New Jersey Energy Efficiency and Distributed Generation Market Assessment

Final Report to

Rutgers University
Center for Energy, Economic and Environmental Policy

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Burlington, MA

ES EXECUTIVE SUMMARY

This study estimates potential for energy and peak-demand savings from energy-efficiency measures, and for distributed generation (DG), in the State of New Jersey over the mid-term (through 2008) and the long-term (through 2020). These dates align with New Jersey's targets for the Renewable Portfolio Standard to construct 300 MW of new Class I renewable energy by 2008, and to source at least 20% of new demand from renewables by 2020.

In contrast to energy conservation, which often involves short-term behavioral changes, energy-efficiency gains typically entail physical, long-lasting enhancements to buildings and equipment that result in decreased energy use while maintaining maximum levels of energy service. DG can provide electricity production from sources that are more localized or closer to key customer groups than central station power, and it uses energy more efficiently. This study demonstrates that significant additional and long-lasting energy efficiency and DG potential exists within the state.

ES.1 STUDY SCOPE – ENERGY EFFICIENCY

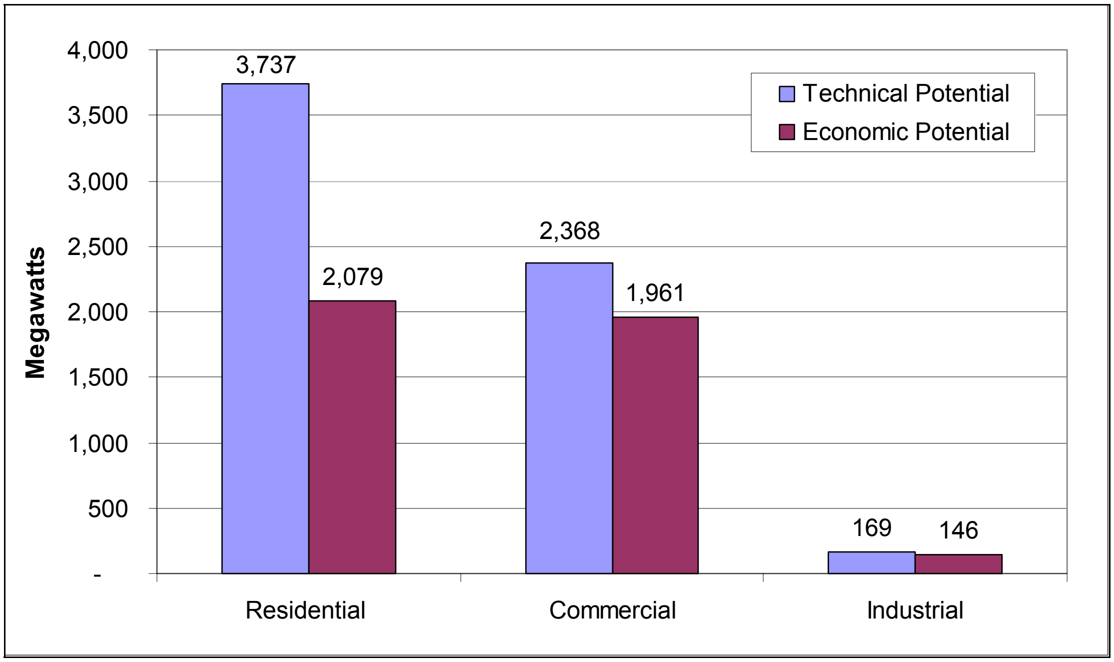
This study assesses energy-efficiency potential for saving electricity and natural gas in all sectors in New Jersey. It calculates technical, economic, and achievable potential savings through 2020, and is restricted to energy-efficiency measures and practices that are presently commercially available. This study leverages recent research conducted by the major investor-owned utilities in New Jersey and the New Jersey Board of Public Utilities (NJBPU), which provided an extensive foundation for estimates of potential in existing commercial, industrial, and residential buildings.

ES.2 KEY FINDINGS – ELECTRICITY AND GAS ENERGY EFFICIENCY

ES.2.1 Peak-Demand Savings

If all the *technically* feasible energy-conservation measures analyzed in this study were implemented regardless of economics, the overall technical peak-demand savings could amount to some 6,275 megawatts (MW) by 2020. If, however, only the measures that are *economic* (i.e., cost-effective when compared to supply-side alternatives) were implemented, potential peak-demand savings would be roughly 4,186 MW—33 percent lower than the technically feasible amount. These savings correspond to the equivalent of 8-12 mid-sized (500 MW) power plants. The residential sector contributes the most to both technical and economic savings potential, followed by the commercial sector (Figure ES-1).

Figure ES–1
Technical and Economic Peak-Demand Savings Potential, 2020



Economic potential assumes that all economically feasible measures will, in fact, be installed (for example, every incandescent light bulb in every house in New Jersey will be replaced by a compact fluorescent bulb). This of course is not feasible. For this reason, in order to provide reasonable estimates of impacts from energy-efficiency programs, we have also developed estimates of *achievable* potential, which are based on assumptions regarding the success of measure adoption. Since the latter depends to a large degree on programmatic support, we estimated potential savings under alternative future investment scenarios.

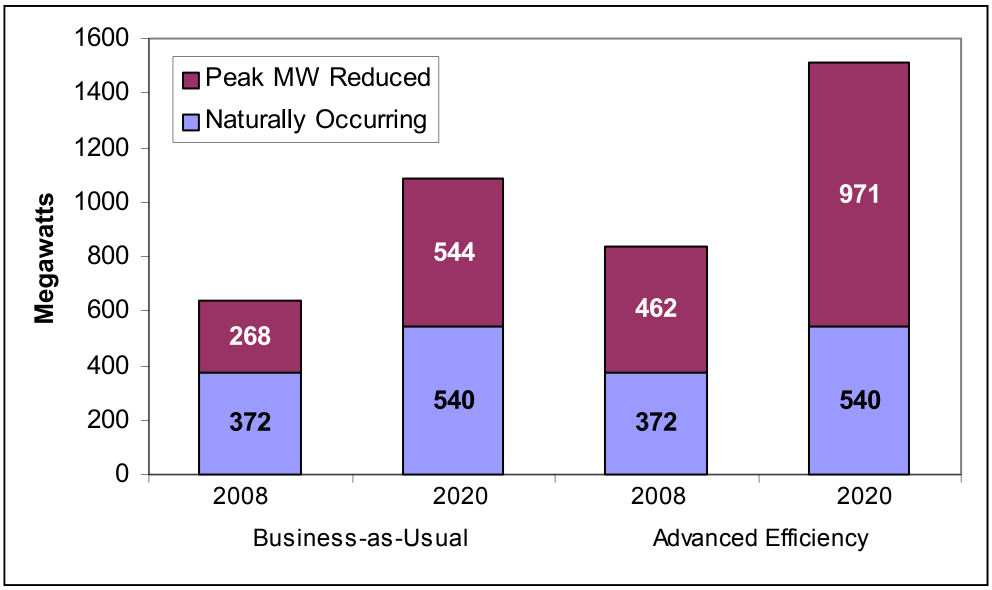
Achievable (or program) potential refers to the amount of energy saved as a result of a specific program's funding levels and incentives provided. These savings are above and beyond those that would occur naturally in the absence of any market intervention (estimated at 372 MW in 2008 and 462 MW in 2020).

As Figure ES-2 demonstrates, net program peak-demand savings potential ranges from over 540 MW by the year 2020 under the current program configuration (Business-as-Usual scenario) to some 970 MW if funding levels are significantly increased under very aggressive program activity (Advanced-Efficiency scenario). For reference, Figure ES-2 also includes the "naturally occurring" potential efficiency gains, i.e., energy that would be saved as a result of normal market forces, without any utility or governmental program intervention.

The Business-as-Usual scenario is based on New Jersey's current program configuration and measure mix. This scenario starts at approximately $85 million/year in program spending and trends down over time as some of the measures currently covered by the programs become standard practice and standards change. Under the Advanced-Efficiency case, funding starts at approximately $180 million/year and provides much higher incentive, marketing, and administrative costs than the Business-as-Usual case.

Programs intervention can provide significant energy-efficiency savings but will not capture the full economic potential. In our study, the Advanced-Efficiency case is projected to achieve about 25 percent of the total economically feasible potential savings by 2020. We estimate that capturing the entire economic potential through program activity would cost more than $5 billion over the 2004-2020 period.

Figure ES-2
Potential Peak-Demand Savings Due to Efficiency Gains Under Increased Program Funding, 2008 and 2020



ES.2.2 Electric Energy Savings

By the year 2020, the study estimates technical electricity savings potential at 16,999 GWh per year, and economic potential at 12,832 GWh per year — about 23 and 17 percent of base usage, respectively (Figures ES-3 and ES-4).

Figure ES–3
Technical and Economic Potential Energy Savings by Sector, 2020

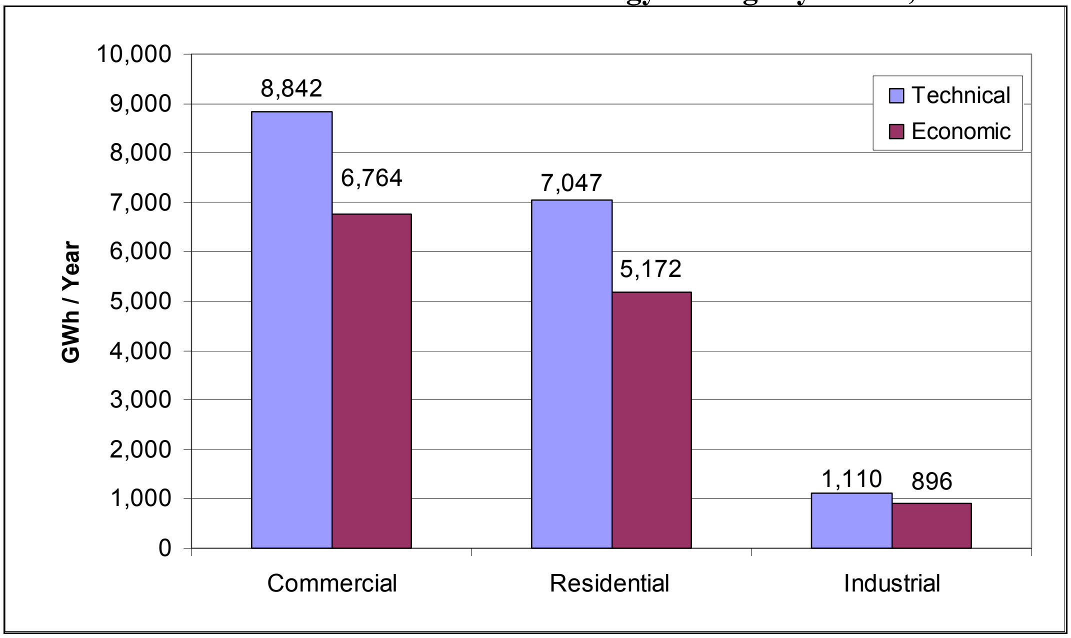


Figure ES–4
Potential Reduction of Base from Technical Energy Savings as a Percentage of 2004 Base

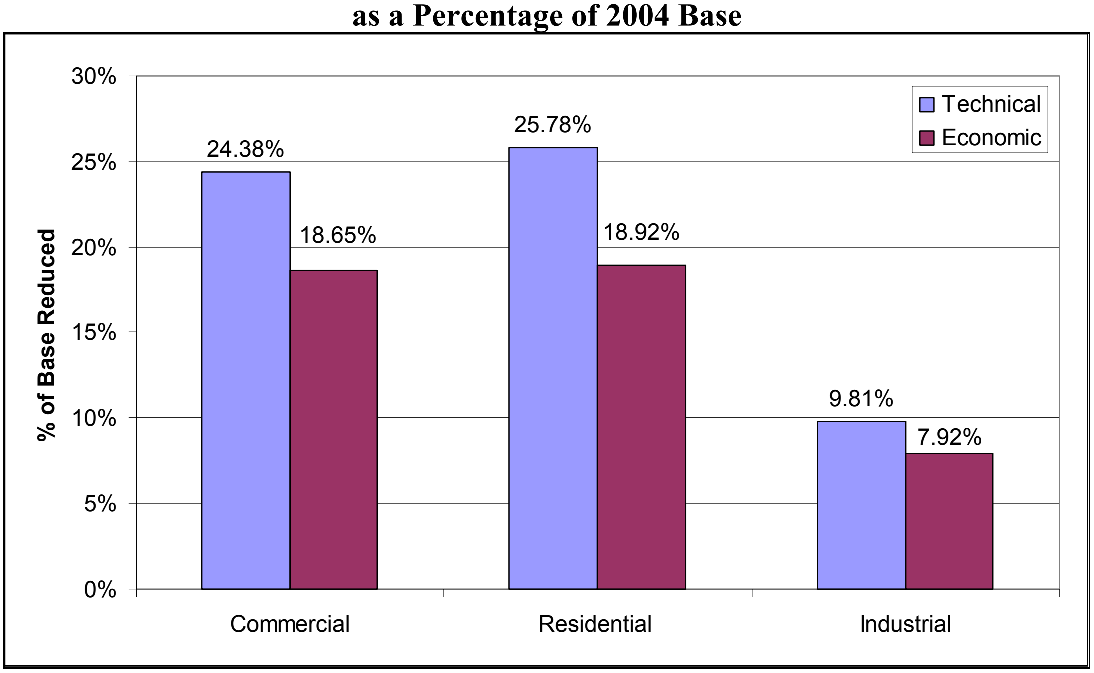
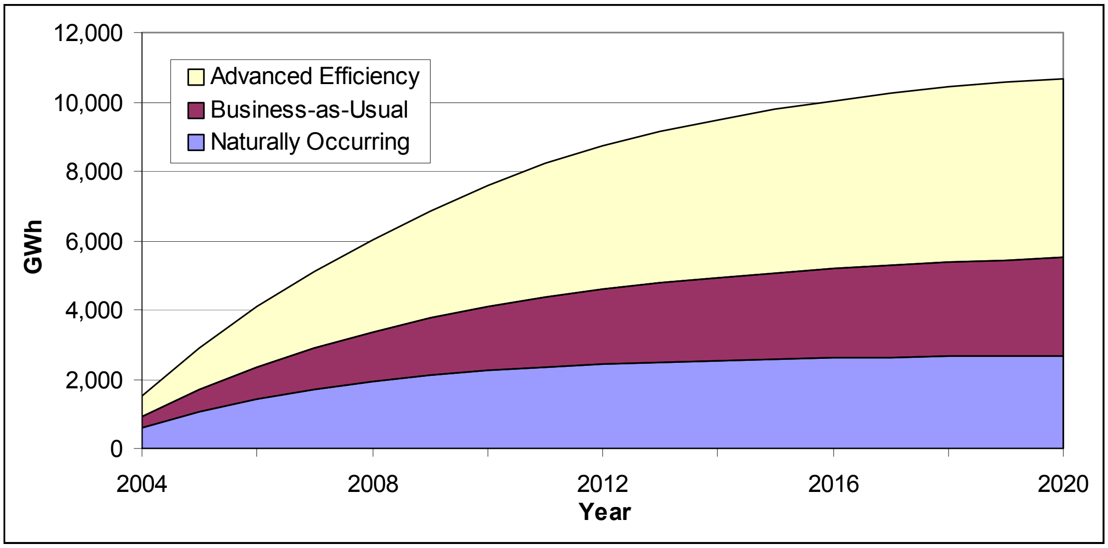


Figure ES-5 depicts annual electricity savings under the two funding scenarios. It also shows the "naturally occurring" potential efficiency gains resulting from normal market forces, without any program intervention.

Figure ES–5
Annual Electric Energy Savings by Scenario, 2004–2020



ES.2.3 Natural Gas Savings

Figure ES-6 illustrates potential technical and economic savings in demand for natural gas. If all the technically feasible gas measures analyzed in this study were in fact implemented, close to 1.5 billion therms could be saved annually over the forecast period. If only the economically feasible measures were implemented, over 1.4 billion therms/year of gas could be saved. Most of the gas is consumed in the residential sector.

Figure ES–6
Potential Technical and Economic Energy Savings in Natural Gas Annual Equivalent, 2004–2020

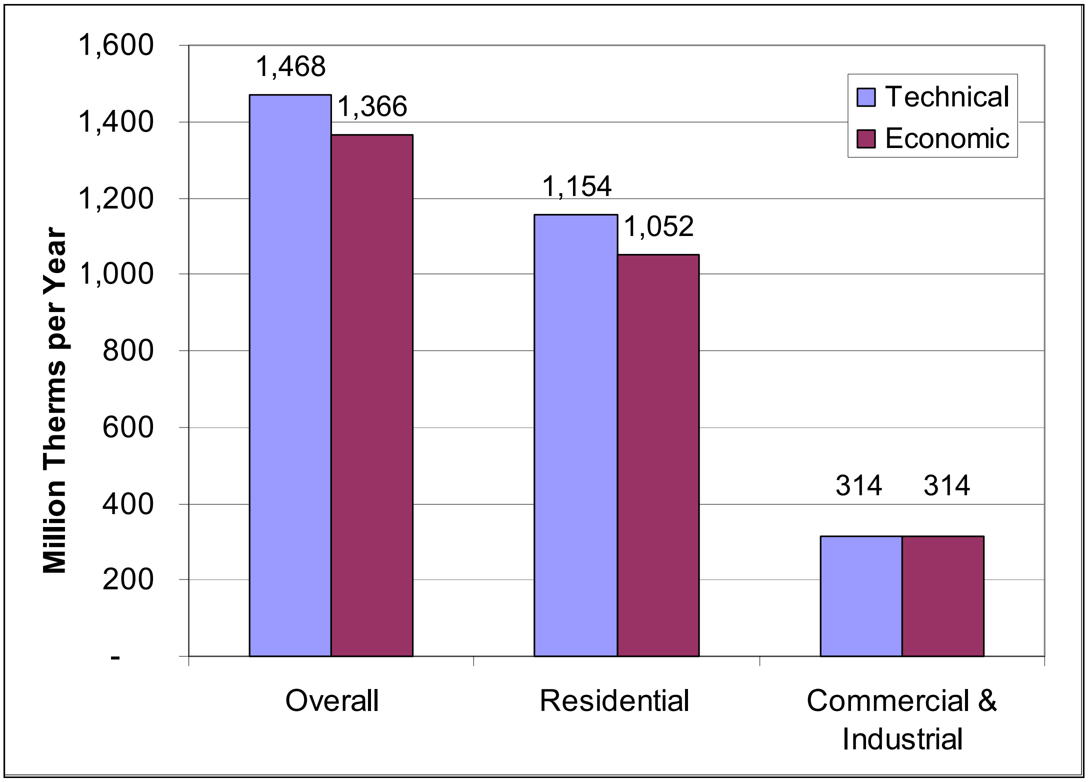
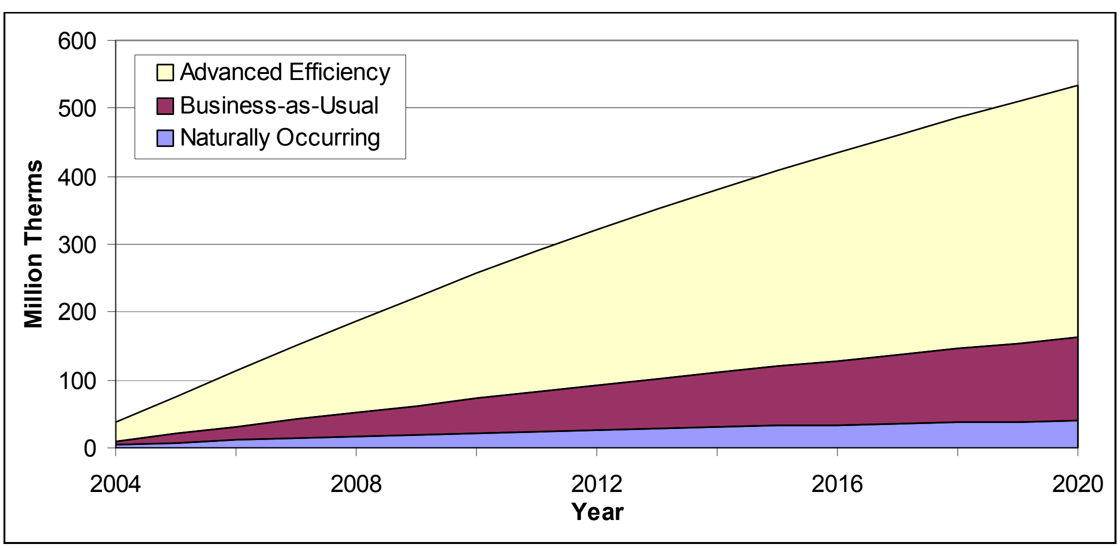


Figure ES-7 below shows annual energy savings for natural gas under alternative funding scenarios.

Figure ES–7
Potential Energy Savings for Natural Gas under Alternative Scenarios, 2004-2020



ES.2.4 Comparison to State Goals

As documented in Docket No.EX03110946 / EX0404276, the BPU's goal was to achieve by December 31, 2012 annual electric energy savings of 785,000 MWh and gas savings of 20 billion cubic feet (2 billion therms) from energy efficiency and renewable energy measures.

Our estimates of the technical, economic, and market potential exceed this stated BPU's goal for electricity savings. The estimated cumulative achievable energy savings by 2012 for the Business-as-Usual funding scenario, for example, is 2,153 GWh. However, our estimate of the technical, economic, and market potential for natural gas falls short of BPU's stated goal. The estimated cumulative achievable energy savings by 2012 for the Advanced Efficiency funding scenario is 230 million therms.

ES.2.5 Costs and Benefits of Energy-Efficiency Programs

Under our Business-as-Usual funding scenario, we estimate that from 2004 to 2020 almost $967 million (in present value) would be spent on gas and electric programs to promote energy efficiency in New Jersey. This investment could provide roughly $3.9 billion in avoided electric and gas energy costs. Increasing funds for these programs could reduce consumption further and capture billions of dollars in additional savings. By increasing program funding to about $2 billion (excluding non-incentive participant costs) the state could save over $6.2 billion on electricity and gas energy costs. As shown in Figure ES-8, this investment would provide a net benefit of roughly $3.8 billion. Figure ES-9 illustrates the same information for the years 2004 to 2008. Net benefits for the Business-as-Usual and Advanced Efficiency funding scenarios are roughly $1.8 billion and $2.6 billion, respectively.

Figure ES-8
Costs and Benefits of Energy-Efficiency Programs, 2004–2020

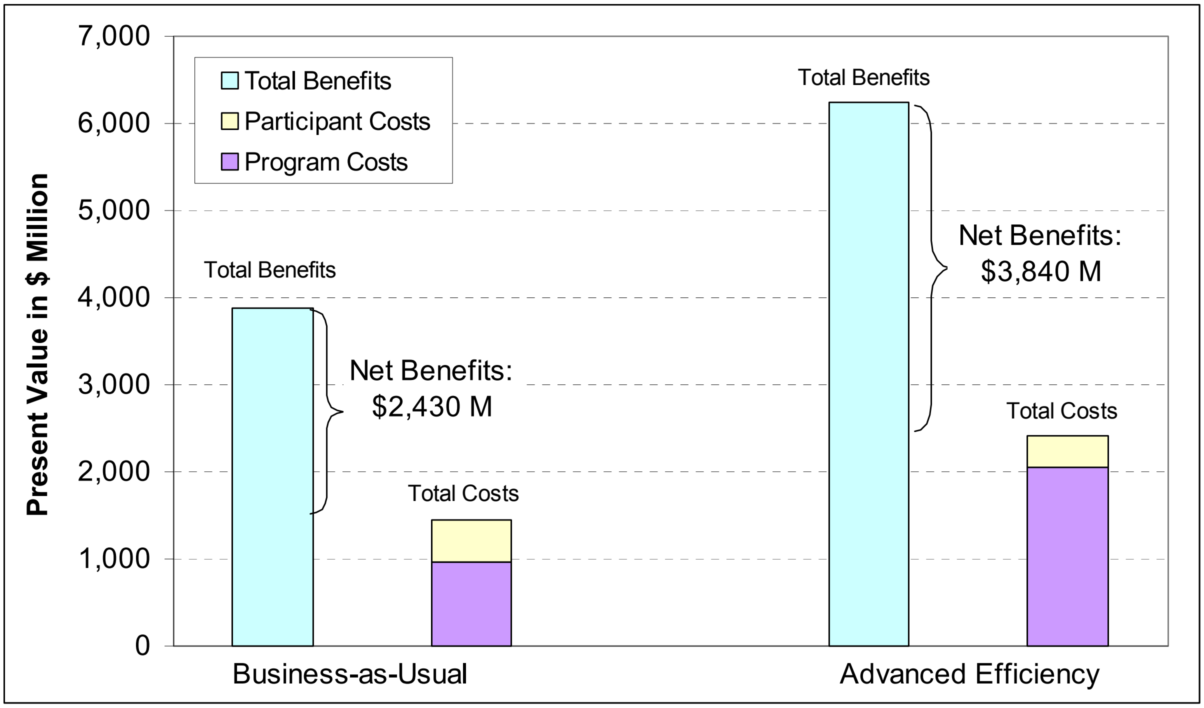
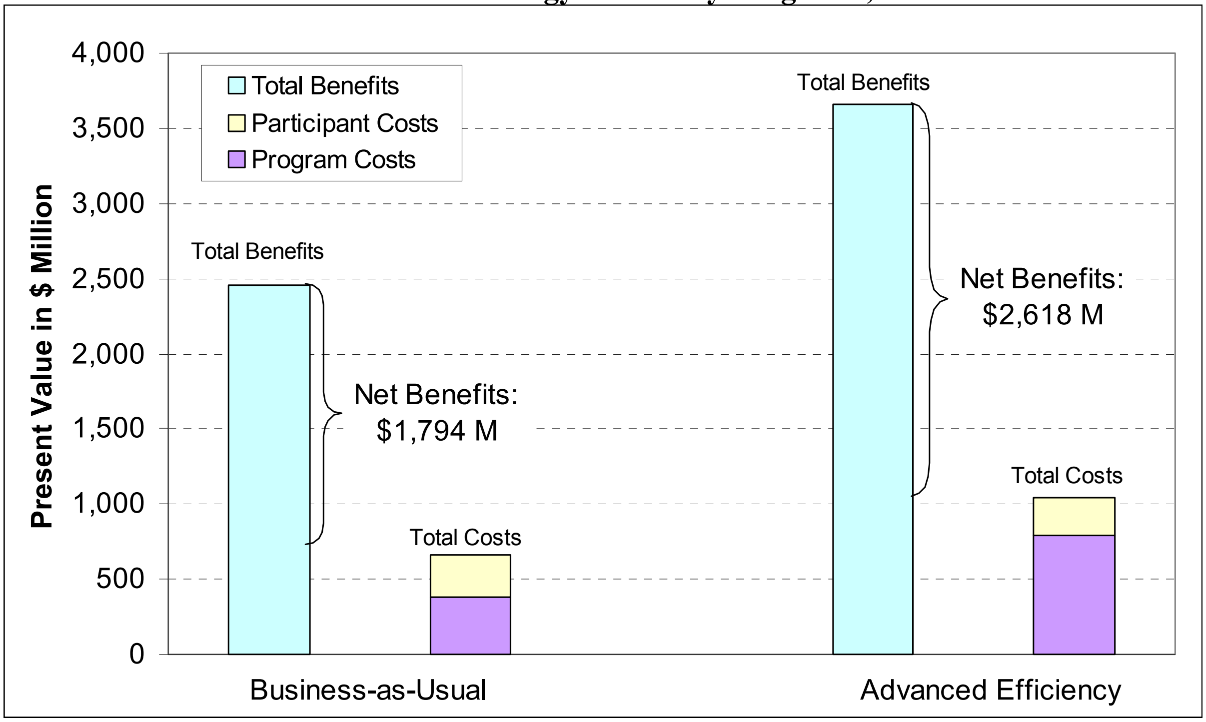


Figure ES-9
Costs and Benefits of Energy-Efficiency Programs, 2004–2008



ES.3 RECOMMENDATIONS – ENERGY EFFICIENCY PROGRAMS

This market assessment has identified a significant remaining resource for New Jersey. Barriers to the implementation of these technologies continue to exist, so ongoing program activity in these markets is warranted. Recommendations are presented first generally and then by program segments shown above. Our recommendations are based on the results of this analysis, our review of the existing programs, and discussions with various working group members.

ES.3.1 General Recommendations

The current programs are designed to overcome the existing market barriers in the markets they serve. Our analysis indicates that there is a significant cost effective resource available in New Jersey and that more resource could be tapped if additional resources are allocated to the programs. Overall recommendations include:

- Continue with the existing major program designs in major market sectors.
- Additional resources could be added above the business as usual scenario by increasing incentive, marketing and administrative costs.
- Monitor key markets such as residential HVAC as they change due to appliance standards and adjust programs accordingly

ES.3.2 Residential

HVAC

Central air conditioning is a major component of increasing electric growth in the residential sector in New Jersey. Market barriers include lack of information and training of contractors and lack of information for consumers. The current program is designed to overcome these barriers. The current program will be significantly impacted by the new residential appliance standards in 2006. Recommendations for this area include:

- Continue with successful aspects of the existing program. The existing program appropriately promotes both the sale of qualifying energy-efficient HVAC equipment *and* proper system sizing and installation "best practices" that affect operating efficiency. Proper sizing and installation have large economic potential and should continue to be emphasized
- Update the incentive structure of the existing program with new levels of efficiency after 2006 as new measures become cost-effective
- Add SEER 16 air source heat pumps to the program as they are cost-effective.
- Consider adding forced air heating systems using energy efficiency motors.
- Explore the addition of a maintenance program for older units.

- Coordinate with utilities to add direct load control as appropriate at time of installation. In order to make this option successful, a TOU or Real Time Pricing Rate may need to be developed and offered.

New Construction

The current program uses the ENERGY STAR model that has proven to be successful in New Jersey and elsewhere. This program has been very successful in large builder participation and should continue as currently configured. Specific recommendations for this program area include:

- Continue to increase awareness of current program and increase participation by smaller builders.
- Continue to coordinate with any zero energy home activities.
- Explore options to include renewable energy/green building concepts in new construction, where appropriate.

ENERGY STAR

Awareness of the ENERGY STAR brand has been increasing over time, especially in areas such as New Jersey where there has been active promotion of the brand. Windows, thermostats, lighting and appliances continue to be cost-effective resource. Some informational barriers have been removed both at the consumer and supply chain level. Windows are a large potential opportunity under this program. Recommendations for this program area include:

- Increase marketing of windows as an option under the program, as this is a large area of potential savings for both electric and gas.
- Continue to coordinate with regional and national activities such as Northeast Energy Efficiency Partnerships (NEEP) and DOE/ EPA initiatives.
- Add new measures as appropriate to marketing activities.
- Consider bundling Energy Star products that are applicable for home remodeling projects such as kitchen remodeling and outreach to remodeling contractors.
- Assess whether an incentive for windows would be appropriate.
- Review lighting incentives relative to other incentives in the region and current measure costs in New Jersey.
- Continue to push for new appliance standards, similar to those recently passed by the New Jersey Senate.

Other

- Consider a limited solar hot water heating pilot in conjunction with efforts to stimulate the PV market in the state.
- Significant savings for gas measures in existing homes such as tank wraps, low flow shower heads, floor / basement insulation, and air sealing are currently not covered under any existing programs. Explore potential program designs that would address these measures such as Home Performance with Energy Star.

ES.3.3 Commercial / Industrial Programs

Key market barriers for this sector of customers include financial barriers, lack of information, and lack of time. Key barriers for market actors include lack of information, lack of time, and lack of training, and lack of awareness of new technology use. The current program serves large customers well. The program design includes measure design support, technical assistance, and financial incentives to overcome the barriers. This program also provides for both gas and electric measures in one program making it easier for customers to identify their best options for a given end use solution. Specific program recommendations include:

- Continue existing program structure.
- Program goals for SmartStart Buildings Program, as articulated on page 43 of the MOA are excellent. Program designs should be tested against these goals.
- Pay only the costs directly associated with the energy efficiency aspects of LEED. Do not pay LEED registration costs. It is inappropriate for public funds to pay for a private, propriety certification fee.
- Investigate better ways to define high performance schools. Investigate the New Buildings Institute's Advanced Buildings Guidelines and the Massachusetts version of CHPS.
- Implementation of the high performance schools component at the Schools Construction Corporation appears to be stuck and not moving. Investigate third-party administration that would cooperate with the SCC, but give HPS more focused attention.
- NJ should investigate a direct install program for the small C&I market along the lines of Massachusetts and New Hampshire. It is more cost-effective and could be target to growth zones (or anywhere else). It also creates jobs for local contractors in communities, not ESCO's.
    - This approach can be relatively expensive, although typically still cost-effective from a total resource cost perspective. Several New England utilities have had success in reducing total program cost by supplementing incentives with on-bill financing.
- Provide training and education on new and emerging HVAC technologies soon to hit the market.

  - For example, Florida Power and Light may pilot an Energy Recovery Ventilator that pre-cools and dehumidifies make-up air using conditioned exhaust air.
  - Significant cost-effective savings can also still be captured through comprehensive air-conditioning design practices.
- Continue to promote commissioning other related services.
  - Consider piloting a turn-key retro-commissioning program, this approach can be very effective at capturing both electric and gas savings in an integrated process.
- Emphasize opportunities to beat lighting baseline levels by 15 to 25% using lighting design best practices in new construction.
- Support regional and national efforts such as CEE, NEEP and Energy Star as appropriate.
- Ensure the custom incentive portion of C&I portfolio is effective at setting incentives and program requirements to encourage net adoptions and minimize free ridership.
- Consider the economic development benefits of comprehensively addressing industrial process improvements.
- Leverage local governments and community-based organizations to enhance program marketing to smaller customers.
- Target energy efficiency and distributed generation opportunities on congested distribution feeders as the opportunity arises.

ES.4 KEY FINDINGS - DISTRIBUTED GENERATION

This study estimated: DG market potential among New Jersey commercial and industrial customers; fuel cells' potential in all sectors; and photovoltaic technology (PV) potential in new residential construction. We considered a multitude of factors, including current levels of market penetration, the economic value of the technology to the customer, a maximum achievable growth rate, and the size of the remaining potential market. Economic value was based on payback resulting from on-site electricity generation, thermal energy for combined heat and power (CHP) applications, and other potential savings/revenues. Current levels of DG and PV market penetration in New Jersey reflect the existing financial and regulatory barriers. With barriers lowered, the feasibility and economic value of DG and PV to the potential customer or host will increase, the payback period will be reduced, and market penetration rates will rise.

ES.4.1 DG Market Penetration

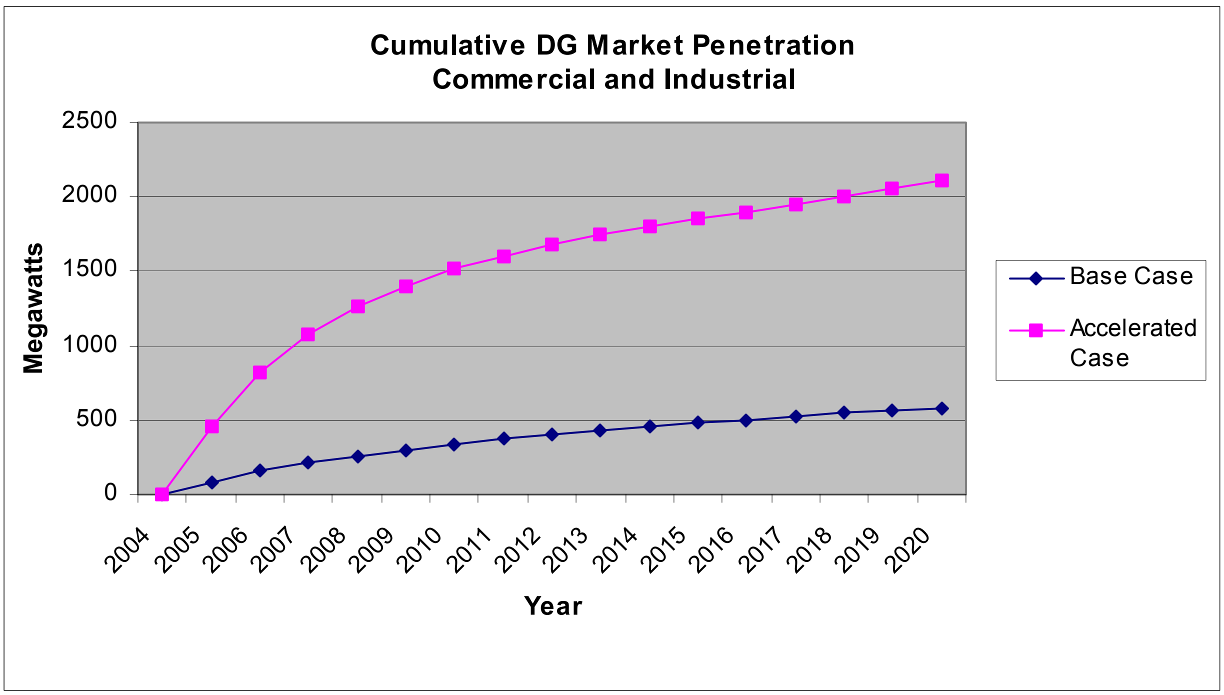
The study modeled DG market penetration for commercial and industrial (C&I) customers under two cases:

- Base Case assumes current electric rates, gas rates, and standby charges.

- Accelerated Case assumes a rebate of $1/watt or 30 percent (whichever is lower), reduced standby charges, and higher market potential.

Both cases assume natural gas as the fuel. Both cases assume the use of current technologies and a slight annual technology cost-reduction curve (–1 percent in 2004$). Figure ES-10 shows cumulative market penetration through 2020 for combined commercial and industrial applications under the two cases. Under the Base Case, some 550 MW of DG could be installed by 2020. Under the Accelerated Case, market penetration might increase almost four-fold — to about 2100 MW.

Figure ES–10
DG Market Penetration in the C&I Sector, 2004-2020



The Base Case reveals moderate market penetration through 2020. As indicated in Table ES-1, the Accelerated Case would result in significantly more installed DG than the Base Case. However, the Accelerated Case would have a policy cost[1] of about $660 million.

Table ES-1
DG Penetration and Rebate Cost

Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Base	583.18	$ -	$ -
Accelerated	2104.30	$ 662,345,018	$ 314.76

[1] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

ES.4.2 The Fuel-Cell Technology Market Penetration

The fuel-cell analysis covered residential, commercial, and industrial sectors. The technology used in the analysis was proton exchange membrane (PEM) for the residential sector and solid oxide (SOFC) for the C&I sectors. Aggressive annual cost reductions were assumed for both technologies. Both the Base Case and Accelerated Case assume an initial rebate of $2.5/watt for fuel cells (which results in a high policy cost per MW relative to conventional technologies). The Base Case assumes that the rebate is cut in half in 2013. In addition, the Accelerated Case assumes reduced standby charges, and higher market penetration rates. As Figure ES-11 demonstrates, the Accelerated Case for fuel cells achieves similar penetration as the Accelerated Case for DG, but it assumes a much higher incentive.

Figure ES–11
Fuel Cells' Market Penetration in the Residential and C&I Sectors, 2004-2020

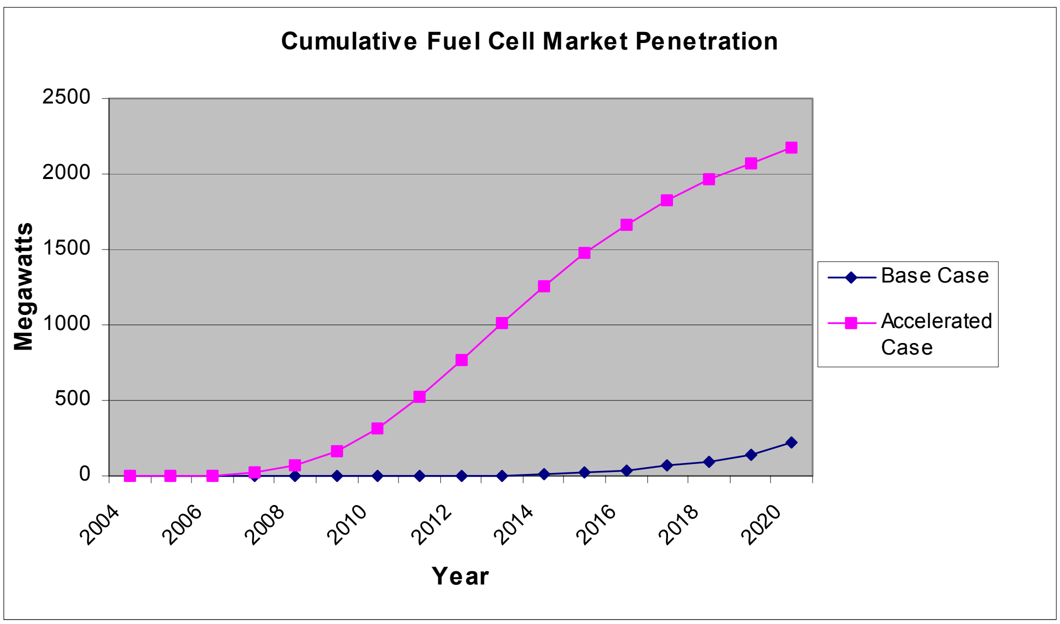


Table ES-2 lists the cost and performance assumptions for typical technologies used in this analysis. It indicates that there would be significantly more fuel-cell capacity installed and much higher policy costs[2] under the Accelerated Case. However, the Base Case would not result in any significant market penetration in the near-to-mid-term.

[2] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

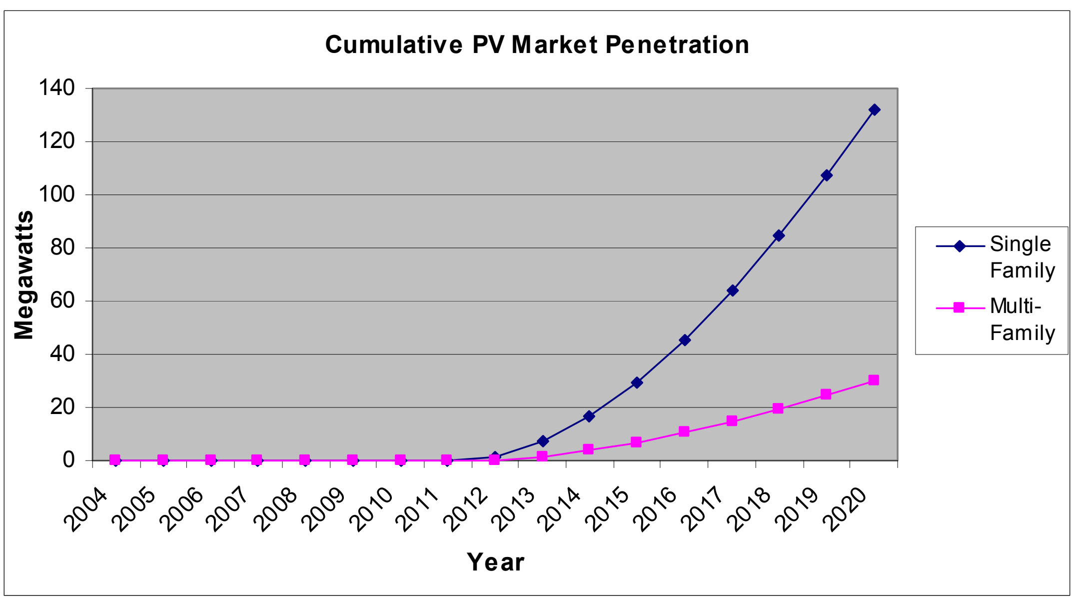
Table ES-2
Fuel Cell Penetration and Policy Cost

Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Base	218.17	$ 292,370,912	$ 1,340.08
Accelerated	2214.82	$ 5,813,889,535	$ 2,625.00

ES.4.3 Photovoltaic Market Penetration

To determine PV market penetration in the new home construction market, PV homes were bundled with qualified Energy Star New Homes as a way to reduce the initial payback period associated with new solar homes. The model used a variety of assumptions related to technical potential, PV policy, and system performance. In summary, the model assumed that PV and energy efficiency were bundled for purposes of calculating payback, the $5.50/watt subsidy was slowly phased out, and PV underwent an aggressive cost-reduction curve. The typical capacity of PV systems for both single and multi-family homes was 3.0 kW DC. New Energy Star homes sold for approximately $4,000 higher than new homes built to standard building code and saved about $700 annually. Figure ES-12 shows cumulative market penetration through 2020 in single- and multi-family homes.

Figure ES–12
PV Market Penetration, 2004-2020



Even with a gradual phase out of the rebate, the Base Case would result in significant policy costs. As indicated in Table ES-3, the installation of 163 MW of PV would have a policy cost[3] of about $477 million, or an average of $2,936/kW.

Table ES-3
PV Penetration and Rebate Cost

Base Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Single Family	132.29	$ 388,385,243	$ 2,935.85
Multi-Family	30.21	$ 88,691,534	$ 2,935.85
Total	162.50	$ 477,076,777	$ 2,935.85

ES.5 RECOMMENDATIONS – DISTRIBUTED GENERATION

In addition to offering meaningful rebates for DG and renewables, New Jersey has taken substantial steps to help address a couple of key market barriers:

- At the end of 2003, the BPU proposed amendments to the rule that would increase the maximum customer-generated capacity to two megawatts. The proposed amendments would also expand the class of customer-generators who are permitted to net-meter to include most renewables. To support and streamline the safe installation of these systems, New Jersey has also proposed to upgrade its standard interconnection procedures. The proposed amendment will be voted upon by the BPU on August 18, 2004.
- In addition, at least one New Jersey natural gas utility offers discounted rates to customers that use natural gas for DG.

The following areas of additional research would help to clarify and quantify the benefits and impacts of DG in New Jersey. Ultimately, they would form a quantitative case for (or against) the various options to support DG:

- Sponsor research and development on next-generation DG technologies and creative applications for DG, e.g., residential CHP.
- Perform comprehensive customer-based analysis and site audits (to better understand market potential).
- Research potential DG customers' financial decision-making.
- Quantify the technical and economic impact of DG on the T&D system.
- Determine impact of DG on the natural gas delivery system.
- Perform environmental impact assessment.
- Perform economic development research.

[3] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

Consistent with the above areas of research and the related objective of pursuing a suite of policy initiatives for supporting DG, the following recommendations should be considered:

- Develop and institutionalize long-term, predictable, and cost-effective funding and financing mechanisms (including existing rebates and tax incentives, and new financing mechanisms such as interest rate discounts, etc.).
- Further explore tax benefits to support DG.
- Continue to support standardized interconnection procedures.
- Explore the inclusion of CHP in net metering
- Develop supportive municipal ordinances and building codes.
- Explore electricity tariff revisions and options to reduce impact of standby charges on DG.
- Continue to explore discounted natural gas tariffs for CHP.
- Explore T&D avoided-investment credit/incentives.
- Continue to support load response.
- Promote inclusive renewable portfolio standard.
- Foster emissions policy that is supportive of low-emissions DG.

ES.6 PROGRAM RANKING

This study demonstrates that energy efficiency and DG resources could play a significantly expanded role in New Jersey's resource mix over the next two decades. While it is extremely important to have determined that more cost-effective efficiency savings could be achieved, this study does not seek to answer the larger resource-planning question of how much energy efficiency or DG should be purchased as part of a well-diversified overall portfolio of resources for the state. This will be accomplished through the comprehensive resource assessment (CRA) process.

To provide additional guidance for the CRA process, we developed evaluation criteria and scored the results for both energy efficiency and DG. Each energy efficiency measure[4] and program concept was scored based on four criteria:

Market Potential – We first estimated the technical potential, i.e., the maximum technically feasible energy savings from a measure or program concept. Market potential was then calculated by adjusting the technical potential by the likely market-penetration rates over the

[4] Throughout this report, the term *measure* refers both to hardware-based approaches to energy efficiency and to changes in design, operation, and specification practices among end users, contractors, architects, engineers, and other trade allies.

time frame of the analysis. The technical potential reflected first-year savings and market potential reflected cumulative energy and demand savings through 2020.

Total Resource Costs – Total Resource Cost (TRC) was calculated for each energy-efficiency measure or program concept. This value represents all capital, operational, and maintenance costs and benefits over the measure's life. The benefits include both the energy and demand savings, and the costs include program costs (such as rebates and marketing) and the customer costs. The values for this criterion were expressed as the benefit-cost ratio. For DG, payback was used as the economic criterion.

Market Barriers – The need for programs is predicated, in part, by the need to overcome market barriers to increase measure or program penetration. This criterion examines the extent of these market barriers and assesses whether intervention might be required to help overcome them. It does not assess whether a given program concept will overcome these barriers. This criterion also includes an assessment of the potential environmental impacts, the electric reliability impacts, the impact on underserved customers, and smart-growth compatibility. This criterion is scored on a range of values from 1 to 5.

Likelihood of Success – This criterion measures the likelihood that a given program concept promoting one or more measures will succeed. It considers several factors, including the extent of market barriers, whether there are federal or regional initiatives that would complement a utility program, and if non-energy benefits increase the attractiveness of a measure or program to a customer group. This criterion is scored on a range of values from 1 to 5.

For each measure or program concept, the values or scores for each of these four criteria were calculated or estimated. Within a given market, all of the measures or program concepts were ranked within each criterion based on these scores. Criteria were weighted to generate a final score.

Table ES-4 presents an overall ranking of the program concept for the following markets:

- Residential new construction
- Residential low-income
- ENERGY STAR®
- Residential HVAC
- Commercial and Industrial Retrofit,
- Commercial Industrial new construction
- Industrial Process
- Commercial/Industrial Gas
- Commercial and Industrial Distributed Generation
- PV new construction/zero-energy homes

- Fuel Cells

Energy-efficiency technologies were scored differently from DG technologies. The Total Resource Cost Test was used as the economic criteria for energy efficiency programs and payback was used as the economic criteria for DG. These criteria scoring presents energy-efficiency concepts relative to each other, but not on a comparable basis to DG concepts.

Table ES-4
Energy Efficiency Criteria Scoring and Weighting

Program Concept	Market Potential (MW)	Market Potential Score	Market Potential (GWh)	Market Potential (MTherm)	Market Potential Score	Cost Effectiveness (TRC Ratio)	Cost Effectiveness Score	Likelihood of Success Score	Market Barriers Score	Overall Scores
Criteria Weight		**12.50%**			**12.50%**		**25.00%**	**25.00%**	**25.00%**	
Residential Electric& Gas										
New Construction	18	1	50	11	1	1.4	2	5	5	3.3
Low Income	304	3	875	173	2	0.6	1	5	5	3.4
HVAC	1,307	4	1,630	714	3	1.9	2	3	2	2.6
Energy Star	118	2	2,264	122	4	2.6	3	4	3	3.3
Commercial / Industrial Electric										
Retrofit	1,538	5	6,665	-	5	3.9	5	4	3	4.3
Renovation / NC	26	1	98	-	2	2.8	3	5	5	3.6
Industrial / Process	146	3	896	-	3	2.8	3	4	3	3.3
Commercial / Industrial Gas										
Total	-	-	-	314	2	5.9	5	5	5	4.0

Table ES-5
Distributed Generation Criteria Scoring and Weighting

Program Concept	Market Potential (MW)	Market Potential Score	Market Potential (GWh)	Market Potential (MTherm)	Market Potential Score	Payback Period		Cost Effectiveness Score	Likelihood of Success Score	Market Barriers Score	Overall Scores
Criteria Weight		**12.50%**			**12.50%**			**25.00%**	**25.00%**	**25.00%**	
Distributed Generation						*2010*	*2020*				
Commercial and Industrial	583	4	-	-	4	2.0-28.3	1.6-18.6	3	4	3	3.5
Fuel Cells	218	3	-	-	3	7.5-20.2	4.5-10.4	2	4	5	3.5
Zero Emmission Home SF, MF	132	2	-	-	2	10.2	3.1	2	4	5	3.3

ES.7 Report Format

The remainder of this report is organized as follows:

Section 1 – Introduction and Study Objective

Section 2 – Energy Efficiency Analysis – Methodology

Section 3 – Energy Efficiency Analysis – Results

Section 4 – Distributed Generation Methodology and Results

Appendix A– Residential Assumptions and Criteria Scoring

Appendix B– Commercial and Industrial Assumptions and Criteria Scoring

Appendix C– Zero-Energy Homes Assumptions

Appendix D– Natural Gas Expansion Technology

Appendix E– Data Sources and Assumptions

Appendix F– TRCs by Measure

1 INTRODUCTION AND STUDY OBJECTIVE

1.1 REGULATORY CONTEXT

The need for the energy-efficiency and distributed-generation (DG) market assessment arises directly from New Jersey's legislation restructuring the energy industry — the Electric Discount and Energy Competition Act, which was signed into law on February 9, 1999. The Act requires that the Board of Public Utilities (BPU) initiate a proceeding every four years to undertake a Comprehensive Resource Analysis (CRA) of energy resources in the state. The initial CRA order issued by the BPU stated:

> ". . . *it has become necessary to re-evaluate existing DSM policies and programs and to consider the new energy efficiency alternatives to either replace or supplement existing programs in the state and to foster new energy resources in such alternatives as renewable energy resources."*

In 2004, the BPU initiated its second CRA proceeding that will determine funding levels for the years 2005–2008, identifying programs to be funded and their budgets. In order to inform its decision in this CRA proceeding, the BPU has commissioned the Rutgers University's Center for Energy, Economic and Environmental Policy (CEEEP) to assess market opportunities for energy efficiency and DG in New Jersey. The CEEEP has subsequently contracted KEMA Inc. to conduct the study and prepare this report.

1.2 STUDY OBJECTIVE

The objective of this study is to characterize and rank potential energy-efficiency and DG measures, technologies, and program concepts. The criteria used to characterize and rank these opportunities go beyond those usually considered within a resource-acquisition framework. Typically, two kinds of criteria are used:

- Size of the potential markets -- how much efficiency savings or renewable generation can be attained by a given date?
- Cost-effectiveness of the measures, technologies, and program concepts.
  - For energy efficiency -- do the measures or program concepts generate net benefits?
  - For DG -- is the cost of generation competitive with conventional resources?

While these criteria remain valid metrics for assessing market potential, a broader set of screening attributes is needed to account for changes in the energy industry and in the underlying strategic rationale for energy-efficiency programs. Climate change and other environmental considerations have been used to buttress the continued need for efficiency programs at all levels—federal, regional, and state. Furthermore, the methods to achieve these efficiency goals have become more strategic in program planning, design, and implementation. Many programs and initiatives now seek to identify and lessen or remove market barriers to energy efficiency. These efforts are often coordinated on the state, regional, or national level. The goal of these market transformation efforts is to attain long-term, sustainable changes in the markets for energy efficiency.

To account for these additional energy-efficiency market considerations, the methodology used in this study incorporates additional criteria that characterize the measures, technologies, and programs in a more comprehensive manner.

Restructuring has also been seen as a potential boon to DG technologies, such as co-generation, fuel cells, and zero-emission homes. Moreover, fuel cell deployment is most likely to develop in niche markets where reliability and power quality can exact a price premium. The identification of such niche markets will be an important step in the commercialization of certain technologies.

As with market transformation efforts to promote energy efficiency, current initiatives to develop distributed generation are increasingly focused on lessening market barriers and leveraging market forces to accelerate DG energy development.

1.3 USE OF THE STUDY'S FINDINGS

It is anticipated that the results from this study will inform the BPU and other interested parties on how energy-efficiency and DG resources may be dedicated over the next several years. It is important to note, however, that the ranking process used in this study does not automatically produce the "right" answers. While we have employed a multiple-attribute approach to scoring and ranking measures, technologies, and program concepts, there are other factors that must be considered in developing any final set of program recommendations. For example, the gas and electric utilities in New Jersey have been offering DSM programs for more than 15 years. Such programs are now transitioning to the BPU. Any set of final program recommendations must consider the experience from these past and current program efforts, as well as best practices from other regions. Program successes should be built upon experience to the extent that it is consistent with current state energy policy.

2 ENERGY EFFICIENCY - METHODS

This section provides a brief overview of the concepts, methods, and scenarios used in our study for the CEEEP. Additional methodological details are included in Appendices A, B and E.

2.1 CHARACTERIZATION OF THE ENERGY-EFFICIENCY RESOURCE

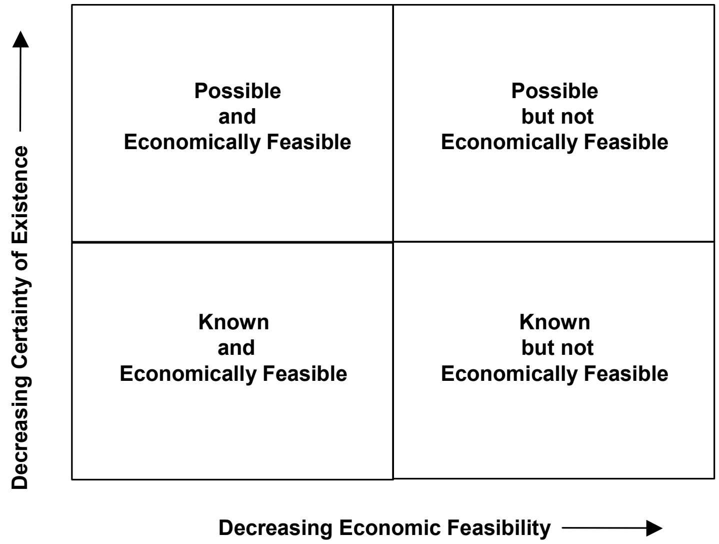
In the early 1980s, energy economists introduced the concept of a conservation supply curve to illustrate the potential costs and benefits of energy conservation and efficiency. Under this paradigm, technologies or practices that reduced energy use through efficiency were "liberating supply for other energy demands" and could, therefore, be thought of as a resource and plotted on an energy supply curve. Simply put, the more energy efficiency (or "mega-watts") produced, the fewer new power plants would be needed to meet end-users' demands.

2.1.1 Defining Energy-Efficiency Potential

Estimating the market potential of various energy-efficiency measures became popular throughout the utility industry from the late 1970s through the mid-1990s. Coinciding with the advent of the so-called "least-cost" or "integrated resource planning" (IRP), these studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

Similarly to the resource studies developed for fossil fuels, the energy- efficiency market potential can be characterized and estimated based on the techno-economic definitions applied in the study. For example, fossil fuel resources are typically characterized along two primary dimensions: the geological probability that the reserves will be found with the existing technology, and the feasibility that extraction of the resource will be economic (Figure 2-1)

Figure 2-1
Conceptual Framework for Estimating Resources



Somewhat analogously, this study for the CEEEP defines five types of energy-efficiency potential:

***Technical* potential** assumes the *complete* penetration of all energy-conservation measures that are considered technically feasible from an engineering perspective — regardless of price.

***Economic* potential** refers to the technical potential of those measures that are cost-effective when compared to supply-side alternatives.

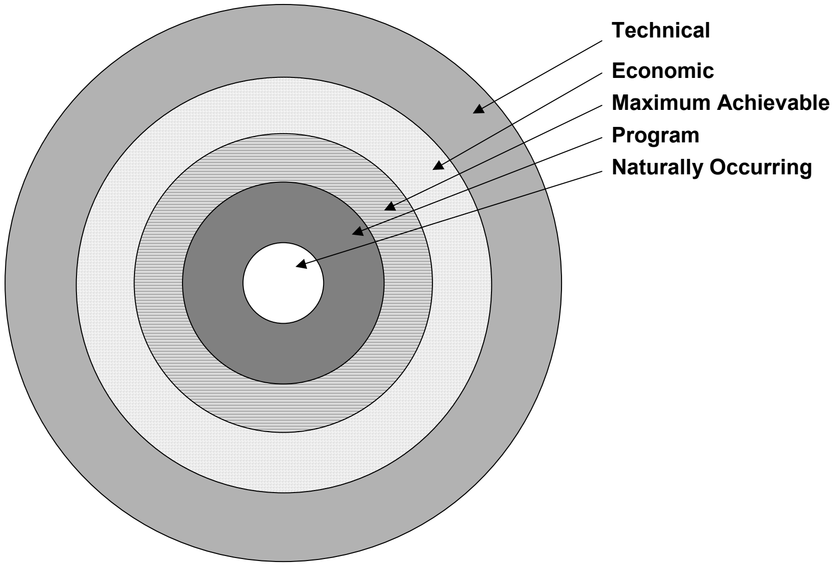
***Advanced-efficiency* potential** describes the economic potential that could be realized over time under a more aggressive program-marketing scenario.

***Achievable (Program)* potential** refers to energy saved as a result of a specific program's funding levels and incentives provided for implementation. These savings are above and beyond those that would occur naturally in the absence of any market intervention.

***Naturally occurring* potential** refers to energy saved as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

As can be expected, these different definitions will result in different estimates of the potential for energy savings (Figure 2.2).

Figure 2-2
Conceptual Relationship of Energy-Efficiency Potential Definitions



2.2 SUMMARY OF ANALYTICAL APPROACH USED IN THIS STUDY

To estimate the various energy-efficiency potentials, we followed a six-step approach described below. Figure 2.3 depicts these basic analytical steps in relation to one another. The bulk of the analytical process was performed using a model developed by KEMA for conducting energy-efficiency potential studies. The model, DSM ASSYST™, is an MS-Excel-based tool that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system. Appendices A, B and E, contain details on the steps and analyses conducted in this study.

The key steps included:

Step 1. Develop Initial Input Data

- Develop list of energy-efficiency measure opportunities defined for New Jersey.
- Gather and develop technical data (costs and savings) on efficient measure opportunities.
- Gather, analyze, and develop information on building characteristics, including: total square footage or total number of households; electricity consumption and intensity by end use; end-use consumption load patterns by time of day and year (i.e., load

shapes); market shares of key electric consuming equipment; and market shares of energy-efficiency technologies and practices.

Step 2. Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data on existing building characteristics to produce estimates of technical potential and energy-efficiency supply curves.

Step 3. Estimate Economic Potential

- Gather economic input data, such as current and forecasted retail electric and gas prices and current and forecasted costs of electricity generation. Also obtain estimates of other potential benefits of reducing supply, such as the value of reducing environmental impacts associated with electricity production.
- Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer).
- Estimate total economic potential.

Step 4. Estimate Maximum Achievable, Program, and Naturally Occurring Potentials

- Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings.
- Develop estimates of customer adoption of energy-efficiency measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention.
- Estimate maximum achievable, program, and naturally occurring potentials .
- Develop alternative economic estimates associated with alternative future scenarios.

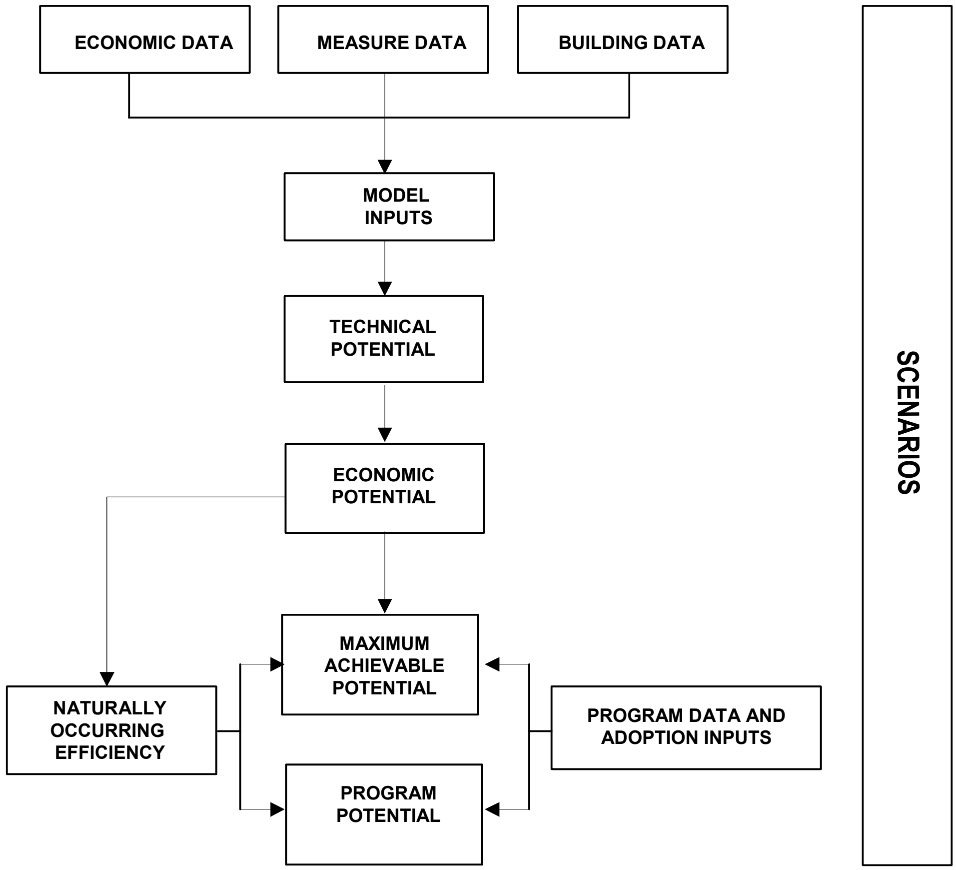
Step 5. Scenario Analyses

- Recalculate potentials under alternate economic scenarios.

Step 6. Criteria Ranking

- Rate according to four key criteria at the program level:
    1. Market Potential
    2. Total Resource Cost
    3. Market Barriers
    4. Likelihood of Success
- Weight criteria.

Figure 2-3
Conceptual Overview of Study Process



2.3 SCENARIO ANALYSIS

Scenario analysis is a tool commonly used to structure the uncertainty and examine the robustness of projected outcomes to changes in key underlying assumptions. This section describes the alternative scenarios under which energy-efficiency potential is estimated in this study. We developed these scenarios of energy-efficiency potential for two key reasons:

- First, our estimates of potential depend on future adoptions of energy-efficiency measures that are a function of data inputs and assumptions that are themselves forecasts. For example, our projections depend on estimates of measure availability, measure costs, measure savings, measure saturation levels, retail rates, and avoided costs. Each of the inputs to our analysis is subject to some degree of uncertainty.

- Second, the ultimate achievable energy-efficiency potential depends, by definition, on policy choices — including the level of resources and strategies used to increase measure adoption.

The cost components of program funding that vary under each scenario include:

Marketing Expenditure
Customers must be aware of efficiency measures and associated benefits in order to adopt those measures. In our analysis, program marketing expenditures are converted to increases in awareness. Thus, under higher levels of marketing expenditures, higher levels of awareness are achieved.

Incentives and Direct Implementation Expenditures
The higher the percentage of measure costs paid by the program, the higher the participants' benefit-cost ratio and, consequently, the number of measure adoptions.

Administration Expenditure
Purely administrative costs, though necessary and important to the program process, do not directly lead to adoptions; however, they have been included in the program funding because they are an input to program benefit-cost tests.

Business-as-Usual Funding Scenario

Our Business-as-Usual case is based on the current level of program activity and the major investor-owned utilities' programs. In developing this case, we reviewed actual expenditures provided in the reports to the BPU, as well as other sources for residential and nonresidential programs.

The total incentives dollars were estimated directly in our model as a function of predicted adoptions. What was specified in the model was the percentage of incremental measure cost paid by the program. We attempted to set these percentages as closely as possible to the utility incentive levels in recent years. We believe that the percentage of measure costs paid in our Business-as-Usual scenario, which average about 30 –65 percent of measure costs, reasonably approximates actual program incentive levels over the past few years.

In the Business-as-Usual scenario, total marketing costs increase by inflation over the analysis period. We set administration costs to vary slightly over time as a function of program activity levels. The percent of incremental measure costs paid over time was generally held constant (though incentive levels were ramped up over time under the higher funding scenarios). The actual incentive paid decreased over time due to structural changes in the market — most notably, changes in the appliance standard.

Advanced- Efficiency Funding Scenario

The Advanced-Efficiency case represents a significant increase in funding from Business-as-Usual. We increased funding levels by raising both the total marketing expenditures and the per-unit incentive levels. Administration levels increased as a function of greater program activity. Marketing costs increased by 35% and the average fraction of incremental costs paid for by incentives rose from roughly 40- 50 % in Business-as-Usual to approximately 80% in Advanced-Efficiency.

Summary of Scenarios

Table 2-1 shows average spending for each of the scenarios during the 2004-2012 and 2004-2020 forecast periods.

Business as Usual: Yearly Average (2004-2012)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	40.07	12.27	90.18	1.72
Commercial & Industrial	29.54	31.58	273.05	4.47
Total	69.60	43.86	363.23	3.20

Business as Usual: Yearly Average (2004-2020)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	34.41	9.10	69.64	1.60
Commercial & Industrial	22.46	19.63	158.92	3.78
Total	56.87	28.73	228.56	2.67

Advanced Efficiency: Yearly Average (2004-2012)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	83.87	18.84	220.15	2.14
Commercial & Industrial	72.24	19.08	354.53	3.88
Total	156.12	37.92	574.68	2.96

Advanced Efficiency: Yearly Average (2004-2020)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	68.78	13.30	159.97	1.95
Commercial & Industrial	51.48	7.97	207.40	3.49
Total	120.27	21.27	367.37	2.60

Development of Criteria and Criteria Weights

To provide additional guidance, the results for energy-efficiency program concepts were scored on four key criteria. The program concepts, described in more detail in Section 3, were formulated based on existing program offerings. For the market assessment, the following four criteria were examined and quantified to characterize and rank each measure:

Market Potential – We first estimated the technical potential, i.e., the maximum technically feasible energy savings from a measure or program concept. Market potential was then calculated by adjusting the technical potential by the likely market-penetration rates over the time frame of the analysis. The technical potential reflected first-year savings, and market potential reflected cumulative energy and demand savings through 2020.

Total Resource Costs – Total Resource Cost (TRC) was calculated for each energy-efficiency measure or program concept. This value represents all capital, operational, and maintenance costs and benefits over the measure's life. The benefits include both the energy and demand savings, and the costs include program costs (such as rebates and marketing) and the customer costs. The values for this criterion were expressed as the benefit-cost ratio. For DG, payback was used as the economic criterion.

Market Barriers – The need for programs is predicated, in part, by the need to overcome market barriers to increase measure or program penetration. This criterion examines the extent of these market barriers and assesses whether intervention might be required to help overcome them. It does not assess whether a given program concept will overcome these barriers. This criterion also includes an assessment of the potential environmental impacts, the electric reliability impacts, the impact on underserved customers, and smart-growth compatibility. This criterion is scored on a range of values from 1 to 5.

Likelihood of Success – This criterion measures the likelihood that a given program concept promoting one or more measures will succeed. It considers several factors, including the extent of market barriers, whether there are federal or regional initiatives that would complement a utility program, and if non-energy benefits increase the attractiveness of a measure or program to a customer group. This criterion is scored on a range of values from 1 to 5.

For each measure or program concept, the values or scores for each of these four criteria were calculated or estimated. Within a given market, e.g., commercial retrofit, all of the measures or program concepts were ranked within each criterion based on these scores. Criteria were weighted to generate a final score.

Overall ordering of the program concept rankings was calculated for the following energy efficiency markets:

- Residential new construction

- Residential low income
- Energy Star
- Residential HVAC
- Commercial Retrofit
- Commercial New Construction
- Industrial
- Commercial and Industrial Gas

These program configurations and their criteria scoring are presented in Chapter 3.

3 ENERGY EFFICIENCY - RESULTS

Our study analyzed the potential for over 200 energy-efficiency measures across dozens of market-segment applications. In this section, we present the results of this analysis under the Business-as-Usual and Advanced-Efficiency funding scenarios. We first discuss the overall results, followed by a more detailed breakdown by customer class, end use, and type of measure.

3.1 OVERALL RESULTS

Estimates of energy-efficiency *technical* and *economic* potential are shown below in Section 3.1.1, and the *achievable* potential is discussed in Section 3.1.2. Definitions of these different types of potential are provided in Section 2 and discussed in Section 2. The bottom-up methodology used in this study is described in Appendix E.

3.1.1 Technical and Economic Potential

Figures 3-1 and 3-2 present our overall estimates of total technical and economic potential for peak-demand and electrical energy in New Jersey. *Technical potential* represents the sum of all savings from all the measures deemed applicable and technically feasible. *Economic potential* is based on efficiency measures that are cost-effective based on the total resource cost (TRC) test — a benefit-cost test that compares the value of avoided energy production and power plant construction to the costs of energy-efficiency measures and program activities necessary to deliver them. The values of both energy savings and peak-demand reductions are incorporated into the TRC test.

Peak-Demand Savings. If all the measures analyzed in this study were implemented whenever technically feasible, technical potential would be roughly 6,275 MW by 2020. If only the measures that pass the TRC test were implemented, economic potential would be 4,186 MW. These savings correspond to the equivalent of 13 and 8 mid-sized (500 MW) power plants, respectively.

Energy Savings. Technical potential is estimated at 16,999 GWh/year, and economic potential at 12,832 GWh/year (about 23 and 17 percent of base usage, respectively).

Natural Gas Savings. The technical gas savings would be approximately 1,468 million therms/year, and the economic savings would be about 1,366 million therms/year, as Figure 3.3 shows.

Figure 3-1
Technical and Economic Potential Demand Savings, 2020

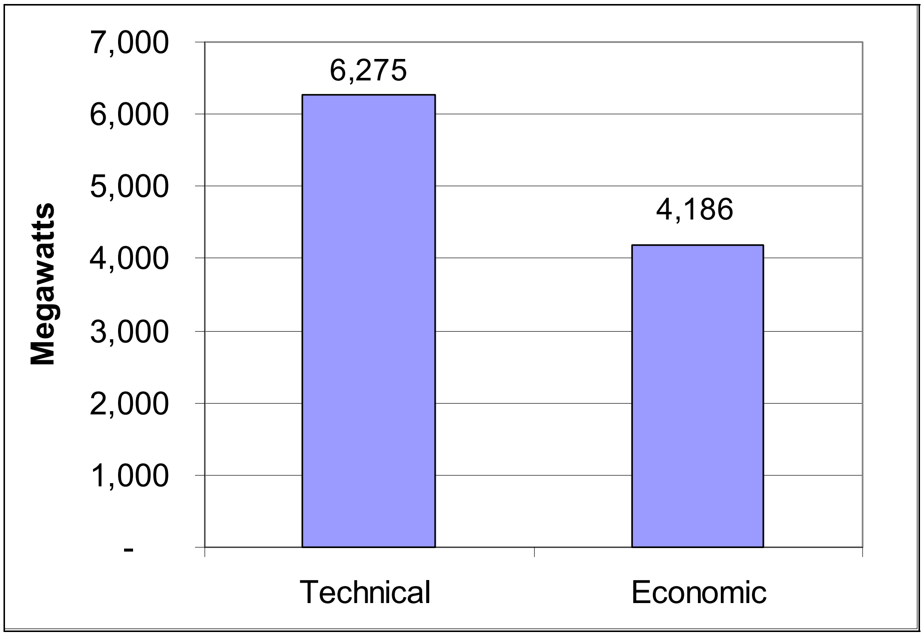


Figure 3-2
Technical and Economic Potential Energy Savings, 2020

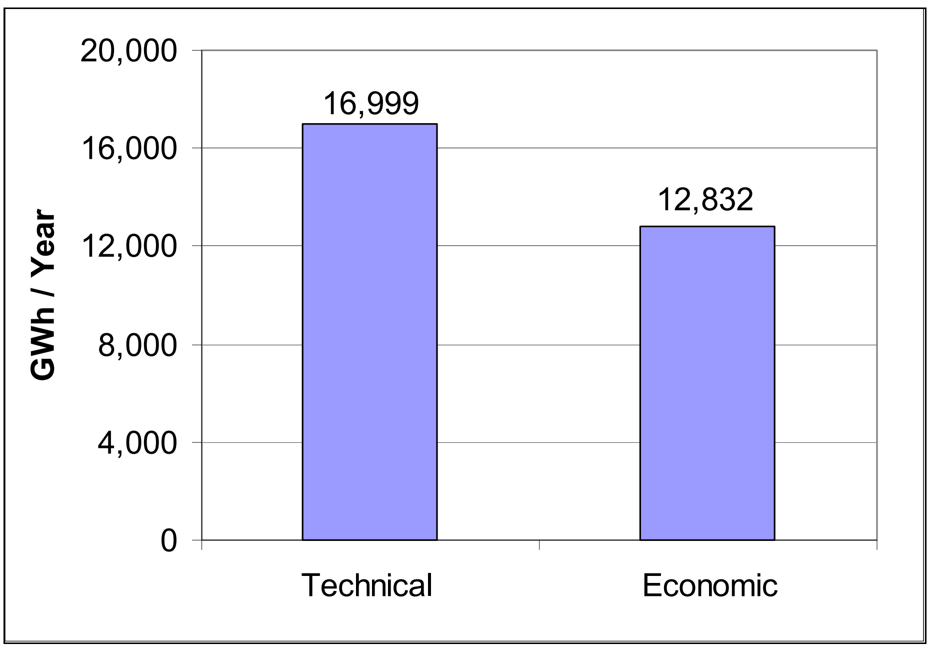
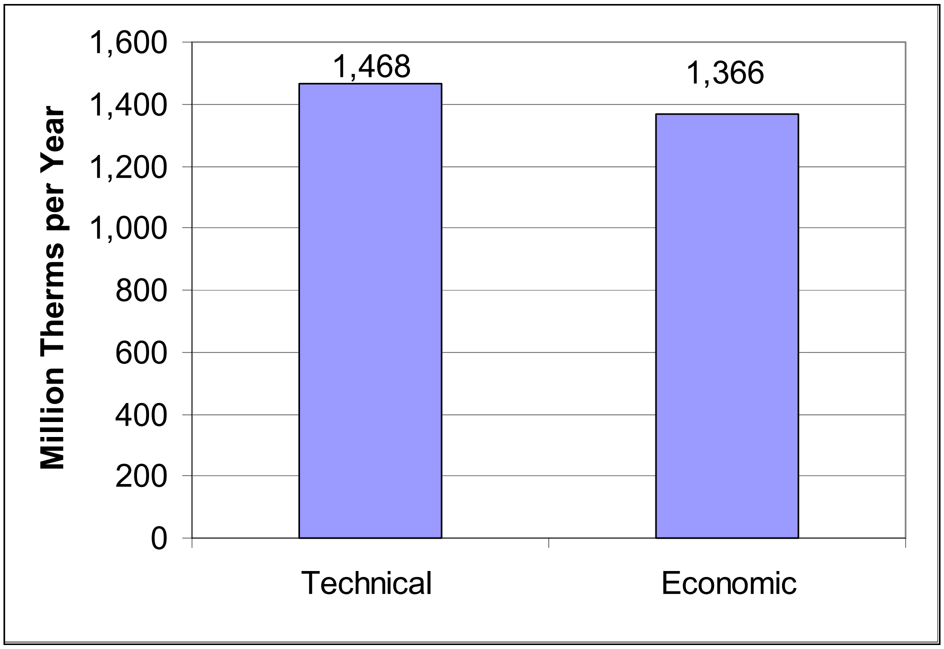


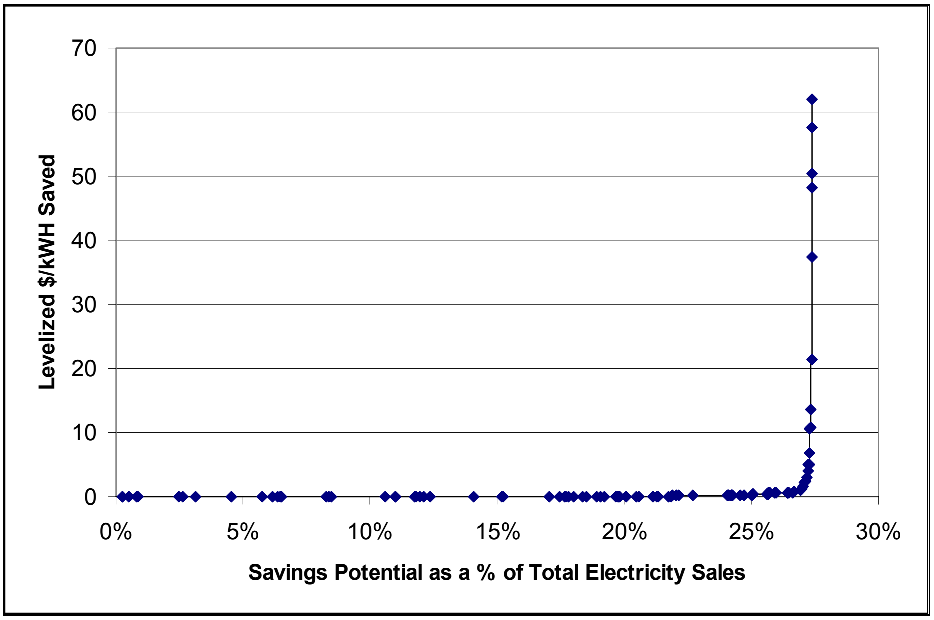
Figure 3-3
Technical and Economic Potential Gas Savings, 2020



A common way to illustrate the amount of energy savings per dollar spent is to construct an energy-efficiency supply curve. A supply curve typically is depicted on two axes—one captures the cost per unit of saved electricity (e.g., levelized $/kWh saved), and the other shows energy savings at each level of cost. Measures are sorted on a least-cost basis, and total savings are calculated incrementally with respect to measures that precede them. The costs of the measures are levelized over the life of the savings achieved.

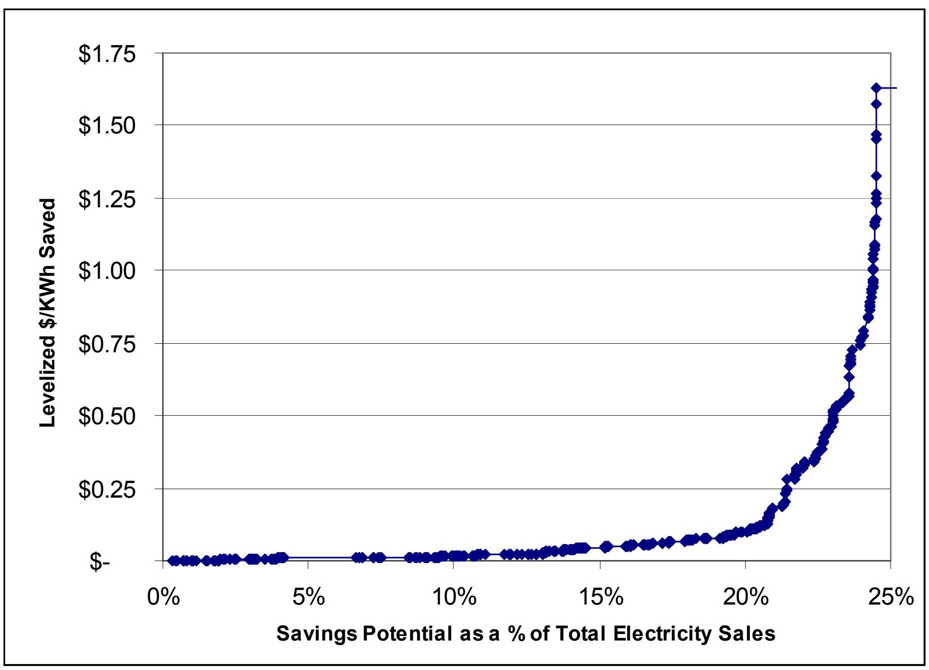
Figures 3-4 through 3-7 present the energy-efficiency supply curves constructed for this study for the following four markets: residential, commercial/existing buildings, commercial/new construction, and industrial. Each curve represents energy savings as a percentage of total energy consumption in New Jersey in the year 2020. Savings potentials and levelized costs for the individual measures that comprise the supply curve are provided in Appendix F. End-use and measure savings are discussed later in this section.

Figure 3-4
Residential Electric Supply Curve – Potential in 2020*



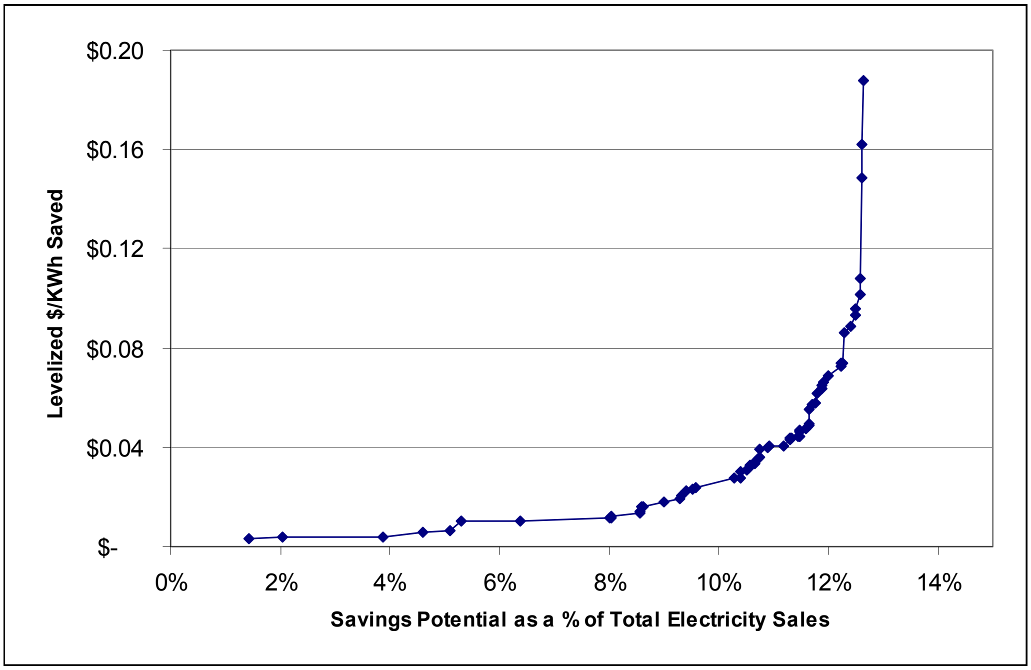
*Levelized cost per kWh saved is calculated using an 8.44 percent nominal discount rate.

Figure 3-5
Existing-Buildings Commercial Electric Supply Curve – Potential in 2020*



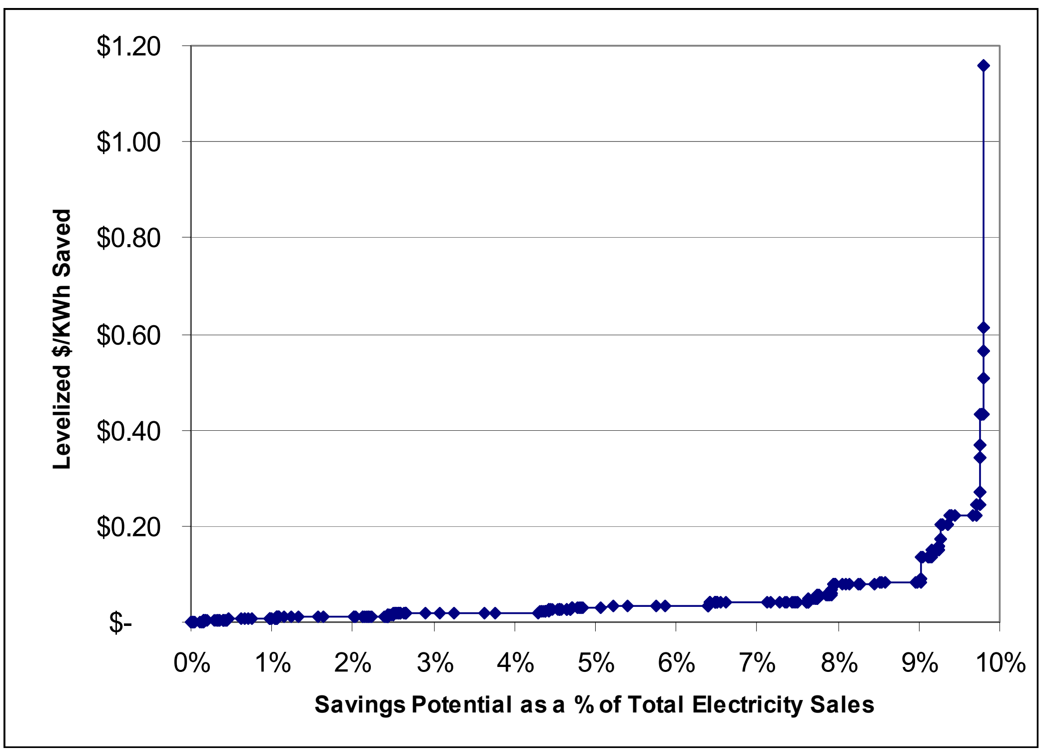
*Levelized cost per kWh saved is calculated using an 8.44 percent nominal discount rate.

Figure 3-6
New-Construction Commercial Electric Supply Curve – Potential in 2020*



*Levelized cost per kWh saved is calculated using an 8.44 percent nominal discount rate.

Figure 3-7
Industrial Commercial Electric Supply Curve – Potential in 2020*



*Levelized cost per kWh saved is calculated using an 8.44 percent nominal discount rate.

3.1.2 Achievable (Program) Potential

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. Our method of estimating measure adoption takes into account market barriers and reflects actual consumer- and business-implicit discount rates. This section presents overall results for achievable potential

Achievable potential refers to the amount of savings that would occur in response to one or more specific program interventions. *Net* savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential depends on the type and degree of intervention applied, we developed potential estimates under alternative funding scenarios: Business-as-Usual, and Advanced-Efficiency. The Business-as-Usual funding scenario represents continuation of the current programs offered by the state's IOU's that will be turned over the Office of Clean Energy on or about January 1, 2005. The Advanced-Efficiency scenario represents a significant increase in funding as compared with the Business-as-Usual. As discussed in Section 2, our model projects that spending in some of the existing programs will decrease over time as appliance standards and baselines change. Our model projects lower budget for the Business-as-Usual programs over the 16-year period. The Advanced-Efficiency case, which represents an increase in incentive levels and marketing costs over time, has average spending of $156 million in the first eight years of the model projections. This compares to an average spending of $70 million in the Business-as-Usual scenario. The Advanced- Efficiency case includes a significant increase in gas saving measures over the Business-as-Usual case.

We forecasted program energy and peak-demand savings under each scenario for the 2004-2020 period. KEMA's energy-efficiency adoption model was calibrated to actual program accomplishments over the 2000-2003 period. Figures 3-8 through 3-10 show our estimates of achievable potential savings and their effect on projected demand and energy consumption.

As shown in Figure 3-8, by 2020 *net*[1] peak demand savings are projected to be roughly 544 MW under Business-as-Usual and 950 MW under Advanced-Efficiency. Figure 3-9 depicts projected net energy savings of 2,831 GWh under Business-as-Usual and 5,183 GWh under Advanced-Efficiency. Figure 3-10 shows the results for natural gas.

[1] Again, *net* refers throughout this section to savings beyond those estimated to be naturally occurring; that is, from customer adoptions that would occur in the absence of any programs or standards.

Figure 3-8
Achievable Peak-Demand Savings

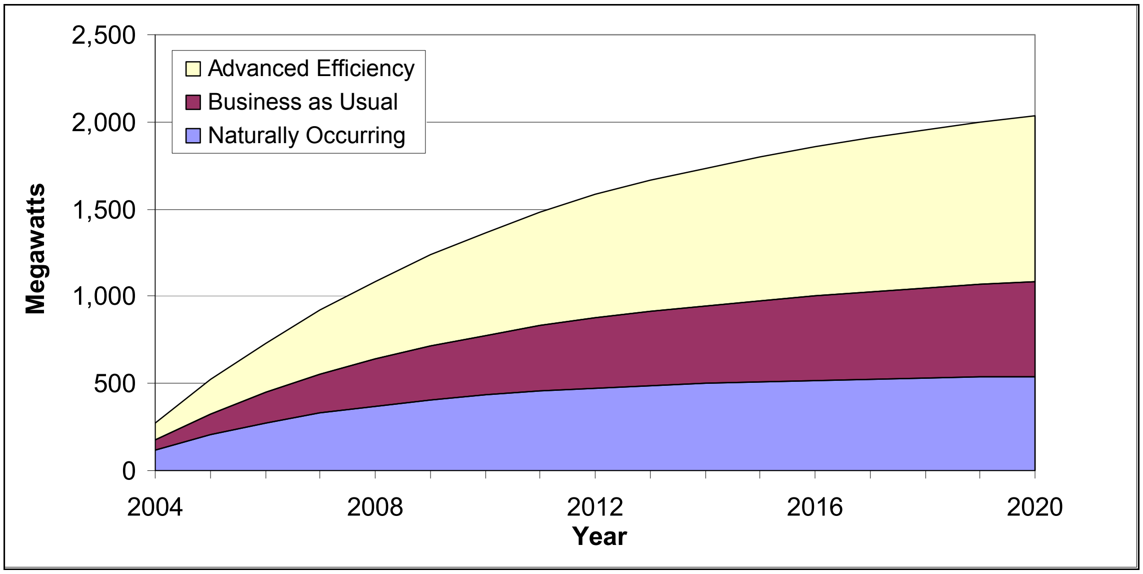


Figure 3-9
Achievable Electricity Savings

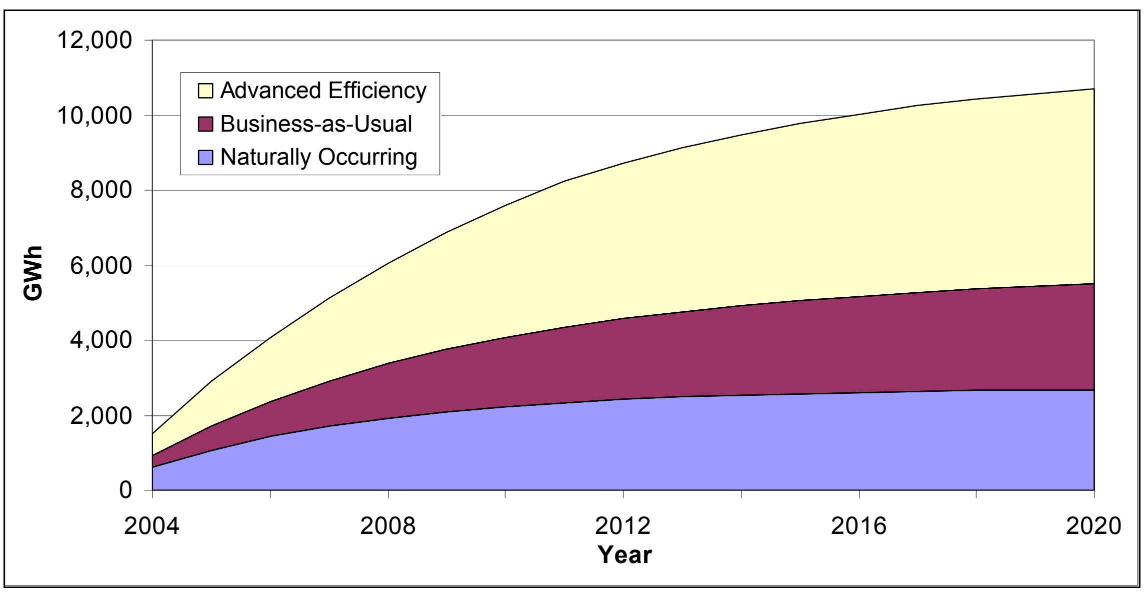


Figure 3-10
Achievable Gas Energy Savings

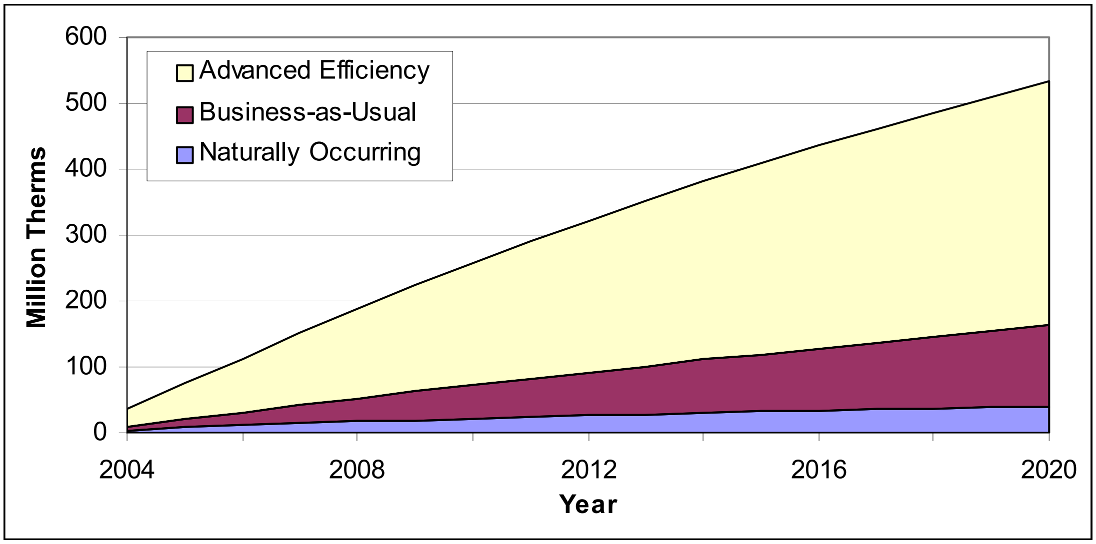
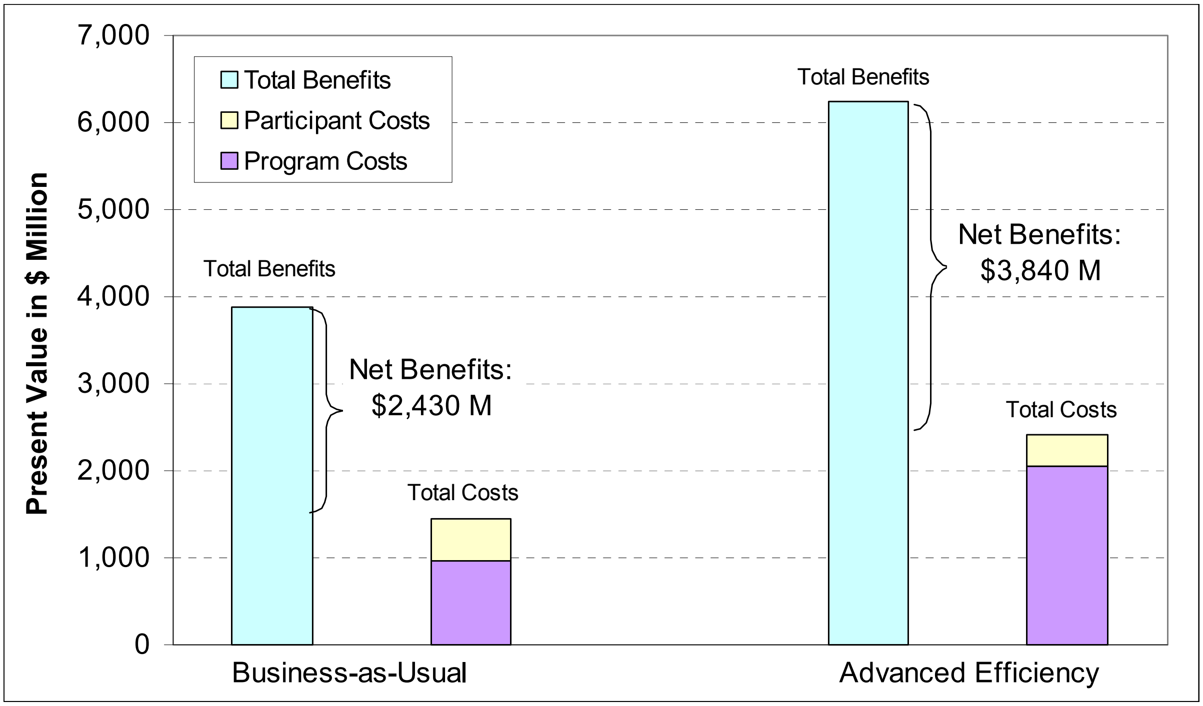


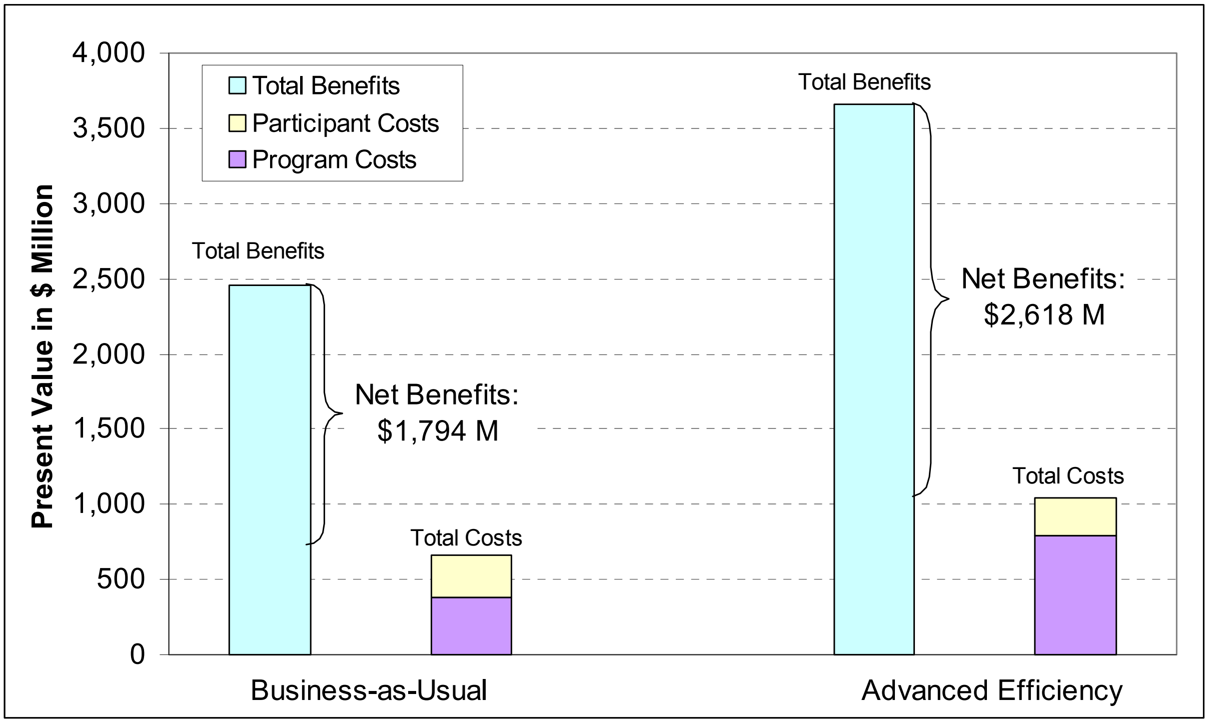
Figure 3-11 depicts costs and benefits under each funding scenario from 2004 to 2020. Total program costs (including administration, marketing, and incentives) are $967 million under Business-as-Usual and $2 billion under Advanced-Efficiency. Total avoided-cost benefits are $3.9 billion under Business-as-Usual and over $6.2 billion under Advanced-Efficiency. Net avoided-cost benefits, i.e., the difference between total avoided-cost benefits and total resource costs (which include participant costs in addition to program costs) are $2.40 billion under Business-as-Usual and $3.84 billion under Advanced-Efficiency. Figure 3-12 illustrates the same information for the years 2004 to 2008. Net benefits for the Business-as-Usual and Advanced Efficiency funding scenarios are roughly $1.8 billion and $2.6 billion, respectively.

Figure 3-11
Benefits and Costs of Energy-Efficiency Savings—2004–2020*



* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate = 8.44 percent, inflation rate = 3 percent.

Figure 3-12
Benefits and Costs of Energy-Efficiency Savings—2004–2008*



* Present value of benefits and costs over normalized 20-year measure lives; nominal discount rate = 8.44 percent, inflation rate = 3 percent.

All of the funding scenarios are cost-effective based on the TRC test, which is the principal test used in New Jersey to determine program cost-effectiveness. The TRC benefit-cost ratios are 2.67 and 2.60 for the Business-as-Usual and Advanced-Efficiency scenarios, respectively. Key results of our efficiency scenario forecasts from 2004 to 2020 are summarized in Table 3-1.

Table 3–1
Summary of Net Achievable Potential Results
2004–2020

Total	Business-as-Usual	Advanced-Efficiency
Program Costs	$966 M	$2,045 M
Participant Costs	$488 M	$362 M
Total Costs	$1,455 M	$2,406 M
Benefits	$3,888 M	$6,245 M
Net Energy Savings	2,831 GWh	5,183 GWh
Net Peak-Demand Savings	544 MW	971 MW
Net Gas Savings	122 M therms	371 M therms
Program TRC	2.67	2.60

Present value of benefits and costs is calculated over a 20-year normalized measure life for 2004-2020 program years, nominal discount rate = 8 percent, inflation rate = 3 percent; GWh and MW savings are cumulative through 2020.

3.2 Detailed Results

Below we provide additional information on the estimates of electric efficiency potential developed for this study. We discuss results by customer class, end use, and type of measure.

3.2.1 Technical and Economic Potential

All Sectors. The technical and economic potential for demand savings in the New Jersey energy service territory are shown in Figure 3-13 and Table 3-2. Overall technical potential for energy savings in the residential, commercial, and industrial sectors is approximately 6,275 MW by 2020. Economic potential for energy savings is estimated to be approximately 4,186 MW. The residential sector contributes the most to both technical and economic savings potential, followed by the commercial sector.

Figure 3-13
Technical and Economic Demand Savings Potential by Market Sector in New Jersey, 2020

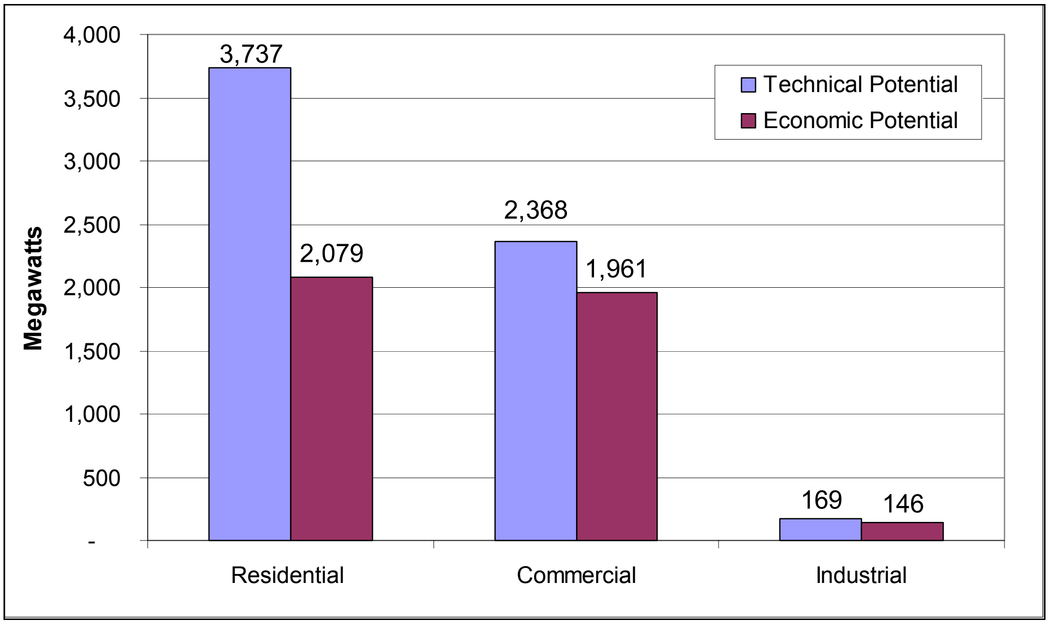


Table 3–2
Technical and Economic Demand Savings Potential in New Jersey by Market Sector, 2020

MW	Technical Potential	Economic Potential
Residential	3,737	2,079
Commercial	2,368	1,961
Industrial	169	146
Overall	6,275	4,186

Annual GWh savings for technical potential are presented in Figure 3-14, along with percent reduction they represent compared to the total load. Figure 3-15 provides this information for the economic potential. Figure 3-16 and Table 3-3 provides the economic and technical potential for gas.

Figure 3-14
Technical and Economic Energy Savings Potential in New Jersey by Market Sector, 2020

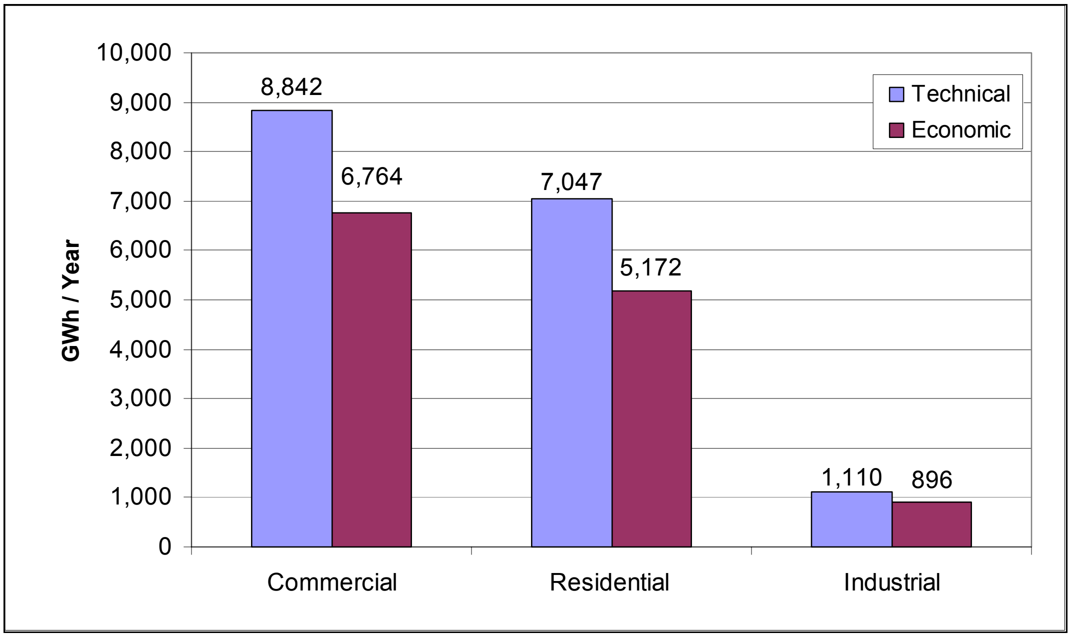


Figure 3-15
Technical and Economic Energy Savings Potential, 2020 as Percentage of 2004 Base

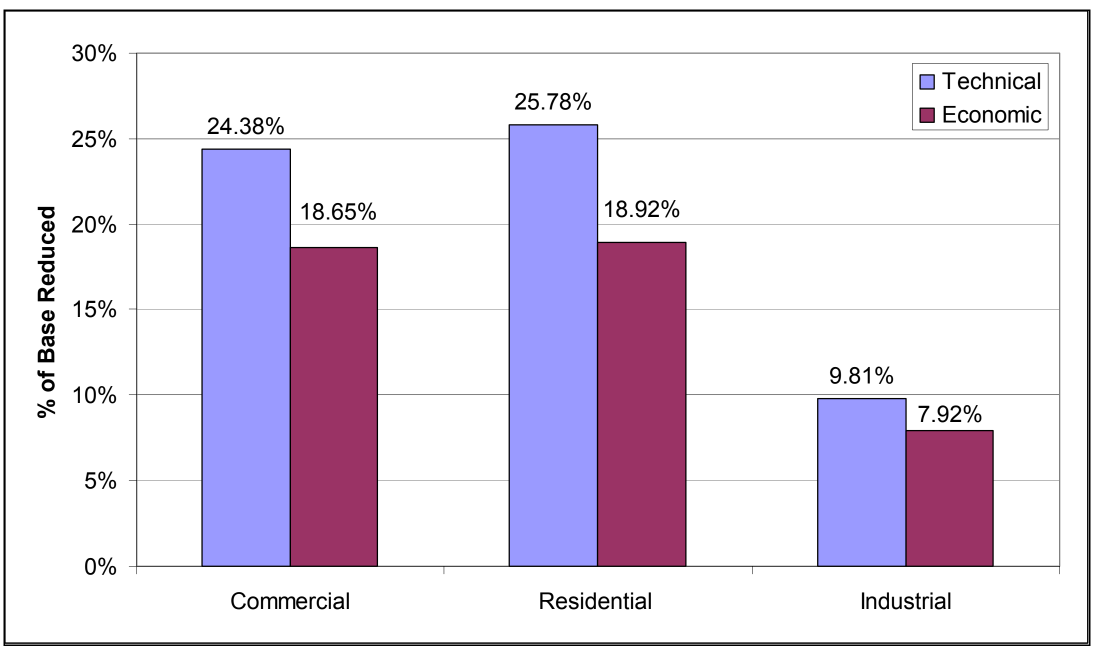


Table 3–3
Technical and Economic Energy Savings Potential in New Jersey by Market Sector, 2020

	Energy Savings Potential (GWh/Year)		% of 2004 Base	
	Technical Potential	Economic Potential	Technical Potential	Economic Potential
Commercial	8,842	6,764	24.38	18.65
Residential	7,074	5,172	15.78	18.92
Industrial	1,110	896	9.81	7.92
Overall	16,999	12,832	22.69	17.13

Figure 3-16
Technical and Economic Gas Energy Savings Potential in New Jersey by Market Sector, 2020

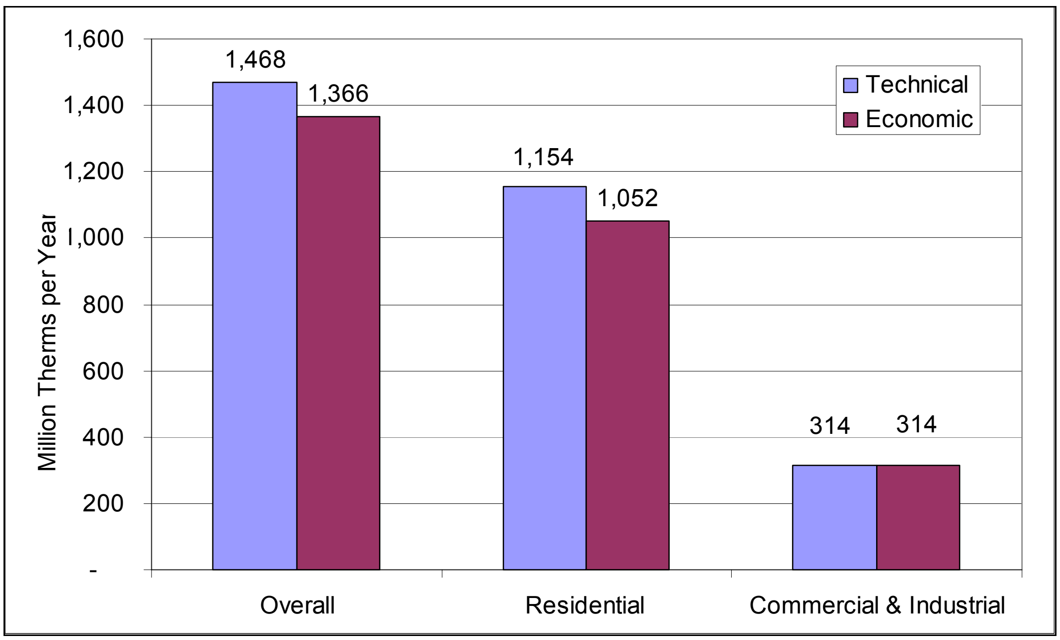


Figure 3-17
Technical and Economic Gas Energy Savings Potential by Market Sector, 2020 as Percent of 2004 Base

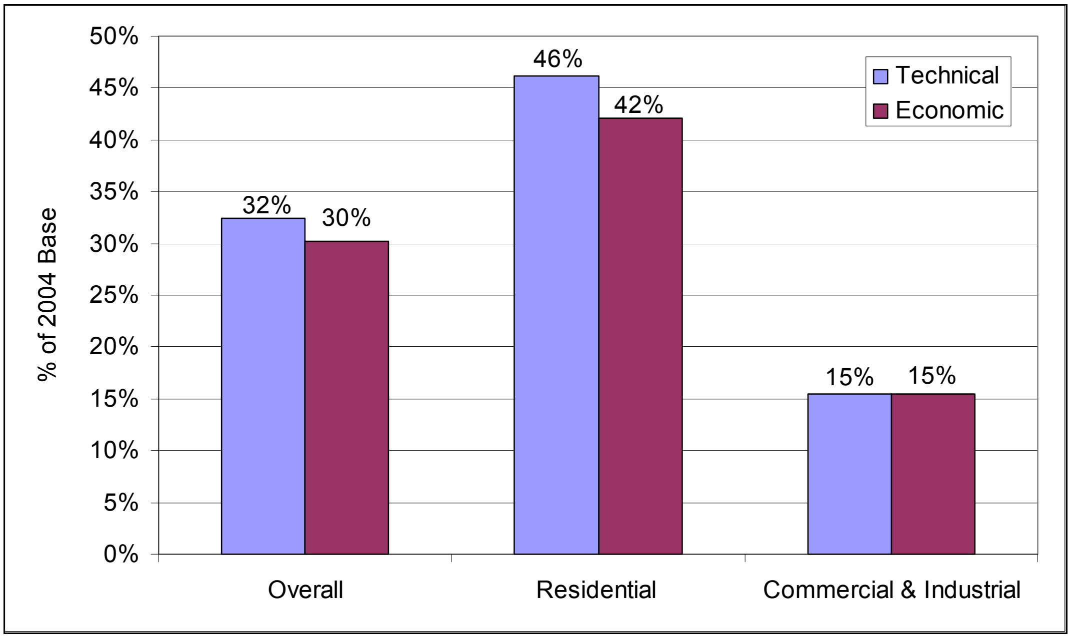


Table 3–4
Technical and Economic Gas Energy Savings Potential in New Jersey by Market Sector, 2020

	Energy Savings Potential (Million Therms / Year)		% of 2004 Base	
	Technical Potential	Economic Potential	Technical Potential	Economic Potential
Residential	1,154	1,052	46.19	42.09
Commercial & Industrial	314	314	15.48	15.48
Overall	1,468	1,366	32.42	30.16

Residential Sector. Residential economic potential in New Jersey is presented by key end use in Figure 3-18. Key contributors to overall economic potential are HVAC (45 percent of energy technical potential and 92 percent of demand) and lighting (22 percent of the total energy), as shown in Figure 3-19.

Figure 3-18
Residential Economic Potential by End Use — Total Energy

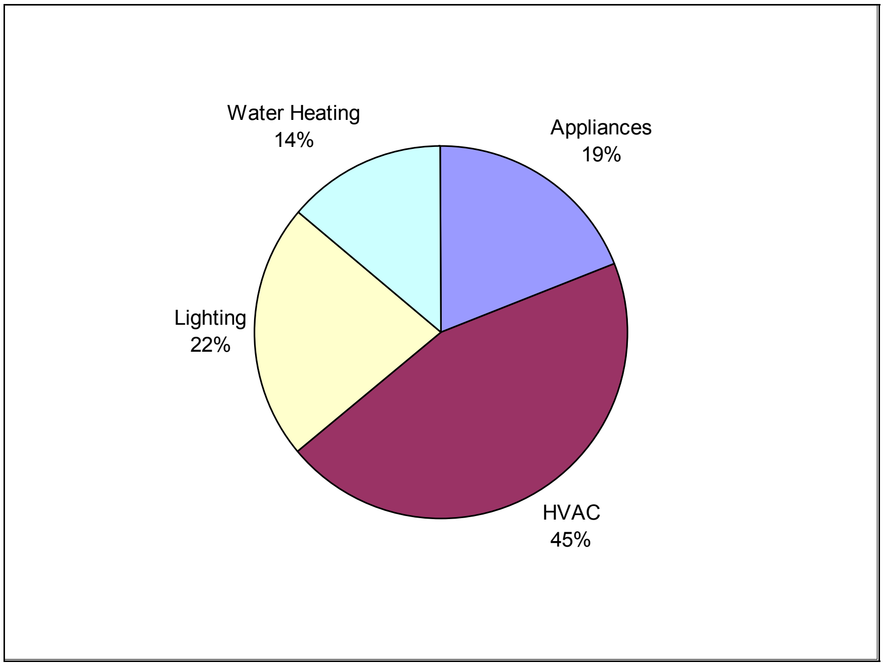
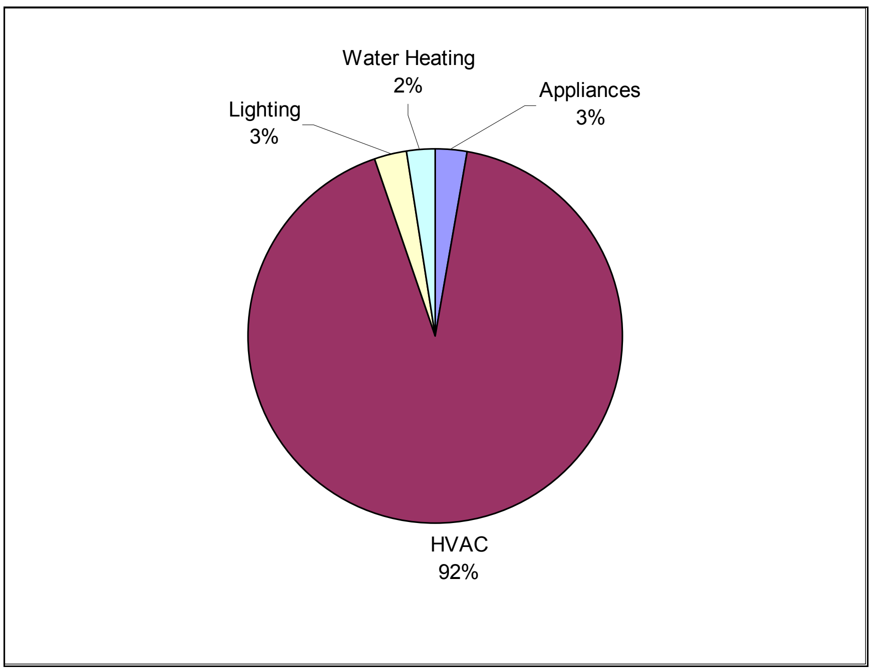


Figure 3-19
Residential Economic Potential by End Use — Demand



Commercial Sector. Total economic potential for the commercial sector is approximately 6,764 GWh/Year. Figure 3-20 and Figure 3-21 show commercial sector economic potential estimates by key end use. Lighting dominates both the energy savings and demand savings (52 percent). End uses in the "other" category include refrigeration, water heating, and office equipment.

Figure 3-20
Commercial Economic Energy Potential by End Use

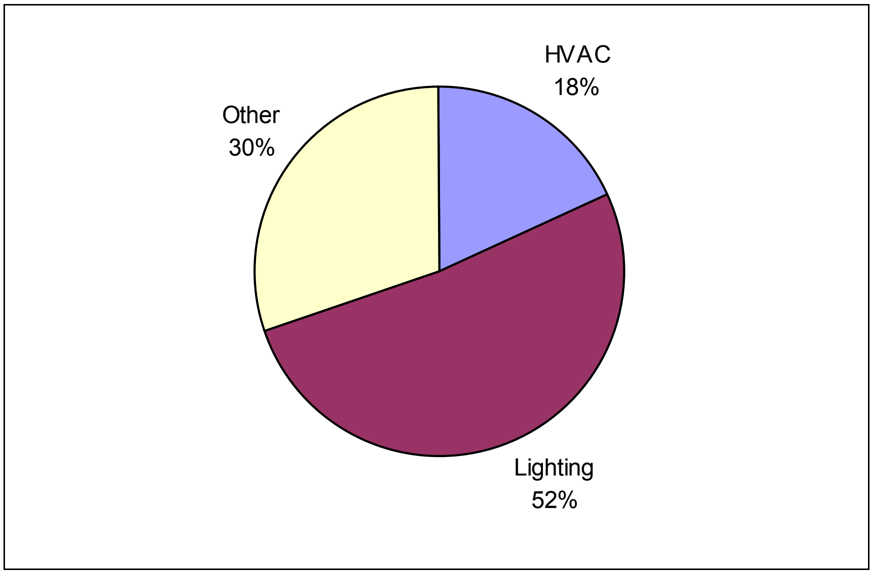
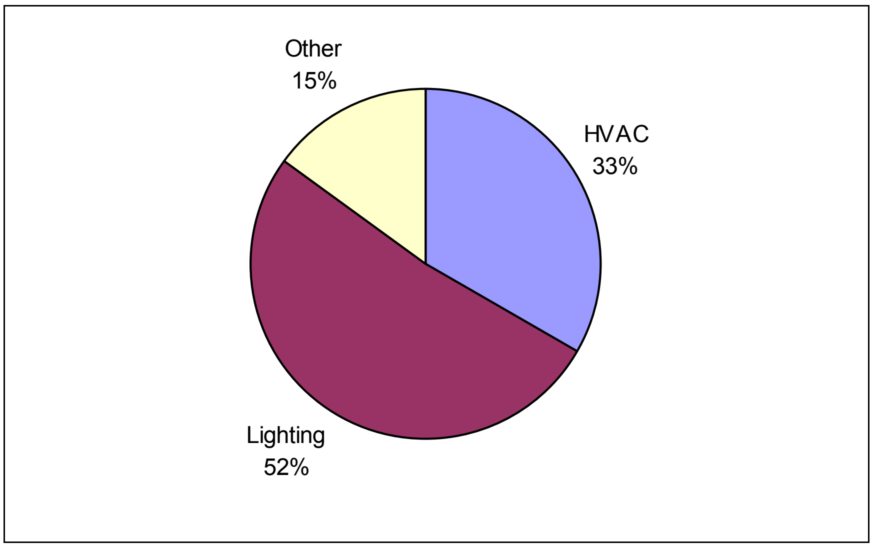


Figure 3-21
Commercial Economic Potential for Demand by End Use



Industrial Sector. Total economic potential in the industrial sector is approximately 896 GWh /year. Figures 3-22 and 3-23 show industrial sector economic potential estimates by key end use. The economic potential demand savings is dominated by process improvements.

Figure 3-22
Industrial Energy Economic Potential by End Use

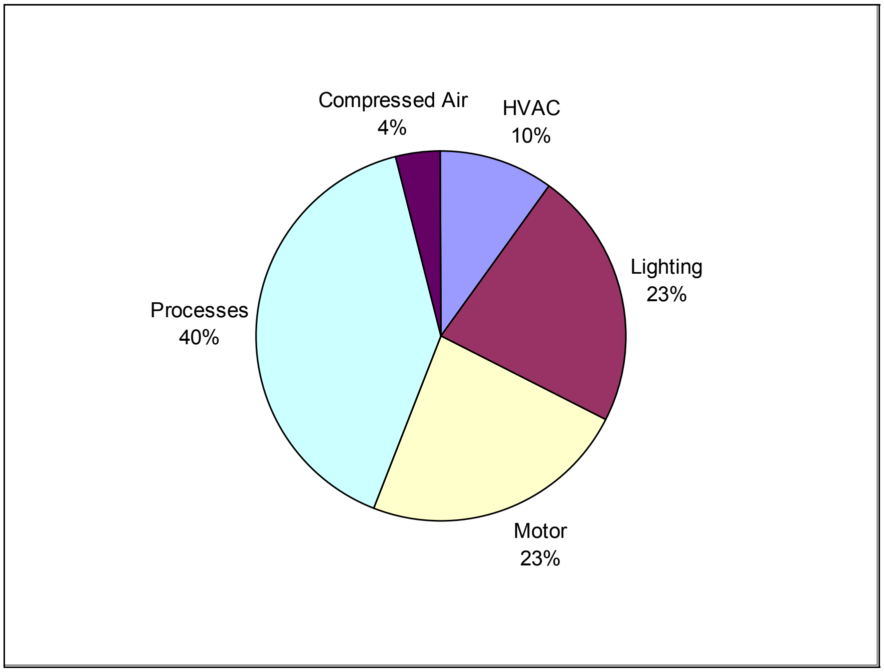
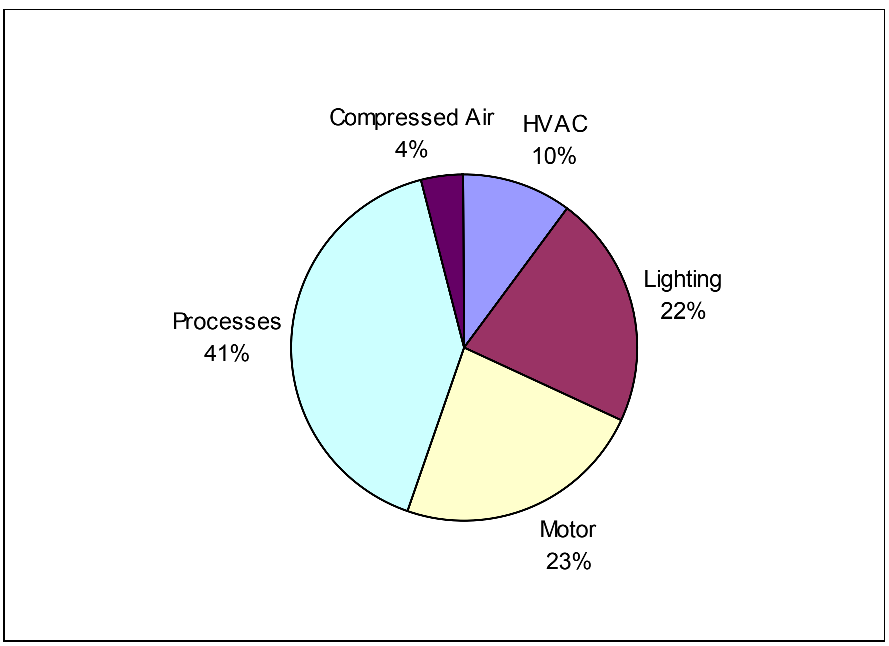


Figure 3-23
Industrial Economic Potential by End Use – Demand Savings



3.2.2 Key Measures in Economic and Technical Potential

Tables 3-5 and 3-6 list the key energy-efficiency measures that proved cost-effective in our analysis.

Table 3-5
Key Residential Measures by Program

Sector	Market	Fuel	Key Cost Effective Measures
Residential	Existing Homes Low Income	Gas	High-performance windows, programmable thermostats, low-flow measures, tank wraps, ceiling insulation, HVAC diagnostics and repair, wall insulation, duct diagnostics and repair, blower door/ Air Sealing, high-efficiency heaters, AC cycling
Residential	Existing Homes Low Income	Electric	High-performance windows, CFL's , torchieres, proper sizing of CAC, programmable thermostats, low flow measures, tank wraps, ceiling insulation, HVAC diagnostics and repair, wall insulation, duct diagnostics and repair, blower door/ air Sealing
Residential	New Construction	Gas	High-performance windows, high-efficiency water heater, programmable thermostats, high- efficiency heaters, tank /pipe wrap
Residential	New Construction	Electric	High-performance windows, CFL's, torchieres, proper HVAC sizing, high-efficiency water heater, air source heat pumps, ceiling insulation, programmable thermostats, tank /pipe wrap

Table 3-6
Commercial/ Industrial Key Measures by Sector

Overall Sector	Market	Fuel	Key Cost Effective Measures
C/I	Retrofit	Electric`	Super T-8's, T-5's, T-8's, CFL's, occupancy sensors, daylighting, HID's, HVAC tune up diagnostics, vendor miser, commissioning, HVAC proper installation , high- efficiency AC, compressed air, motors, VSD's, exit signs, LED signs,
C/I	New Construction	Electric	Super T-8's, T-5's, T-8's, CFL's, occupancy sensors, daylighting, HID's, HVAC tune up diagnostics, commissioning, HVAC proper installation , high-efficiency AC, compressed air, motors, VSD's, exit signs, LED signs
C/I	Existing and New Construction	Gas	High-efficiency condensing heaters, high- efficiency conventional heater, vent damper, roof insulation, low-flow fixtures, high-efficiency water heating

3.3 Achievable Market Potential

3.3.1 Aggregate Measures and Determine Market Potential

The market potential is that portion of the technical potential realized by normal market forces, with or without the intervention of a utility program. In this analysis, market potential is defined as the cumulative net measure (or program penetration) in 2020 caused by potential energy-efficiency program intervention over an assumed baseline.

Market penetration was evaluated by bundling together measures that are likely to be offered within a single program. Program concepts were based on the current portfolio of programs offered in New Jersey. The specific measures selected for each program are based on the result of the TRC test ratio. Measures with a TRC ratio greater than 1 were included in the program concepts. The measures excluded from programs based on the TRC ratio are shown in Table 3-7

Table 3–7
Measures Excluded

Residential Measures	Commercial / Industrial Measures
Solar DHW	Window Film
Ceiling Insulation R19 - R38	
Ceiling Insulation R30 - R38	
High Efficiency Dishwasher	
Convection Oven	
Induction Cooktop	
Daylighting Controls	

The tables below show how the remaining measures were grouped into programs. For some measures, adjustments within DSM ASSYST had to be made if a measure was part of more than one program concept. For low-income customers, the same measures were analyzed as for the balance of existing customers. New construction measures were analyzed separately. The residential programs were separated into markets and electric and gas measures were analyzed.

The commercial/industrial sector was broken into the following markets: new construction and major renovation, commercial retrofit, natural gas measures, and industrial measures.

Table 3–8
Residential Program Concepts

Program	Delivery Mechanism	Incentive Levels	Measures
Low Income	Direct Installation of Shell measures	Up to 100% of measure cost	High-performance windows, ceiling insulation, wall insulation, floor insulation, low-flow fixtures, pipe wrap
ENERGY STAR	Point-of-purchase rebates and promotion of ENERGY STAR Products	40–50% of incremental cost	High-performance windows, room air conditioners, refrigerators, clothes washers, water heaters, CFL lamps, CFL fixtures, windows
HVAC	Provide Rebates for qualifying equipment	30–50% of incremental cost	Central air conditioners, heat pumps, geothermal heat pumps, furnaces, boilers, programmable thermostats, proper installation / sizing
New Construction	Provide incentives for meeting ENERGY STAR guidelines		High-performance windows, ceiling insulation, wall insulation, floor insulation central air conditioners, heat pumps, geothermal heat pumps, furnaces, boilers, programmable thermostats, proper installation / sizing, high performance windows, room air conditioners, refrigerators, clothes washers, water heaters, CFL lamps, CFL fixtures

Table 3–9
C&I Program Concepts

Program	Delivery Mechanism	Incentive Levels	Measures
Renovation / New Construction/ retrofit	Provide rebates for qualifying equipment	40-- 60% of incremental cost	superT/8 electronic ballasts, CFL fixtures, LED exit signs, super T8s, occupancy sensors, daylighting, refrigeration measures, high-efficiency DX, high-efficiency chillers, VAV control, EMS, high-efficiency boilers, high-efficiency water heaters
Commercial retrofit	Provide rebates for qualifying equipment	approximately 40-50% of cost	superT/8 electronic ballasts, CFL fixtures, LED exit signs, super T8s, occupancy sensors, daylighting, refrigeration measures, high-efficiency DX, high-efficiency chillers, VAV control, EMS, high-efficiency boilers, high-efficiency water heaters
Other Industrial / Process	Provide rebates for qualifying equipment	40-50% of incremental cost	High-efficiency motors, VSD, compressed air measures, process improvements, lighting
Gas measures	Provide rebates for qualifying equipment	30-50 % of incremental cost	Heating, water heating, insulation, low-flow fixtures

For each of the program concepts in the tables above, market penetration rates to 2020 were estimated. This analysis was done with DSM ASSYST using an embedded market diffusion model. The diffusion model requires a forecast of program budgets, as this information affects customer payback and customer awareness, which are direct inputs into the diffusion model. The budgets were developed based on historical data of program expenditures for the three years 2001–2003. Residential program budgets were delineated along the program concepts developed above. The commercial and industrial program budgets were reported together. The budgets were allocated to the program concepts based on the relative magnitude of the technical potential within each bundle of programs.

Table 3–10

Program Budgets, Business-as-Usual and Advanced-Efficiency Scenarios

Business as Usual: Yearly Average (2004-2012)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	40.07	12.27	90.18	1.72
New Construction	14.19	1.67	21.82	1.38
Low Income	10.38	0.17	6.66	0.63
HVAC	9.58	3.12	25.76	2.03
Energy Star	5.91	7.32	35.94	2.72
Commercial & Industrial	29.54	31.58	273.05	4.47
TOTAL	69.60	43.86	363.23	3.20

Business as Usual: Yearly Average (2004-2020)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	34.41	9.10	69.64	1.60
New Construction	13.59	1.68	20.54	1.65
Low Income	8.62	0.14	5.27	0.60
HVAC	7.40	2.33	18.22	1.87
Energy Star	4.80	4.95	25.61	2.62
Commercial & Industrial	22.46	19.63	158.92	3.78
TOTAL	56.87	28.73	228.56	2.67

Advanced Efficiency: Yearly Average (2004-2012)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	83.87	18.84	220.15	2.14
New Construction	18.30	1.89	27.87	
Low Income	12.52	0.17	6.90	
HVAC	39.54	8.92	131.62	
Energy Star	13.51	7.86	53.77	
Commercial & Industrial	72.24	19.08	354.53	3.88
TOTAL	156.12	37.92	574.68	2.96

Advanced Efficiency: Yearly Average (2004-2020)

$ Million	Program Costs	Participant Costs	Total Benefits	TRC
Residential	68.78	13.30	159.97	1.95
New Construction	16.88	1.81	25.21	1.35
Low Income	10.39	0.14	5.45	0.52
HVAC	29.49	6.65	89.49	2.48
Energy Star	12.02	4.69	39.82	2.38
Commercial & Industrial	51.48	7.97	207.40	3.49
TOTAL	120.27	21.27	367.37	2.60

3.3.2 Year-by-Year Forecast

We developed energy savings forecasts for the program concepts described above. These programs include all of the measures passing the cost-effectiveness screening and generally correspond to the current portfolio of programs offered in New Jersey. Estimates of achievable potential by market sector (residential, commercial, and industrial) and by sector-specific program (e.g., New Construction, HVAC, appliances) are provided for the forecast of customers in New Jersey. Figures 3-24 through 3-28 present detailed results for residential and C&I programs under both the Business-as-Usual and Advanced-Efficiency scenarios. These results are cumulative.

Figure 3-24
Residential Programs –Cumulative Peak-Demand Savings (Electric): Business-as-Usual

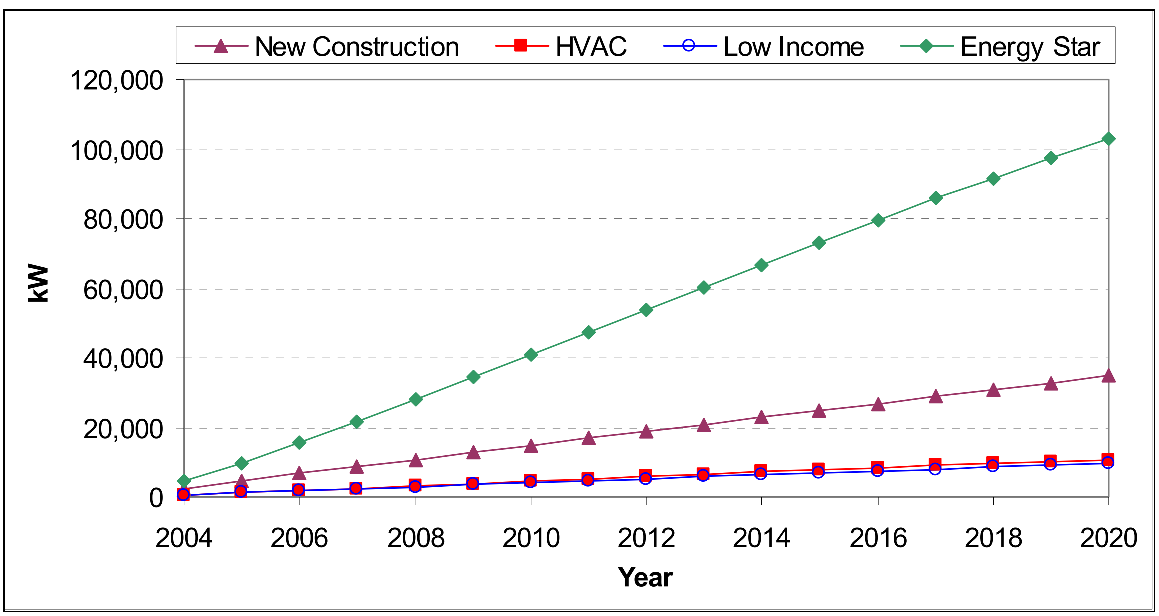


Figure 3-25
Residential Programs –Cumulative Peak-Demand Savings (Electric): Business-as-Usual

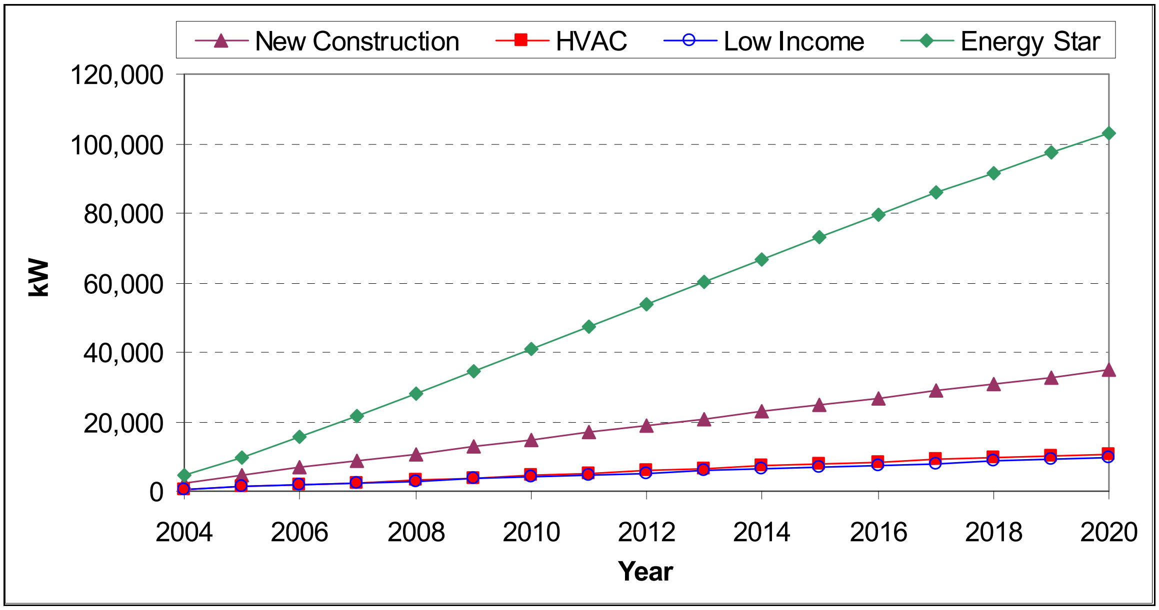


Figure 3-26
Residential Programs-Cumulative Peak-Demand Savings (Electric): Advanced Efficiency

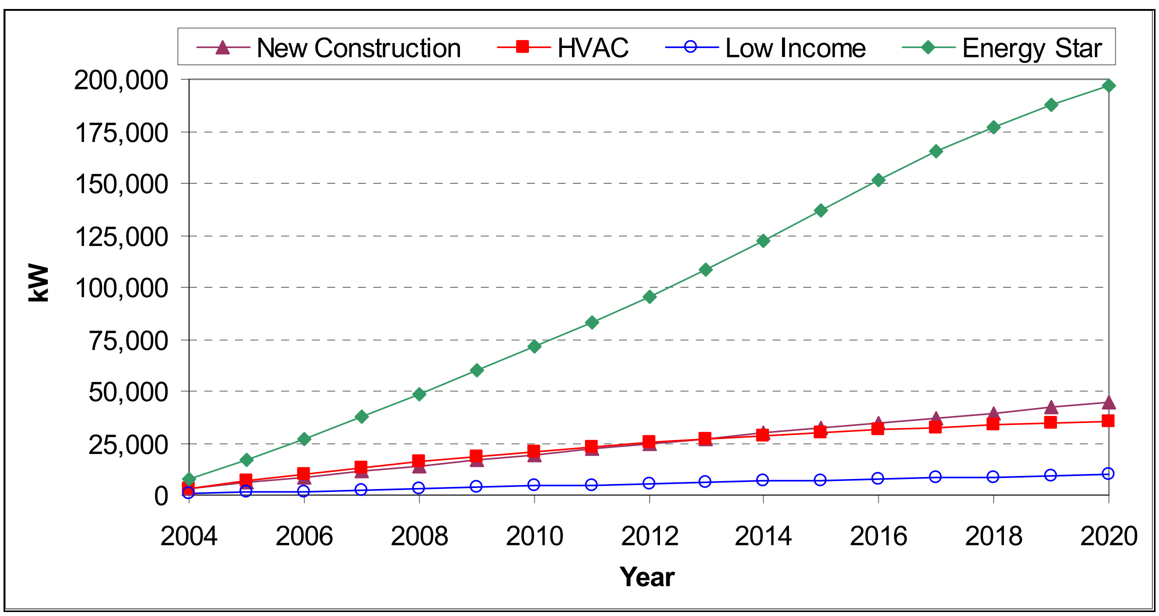


Figure 3-27
Residential Cumulative Energy Savings by Year: Business-as-Usual

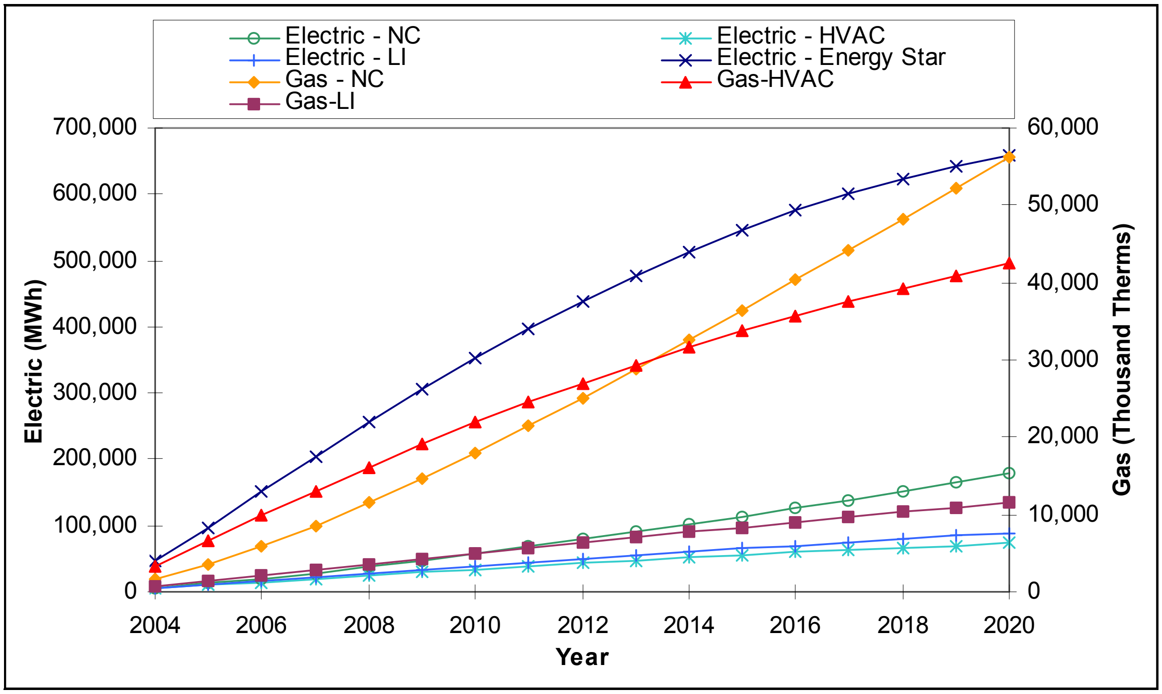
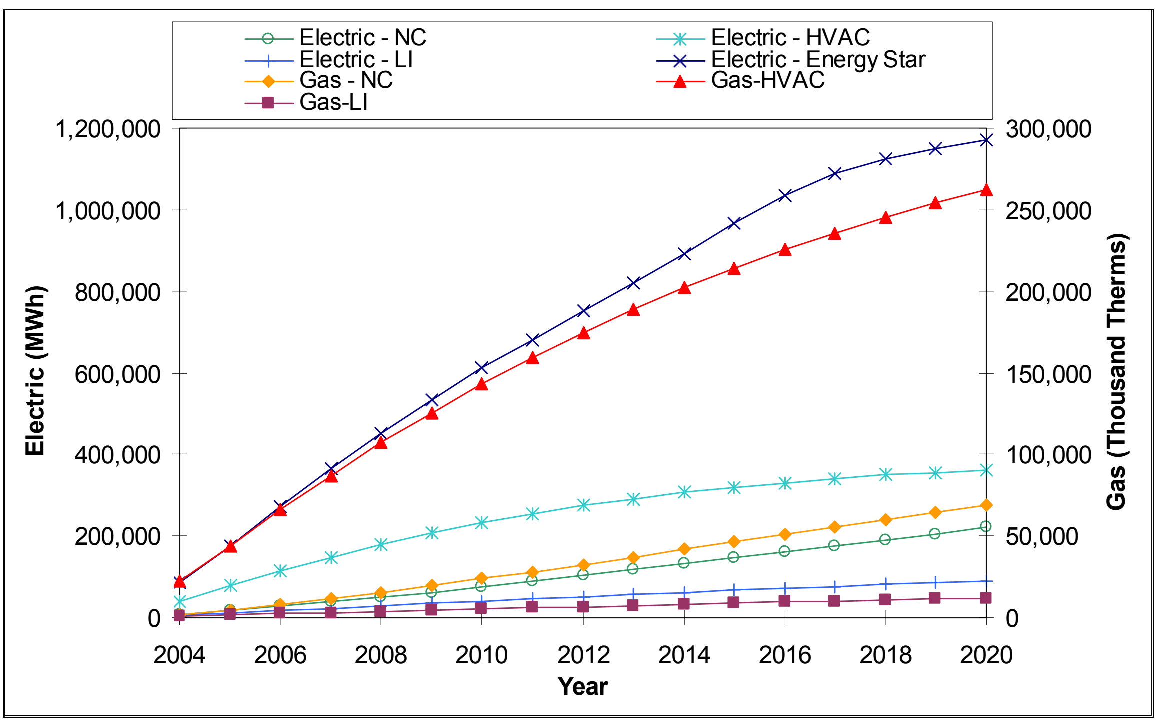


Figure 3-28
Residential Energy Cumulative Savings by Year: Advanced Efficiency



Figures 3-29 through 3-32 present energy savings for commercial and industrial programs in MWh, kW, and thousand therms.

Figure 3-29
Commercial and Industrial Programs Cumulative Peak-Demand Savings (Electric): Business-as-Usual

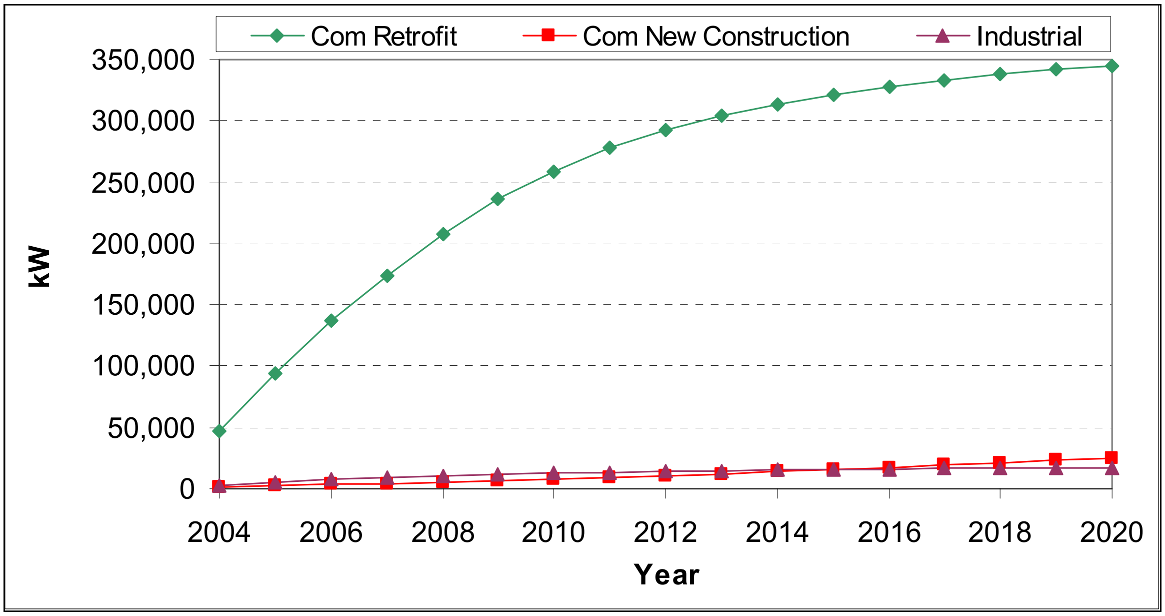


Figure 3-30
Commercial and Industrial Programs Cumulative Peak-Demand Savings (Electric): Advanced Efficiency

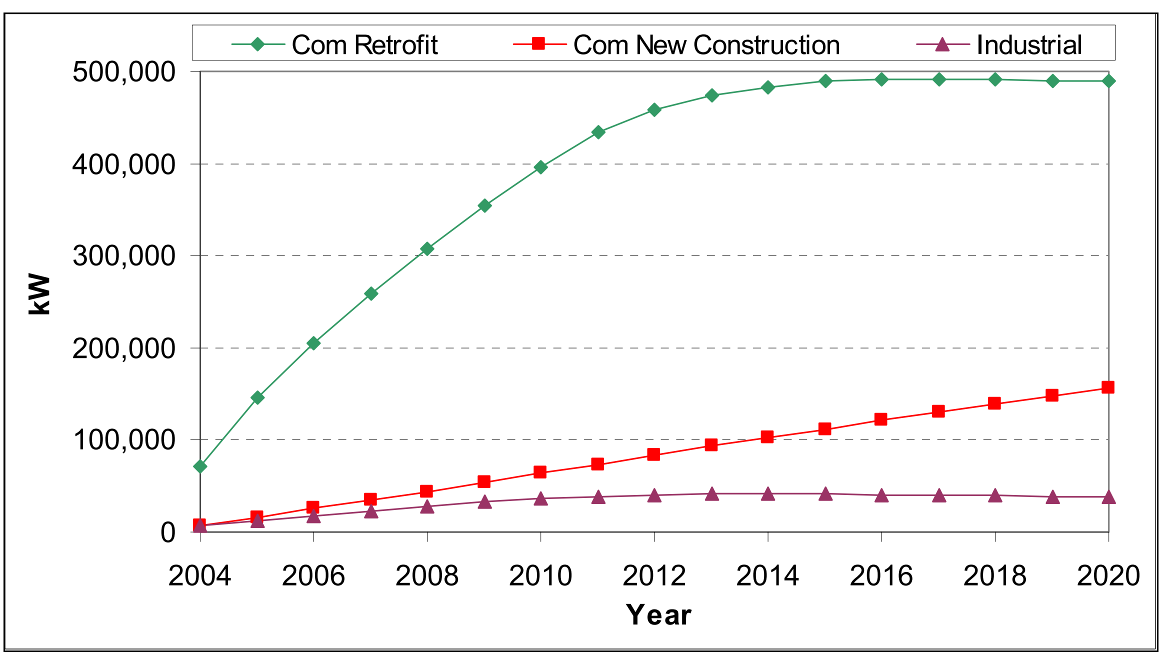


Figure 3-31
Commercial and Industrial Programs Cumulative Energy Savings: Business-as-Usual

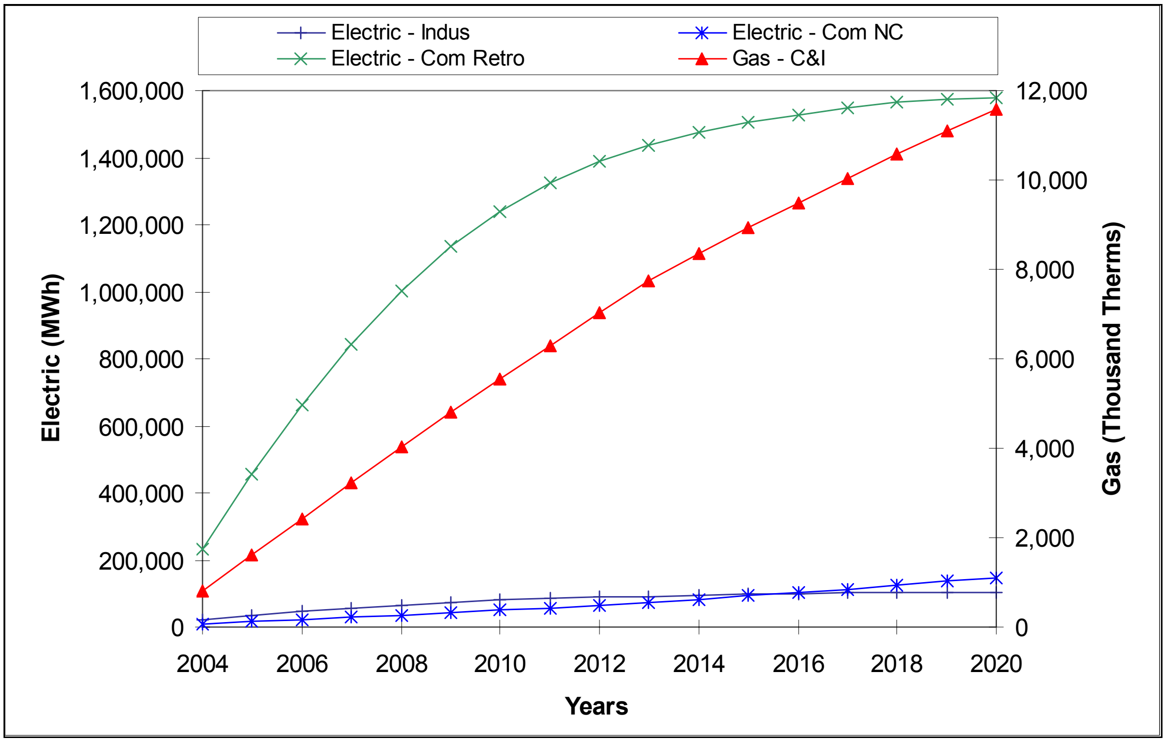
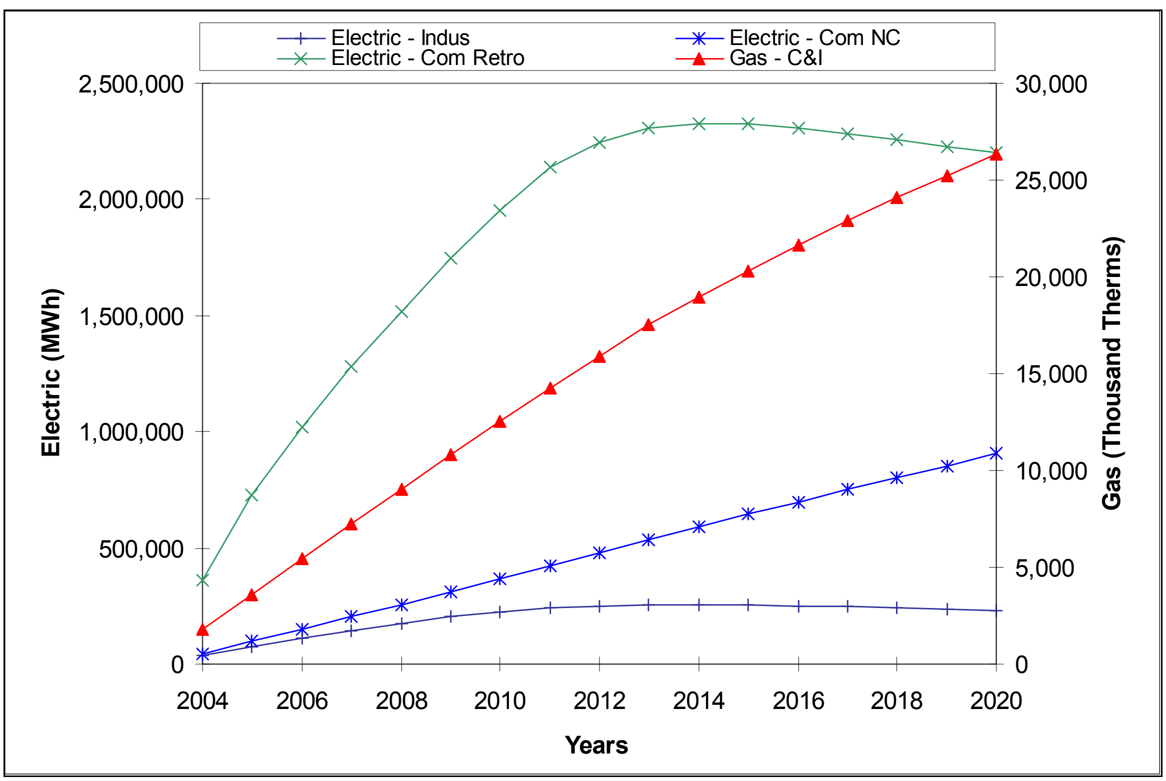


Figure 3-32
Commercial and Industrial Programs Cumulative Energy Savings: Advanced Efficiency



3.4 RANKING OF PROGRAM CONCEPTS

Table 3-11 shows the scoring and ranking of the program concepts. This ranking integrates the four scoring criteria values for each program concept. The market potential and cost-effectiveness scores are based on the relative magnitude of the energy savings and cost-effectiveness test for the program. The other criteria scores are based on a qualitative look at the individual measure scores. All program concepts presented below had a weighted score of 3 or above, indicating a good opportunity for continued program support.

Table 3–11
Overall Program Concept Rating

Program Concept	Market Potential (MW)	Market Potential Score	Market Potential (GWh)	Market Potential (MTherm)	Market Potential Score	Cost Effectiveness (TRC Ratio)	Cost Effectiveness Score	Likelihood of Success Score	Market Barriers Score	Overall Scores
Criteria Weight		**12.50%**			**12.50%**		**25.00%**	**25.00%**	**25.00%**	
Residential Electric& Gas										
New Construction	18	1	50	11	1	1.4	2	5	5	3.3
Low Income	304	3	875	173	2	0.6	1	5	5	3.4
HVAC	1,307	4	1,630	714	3	1.9	2	3	2	2.6
Energy Star	118	2	2,264	122	4	2.6	3	4	3	3.3
Commercial / Industrial Electric										
Retrofit	1,538	5	6,665	-	5	3.9	5	4	3	4.3
Renovation / NC	26	1	98	-	2	2.8	3	5	5	3.6
Industrial / Process	146	3	896	-	3	2.8	3	4	3	3.3
Commercial / Industrial Gas										
Total	-	-	-	314	2	5.9	5	5	5	4.0

3.5 Recommendations – Energy Efficiency Programs

This market assessment has identified a significant remaining resource for New Jersey. Barriers to the implementation of these technologies continue to exist, so ongoing program activity in these markets is warranted. Recommendations are presented first generally and then by program segments shown above. Our recommendations are based on the results of this analysis, our review of the existing programs, and discussions with various working group members.

3.5.1 General Recommendations

The current programs are designed to overcome the existing market barriers in the markets they serve. Our analysis indicates that there is a significant cost effective resource available in New Jersey and that more resource could be tapped if additional resources are allocated to the programs. Overall recommendations include:

- Continue with the existing major program designs in major market sectors.
- Additional resources could be added above the business as usual scenario by increasing incentive, marketing and administrative costs.
- Monitor key markets such as residential HVAC as they change due to appliance standards and adjust programs accordingly

3.5.2 Residential

HVAC

Central air conditioning is a major component of increasing electric growth in the residential sector in New Jersey. Market barriers include lack of information and training of contractors and lack of information for consumers. The current program is designed to overcome these barriers. The current program will be significantly impacted by the new residential appliance standards in 2006. Recommendations for this area include:

- Continue with successful aspects of the existing program. The existing program appropriately promotes both the sale of qualifying energy-efficient HVAC equipment *and* proper system sizing and installation "best practices" that affect operating efficiency. Proper sizing and installation have large economic potential and should continue to be emphasized
- Update the incentive structure of the existing program with new levels of efficiency after 2006 as new measures become cost-effective
- Add SEER 16 air source heat pumps to the program as they are cost-effective.
- Consider adding forced air heating systems using energy efficiency motors
- Explore the addition of a maintenance program for older units.

- Coordinate with utilities to add direct load control as appropriate at time of installation. In order to make this option successful, a TOU or Real Time Pricing Rate may need to be developed and offered.

New Construction

The current program uses the ENERGY STAR model that has proven to be successful in New Jersey and elsewhere. This program has been very successful in large builder participation and should continue as currently configured. Specific recommendations for this program area include:

- Continue to increase awareness of current program and increase participation by smaller builders.
- Continue to coordinate with any zero energy home activities.
- Explore options to include renewable energy/green building concepts in new construction, where appropriate.

ENERGY STAR

Awareness of the ENERGY STAR brand has been increasing over time, especially in areas such as New Jersey where there has been active promotion of the brand. Windows, thermostats, lighting and appliances continue to be cost-effective resource. Some informational barriers have been removed both at the consumer and supply chain level. Windows are a large potential opportunity under this program. Recommendations for this program area include:

- Increase marketing of windows as an option under the program, as this is a large area of potential savings for both electric and gas.
- Continue to coordinate with regional and national activities such as Northeast Energy Efficiency Partnerships (NEEP) and DOE/ EPA initiatives.
- Add new measures as appropriate to marketing activities.
- Consider bundling Energy Star products that are applicable for home remodeling projects such as kitchen remodeling and outreach to remodeling contractors.
- Assess whether an incentive for windows would be appropriate.
- Review lighting incentives relative to other incentives in the region and current measure costs in New Jersey.
- Continue to push for new appliance standards, similar to those recently passed by the New Jersey Senate.

Other

- Consider a limited solar hot water heating pilot in conjunction with efforts to stimulate the PV market in the state.
- Significant savings for gas measures in existing homes such as tank wraps, low flow shower heads, floor / basement insulation, and air sealing are currently not covered under any existing programs. Explore potential program designs that would address these measures such as Home Performance with Energy Star.

3.5.3 Commercial / Industrial Programs

Key market barriers for this sector of customers include financial barriers, lack of information, and lack of time. Key barriers for market actors include lack of information, lack of time, and lack of training, and lack of awareness of new technology use. The current program serves large customers well. The program design includes measure design support, technical assistance, and financial incentives to overcome the barriers. This program also provides for both gas and electric measures in one program making it easier for customers to identify their best options for a given end use solution. Specific program recommendations include:

- Continue existing program structure.
- Program goals for SmartStart Buildings Program, as articulated on page 43 of the MOA are excellent. Program designs should be tested against these goals.
- Pay only the costs directly associated with the energy efficiency aspects of LEED. Do not pay LEED registration costs. It is inappropriate for public funds to pay for a private, propriety certification fee.
- Investigate better ways to define high performance schools. Investigate the New Buildings Institute's Advanced Buildings Guidelines and the Massachusetts version of CHPS.
- Implementation of the high performance schools component at the Schools Construction Corporation appears to be stuck and not moving. Investigate third-party administration that would cooperate with the SCC, but give HPS more focused attention.
- NJ should investigate a direct install program for the small C&I market along the lines of Massachusetts and New Hampshire. It is more cost-effective and could be target to growth zones (or anywhere else). It also creates jobs for local contractors in communities, not ESCO's.
    - This approach can be relatively expensive, although typically still cost-effective from a total resource cost perspective. Several New England utilities have had success in reducing total program cost by supplementing incentives with on-bill financing.
- Provide training and education on new and emerging HVAC technologies soon to hit the market.

  - For example, Florida Power and Light may pilot an Energy Recovery Ventilator that pre-cools and dehumidifies make-up air using conditioned exhaust air.
  - Significant cost-effective savings can also still be captured through comprehensive air-conditioning design practices.
- Continue to promote commissioning other related services.
  - Consider piloting a turn-key retro-commissioning program, this approach can be very effective at capturing both electric and gas savings in an integrated process.
- Emphasize opportunities to beat lighting baseline levels by 15 to 25% using lighting design best practices in new construction.
- Support regional and national efforts such as CEE, NEEP and Energy Star as appropriate.
- Ensure the custom incentive portion of C&I portfolio is effective at setting incentives and program requirements to encourage net adoptions and minimize free ridership.
- Consider the economic development benefits of comprehensively addressing industrial process improvements.
- Leverage local governments and community-based organizations to enhance program marketing to smaller customers.
- Target energy efficiency and distributed generation opportunities on congested distribution feeders as the opportunity arises.

4 Distributed Generation and PV

4.1 Overview

This section discusses the market potential in New Jersey for: distributed generation (DG) in the commercial and industrial sectors; fuel-cell technology in all sectors; and photovoltaic technology (PV) in new residential construction (e.g., zero energy homes). For each of these three technologies, we describe the methodology and market penetration model, assumptions, and findings. The first section on DG includes a detailed description of the market penetration model.

4.2 Distributed Generation

4.2.1 Methodology

The DG market penetration scenarios are based on a methodology published in a 2002 study by NYSERDA, *Combined Heat and Power Market Potential for New York State.*[1] Technology and market data relevant to New Jersey were estimated based on two corollary studies completed for the U.S. Energy Information Administration.[2, 3]

Development of the DG market penetration scenarios involves the following steps:

- Establish general boundaries and assumptions.
- Estimate technical potential for combined heat and power (CHP) and fuel cells for each energy sector in New Jersey.
- Subdivide CHP and fuel cell potential into five categories based on application size: (100 to 500 kW; 500 to 1000 kW; 1 to 5 MW; 5 to 20 MW; and >20 MW).
- Develop payback periods for a current typical DG technology for each application size based on capital costs, fuel costs, electricity costs, interest rate, etc.
- Run market penetration scenarios based on paybacks for each technology according to a Base Case and Accelerated Case.

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[1] "Combined Heat and Power Market Potential for New York State." October 2002. Prepared for NYSERDA by Energy Nexus Group Onsite Energy Corporation and Pace Energy Project.

[2] "The Market and Technical Potential for Combined Heat and Power in the Industrial Sector." January 2000. Prepared for U.S. Energy Information Administration by ONSITE SYCOM Energy Corporation.

[3] "The Market and Technical Potential for Combined Heat and Power in the Commercial/ Institutional Sector." January 2000. Prepared for U.S. Energy Information Administration by ONSITE SYCOM Energy Corporation.

General Boundaries and Assumptions

A number of assumptions are implicit in the development of DG market penetration forecasts for New Jersey. General assumptions include:

- For purposes of this analysis, the term DG is used broadly to include conventional on-site energy generation in five different capacity ranges: 100 to 500 kW; 500 kW to 1 MW; 1 to 5 MW; 5 to 20 MW; and >20 MW.
- The lowest-cost base load technology that can be permitted is used to determine market penetration for each size category. Diesel generators, which are likely to operate as peaking units only, are not considered to be permitted as base load and are, therefore, not reflected in our market forecast.
- Base load DG technologies are assumed to operate as CHP units. In many cases, the economics of DG will not lead to project development unless process heat can be captured and re-used. Recoverable heat is valued at the cost of natural gas delivered to the end user.
- Residential customers are not included in this DG analysis because of the limited technical and market penetration potential for small conventional CHP technologies in the residential sector without relatively high subsidies or technology advances. Residential potential is addressed in the fuel cell and PV sections.

Technical Potential

Technical market potential is an estimate of market size constrained only by technological limit—e.g., the ability of CHP technologies to meet existing customer needs. Since it takes no consideration of economics, it represents the upper bound of potential penetration within a given market-size category. The technical potential includes sites that have energy consumption characteristics that could apply to CHP. For commercial and industrial sites, this means applications that meet the following criteria:

- Relatively coincident electric and thermal loads.
- Thermal energy loads in the form of steam or hot water.
- Electric-demand-to-thermal-demand ratios in the 0.5 to 2.5 range.
- Moderate to high operating hours (>4000 hours per year).

The estimates of technical market potential provided here do not consider such factors as ability to retrofit, owner interest in applying CHP, capital availability, natural gas availability, and variation of energy consumption within customer application/size class. The technical market potential also does not consider the capability of distribution systems in New Jersey to support DG. All of these factors affect the feasibility, cost, and ultimate acceptance of CHP at specific sites, and are critical to the economic implementation of CHP. Notably, the analysis also considers only traditional hot water-steam electric power CHP, and makes no estimate for mechanical drive applications or for uses of thermal energy other than steam or hot water.[4]

Using the above conditions, estimates of technical potential for DG for New Jersey were derived for the industrial and commercial/institutional energy sectors. Specific estimates and the data used to arrive at them are described below.[5]

Estimates of commercial/institutional technical potential by application size for New Jersey are based on the aforementioned report on CHP technical and market potential in the commercial/ institutional sector. This number is already net of existing CHP, and translates into about 30 percent of total commercial/institutional load.

For purposes of this report, industrial technical potential is estimated at about 75 percent of total load (industrial customers are far more likely to meet minimum criteria than commercial/ institutional customers).

To allow for estimates of market penetration, industrial technical potential for New Jersey is subdivided into five categories representing the aforementioned application sizes (100 to 500 kW; 500 to 1000 kW; 1 to 5 MW; 5 to 20 MW; and >20 MW). Capacity within each category in New Jersey is estimated by applying the ratios in each category from published estimates for New York State. For the industrial sector, the analysis, therefore, assumes that the breakdown of total industrial CHP potential by application size in New York State is similar to that of New Jersey.

Market Penetration Model

Market potential is estimated based on economic analysis that determines the economic attractiveness to end users of installing and operating a DG system. The analysis assumes that the decision is based on payback achieved from on-site use of generated power (and thermal energy for CHP applications) and other potential savings and revenue.

Payback periods for each technology are projected on a moving-forward basis for each year forecasted in the market penetration analysis. Thermal savings are calculated based on recoverable heat valued at the delivered price of natural gas. Utility bills are based on EIA data. Customers that use on-site generation, even to meet 100 percent of their needs, will still need to pay standby charges.

[4] For more detailed information about how technical market potential is estimated, see "Combined Heat and Power Market Potential for New York State."

[5] The technical potential for New Jersey was not based on actual customer electricity data. Therefore, actual technical potential within each customer category may vary. However, assuming that the total technical potential for all customer categories 1 MW and larger would remain approximately the same, it is reasonable to assume (based on similar payback periods and penetration rates) that the market penetration projections would also remain approximately the same.

CHP market penetration depends on a multitude of factors, including current levels of market penetration, the economic value of CHP to the customer, a maximum achievable growth rate, and the size of the remaining potential market. Current market penetration levels represent a starting point. The current levels of CHP development in New Jersey reflect a lack of economic value for CHP to the potential customer. Therefore, as economic value increases, market penetration rates can also be expected to increase. However, because there are a limited number of experienced market development, construction, and financing entities currently operating, the rate of increase will be constrained until such development groups can expand their efforts to meet new market conditions. Similarly, as market development proceeds, there will be an ever-declining pool of potential customers. Accounting for these hypotheses, the market penetration model incorporates the following features:

- Initial market rates are based on an assessment of current market levels.
- Maximum growth rates are defined to reflect the speed at which the market can ramp up if the economic value to the customer achieves an optimum level.
- Maximum growth rate is tempered by an economic acceptance factor (EAF) that equals 100 percent for project paybacks of 2 years or less and declines linearly to zero for paybacks of 8 years or more.
- As the ratio of remaining market potential to initial market potential declines, so too does the maximum rate of growth.
- It is impossible to achieve 100 percent penetration of the technical market potential due to a variety of factors, including site restrictions, customer risk preferences, customer diversity in economic value received, and any of a number of other factors that might inhibit the customer from implementing CHP. Such restrictions become more limiting as customer size decreases.
- Alternative market penetration rates may be defined on changes in economic value to the customers; e.g., through technology cost improvements, incentives, and changes in standby rates.

The model allows for rapid early growth rates from historical levels, which then decrease as a result of market saturation as technical potential is approached. Cumulative market penetration formulas are shown below:[6]

$$AM_0 = TMP \times MMP$$
$$MP1 = AM_0 \times IMS \times EAF$$
$$MPn = AM_n \times (MaxGR \times EAF) \times sqrt.(AM_{n-1}/AM_0)$$

[6] The model allows for rapid early growth rates from historical levels that are moderated by market saturation as technical potential is approached. The outcome in a robust economic market is a typical "S-shaped" market penetration curve.

where

AM_0	=	initial addressable market
AM_n	=	AM_{n-1} x (1+AMG) – MP_{n-1}
TMP_0	=	initial technical market potential (in MW)
MMP	=	maximum market penetration (percent)
EAF	=	economic acceptance factor; increases linearly from 0 to 100 percent as paybacks vary from 2 years or less to 8 years or more
MP_1	=	market penetration in year 1
MP_n	=	cumulative market penetration in year n
IMS	=	initial market share
MaxGR	=	maximum growth rate
AMG	=	addressable market growth.

As noted previously, the technical market potential (TMP) does not account for external factors that might limit CHP penetration, such as ability to retrofit, owner interest in CHP, capital availability, and natural gas availability. Certainly, these factors are important in the actual economic implementation of CHP. TMP is therefore discounted by an assumption of maximum market penetration (MMP). Assumptions of MMP increase in the larger technology size ranges. The Accelerated Case is based on the assumption that MMP increases due to factors such as greater customer awareness, streamlined permitting and installation, and more aggressive marketing. The initial market share (IMS) represents initial market penetration of the addressable market (AM). The maximum growth rate (MaxGR) is the maximum rate at which the early market can increase.

Below, we examine DG market penetration for commercial and industrial customers in New Jersey under two cases: (1) Base, and (2) Accelerated. The Base Case assumes current electric and gas rates, as well as standby charges. The Accelerated Case assumes a rebate of $1/watt or 30 percent of installed cost, whichever is lower[7]; lower standby charges; and a higher maximum market penetration rate (i.e., an increase in the percentage of technical potential that can be achieved).

Technology Assumptions

Both cases assume the use of current technologies and a slight annual technology cost reduction curve (–1 percent in 2004$). The following are the cost and performance assumptions made for typical technologies used in this analysis prior to the application of any incentives (e.g., the $1/watt rebate for Level 2 CHP).

[7] In all cases, 30 percent of installed costs is lower than $1/watt. The current New Jersey CHP rebate specifies $1/watt or 30 percent of installed cost, whichever is lower, for Level 2 projects less than 1 MW. Many of the projects assumed in this analysis are larger than 1 MW. Accordingly, the rebate used in this analysis is for illustrative purposes and not intended to represent the current rebate.

Table 4-1
Typical Conventional DG Technologies Performance and Cost

	Gas Engine	Gas Engine	Gas Turbine	Gas Turbine	Gas Turbine
Applicable Size Range (kW)	0 to 500	500-1,000	1,000-5,000	5,000-20,000	>20,000
Size (kW)	100	800	5,000	10,000	50,000
Efficiency (HHV)	28.10%	30.90%	27.60%	29.10%	37.00%
Heat Rate (Btu/kWh HHV)	12,126	11,050	12,366	11,750	9,220
Recoverable Heat (Btu/kWh)	5,683	4,323	5,622	5,282	3,779
Basic Turnkey Cost ($/kW)	$ 1,390.00	$ 975.00	$ 1,075.00	$ 965.00	$ 700.00
Variable O&M Cost $/kWh	$ 0.017	$ 0.011	$ 0.006	$ 0.006	$ 0.004
Fixed O&M Cost $/kW/yr	$ 119.14	$ 77.09	$ 42.05	$ 42.05	$ 31.54
Project Economic Life (Years)	10	15	15	15	20
Annual Capacity Factor	80%	80%	80%	80%	90%

Market Assumptions

Tables 4-2 and 4-3 show the market size and cost assumptions used in this analysis. Both cases assume a slight annual energy cost increase (1 percent in 2004$). (Residential data are included because they are used in the fuel cell and photovoltaic market penetration sections.)

Table 4-2
New Jersey Energy Use

	Annual MWh	Load Factor	Demand (MW)	Technical Potential (MW)	Market Potential (Base)	Market Potential (Accelerated)
Residential	27,333,152	49%	6,396	1,919	576	1,151
Commercial	36,263,549	46%	9,006	3,152	946	1,891
Industrial	11,318,808	69%	1,873	1,405	421	843
Total			17,275.00	6,475.65	1,943	3,885

Table 4-3
New Jersey Energy Rates

	Gas Rate ($/Mcf)	Electricity Rate ($/kWh)	Standby Charge ($/kWh)
Residential	$ 8.20	$ 0.107	N/A
Commercial	$ 7.50	$ 0.091	$ 0.015
Industrial	$ 4.70	$ 0.079	$ 0.010

Payback Assumptions

Tables 4-4 and 4-5 summarize Base Case payback for a CHP system installed in 2004 for commercial and industrial customers, respectively.

Table 4-4
Commercial Payback (No Incentive)

CHP Payback by Size (Current Technologies)					
CHP Size	100 kW	800 kW	5 MW	10 MW	50 MW
Technology	Engine	Engine	Turbine	Turbine	Turbine
CHP O & M Cost	$ 11,914	$ 61,670	$ 210,240	$ 420,480	$ 1,576,800
CHP Fuel Cost	$ 63,820	$ 464,297	$ 3,248,817	$ 6,162,705	$ 27,263,724
Thermal Savings	$ 26,136	$ 159,052	$ 1,477,462	$ 3,123,247	$ 11,172,614
Annual Utility Bill with CHP	$ 10,512	$ 84,096	$ 525,600	$ 1,051,200	$ 5,913,000
Total Costs with CHP	$ 60,110	$ 451,012	$ 2,507,196	$ 4,511,139	$ 23,580,911
Base Utility Bill w/out CHP	$ 63,773	$ 510,182	$ 3,188,640	$ 6,377,280	$ 35,872,200
Annual Savings	$ 3,663	$ 59,171	$ 681,444	$ 1,866,141	$ 12,291,289
First Cost	$ 139,000	$ 780,000	$ 5,375,000	$ 9,650,000	$ 35,000,000
Payback Years	37.9	13.2	7.9	5.2	2.8

Table 4-5
Industrial Payback (No Incentive)

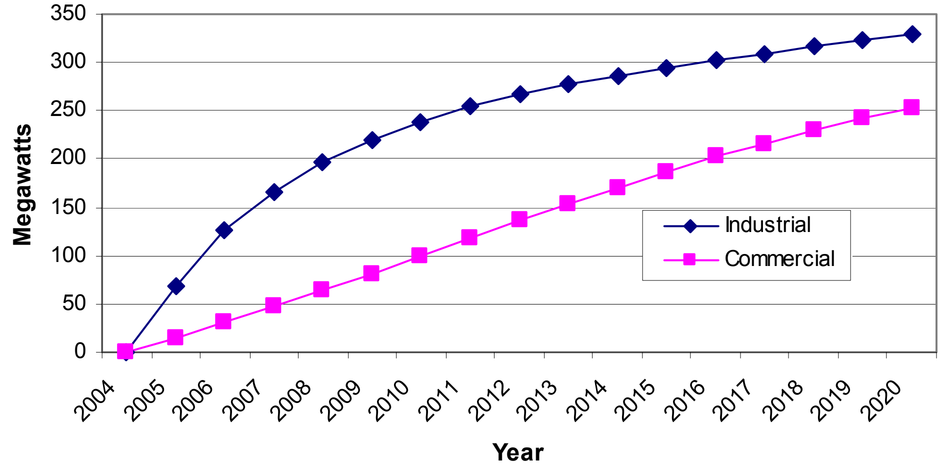
CHP Payback by Size (Current Technologies)					
CHP Size	100 kW	800 kW	5 MW	10 MW	50 MW
Technology	Engine	Engine	Turbine	Turbine	Turbine
CHP O & M Cost	$ 11,914	$ 61,670	$ 210,240	$ 420,480	$ 1,576,800
CHP Fuel Cost	$ 39,994	$ 290,959	$ 2,035,926	$ 3,861,962	$ 17,085,267
Thermal Savings	$ 16,379	$ 99,672	$ 925,876	$ 1,957,235	$ 7,001,504
Annual Utility Bill with CHP	$ 7,008	$ 56,064	$ 350,400	$ 700,800	$ 3,942,000
Total Costs with CHP	$ 42,537	$ 309,021	$ 1,670,690	$ 3,026,007	$ 15,602,563
Base Utility Bill w/out CHP	$ 55,363	$ 442,906	$ 2,768,160	$ 5,536,320	$ 31,141,800
Annual Savings	$ 12,826	$ 133,884	$ 1,097,470	$ 2,510,313	$ 15,539,237
First Cost	$ 139,000	$ 780,000	$ 5,375,000	$ 9,650,000	$ 35,000,000
Payback Years	10.8	5.8	4.9	3.8	2.3

4.2.2 Market Penetration Findings

Figures 4-1 and 4-2 represent estimated DG market penetration for commercial and industrial customers under the Base and Accelerated Cases.

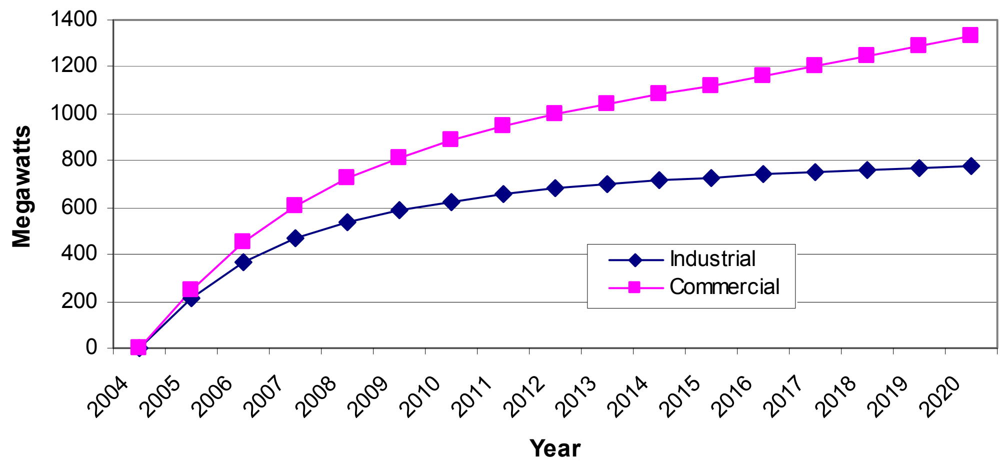
Under the Base Case, commercial and industrial customers will install some 575 MW of DG through 2020. This market penetration represents approximately 12 percent of technical potential and 40 percent of the Base Case maximum market penetration.

Figure 4–1
Cumulative DG Market Penetration — Base Case



The Accelerated Case allows for an increased maximum market penetration rate and no standby charges (which improves payback). Under the Accelerated Case, market penetration through 2020 increases significantly (2100 MW). This market penetration represents ~60 percent of technical potential and ~75 percent of the Accelerated Case maximum market penetration.

Figure 4–2
Cumulative DG Market Penetration — Accelerated Case



The Base Case reveals moderate market penetration through 2020. As indicated in the following table, the Accelerated Case would result in significantly more installed DG than the Base Case. However, the Accelerated Case would have a policy cost[8] of about $660 million.

[8] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

Table 4-6
DG Penetration and Rebate Cost

Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Base	583.18	$ -	$ -
Accelerated	2104.30	$ 662,345,018	$ 314.76

4.2.3 Recommendations

The greater market penetration associated with the Accelerated Case substantiates the need for further research and policy development to help reduce the cost of DG and renewables and spur market growth. The following section discusses recommendations associated with supporting DG, including renewables. The later sections on fuel cell and PV market penetration also include specific recommendations for those technologies.

Recent Progress

In addition to offering meaningful rebates for DG and renewables[9], New Jersey has taken substantial steps to help address a couple of key DG and renewable energy market barriers.

- Net metering rules for instance, which have been in effect in New Jersey since 1999, have limited net metering to customer-generated facilities with a capacity of 100 kilowatts or less. At the end of 2003, the BPU proposed amendments to the rule that would increase the maximum customer-generated capacity to two megawatts. The proposed amendments would also expand the class of customer-generators who are permitted to net-meter to include: wind, solar photovoltaic, tidal, geothermal, fuel cells powered by renewable energy, biomass, and all other sources listed in N.J.A.C. 14:4-8.
- To support and streamline the safe installation of these systems, New Jersey has also proposed to upgrade its standard interconnection procedures. The proposed BPU amendment (N.J.A.C. 14:4-8) sets forth revised interconnection requirements, designed to standardize the procedures for approving the interconnection of a customer-generator facility with the existing electric distribution system[10].

The proposed amendment is scheduled to be voted upon by the BPU on August 18, 2004.

- In addition, at least one New Jersey natural gas utility offers discounted rates to customers that use natural gas for DG. For example, New Jersey Natural Gas Company

[9] For more details on rebates please see http://www.njcleanenergy.com/.

[10] For more details please see: Amendments to N.J.A.C. 14:4-9 "Net Metering and Interconnection Standards for Class I Renewable Energy Systems"

(NJNG) received approval in January 2003 from the New Jersey Board of Public Utilities (BPU) to offer a special pricing plan to residential and commercial customers who use natural gas to fuel distributed generation (DG) technologies like fuel cells or microturbines.[11]

Additional Research

Areas of additional research that would help to clarify and quantify the benefits and impacts of DG in New Jersey and, ultimately, form a quantitative case for (or against) the various options to support DG, are listed below.

- Sponsor research and development on next-generation DG technologies and creative applications for DG, e.g., residential CHP.
- Perform comprehensive customer-based analysis and site audits (to better understand market potential).
- Research potential DG customers' financial decision-making.
- Quantify the technical and economic impact of DG on the T&D system.
- Determine impact of DG on the natural gas delivery system.
- Perform environmental impact assessment.
- Perform economic development research.

Potential Policy Initiatives

Consistent with the above areas of research and the related objective of pursuing a suite of policy initiatives for supporting DG, potential growth opportunities for DG in New Jersey could be realized by considering the following recommendations:

- Develop and institutionalize long-term, predictable, and cost-effective funding and financing mechanisms (including existing rebates and tax incentives, and new financing mechanisms such as interest rate discounts, etc.).
- Further explore tax benefits to support DG.
- Continue to support standardized interconnection procedures (e.g., N.J.A.C 14:4-9)
- Explore the inclusion of CHP in net metering.
- Develop supportive municipal ordinances and building codes.
- Explore electricity tariff revisions and options to reduce impact of standby charges on DG.
- Continue to explore discounted natural gas tariffs for CHP.

[11] For more details please see: NJ BPU Order (GT01070450) - In the matter of New Jersey Natural Gas Company distributed generation tariff filing, January 23, 2003

- Explore T&D avoided-investment credit/incentives.
- Continue to support load response.
- Promote inclusive renewable portfolio standard.
- Foster emissions policy that is supportive of low-emissions DG.
- Provide technical support and public education and awareness.

4.3 Fuel Cells

4.3.1 Methodology

The methodology used to estimate market penetration for fuel cells in all market sectors (residential, commercial, and industrial) is the same as the DG market penetration methodology. However, technology and policy assumptions vary. In addition, this analysis should be considered independent of the DG analysis, as it assumes fuel cells are the most desirable option.

Both cases assume the use of available technologies and an aggressive annual technology cost reduction curve (-7 percent in 2004$). The following are the cost and performance assumptions made for typical technologies used in this analysis.

The fuel cell technology used for the residential sector is Proton Exchange Membrane (PEM):

Table 4-7
Proton Exchange Membrane Fuel Cell Performance and Cost

System Parameters	PEM
Applicable Size Range (kW)	Res
Size (kW)	5
Efficiency (HHV)	35.0%
Heat Rate (Btu/kWh HHV)	9,750
Recov. Heat (Btu/kWh)	0
Basic Turnkey Cost ($/kW)	$5,000
O&M Cost $/kWh	$0.029
O&M Cost $/kW/yr	$230.00

The fuel cell technology used for the commercial and industrial sectors is solid oxide (SOFC):

Table 4-8
Solid Oxide Fuel Cell Performance and Cost

System Parameters	SOFC	SOFC	SOFC	SOFC	SOFC
Applicable Size Range (kW)	50-500	500-1,000	1,000-5,000	5,000-20,000	>20,000
Size (kW)	100	800	5,000	10,000	50,000
Efficiency (HHV)	50.0%	50.0%	50.0%	50.0%	50.0%
Heat Rate (Btu/kWh HHV)	7,300	7,300	7,300	7,300	7,300
Recov. Heat (Btu/kWh)	2,300	2,300	2,300	2,300	2,300
Basic Turnkey Cost ($/kW)	$4,500	$4,500	$4,500	$4,500	$4,500
O&M Cost $/kWh	$0.027	$0.027	$0.027	$0.027	$0.027
O&M Cost $/kW/yr	$225	$225	$225	$225	$225

Both the Base Case and Accelerated Case assume an initial rebate of $2.5/watt[12] for fuel cells. The Base Case assumes the rebate is cut in half in 2013. In addition, the Accelerated Case assumes reduced standby charges and higher market penetration rates.

4.3.2 Market Penetration Findings

As indicated in Figure 4-3, even with the $2.5/watt rebate, there is no significant market penetration in early years under the Base Case. The Accelerated Case allows for earlier penetration (due to reduced standby charges) and greater market penetration by 2020 (due to a higher maximum market penetration rate). There is little to no meaningful market penetration for the residential sector under either case. The fuel cell Accelerated Case achieves similar penetration as the DG Accelerated Case, but assumes a much higher incentive.

[12] The current New Jersey CHP rebate specifies $2.5/watt or 40 percent of installed cost, whichever is lower, for projects less than 1 MW. Accordingly, the rebate used in this analysis is for illustrative purposes and not intended to represent the current rebate.

Figure 4–3
Cumulative Fuel Cell Market Penetration – Base Case

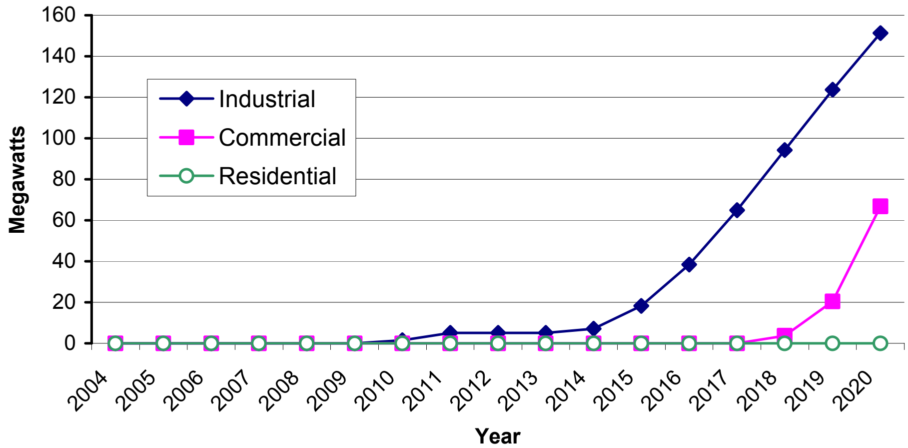
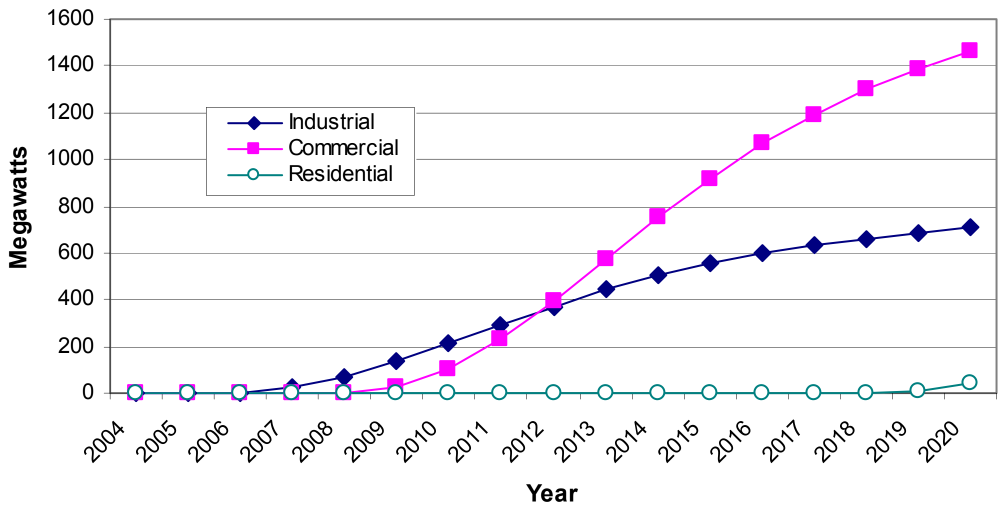


Figure 4–4
Cumulative Fuel Cell Market Penetration — Accelerated Case



As indicated in the following table, there would be significantly more fuel cell MW installed and much higher policy costs[13] under the Accelerated Case. However, the Base Case would not result in any significant market penetration in the near to mid-term.

[13] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

Table 4–9
Fuel Cell Penetration and Policy Cost

Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Base	218.17	$ 292,370,912	$ 1,340.08
Accelerated	2214.82	$ 5,813,889,535	$ 2,625.00

4.3.3 Recommendations

Many of the aforementioned recommendations for DG are also applicable to efforts to stimulate wider fuel cell development. It is important to stress that given the current cost structure associated with fuel cells relative to other DG technologies, a long-term incentive plan (as well as removal of DG market barriers) will be required to achieve meaningful market penetration in the near to mid term. In addition, it will be important to explore incentives that are potentially more cost-effective than rebates to balance market support and associated policy costs.

With regard to the residential market, it will be important to improve the efficiency of fuel cell applications in residential uses. One example would be to perform further research and development of the use of fuel cells as residential CHP in both existing and new construction.

4.4 NEW ZERO ENERGY HOMES

4.4.1 Methodology

The methodology for estimating market penetration for PV energy efficiency measures in the new home construction is the same as the DG market penetration methodology. However, the technical potential, policy, and performance assumptions are unique to PV homes. A detailed list of the assumptions is included in Appendix C.

In summary, the model assumes that PV and energy efficiency (ENERGY STAR home level) are bundled for purposes of calculating payback, the $5.5/watt subsidy is slowly phased out, and PV costs are aggressively reduced. The model also assumes that the typical technology for both single- and multi-family homes is 3.0 kW DC.

Bundling new PV homes with qualified ENERGY STAR New Homes provides a way to reduce the initial payback period associated with new solar homes. Based on our research[14], new ENERGY STAR Homes in New Jersey were determined to have a sale price approximately $4,000 higher

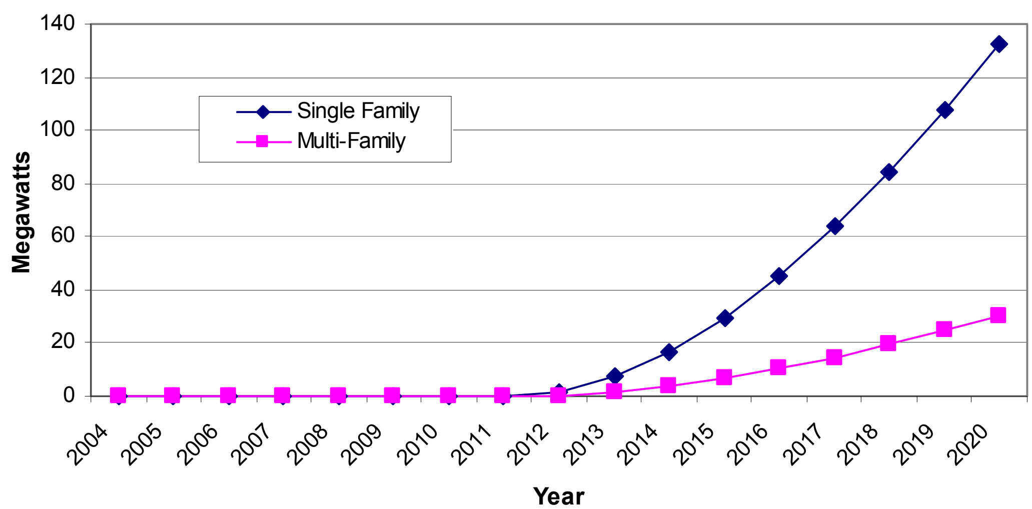
[14] Conversations with ENERGY STAR Home developers, including CSG Services. June 2004.

than new non-ENERGY STAR Homes built to standard building code.[15] Annual energy savings associated with ENERGY STAR Homes installed in 2004 was estimated to be about $700 more than equivalent new non-ENERGY STAR Homes. In 2004, a 3 kW PV system (building integrated) would cost about $8,500 after rebate. Associated annual PV energy savings would be about $400 in 2004.[16]

4.4.2 Market Penetration Findings

In the following figures, only a Base Case is examined for each of two housing markets: single-family and multi-family. Our findings indicate that by 2020, upwards of 160 MW of PV (cumulative) bundled with energy efficiency could be installed on new residential construction. There is no significant market penetration until 2012—when the payback period falls below 8 years. It is worth noting that although the bundling of PV with energy efficiency helps to achieve PV market penetration early on, it also serves to retard PV growth once PV achieves a payback period lower than that of energy efficiency in later years.

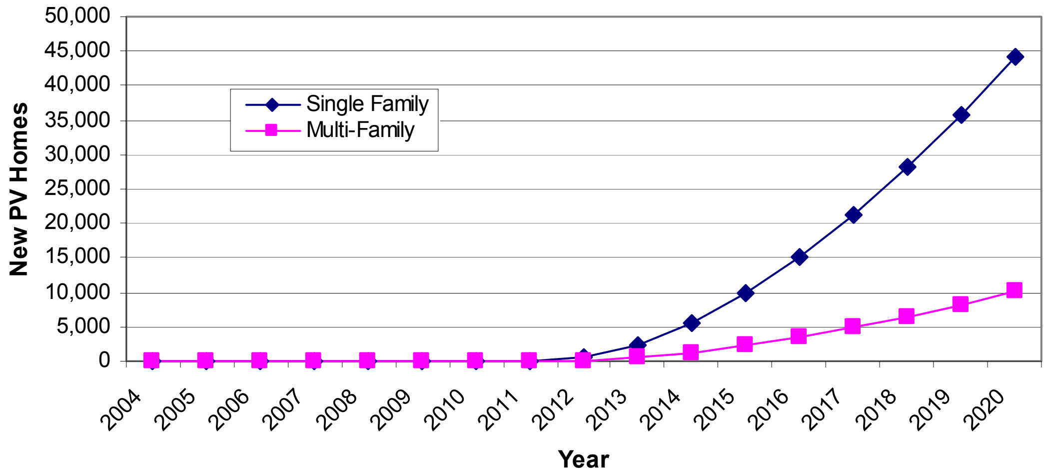
Figure 4–5
Cumulative Zero Energy Home Market Penetration (MW)



[15] The $4,000 is the incremental cost for an ENERGY STAR new home versus the cost for a comparable new home that only complies with minimum building code standards. Based on a 3 kW system, the PV system would cost $3,000/kW or an additional $9,000 in 2004 ($8,500/kW installed cost minus the $5,500/kW rebate).

[16] These savings calculations do not include financing costs associated with the cost of energy efficiency and PV.

Figure 4–6
Cumulative Zero Energy Home Market Penetration (No. of New Homes)



Even with a gradual phase out of the rebate, the Base Case would result in significant policy costs. As indicated in the following table, the installation of 163 MW of PV would have a policy cost[17] of about $475 million or an average of $2,900/kW.

Table 4-10
Zero Energy Home Penetration and Rebate Cost

Base Case	MW Installed through 2020	Total Rebate Cost	Average Cost ($/kW)
Single Family	132.29	$ 388,385,243	$ 2,935.85
Multi-Family	30.21	$ 88,691,534	$ 2,935.85
Total	162.50	$ 477,076,777	$ 2,935.85

4.4.3 Recommendations

Many of the DG recommendations also apply to promoting the integration of PV on new residential construction. Recommendations specific to stimulating the growth of PV on new residential construction in New Jersey include:

- Continue to maintain traditional policies to spur market penetration in the near term to bridge the gap with the next generation of solar policy, including net metering, tax credits, and rebates. Explore other incentives, including property tax exemptions and new home financing incentives for developers and homebuyers.
- Explore opportunities for PV on commercial and industrial new construction.
- Work with builders, appraisers, local municipalities, and loan companies to explore building codes, programs and policies to promote solar on new construction.

[17] The policy cost assumes only the cost of the rebate and a 5% administrative charge.

4.5 COMMENTS ON ALTRUISTIC OR EXPERIMENTAL MARKET PENETRATION

The intent of the market penetration model is to predict market penetration based on economic signals—in this case, customer payback. However, it is important to recognize that some customer adoption of technologies with low economic performance is likely to occur regardless of customer payback period. For instance, although the current situation in New Jersey does not support a customer payback period of less than 8 years, in many cases PV installation is still observed. This market penetration, which in many cases can be broadly categorized as altruistic or experimental adoption, may reflect economic considerations as well as non-economic customer motivations, such as a desire to support environmental causes, or to test new technology applications.

While significant from a new technology perspective, the altruistic or experimental adoption of solar PV or fuel cells by a very small segment of the population is not captured by a macro market penetration model. Of greater interest is the ability to predict the potential for widespread market penetration and the impacts of associated policy, based on the economic behavior of society as a whole. This approach, upon which the market penetration model is founded, presupposes that economic signals, such as payback, provide a robust representation of widespread societal behavior.

4.6 CRITERIA SCORING

Table 4-11 presents the criteria ranking for the distributed generation technologies presented in this report. Payback ranges are used for the economic criteria. MW in 2010 and 2020 are used to score the market potential criteria.

Table 4-11
Criteria Scoring for DG Technologies

Program Concept	Market Potential (MW)	Market Potential Score	Cost Effectiveness (TRC Ratio)		Cost Effectiveness Score	Need for program Score	Market Barriers Score	Overall Scores
Criteria Weight		**25 %%**			**25.00%**	**25.00%**	**25.00%**	
Distributed Generation			(payback)					
			2010	*2020*				
Commercial and Industrial	583	4	2.0-28.3	1.6-18.6	3	4	3	3.5
Fuel Cells	218	3	7.5-20.2	4.5-10.4	2	4	5	3.5
Zero Energy Home SF, MF	132	2	10.2	3.1	2	4	5	3.3