies from penetrating the marketplace? Certainly cost is a factor. New, energy efficient technologies often cost more than conventional technologies. Tax incentives and loan and rebate programs do help to overcome cost barriers. However, cost is not the only market barrier to consider. In fact, a complete list of factors is beyond the scope of this report. Here is a diverse list compiled from experiences gained by ORNL in this area:

- Low-income households simply have no extra funds to invest in energy efficiency;
- Most Americans have little knowledge about energy efficiency or what they could do to improve the energy efficiency of their homes (e.g., adjusting thermostats when no one is home during the day; closing the drapes during the summer; washing clothes in cold water);
- A substantial number of small manufacturing companies do not have staff with energy efficiency responsibilities, primarily due to their need to reduce staff as much as possible to be globally competitive;
- These same companies often do not trust vendors who sell energy-efficient products or services;
- Small and large companies alike are very averse to modifying production processes to increase energy-efficiency for fear of bringing down the processes for extended periods of time;
- Large companies often suffer severe bureaucratic problems with respect to energy efficiency (e.g., plant managers do not have the power or authority to implement capital improvements to increase energy efficiency; internal investment capital is more typically targeted to new product development rather than cost cutting regardless of demonstrated internal returns);
- Companies of all sizes had rather not pioneer new energy efficient technologies due to high levels of risk aversion;
- Complex interactions between manufacturers and their suppliers may result in new energy efficient technologies falling through the cracks (e.g., aluminum suppliers may not develop new lightweight aluminum components for vehicles until automobile manufacturers demand such components but the manufacturers will not demand the

components until the suppliers can prove that the components can be produced economically with high quality);

- Consumers are often unaware of new energy efficient products;
- Consumers often let lower initial prices of energy inefficient products guide their decision making rather than the lower life cycle prices of energy efficient products;
- Producers of new energy efficient technologies, especially start-up firms, may not have the business skills to run successful businesses;
- Potential producers of new energy efficient technologies may not invest in and produce new products without some guarantees concerning sales of the new technologies;
- Consumers of new energy efficient technologies may consider the new technologies unreliable, hard to use, or lower in quality than conventional products;
- Some energy efficient technologies may indeed be limited compared to conventional products (e.g., CFLs often fail in cold weather); and
- Outdated building codes and subdivision ordinances may prevent the installation of energy efficient and renewable energy technologies.

This list suggests that there are numerous institutional, technological, and educational barriers to the market penetration of new energy efficient technologies in addition to cost barriers. The opportunities for state-level energy efficiency programs to help overcome market barriers such as these are plentiful.

7. SUMMARY AND CONCLUSIONS

It is very likely that there is a substantial amount of energy that can be saved in the state of North Carolina. Studies suggest that energy consumption could be reduced by at least 20% with cost effective programs. That figure, it can be strongly argued, is probably an underestimate. Saving energy will economically benefit energy consumers, including residents, commercial establishments, industrial plants, farmers, and institutions. Saving energy also offers a host of other very substantial non-energy benefits, from reducing emissions of carbon dioxide, SO_X, and NO_X to improving the health of residents to improving the safety in industrial plants.

Numerous states are treating energy efficiency as an economic development opportunity. With increasing energy prices, and no relief in sight, it is easy to argue that markets for energy efficient technologies will only grow in the future. Given the substantial amounts of energy that can be saved in all sectors of the economy, opportunities for new energy efficiency ideas and technologies are numerous. North Carolina has ample knowledge-based industries and research-oriented institutions (e.g., in and around Research Triangle) to compete for new jobs in this area. It is apparent that venture capital is flowing into the energy industry and could be used to support new North Carolina energy efficiency businesses.

8. REFERENCES

Advanced Technology Development Center, 2006. http://www.atdc.org

American Venture Magazine, 2006. "Advanced Technology Ventures Announces Support for the California Clean Tech Open," April 20, http://www.americanventuremagazine.com/news.php?newsid=997

Bernstein, M., Lempert, R., Loughran, D., and Ortiz, D. 2000. "The Public Benefit of California's Investments in Energy Efficiency," MR-1212.0-CEC, California Energy Commission, Sacramento, CA.

BizTech and Business Innovation Center, 2006. http://www.biztech.org

California Energy Commission 2005a. "2004 Annual Review of the PIER Program: Volume 1 – Commercial Successes and Benefits," CEC-500-2005-055-V1, Sacramento, CA.

California Energy Commission, 2005b. "Economic Development Programs at the Energy Commission," http://www.energy.ca.gov/commission/economic_development.html

Connecticut Clean Energy Fund, 2006. "CCEF Initiative & Program Structure," http://www.ctcleanenergy.com/investment/index.html

Cortese, A. 2006. "$6.5 Million Being Invested in a Venture on Solar Cells," New York Times, see http://www.nanosolar.com/cache/nyt.html

Environmental Business Cluster, 2006. http://www.environmentalcluster.org

FuturePundit, 2005. "Venture Capital Flows into Solar Power Companies," http://www.futurepundit.com/archives/003183.html

Global Insight, 2004. Venture Impact 2004: Venture Capital Benefits to the U.S. Economy. National Venture Capital Association, Arlington, VA.

Paul Hawken, Amory Lovins, and L. Hunter Lovins. 1999**.** Natural Capitalism: Creating the Next Industrial Revolution. Back Bay Books; Little, Brown and Company, Boston.

Jones, D., Tonn, B., and Martin, M. 2002. Preliminary Estimation of Energy Management for the Best Practices Program. ORNL/TM-2002/134, Oak Ridge National Laboratory, Oak Ridge, TN, July.

Mansfield, E. 1963. "Intrafirm Rates of Diffusion of an Innovation," *The Review of Economics and Statistics*, November, 348-359.

Mansfield, E. 1989. "The Diffusion of Industrial Robots in Japan and the United States," *Research Policy*, 18, 183-192.

Mansfield, E., Rapoport, J., Romeo, A., Villani, E., Wagner, S., and Husic, F. 1977. *The Production and Application of New Industrial Technology*. W.W. Norton & Co., NY.

Martin, M., Tonn, B., Schmoyer, R., Overly, J., Schexnayder, S., and Johnson, D. 2000. Evaluation of DOE's Industrial Assessment Center Program. ORNL/CON-473, Oak Ridge National Laboratory, Oak Ridge, TN, January.

National Academy of Sciences (NAS). 2001. *Energy Research at DOE was it Worth it? Energy Efficiency and Fossil Energy Research 1978 to 2000*. National Academy Press, Committee on Benefits of DOE R&D on Energy Efficiency and Fossil Energy, Washington, DC.

National Alliance of Clean Energy Business Incubators, 2006. http://www.cleanenergyalliance.com

National Renewable Energy Laboratory, 2006. "Clean Energy Investors Directory," http://www.nrel.gov/technologytransfer/entrepreneurs/directory.html

New York State Energy Research and Development Authority, 2005. New York Energy $mart™ Program Evaluation and Status Report. Albany, New York, May.

PA Consulting Group, 2006. Focus on Energy Public Benefits Evaluation: Semiannual Summary Report (FY06, Midyear), State of Wisconsin Department of Administration: Division of Energy, Madison, Wisconsin, March.

PriceWatershouseCoopers, 2006. MoneyTree™ Survey Report. http://www.pwcmoneytree.com/moneytree/nav.jsp?page=historical

Prindle, W., Shipley, A., and Elliott, R.N. 2006. "Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results form the Regional Greenhouse Gas Initiative," ACEEE, Washington, DC.

Prindle, W., Dietsch, N., Elliott, R. N., Kushler, M., Langer, T., and Nadel, S. 2003. "Energy Efficiency's Next Generation: Innovation at the State Level," Report Number E031, ACEEE, Washington, DC. November.

Renewable Energy Trust, 2006. "Energy Efficiency and Renewable Energy: A Growing Opportunity for Massachusetts," http://www.mtpc.org/renewableenergy/reports/clusterreport11405.pdf

Repowering the Midwest, 2006. "Job Jolt Illinois," http://www.repowermidwest.org/Job%20Jolt/Il.pdf

Schweitzer, M. 2005. Estimating the National Effects of the U.S. Department of Energy's Weatherization Assistance Program with State-Level Data: A Metaevaluation Using Studies from 1993 to 2005. ORNL/CON-493, Oak Ridge National Laboratory, Oak Ridge, TN, September.

Schweitzer, M. and Tonn, B., 2005. An Evaluation of State Energy Program Accomplishments: 2002 Program Year. ORNL/CON-492, Oak Ridge National Laboratory, Oak Ridge, TN, June.

Schweitzer, M. and Tonn, B. 2001. Non-energy Benefits from the Weatherization Assistance Program: A Summary of Findings from the Recent Literature. ORNL/CON-484, Oak Ridge National Laboratory, Oak Ridge, TN, April.

Sustainable Business, 2006. "NYSERDA: Renewable Energy Business Development Program Opportunity Notice (PON 949)," http://www.sustainablebusiness.com/businessconnections/detail.cfm?id=1677&type_id=11

Texas State Energy Conservation Office, 2006. "LoanSTAR Revolving Loan Program," http://www.seco.cpa.state.tx.us/ls.htm

Tonn, B., Schexnayder, S., and Martin, M. 2004. "Preliminary Assessment of IAC Leveraged and Non-Energy Benefits," Oak Ridge National Laboratory, Oak Ridge, TN.

Tonn, B. 2003. "Evaluation of Synergistic Impacts of the New York Energy $mart[SM] Program," Appendix C, New York Energy $mart[SM] Program Evaluation and Status Report. New York State Energy Research and Development Authority, May.

Valente, T. 1995. *Network Models of the Diffusion of Innovations*. Hampton Press, Cresskill, NJ.

9. ACKNOWLEDGMENTS

I would like to thank Barbara Ashdown for her help in initiating this research and for the cooperation with the State of North Carolina, and Sharon Stroud in particular, in guiding this research. I would also like to thank Marty Schweitzer, Barbara Ashdown, and Joel Eisenberg for their comments on the draft version of this report.

INTERNAL DISTRIBUTION

1. B. G. Ashdown
2. J. F. Eisenberg
3. G. K. Jacobs
4. M. J. Sale
5. M. Schweitzer
6. B. E. Tonn
7. A. K. Wolfe
8. ORNL Central Research Library
9. ORNL Laboratory Records – RC

ELECTRONIC DISTRIBUTION

10. S. Stroud sharon.stroud@ncmail.net