IMPROVING ENERGY PRODUCTIVITY: SUCCESSES AND REMAINING POTENTIAL[a]

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Abstract

For over two decades, utilities, states and the federal government, and a myriad of consultants have been estimating the potential for energy efficiency and renewable energy resources to help meet the nation's growing electricity needs. Three recent papers presented at the American Council for an Energy Efficient Economy (ACEEE) 2004 Summer Study on Buildings have provided updated analyses of the energy efficiency and renewable energy potential for a number of states and utilities.[b] While these papers are not explicated summarized in this paper, they do support the general finding that not much has changed. The potential of energy efficiency and renewable energy technologies to help meet growing electricity needs estimated over two decades ago is very similar to the potential that is estimated today. This does not mean, however, that little or nothing has been accomplished to date. Rather, great strides have been made in improving energy efficiency and developing renewable energy resources and technologies – and the contribution of these resources toward meeting electricity needs continues to increase. Energy efficiency has improved markedly over the past 20 years and technological innovations unimaginable 20 years ago are now possible. This paper presents a brief analysis of progress made to date in New York in realizing the potential for alternative energy resources, specifically, energy efficiency, and briefly discusses remaining opportunities.

Introduction

Improving energy efficiency is really all about increasing energy productivity just like improving labor efficiency is about increasing labor productivity – getting the same or more output or service for less or the same amount of input. The link between improved productivity and greater corporate earnings are clear – yet the added contribution to earnings is seldom used as justification for investment in energy efficiency. It is typical for technical potential studies to identify electricity savings upwards of 40 percent across energy using sectors with some variations by end-uses. It is also typical for economic and achievable electricity savings potential to range from 15 percent to 40 percent. Of course, many factors affect the potential percentage, including the current and anticipated future state of technology, avoided electricity and related marginal costs including peak demand savings, forecasts of energy prices and demand, present value discount rates, and finally, the temporal distribution and life expectancy of technologies. The estimates of potential today remain very similar to the estimates of potential of 20 years ago.

New York's Experience

New York's primary energy consumption has steadily declined per unit dollar ($) of gross state product

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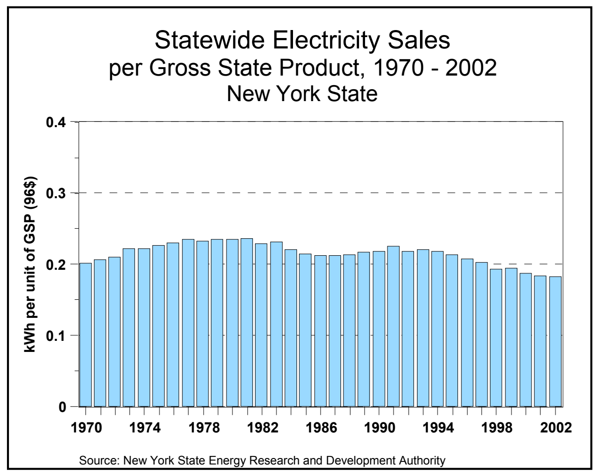
[a] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the New York State Energy Research and Development Authority.

[b] Several papers are cited as references in this paper.

(GSP) – declining 45% from 9,720 to 5,310 Btu's per unit of GSP (constant 1996 dollars) since 1970. The greatest proportion of this decline occurred from 1976 to 1984. The reasons for this continued improvement in energy productivity are many and varied, including a shift in the State's economy from a manufacturing to a service-based economy, high population density and increasing use of public transportation in cities, and a general improvement in energy productivity from more aggressive energy demand management programs by utilities, government, and more aggressive building codes and appliance and equipment standards. All of these conditions have contributed to the decline in energy use per unit of GSP. For example, industrial sector energy use as a share of the total has shifted over the 1970 to 2002 period with manufacturing declining from 19% to 9%, while the services sector (finance, insurance, & real estate) increased from 23% to 34%.

Over the same period, statewide electricity sales per unit of gross state product have declined by 9% from 0.202 kWh to 0.183 kWh per unit of GSP, as shown in Figure 1. And, the most recent downward trend has shown its most rapid decline from 1991 to 2002 of 19%. The large decline in electric use per unit of GSP over the 1991 to 2002 period is partly attributable to New York's changing structural economy and also in part to the large investment by utilities and states and the federal government in electric energy efficiency programs. Energy efficiency programs that first began as pilot programs in the mid to late eighties ramped up significantly in the early nineties and still remain large today.

Figure 1



The State's primary energy consumption per capita has declined by 6% over the 1970 to 2002 period from 231 to 217 million Btu's – making New York one of the most energy-efficient states in the United States on a per capita basis. Net commercial consumption of energy per non-manufacturing GSP has declined by 31% over the 1980 to 2002 period. New York continues to improve energy productivity in the commercial sector even though a large potential for improvements exist. Commercial electricity sales per non-manufacturing gross state product have declined by 11% over the past twenty-two years from 0.115 kWh to 0.103 kWh per unit of GSP. Most of this decline occurred in the last seven years, between 1995 and 2002, corresponding with the large investment in energy efficiency by utilities, states, and the federal government. These data are presented in Figure 2.

New York's net industrial consumption of energy per $ unit of manufacturing GSP had declined by 34% from 1980 to 1987 and then rose by 41% from 1987 to 2002. The State's industrial sector is struggling to improve its energy productivity with the industrial sector using almost as much energy per unit of GSP as it did in 1980. Several factors might explain this trend, including a greater proportional loss of less energy intensive industry relative to the more energy intensive industry, and a lack of available technology for industrial manufacturing and process improvements to boost productivity. Industrial electricity sales per manufacturing gross state product have declined by 14% over the past twenty-two years from 0.396 kWh to 0.341 kWh per unit of GSP. Most of this decline occurred between 1993 and 2002, as shown in Figure 3.

Figure 2

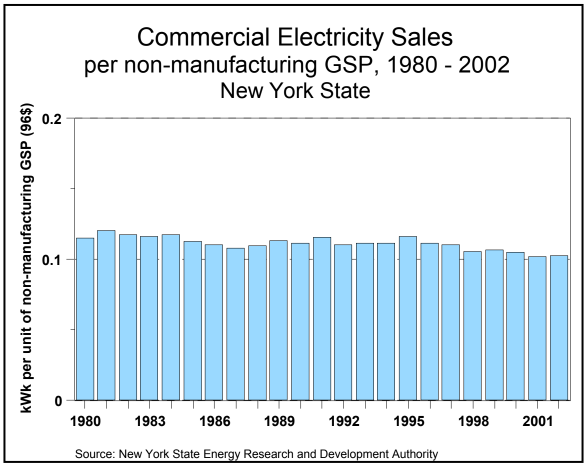
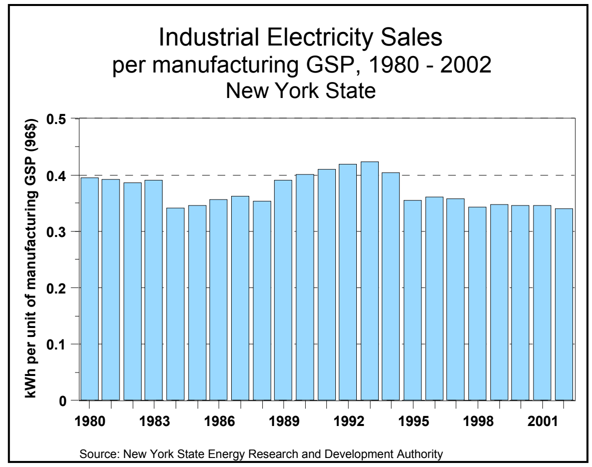


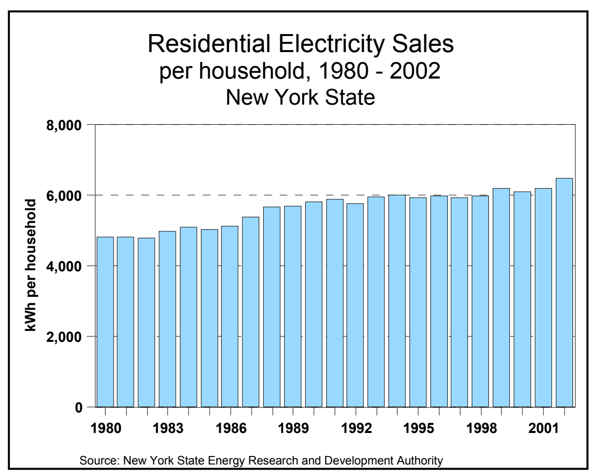
Figure 3



Net residential energy use has shown little improvement over the past 22 years, with the sector struggling to reap greater energy productivity. However, the energy-use data are very sensitive to abnormal heating and cooling degree-days experienced in New York.

In New York, households continue to increase their use of electricity – an increase of nearly 34% from 1980 to 2002. Figure 4 shows the increase in demand for electricity increasing from 4,825 kWh to 6,488 kWh annually over the past twenty-two years. The average size of residential dwellings in New York has increased in square footage by approximately 20 percent over the past several years and plug load continues to increase. New single-family homes built in New York are averaging 2,100 square feet per dwelling. Residential sector electricity use has increased 38 percent per capita over the 1980 to 2002 period.

Figure 4



Energy Potential Studies

The New York State Energy Research and Development Authority (NYSERDA) initiated a study to update previous estimates of energy efficiency and renewable energy resource potential in the State to support development of the 2002 *State Energy Plan*.[c] The study examined the technical and economic potential of selected technologies as alternatives to electricity generation and

[c] New York State Energy Planning Board. 2002. *State Energy Plan and Final Environmental Impact Statement*. Albany, NY: NYSERDA.

considered one additional scenario that examined the least cost mix of energy efficiency and renewable energy technologies that could meet the State's greenhouse gas emission reduction targets, adopted by the *State Energy Plan*. The analysis was conduced for the following three periods: 2002 through 2007; 2002 through 2012; and 2002 through 2022, recognizing that additional technologies will be developed over the longer-term that can affect the estimates of potential.

Technologies might be cost-effective in one zone due to transmission constraints, but not in another where power exchange is less constrained. Therefore, the study disaggregated the State into five separate electricity control areas (zones) to ensure that appropriate avoided costs were used in each zone. Thousands of efficiency and renewable technologies were analyzed across markets, sectors, and end-uses. The study had four main objectives:

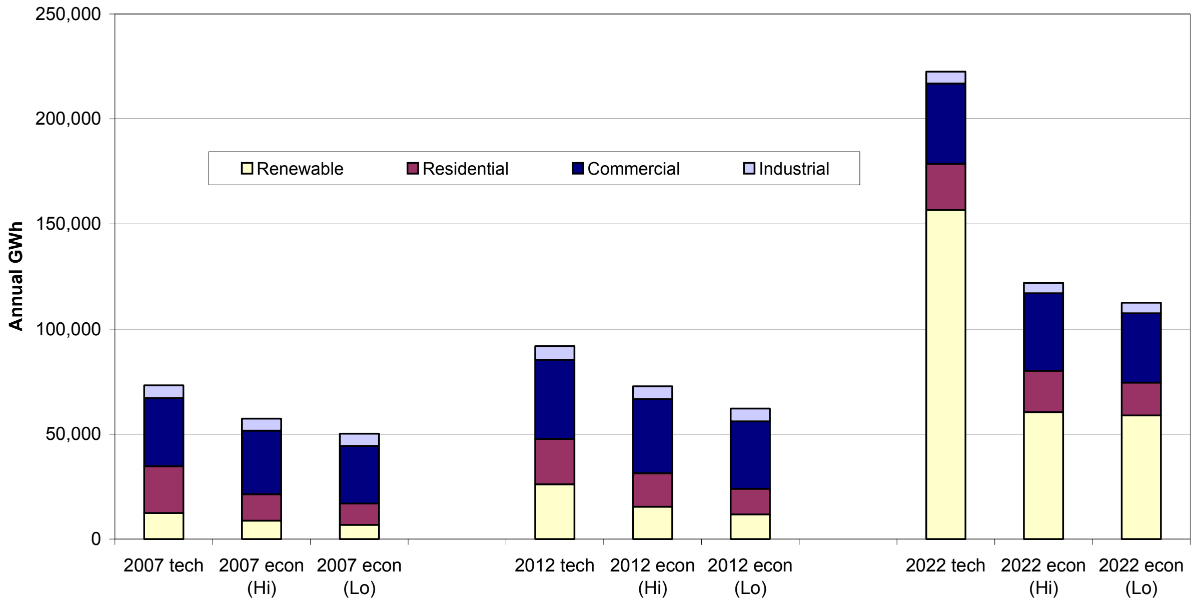
1. Estimate the technical potential or theoretical maximum amount of electricity physically able to be displaced by efficiency and renewable energy technologies, without any regard for cost or market acceptability, both throughout New York and in each of the five control area zones within the State.
2. Of this technical potential, determine how much efficiency and renewable energy would be economical compared with conventional generation that would be avoided both statewide and in the five specified zones.
3. Working from the theoretical analysis of statewide technical and economic potential, estimate how much electricity New York could realistically expect efficiency and renewable energy resources to displace as part of a least-cost solution to the State's greenhouse-gas reduction targets established for the electricity sector over the next 10 and 20 years.
4. Independently assess the impacts throughout New York from currently planned energy policy and program initiatives.

Figure 5 shows the technical and economic potentials for efficiency and electric energy from renewable energy resources, with efficiency savings broken out among the residential, commercial, and industrial sectors. Figure 6 shows the comparable peak-capacity potential. These figures represent the cumulative annual contributions from 2003 up to and including 2007, 2012, and 2022.

Technical potential from efficiency measures remains flat or grows only slightly over the study's 20-year horizon. This is attributable to two opposing influences. Projected growth in electricity use in new construction and increasing electricity saturation of some end uses in existing buildings (*e.g.*, residential air conditioning) both increase opportunities for efficiency savings. This is at least somewhat offset by expected improvements in base-case efficiency levels reflected in the underlying forecast of electricity requirements. In contrast, technical potential from renewable energy resources grows substantially over the analysis period. There is a steeper trajectory for renewable energy potential because, unlike efficiency potential, renewable energy supply is largely independent of underlying electricity requirements. Renewable energy technical potential depends much more heavily than efficiency on changes in manufacturing economies over time. For example, the technical potential for photovoltaic electricity depends on substantial growth in the worldwide manufacturing capacity for photovoltaic cells.

These results indicate that the relative shares of efficiency and renewable energy technical potential change over time. In 2007, efficiency resources comprise most of the technical potential for electric energy, with the greatest potential arising in the commercial sector. By 2022, however, the technical potential for renewable energy supply surpasses the potential for efficiency, as greater efficiency becomes increasingly embedded in the electricity forecast over time.

Figure 5 - Technical and Economic Potential for Electric Energy from Efficiency and Renewables in New York (Annual GWh)

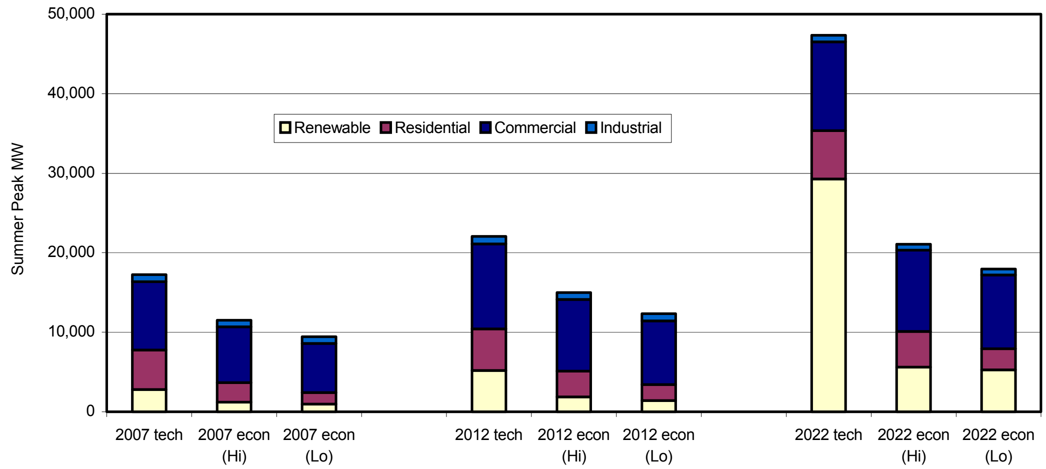


As shown in Figure 6 the study found that much of New York's efficiency and renewable energy technical potential would be economical at NYSERDA's estimates of avoided electricity costs. (The study used the West and Long Island zonal avoided costs to represent the high and low end of the range for determining the statewide economic potential for efficiency and renewable energy.) On a statewide basis, the study found that 77% of efficiency technical potential in 2012 would be economic at the lowest avoided costs in the State (West Zone); by 2022, the economic potential represents 81% of efficiency technical potential. Valued at the highest avoided costs in the State (New York City and Long Island), 87% of statewide technical potential in 2012 would be economic; 93% would be economic by 2022.

Accomplishments

Over the past decade, energy efficiency programs in New York have evolved in terms of their depth and breadth, and strategic focus. The State now offers a diverse portfolio of programs designed to better capture available energy efficiency and renewable potential beyond past efforts. Since 1990, the State has spent well over $3.0 billion on energy efficiency and renewable energy programs. Annual energy efficiency spending has been increased through 2006 due to the continuation and expansion of the State's System Benefits Charge (SBC) program, and the anticipated spending of the New York Power Authority (NYPA) and the Long Island Power Authority (LIPA) on public benefits programs. Between 1990 and 2004, the major energy efficiency programs of utilities and the State have resulted in cumulative annual savings in 2003 of over 8,000 GWh, representing about six percent of the State's total electric energy demand. Cumulative summer peak demand reductions were close to 2,000 MW, representing about seven percent of the State peak demand in 2003. New Yorkers also realized additional benefits of improved air quality and greater economic development over and above what would have occurred absent these programs.

Figure 6 - Technical and Economic Potential for Electric Capacity from Efficiency and Renewables in New York (Summer Peak MW)



Conclusions

Even given the strides that New York and other states have made in improving energy productivity and increasing the share of primary energy demand supplied by energy efficiency and renewable energy resources, much potential remains. In an era of tight government budgets and increasing electric sector competition, we cannot lose sight of the fact that a large potential remains and over time, government and utility policies and strategies must support efforts to realize this potential.

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