GEORGE CAVROS
ATTORNEY AT LAW

September 6, 2007

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COMMISSION CLERK

Ms. Ann Cole, Director
Division of Commission Clerk
And Administrative Services
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, Florida 32399-0850

Re: Docket No 070467-EI: Southern Alliance for Clean Energy's Prepared Direct Testimony

Dear Ms. Cole:

Enclosed for filing on behalf of the Southern Alliance for Clean Energy are the original and fifteen (15) copies of the following:

1. Prepared Direct Testimony and Exhibits of David Nichols
2. Prepared Direct Testimony and Exhibits of Stephen A. Smith

Please acknowledge receipt and filing of the above documents by stamping the duplicate copy of this letter and returning it via mail to the address below.

DOCUMENT NUMBER-DATE 08128 SEP-7 07 FPSC-COMMISSION CLERK Smith

Thank you for your assistance,

George Cavros

GSC/rs
Enclosures

DOCUMENT NUMBER-DATE 08127 SEP-7 07 FPSC-COMMISSION CLERK Nichols

CMP ____
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BEFORE THE
FLORIDA PUBLIC SERVICE COMMISSION

IN THE MATTER OF	)	
THE PETITION OF	)	
TAMPA ELECTRIC TO	)	
DETERMINE NEED FOR	)	DOCKET NO. 07-0467-EI
POLK POWER PLANT	)	
UNIT 6	)	

PREPARED DIRECT TESTIMONY OF

DAVID NICHOLS

SOUTHERN ALLIANCE FOR CLEAN ENERGY

SEPTEMBER 6, 2007

1. INTRODUCTION AND QUALIFICATIONS

Q. What is your name, position and business address?

A. My name is David Nichols. I am Senior Consultant with Synapse Energy Economics, Inc, 22 Pearl Street, Cambridge, Massachusetts 02139.

Q. Please describe Synapse Energy Economics.

A. Synapse Energy Economics is a research and consulting firm specializing in electricity industry regulation, planning and analysis. Synapse works for a variety of clients, with an emphasis on consumer advocates, regulatory commissions, and environmental advocates.

Q. Please describe your experience in the area of electric utility restructuring, regulation and planning.

A. My experience is summarized in my resume, which is attached as Exhibit __ (DN-1). For three decades, I have professionally assessed the costs and benefits of energy conservation, energy efficiency, and load management to utility ratepayers; designed demand-side management ("DSM") programs; evaluated DSM programs of electric utilities, gas utilities, and state agencies; and analyzed utility DSM cost recovery claims. I have presented studies on these matters in testimony before regulatory commissions in most U.S. states, before the U.S. Federal Energy Regulatory Commission, and in Canadian provinces. I have also worked in other energy areas such as rate design, resource planning, and renewable resources.

Q. Please describe your professional experience before beginning your current position at Synapse Energy Economics.

A. Before joining Synapse Energy Economics this year, I was an independent energy analyst in Boston, Massachusetts. Prior to that, I was for 25 years a vice-president at Tellus Institute for Resource and Environmental Strategies, of which I am a co-founder. I received an A.B. degree from Clark University and a Ph.D. from the Massachusetts Institute of Technology.

Q. On whose behalf are you testifying in this case?

A. I am testifying on behalf of the Southern Alliance for Clean Energy (SACE).

Q. Have you testified previously in this docket?

A. No, I have not.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to describe my review of the electric DSM programs of Tampa Electric Company (TECO or the Company); significant increases which I believe the company could achieve to its planned DSM impacts on energy requirements and peak demands; and whether there are DSM measures reasonably available to TECO that would further mitigate the need for the proposed plant.

Q. How is your testimony organized?

A. My testimony is organized as follows:

1. Introduction and Qualifications.
2. Summary of Conclusions and Recommendations.
3. Increasing DSM Impacts Under the RIM Test Constraint
4. Increasing DSM Impacts Based on Total Ratepayer Benefits
5. DSM Impacts on the Company's 2013 Capacity Need

2. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Q. Please summarize your conclusions.

A. My primary conclusions are summarized as follows:

1. Pending in Docket 070375-EG is a modified TECO Demand Side Management Plan. Based on this Plan, TECO states in the present docket for the proposed Polk Unit 6 that it has identified all of the cost-effective DSM program potential in its service area for the years 2007 through 2014. This conclusion is not supported by analysis of TECO's filings in the DSM docket or in this docket.

2. The customer financial incentives employed in the Company's modified DSM proposal are low, as low as two percent of the customer's cost for an efficiency measure. Increased incentives would increase customer participation levels and the energy and demand impacts of the Company's DSM.

3. The Company offers no financing program, whereby the utility advances the money needed by the customer to invest in qualifying DSM measures and the customer then repays this money through the utility bill, out of his or her energy savings. Offering such a financing program would increase customer participation levels and the energy and demand impacts of the Company's DSM.

4. Under the Rate Impact Measure (RIM) test constraint on DSM cost-effectiveness, there is room for the Company to both increase incentives and offer a financing program, as described above. Since DSM impacts can be increased through these means, the Company has not succeeded in identifying all the cost-effective DSM program potential in its service area for the years 2007 through 2014.

5. If the Total Resource Cost (TRC) test for DSM cost-effectiveness is used instead of the RIM test, there is even more room for the Company to increase

incentives, and additional measures can be added to its DSM program, while at the same time a financing program can be added, as described above.

6. Both the level of DSM potential realized by the Company in the past, and that planned for the future, necessarily affect the magnitude and timing of projected future capacity needs, such as those asserted in the present docket. While it is difficult to determine the quantity of additional DSM available at this time without further information from TECO, it is clear that additional DSM beyond that in the modified DSM Plan is reasonably available, and that further load reductions can be achieved that might further mitigate the need for the proposed plant.

Q. Please summarize your recommendations.

A. In order to assure that the Company both identifies and pursued all the cost-effective DSM program potential in its service area for the years 2007 through 2014 and beyond, the Commission should direct the Company to evaluate all of the DSM that is achievable if both customer incentive levels and the array of DSM measures offered through its programs are increased as much as possible under the TRC test, and at the same time a customer efficiency financing program is offered as part of TECO's DSM programming. The Commission should also:

1. Direct the Company to report in this docket the changes to its reliability analysis that would result from implementing such an expanded DSM program.

2. Waive the RIM test DSM constraint for TECO in light of its apparently mounting capacity needs.

3. Consider approving this expanded TECO DSM program as soon as possible after appropriate review.

Q. What if the Commission is disinclined to relax the RIM test constraint for TECO DSM?

A. In this event, the Commission should direct the Company to evaluate all of the DSM that is achievable if customer incentives are increased as much as possible under the RIM test constraint, and at the same time a customer efficiency financing program is offered as part of TECO's DSM program. The Commission should also direct the Company to report in this docket the changes to its reliability analysis that would result from implementing such an expanded DSM program. Finally, the Commission should consider approving this expanded TECO DSM program as soon as possible after appropriate review.

3. INCREASING DSM IMPACTS UNDER THE RIM TEST CONSTRAINT

Q. Has the Company successfully identified all the cost-effective DSM program potential in its service area for the years 2007 through 2014?

A. Based on my review of their recent Petition to the Commission for modifications to their DSM Plan, I believe the Company has not identified all the DSM potential that would be cost-effective under the constraint of the Rate Impact Measure (RIM) cost-effectiveness test. In the next section of my testimony I will address cost-effective DSM potential that may not pass the RIM test; but in this section I focus on DSM that can pass the RIM test.

Q. Please explain how you conducted this aspect of your review.

A. I relied primarily on the Petition for Modifications to Tampa Electric Company's Demand Side Management Plan, as filed with the Commission on June 15, 2007 (Docket 070375-EG), supplemented by other information provided by the Company and as identified herein. I would like to begin by discussing Appendix C of the Docket 070375-EG Petition, which starts on page 163 and describes the cost-effectiveness screening of each component of the proposed modified Plan. Going through Appendix C, I took note of the prospective benefit-to-cost (B/C) ratio under the RIM test as estimated for each option through the Company's screening analysis.

Q. What did you observe about the RIM test results?

A. I observed that the result for each option was well above 1.0, the level at which a program becomes cost-effective under this test. For eight residential energy efficiency options, for example, the RIM test results ranged from a low of 1.2 for the low-income weatherization program to a high of 1.9 for the residential wall insulation measure. For 14 commercial/industrial options, the RIM test results ranged from 1.2 for two commercial cooling measures to over 2.0 for the occupancy sensor (a lighting measure).

Q. What do these results mean to you?

A. To me, these results mean that the Company should increase the incentives it provides to customers to participate in all of its programs, as this would be likely to result in increased customer participation and thereby to greater total savings in annual energy use and peak demands.

Q. Please explain your conclusion.

A. Incentives to help defray the cost of conservation measures or the extra costs of more efficient equipment are intended to increase customer investment in energy efficiency by making it more affordable. The incentives to customers that are provided in Company DSM programs are a cost element in a RIM test framework. In order to capture a larger amount of DSM potential, the incentives should be increased until costs equal benefits. Looking at the RIM test, the B/C should be at 1.0, and not above that level.

For example, the Company screening of the "residential wall insulation" measure assumes a customer incentive that equals only 14 percent of the total cost of this measure. Yet its RIM "score" is 1.9. Clearly, the incentive for customers to install this measure could be increased above this low level, until the RIM result falls to 1.0.

Another example comes from the commercial lighting area, where the proposed incentive for occupancy sensors amounts to 2 percent of customer costs, yet the RIM result is over 2.0. Again, the incentive for customers to install this measure could be increased above the proposed level, until the RIM result falls to 1.0.

The same procedure should be followed for every program.

The participation and energy and demand impacts which TECO now projects for each program assume the parsimonious incentives described above. All else equal, increasing the customer incentives will increase these program impacts.

Q. But shouldn't the RIM result be above 1.0, in order to help reduce rates for customers?

A. No, even if the RIM test is used, the aim should not be to reduce rates. The purpose of DSM is to reduce total energy resource costs and environmental impacts going forward, If the RIM is at 1.0, this objective is furthered without any overall rate increase. In a later section of my testimony I urge that the Commission to focus on a broad cost-effectiveness criterion such as the TRC test, because requiring that each DSM program pass the RIM test constrains the ability of utilities to reduce total energy resource costs and environmental impacts for all ratepayers going forward. My point here is that even if the RIM test is the focus, the Company can and should increase customer incentives in all its programs in order to more fully exploit DSM potential.

Q. Is there anything the Company can do to increase DSM impacts, besides increasing customer DSM incentives?

A. Yes, there is. In reading the DSM program descriptions in Appendix B of the Docket 070375-EG Petition for DSM modifications, I did not see any description of financing services to help customers pay for their DSM measures costs over time. Discussions with the company confirmed that no such services are currently available. Under a financing program, the utility or a third party lender advances the money needed by the customer to invest in qualifying DSM measures. The customer then repays this money through the utility bill, with interest. The repayment schedule is sufficiently long that the customer comes out ahead each month -- that is, the expected electric bill savings from the efficiency measures are greater than the loan repayments.

An on-bill financing program would increase participation in Company DSM programs, but would not add any utility costs (other than for initial set-up of the program). Thus, the costs of DSM would not be greater from a RIM perspective, but customer participation and electricity saving impacts would be greater.

Q. Should the Company develop a customer financing program such as you describe?

A. Yes, the Company should do so for the reasons I have given. The Company might create a financing program of its own design, as some utilities have done. Alternatively, the Company might make use of an existing financing approach that has already been developed and has been pilot tested at a number of utilities. Here I refer to the Pay As You Save® system developed by the Energy Efficiency Institute. The PAYS® system enables building owners or tenants to obtain and install money-saving energy efficiency products with no up-front payment. Those who benefit from the resulting savings pay for the products through a tariffed charge on their utility bill. Like a loan, PAYS allows for payment over time. However, should an occupant move, the obligation to repay remains with the account meter until discharged. So unlike a loan, the customer's PAYS obligation ends if occupancy ends. I recommend that the Company explore the PAYS option, since this may be the most expeditious way to establish a financing program. At the website http://www.paysamerica.org/ more information about PAYS may be obtained.

4. INCREASING DSM IMPACTS BASED ON TOTAL RATEPAYER BENEFITS

Q. Has the Company identified all the DSM program potential that is cost-effective from a total resource cost (TRC) perspective in its service area for the years 2007 through 2014?

A. Based on my review of their Docket 070375-EG Petition, I conclude that TECO has not identified all such potential.

Q. Please explain how you arrived at your conclusion.

A. In Appendix C of the Petition, the Company reports cost-effectiveness screening results from the TRC perspective. In this screening, however, they assume the same low customer incentives that made it possible for each program to pass the RIM test, as described above.

However, broader cost-effectiveness tests, such as the TRC test, would permit much more adequate incentives, such as are employed by the electric utilities elsewhere which have achieved the greatest reported cost-effective DSM impacts in the nation. Customer incentive levels at utilities with comprehensive TRC based DSM programs often average about fifty percent of the incremental cost of the measures, and can be as high as 90 percent of the cost for targeted programs and markets.

In Appendix E of the Company's Petition in Docket 070375-EG, the Company summarizes the DSM impacts it projects through 2014. One simple way to increase impacts that TECO could achieve in this period through the programs it has proposed is to substantially increase each customer incentive. An initial estimate of the increase to DSM savings from increased incentives would be to multiply projected impacts per program by the ratio of an increased incentive to the presently proposed incentive.

In Exhibit __ (DN-2), I list the Company's and my proposed incentives as a percentage of customer costs to participate, and show the ratios of the two sets of incentives. The table does not include commercial load management/demand response or standby generators, but a similar approach could be taken to those programs as well. The residential incentives I propose are often two to three times those proposed by the Company. My proposed commercial/industrial incentives are generally two to nine times those proposed by the company. If the customer participation and energy savings impacts increase by the ratios of these incentive changes, total DSM achievements will be about four times those projected from the programs in their current form.

I plan to calculate those increased impacts as soon as the Company provides the specific participation and energy and demand impacts which they project for each program. Those projections were not included in its Petition in Docket 070375-EG, but have been requested by SACE through discovery in the present docket. SACE has also requested that the Company perform these calculations. I hope to have the results of the calculations before the time I appear to defend this testimony.

Q. **Is there other ways to estimate the DSM potential that is cost-effective from a TRC perspective but would be left untapped by the Company's proposal?**

A. Yes, there are. One way is to consider a major recent study, *Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands*, was published by the American Council for an Energy-Efficient Economy (ACEEE Report Number E072, June 2007). This report is attached as Exhibit __ (DN-3). I have reviewed this report, which appears to be a rigorous study by respected professionals in the energy field, including personnel from the Florida Solar Energy Center. I am relying on this report, in part, for my opinions in response to this question.

The ACEEE report found that by 2013, statewide annual electricity consumption could be reduced by 7183 GWH and summer peak demand by 1375 MW, through DSM type activities by the electric utilities. An additional summer peak demand impact of nine percent was identified as achievable through utility demand response type activities. In evaluating DSM opportunities, some of the measures ACEEE used are additional to those included in TECO's programs. In addition, ACEEE's customer participation targets and savings projections were based on a broader cost-effectiveness perspective.

I apportioned results from the ACEEE study to the TECO area based on TECO's percentage of statewide electricity consumption and summer peak demand, which is about 8.5 percent in each case. While such a scaling involves some approximations, it can for the basis for an opinion about whether TECO has underestimated DSM potential in its service area. TECO projects a year 2013 impact of 110 GWH from its expanded DSM, according to the testimony in this docket of Mr. Bryant. By contrast, the ACEEE identified potential for that year is some 600 GWH, over 500% more. And compared to TECO's projected year 2013 summer peak impact of 78 MW from its expanded DSM, the implied ACEEE identified potential for that year is 534 MW, well over 600% more. (TECO's winter peaks are somewhat higher than their summer peaks, but winter peak impacts are not readily available from the ACEEE study.)

In sum, the ACEEE report clearly suggests that more aggressive utility DSM informed by a more adequate cost-effectiveness test could realize far more

DSM potential in the TECO area than the Company has so far proposed.

At a more detailed level, the ACEEE report also underscores the inadequacy of the Company's proposed customer incentives for efficient commercial lighting. As Exhibit __ (DN-2) shows, the Company's proposed incentives for major lighting measures are only seven percent of the customer's costs to install such measures. Yet efficient commercial lighting has been a major source of cost-effective electric DSM savings realized around the country. In the ACEEE study of Florida efficiency potential, over half of the savings potential identified in the existing commercial building stock comes from lighting efficiency gains (ACEEE, page 11). Through its parsimonious incentives, TECO is clearly losing major opportunities to save electricity used for commercial lighting.

The ACEEE study also includes a number of efficiency measures that do not appear to be included in the Company's proposed Modified DSM Plan at all. In the residential market, for example, it includes fluorescent lights in lieu of conventional lights (included by TECO only in a low-income program), Energy Star refrigerators, Energy Star dishwashers, heat pump water heaters, highest efficiency storage water heaters, and front-loading clothes washers. These are all measures that are low to moderate in cost in relation to the electric energy which they save over their lifetimes, and they appear in many electric utility DSM programs.

Q. Is there any other way to estimate the DSM potential that is cost-effective from a broader cost-effectiveness perspective, but would be left untapped by the Company's proposal?

A. Yes. It is interesting to compare the magnitude of energy savings and demand reductions that the Company expects to realize from its Modified DSM Plan with the level of achievements that leading utilities realize and plan for. By leading utilities, I mean electric utilities which field comprehensive DSM initiatives that are cost-effective based on a broader screen such as the TRC or Utility test. Under its DSM Plan, TECO would achieve annual incremental savings impacts of about 11 GWH/year, 9 MW summer peak reduction/year, and 10 MW winter peak reduction/year. These impacts as a percent of the utility's loads are very low, a small fraction of a percent in each case. Even on a cumulative basis over nine years through 2013, the impacts are low. In that year, the energy savings from DSM Plan program activity from 2005 forward would only be one-half of one percent of the projected sales in 2013, and the winter and summer demand impacts would only be about 1.6 percent in each case.

Exhibit __ (DN-4) consists of two tables. The first lists energy efficiency savings reported by utilities, all of which have saved a greater portion of electric energy use from one year's worth of DSM than TECO would attain based on several years through 2013. The second lists a mix of achieved and planned peak demand impacts from one year's worth of DSM, all which again are several times greater than TECO's. To me, these achievements and plans by utilities in a variety of regions are indicative of what TECO could strive to achieve if its programming were more adequate and, in particular, if it were freed from a RIM test constraint.

Q. In this section of your testimony, you are identifying DSM potential that TECO would leave untapped due at least in some part to its reliance on the RIM test constraint. Why do you believe the Company and the Commission should not focus on the RIM test in this case?

A. If the Commission relied on a broader test, particularly the TRC test or the Utility Cost test, as its primary indicator for DSM going forward, it would pave the way for more DSM leading to greater reductions in the total revenue requirements of electric utilities and to reductions to the total of electricity bills paid by all customers over time. This would reduce the state's total costs for energy services, while increasing the environmental benefits from DSM. This issue is also addressed by the authors of the ACEEE report. See Exhibit __ (DN-3), page 18.

Q. If the Commission adopts a broader test for DSM, and TECO can as a result increase its customer incentives as well as the array of efficiency measures it promotes through DSM, would there still be a role for the financing services to help customers pay for their DSM measures costs, such as you discussed earlier in your testimony?

A. Yes, there would be a role for such services. For TECO to offer a financing program such as PAYS would make it easier for customers to participate and would amplify even further the effects of an enhanced DSM program.

5. DSM IMPACTS ON THE COMPANY'S 2013 CAPACITY NEED

Q. What capacity need has the Company identified in this docket?

A. In his testimony, Mr. Smotherman states that the Company has identified a requirement for an additional 482 MW of firm supply resources in Summer 2013, and 576 MW of firm supply resources in Winter 2013. The need identified by Mr. Smotherman may take account of the year 2013 DSM impact projections from the Company's proposed modified DSM Plan, which as identified in the testimony of Mr. Bryant are 78 MW and 84 MW, respectively.

Q. Would additional DSM beyond what the Company has proposed reduce the magnitude of the capacity needs the Company has identified?

A. I believe that it would. For example, I indicated earlier that the ACEEE study implies that a total reduction of 534 summer peak MW may be achievable in the TECO area through cost-effective utility energy efficiency and demand response programs. At a reserve margin requirement of 20%, such a decrement would obviate the need for 640 MW of summer capacity.

I also expect that calculation of the additional DSM achievable through increased customer incentives, particularly if the RIM test constraint is relaxed, will show that summer and winter peak demand reductions above the levels described by the Company's new DSM projections are attainable.

Q. Have you performed an overall evaluation of the need for Polk Power Plant Unit 6?

A. No, I have not evaluated the Integrated Resource Planning modeling and the economic analyses performed by the Company to demonstrate the need for the proposed Polk Unit 6. I have limited my evaluation to the question of whether the Company has identified all of the cost-effective DSM program potential in its service area for the years 2007 through 2014, as is asserted by Mr. Bryant. For the reasons described above, I believe the

Company has not succeeded at identifying all of this potential or at including it in its proposed DSM Plan. By including additional achievable DSM in its Plan, the Company could reduce the capacity need in response to which it has proposed Polk Unit 6.

Q. Based on your findings, what would you recommend to the Commission in this docket?

A. My overall recommendation is that the Commission act to encourage more aggressive and effective DSM programs from TECO. Had TECO achieved greater DSM impacts in the recent past, this would have reduced the firm supply requirements it now foresees. Similarly if TECO achieves greater DSM impacts in the future than it now plans, this will affect future evaluations of capacity needs. The link between success at demand-side DSM and the level of capacity need in the future is inexorable. The Commission should act to accelerate the pace of future DSM and tie these actions to its determination in this docket, whether or not Polk Power Plant Unit 6 is found necessary.

Q. How specifically might the Commission act to accelerate the pace of DSM?

A. I would recommend that the Company be directed to evaluate all of the DSM that is achievable if both customer incentive levels and the array of DSM measures offered through its programs are increased as much as possible under the TRC test, and at the same time a customer efficiency financing program is offered as part of TECO's DSM programming. The Commission should also:

1. Direct the Company to report in this docket the changes to its reliability analysis that would result from implementing such an expanded DSM program.

2. Focus in this case on a broad DSM cost-effectiveness criterion such as the TRC test, and not exclusively on the RIM test.

3. Consider approving this expanded TECO DSM program as soon as possible after appropriate review.

Q. What if the Commission is not willing to focus on a broad cost-effectiveness test such as the TRC test for TECO DSM?

A. In this case, the Commission should direct the Company to evaluate all of the DSM that is achievable if customer incentives are increased as much as possible under the RIM test constraint, and at the same time a customer efficiency financing program is offered as part of TECO's DSM program. The Commission should also direct the Company to report in this docket the changes to its reliability analysis that would result from implementing such an expanded DSM program. Finally, the Commission should consider approving this expanded TECO DSM program as soon as possible after appropriate review.

Q. Does this conclude your testimony?

A. Yes, it does.

DAVID NICHOLS

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EMPLOYMENT

Synapse Energy Economics Inc., Cambridge, MA. *Senior Consultant*, 2007 - present.
Analysis and consulting on energy policy, climate change, renewable energy, energy efficiency, comsumer advocacy, environmental compliance and technology and business strategy within the energy industry.

Independent research, analysis, and consulting, 2002 – present.
Energy work includes efficiency studies, rate design, performance-based ratemaking, renewable energy, technology assessment, cost benefit analysis, design and evaluation of demand-side load response and efficiency programs, and policy analysis.

Tellus Institute for Resource and Environmental Strategies, *Vice President and Director*, 1977-2002.
Energy consulting on myriad topics. Led Industrial Eco-Efficiency (E2) Initiative to promote integrated assessment of pollution prevention and energy efficiency. The Initiative created software for financial analysis of projects within firms, and the *E2 Financing Directory*, a U.S. EPA data base of resources for New England businesses seeking financing for E2 projects.

State University of New York at Albany, Allen Center and Graduate School of Public Affairs, *Associate Professor,* 1974-1978

Rensselaer Polytechnic Institute, Department of History and Political Science, *Assistant Professor,* 1973-1974.

Department of Environmental Conservation, Albany, New York, *New York Civil Service Public Administration Intern,* 1973.

EDUCATION

Clark University, (A.B.)
University of Chicago
Massachusetts Institute of Technology, (Ph.D.)

EXPERT TESTIMONY*

Rate Design & Cost Allocation

Before:
Nevada Public Service Commission, docket 94-7001 (1995)
New Jersey Board of Public Utilities, docket ER02080506 (2003)
New York Public Service Commission, case 91-E-1185 (1991)
Ontario Energy Board, H.R. 24 submission (1996)
Rhode Island Public Utilities Commission, docket 2036 (1992)
Utah Public Service Commission, docket 02-057-02 (2002).

Energy Efficiency & Renewable Energy

Before:
Colorado Public Utilities Commission, dockets 99A-377EG (1999), 00A-008E (2000)
Delaware Public Service Commission, docket 94-83 (1995)
Maine Public Utilities Commission, docket 91-213 (1992)
New Jersey Board of Public Utilities, dockets EX04040276 (2004), GR01040280 (2001), EX99050347 (2000 and 1999), EE98060402 (1998), EX94120585U (1998), ER97020101 (1997)
North Carolina Utilities Commission, docket E-100 (1990)
Ohio Public Utilities Commission, cases 91-700-EL-FOR (1993), 92-708-EL-FOR (1992)
Ontario Energy Board, EBROs 497 (1998), 495 (1997), 487 (1994)
Utah Public Service Commission, docket 01-035-01 (2001)
Vermont Public Service Board, docket 5330 (1990)
Wisconsin Public Service Commission, dockets 05-CE-117 (2002), AP7 (1995)

*Testimony listed here was defended before agencies noted. Testimony that was filed but not heard is listed in the next section. List of testimony prior to 1990 available upon request

PUBLICATIONS, PAPERS & REPORTS

2007: **Independent Administration of Energy Efficiency Programs: A Model for North Carolina.** A Synapse Energy Economics report to Clean Water for North Carolina. Senior author.

2005: **New Jersey's Proposed Renewable Portfolio Standards Rule: Analysis and Recommendations**. Report to: New Jersey Division of the Ratepayer Advocate.

2005: **Emerging Technologies for a Second Generation of Gas Demand-Side Management.** Draft report to: Enbridge Gas Distribution Inc. and Union Gas Ltd. Senior author.

2004: **Policy & Program Actions: Buildings & Facilities.** For the Stakeholders of the Rhode Island Greenhouse Gas (GHG) Process to develop the RI Climate Change Action Plan.

2002: **Final Report on Energy Efficiency and Renewable Energy.** Report of the Air Pollution Prevention Forum to the Western Regional Air Partnership.

Development Of Options: Scoping Paper. For the Working Group on Buildings & Facilities of the Rhode Island GHG Process. Senior author.

Testimony of David Nichols, New Jersey Board of Public Utilities. Pre-filed testimony on demand-side management cost recovery in a Public Service Electric & Gas Company matter that was settled. Prepared for the Division of the Ratepayer Advocate. Tellus Institute Study 01-109.

2001: **"Load Response: New, or Déjà Vu?"** in *Electricity Journal*, vol. 14, no. 4, May. Co-author.

An Economic Analysis of Achievable New Demand-Side Management Opportunities in Utah. Prepared for the System Benefits Charge Stakeholder Advisory Group to the Utah Public Service Commission. Tellus Study 00-076. Principal author.

"The Role of Regulators in Promoting Energy Efficiency and Renewable Technologies," in *Pace Environmental Law Review*, vol. 18, no. 2.

2000: **Measuring Results from Climate Change Programs: Performance Indicators for GEF.** Global Environmental Facility Monitoring and Evaluation Working Paper 4. Co-author.

Institutional and Governance Issues V.1: Planning Approaches. A Thematic Review published by the World Commission on Dams. Principal author.

Best Practices Guide: Integrated Resource Planning for Electricity. US Agency for International Development and the Institute of International Education, Washington, D.C. Co-author.

Paper, "What's A Policy Maker To Do?" Western Regional Air Partnership Air Pollution Prevention Forum, Scoping of Energy Efficiency. San Francisco, May.

Paper, "State Renewable Energy Policies." Spring 2000 Conference of the National Pollution Prevention Roundtable.

Reducing Peak Demands Through Customer-Side Initiatives. Report to Citizens Utility Board, Chicago. Tellus Study 00-061. Senior author.

1999: **Regulatory Incentives for Demand-Side Management.** Report to the West Kootenay Power Company Demand-Side Management Committee. Tellus Study 98-211.

Funding for Energy-Related Public Benefits: Needs and Opportunities With and Without Restructuring. Report to the Colorado Governor's Office of Energy Management and Conservation. Senior Author. Tellus Study 98-002.

Support for Energy-Related Public Benefits: Funding Approaches and Related Options. Report to the American Council for an Energy-Efficient Economy. Tellus Study 99-017. Senior author.

Development of Climate Change Program Performance Indicators. Report to the Global Environmental Facility. Senior author. Tellus Study 98-222.

Paper, "Environmental Benefits of Low-Income Weatherization," in Evaluation in Transition: Working in a Competitive Energy Industry Environment. Proceedings of 1999 International Energy Program Evaluation Conference, pp. 427-434. Co-author.

Paper, "Auditing Performance in a 'Standard Offer' Efficiency Program," in Evaluation in Transition. Proceedings of the 1999 International Energy Program Evaluation Conference, pp. 649-656. Co-author.

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List of publications & papers prior to 1990 available upon request.

OTHER PROFESSIONAL ACTIVITY

2007 — Consultant to Nova Scotia Utility and Review Board for Nova Scotia Power's electric integrated resource planning process.

2001-2007 — Technical consultant to the Rhode Island Department of Environmental Management for the state's greenhouse gas process and *Climate Change Action Plan.*

1996-2007 — Consultant to the New Jersey Division of Rate Counsel for:
- New Jersey Clean Energy Council;
- New Jersey Energy Master Plan;
- Governor's Renewable Energy Task Force;
- comments on draft electricity & gas restructuring legislation;
- advice to Consumer Protection Task Force (restructuring issues);
- evaluation of off-tariff rate agreements; and
- evaluation of gas and electric utilities' DSM cost recovery.

1994-99; 2004-5 — Consultant to Enbridge Gas Distribution Inc. (Ontario) for development and implementation of natural gas demand-side energy efficiency plans and programs.

2004-5 — Consultant to Enbridge Gas - New Brunswick for development of an electric demand-side energy efficiency system for New Brunswick.

2002-3 — Consultant to the Western Regional Air Partnership for the Air Pollution Prevention Forum's *Final Report on Energy Efficiency and Renewable Energy* and supporting technical analyses.

2002 — Presentation to National Association of Energy Service Companies, Mid-Year Conference, Chicago.

2002 — Lead instructor, U.S. Agency for International Development (USAID) training courses in Electric Resource Planning and Demand-Side Management. Bangalore and Jaipur, India.

2002	Instructor, USAID training course in Integrated Resource Planning. Jakarta, Indonesia.
1999	Lead instructor, USAID training course in Electric Resource Planning at Tellus Institute, Boston.
1998	Presentation to the Advisory Committee on Resource Planning of the Québec Energy Board, Montreal.
1998	Panelist, Pollution Prevention & Energy Efficiency Training Session, Pollution Prevention Roundtable Conference, Cincinnati.
1996	Consultant to the Kentucky Attorney General—technical assistance on utility cost recovery for demand side management programs.
1995-1998	Consultant to Massachusetts Division of Energy Resources for development of policy, program and cost-effectiveness frameworks for gas utility demand-side management.
1995	Consultant to Nevada Office of Advocate for Customers of Public Utilities for assessment of Sierra Pacific Power integrated resource plan, docket 95-5001.
1994-98	Consultant to The Gas Company of Hawaii for development of DSM programs.
1992-95	Technical agent to the commissioners, District of Columbia Public Service Commission, Formal Case No. 917, phases I and II.
1993-4	Consultant to the Staff of the Arkansas Public Service Commission for review of the integrated resource plans of three electric utilities.
1993	Technical agent to the commissioners, D.C. Public Service Commission, Formal Case No. 929.
1992-93	Consultant to Ohio Office of Consumers' Counsel for training of staff and assessment of utility integrated resource plans.
1990-93	Consultant to Long Island Power Authority for implementation of conservation programs and participation in New York PSC cases 28223, 91-E-0382, and 92-E-0291.
1992	Consultant to Minnesota Office of Attorney General for assessment of Northern States Power integrated resource plan, docket E-002/RP-91-682.

1990-91	Consultant to Connecticut Municipal Electric Energy Co-operative. Commercial customer surveys, end-use data base development, and DSM option screening.
1990	Presenter, "Evaluating Residential Conservation Programs," at "Affordable Comfort IV" Conference, Philadelphia.
1990	Consultant to Wisconsin Gas Company: preparation and implementation of gas DSM bid.
1988-90	Independent representative on three-party panel administering Madison (Wisconsin) Gas & Electric Company conservation competition pilot program.

Other professional activity prior to 1990 available upon request.

Exhibit __ (DN-2)

HIGHER DSM INCENTIVES VS. TECO PROPOSED DSM INCENTIVES

TECO Program or Measure	**Utility Incentives as Percentage of Customer cost**		**Alternative vs. TECO**
	TECO	Alternative	Ratio
RESIDENTIAL			
Cooling -- efficient heat pump	26	50	1.9
Cooling -- duct repair	82	90	1.1
Shell -- ceiling insulation	20	50	2.5
Shell -- wall insulation	14	50	3.5
Shell -- windows upgrade	20	50	2.5
Shell -- window film	18	50	2.8
Residential new construction	27	50	2.2
Low income weatherization	100	100	1.0
COMMERCIAL/INDUSTRIAL			
Duct repair	31	50	1.6
Solar window film	18	50	2.8
Ceiling insulation	19	50	2.6
Wall insulation	21	50	2.4
Efficient motors	9	50	5.3
Cooling equipment -- direct expansion	20	50	2.5
Cooling equipment -- package terminal air conditioner	20	50	2.5
Cooling equipment -- chiller replacement	9	50	5.5
Lighting -- conditioned space	7	50	7.0
Lighting -- unconditioned space	7	50	7.0
Lighting -- occupancy sensor	2	20	9.6
Refrigeration (anti-condensate)	6	50	9.0
Efficient water heating	17	50	2.9
"Conservation Value" (custom measures)	13	40	3.2

Calculated from Appendix C of TECO Petition, Docket 070375-EG.
TECO incentives are rounded to the nearest whole percent.

Exhibit__(DN-3)
See attached document titled
Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands (June 2007)

DSM Achievements and Plans of Selected Utilities

Table 1
Annual Electric Energy Savings Realized Through DSM

Jurisdiction or Entity	Annual Savings %	Year(s)	Source
SDG&E (CA)	2.0	2005	SDG&E 2006, *Energy Efficiency Programs Annual Summary*
California	2.0	2001	ACEEE 2004 paper
Southern California Edison	1.7	2005	SCE 2006, *Energy Efficiency Annual Report*
Massachusetts Electric Co.	1.3	2005	MECo 2006, *2005 Energy Efficiency Annual Report Revisions*
Sacramento Municipal Utility District (CA)	1.2	1991 - 1996	Data provided by SMUD
Connecticut	1.1	2005	CT Energy Conservation Mgmt. Board, 2006
Vermont	1.0	2005	Summit Blue, *NSPI Inc.: DSM Report*, 2006
Western Mass. Electric Co.	1.0	1991 - 2001	MA Dept. of Telecommunications & Energy 2003, *Electric Utility Energy Efficiency Database*

Table 3
Actual and Projected Peak Load Reduction Through DSM

Type of Analysis	State/Utility	Period	Average Annual Peak Saving as % of Summer Peak Load	Source
Actual	CT	2003-05	1.5	CT ECMB
Projected (potential study)	CT	2003-12	1.3	GDS Associates 2004
Actual and projected	VT	2003-06	0.8	Efficiency Vermont
Projected (transmission study)	VT	2003-20	0.45	VELCO 2006
Projected (potential study)	New England	2004-2013	4. (2004-08) and 5.8 (2008-13)	Optimal Energy 2004
Projected (IRP)	Avista	2004–08	0.8	LBNL 2006*
Projected (IRP)	BC Hydro	2004–08	1.1	LBNL 2006
Projected (IRP)	PacifiCorp	2004–08	0.5	LBNL 2006
Projected (IRP)	PGE	2004–08	0.7	LBNL 2006
Projected (IRP)	PSCO	2004–08	1.0	LBNL 2006
Projected (IRP)	PSE	2004–08	1.4	LBNL 2006
Projected (IRP)	PG&E	2004–08	1.1	LBNL 2006
Projected (IRP)	SCE	2004–08	1.4	LBNL 2006
Projected (IRP)	SDG&E	2004–08	1.9	LBNL 2006
Projected (IRP)	Sierra Pacific	2004–08	0.5	LBNL 2006

*As reported in LBNL 2006, *Energy Efficiency in Western Utility Resource Plans*

DN-3

Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands

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June 2007

Report Number E072

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CONTENTS

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ABOUT THE AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY (ACEEE)

ACEEE is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. For more information, see http://www.aceee.org. ACEEE fulfills its mission by:

- Conducting in-depth technical and policy assessments
- Advising policymakers and program managers
- Working collaboratively with businesses, public interest groups, and other organizations
- Organizing conferences and workshops
- Publishing books, conference proceedings, and reports
- Educating consumers and businesses

Projects are carried out by staff and selected energy efficiency experts from universities, national laboratories, and the private sector. Collaboration is key to ACEEE's success. We collaborate on projects and initiatives with dozens of organizations including federal and state agencies, utilities, research institutions, businesses, and public interest groups.

ACEEE is not a membership organization. Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

EXECUTIVE SUMMARY

Florida is among the fastest growing states in the country, and the state's electricity demand is growing even faster than the state's population. To sustain this rapid economic and population growth, Florida needs to take action to meet the resulting increases in energy needs. A particular challenge is peak demand (those times when extreme heat or extreme cold crank up air conditioners and heaters), which is growing slightly faster in recent years than regular day-to-day electricity demand, and is the most expensive type of electricity.

Florida's unique energy vulnerabilities have also become apparent during the past several years. Florida is one of the most natural-gas-dependent states in the country, with more than a third of its electricity generated by natural gas. In December 2005, the natural gas "crisis" drove utility prices from less than $3 per thousand cubic foot to over $14, a price that hurt Floridians' pocketbooks. The pain intensified when Hurricane Katrina disrupted natural gas supplies and jeopardized electricity generation. While the price of natural gas has fallen over the past year, it still costs over two and a half times more than it did when many of the state's new natural gas power plants were planned. It is not the bargain we once thought. To meet the growing electricity needs, Florida's utilities project the need for both more natural-gas- and coal-powered plants.

Opportunities for Energy Efficiency and Renewable Energy

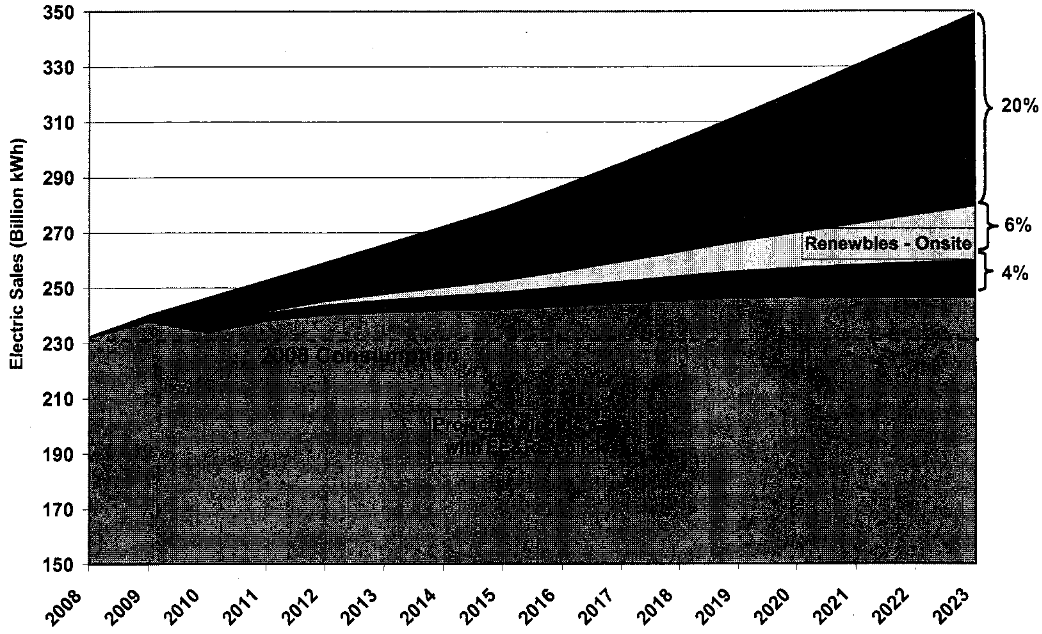
Fortunately, another suite of energy resource options is available—slowing energy demand growth with energy efficiency resources and demand response, and diversifying the supply resources with renewables. This report explores the magnitude of the efficiency and renewable resources that are available to the state, and suggests some specific policies that could be implemented to reduce future energy demands. If all the policies we recommend were implemented, the state could reduce its projected future use of electricity from conventional sources (i.e., natural gas, coal, oil, and nuclear fuels) by about 29% in the next 15 years (see Figure ES-1). Energy efficiency accounts for about two-thirds of the 2023 total 102,513 million kWh electricity reductions, with the renewable energy provisions accounting for the balance.

To make these energy efficiency and renewable energy resources a reality, we recommend eleven specific policies that the state should consider adopting:

1. Utility-Sector Energy Efficiency Policies and Programs (EERS)
2. Appliance and Equipment Standards
3. Building Energy Codes
4. Advanced Building Program
5. Improved Combined Heat and Power (CHP) Policies
6. Industrial Competitiveness Initiative
7. State and Municipal Buildings Program
8. Short-Term Public Education and Rate Incentives
9. Expanded Research, Development, and Demonstration Efforts
10. Renewable Portfolio Standard (RPS)
11. Onsite Renewables Program

Figure ES-1. Share of Future Electricity Consumption that Can Be Met with Energy Efficiency and Renewable Energy Resources

2023 Savings = 102,513 Million kWh



We believe these policies would establish a foundation upon which the state could build a sustainable energy future, while improving the state's economic health. The most significant energy efficiency recommendation is for a Utility-Sector Energy Efficiency Program, specifically an Energy Efficiency Resource Standard (a utility savings target similar to the RPS concept), which accounts for 30% of the total savings in 2023 (see Table ES-1). As would be anticipated because of the importance of buildings-related electric loads, buildings policies (including an improved building energy code and advanced buildings policies) would contribute another 19% toward the total electricity savings in 2023.

Our calculations show that these energy efficiency and renewable energy policies can also reduce peak demand for electricity by over 20,000 MW in 2023, or 32% of projected peak demand. In addition, we also recommend that the state consider implementing a robust demand response effort, which could reduce peak demand by an additional 4,353 MW in 2013 and 9,637 MW in 2023, or 9% and 15% of projected peak demand, respectively (see Figure ES-2). While the utilities in the state have had various curtailable tariffs for many years, there is much more that could be done to reduce peak electrical loads. Demand response programs combined with energy efficiency and renewable energy policies could slow the rapid growth in peak demand projected by the state's utilities.

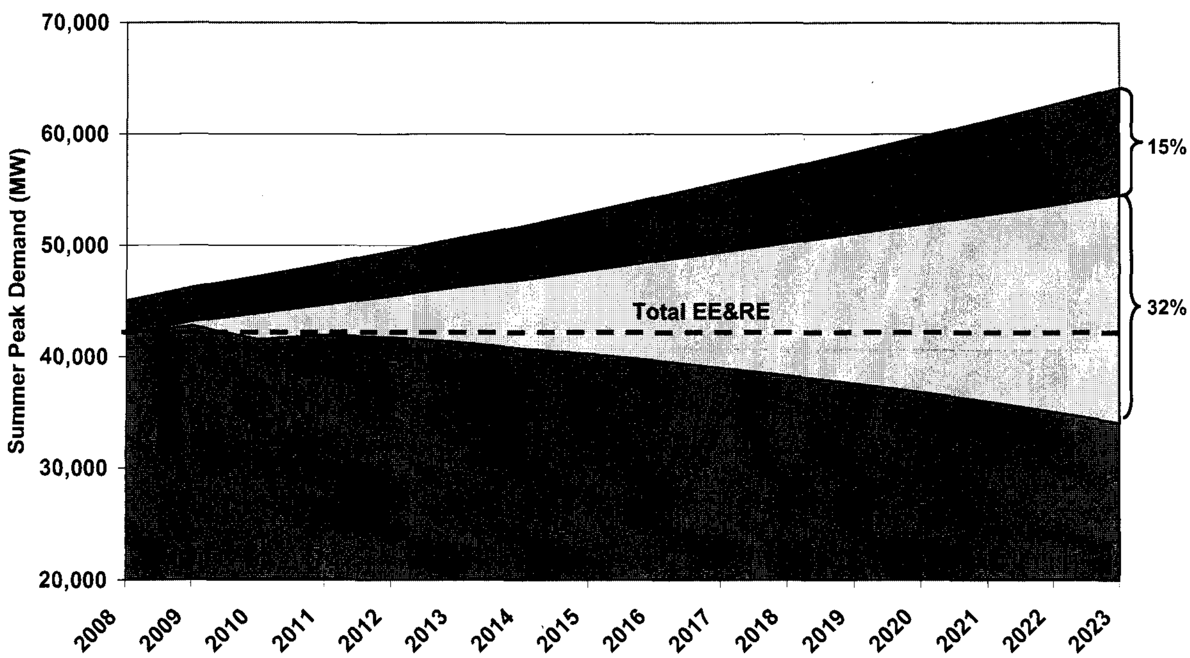
Our study asserts that energy efficiency, coupled with renewable energy, can slow future electricity demand. It would also diversify the state's energy resources, making Florida less vulnerable to global markets and volatile energy prices. The study shows that implementing energy efficiency policies alone (such as efficient windows, compact fluorescent light bulbs, and ENERGY STAR new homes and appliances) can almost offset the future growth in electric demand.

Table ES-1. Summary Results from Analysis of Recommended Policies

Annual Savings in 2013 and 2023

		2013		2023	
	Energy Efficiency (EE) Policies	**Electricity Savings (million kWh)**	**Demand Savings (MW)**	**Electricity Savings (million kWh)**	**Demand Savings (MW)**
1	Utility savings target	7,183	1,375	30,962	5,828
2	More stringent building codes	1,760	336	12,286	2,302
3	Public buildings program	1,536	293	4,608	847
4	Improved CHP policies	1,097	172	3,291	517
5	Short-term public ed. & rate incentives	4,582	873	3,549	653
6	Appliance & equipment standards	776	233	3,680	990
7	Advanced buildings program	458	336	7,503	2,302
8	Industrial competitiveness initiative	232	44	676	124
9	Expanded RD&D efforts	23	6	2,800	756
	Subtotal	*17,647*	*3,668*	*69,354*	*14,319*
	Renewable Energy (RE) Policies				
10	Onsite renewables policy package	2,542	486	20,183	3,775
11	Renewable portfolio standard	4,090	779	12,976	2,386
	Subtotal	*6,631*	*1,265*	*33,159*	*6,161*
	Total	**24,278**	**4,933**	**102,513**	**20,480**

Figure ES-2. Impact on Summer Peak Demand of Expanded Demand Response, Energy Efficiency, and Renewable Energy



Economic and Jobs Impacts

Increased investments in energy efficiency rather than construction of new conventional power generation would result in significant reduction in consumer energy expenditures over the next 15 years, while promoting robust job growth in the state (see Table ES-2). The energy efficiency policies would reduce consumer energy costs by over $28 billion relative to constructing new power plants, and would result in the creation of more than 14,000 new jobs—many trade jobs related to the implementation of the energy efficiency measures. The direct and indirect total jobs mean that the efficiency strategy would be equivalent to nearly 100 new manufacturing plants relocating to Florida, but without the demand for infrastructure and other energy needs. And, in light of recent volatility in energy prices, the efficiency strategy would have an added benefit of balancing the fuel supply and therefore stabilizing energy prices.

The state's environment would benefit as well, with reductions in conventional power plant operations reducing sulfur dioxide (SO_2) by more than 16 thousand tons and nitrogen oxides (NO_X) by almost 11 thousand tons. With concern growing about global warming, these efficiency measures would reduce carbon dioxide (CO_2) by over 37 million metric tons in 2023, making a down payment of reducing the state's carbon signature.

Table ES-2. Economic Impact on the State of Florida of Expanded Energy Efficiency

Financial Impacts (Millions of $2004)	**2008**	**2013**	**2018**	**2023**
Annual Consumer Outlays	1	1,585	2,172	2,584
Annual Electricity Savings	3	1,174	2,679	4,674
Electricity Supply Cost Adjustment	(1)	(894)	(1,867)	(2,975)
Net Consumer Savings	3	484	2,375	5,065
Net Cumulative Energy Savings	2	840	8,652	28,250
Macroeconomic Impacts	**2008**	**2013**	**2018**	**2023**
Jobs (Actual)	(33)	366	7,557	14,264
Wages (Million $2004)	(2)	(168)	(62)	64
GSP (Million $2004)	(4)	(1,134)	(1,857)	(2,745)
Estimate of Avoided Emissions *	**2008**	**2013**	**2018**	**2023**
SO_2 (thousand short tons)	0.0	5.9	10.8	16.3
NO_x (thousand short tons)	0.0	3.7	6.7	10.9
CO_2 (million metric tons)	0.0	11.1	21.8	37.1

* Note: Emissions are based on average emission rates.

Conclusions

Based on this analysis, we are confident that energy efficiency and renewable energy can change Florida's energy future for the better. Energy efficiency resource policies can offset the majority of projected load growth in the state over the next 15 years. Expanded development of renewable energy resources in the state would further reduce future needs for conventional generation. Combined, these policies can meet nearly 30% of projected needs for electricity in 2023, deferring the need for many new electric power generation projects in the state.

The economic savings from the recommended energy efficiency policies alone in this report can cut Florida consumers' electricity bills by about $840 million by 2013 and $28 billion by 2023. While these savings will require substantial investments, they cost less than the projected cost of electricity from conventional sources. In addition, the investments would save consumers money while creating new jobs for the state.

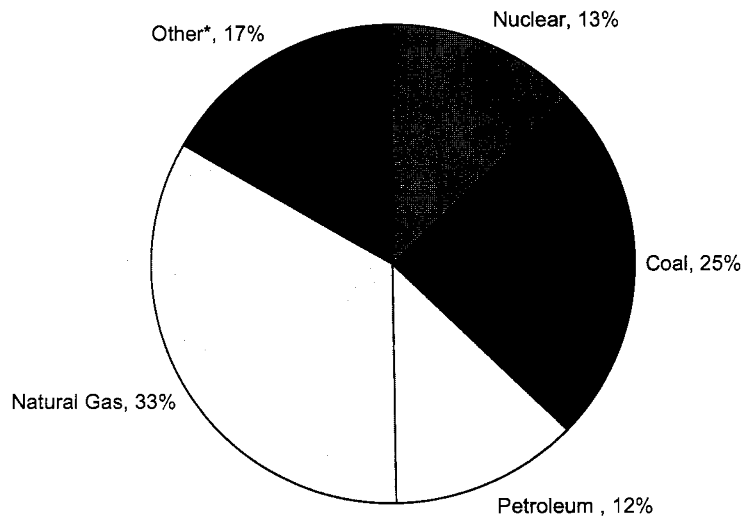
Reducing demand for electricity with efficiency and renewables will also reduce emissions from the combustion of fossil fuels at utility power plants, offering the state a more sustainable environmental future at an affordable cost and allowing the state to start on a path to reducing its global warming emissions.

Florida faces important decisions regarding its energy future. The current course calls for investments in new coal, gas, and potentially nuclear generation to make sure that the state has enough electricity to sustain its economic prosperity. Energy efficiency and renewable energy resources would offset some of that growth in demand, offering a lower cost, cleaner, and more stable energy path, without sacrificing Florida's quality of life or its economic growth.

INTRODUCTION

The past decade has seen fundamental shifts in national energy markets. Low prices and surplus capacity for both natural gas and electricity in the 1990s have been replaced by high natural gas prices and rising electric prices, resulting from tight natural gas markets and constraints in other generating fuels markets (Elliott 2006). Florida has been particularly hard hit by this shift because of its dependence on natural gas for electric power generation. The state generates 32.5% of its electricity (see Figure 1) from natural gas (FPSC 2006a), in contrast to a national average of 13.7% (EIA 2006a). By 2015, natural gas-fired electricity is expected to comprise 43.7% of Florida's generation mix (FPSC 2006a).

Figure 1. Florida 2005 Utility Energy Generation by Fuel Type (%)



* "Other" includes Non-Utility Generation (3.3%), Wholesale (7.1%), Hydro (0.1%), and Non-Specified (6.3%).

Tightening natural gas markets in the early years of this decade began to create problems for the state as rapidly growing demand for electricity exceeded deliverability of the natural gas supply system. The resulting market tightness has amplified natural gas price volatility (Elliott 2006). The hurricanes of 2005[5] were felt particularly strongly in Florida as disruptions in natural gas production and transmission imperiled temporarily electricity system reliability for the state. These problems have led to calls to diversify the state's fuel mix while adding new capacity to meet growing demand. The Florida Public Service Commission (FPSC) projects summer peak demand to grow at 2.39% per year and winter peak to grow at 2.36% annually over the next ten years (FPSC 2006a). This means that the state will need to find additional energy resources (Economy.com 2007).

According to FPSC, the utility industry's response to the challenge of meeting the growth has been to propose construction of about 10,500 MW of new natural gas and 5,200 MW of new coal capacity (FPSC 2006a). The FPSC has also called for greatly increased resource

[5] For more information, see Energy and Environmental Analysis, Inc. (2005) on the effect of the hurricanes.

commitments in fuel diversity, energy efficiency, demand response, and renewable generation (FPSC 2006a).

The state took some initial steps, as evidenced by the passage of the *2006 Florida Energy Act* (SB 888), that focused some attention on both renewable energy and energy efficiency as resource options, rather than relying on conventional power supply resources. The legislation established a solar rebate program, grant and tax credit opportunities, and a sales tax holiday for ENERGY STAR® appliance purchases. The Public Service Commission must review the state's need for new generation, and any proposed steam generator larger than 75 MW is subject to a Commission need determination; as part of that proceeding, the proposing utility must show that "all cost-effective conservation and demand-side management (DSM) opportunities have been exhausted in order to obtain a need determination order for new electric generating capacity" (FPSC 2006a).

Although total peak demand and energy saved by Florida's investor-owned utilities have increased over the past decade, total expenditures in DSM recovered by utilities fell steadily between 1995 and 2004. This occurred because Florida requires energy efficiency programs to meet a cost-effectiveness test, but declines in the capital and fuel costs of new generating units lowered the potential cost reduction benefits from deferring generating capacity. At the same time, changes in appliance standards and building codes to increase energy efficiency left less opportunity for utility-sponsored efficiency programs to make a substantive, cost-effective impact (FPSC 2006c). Recently, investor-owned utilities have filed significant new DSM plans, though the focus of the plans remains largely focused on demand reductions rather than energy savings as a result of the direction provided by the FPSC (IOU 2007).

Scope and Purpose of this Project

This report estimates the capacity for energy efficiency and renewable energy resources in Florida and suggests a suite of policy options that the state should consider to realize their achievable potential. As the report will show, energy efficiency resources are available at a fraction of the cost of new conventional generation, slowing the rate of energy demand growth while offering greater resource diversity and system reliability compared with construction of major new conventional generation. Expanded energy efficiency policies will also result in energy cost savings to consumers, creation of new jobs in the state as a result of the investments and substantial reduction in emissions from electric power generation. Expanded investment in renewable energy resources would reduce emission even more and place the state on the path for a sustainable energy future.

The remainder of this report is divided into five sections:

1. Overview of the reference case used for this analysis and how the results should be used;
2. An assessment of the economic potential for energy efficiency, combined heat and power, renewable energy, and demand response;
3. Suggestion of a portfolio of policy recommendations that could help realize the resource potential identified in the economic assessment, and projected impacts of these policies;

4. Suggestions on how these policies might be implemented in Florida; and
5. The assessment of the economic impacts of the suggested policies on the economy of the state, employment and consumer energy bills, and reduction in emissions.

Details on the analyses and assumptions are included in appendices along with the detailed results tables.

OVERVIEW OF ANALYSIS

Methodology

We approached this analytical effort by building upon other state resource potential analyses that ACEEE has undertaken over the past two decades. During these years, we have developed a general approach as follows:

1. We began the analysis by developing reference projections for electric consumption and demand, disaggregated by end-user category (e.g., residential, commercial, and industrial) based on available data, along with estimates of energy prices and utility avoided costs (as discussed in the next section).
2. We then assessed the potential for energy savings and demand reduction in each sector, based on available technology performance and cost.
3. We applied the savings projections to the reference case to estimate the impact that efficiency and renewable resources could have on the state's energy future.
4. We developed a set of policy proposals that have achieved results reliably in other states' energy markets, and we estimated the fraction of the potential savings that would be realized if these policies were implemented.

ACEEE's research has identified three general types of energy efficiency and renewable energy resource potential: technical, economic, and achievable.

- The technical potential represents what can be saved from available or emerging efficiency and renewable technologies and practices without considering the cost of the measures.
- The economic potential represents the fraction of the technical potential that is cost-effective under a set of technology costs and avoided costs developed for the analysis period.
- The achievable potential represents the fraction of the economic potential that can plausibly be realized in the marketplace given market constraints (e.g., equipment turnover rates) and the impacts of programs and policies that could be implemented. For purposes of this study, we have elected not to develop an entirely new set of technical potential data, because numerous studies conducted by ACEEE and others have largely characterized the potential measures that are available in Florida. This allowed us to focus on the more important economic potential and achievable potential estimates (see Nadel, Shipley, and Elliott 2004 for a more detailed discussion of these issues and past research).

With respect to the achievable potential estimates, we have relied upon results from the best-practice programs and policies that have been implemented in other states in recent years; these are discussed in the section on policy recommendations. While the economic potential reported here represents the overall size of the resource, for policy-making decisions, the appropriate focus should be on achievable potential results.

Energy Demand Reference Case

In order to determine energy efficiency potentials for Florida, it was first necessary to establish disaggregated reference case energy consumption and demand forecasts. There are currently no publicly available long-term energy consumption forecasts that include both statewide and end-use sector (residential, commercial, and industrial) breakdowns. We used short-term electricity sales and summer peak demand forecasts (through 2015) from the Florida Reliability Coordinating Council (FRCC) and applied an average growth rate to project to the year 2023 (FRCC 2006) (see Tables 1 and 2). For electricity consumption data, we used FRCC's total and end-use sector data, which accounts for conservation in each sector. For peak demand forecast, we used FRCC's "Summer Net Firm Peak Demand," which accounts for demand reduction from conservation and load management. Sector-specific forecasts of peak summer demand, however, were not included in FRCC data.

We also used publicly available data from the U.S. Department of Energy's Energy Information Administration (EIA) and purchased data from economy.com for other economic information to produce sector-specific data for the electricity consumption reference case forecast.

Table 1. Florida Reference Case Electricity Consumption Forecast by End-Use Sector

	Million kWh			2008–2023
Sector	**2008**	**2013**	**2023**	**Average Growth Rate**
Electricity Consumption—All Sectors (million kWh)*	232,396	265,566	349,059	2.8%
Residential	120,011	137,401	179,259	2.7%
Commercial	83,456	96,572	131,960	3.1%
Industrial[+]	22,541	24,306	31,412	2.2%
Peak Summer Demand—All Sectors (MW)	45,029	50,611	64,184	2.4%

* Total electricity sales also include street and highway lighting and unspecified "other" sales, which are not specified here.
[+] Note that the FRCC estimates for industry are used for the policy estimates, but that a more detailed disaggregated forecast discussed below is used for the economic analysis.

Figure 2. Reference Forecast for Electricity Consumption by Sector

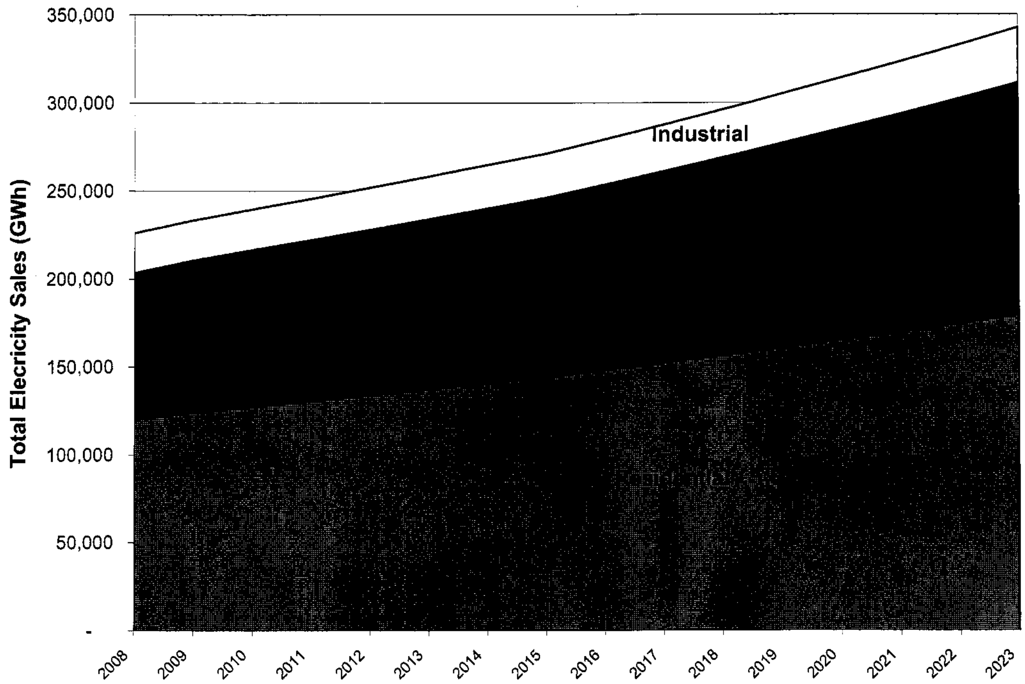
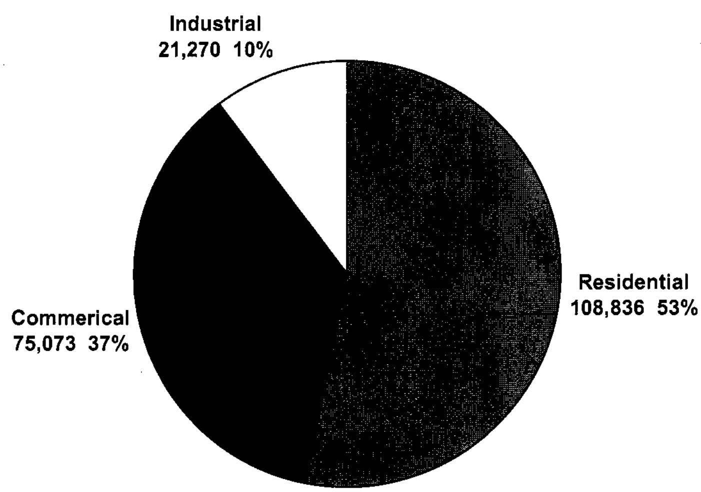


Figure 3. 2005 Florida Electricity Consumption (Million kWh)



Source: FRCC 2006

Industrial Sector

Comprehensive, highly disaggregated electricity data for the industrial sector is not available in the state-level FRCC forecast. To estimate the electricity consumption, this study drew upon a number of resources, all using the same classification system[6] and sample methodology. Fortunately, a conjunction of the various economic censuses for each state allows us to use a common base year of 2002. The major data source available for Florida was *2002 Economic Census Subject Series for Mining and Manufacturing* (Census 2006).

Unfortunately, disaggregated state-level electricity consumption data was not reported for the sub-sectors (such as chemical, paper, primary metals industries, etc.). Because of the magnitude and diversity in this manufacturing sub-sector, it is important to disaggregate beyond the sub-sector or industry group level (e.g., the fraction of pharmaceutical products in the chemicals industry). As a result, we used national industry electricity intensities derived from industry group electricity consumption data reported in the *2002 Manufacturing Energy Consumption Survey* (MECS) (EIA 2005) and the value of shipments data reported in the *2002 Annual Survey of Manufacturing* (ASM) (Census 2005). These intensities were then applied to the value of shipments data for the manufacturing energy groups (three-digit NAICS) in Florida. These electricity consumption estimates were then used to characterize each sub-sector's share of the industrial sector electricity consumption.

Because state-level disaggregated economic growth projections are not publicly available, data was used from the *Annual Energy Outlook 2006* (AEO) (EIA 2006b). The growth rate of industrial electricity consumption from the 2006 AEO was applied to the base year (2002) disaggregated electricity consumption. These values were then calibrated to the 2005 industrial electric sales as stated in the 2005 *Electric Power Annual* (EIA 2006c).

ECONOMIC POTENTIAL: COST-EFFECTIVE ENERGY SAVINGS FROM EFFICIENCY AND RENEWABLE ENERGY

As noted above, the economic potential represents an assessment of the overall resource potential that exists from energy efficiency and renewable energy, given an assessment of full benefits and full costs. In this section, we evaluate energy resources that are cost-effective, i.e., the dollar savings from reduced energy consumption or demand outweighs implementation costs to the customer. In general, experience with actual programs suggests that only a portion of this is realistically achievable in the real world from programs and policies (see Nadel, Shipley, and Elliott 2004). In the next section, we explore the fraction of this economic resource potential that can be realistically achieved through a suite of suggested policies, limiting our analysis to full policy and investment costs, but only direct electricity bill impacts or savings. This analysis does not take into consideration any externalities, such as avoided emissions, avoided future carbon control risks, health implications, or other indirect benefits of this deployment of these resources. If these costs were included, energy efficiency and renewable energy resources would be even more cost competitive with conventional fossil-fueled generation.

[6] ACEEE's industrial analyses use the North American Industrial Classification System (NAICS) to disaggregate industrial sector economic activity and energy use.

Residential Efficiency

In 2005, Florida's residential sector consumed about 50% of the state's electricity use. There is a large potential for cost-effective electricity savings in the state from energy efficiency improvements in both existing and new homes. To estimate this potential for homes in Florida, detailed building energy use analysis was conducted for both new and existing residential buildings. The analyses were conducted using the EnergyGauge® software suite.[7] This software suite uses the DOE-2.1E building energy simulation engine, with simulation enhancements and a user-friendly front-end and report preparation functions written by the Florida Solar Energy Center (FSEC), to simulate energy use.

Baseline homes were created for both existing and new building prototypes and then efficiency improvement measures for these baselines were compared on a measure-by-measure basis to determine the energy and demand savings potential for each measure. For residential buildings, a table of costs was prepared using a combination of the R.S. Means database (RSMeans 2005) and the best judgment and experience of the authors. The detailed cost data used for this analysis are given in Appendix A.

For residential buildings, the existing baseline prototype was configured using a process that "calibrated" the home's characteristics against a large data set of monitored existing home energy end-use characteristics that were measured in central Florida homes (Parker 2002). For new homes, the baseline prototype was configured to reflect the minimum code compliance characteristics of the latest edition of the Florida Building Code, which became effective December 8, 2006. These new Florida building code requirements are closely aligned with the minimum requirements of the 2006 International Energy Conservation Code (IECC). The detailed characteristics of the new and existing baseline homes along with the individual efficiency improvements considered by the analysis are provided in Appendix A.

Using the simulated energy savings, the cost data, and a capital recovery discount rate of 4.5%, a levelized cost of conserved energy (CCE) was calculated for each efficiency measure (Meier, Wright, and Rosenfeld 1983). Using the CCE, sets of efficiency "packages" were then created by selecting non-competing single efficiency measures that produced CCEs of less than $0.11/kWh.[8] These packages were then simulated to determine the energy and demand savings and the levelized cost for each package. For new homes, an ENERGY STAR new home and a federal tax credit package were also created and analyzed by combining the most cost-effective efficiency measures from the measures list that qualified the homes for these programs. To estimate the statewide potential for energy savings in both existing and new homes, the savings from each package of efficiency measures were then applied to a percentage of homes to which the cost-effective measures would be applicable.

Existing homes can achieve significant energy savings through more efficient air conditioners, insulation improvements, and more efficient lighting and appliances. Efficiency measures in Package EH1 includes six replacement measures: SEER 15 air

[7] EnergyGauge is a registered trademark of the Florida Solar Energy Center. See http://energygauge.com/

[8] The cut-off of $0.11/kWh was selected as a reasonable value in light of the fact that the average retail residential cost of electricity in Florida is currently running at about $0.12/kWh.

conditioner and 9.0 HSPF heat pump; efficient air ducts (reducing air leakage from 10% to 3%); ceiling insulation improvement from R-18 to R-30; solar hot water system; 50% fluorescent lighting replacement; and programmable thermostats. At a levelized lifecycle cost of about $0.10 or less per kWh saved, homeowners can reduce electricity consumption by up to 28% by implementing these measures. We assume that 50% of homes can cost-effectively implement Package EH1 measures by 2023, for a total savings of 15,681 GWh statewide by 2023. Package EH2 achieves even greater savings: about 47% electricity savings per home at a cost of about $0.07 per kWh saved. In addition to the measures included in Package EH1, Package EH2 also includes the replacement of an old refrigerator with an ENERGY STAR unit, selection of ENERGY STAR ceiling fans, the replacement of a standard roof with a cool roof (high performance roofing materials), the replacement of regular windows with high-efficiency windows, and a change of wall color to white We assume that by 2023, 20% of homes can cost-effectively achieve Package 2 efficiency measures, resulting in statewide savings of 11,628 GWh.

New homes built in the 15-year period between 2008 and 2023 can achieve significant additional savings. A total of 30 new home measures and measure packages are analyzed by this study (see Figure 4 for cost and savings information for these measures). The acronyms and descriptions of the single measures and measure packages are given in Appendix Table A-1. New homes that achieve 50% savings of heating and cooling energy (or about 25% savings of total home energy use), which are currently eligible for a $2,000 federal tax credit, are achievable at a levelized cost of $0.03 per kWh saved when the tax credit is used. A second package reaches the Energy Star level of performance (15% savings) and results in a levelized cost of $0.06 per kWh saved. A third option for new homes is a more aggressive package of measures (Package NH1) that reaches 40% total energy savings at a cost of about $0.06–0.07 per home.

A high level of adoption of efficiency measures in new buildings is achievable through building energy codes. We assume that 50% of new homes in 2008 can meet the cost-effective ENERGY STAR specifications and that new Florida building codes mandating 15% savings above today's code go into effect in 2009, resulting in savings of 5,764 GWh by 2023. We assume that 50% of new homes built between 2008 and 2023 can achieve the Tax credit eligible homes level of savings, resulting in additional savings of about 3,894 GWh. We assume that 10% of new homes can achieve the Package NH1 savings cost-effectively, resulting in an additional 838 GWh of electricity savings by 2023. Using these assumptions, we estimate that there is an economic potential (i.e., potential for cost-effective energy efficiency measures) of 40,293 GWh statewide electricity savings by 2023, or 22% of the projected electricity consumption of 179,259 GWh in the same year. See Table 2 for the breakdown of potential savings.

Figure 4. Annual Energy Savings and Levelized Cost of Conserved Energy for Energy Savings Measures and Packages for New Homes in South Florida (Miami)

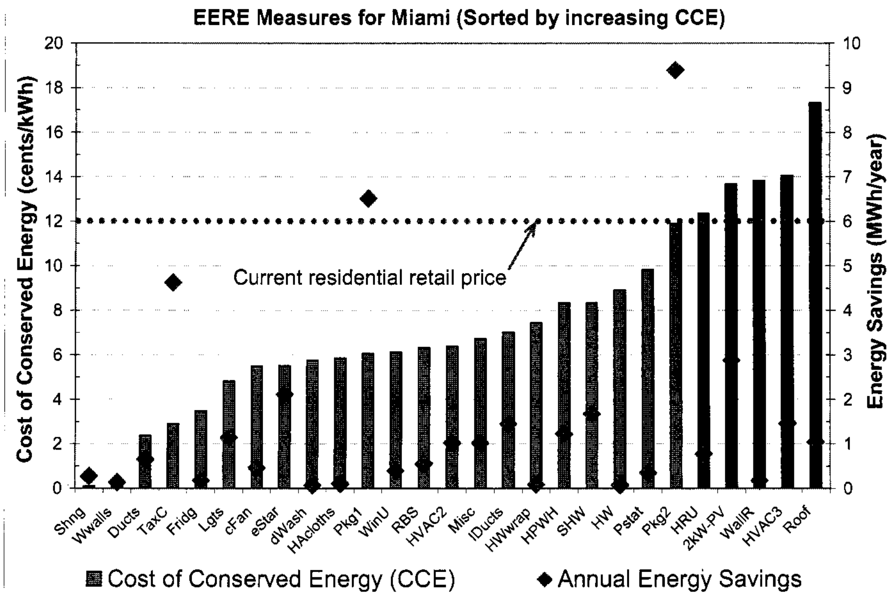


Table 2. Residential Energy Efficiency Measures

Existing Homes Efficiency Measures	kWh Saved per Home per Year (Statewide Average)	2023 Statewide Savings (GWh)	Economic Savings Potential (% of Total Residential Electricity Potential)	Cost per kWh Saved
Package EH1	*3504*	*15,681*	*39%*	*$ 0.10*
High-efficiency air conditioner (SEER-15; HSPF-9)	977			$ 0.09
Ducts: Normalized leakage 0.10 to 0.03	589			$ 0.08
Ceiling insulation: R-18 to R-30	560			$ 0.06
Solar hot water system	1780			$ 0.08
50% fluorescent lighting replacement	803			$ 0.06
Programmable thermostat with 2°F setup/setback	403			$ 0.08
Package EH2[a]	*6,497*	*11,628*	*29%*	*$ 0.07*
Cool roof	353			$ 0.00
ENERGY STAR refrigerator	157			$ 0.04
ENERGY STAR ceiling fans	560			$ 0.03
Miscellaneous load reduction (30%)	717			$ 0.09
Window replacement (U=0.39: SHGC=0.40 vinyl)	1257			$ 0.04
White walls (alpha = 0.40)	233			$ 0.00
New Construction				
ENERGY STAR Home (15% savings)	*2,021*	*8,252*	*20%*	*$ 0.06*
Tax Credit Eligible Home (25% savings)[b]	*1,857*	*3,894*	*10%*	*$ 0.03*
Package NH1 (40% savings)[c]	*1,998*	*838*	*2%*	*$ 0.07*
Total Savings (GWh)		**40,293**	**100%**	**$ 0.056**
% Savings (% of 2023 Projected Sales)		**22%**		

[a] Package EH2 efficiency measures also include all measures in Package EH1.
[b] Savings are incremental to ENERGY STAR Homes.
[c] Savings are incremental to both ENERGY STAR homes and Tax Credit Eligible Homes.

Commercial Efficiency

In 2005, Florida's commercial sector consumed about 40% of the state's electricity use. To estimate the potential for energy efficiency in commercial buildings in Florida, we defined baseline characteristics of the existing and new commercial buildings stock and then analyzed cost-effective packages of efficiency improvements in eight prototypical building types. We used the 1993 vintage Florida code requirements to define the baseline characteristics of the existing commercial building stock and the 2006 version of Florida's code to define the baseline characteristics of new commercial buildings. The 1993 vintage Florida code is equivalent to ASHRAE Standard 90.1-1989 and the 2006 version of the Florida code is equivalent to ASHRAE Standard 90.1-2004.

A total of eight commercial building types were simulated and analyzed by this study. These prototypes were developed by LBNL (Huang & Franconi 1999) based on the Commercial Buildings Energy Consumption Survey (EIA 1995). These prototypes represent building types, which cover 85% of the commercial building stock surveyed by CBECS. See Table 3 for a breakdown of potential savings by building type. The building types and sizes are:

- Large office (90,000 ft^2)
- Small office (6,600 ft^2)
- Large retail store (80,000 ft^2)
- Small retail store (6,400 ft^2)
- School (16,000 ft^2)
- Hospital (155,800 ft^2)
- Large hotel (250,000 ft^2)
- Restaurant (5,200 ft^2)

For the small existing building prototypes, the energy efficiency improvements included T-8 lighting retrofits and occupancy sensors, window film retrofit, cool roof retrofit, EER 12.5 air conditioning replacement, and variable speed drive blowers. For the large existing building prototypes, improvements included the same measures as for the small existing prototypes, except that chiller plant efficiency was improved to COP=4.7 rather that air conditioning replacement.

For the small new building prototypes, the energy efficiency improvements included improved wall and roof insulation (R-13 and R-30, respectively), a cool roof, daylighting and occupancy sensors, and high-efficiency cooling (EER-12.5) with variable speed drive blowers. For the large new building prototypes, the measures were the same except that the chiller plant efficiency was improved to COP=6.0.

According to our analysis, the economic efficiency potential for the commercial sector is roughly 30%, or 39,495 GWh, by 2023. The majority of the savings come from energy efficiency improvements in existing buildings (20,765 GWh), while significant additional savings can be achieved through advanced new buildings (18,730 GWh). See Table 3 for a breakdown of savings by building type and Appendix Tables A-11s and A-11b for more detailed efficiency measure savings information by region.

Table 3. Economic Potential for Energy Efficiency in Commercial Buildings

Existing Building Measure Savings	**Sm. Office** kWh/yr	**Lg Office** kWh/yr	**Lg. Hotel** kWh/yr	**Sm. Retail** kWh/yr	**Lg. Retail** kWh/yr	**Restaurant** kWh/yr	**School** kWh/yr	**Hospital** kWh/yr
Baseline Energy Use:	87,468	1,544,634	4,694,226	114,970	1,564,765	275,782	176,372	8,991,263
Roof Absorptivity	1,865	6,388	5,315	1,827	14,837	3,038	2,340	7,863
Window Shading Coefficient	3,365	108,195	234,397	6,542	31,495	4,362	7,159	91,310
Lighting Watts per SF*	14,135	176,429	571,484	18,094	271,341	31,969	25,056	935,102
Cooling System EER=12.5	10,054	n/a	n/a	14,454	n/a	22,702	n/a	n/a
Cooling Plant COP=4.7	n/a	81,700	283,843	n/a	68,284	n/a	10,858	458,080
Fan Watts per CFM (VSD fans)	n/a	41,019	110,832	n/a	34,090	n/a	3,691	205,024
Existing Buildings Package	27,378	388,518	942,976	37,708	394,513	58,560	46,230	1,622,504
Package savings (%)	31.3%	25.2%	20.1%	32.8%	25.2%	21.2%	26.2%	18.0%
New Building Measure Savings								
Baseline Energy Use:	60,318	1,121,008	3,484,331	90,149	1,431,837	241,115	119,957	8,795,278
R-Value of External Walls	4,138	36,722	76,250	1,610	11,876	5,270	1,617	33,940
R-Value of Roof	756	1,928	3,272	600	5,155	1,556	1,019	1,990
Roof Absorptivity	1,275	3,377	4,316	1,093	10,540	2,235	1,394	5,240
Lighting Watts per SF	11,514	197,810	552,650	31,855	536,599	56,402	23,130	1,727,534
Cooling System EER	5,790	n/a	n/a	8,165	n/a	13,336	n/a	n/a
Cooling Plant COP	n/a	104,292	386,938	n/a	133,476	n/a	14,488	921,319
Fan Watts per CFM (VSD)	n/a	72,712	242,729	n/a	94,020	n/a	9,126	632,462
New Package	21,630	319,091	957,498	41,355	643,377	75,046	42,837	2,526,488
Package savings (%)	35.9%	28.5%	27.5%	45.9%	44.9%	31.1%	35.7%	28.7%
Statewide Savings in 2023 (GWh)	GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Existing Buildings	4,098	3,293	3,045	2,869	2,205	2,434	1,457	1,362
Total Existing Buildings	*20,765 GWh, 16% of projected electricity sales in 2023*							
New Buildings	2,979	2,365	2,758	2,559	2,504	2,284	1,362	1,324
Total New Buildings	*18,730 GWh, 14% of projected electricity sales in 2023*							
Total Savings in 2023	***39,495 GWh, 30% of electricity sales in 2023***							

* Daylighting
** T-8 and Occupancy Sensors

Industrial Efficiency

In 2004, Florida's industrial sector consumed 19,518,051 MWh of electricity. Within the manufacturing sector, chemical manufacturing (NAICS 325) dominated at 18.4% of the electricity use, with phosphate fertilizer production the state's largest industrial electric energy user. Nonmetallic mineral products, food, paper, and computer and electronics followed at 12.7%, 9.8%, 9.7%, and 9.0%, respectively, of electricity use.

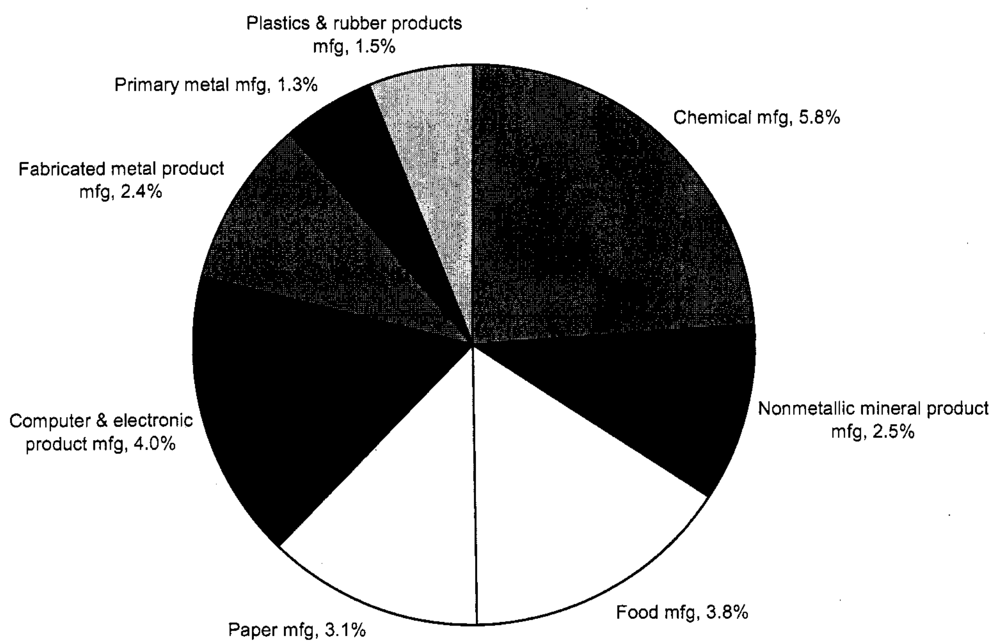
We accomplished our analysis of electricity savings potential in a series of steps. First, the project team characterized the industrial electricity market in Florida. Then energy-saving technologies were selected for analysis based on prior ACEEE analyses, and we estimated the economic potential based on these measures. Twenty-one distinct measures and measure bundles were analyzed (13 of which were cost-effective, with a cost of saved energy under $0.07/kWh saved) across 22 industrial sub-sectors for the Florida industrial sector. The measure bundles are presented in Table 4.

Table 4. Industrial Energy Efficiency Measure Bundles

Measure	Cost of Saved Energy ($/KWh saved)	Percent Savings Attributable to each Individual Measure	Economic Savings Potential (% of Total Industrial Electricity Potential)
Sensors and controls	0.02	1.4%	5.8%
Pipe insulation	0.065	4.1%	16.7%
Electric supply improvements	0.01	4.0%	16.5%
Lighting	0.03	3.4%	13.7%
Motor design	0.03	3.8%	15.6%
Motor management	0.02	0.7%	2.7%
Lubricants	—	0.6%	2.3%
Motor system optimization	0.01	0.4%	1.5%
Compressed air management	—	2.1%	8.6%
Compressed air—advanced	0.00	0.1%	0.4%
Pumps	0.01	2.9%	11.7%
Fans	0.03	0.7%	3.0%
Refrigeration	0.00	0.4%	1.4%
TOTAL		24.4%	100%

According to our analysis, the economic efficiency potential for the industrial sector is roughly 24%. The savings can be broken down by industry type as presented in Figure 5.

Figure 5. Fraction of Potential Savings by Industry Type



Combined Heat and Power Systems

Combined heat and power (CHP), also known as cogeneration, involves co-production of two or more usable energy outputs (e.g., electricity and steam) from a single fuel input. By harnessing much of the energy normally wasted in power-only generation, significant improvements in efficiency can be realized relative to separate production of power and thermal energy (see Elliott and Spurr 1999).

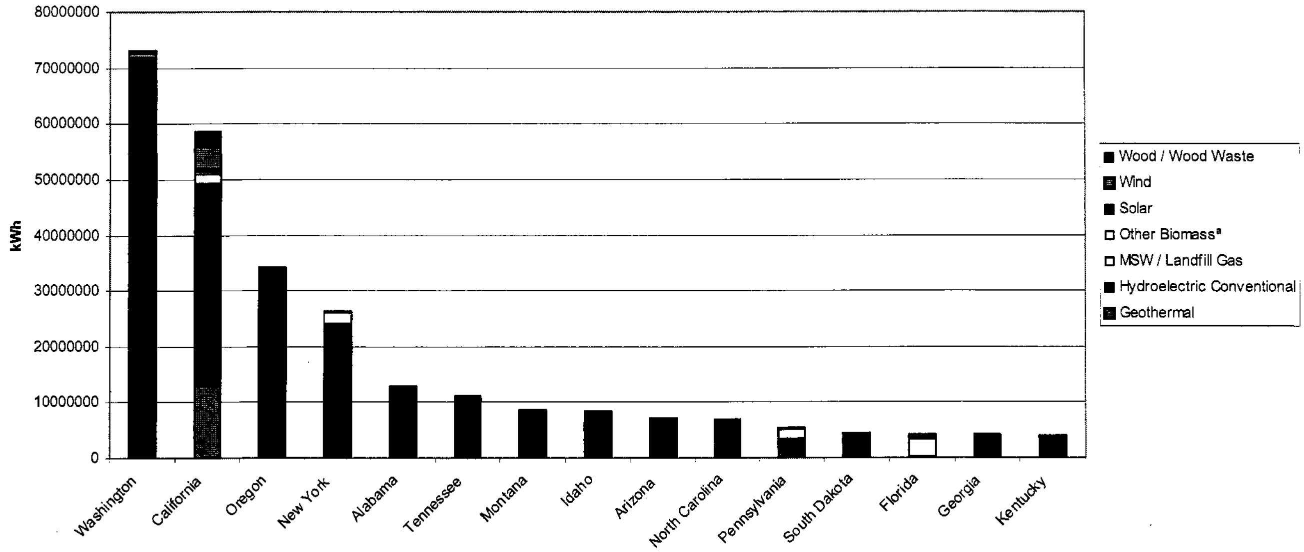
While Florida has some installed CHP, most of the capacity is PURPA QF, since utility policies have significantly discouraged expansion of this capacity (Brooks, Eldridge, and Elliott 2006; Davis 2007). The state also lacks standard retail interconnection policies, creating significant uncertainty and costs for potential Facilities considering installing CHP in the state. There are also no net metering rules where CHP is eligible (DSIRE 2007), which serves to severely limit the economic feasibility of any new projects. Although Florida is certainly not the only state where this is the case, the lack of net metering and uniform interconnection standards for CHP makes for a particularly harsh environment for the development of this important resource.

One important application of CHP is in the production of power and cooling through the use of thermally activated technologies such as absorption refrigeration. This application has the benefit of producing electricity to satisfy onsite power requirements and displacing electrically generated cooling, which both reduce demand for electricity from the grid, particularly at periods of peak demand (see Elliott and Spurr 1999). We estimate that a technical potential of almost 11,370 MW of additional CHP could be available in the state of Florida by 2023. If Florida's barriers to CHP adoption were to be effectively addressed, our analysis estimates that over 400 MW of additional CHP would be economically achievable at current fuel and electricity prices, without incentives, in 2023. Were incentives on the order of $600/kW provided for the installation of CHP systems (far less than the cost of any new generation technology), the economic potential would almost double. For details on estimation of the technical and economic potential for CHP, see Appendix A.

Renewable Resources in Florida

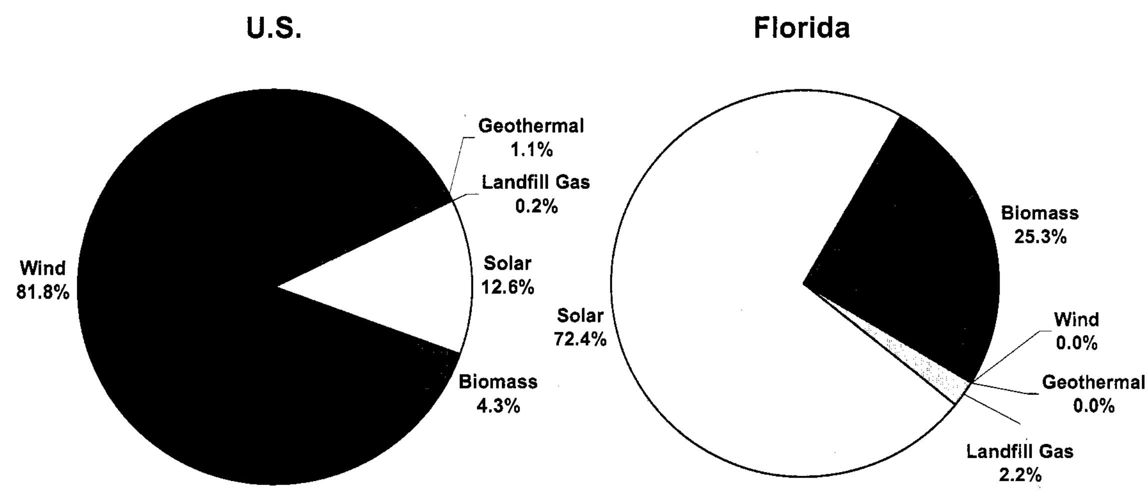
Florida ranks 13th among the states in installed renewable resources with the current base dominated by landfill gas and municipal solid waste (see Figure 6). Compared with other states, Florida is not particularly rich in renewable resources, with just 0.3% of the identified renewable resources in the United States. The available resources of about 57 Billion kWh would be able to only meet a quarter of the state's 2003 electricity need while the nation as a whole is estimated to have renewable resources of over five times its 2003 electricity need. As Figure 7 suggests, the absence of wind in Florida, which dominates the national resource, accounts for the majority of this difference (Deyette, Clemmer and Donavan 2003). Florida's resources are dominated by solar and biomass. This lack of wind resource is based on a late 1980s assessment, which may underestimate the potential based on current higher hub heights as well as significant offshore potential that were not considered in these assessments. Unfortunately, the National Renewable Energy Laboratory has not yet updated these assessments for Florida (Clemmer 2007). Individual renewable resource assessments from this study are presented in the appendices.

Figure 6. 2003 Renewable Energy Production in Florida



Source: Hartman 2007

Figure 7. Comparison between the Renewable Energy Resource Potential in Florida and U.S.



Source: Clemmer 2007

It is important that the state have a better understanding of the renewable resource available to the state, taking into account the advances in technology, particularly related to wind power, which may mean that the resources estimated here represent only a portion of the potential in fact available in the state. If the federal government is unwilling to commit the resources to complete the assessment, the state should consider funding the effort.

ACHIEVABLE POTENTIAL: ENERGY EFFICIENCY AND RENEWABLE ENERGY POLICIES

As noted in a report prepared for the Department of Community Affairs (FSEC 2004), there have been limited efforts to accelerate investment in energy efficiency and renewable energy in the past. In part this results from the FPSC's focus on demand reductions in their regulatory guidance to the utilities. As a result, there are many opportunities for policies to encourage savings. We recommend the consideration of eleven specific policies that will provide a significant turn on investment and put Florida on the path to true diversity and cost savings.

1. Utility-Sector Energy Efficiency Policies and Programs
2. Appliance and Equipment Standards
3. Building Energy Codes
4. Advanced Building Program
5. Improved CHP Policies
6. Industrial Competitiveness Initiative
7. State and Municipal Buildings Program
8. Short-Term Public Education and Rate Incentives
9. Expanded Research, Development, and Demonstration Efforts
10. Renewable Portfolio Standard (RPS)
11. Onsite Renewables Program

These policies would establish a foundation upon which the state could build a sustainable energy future, while bolstering the state's economic health. This report provides an overview of the impacts that could be achieved from these policies and then discusses each of the policies in greater detail.

In addition, we also recommend that the state consider implementing a robust demand response effort to curtail energy use during times of peak demand. While the utilities in the state have had various curtailable tariffs for many years, there is much more that could be done to reduce peak electrical loads, as will be discussed in a following section. Demand response programs combined with energy efficiency and renewable energy policies could significantly slow the rapid growth in peak demand reported by the state's utilities (FPSC 2006a).

Summary of Achievable Potential

If all the recommended policies were implemented, the state could meet nearly 30% of its projected electricity consumption in 15 years with energy efficiency and renewable energy, diversifying the state's generation mix and reducing the pressure on demand for conventional energy sources (i.e., natural gas, coal, oil, and nuclear fuels) (see Figure 8).

The benefits from the recommended policies regarding the state's energy supply can be seen in the near and long term: 24,278 million kWh in 2013 and 102,513 million kWh in 2023, or 9% and 29% of the state's projected electricity consumption in the same year, respectively (see Figure 8). As can be seen in Figure 9, a utility-sector energy efficiency program, for which we recommend an Energy Efficiency Resource Standard (EERS) (a utility savings target similar to the RPS concept), represents the largest contributor to the electricity potential at 30% of the 102,513 million kWh in 2023. Renewable energy policies, which include onsite renewables and an RPS, account for about 32% of the total 2023 electricity potential. As would be anticipated because of the importance of buildings-related electric loads, buildings policies (including an improved building energy code and advanced-buildings policies) contribute about 19% toward the total.

These policies can also reduce peak summer demand for electricity by 32%, not including demand resource programs discussed later in this report. The total impacts of each policy recommendation for 2013 and 2023 are presented in Table 5. The investments required and savings benefits from each policy recommendation are presented at the end of this section.

Figure 8. Impact of Energy Efficiency and Renewable Energy Policies on Florida Electricity Sales

2023 Savings = 102,513 Million kWh

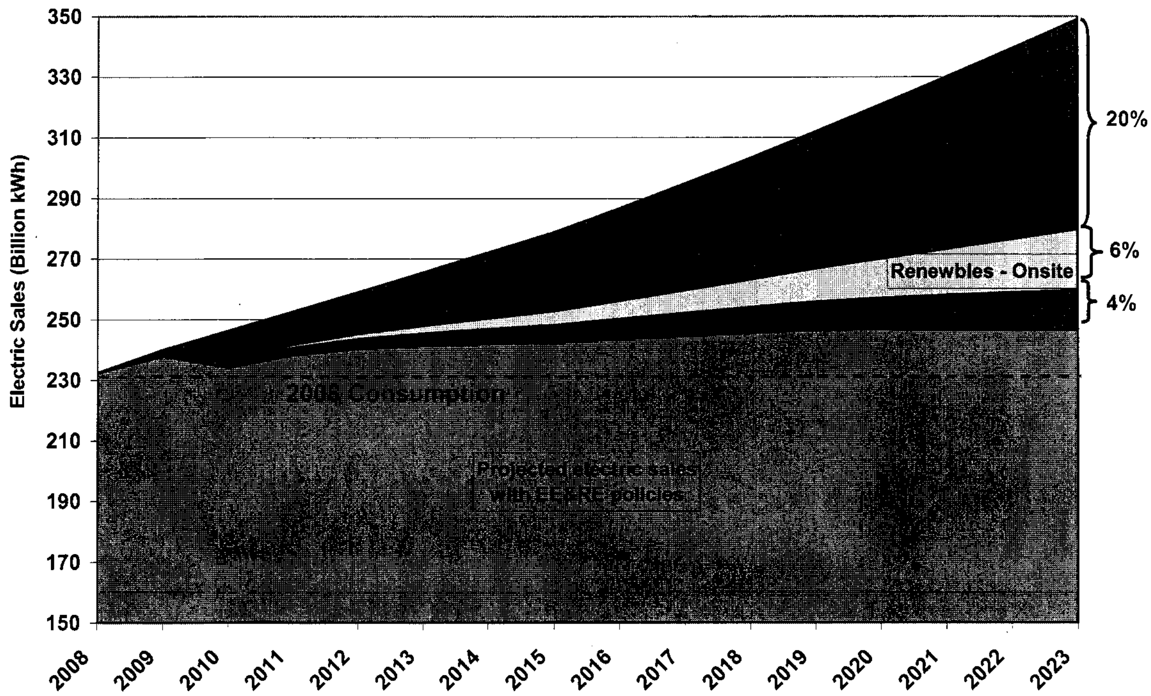


Figure 9. Electricity Savings from Policies in 2023
2023 Savings = 102,513 Million kWh

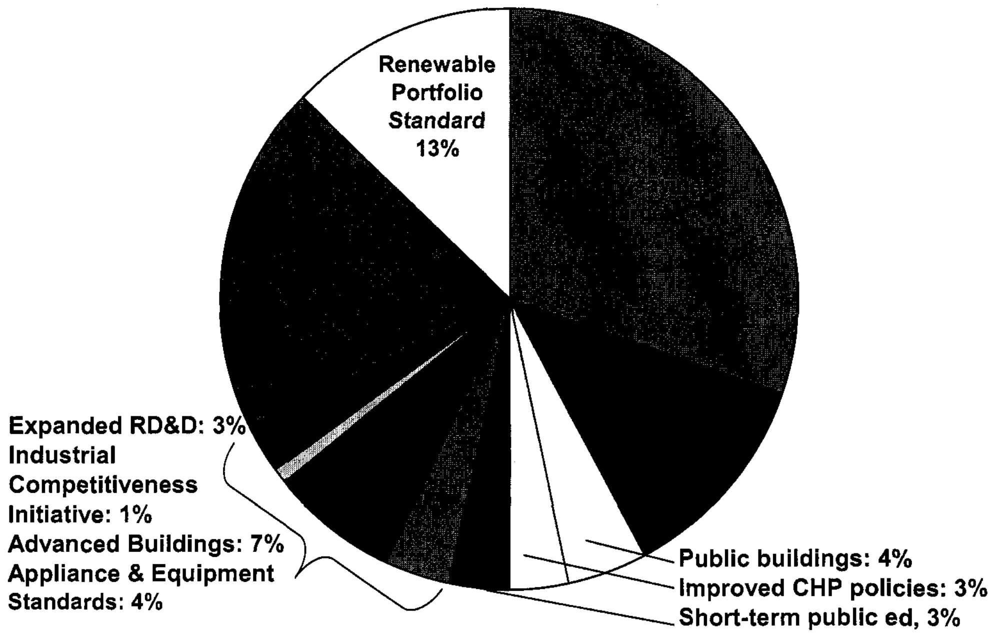


Table 5. Summary Results from Analysis of Recommended Policies

	2013		2023	
Energy Efficiency (EE) Policies	**Electricity Savings (million kWh)**	**Demand Savings (MW)**	**Electricity Savings (million kWh)**	**Demand Savings (MW)**
Utility savings target	7,183	1,375	30,962	5,828
More stringent building codes	1,760	336	12,286	2,302
Public buildings program	1,536	293	4,608	847
Improved CHP policies	1,097	172	3,291	517
Short-term public ed. & rate incentives	4,582	873	3,549	653
Appliance & equipment standards	776	233	3,680	990
Advanced building program	458	336	7,503	2,302
Industrial competitiveness initiative	232	44	676	124
Expanded RD&D efforts	23	6	2,800	756
Subtotal	*17,647*	*3,668*	*69,354*	*14,319*
Renewable Energy (RE) Policies				
Onsite renewables policy package	2,542	486	20,183	3,775
Renewable portfolio standard	4,090	779	12,976	2,386
Subtotal	*6,631*	*1,265*	*33,159*	*6,161*
Total	**24,278**	**4,933**	**102,513**	**20,480**

Description of Individual Policy Recommendations

Utility-Sector Energy Efficiency Policies and Programs

Florida's utilities focus on load management (shifting loads from peak to off-peak periods) as a result of the guidance and targets set by the FPSC, with less emphasis on energy efficiency (using less). In an analysis of 2004 energy efficiency expenditures by state, Florida ranked 19th among the 50 states. Comparing the increment from 2003 to 2004, energy savings achieved in Florida were higher in 2003 than in 2004, indicating that measures are wearing out quicker than they are being replaced in Florida utility energy efficiency programs (York and Kushler 2005, 2006). By comparison, in some leading states such as Vermont, California, and Connecticut, energy savings are growing by about 1% of sales each year from energy efficiency programs (Nadel 2006). While the investor-owned utilities have recently filed expanded DSM plans (IOU 2007), these efforts continue to focus on load management because of the FPSC direction. Given the energy problems facing Florida, there is an imperative for Florida to become a leader in this area. As a result, the regulatory framework for efficiency programs needs to be changed in the state, and the FPSC needs to refocus its guidance and targets for the utilities with a greater emphasis on energy efficiency.

A major reason for Florida's poor performance is that Florida still relies on the largely abandoned Rate Impact Measure (RIM) cost-effectiveness test. This test holds that if non-participating customers receive any rate increases from a program, no matter how small, the program is deemed not cost-effective, even if total system costs are reduced over the longer term. The RIM test is a very stringent test that few efficiency programs can pass as there are almost always some short-term rate impacts from efficiency programs. However, a non-participant in one year may be a participant the next year, and even chronic non-participants benefit from the fact that the long-term cost of electricity is lower because of the program. The RIM test has typically only been used for energy efficiency and has not been applied to other utility system expenditures, such as power plant resource decisions. If there were a RIM test for power plant construction, then only plants that reduce rates would be approved, few or no plants would be built, and electricity shortages could result. Energy efficiency should be considered an essential energy resource for Florida, just like new power plants. Most states recognize this and use either the Utility Cost (UC) test or the Total Resources Cost (TRC) test for assessing efficiency programs. In fact, a recent survey by ACEEE revealed that Florida was the only state among the more than 25 states with significant utility-sector energy efficiency programs that still places primary reliance on the RIM test (Kushler, York, and Witte 2006). In contrast, the other states rely on tests that compare the total costs of a program to the utility (UC), or the utility plus participating customer (TRC), with the avoided-cost benefits to the utility system of using less power. We recommend that the FPSC employ the TRC and/or UC tests as the primary vehicle(s) for assessing energy efficiency programs. If these tests were used, many more programs would be found to be cost-effective, much more energy would be saved, and total utility system costs would be reduced considerably.

In the U.S. today, three primary mechanisms are used as policies to guide utility energy efficiency efforts:

- **Traditional Demand-Side Management.** In a DSM framework, the utility plans specific programs and proposes these to the utility commission for approval. Under this approach, the level of efficiency spending and savings commonly varies from year to year depending on utility and utility commission interest in the programs. This approach was widely used in the 1980s and 1990s but is less common now.
- **Public Benefits Funds (PBF).** In a PBF framework, the legislature (or in some cases the utility commission) establishes a long-term level of funding for energy efficiency programs and the utility (or sometimes a statewide organization) plans a set of programs to optimize savings achieved within this budget. Typically funding levels are set in terms of tenths of a cent (mills) per kWh of sales. This approach is also commonly called a System Benefit Charge. This approach became popular in the late 1990s and early in this decade and is now in use in approximately 20 states (for a list, see Nadel 2006).
- **Energy Efficiency Resource Standards.** In an EERS framework, the legislature or utility commission establishes energy savings requirements and the utility develops programs to meet these goals at minimum cost. This approach is also commonly called an Energy Efficiency Performance Standard (EEPS). The advantages of this approach are that (1) the amount of savings achieved is known with some certainty and (2) the utility has an incentive to minimize costs per kWh saved. This approach has been gathering interest for the past few years. Currently, eight states have an EERS in place or in development, with more considering it. A detailed ACEEE report on this approach was published in early 2006 (Nadel 2006).

All three of these approaches could work in Florida. However, we recommend the EERS approach as the guiding framework because it has the greatest certainty of achieving energy savings goals at minimum cost. Specifically, we recommend that goals be set in 2007, that programs be planned and begun in 2008, and steadily increasing goals be in effect for 2009 and beyond. For example, goals could require electricity savings of 0.2% of sales in 2009, an additional 0.4% of sales in 2010, etc. until savings of 1% per year are being achieved. More modest goals are appropriate for gas sales (e.g., 0.1% savings in year one, 0.2% in year two, etc., rising to 0.5% savings in year five and thereafter). We used these targets to estimate savings for Florida.

Within an EERS framework, savings could be realized either through traditional DSM, with utilities funding and running the programs, or through a PBF approach, with a state funding mechanism and the choice of running the programs through utilities or other entities. Some states use a hybrid approach, such as California and Connecticut, where the EERS drives overall savings targets, and various mechanisms are used to implement the programs.

One other consideration for utility-sector programs is that for programs to be effective, the utilities running the programs need to be financially motivated for them to work. For a number of reasons related to ratemaking design, a successful utility energy efficiency program can often have a negative effect on utility profits. To address this problem, several states have adopted incentives for utilities that achieve energy savings goals, or have created other mechanisms to assure utilities that effective efficiency programs will not cut profits. More information about these approaches can be found in an ACEEE report published in late 2006 (Kushler, York, and Witte 2006).

Appliance and Equipment Standards

Appliance and equipment efficiency standards are mandatory efficiency requirements that products must meet for sale in a state or country. Efficiency levels are set that are both technically feasible and economically justified. Typically, standards eliminate the least efficient products from the market, while leaving consumers a wide array of products to choose from. Efficiency standards for more than 40 products are now in effect in the U.S. Typically, one or more states adopt a standard and then national standards are adopted by Congress or the U.S. Department of Energy (DOE). Most recently, this process played out in the federal *Energy Policy Act of 2005* in which Congress adopted new efficiency standards on 16 products. From our review of Florida utility forecasts, it appears the state has not yet factored these new standards into its forecasts and thus we estimate savings from these standards in our policy scenario and use them to adjust the reference case. Savings and costs associated with EPAct 2005 standards are not included in our results.

In addition to federally regulated products, there are a number of other products that individual states are starting to regulate. The following products may be appropriate for standards in Florida:

- Bottle-type water coolers
- Commercial hot food holding cabinets
- Compact audio products
- DVD players and recorders
- Metal halide lamp fixtures
- Portable electric spas (hot tubs)
- Residential pool pumps
- Single-voltage external AC to DC power supplies
- State-regulated incandescent reflector lamps
- Walk-in refrigerators and freezers

Eight states have already adopted standards on one or more of these products (AZ, CA, MA, NY, OR, RI, VT, and WA). More information on these products and specific standard recommendations can be found in an early 2006 ACEEE report (Nadel et al. 2006). This report is the source of our savings estimates for both the 2005 federal standards and new Florida state standards.

More Stringent Building Energy Codes

Florida recently updated its building code to reflect new commercial building lighting limits and to incorporate the new federal residential air conditioner efficiency standard (the inclusion of the SEER 13 air conditioner standard in the state's building code will significantly increase stringency). The likely next opportunity to upgrade the Florida code will come around 2010. At that time, upgrades to both the residential and commercial codes should be considered. For new homes, the code should be amended to require significantly increased whole-house energy efficiency, with the goal of increasing the whole-house efficiency by 30% by the 2010 code cycle. Using whole-house energy use, and perhaps the HERS Index methods, as the basis for these code changes will provide additional cost-effective solutions to builders, such as efficient lighting and appliances, which have not been available in codes up through the present. For commercial buildings, the national reference code is developed by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). It has recently announced an effort to update its code so that the 2010 version reduces energy use by 30% relative to the 2007 version. Florida should adopt this new code as soon as it becomes available. For our savings analysis, to be conservative, we assume 10% savings in new homes and 20% savings in new commercial buildings, starting in 2012.

Advanced Building Program

As discussed in the earlier section on buildings, there is the economic potential to reduce energy use in new Florida homes and commercial buildings by as much as 40% compared with 2007 code standards. New technologies should make 50% savings realistic in the next few years. If building codes in 2012 are updated to save 10–20%, this leaves an additional 20–40% savings still to be captured. One way to do this is to create an advanced building program that combines training and technical assistance for architects, engineers, and builders on ways to achieve these savings at modest cost, with financial incentives to help defray the extra costs, particularly on the first energy-efficient homes and buildings an architect or builder designs. The U.S. Department of Energy has developed many materials on how to reach these targets for new homes.[9] For commercial buildings, a good information source is the New Buildings Institute, which has a Web site on "Getting to Fifty" [percent savings].[10] Leveraging federal tax incentives can also be a key ingredient in an advanced building program. The Energy Policy Act of 2005 included $2,000/home tax credits to home builders and $1.80/square foot tax deductions for commercial building owners for each home or commercial building they build that uses 50% less energy than a new home or building designed to a national model reference code. An advanced building program for Florida should be run by an organization with extensive experience with advanced building design and construction techniques. Funding for such a program could come through the Florida state budget, or as part of the DSM programs currently operated by the state's utilities.

For our savings analysis, we assume 2.5% of new buildings participate in the first year, 5% in the second year, 10% in the third year, and so on until 50% are participating in the eleventh year. After 50% participation is reached, we assume that the Florida building code is upgraded to 30% above the current code, achieving 100% participation.

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[9] See http://www.eere.energy.gov/buildings/highperformance/

[10] See http://www.advancedbuildings.net/

Improved CHP Policies

There are several policies that could be implemented to improve the adoption rate of CHP in the state. The following bullets describe the current environment for CHP adoption in the state.

- In Florida, new grid-interconnected CHP projects (non-PURPA qualifying facilities) are illegal unless they are owned by a regulated utility.
- There are no statewide net metering rules, and no net metering rules anywhere where CHP is eligible (DSIRE 2007).
- The FPSC has adopted interconnection rules only for photovoltaic (PV) systems up to 10 kW. The rules apply to all IOUs in Florida, but not to municipal utilities or rural electric cooperatives (DSIRE 2007).
- In June 2006, a renewable energy production tax credit was established in Florida (SB 888) to encourage the development and expansion of renewable energy facilities in the state. This annual corporate tax credit is equal to $0.01/kWh of electricity produced and sold by the taxpayer to an unrelated party during a given tax year. CHP/cogeneration is eligible for this tax credit (DSIRE 2007).
- The Renewable Energy Technologies Grants Program was established in June 2006 (SB 888) to provide renewable energy matching grants for demonstration, commercialization, research, and development projects relating to renewable energy technologies. Eligible recipients (must be in-state) include municipalities and county governments, businesses, universities and colleges, utilities, not-for-profit organizations, and other qualified entities as determined by the Department of Environmental Protection (the program administrator). CHP/cogeneration is eligible for this program (DSIRE 2007).

We propose the following policy mechanisms for encouraging the adoption of CHP.

- Interconnection: Florida should allow non-utility-owned CHP systems to interconnect to the grid following IEEE standards. Interconnection should be fast and streamlined, especially for smaller units. The state should develop and disseminate "model" utility regulatory principles, tariffs, and legislative provisions for distributed energy generation and CHP projects.
- Permitting: Florida should modify its permitting language towards an output-based (i.e., lb/MWh) system. Credit should be given for both the electrical and thermal output of the system.

Two recent reports are available that can serve as resources as Florida considers specific policies (Banerjee 2006; EPA 2005).

Industrial Competitiveness Initiative

In contrast to other consuming sectors, the majority of the opportunities for energy efficiency in the manufacturing sector are site specific and related to the production and ancillary processes specific to an individual facility. As a result, prescriptive programs that offer rebates or other fixed forms of incentives are not particularly effective. Rather, programs that bring industry-specific expertise to manufacturing facilities to identify efficiency opportunities have proven effective. One long-running example is the Industrial Assessment Center (IAC) program run by the DOE that makes use of engineering university faculty and students to conduct audits of manufacturing facilities. These assessments have typically found over the past 25 years about 10% savings potential and achieved an implementation rate approaching 50% (Shipley, Elliott, and Hinge 2002; Shipley and Elliott 2006). Florida is blessed with two of these centers at the University of Florida and University of Miami (DOE 2007a). Some states, including Texas and New York, have supplemented federal funding for IACs in their states to expand the number of facilities that they can serve. We recommend that Florida follow suit.

More recently, the DOE has begun a new program called *Save Energy Now* (DOE 2007b). This program uses a network of industry energy experts to provide more extensive energy savings assessments of major manufacturing facilities. In the first year (calendar 2006), the program surveyed 200 facilities, finding an average of over 7% savings per facility with a payback of less than 2 years. The DOE has expressed an interest in partnering with states and utilities to make the network of expertise and tools available to a broader range of facilities across the country (Scheihing 2007). We recommend that Florida partner with DOE to make *Save Energy Now* assessments available to the state's manufacturers.

State and Municipal Buildings Program

State and municipal governments and school districts have large energy bills that strain budgets, but typically have limited access to capital or expertise to make major efficiency investments. Efficiency investments can reduce energy bills, freeing up taxpayer money. In addition, if government provides leadership by demonstrating these technologies, it will provide a useful example to the private sector. To address these opportunities, a major program to help state agencies, municipalities, and school districts identify and implement energy savings measures would be an excellent investment. We recommend that Florida establish a program based on the Texas LoanStar revolving loan program. In LoanStar, the state energy office set aside funds into a revolving loan fund to finance energy-saving improvements to public buildings. Funding was also provided to Texas A&M University to provide technical assistance.[11] We recommend the Florida legislature establish such a program. Our savings analysis assumes state and municipal buildings in Florida can achieve an average of about 15% energy savings, with about 50% of public buildings participating in the program (Haberl et al. 2002, Verdict 2006).

Short-Term Public Education

It will require several years before many of the other initiatives discussed in this report fully taken effect. So to jump-start efficiency in the state, we recommend that Florida consider undertaking a public education initiative to encourage energy-saving practices. This could be done through a wide array of media to promote calls by the governor for investments in energy efficiency and conservation. In 2001, California and other western states used such

[11] For information on the *LoanSTAR Revolving Loan Program,* see http://www.seco.cpa.state.tx.us/ls.htm.

programs to achieve substantial savings and help weather their energy crisis with minimum disruptions. For example, an evaluation of the California program found that it reduced energy use by 6.7% in the summer of 2001 and peak demand by about 11% relative to the year before (Global Energy Partners 2003). And significant benefit persisted for multiple years, especially as approximately 60 percent of the actions involved technology investments with a two-year payback. We use the California experience to project impacts in Florida, except that we conservatively assumed a Florida program is only half as effective (e.g., 3% energy savings and 5% peak demand savings). The California programs produced impressive near-term savings; however, these public action programs are by their nature of limited duration, being effective for a few years at best. While the direct impacts of these efforts may have limited longer-term impact, they can play an important role in sensitizing consumers to the efficiency message, enhancing the impacts of other programs.

Public education should also be an ongoing part of any long-term efficiency program suite. The states with the most effective programs typically invest in significant communications efforts, in which leaders including the governor appear prominently in public media. The value of leadership in this regard cannot be overstated.

Expanded Research, Development, and Demonstration (RD&D) Programs

Energy issues will confront Florida for many decades. To help address these issues, new technologies and practices need to be developed. Currently the utilities in the state have formed a consortium to pool research needs and funds. Also, the state of Florida through the Florida Technology, Research and Scholarship Board has established Centers of Excellence focused on particular technologies such as the Florida Atlantic University's Center of Excellence in Ocean Energy Technology and the University of Central Florida has the Florida Solar Energy Center. The state should look to expand its programs to similar levels as states such as New York, Wisconsin, Iowa, and California that have major RD&D programs to help develop these new technologies, with a focus on technologies that will address important local needs and help local businesses to develop products they can sell in and out of state.

For example, New York established the New York State Energy Research and Development Authority (NYSERDA), with an annual RD&D budget of $17 million per year. Since its inception in 1975, NYSERDA estimates that its RD&D program has helped develop products and services with sales of more than $65 million and with benefits (energy savings and other benefits) of more than $30 million. A total of 50 new products have been developed, including seven start-up companies. NYSERDA estimates that these projects together have produced more than 4,000 jobs in the state (Douglas 2007). Funding comes out of a very small surcharge on electric and gas rates enacted by the legislature and included in the state budget. Based on the New York program and relative population of the two states, an annual budget of no less than $16 million per year would be appropriate for Florida. We use this budget, and estimates of the savings of the New York program per dollar spent, to estimate savings for Florida. We would encourage the state to consider an even higher funding level at least for the near term to jump-start energy research in the state.

Renewable Portfolio Standard and Onsite Renewable Energy Policies

This section provides a brief overview of RPS and onsite renewable energy incentives, based on the estimates of the available renewable resources in the state as discussed above, and suggests specific policy recommendations that the state should consider that would expand the share of the state's future energy requirements met from renewables resources.[12]

According to the 2006 FPSC's 10-year site plan review, Florida's current renewable capacity represents 2.2% of present statewide capacity (56,914 MW) and 0.1 % of generation (FPSC 2006a). Adding the future renewable capacity projected by Florida's utilities results in a drop in the renewable energy generation share to 2.05% as total capacity requirements are projected to increase to 73,318 MW by 2015.

A report to the FPSC from the Renewable Energy Policy Project (REPP 2002) concluded that a cost comparison between photovoltaics and electric service costs per kilowatt-hour will be pivotal to how attractive consumers will see photovoltaics as an option. An analysis performed for this study indicates that with the current $2,000 federal tax credit and $4/peak watt Florida rebate, the levelized cost for a 2 kW residential photovoltaic array is $0.1367/kWh while Florida's typical residential retail rate is currently $0.12/kWh. A relatively small increase in electric rates would erase the remaining cost difference.

Twenty other states and the District of Columbia have mandated that utilities meet goals for renewable electricity, generally referred to as renewable portfolio standards. States define renewables differently, administer programs differently, and offer various incentives. Most of the states passed their RPS legislation under Republican governors. It is important to note that Colorado's RPS was enacted by a voter-initiated state ballot petition, overcoming considerable, well-funded utility opposition.

California set one of the highest RPS targets, meeting 20% of its electricity needs with eligible sources by 2017. A more recent state energy action plan has set the goal of accelerating this to 2010. California's utility commission has developed a process for verifying that targets are met—something the legislation was silent about. This process includes important steps for any successful renewable program:

- Establishing each utility's initial baseline
- Establishing an annual procurement target
- Approving or rejecting contracts executed to procure RPS-eligible electricity
- Determining whether the utility is in compliance with the commission's rules
- Imposing penalties for non-compliance [CEC_300-2006-002-CMF, Feb. 2006]

Most states have revised their utility interconnection and net-metering laws for small-scale systems to better accommodate and encourage onsite, grid-connected power sources.

[12] Details on Florida's current renewable production and the policies that other states have pursued in the realm of RPS are given in Appendix C.

Our cost analysis for an RPS assumes that about 49% of the renewable energy requirements will be generated from biomass, 49% from PV, and the remaining 2% from Land-fill gas (LFG) (Deyette et al. 2003). To estimate both the levelized and investment costs of the RPS requirements, we calculated a weighted average using this technology mix and projected cost estimates from *Assumptions to the Annual Energy Outlook 2007* (EIA 2006e).[13]

We recommend the following policies to support renewable energy development in Florida. As noted in the resource discussion, this resource estimate is conservative, so assuming a significant share of the resource can be realized over the next 15 years appears reasonable.

1. *Renewable Portfolio Standard*—The RPS should be designed to require utilities to generate or acquire 5% of their total electricity supply in 2023, after accounting for efficiency savings, from qualified renewable sources. This level of renewables would account for about 4% of the total identified potential from energy efficiency and renewable energy in 2023. Because of the dominance of the solar resource, it is anticipated that a significant share of the implemented renewables would be solar. The state should set penalties for missing a target in any tier in any year, at levels at least twice as large as the prevailing prices for qualifying resources in that year. Such funds should be used to increase incentives for renewables.

2. *Net Metering*—Florida should establish net metering laws that allow customer-owned, interconnected renewable energy systems to receive credit for electrical power supplied to the utility at full retail tariff value. This is typical practice for the many states with net metering and is an essential policy for making customer-owned solar electric systems attractive.

3. *Incentives for Onsite Solar*—Florida should provide incentive funding for customer-owned solar electric and solar thermal energy systems. Total funding should be provided starting at the current $2.5 million level, increasing to $10 million annually by 2010, $50 million annually by 2013, and $100 million annually by 2016, and should be maintained at the $100 million level through 2023. We estimate that these incentives would realize an additional 35% of the available renewable resource. The current commercial solar thermal cap shall be removed or increased to $100,000 to encourage large hot water users such as lodging, dormitories, and prisons to receive the benefit.

As shown in Table 5 above, the recommended renewable energy policy initiatives result in significant new energy resources to meet almost 10% of the state's 2023 energy requirements. The onsite solar incentives would meet 5.8% of the 2023 energy needs and the RPS would meet 3.7%. Combined, these two policy options offer over 33 billion kWh in cumulative energy resources and more than 6,000 MW in demand savings in 2023.

[13] Based on weighted averages, these costs are assumed be $0.157/kWh in 2008 and decline steadily to $0.116/kWh by 2023 as a result of greater technology advances and experience in the production of these systems.

Current Florida policy, while offering a substantial rebate of $4 per peak-watt for solar photovoltaic applications, has a very limited pool of funds to support this rebate. The fund for all onsite solar renewable applications (PV and solar hot water) is limited to $2.5 million per year; at this level, it would support typical 2 kW systems on only 300 homes per year. Unless this fund is substantially expanded—to the range of $100 million per year, Florida will not develop a competitive solar energy market that can compete with other states that have both aggressive RPS and well-funded PBF to support these standards. Unless this fund is substantially increased, Florida will fall far short of the policy goals for renewable solar energy that is supported by the analysis presented in this report. A recent poll finds that an overwhelming majority of Florida citizens supports investment in solar energy in Florida (90% of respondents) and also would support a one dollar charge on utility bills to finance the investment (78% of respondents) (Mason-Dixon 2007). About 40% of respondents who opposed the one dollar utility bill increase *would* support a charge of 50–99 cents. This evidence supports the creation of aggressive renewable energy standards and the PBF funds to support them.

INVESTMENTS, COSTS, AND BENEFITS OF POLICIES

If implemented, the policies detailed in this report will spur investments in energy efficiency and renewable energy that will result in energy expenditure savings to the consumers making these investments. Of the cumulative investments, a small portion would come from public programs and policies, with the majority coming from the private sector. In addition to the actual investments required to realize the savings, there will be costs associated with administrating these programs and policies as well as with the measurement and verification required to assure policymakers that Florida and its citizens are receiving the promised benefits. Table 6 presents the 2013 and 2023 cumulative investment and administrative costs for each of the policy measures, grouped by efficiency and renewables.

Table 6. Cumulative Investment and Administrative Costs

	Cumulative Cost from 2008 (Million $)			
	2013		2023	
Policy	**Investment Costs**	**Policy Costs**	**Investment Costs**	**Policy Costs**
Energy Efficiency				
Utility savings target	2,183	327	10,909	1,636
Appliance & equipment standards	186	2.2	651	10
More stringent building codes	682	44	4,226	634
Advanced building program	164	102	2,121	318
Public buildings program	194	29	2,917	438
Short-term public ed. & rate incentives	976	443	976	443
Expanded RD&D efforts	79	12	237	36
Improved CHP policies	102	5	306	15
Industrial competitiveness initiative	8	1	23	3
Efficiency Subtotal	4,574	965	22,366	3,533
Renewable Energy				
Renewable portfolio standard	13,659	6	99,930	22
Onsite renewables policy package	4,277	9	32,532	31
Renewable Subtotal	17,936	15	132,462	53
Total	**22,511**	**980**	**154,827**	**3,585**

As can be seen from Table 6, the renewable investment required is far greater than that required for efficiency. This required investment results in the levelized[14] cost of saved energy for renewables being an order of magnitude greater than the efficiency costs (see Table 7). This higher cost results from the apparently limited low-cost renewable energy resources in the state. As noted earlier, however, there is significant uncertainty in the renewable resource potential and cost projections. It is anticipated that an updated renewable resources study would identify additional low-cost resources, and therefore lower costs for the total renewable resource mix. There is additional uncertainty in future costs for renewable resources. As investments are made toward these resources, costs will likely come down.

[14] Levelized cost involves dividing a lump sum investment into equal payments over period of time. This costing approach is commonly used in utility ratemaking to allow the recovery of capital costs over time.

Table 7. Levelized Cost of Saved Energy

Policies	Total Investment including Prog. & Admin. Costs (Mill.$)	Total 2023 Savings (Mill. kWh	Levelized Cost of Saved Energy ($/kWh)*
Efficiency	25,898	69,354	0.035
Renewables	132,514	33,159	0.307
Total	158,412	102,513	0.144

* Assumes a 15-year measure life and 4.5% discount rate

It should be pointed out that the savings from many of the energy efficiency and renewable energy resource investments made during this analysis period will continue to return energy savings long after 2023, and the benefits of these savings are not captured in these benefit calculations. In addition, this analysis does not consider the impact of reduced natural gas consumption in the electric power sector—the state's major consumer—that would likely reduce prices of natural gas and electricity for all customers (see Elliott and Shipley 2005).

Environmental Impacts

In addition to the economic gains, the state's environment would benefit, with reductions in conventional power plant operations reducing SO_2 by more than 16 thousand tons and NO_X by nearly 11 thousand tons (see Table 8). In light of growing concern over global climate change, these efficiency measures would reduce CO_2 by over 37 million metric tons in 2023, making an important down payment toward reducing the state's carbon signature.

Table 8. Estimate of Avoided Air Emissions from Energy Efficiency Policies

Category of Pollutant*	2008	2013	2018	2023
SO_2 (thousand short tons)	0.0	5.9	10.8	16.3
NO_x (thousand short tons)	0.0	3.7	6.7	10.9
CO_2 (million metric tons)	0.0	11.1	21.8	37.1

* Note: Emissions are based on average emission rates.

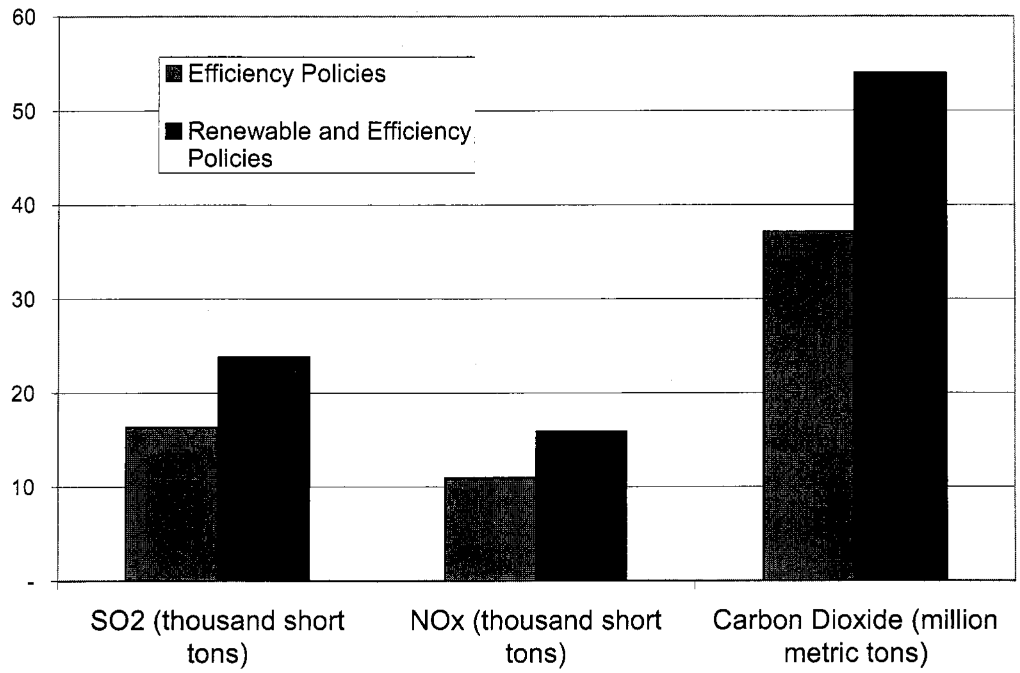
As would be expected, expanding the policies to include renewable energy as well as efficiency increases the emissions reductions by 47% relative to reductions from energy efficiency only when compared to the reference case (see Table 9 and Figure 10). These reductions represent an almost 30% reduction from the projected 2023 levels.

Table 9. Estimate of Avoided Air Emissions from Combined Energy Efficiency and Renewable Energy Policies

Category of Pollutant *	2008	2013	2018	2023
SO_2 (thousand short tons)	0.0	7.7	15.1	23.8
NO_x (thousand short tons)	0.0	4.8	9.4	15.9
CO_2 (million metric tons)	0.1	14.4	30.5	54.0

* Note: Emissions are based on average emission rates.

Figure 10. Avoided Emissions in 2023 from Efficiency Policies and Combined Renewable and Efficiency Policies



Macroeconomic Analysis: Impact of Policies on Florida's Economy, Employment, and Energy Prices

In this section of the report we evaluate these macroeconomic impacts of the energy efficiency policy recommendations. We have elected not to undertake an assessment of the combined renewable energy and energy efficiency policies because of the significant investment cost uncertainty that exists for renewable energy in Florida.

The recommended energy efficiency policies result in an increase in the number of new jobs and a substantial reduction in consumer energy expenditures. As noted earlier, this analysis understates the benefits of the investments in energy efficiency and renewable energy, however, because the analysis does not capture the full benefits that would accrue after the analysis period. Investments would continue to yield energy resource benefits for many years into the future. More appropriately, this period should be viewed as a transition in the Florida energy markets from a central generation model to a more distributed, sustainable energy market.

Methodology

In this economic evaluation we follow three steps. First, we calibrate an economic assessment model called DEEPER (Dynamic Energy Efficiency Policy Evaluation Routine) to reflect the economic profile of the Florida economy (Laitner 2007a) and also the anticipated investment patterns that are assumed in the reference case (e.g., construction of new electric power plants projected in the FRCC forecast). Second, we apply the set of key scenario results from the policy analysis above and transform them as inputs for the economic model. The resulting inputs include such things as:

1. The level of annual program spending that drives the policy scenario;
2. The electricity savings that result from the various energy efficiency policies or the level of alternative electricity generation from onsite renewable and combined heat and power technologies; and
3. The capital and operating costs associated with those technology investments.

Finally, we run the model to check both the logic and the internal consistency of the modeling results. See Appendix D for a detailed description of the economic model.

Impacts of Recommended Energy Efficiency Policies

The investment and savings data from the efficiency scenario were used to estimate three sets of impacts for the five-year periods of 2008, 2013, 2018, and 2023. For each benchmark year, each change in a sector's spending pattern for a given year—relative to the reference or business-as-usual scenario—was matched to the appropriate sectoral impact coefficient. These negative and positive changes were summed to generate a net result shown in the series of tables that follow.

Table 10 summarizes, for selected years, two sets of key changes in the Florida electricity production patterns that are driven by the energy efficiency policy initiatives outlined in the policy analysis. The table also summarizes the initial financial impacts from these two sets of changes as then estimated by the Investment and Spending module within the DEEPER model. It is this combined set of three financial impacts that are then further evaluated by DEEPER's macroeconomic module to estimate the larger net gains to the Florida economy.

Starting with very small impacts in 2008, the set of energy efficiency policies spur both program costs and technology investments that, in turn, begin to change the production patterns of electricity consumption and production. Program spending of $199 million in 2013 leverages $1,405 million or $1.4 billion in efficiency technology investments in that same year. The initial impacts on electricity production are quite small in 2008, reducing electricity demand by only 37 GWh. However, both program spending and technology investments rise to 281 and 1.9 billion dollars, respectively, by 2023. The cumulative impact of activities over the 15-year time horizon steadily reduces the demand for conventional electricity generation so that by 2023 energy efficiency displaces the forecasted electricity production by about 20%.

Table 10. Changes in Florida Electricity Production and Financial Impacts from Energy Efficiency Policy Scenario

	2008	2013	2018	2023
Implied Program Spending (Millions of 2004 Dollars)				
Annual Policy and Program Costs	0	199	240	281
Annual Technology Investments	1	1,405	1,677	1,948
Changes in Electricity Production Patterns				
Efficiency Gains (GWh)	37	17,647	40,135	69,354
Change from Reference Case	0.0%	6.6%	13.2%	19.9%
Financial Impacts (Millions of $2004)				
Annual Consumer Outlays	1	1,585	2,172	2,584
Annual Electricity Savings	3	1,174	2,679	4,674
Electricity Supply Cost Adjustment	(1)	(894)	(1,867)	(2,975)
Net Consumer Savings	3	484	2,375	5,065
Net Cumulative Energy Savings	2	840	8,652	28,250

As might be expected, the program spending and changed investment patterns have a distinct financial impact within Florida. The third set of information in Table 10 highlights the key financial impacts for the same years. For example, program costs and technology investments are only part of the expenditures paid by consumers (including both households and businesses). Notably, the utility customers will likely borrow money to pay for these investments. Thus, consumer outlays, estimated at $1 million in 2008 and rising to $2.6 billion in 2023, include actual "out-of-pocket" spending for programs and investments, but also money borrowed to underwrite the larger technology investments. Annual electricity savings is a function of reduced electricity purchases from the Florida utilities at the initial electricity prices in a given year. This starts with a savings of $3 million in 2008 and rises quickly to $4.7 billion in 2023.

The analysis also explored the impact of reduced consumption on electricity prices. Previous research has shown that in tight markets, small changes in energy demand can have large impacts on energy prices, particularly for natural gas (see Elliott and Shipley 2005; Elliott 2006). The changed electricity production patterns, including both reduced electricity demands and efficiency technology investments, forces a negative adjustment in the electricity supply costs (see Table 10) due to the lower capital and operating expenditures associated with the energy efficiency policy scenario. This means that efficiency policies actually reduce electricity costs to consumers starting with an estimated savings of $1 million in 2008 and rising to nearly $3 billion in 2023.

The category of net consumer savings shows consumers' total savings from both lower electricity consumption and lower costs, minus consumer outlays. In 2008, businesses and households save $3 million in reduced electricity consumption, $1 million in reduced electricity prices, and spend $1 million in outlays for a net savings of $3 million. As electricity savings increases and as costs further decline, the net consumer savings quickly rises to a net gain of about $484 million by 2013 and $5.1 billion by 2023. Cumulative net savings in the last row of Table 8 suggests a net gain to consumers of $28.3 billion by 2023.

With the set of program spending, investment changes, and financial impacts identified in Table 10, and given the other modeling assumptions described earlier in this section, the macroeconomic module of the DEEPER model then traces how each set of changes works or ripples its way through the Florida economy in each year of the assessment period. Table 11 summarizes the estimated change in sector spending within Florida, given the policy and program expenditures for the same benchmark years.

Table 11. Changes in Sector Spending (Millions of 2004 Dollars)

Sector	2008	2013	2018	2023
Agriculture	$0.0	$1.7	$12.0	$26.8
Oil and Gas Extraction	$0.1	$7.1	$107.2	$251.0
Coal Mining	$0.0	$0.0	$0.6	$1.5
Other Mining	$0.0	$0.1	$2.1	$5.0
Electric Utilities	-$3.6	-$2,049	-$4,500	-$7,572
Natural Gas Distribution	$0.0	$1.4	$6.0	$12.5
Construction	-$3.9	$10.3	$215.8	$284.8
Manufacturing	$0.5	$55.5	$428.3	$961.0
Wholesale Trade	$0.1	$17.0	$79.1	$167.5
Transportation, Other Public Utilities	$0.0	$8.7	$40.2	$85.0
Retail Trade	$0.2	$40.5	$187.1	$395.7
Services	$1.0	$184.1	$842.3	$1,778.6
Finance	$0.0	$54.8	$29.8	-$21.2
Government	$0.2	$164.2	$217.0	$278.6

Once each of the net sector spending changes has been evaluated for a given year, the DEEPER model then evaluates the sector-by-sector jobs and wages. It also evaluates their contribution to the state's GSP. Table 12 highlights the net impacts, again by the benchmark years.

Table 12. Net Economic Impacts for Benchmark Years

Category of Impact	2008	2013	2018	2023
Jobs (Actual)	-33	366	7,557	14,264
Wages (Million $2004)	-$2	-$168	-$62	$64
GSP (Million $2004)	$-4	-$1,134	-$1,857	-$2,745

The first of the three impacts evaluated here is the net contribution to the Florida employment base as measured by full-time jobs equivalent. In other words, once the gains and losses are sorted out in each year, the analysis provides the net annual employment benefit of the policies as they impact the larger Florida economy. In 2008, the impact starts small with a net loss of 33 jobs, rising to a net gain of 14,300 jobs. The second impact is the net gain to the state's wage and salary compensation, measured in millions of 2004 dollars.

Showing a similar pattern as job impacts, wages rise from a net loss of $2 million in 2008 to a gain of $64 million in 2023.

The impact on the Florida GSP might suggest a somewhat counterintuitive result, however. While job and wage benefits are small but net positive, the impact on GSP is small but negative. By 2023, for example, GSP is down by about $2.7 billion. The reason is that the electric utilities are a capital-intensive sector, but one that is also generally non-labor intensive. Movement away from greater capital intensity to a more labor-intensive energy policy shifts the composition of GSP away from utility plant investment toward more productive and more labor-intensive spending. As it turns out, this generates a small but negative impact on GSP compared to how the changed spending patterns impact jobs and wages.

DEMAND RESPONSE

Demand Response Background

Although several Florida utilities have been offering substantive demand response programs for a decade or longer, many significant opportunities remain. There are a number of demand response programs offered at present:

- Direct load control (DLC)—six utilities offer programs that pay participating customers a rebate or bill credit to allow the utility to cycle off their air conditioners, water heaters, and/or pool pumps during peak periods. The most extensive programs are offered by Florida Power & Light and Progress Energy, which together have over 1.1 million residential customers and 18,500 commercial customers enrolled. Three cooperative utilities (over 68,000 customers enrolled) and one municipal utility (over 3,000 customers enrolled) also operate direct load control programs (FERC 2006, Appendix I-5, Figures IV-6 and IV-7).
- Interruptible and curtailable load—Three cooperatives, two investor-owned utilities, and one municipal utility offer interruptible and curtailable load options for larger commercial and industrial customers, receiving a reduced rate in exchange for turning off a portion of their load at short notice when needed for grid support (FERC 2006, Figure IV-8).
- Time-of-use rates—Five utilities offer rate options designed to discourage on-peak energy use by charging higher prices during peak hours, but very few customers are actually signed up under the time-of-use tariffs (FERC 2006, Figures IV-10 and IV-11).
- In addition, the investor-owned utilities are involved with demonstrations of smart thermostats that could be significantly expanded in coming years (IOU 2007).

The Florida Reliability Coordinating Council reports that they have enough demand response potential to meet 7% of peak demand, with 2,264 MW potential but 1,297 MW actually delivered to meet summer 2006 demand (FERC 2006, Figure V-5). The limited usage of load management results in part from the high reserve margins that the state's utilities have been able to maintain, and in part because of their successful demand response programs. Florida resource plans project 3,504 MW of interruptible load and residential, commercial, and industrial load management to meet winter peak demand for 2006–2007; however, since they report only 164 MW of actual demand reduction for the winter of 2005–2006 (0.4% of peak) and 446 MW for the summer of 2005 (0.9% of peak) (FRCC 2006, pps. 3–4), and several of these programs have been closed to new participants, it will be a challenge for them to deliver the significantly higher demand response levels forecast.

Cost-Effectiveness and Investment in Demand Response

Most of the measures recommended here are already in use in Florida, as in other locations across the nation, and have been consistently cost-effective for both participants and all ratepayers in many jurisdictions; however, this analysis proposes expanding the penetration of these measures. Much of this expansion would be accomplished through mandatory requirements placed upon new residential and commercial construction, placing the burden of device acquisition and installation upon builders and buyers rather than utilities and their ratepayers. Additionally, since many of Florida's demand response programs have been in place for many years, it is likely that they can now be improved by modifications to program design and technology that will lower costs and increase impact for each new installation. Last, this analysis proposes that the burden of delivering demand response be expanded beyond the investor-owned utilities to the cooperatives and municipal utilities through a mandatory minimum demand response portfolio requirement for all load-serving entities in Florida.

While we believe that it would be valuable to place more Florida electricity users under time-of-use rates, that is not recommended here for the short term because it will require several additional steps that will increase costs and delay peak reduction impacts. Those steps will include revising existing time-of-use rates to send more distinct signals about the value of electricity across season and time of day, acquiring and installing many more advanced meters and associated communications and information processing systems, educating and recruiting customers about the rates, and conducting studies to determine the load-shifting and efficiency impacts of the time-of-use rates on customer energy use decisions. Therefore, while we advocate expansion of time-of-use rates—even potentially requiring that all customers with loads over 500 kW be served under such rates, we recommend that this measure be delayed until one or more Florida utilities makes a significant commitment to advanced metering infrastructure investment for other purposes, and then piggy-backing time-of-use rate expansion upon that investment.

Savings Impact

Most demand response measures save on capacity (kW) but not energy (kWh). Therefore their impact should be valued at the cost of capacity avoided, which should be measured over time at the marginal cost of a new power plant—presently coal or natural gas. Since the current value of avoided marginal capacity is $59/kW-year (Chernick 2007); Florida policymakers do not presently add a premium for transmission and distribution avoidance because they believe energy efficiency and demand response have been so geographically diffuse that they do not avoid or defer any transmission or distribution. However, if Florida chooses to commit to the higher levels of efficiency and demand response recommended here, the greater levels of peak avoided as Florida's population grows will quickly make a substantive impact on the rate of new transmission and distribution requirements (see Table 13).

Table 13. Savings in Demand Cost for Demand Response Program

Avoided Cost	Benefits (1000 $) 2013	2023
Generation @ $59 per avoided kW-year	257	569
Generation and T&D @ $120 per avoided kW-year	522	1,156

Demand Response Recommendations

Verify Demand Response Resource

Given how little demand response the FRCC recognized as available at the summer and winter peaks in 2004–2006, and the large amount forecast for 2007 and future years, the FPSC and FRCC should consider requiring formal audits and testing of the current demand response mechanisms, programs, and participants. Many demand response programs in other states require regular testing to be sure that the equipment works and the customers understand and accept their obligations and opportunities under the various rate and program offerings. This will help to determine how much of the demand response presently claimed and funded is valid and available when needed to assure future grid reliability and generation capacity avoidance.

Accelerate DSM Goals under Florida Energy Efficiency and Conservation Act

The FPSC approved its regulated utilities' demand-side management plans, including program approvals and specific MW and MWh savings goals and cost recovery mechanisms, between mid-2004 and early 2006. It is presently scheduled to "reset" those goals in 2009, to be effective in 2010. However, conditions have changed significantly since 2004–2005—there is now a wide gap forecast between demand and available generation, a number of new power plants have been proposed, and there have been significant increases in the capital costs of generation and transmission and in the fuel costs of both coal and natural gas. These factors have materially changed the cost-effectiveness of demand-side resources and should justify reconsideration of the utilities' demand-side management goals and recalculation of the value of avoided energy and capacity (including transmission as well as generation) in 2007 rather than 2009.

Furthermore, since energy efficiency and demand response offer significant risk management benefits to both the electric industry and to the state's citizens relative to Florida's vulnerability to fuel and electricity supply interruptions (as due to coal train delays, gas pipeline accidents, or hurricane-caused damages to transmission and distribution systems), the FPSC should consider adding a benefit premium to these resources in its cost-effectiveness methodology.

Set Mandatory Demand Response Targets for all Florida Utilities

Although several cooperatives and municipal utilities provide direct load control and interruptible or curtailable rates, most of the existing demand response programs and peak reduction comes from investor-owned utility programs. The legislature should consider setting a demand response portfolio requirement upon every Florida utility, making each responsible for delivering dispatchable demand response (from its own customers, or secured from another utility) for at least 5% of its next year's forecast peak load plus reserve margin by 2010 and 10% by 2017, with the demand response measures verified by actual performance. Since this would be a mandate to maintain reliability and reduce vulnerability to fuel import interruptions for the state, the Commission could encourage the utilities to choose the most cost-effective programs possible (including out-sourcing) to meet the mandates.

Require Direct Load Control Devices on All New Residential and Commercial Buildings

Given the high growth rate in Florida's population and the resulting high rates of building construction, the legislature should consider requiring every new residential building to have direct load control devices (such as programmable communicating thermostats) installed on every air conditioner, water heater, space heater, and pool pump in those buildings, with the new residents automatically enrolled in the local utility's direct load curtailment program. Very high proportions of the residential customers of Florida Power & Light, Progress Energy, and three cooperatives were placed in the direct load control programs in the past, so those programs are clearly widely understood and accepted already and this requirement should not impose an inordinate cost or other burden.

New commercial buildings should be required to have an energy management and control system with communications capability installed, connected to the utility's direct load curtailment system and placed on the DLC tariff. Such requirements could be put in place as early as 2009.

FRCC Should Use DLC for Spinning Reserve

The Florida Reliability Coordinating Council should include all resources under direct load control as both operating and planning reserves.

Redesign Programs for Greater Impact and Penetration

There is some variation in the demand response programs now offered within Florida (FPSC 2006c, Section 3; EEI 2006). However, it is likely that Florida's demand response programs could become lower in cost and higher in impact, which would improve their impact and cost-effectiveness. This could happen by charging the state's utilities and interested stakeholders to jointly evaluate the most effective demand response programs in place across the state and nation, develop a common suite of program designs (with greater customer segmentation) and terms that will work across Florida (including agricultural offerings), and set those in place for an extended period of time. After the start-up investment, this would lower administrative and program development costs for all utilities, enable statewide marketing and education plans about the value and importance of demand response, enable more third-party vendors to support the programs across a near-statewide market, and simplify equipment and communications protocols. This would also simplify the FPSC's review and approval process.

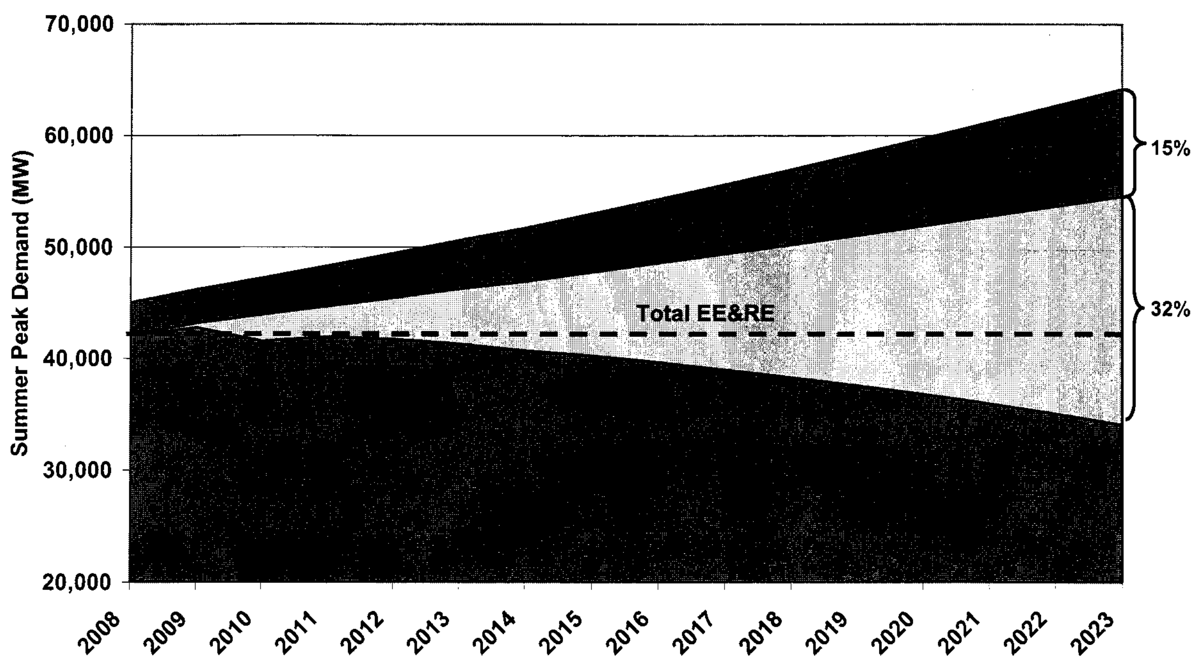
Advanced Meters and Time of Use Rates

The Florida PSC should encourage the utilities to expand their offerings and marketing of time-of-use rates to residential and commercial customers, and assure cost recovery for utility investments in advanced metering and communications systems. The Commission should consider requiring that every industrial customer and commercial customers over a stated consumption level (say 500 kW) be given an advanced meter and a well-designed time-of-use rate, to grow the amount of price-responsive load within the state. For smaller commercial loads, the FPSC should also encourage the utilities to establish programs for automated demand response using building controls, which has great potential to deliver high levels of energy and demand savings on a sustained, predictable basis.

Estimated Impacts of Demand Response

We estimate that these demand response policies would reduce the summer peak by 9% in 2013 and 15% in 2023. When combined with the load reductions from energy efficiency and renewable energy, we can reduce the peak by 18% in 2013 and 47% in 2023, as can be seen in Figure 10.

Figure 11. Impacts on Summer Peak Load from Energy Efficiency, Renewable Energy, and Demand Response



SUMMARY AND CONCLUSIONS

Based on this analysis, we are confident that we have demonstrated that energy efficiency and renewable energy can change Florida's energy future for the better. Energy efficiency resource policies can offset the majority of projected load growth in the state over the next 15 years. Expanded development of renewable energy resources in the state would further reduce future needs for conventional generation. Combined, these policies can serve nearly 30% of projected needs for electricity in 2023, deferring the need for many new electric power generation projects in the state.

The economic savings from the recommended energy efficiency policies alone in this report can cut Florida consumers' electricity bills by about $840 million by 2013 and $28 billion by 2023. While these savings will require substantial investments, they cost less than the projected cost of electricity from conventional sources. In addition, the investments would save consumers money while creating new jobs for the state.

Reducing demand for electricity with efficiency and renewables will also reduce emissions from the combustion of fossil fuels at utility power plants, offering the state a more sustainable environmental future at an affordable cost and allowing the state to start on a path to reducing its global warming emissions. Together, energy efficiency and renewable energy can reduce the state's emissions by 54 million metric tons of carbon dioxide in 2023—almost 30% of the state's projected emissions.

Florida faces important decisions regarding its energy future. The current course calls for investments in new coal, gas, and potentially nuclear generation to make sure that the state has enough electricity to sustain its economic prosperity. Energy efficiency and renewable energy resources offset some of that growth in demand, offering a lower cost, cleaner, and more stable energy path, without sacrificing Florida's quality of life or its economic growth. What is needed is leadership to put the state on this alternative path.

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APPENDIX A: ECONOMIC POTENTIAL ASSESSMENT APPROACH AND DETAILED TABLES

Residential Efficiency

Table A-1. Description of Energy Efficiency and Renewable Energy (EERE) Measures Studied

Acronym	Description of Measure
HVAC1:	SEER-13; HSPF-7.7 replacement heat pump (existing homes only)
HVAC2:	SEER-15; HSPF-9.0 high efficiency heat pump ($300 federal tax credit)
HVAC3:	SEER-17; HSPF-9.2 ultra high efficiency heat pump ($300 federal tax credit)
RBS:	Attic radiant barrier system
Ducts:	Tight ducts (normalized leakage from 0.10 to 0.03)
Roof:	White metal roof (solar reflectance = 70%)
SHW:	Solar hot water system* (closed loop; 40 ft^2-80 gal; PV pumped—30% federal tax credit + $500 Florida rebate)
Lgts:	50% fluorescent lighting
eStarLgts:	3 fluorescent lights
eStarHP:	SEER-14: HSPF-8.2
eStarWin:	U = 0.55; SHGC = 0.35
Infil:	Annual average natural infiltration = 0.35 ach
IDucts:	Entire forced air distribution system inside conditioned space boundary
Fridg:	ENERGY STAR refrigerator (~80% of baseline energy use)
WinU:	Window upgrade to vinyl frame; U=0.39; SHGC=0.28
Wtint:	Add window tint to bring SHGC-0.65 to 0.45 (existing homes only)
WinR:	Window replacement with U=0.39: SHGC=0.40 vinyl (existing homes only)
Pstat:	Programmable thermostat with 2 °F setup/setback
cFans:	ENERGY STAR ceiling fans (Gossamer Wind—140 cfm/watt)
Misc:	Reduced miscellaneous (plug) loads (70% of baseline)
Shng:	White composite shingles (solar reflectance = 25%)
HW:	Hot water heater EF increased from 0.90 to 0.92
HW1:	Replace hot water heater with minimum standard (existing homes only)
WallR:	Increased wall insulation from R-3 to R-7.6 (new homes only)
WallU:	Add R-10 exterior insulation to CMU walls (existing homes only)
Wwalls:	White walls (solar reflectance = 60%)
HAcloths:	Horizontal axis cloths washer (1.5 gpd hot water savings)
HWwrap:	Additional R-10 hot water tank wrap
HRU:	Heat recovery water heater
HPWH:	Heat pump water heater (COP = 3.0)
dWash	Energy Star dishwasher (EF=0.58; 1.06 gpd hot water savings)
2kW-PV:	2.1 kW-peak PV system ($2000 federal tax credit + $4/peak watt Florida rebate)
eStar:	ENERGY STAR new home builder option package (BOP)—(eStarHP; eStarWin; Infil; eStarLgts; Ducts; Shng; Fridg; WallR; dWash)
TaxC:	Tax Credit qualified new home ($2000 federal tax credit)—(WallR, WinU, HVAC2, Ducts, IDucts, Pstat)
Pool:	Standard pool home (pool home baseline)
effPool:	Efficient, downsized pool pump and oversized piping (40% energy savings)
NG-Base:	Natural gas baseline home (furnace AFUE=78%, hot water EF=0.59, std. gas dryer & std. gas range)
Furn1:	High-efficiency non-condensing furnace (AFUE=90%)
Furn1:	High-efficiency condensing furnace (AFUE=95%)
HW1:	Medium efficiency gas hot water heater (EF=0.63)
HW2:	High efficiency gas hot water heater (EF=0.80)
PkgEH1	HVAC2; Ducts; Ceil; SHW; Lgts; Pstat (existing homes only)

Acronym	Description of Measure
PkgEH2:	HVAC2; Ducts; Ceil; Shng; SHW; Lgts; Fridg; Pstat; cFans, Misc; WinR; Wwalls (existing homes only)
PkgNH1:	HVAC2; Ducts; RBS; SHW; Lgts, Fridg; WinU; Pstat; cFan; Shng; Wwalls; HAcloths; dWash (new homes only)
PkgNH2:	Pkg1 + 2kW-PV (new homes only)

* For solar hot water systems closed-loop systems were assumed in north Florida and open-loop systems were assumed in central and south Florida.

The results of the analysis show significant potential for cost-effective energy efficiency and renewable energy savings. Some visual analysis is helpful in understanding the results so detailed graphical analysis of the results from the Miami simulations are presented here. Figure A-1 below shows results in terms of both the levelized cost of conserved energy (CCE) and the annual energy savings for new single-family residences in south Florida.

There are four packages of measures included in the new home analysis. The eStar package consists of the minimum energy efficiency measures required by EPA's prescriptive Builder Option Package (BOP) for Florida. The TaxC package consists of the non-competing measures with the lowest CCE that will qualify the home for the 2005 EPAct federal tax credit of $2000. PkgNH1 consists of all the non-competing measures with CCE less than $0.10/kWh. Where measures competed (e.g., SHW and HPWH) the measure with the lowest CCE was selected. PkgNH2 comprises PkgNH1 plus the 2kW-PV solar electric measure. Note that this package did not make the $0.10/kWh cut-off that was used in the packages reported in the main body of the report.

Figure A-1. Annual Energy Savings and Levelized Cost of Conserved Energy for Energy Efficiency and Renewable Energy Measures and Packages for New Homes in South Florida (Miami)

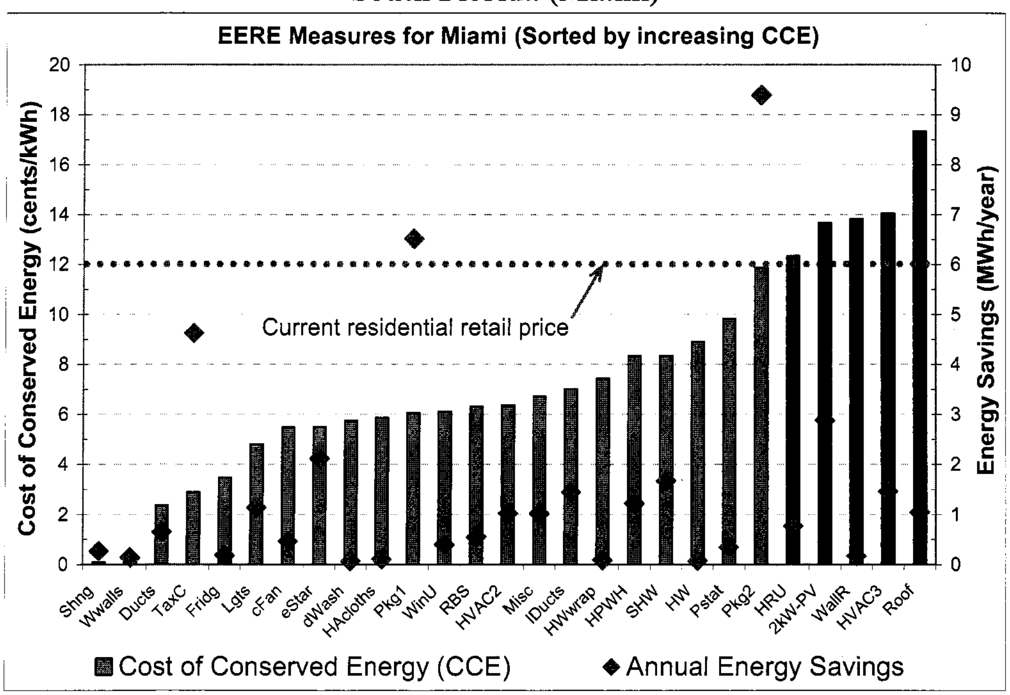


Figure A-1 is sorted by CCE with an annual energy savings overlay. Note that only 5 of the measures (darker blue on chart) have levelized costs in excess of the current typical Florida residential retail rate of $0.12/kWh. Also note that there is no consistent relationship between annual energy savings and CCE. Some measures with relatively large savings (e.g. TaxC) result a relatively small CCE, while other measures with relatively small annual savings (e.g. WallR and Roof) result in a relatively large CCE and everything in between.

Thus, neither CCE nor annual energy savings tell the entire story. To simultaneously capture the energy benefits and their costs (and produce a more informative single metric), the authors have constructed a metric that combines annual energy savings with CCE. This metric we called the "Investment Efficacy." It is constructed simply by dividing the annual MWh saved by the CCE. Thus, the metric is quite similar to a benefit-to-cost ratio except that the benefit is measured in annual MWh savings and the cost is levelized over the lifetime of the measure. This metric substantially changes the order in which the measures are ranked.

Figure A-2, presented below, shows the results of this analysis for new single-family homes located in south Florida (Miami). The measures and packages shown with red bars in Figure A-1 are the only measures with CCE greater than Florida's prevailing typical retail residential rate of $0.12/kWh. While these measures and packages my not pass a consumer cost-effectiveness test, one of them (2kW-PV) produces relatively large energy savings (18% compared with the baseline) and appears to be a reasonable investments from an annual energy savings to levelized cost perspective.

Figure A-2. Sorted Investment Efficacy of Energy Efficiency and Renewable Energy Measures (including packages) for New Single-Family Residences in South Florida Showing Annual MWh Savings for Each Dollar of annual Investment

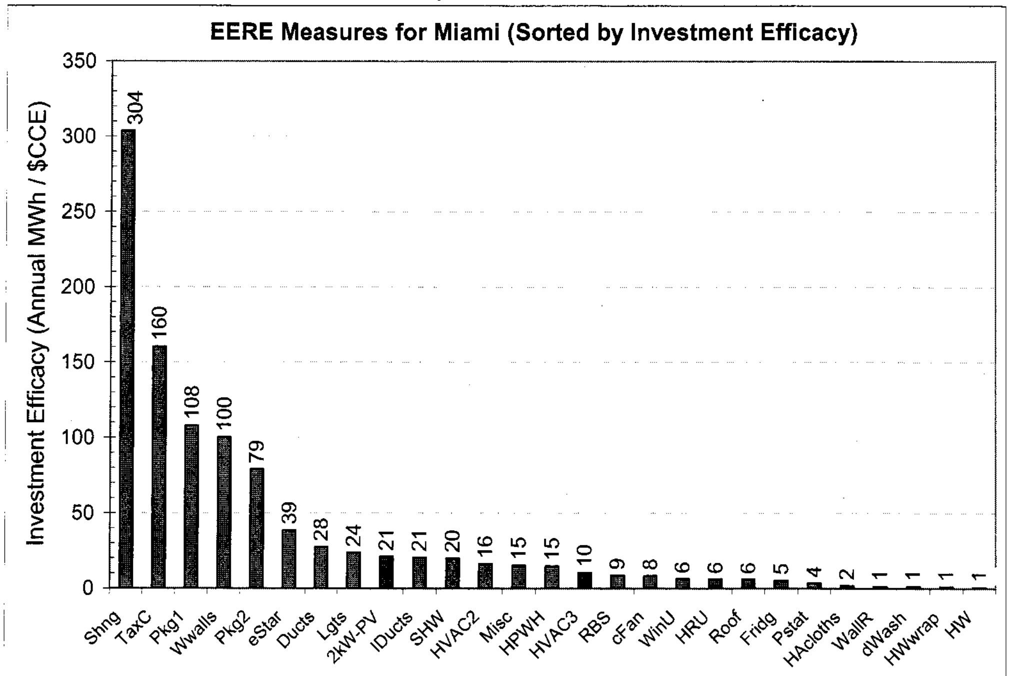


Figure A-2 clearly demonstrates that, if the goal is to reduce electricity consumption, the best overall strategy from a policy perspective may be to aggressively promote and further incent comprehensive packages of measures rather than individual measures. The individual measures of Shng (white instead of medium colored composition shingles) and Wwalls (white wall paint instead of beige wall paint) end up at the upper end of the scale with the four packages because their incremental cost is negligible (there is no incremental cost for a color choice). Excepting these two individual measures, the upper end of this ranking metric consists of the four packages considered by this analysis. Note also in Figure A-1 that the energy savings for these two highly-ranked individual measures are quite small compared with the measure packages with which they are intermingled. Thus, they only appear at this end of the scale because of their negligible cost. If, like other individual measures, they had some associated cost, they would surely rank lower than the four packages, which save significant energy.

A similar analysis has been performed for all three Florida climates. The resulting data are presented in Tables 2 through 4, below. The tabular data are sorted by Investment Efficacy (MWh/$CCE) from high to low. Where a measure's levelized cost (CCE) exceeds the current typical Florida retail residential electricity rate, the row is highlighted. In addition, data for the measure life, first cost, federal and state financial incentive and the net cost of the measure are included in the tables.

Table A-2. South Florida New Home EERE Measure Potentials

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Shng	303.6	$0.0009	0.27	1.7%	15	$3		$3
TaxC	160.2	$0.0289	4.63	28.8%	20	$3,737	$2,000	$1,737
PkgNH1	107.6	$0.0606	6.52	40.6%	15	$5,910	$1,728	$4,333
Wwalls	100.2	$0.0014	0.14	0.9%	10	$2		$2
PkgNH2	79.1	$0.1188	9.39	58.4%	20	$25,377	$10,700	$14,677
eStar	38.5	$0.0550	2.12	13.2%	20	$1,516		$1,516
Ducts	27.6	$0.0236	0.65	4.1%	15	$165		$165
Lgts	23.6	$0.0481	1.14	7.1%	5	$240		$240
2kW-PV	21.0	$0.1367	2.88	17.9%	30	$16,800	$10,400	$6,400
IDucts	20.6	$0.0701	1.44	9.0%	30	$1,650		$1,650
SHW	20.1	$0.0834	1.67	10.4%	20	$3,242	$1,428	$1,815
HVAC2	16.1	$0.0637	1.02	6.4%	15	$1,000	$300	$700
Misc	15.1	$0.0672	1.02	6.3%	5	$300		$300
HPWH	14.7	$0.0833	1.22	7.6%	15	$1,092		$1,092
HVAC3	10.4	$0.1404	1.46	9.1%	15	$2,500	$300	$2,200
RBS	8.7	$0.0631	0.55	3.4%	30	$563		$563
cFan	8.4	$0.0548	0.46	2.9%	10	$200		$200
WinU	6.5	$0.0612	0.40	2.5%	30	$396		$396
HRU	6.2	$0.1234	0.77	4.8%	10	$750		$750
Roof	6.0	$0.1733	1.04	6.5%	30	$2,941		$2,941
Fridg	5.2	$0.0347	0.18	1.1%	10	$50		$50
Pstat	3.5	$0.0982	0.35	2.2%	5	$150		$150
HAcloths	1.8	$0.0585	0.11	0.7%	10	$50		$50
WallR	1.2	$0.1382	0.17	1.0%	30	$376		$376

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
dWash	1.1	$0.0574	0.07	0.4%	10	$30		$30
HWwrap	1.1	$0.0743	0.09	0.5%	10	$50		$50
HW	0.8	$0.0890	0.07	0.4%	10	$50		$50

Table A-3. Central Florida New Home EERE Measure Potentials

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Shng	203.0	$0.0011	0.22	1.5%	15	$3	$0	$3
TaxC	100.2	$0.0365	3.66	24.3%	20	$3,737	$2,000	$1,737
PkgNH1	78.9	$0.0702	5.54	36.8%	16	$5,910	$1,728	$4,333
PkgNH2	64.6	$0.1310	8.47	56.2%	21	$25,377	$10,700	$14,677
Wwalls	45.5	$0.0020	0.09	0.6%	10	$2	$0	$2
eStar	35.8	$0.0571	2.04	13.6%	20	$1,516	$0	$1,516
SHW	21.6	$0.0804	1.74	11.5%	20	$3,092	$1,428	$1,815
2kW-PV	21.7	$0.1345	2.92	19.4%	30	$16,800	$10,400	$6,400
Lgts	19.1	$0.0534	1.02	6.8%	5	$240	$0	$240
Ducts	18.5	$0.0288	0.53	3.5%	15	$165	$0	$165
HPWH	16.5	$0.0785	1.30	8.6%	15	$1,092	$0	$1,092
IDucts	15.0	$0.0821	1.23	8.2%	30	$1,650	$0	$1,650
Misc	12.6	$0.0736	0.93	6.2%	5	$300	$0	$300
HVAC2	9.6	$0.0824	0.79	5.3%	15	$1,000	$300	$700
WinU	6.9	$0.0593	0.41	2.7%	30	$396	$0	$396
RBS	6.5	$0.0728	0.48	3.2%	30	$563	$0	$563
HVAC3	6.4	$0.1789	1.15	7.6%	15	$2,500	$300	$2,200
cFan	4.8	$0.0724	0.35	2.3%	10	$200	$0	$200
Fridg	4.5	$0.0374	0.17	1.1%	10	$50	$0	$50
Roof	3.3	$0.2324	0.78	5.2%	30	$2,941	$0	$2,941
HRU	3.1	$0.1746	0.54	3.6%	10	$750	$0	$750
Pstat	3.1	$0.1055	0.32	2.2%	5	$150	$0	$150
HAcloths	2.0	$0.0564	0.11	0.7%	10	$50	$0	$50
HWwrap	1.4	$0.0672	0.09	0.6%	10	$50	$0	$50
dWash	1.3	$0.0549	0.07	0.5%	10	$30	$0	$30
HW	1.0	$0.0810	0.08	0.5%	10	$50	$0	$50
WallR	0.9	$0.1570	0.15	1.0%	30	$376	$0	$376

It is interesting to note in Table A-3, above, that Pkg2 no longer meets the $0.12/kWh threshold as it did in south Florida. Nonetheless, it only slightly exceeds this value and its annual energy savings are such that its relative position among the measures has not changed.

Table A-4. North Florida New Home EERE Measure Potentials

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Shng	77.59	$0.0018	0.1	0.9%	15	$3	$0	$3
PkgNH1	72.60	$0.0729	5.3	34.6%	16	$5,910	$1,728	$4,333
TaxC	61.51	$0.0466	2.9	18.8%	20	$3,737	$2,000	$1,737
PkgNH2	58.11	$0.1386	8.1	52.7%	20	$25,377	$10,700	$14,677
eStar	27.53	$0.0651	1.8	11.7%	20	$1,516	$0	$1,516
2kW-PV	19.39	$0.1424	2.8	18.1%	30	$16,800	$10,400	$6,400
HPWH	18.75	$0.0736	1.4	9.0%	15	$1,092	$0	$1,092
SHW	18.31	$0.0873	1.6	10.5%	20	$3,242	$1,428	$1,815
Lgts	16.33	$0.0579	0.9	6.2%	5	$240	$0	$240
Ducts	89.73	$0.0319	0.5	3.1%	15	$165	$0	$165
WinU	11.73	$0.0455	0.5	3.5%	30	$396	$0	$396
Wwalls	11.62	$0.0040	0.0	0.3%	10	$2	$0	$2
Misc	11.10	$0.0785	0.9	5.7%	5	$300	$0	$300
IDucts	11.01	$0.0959	1.1	6.9%	30	$1,650	$0	$1,650
HVAC2	9.36	$0.0835	0.8	5.1%	15	$1,000	$300	$700
HVAC3	5.46	$0.1936	1.1	6.9%	15	$2,500	$300	$2,200
RBS	4.22	$0.0905	0.4	2.5%	30	$563	$0	$563
Pstat	3.75	$0.0954	0.4	2.3%	5	$150	$0	$150
Fridg	3.61	$0.0418	0.2	1.0%	10	$50	$0	$50
cFan	2.86	$0.0940	0.3	1.8%	10	$200	$0	$200
WallR	2.82	$0.0905	0.3	1.7%	30	$376	$0	$376
dWash	2.53	$0.0387	0.1	0.6%	10	$30	$0	$30
HAcloths	2.13	$0.0545	0.1	0.8%	10	$50	$0	$50
HRU	1.75	$0.2329	0.4	2.7%	10	$750	$0	$750
HWwrap	1.58	$0.0632	0.1	0.7%	10	$50	$0	$50
Roof	1.29	$0.3746	0.5	3.2%	30	$2,941	$0	$2,941
HW	1.09	$0.0761	0.1	0.5%	10	$50	$0	$50

The importance of climate becomes more evident in Table A-4 where increased wall insulation has moved substantially up in the ranking order and its levelized cost is now below the $0.12/kWh threshold, where it was not in either south or central Florida. In addition, it is interesting to note how far down in the rankings Wwalls has dropped between central and north Florida. One may also note in the tables that the highest ranked measure (Shng) is dramatically impacted by climate, with Investment Efficacies ranging from a high of 304 in south Florida to low of 78 in north Florida. The reasons for this are fairly straightforward. First, the measure has negligible costs because there is not incremental cost for a color decision (that is why it and Wwalls rank near the top to begin with). And second, solar reflectance measures are beneficial for cooling but detrimental for heating. Thus, as we move from south Florida where there is virtually no heating load and where the Shng measure is literally "off the charts" to north Florida where heating is a consideration, the Investment Efficacy of this measure (and the Wwalls measure) drops substantially. However, the four packages of measures (Pkg1, Pkg2, eStar and TaxC) remain relatively constant in ranking order across all climates, with all four of them consistently ranked within the top five or six measures.

Existing Homes

Existing homes are significantly different than new homes.

Table A- 5a. South Florida Existing Home EERE Measure Potentials (Full Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
PkgEH0	52.0	$0.0770	4.01	22.0%	16	$4,890	$1,575	$3,465
PkgEH2	38.4	$0.1820	6.99	45.6%	16	$16,302	$2,075	$14,377
HVAC2	24.9	$0.1253	3.12	17.2%	15	$4,500	$300	$4,200
2kW-PV	21.0	$0.1367	2.88	15.8%	30	$16,800	$10,400	$6,400
SHW	19.6	$0.0908	1.78	9.8%	20	$3,650	$1,550	$2,100
PkgEH1	19.5	$0.1889	3.68	24.0%	16	$9,390	$1,875	$7,665
Lgts	14.9	$0.0566	0.85	4.6%	5	$210	$0	$210
HVAC1	13.5	$0.1436	1.95	10.7%	15	$3,000	$0	$3,000
HPWH	10.7	$0.1143	1.22	6.7%	15	$1,500	$0	$1,500
Ceil	8.6	$0.0599	0.52	2.8%	30	$530	$25	$505
WinR	8.4	$0.1523	1.28	7.0%	30	$3,376	$200	$3,176
HRU	8.3	$0.1066	0.89	4.9%	10	$750	$0	$750
Ducts	7.9	$0.0767	0.61	3.3%	15	$500	$0	$500
HWwrap	6.5	$0.0311	0.20	1.1%	10	$50	$0	$50
Misc	6.3	$0.1200	0.76	4.2%	5	$400	$0	$400
RBS	5.8	$0.1361	0.78	4.3%	20	$1,388	$0	$1,388
Pstat	4.9	$0.0833	0.41	2.3%	5	$150	$0	$150
Roof	3.0	$0.4655	1.40	7.7%	30	$11,100	$500	$10,600
WtInt	2.7	$0.2359	0.64	3.5%	10	$1,200	$0	$1,200
HW	1.1	$0.2042	0.22	1.2%	12	$408	$0	$408
cFan	1.1	$0.3573	0.38	2.1%	10	$1,080	$0	$1,080
Wwalls	0.9	$0.3408	0.30	1.6%	10	$806	$0	$806
Shng	0.5	$0.7697	0.38	2.1%	15	$3,100	$0	$3,100
Walls	0.5	$1.1227	0.52	2.8%	5	$2,553	$0	$2,553
HAcloths	0.2	$0.5851	0.11	0.6%	10	$500	$0	$500
Fridg	0.2	$0.9448	0.17	0.9%	10	$1,200	$0	$1,200
dWash	0.1	$0.7654	0.07	0.4%	10	$400	$0	$400

Table A-5b. South Florida Existing Home EERE Measure Potentials (Incremental Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Wwalls	552.7	$0.0005	0.30	1.6%	10	$1	$0	$1
HVAC1	406.3	$0.0048	1.95	10.7%	15	$0	$0	$100
PkgEH2	91.0	$0.0769	6.99	38.5%	16	$7,876	$150	$6,073
HVAC2	87.2	$0.0358	3.12	17.2%	15	$1,500	$0	$1,200
Shng	81.6	$0.0046	0.38	2.1%	15	$19	$0	$19
PkgEH0	56.7	$0.0707	4.01	22.0%	16	$4,482	$150	$3,179
HW	43.7	$0.0050	0.22	1.2%	12	$0	$0	$10
WinR	34.4	$0.0372	1.28	7.0%	30	$976	$0	$776
PkgEH1	34.1	$0.1080	3.68	20.2%	16	$5,982	$150	$4,379
SHW	22.6	$0.0785	1.78	9.8%	20	$3,242	$150	$1,815
2kW-PV	21.0	$0.1367	2.88	15.8%	30	$16,800	$0	$6,400

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Lgts	14.9	$0.0566	0.85	4.6%	5	$210	$0	$210
HPWH	14.7	$0.0832	1.22	6.7%	15	$1,092	$0	$1,092
Misc	9.5	$0.0800	0.76	4.2%	5	$267	$0	$267
Ceil	8.6	$0.0599	0.52	2.8%	30	$530	$0	$505
HRU	8.3	$0.1066	0.89	4.9%	10	$750	$0	$750
Ducts	7.9	$0.0767	0.61	3.3%	15	$500	$0	$500
cFan	7.7	$0.0496	0.38	2.1%	10	$150	$0	$150
Roof	7.2	$0.1932	1.40	7.7%	30	$4,900	$0	$4,400
HWwrap	6.5	$0.0311	0.20	1.1%	10	$50	$0	$50
RBS	5.8	$0.1361	0.78	4.3%	20	$1,388	$0	$1,388
Pstat	4.9	$0.0833	0.41	2.3%	5	$150	$0	$150
Fridg	4.4	$0.0378	0.17	0.9%	10	$50	$0	$50
Wtint	2.7	$0.2359	0.64	3.5%	10	$1,200	$0	$1,200
HAcloths	0.6	$0.1755	0.11	0.6%	10	$150	$0	$150
Walls	0.5	$1.1227	0.52	2.8%	5	$2,553	$0	$2,553
dWash	0.5	$0.1436	0.07	0.4%	10	$75	$0	$75

Table A-6a. Central Florida Existing Home EERE Measure Potentials (Full Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
PkgEH0	53.4	$0.0751	4.01	23.4%	17	$4,890	$1,575	$3,465
PkgEH2	33.8	$0.1919	6.49	44.9%	17	$16,302	$2,075	$14,377
SHW	20.9	$0.0879	1.84	10.7%	20	$3,500	$1,550	$2,100
2kW-PV	20.3	$0.1391	2.82	16.5%	30	$16,800	$10,400	$6,400
HVAC2	19.3	$0.1424	2.75	16.0%	15	$4,500	$300	$4,200
PkgEH1	18.0	$0.1949	3.51	24.2%	16	$9,390	$1,875	$7,665
Ceil	13.8	$0.0475	0.65	3.8%	30	$530	$25	$505
HPWH	13.8	$0.1008	1.39	8.1%	15	$1,500	$0	$1,500
Lgts	13.6	$0.0593	0.81	4.7%	5	$210	$0	$210
HVAC1	10.5	$0.1764	1.85	10.8%	15	$3,500	$0	$3,500
WinR	9.7	$0.1420	1.37	8.0%	30	$3,376	$200	$3,176
HWwrap	7.8	$0.0285	0.22	1.3%	10	$50	$0	$50
Ducts	6.9	$0.0821	0.57	3.3%	15	$500	$0	$500
RBS	6.3	$0.1299	0.82	4.8%	20	$1,388	$0	$1,388
Misc	5.5	$0.1292	0.71	4.1%	5	$400	$0	$400
Pstat	4.9	$0.0833	0.41	2.4%	5	$150	$0	$150
HRU	4.6	$0.1432	0.66	3.9%	10	$750	$0	$750
Walls	2.7	$0.4638	1.25	7.3%	5	$2,553	$0	$2,553
Roof	2.4	$0.5202	1.25	7.3%	30	$11,100	$500	$10,600
Wtint	2.0	$0.2788	0.54	3.2%	10	$1,200	$0	$1,200
HW	1.3	$0.1871	0.24	1.4%	12	$408	$0	$408
cFan	1.1	$0.3500	0.39	2.3%	10	$1,080	$0	$1,080
Wwalls	0.6	$0.3980	0.26	1.5%	10	$806	$0	$806
Shng	0.5	$0.7596	0.38	2.2%	15	$3,100	$0	$3,100
HAcloths	0.2	$0.5642	0.11	0.7%	10	$500	$0	$500
Fridg	0.2	$1.0182	0.16	0.9%	10	$1,250	$0	$1,250
dWash	0.1	$0.7216	0.07	0.4%	10	$400	$0	$400

Table A-6b. Central Florida Existing Home EERE Measure Potentials (Incremental Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Wwalls	405.1	$0.0006	0.26	1.5%	10	$1	$0	$1
HVAC1	366.4	$0.0050	1.85	10.8%	15	$0	$0	$100
HVAC2	115.7	$0.0237	2.75	16.0%	15	$1,000	$300	$700
PkgEH2	87.3	$0.0744	6.49	37.8%	17	$7,376	$1,953	$5,573
Shng	83.8	$0.0045	0.38	2.2%	15	$19	$0	$19
PkgEH0	58.2	$0.0689	4.01	23.4%	17	$4,482	$1,453	$3,179
HW	52.1	$0.0046	0.24	1.4%	12	$0	$0	$10
WinR	39.6	$0.0347	1.37	8.0%	30	$976	$200	$776
PkgEH1	35.6	$0.0986	3.51	20.4%	16	$5,482	$1,753	$3,879
SHW	24.2	$0.0759	1.84	10.7%	20	$3,092	$1,428	$1,815
2kW-PV	19.1	$0.1478	2.82	16.5%	30	$16,800	$10,000	$6,800
HPWH	18.9	$0.0734	1.39	8.1%	15	$1,092	$0	$1,092
Ceil	13.8	$0.0475	0.65	3.8%	30	$530	$25	$505
Lgts	13.6	$0.0593	0.81	4.7%	5	$210	$0	$210
Misc	8.2	$0.0862	0.71	4.1%	5	$267	$0	$267
cFan	8.0	$0.0486	0.39	2.3%	10	$150	$0	$150
HWwrap	7.8	$0.0285	0.22	1.3%	10	$50	$0	$50
Ducts	6.9	$0.0821	0.57	3.3%	15	$500	$0	$500
RBS	6.3	$0.1299	0.82	4.8%	20	$1,388	$0	$1,388
Roof	5.8	$0.2159	1.25	7.3%	30	$4,900	$500	$4,400
Pstat	4.9	$0.0833	0.41	2.4%	5	$150	$0	$150
HRU	4.6	$0.1432	0.66	3.9%	10	$750	$0	$750
Fridg	3.8	$0.0407	0.16	0.9%	10	$50	$0	$50
Walls	2.7	$0.4638	1.25	7.3%	5	$2,553	$0	$2,553
Wtint	2.0	$0.2788	0.54	3.2%	10	$1,200	$0	$1,200
HAcloths	0.7	$0.1693	0.11	0.7%	10	$150	$0	$150
dWash	0.5	$0.1354	0.07	0.4%	10	$75	$0	$75

Table A-7a. North Florida Existing Home EERE Measure Potentials (Full Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
PkgEH0	44.40	$0.0831	3.7	23.2%	16	$4,890	$1,575	$3,465
PkgEH2	24.21	$0.2288	5.5	40.5%	16	$16,302	$2,075	$14,377
2kW-PV	19.39	$0.1424	2.8	17.3%	30	$16,800	$10,400	$6,400
SHW	17.23	$0.0968	1.7	10.5%	20	$3,650	$1,550	$2,100
PkgEH1	14.41	$0.2190	3.2	23.1%	16	$9,390	$1,875	$7,665
HPWH	13.65	$0.1011	1.4	8.7%	15	$1,500	$0	$1,500
HVAC2	12.43	$0.1774	2.2	13.8%	15	$4,500	$300	$4,200
Lgts	10.60	$0.0672	0.7	4.5%	5	$210	$0	$210
HWwrap	9.04	$0.0264	0.2	1.5%	10	$50	$0	$50
Ducts	7.66	$0.0780	0.6	3.7%	15	$500	$0	$500
Ceil	6.65	$0.0683	0.5	2.9%	30	$530	$25	$505
HVAC1	6.55	$0.2231	1.5	9.2%	15	$3,500	$0	$3,500
RBS	5.33	$0.1415	0.8	4.7%	20	$1,388	$0	$1,388
WinR	4.91	$0.1994	1.0	6.1%	30	$3,376	$200	$3,176
Misc	4.74	$0.1387	0.7	4.1%	5	$400	$0	$400

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
Pstat	4.07	$0.0916	0.4	2.3%	5	$150	$0	$150
HRU	2.47	$0.1958	0.5	3.0%	10	$750	$0	$750
HW	1.48	$0.1740	0.3	1.6%	12	$408	$0	$408
Roof	1.28	$0.7120	0.9	5.7%	30	$11,100	$500	$10,600
Wtint	0.98	$0.3929	0.4	2.4%	10	$1,200	$0	$1,200
cFan	0.62	$0.4707	0.3	1.8%	10	$1,080	$0	$1,080
Shng	0.23	$1.1319	0.3	1.6%	15	$3,100	$0	$3,100
HAcloths	0.22	$0.5401	0.1	0.7%	10	$500	$0	$500
Fridg	0.12	$0.1994	0.1	0.9%	10	$1,250	$0	$1,250
dWash	0.11	$0.6920	0.1	0.5%	10	$400	$0	$400
Wwalls	0.03	$1.8194	0.1	0.4%	10	$806	$0	$806

Table A-7b. North Florida Existing Home EERE Measure Potentials (Incremental Costs)

Measure	MWh / $CCE	CCE ($)	MWh saved	% saved	Measure life	First cost ($)	Incentive ($)	Net cost ($)
HVAC1	229.24	$0.0064	1.5	9.2%	15	$0	$0	$100
HVAC2	74.59	$0.0296	2.2	13.8%	15	$1,000	$300	$700
PkgEH3	62.44	$0.0887	5.5	34.8%	16	$7,376	$1,953	$5,573
HW	60.23	$0.0043	0.3	1.6%	12	$0	$0	$10
PkgEH1	48.38	$0.0763	3.7	23.2%	16	$4,482	$1,453	$3,179
Shng	37.75	$0.0068	0.3	1.6%	15	$19	$0	$19
PkgEH2	28.47	$0.1108	3.2	19.8%	16	$5,482	$1,753	$3,879
WinR	20.08	$0.0487	1.0	6.1%	30	$976	$200	$776
SHW	19.94	$0.0836	1.7	10.5%	20	$3,242	$1,428	$1,815
2kW-PV	19.39	$0.1424	2.8	17.3%	30	$16,800	$10,400	$6,400
Wwalls	19.39	$0.0029	0.1	0.4%	10	$1	$0	$1
HPWH	18.75	$0.0736	1.4	8.7%	15	$1,092	$0	$1,092
Lgts	10.60	$0.0672	0.7	4.5%	5	$210	$0	$210
HWwrap	9.04	$0.0264	0.2	1.5%	10	$50	$0	$50
Ducts	7.66	$0.0780	0.6	3.7%	15	$500	$0	$500
Misc	7.11	$0.0925	0.7	4.1%	5	$267	$0	$267
Ceil	6.65	$0.0683	0.5	2.9%	30	$530	$25	$505
RBS	5.33	$0.1415	0.8	4.7%	20	$1,388	$0	$1,388
cFan	4.44	$0.0654	0.3	1.8%	10	$150	$0	$150
Pstat	4.07	$0.0916	0.4	2.3%	5	$150	$0	$150
Roof	3.09	$0.2956	0.9	5.7%	30	$4,900	$500	$4,400
Fridg	3.09	$0.0672	0.1	0.9%	10	$50	$0	$50
HRU	2.47	$0.1958	0.5	3.0%	10	$750	$0	$750
Wtint	0.98	$0.3929	0.4	2.4%	10	$1,200	$0	$1,200
HAcloths	0.72	$0.1620	0.1	0.7%	10	$150	$0	$150
dWash	0.56	$0.1298	0.1	0.5%	10	$75	$0	$75

Statewide Potential

To estimate the statewide economic potential for energy efficiency in residential buildings in Florida, we combined applied weighted averages from three geographic regions: North (Jacksonville), Central (Tampa), and South (Miami). Table A-8 shows the breakdown of economic potential savings in 2023 by efficiency package and region.

Table A-8. Economic Potential for Energy Efficiency in Residential Buildings

Existing Homes Efficiency Measures	kWh Saved per Home per Year				% Applicable[2]	2023 Statewide Economic Potential (GWh)	Cost per kWh Saved
	Jacksonville	Tampa	Miami	Statewide Average[1]			
Package EH1	*3155*	*3506*	*3681*	*3504*	*50%*	*15,681*	*$ 0.10*
High-efficiency Air Conditioner (SEER-15; HSPF-9)	744	899	1177	977			$ 0.09
Ducts: Normalized leakage 0.10 to 0.03	597	567	607	589			$ 0.08
Ceiling Insulation: R-18 to R-30	454	653	517	560			$ 0.06
Solar hot water system	1,668	1,837	1,777	1780			$ 0.08
50% fluorescent lighting replacement	712	807	845	803			$ 0.06
Programmable thermostat with 2 F setup/setback	373	410	410	403			$ 0.08
Package EH2[3]	*5539*	*6490*	*6993*	*6497*	*20%*	*11,628*	*$ 0.07*
Cool Roof	255	380	375	353			$ 0.00
Energy Star Refrigerator	140	155	167	157			$ 0.04
Energy Star Ceiling Fans	454	653	517	560			$ 0.03
Miscellaneous load reduction (30%)	657	705	759	717			$ 0.09
Window replacement (U=0.39: SHGC=0.40 vinyl)	978	1373	1280	1257			$ 0.04
White walls (alpha = 0.40)	56	256	299	233			$ 0.00
New Construction							
Energy Star Home (15% savings)	*1,791*	*2,042*	*2,118*	*2,021*	*100%*	*8,252*	*$ 0.06*
Tax Credit Eligible Home (25% savings)[4]	*1,075*	*1,616*	*2,507*	*1,857*	*50%*	*3,894*	*$ 0.03*
40% Savings Home[5]	*2,426*	*1,886*	*1,894*	*1,998*	*10%*	*838*	*$ 0.07*
Total Savings (GWh)	**10,649**	**21,579**	**20,827**			**40,293**	**$ 0.06**
% Savings (% of 2023 Projected Residential Sales)	**7%**	**14%**	**13%**			**22%**	

[1] Statewide average per home savings were calculated using a regional weighted average based on electricity sales: 20% for Jacksonville, 41% for Tampa, and 39% for Miami (Rose et. al. 1993).

[2] In existing homes, % applicable is the percent of efficiency measure savings assumed to be applied in homes statewide cost-effectively. For new homes, % applicable is the % of homes built between 2008 and 2023 that can cost-effectively achieve electricity savings from each measure.

[3] Package 2 efficiency measures also include measures in Package 1.

[4] Savings are incremental to Energy Star Homes.

[5] Savings are incremental to both Energy Star Homes and Tax Credit Eligible Homes.

Reference Case

Table A-9 below provides a detailed list of the features of the baseline residential buildings used for the simulation and analyses reported here.

Table A-9. Detailed Characteristics of Baseline Homes

Building type: Climate:	Existing Jacksonville	Existing Tampa	Existing Miami	New Jacksonville	New Tampa	New Miami
Envelope:						
conditioned floor area (ft^2)	1600	1600	1600	2200	2200	2200
no. stories	1	1	1	1	1	1
no. bedrooms	3	3	3	3	3	3
avg. ceiling ht (ft)	8	8	8	8.5	8.5	8.5
attached garage	yes	yes	yes	yes	yes	yes
foundation type	slab on grade	slab on grade	slab on grade	slab on grade	slab on grade	slab on grade
slab area (ft^2)	1600	1600	1600	2200	2200	2200
slab insulation	none	none	none	none	none	none
slab perimeter (ft)	167	167	167	188	188	188
roof type	hip	hip	hip	hip	hip	hip
pitch	4:12	4:12	4:12	5:12	5:12	5:12
cover	comp shingles	comp shingles	comp shingles	comp shingles	comp shingles	comp shingles
color	Dark	Dark	Dark	Dark	Dark	Dark
absorptance	0.92	0.92	0.92	0.92	0.92	0.92
insulation	none	none	none	none	none	none
attic type	standard	standard	standard	standard	standard	standard
ventilation	1:300	1:300	1:300	1:300	1:300	1:300
ceiling type	flat	flat	flat	flat	flat	flat
area (ft^2)	1600	1600	1600	2200	2200	2200
insulation	R-18.0	R-15	R-15	R-30.0	R-30.0	R-30.0
wall type	Wood Frame	Concrete block	Concrete block	Concrete block	Concrete block	Concrete block
insulation	R-11.0	R-1.0	R-1.0	R-3.0	R-3.0	R-3.0
sheathing R	none	none	none	none	none	none
absorptance	0.5	0.5	0.5	0.5	0.5	0.5
door type	insulated and wood	insulated and wood	insulated and wood	insulated	insulated	insulated
area (ft^2)	39	39	39	39	39	39
window type	double, std	single, std	single, std	double, low-e	double, low-e	double, low-e
size (% CFA)	15.0%	15.0%	15.0%	18.0%	18.0%	18.0%
orientation	equal	equal	equal	equal	equal	equal
U-Factor	0.75	1.2	1.2	0.75	0.75	0.75
SHGC	0.65	0.7	0.7	0.4	0.4	0.4
overhang (ft)	2	2	2	1.5	1.5	1.5
envelope leakage	standard	standard	standard	standard	standard	standard
rate (ach50)	8	8	8	8	8	8
HVAC Systems:						
mech. vent	none	none	none	none	none	none
cooling type	central	central	central	central	central	central
cooling SEER	9.25	9.25	9.5	13	13	13
heating type	Heat Pump	Heat Pump	Electric Strip	Heat Pump	Heat Pump	Heat Pump
HSPF	5.95	5.95	COP = 1	7.7	7.7	7.7
thermostat schedule	Fl existing proto	Fl existing proto	Fl existing proto	FL new proto	FL new proto	FL new proto
set points (°F)	68/78.5	68/78.5	68/78.5	68/78.5	68/78.5	68/78.5
air distribution system	forced air	forced air	forced air	forced air	forced air	forced air
duct insulation	4.2	4.2	4.2	8	8	8
duct location	Attic	Attic	Attic	Attic	Attic	Attic
AHU location	Garage	Garage	Garage	Garage	Garage	Garage

Building type: Climate:	Existing Jacksonville	Existing Tampa	Existing Miami	New Jacksonville	New Tampa	New Miami
duct leakage (Qn out)	0.1	0.1	0.1	0.1	0.1	0.1
return leak fraction	0.6	0.6	0.6	0.6	0.6	0.6
hot water (size and fuel type)	40 gal electric	40 gal electric	40 gal electric	50 gal electric	50 gal electric	50 gal electric
EF	0.86	0.86	0.86	0.9	0.9	0.9
Appliances:						
% fluorescent	10%	10%	10%	10%	10%	10%
eStar refrigerator	no	no	no	no	no	no
eStar dishwasher	no	no	no	no	no	no
eStar ceiling fans	no	no	no	no	no	no
eStar washer	no	no	no	no	no	no
dryer	electric	electric	electric	electric	electric	electric
range	electric	electric	electric	electric	electric	electric

Commercial Buildings

A total of 8 commercial building types were simulated and analyzed by this study. These prototypes have been developed by LBNL (Huang and Franconi 1999) based on the Commercial Buildings Energy Consumption Survey (EIA 1995). These prototypes represent building types, which cover 85% of the commercial building stock surveyed by CBECS. The building types are:

- Large office (>= 25,000 ft^2)
- Small office (< 25,000 ft^2)
- Large retail store (>= 25,000 ft^2)
- Small retail store (< 25,000 ft^2)
- School
- Hospital
- Large hotel
- Restaurant

A brief description of the building construction of each building prototype used in the analysis is given below.

<u>Large office</u>
Floor area: 90,000 ft^2
Number of floors: 6
Floor types: First floor, interior floor and top floor
Zones: Each floor has 4 perimeter zones and one core zone

<u>Small office</u>
Floor area: 6,600 ft^2
Number of floors: 1
Zone: Each floor has 2 zones

<u>Large retail store</u>
Floor area: 79,000 ft^2
Number of floors: 2

Floor types: First floor, and top floor
Zones: Each floor has a single zone

<u>Small retail store</u>
Floor area: 6,400 ft^2
Number of floors: 1
Zone: A single zone

<u>School</u>
Floor area: 16,000 ft^2
Number of floors: 2 for classrooms
Floor type: First floor, and top floor
Zones: Each floor has a multiplier for class room. Each class room has a floor area of 1,800 ft^2. In addition, the school has a library, gymnasium, auditorium, kitchen, and dinning area. The percentages of each zone compared to the total floor area are listed below:

Library	13%
Gymnasium	13%
Auditorium	8%
Kitchen	2%
Dinning	4%
Classroom	60%

<u>Hospital</u>
Floor area: 155,800 ft^2
Number of floors: 12
Floor type: First floor, interior floors and top floor
Zones: Each floor has patient rooms, core & public area, kitchen, hallway, and clinic. The percentages of each zone compared to the total floor area are listed below:

Patient room	15%
Core & public	35%
Kitchen	5%
Hallway	20%
Clinic	25%

<u>Large hotel</u>
Floor area: 250,000 ft^2
Number of floors: 10
Floor types: First floor, interior floor and top floor
Zones: Each floor has hotel rooms. Kitchen & laundry, and lobby & conference rooms are located in the first floor. The percentages of each zone compared to the total floor area are as listed below:

Hotel room	70%
Lobby/Conf	25%
Kitchen/Laun	5%

Sit-down restaurant
Floor area: 5,250 ft^2
Number of floors: 1
Zones: Consists of dining area and kitchen. The percentages of each zone compared to the total floor area are listed below:

Dining	80%
Kitchen	20%

The primary thermal envelope and HVAC characteristics for each of these prototypes are available from the Florida Solar Energy Center.Table A-10a below provides a detailed list of the features of the baseline commercial buildings used for the simulation and analyses reported here.

Table A-10a. Detailed Characteristics of Baseline Commercial Buildings

Small Office **Building Code** **Climate**	**Existing** **Jacksonville**	**Orlando**	**Miami**	**New** **Jacksonville**	**Orlando**	**Miami**
ExtWallRValue	5.600	5.600	5.600	2.000	2.000	2.000
ExtRoofRValue	12.600	12.600	12.600	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.500	1.580	1.580	1.220	1.220	1.220
WndSC	0.750	0.750	0.750	0.287	0.287	0.287
WWR	0.150	0.150	0.150	0.150	0.150	0.150
LgtWPerSF	1.700	1.700	1.700	1.000	1.000	1.000
ClgSysEff	9.220	9.220	9.220	10.100	10.100	10.100
HeatSysEff	0.780	0.780	0.780	0.800	0.800	0.800
FanWPerCfm	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800
Large Office Building Code Climate	Existing Jacksonville	Orlando	Miami	New Jacksonville	Orlando	Miami
ExtWallRValue	6.000	6.000	6.000	2.000	2.000	2.000
ExtRoofRValue	12.600	12.600	12.600	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.670	1.670	1.670	1.220	1.220	1.220
WndSC	0.710	0.710	0.710	0.287	0.287	0.287
WWR	0.500	0.500	0.500	0.150	0.150	0.150
LgtWPerSF	1.300	1.300	1.300	1.000	1.000	1.000
FanWPerCfm	0.800	0.800	0.800	1.250	1.250	1.250
ClgSysCop	3.800	3.800	3.800	5.000	5.000	5.000
HeatEff	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800
Large Hotel Building Code Climate	Existing Jacksonville	Orlando	Miami	New Jacksonville	Orlando	Miami
ExtWallRValue	6.200	6.200	6.200	2.000	2.000	2.000
ExtRoofRValue	14.000	14.000	14.000	19.000	19.000	19.000

Small Office						
Building Code	**Existing**			**New**		
Climate	**Jacksonville**	**Orlando**	**Miami**	**Jacksonville**	**Orlando**	**Miami**
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.670	1.670	1.670	1.220	1.220	1.220
WndSC	0.740	0.740	0.740	0.287	0.287	0.287
WWR	0.350	0.350	0.350	0.150	0.150	0.150
LgtWPerSF	1.500	1.500	1.500	1.000	1.000	1.000
FanWPerCfm	0.800	0.800	0.800	1.250	1.250	1.250
ClgSysCop	3.800	3.800	3.800	5.000	5.000	5.000
HeatSysEff	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800

Small Retail						
Building Code	Existing			New		
Climate	Jacksonville	Orlando	Miami	Jacksonville	Orlando	Miami
ExtWallRValue	4.400	4.400	4.400	2.000	2.000	2.000
ExtRoofRValue	12.200	12.200	12.200	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.300	1.300	1.300	1.220	1.220	1.220
WndSC	0.830	0.830	0.830	0.287	0.287	0.287
WWR	0.150	0.150	0.150	0.150	0.150	0.150
LgtWPerSF	1.800	1.800	1.800	1.500	1.500	1.500
ClgSysEff	9.220	9.220	9.220	10.100	10.100	10.100
HeatSysEff	0.780	0.780	0.780	0.800	0.800	0.800
FanWPerCfm	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800

Large Retail						
Building Code	Existing			New		
Climate	Jacksonville	Orlando	Miami	Jacksonville	Orlando	Miami
ExtWallRValue	4.800	4.800	4.800	2.000	2.000	2.000
ExtRoofRValue	12.000	12.000	12.000	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.500	1.500	1.500	1.220	1.220	1.220
WndSC	0.760	0.760	0.760	0.287	0.287	0.287
WWR	0.150	0.150	0.150	0.150	0.150	0.150
LgtWPerSF	1.600	1.600	1.600	1.500	1.500	1.500
FanWPerCfm	0.800	0.800	0.800	1.250	1.250	1.250
ClgSysCop	3.800	3.800	3.800	5.000	5.000	5.000
HeatSysEff	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800

Restaurant						
Building Code	Existing			New		
Climate	Jacksonville	Orlando	Miami	Jacksonville	Orlando	Miami
ExtWallRValue	4.900	4.900	4.900	2.000	2.000	2.000
ExtRoofRValue	13.200	13.200	13.200	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.530	1.530	1.530	1.220	1.220	1.220
WndSC	0.800	0.800	0.800	0.287	0.287	0.287
WWR	0.150	0.150	0.150	0.150	0.150	0.150
LgtWPerSF	2.000	2.000	2.000	1.600	1.600	1.600

Small Office **Building Code** **Climate**	**Existing** **Jacksonville**	**Orlando**	**Miami**	**New** **Jacksonville**	**Orlando**	**Miami**
ClgSysEff	9.220	9.220	9.220	10.100	10.100	10.100
HeatSysEff	0.780	0.780	0.780	0.800	0.800	0.800
FanWPerCfm	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800
School Building Code Climate	Existing Jacksonville	Orlando	Miami	New Jacksonville	Orlando	Miami
ExtWallRValue	5.700	5.700	5.700	2.000	2.000	2.000
ExtRoofRValue	13.300	13.300	13.300	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.700	1.700	1.700	1.220	1.220	1.220
WndSC	0.730	0.730	0.730	0.287	0.287	0.287
WWR	0.180	0.180	0.180	0.150	0.150	0.150
LgtWPerSF	2.200	2.200	2.200	1.200	1.200	1.200
FanWPerCfm	0.800	0.800	0.800	1.250	1.250	1.250
ClgSysCop	3.800	3.800	3.800	5.000	5.000	5.000
HeatSysEff	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800
Hospital Building Code Climate	Existing Jacksonville	Orlando	Miami	New Jacksonville	Orlando	Miami
ExtWallRValue	6.900	6.900	6.900	2.000	2.000	2.000
ExtRoofRValue	11.500	11.500	11.500	19.000	19.000	19.000
RoofAbs	0.700	0.700	0.700	0.700	0.700	0.700
WndUValue	1.960	1.960	1.960	1.220	1.220	1.220
WndSC	0.660	0.660	0.660	0.287	0.287	0.287
WWR	0.250	0.250	0.250	0.150	0.150	0.150
LgtWPerSF	1.150	1.150	1.150	1.200	1.200	1.200
FanWPerCfm	0.800	0.800	0.800	1.250	1.250	1.250
ClgSysCop	3.800	3.800	3.800	5.000	5.000	5.000
HeatSysEff	0.800	0.800	0.800	0.800	0.800	0.800
DHWEff	0.610	0.610	0.610	0.800	0.800	0.800

Table A-10b provides a list of the energy efficiency measures that were applied to the baseline commercial buildings for the analysis reported here.

Table A-10b. List of Measures Applied to Commercial Buildings Analysis

New Buildings	Sm. Office	Sm. Retail	Restaurant	Lg. Office	Lg. Hotel	Lg. Retail	School	Hospital
R Value of External Walls	13	13	13	13	13	13	13	13
R-Value of Roof	30	30	30	30	30	30	30	30
Roof Absorptivity	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Lighting Watts per SF	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Cooling System EER	12.5	12.5	12.5	---	---	---	---	---
Cooling Plant COP	---	---	---	6	6	6	6	6
Fan Watts per CFM	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Existing Buildings								
Roof Absorptivity	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Window Shading Coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lighting Watts per SF	1.22	1.296	1.44	0.936	1.08	1.152	1.584	0.828
Cooling System EER	12.5	12.5	12.5	---	---	---	---	---
Cooling Plant COP	---	---	---	4.7	4.7	4.7	4.7	4.7
Fan Watts per CFM	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

According to our analysis, the economic efficiency potential for the commercial sector is roughly 30%, or 39,495 GWh, by 2023. The majority of the savings come from energy efficiency improvements in existing buildings (20,765 GWh), while significant additional savings can be achieved through advanced new buildings (18,730 GWh). The breakdown of savings by building type and region are shown in Tables A-11a and A-11b.

Table A-11a. Economic Potential for Energy Efficiency in Existing Commercial Buildings by Building Type and Region

Existing Buildings		Sm. Office kWh/yr	Lg Office kWh/yr	Lg. Hotel kWh/yr	Sm. Retail kWh/yr	Lg. Retail kWh/yr	Restaurant kWh/yr	School kWh/yr	Hospital kWh/yr
Baseline Energy Use:	North	82,811	1,497,711	4,478,266	107,942	1,495,335	261,416	169,701	8,875,472
	Central	84,222	1,513,719	4,535,697	110,203	1,522,257	266,651	169,829	8,875,203
	South	92,969	1,598,047	4,958,332	123,123	1,640,157	291,759	186,381	9,167,816
Measure Savings:									
Roof Absorptivity	North	1,913	5,791	5,172	1,841	14,269	3,148	2,257	7,944
	Central	1,762	5,987	4,940	1,769	14,269	2,896	2,198	7,948
	South	1,961	7,075	5,794	1,887	15,702	3,154	2,533	7,736
Window Shading Coefficient (Film)	North	3,006	103,849	220,394	5,777	26,774	3,904	5,706	88,683
	Central	3,242	103,483	223,549	6,132	29,286	4,195	6,455	89,400
	South	3,646	115,221	252,162	7,307	35,855	4,733	8,528	94,501
Lighting Watts per SF (T-8 + Occ. Sen.)	North	13,813	127,166	549,128	17,774	260,129	30,635	24,029	925,865
	Central	14,054	181,969	565,877	17,882	267,623	31,563	24,683	932,139
	South	14,354	189,755	586,669	18,459	279,977	32,955	25,884	942,102
Cooling System (EER=12.6)	North	8,814	n/a	n/a	12,605	n/a	18,725	n/a	n/a
	Central	9,202	n/a	n/a	13,207	n/a	20,322	n/a	n/a
	South	11,504	n/a	n/a	16,592	n/a	26,958	n/a	n/a
Cooling Plant (COP=4.8)	North	n/a	72,999	248,905	n/a	58,836	n/a	9,505	439,281
	Central	n/a	77,031	261,048	n/a	63,164	n/a	9,870	441,932
	South	n/a	90,408	323,361	n/a	77,796	n/a	12,507	483,713
Fan Watts per CFM	North	n/a	40,559	105,772	n/a	31,268	n/a	3,651	201,215

Existing Buildings		**Sm. Office** kWh/yr	**Lg Office** kWh/yr	**Lg. Hotel** kWh/yr	**Sm. Retail** kWh/yr	**Lg. Retail** kWh/yr	**Restaurant** kWh/yr	**School** kWh/yr	**Hospital** kWh/yr
(VSD fans)	Central	n/a	40,119	107,549	n/a	32,426	n/a	3,538	202,007
	South	n/a	42,214	116,536	n/a	37,083	n/a	3,880	209,932
Existing Buildings Package	North	25,593	371,164	883,894	35,097	368,925	53,330	42,821	1,589,518
	Central	26,263	376,277	911,798	35,975	382,384	55,627	43,970	1,599,326
	South	29,340	409,181	1,001,513	40,694	418,319	63,937	50,127	1,661,679
Package savings (%)	North	30.9%	24.8%	19.7%	32.5%	24.7%	20.4%	25.2%	17.9%
	Central	31.2%	24.9%	20.1%	32.6%	25.1%	20.9%	25.9%	18.0%
	South	31.6%	25.6%	20.2%	33.1%	25.5%	21.9%	26.9%	18.1%
Statewide 2023 Savings	North	637	511	471	448	340	369	221	213
(GWh)	Central	1,822	1,452	1,360	1,274	981	1,068	643	607
	South	1,639	1,330	1,214	1,147	885	997	593	543
Total Statewide Savings	(GWh)	4,098	3,293	3,045	2,869	2,205	2,434	1,457	1,362

Notes: Our analysis estimates savings in the 15-year time period, 2008–2023. Regions and building types are weighted according to the 1993 Synergic Research Corporation Survey of Commercial Building End-Uses (Rose et al. 1993). Regions are weighted by commercial electricity sales: 45% in Orlando, 16% in Jacksonville, and 40% in Miami.

Table A-11b. Economic Potential for Energy Efficiency in New Commercial Buildings by Building Type and Region

New Buildings		**Sm. Office** kWh/yr	**Lg. Office** kWh/yr	**Lg. Hotel** kWh/yr	**Sm. Retail** kWh/yr	**Lg. Retail** kWh/yr	**Restaurant** kWh/yr	**School** kWh/yr	**Hospital** kWh/yr
Baseline Energy Use:	North	57,329	1,099,182	3,335,772	85,277	1,381,073	229,088	120,214	8,680,740
	Central	57,638	1,102,800	3,364,974	86,849	1,397,787	232,903	118,316	8,682,232
	South	64,520	1,150,160	3,677,604	95,797	1,490,302	255,129	121,702	8,967,943
Measure Savings:									
R-Value of External Walls	North	3,984	39,117	68,782	1,558	12,055	4,736	2,009	17,461
	Central	3,715	35,620	67,219	1,391	9,836	4,544	1,700	19,644
	South	4,674	37,012	89,376	1,876	14,100	6,299	1,367	56,568
R-Value of Roof	North	798	1,841	3,655	639	5,727	1,634	1,147	1,610
	Central	668	1,704	3,079	544	5,017	1,432	982	1,613
	South	839	2,214	3,337	647	5,084	1,664	1,010	2,565
Roof Absorptivity	North	1,362	3,332	3,696	1,180	10,362	2,324	1,359	5,218
	Central	1,187	3,195	4,004	1,098	9,934	2,174	1,214	5,269
	South	1,339	3,599	4,913	1,052	11,293	2,269	1,610	5,215
Lighting Watts per SF	North	11,224	191,399	535,096	31,125	515,179	53,786	21,681	1,701,701
(Daylighting)	Central	11,394	195,230	546,031	31,782	527,153	55,329	22,639	1,718,188
	South	11,765	203,257	567,066	32,227	555,731	58,647	24,259	1,748,307
Cooling System EER	North	5,224	n/a	n/a	7,232	n/a	10,887	n/a	n/a
	Central	5,261	n/a	n/a	7,525	n/a	11,771	n/a	n/a
	South	6611	n/a	n/a	9255	n/a	16070	n/a	n/a
Cooling Plant COP	North	n/a	98,708	351,663	n/a	120,606	n/a	14,941	890,159
	Central	n/a	99,854	362,573	n/a	125,596	n/a	14,292	896,659
	South	n/a	111502	428358	n/a	147452	n/a	14528	961437
Fan Watts per CFM	North	n/a	70,484	225,742	n/a	86,566	n/a	10,114	614,521
(VSD)	Central	n/a	70,279	231,287	n/a	89,204	n/a	9,277	619,243
	South	n/a	76,334	262,348	n/a	102,399	n/a	8,563	654,459

New Buildings		Sm. Office kWh/yr	Lg. Office kWh/yr	Lg. Hotel kWh/yr	Sm. Retail kWh/yr	Lg. Retail kWh/yr	Restaurant kWh/yr	School kWh/yr	Hospital kWh/yr
New Package Savings	North	20,706	310,516	903,523	39,754	615,604	70,134	43,470	2,469,063
	Central	20,490	311,889	922,420	40,307	627,716	71,753	42,457	2,485,340
	South	23,280	330,598	1,018,394	43,170	672,024	80,702	43,013	2,595,584
Package Savings (%)	North	36.1%	28.2%	27.1%	46.6%	44.6%	30.6%	36.2%	28.4%
	Central	35.5%	28.3%	27.4%	46.4%	44.9%	30.8%	35.9%	28.6%
	South	36.1%	28.7%	27.7%	45.1%	45.1%	31.6%	35.3%	28.9%
Statewide 2023 Savings (GWh)	North	472	370	428	409	391	354	217	206
	Central	1,318	1,048	1,227	1,154	1,117	1,009	611	589
	South	1,189	947	1,102	996	996	921	535	529
Total Statewide Savings	(GWh)	2,979	2,365	2,758	2,559	2,504	2,284	1,362	1,324

Notes: Our analysis estimates savings in the 15-year time period, 2008–2023. Regions and building types are weighted according to the 1993 Synergic Research Corporation Survey of Commercial Building End-Uses (Rose et al. 1993). Regions are weighted by commercial electricity sales: 45% in Orlando, 16% in Jacksonville, and 40% in Miami.

Combined Heat and Power Systems

Technical Potential for CHP

This section provides an estimate of the technical market potential for combined heat and power (CHP) in the industrial, commercial/institutional, and multi-family residential market sectors. The estimation of technical market potential consists of the following elements:

- Identification of applications where CHP provides a reasonable fit to the electric and thermal needs of the user. Target applications were identified based on reviewing the electric and thermal energy consumption data for various building types and industrial facilities.
- Quantification of the number and size distribution of target applications. Several data sources were used to identify the number of applications by sector that meets the thermal and electric load requirements for CHP.
- Estimation of CHP potential in terms of megawatt (MW) capacity. Total CHP potential is then derived for each target application based on the number of target facilities in each size category and sizing criteria appropriate for each sector.
- Subtraction of existing CHP from the identified sites to determine the remaining technical market potential.

The technical market potential does not consider screening for economic rate of return, or other factors such 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 potential as outlined is useful in understanding the potential size and size distribution of the target CHP markets in the state. Identifying technical market potential is a preliminary step in the assessment of market penetration.

The basic approach to developing the technical potential is described below:

- *Identify applications where CHP provides a reasonable fit to the electric and thermal needs of the user.* Target applications were identified based on reviewing the electric and thermal energy (heating and cooling) consumption data for various building types and industrial facilities. Data sources include the DOE EIA *Commercial Buildings Energy Consumption Survey (CBECS),* the DOE *Manufacturing Energy Consumption Survey (MECS)* and various market summaries developed by DOE, Gas Technology Institute (GRI), and the American Gas Association. Existing CHP installations in the commercial/institutional and industrial sectors were also reviewed to understand the required profile for CHP applications and to identify target applications.

- *Quantify the number and size distribution of target applications.* Once applications that could technically support CHP were identified, the iMarket, Inc. *MarketPlace Database* and the *Major Industrial Plant Database* (MIPD) from IHI were utilized to identify potential CHP sites by SIC code or application, and location (county). The *MarketPlace Database* is based on the Dun and Bradstreet financial listings and includes information on economic activity (8 digit SIC), location (metropolitan area, county, electric utility service area, state) and size (employees) for commercial, institutional and industrial facilities. In addition, for select SICs limited energy consumption information (electric and gas consumption, electric and gas expenditures) is provided based on data from Wharton Econometric Forecasting (WEFA). MIPD has detailed energy and process data for 16,000 of the largest energy consuming industrial plants in the United States. The *MarketPlace Database* and MIPD were used to identify the number of facilities in target CHP applications and to group them into size categories based on average electric demand in kilowatt-hours.

- *Estimate CHP potential in terms of MW capacity.* Total CHP potential was then derived for each target application based on the number of target facilities in each size category. It was assumed that the CHP system would be sized to meet the average site electric demand for the target applications unless thermal loads (heating and cooling) limited electric capacity. **Tables A-1-1 and A-1-2** present the specific target market sectors, the number of potential sites and the potential MW contribution from CHP.

- *Estimate the growth of new facilities in the target market sectors.* The technical potential included economic projections for growth through 2020 by target market sectors in Florida. The growth factors used in the analysis for growth between the present and 2020 by individual sectors are shown in **Table A-1-3**. Unless otherwise indicated, the growth rates represent the annualized 5-year (2000-2004) trend in GDP quantity growth indices by industry as reported by the Bureau of Economic Analysis. The BEA reports industries by NAICS which was mapped to the older SIC basis used by the market databases described above. Sectors that have been growing annually at greater than 5% per year are capped at 5% per year for the long-term growth estimate. Sectors that are declining are assumed to have zero growth during the forecast period. ACEEE provided growth rates for selected industries in the manufacturing sector; these growth rates were used as provided.

Two different types of CHP markets were included in the evaluation of technical potential. Both of these markets were evaluated for high and low load factor applications resulting in four distinct market segments that are analyzed. The markets, summarized in **Table A-1-4**, are described below:

- **Traditional CHP**—electric output is produced to meet all or a portion of the base load for a facility and the thermal energy is used to provide steam or hot water. Depending on the type of facility, the appropriate sizing could be either electric or thermal limited. Industrial facilities often have "excess" thermal load compared to their on-site electric load. Commercial facilities almost always have excess electric load compared to their thermal load. Two sub-categories were considered:
- **High load factor applications**—This market provides for continuous or nearly continuous operation. It includes all industrial applications and round-the-clock commercial/institutional operations such colleges, hospitals, hotels, and prisons.
- **Low load factor applications**—Some commercial and institutional markets provide an opportunity for coincident electric/thermal loads for a period of 3,500 to 5,000 hours per year. This sector includes applications such as office buildings, schools, and laundries.
- **Combined Cooling Heating and Power (CCHP)** —All or a portion of the thermal output of a CHP system can be converted to air conditioning or refrigeration with the addition of a thermally activated cooling system. This type of system can potentially open up the benefits of CHP to facilities that do not have the year-round thermal load to support a traditional CHP system. A typical system would provide the annual hot water load, a portion of the space heating load in the winter months and a portion of the cooling load in during the summer months. Two sub-categories were considered:
- **Low load factor applications**—These represent markets that otherwise could not support CHP due to a lack of thermal load.

Table A-12. Florida Technical Market Potential for CHP in Existing Facilities—Industrial Sector

SIC	Description	50-500 kW		500-1000 kW		1-5 MW		5-20 MW		> 20 MW		Total	
		Sites	MW	Sites	MW	Sites	MW	Sites	MW	Sites	MW	Sites	MW
20	Food	279	42	73	55	33	83	4	42			389	221
22	Textiles	73	8	12	7	2	4					87	19
24	Lumber and Wood	263	8	32	5	3	2					298	14
25	Furniture	17	1									17	1
26	Paper	98	15	44	33	23	58	1	18	1	30	167	153
27	Printing/Publishing	123	18	12	9	1	3					136	30
28	Chemicals	242	36	70	53	57	143			2	48	371	279
29	Petroleum Refining	43	6	4	3	1	3					48	12
30	Rubber/Misc Plastics	212	10	116	26	34	26					362	61
32	Stone/Clay/Glass	8	1									8	1
33	Primary Metals	32	1	7	1	1	1					40	3
34	Fabricated Metals	119	5	13	3	5	4	1	18			138	30
35	Machinery/Computer Equip	46	2	5	1							51	3
36	Electrical and electronic equipment							1	5			1	5
37	Trasportation Equip.	100	8	44	17	27	34			1	27	172	85
38	Instruments	28	2	8	3			1	7			37	12
39	Misc Manufacturing	38	1	4	1							42	2
	Total Industrial	1,721	165	444	215	187	356	8	91	4	106	2,364	933

Table A-13. Florida Technical Market Potential for CHP in Existing Facilities—Commercial and Institutional Sectors

SIC	Description	50-500 kW		500-1000 kW		1-5 MW		5-20 MW		> 20 MW		Total	
		Sites	MW	Sites	MW	Sites	MW	Sites	MW	Sites	MW	Sites	MW
4222, 5142	Warehouses	55	8									55	8
43	Post Offices	58	9	1	1							59	9
4581	Airports	3,309	248	1,323	496	330	413	25	156			4,987	1,313
4941, 4952	Water Treatment/Sanitary	1,065	80	386	145	60	75					1,511	300
52,53,56,57	Big Box Retail	141	21	1	1							142	22
5411, 5421, 5451, 5461, 5499	Food Sales	118	18									118	18
5812, 00, 01, 03, 05, 07, 08	Restaurants	94	14	3	2	1	3					98	19
6512	Office Buildings - Cooling	52	8	28	21	1	3					81	31
6513	Apartments	106	16	48	36	33	83					187	134
7011, 7041	Hotels	1,661	249	437	328	106	265					2,204	842
7211, 7213, 7218	Laundries	2,257	169	412	155	13	16					2,682	340
7542	Carwashes	3,054	229	23	9							3,077	238
7832	Movie Theaters	2,159	324	477	358	164	410	7	88			2,807	1,179
7991, 00, 01	Health Clubs	73	11	3	2							76	13
7992, 7997-9904, 7997-9906	Golf/Country Clubs	320	48	17	13	1	3					338	63
8051, 8052, 8059	Nursing Homes	677	102	50	38	1	3					728	142
8062, 8063, 8069	Hospitals	533	96	286	257	18	54					837	407
8211, 8243, 8249, 8299	Schools	122	22	90	81	165	495					377	598
8221, 8222	Colleges/Universities	1,107	42	183	34	20	13			1	25	1,311	113
8412	Museums	146	22	95	71	52	130	16	200			309	423
9223, 9211 (Courts), 9224 (firehouses)	Prisons	50	8	135	101	61	153	18	225			264	486
	Commercial, Institutional Totals	17,157	1,742	3,998	2,148	1,026	2,115	66	669	1	25	22,248	6,699

- **Incremental high load factor applications**—These markets represent round-the-clock commercial/institutional facilities that could support traditional CHP, but with cooling, incremental capacity could be added while maintaining a high level of utilization of the thermal energy from the CHP system. All of the market segments in this category are also included in the high load factor traditional market segment, so only the incremental capacity for these markets is added to the overall totals.

Table A-14. Target Market Sectors for CHP and Florida Sector Growth Projections Through 2020

SIC	Industry Description	Florida	Florida Annual Growth Rate	Florida Growth 2007-2020
20	Food	0.99	-1.00%	0%
22	Textiles	0.98	-2.00%	0%
24	Lumber and Wood	1.05	4.70%	99%
25	Furniture	1.02	2.36%	42%
26	Paper	0.99	-1.00%	0%
27	Printing/Publishing	1.01	0.55%	9%
28	Chemicals	1.00	0.27%	4%
29	Petroleum Refining	1.01	1.17%	19%
30	Rubber/Misc Plastics	1.01	1.08%	17%
32	Stone/Clay/Glass	1.02	2.05%	36%
33	Primary Metals	1.01	0.75%	12%
34	Fabricated Metals	0.98	-1.51%	0%
35	Machinery/Computer Equip	1.08	8.00%	110%
37	Trasportation Equip.	0.99	-1.00%	0%
38	Instruments	0.99	-0.52%	0%
39	Misc Manufacturing	1.09	9.27%	110%
4222, 5142	Warehouses	1.01	1.29%	21%
4941, 4952	Water Treatment/Sanitary	1.02	2.31%	41%
5411, 5421, 5451, 5461, 5499	Food Sales	1.06	5.90%	110%
5812, 00, 01, 03, 05, 07, 08	Restaurants	1.04	4.41%	91%
7011, 7041	Hotels	1.01	1.04%	17%
7211, 7213, 7218	Laundries	1.06	5.90%	110%
7542	Carwashes	1.06	5.90%	110%
7991, 00, 01	Health Clubs	1.03	2.62%	47%
7992, 7997-9904, 7997-9906	Golf/Country Clubs	1.03	2.62%	47%
8051, 8052, 8059	Nursing Homes	1.02	1.59%	27%
8062, 8063, 8069	Hospitals	1.02	1.59%	27%
8211, 8243, 8249, 8299	Schools	1.03	2.55%	46%
8221, 8222	Colleges/Universities	1.03	2.55%	46%
8412	Museums	1.00	-0.44%	0%
9223, 9211 (Courts), 9224 (firehouses)	Prisons	1.01	1.21%	20%
6513	Apartments	1.06	5.88%	110%
43	Post Offices	1.01	1.43%	24%
4581	Airports	1.05	4.82%	103%
52,53,56,57	Big Box Retail	1.06	5.90%	110%
7832	Movie Theaters	1.02	1.66%	28%
7011, 7041	Hotels- Cooling	1.01	1.04%	17%
8051, 8052, 8059	Nursing Homes- Cooling	1.02	1.59%	27%
8062, 8063, 8069	Hospitals- Cooling	1.02	1.59%	27%
6512	Office Buildings - Cooling	1.06	5.88%	110%

Color Code
Long term growth capped at 5% per year
Declining Industry -- no growth
Growth specified by ACEEE

Table A-15. CHP Market Segments, Florida Existing Facilities and Expected Growth 2007-2020

Market	50-500 kW MW	500-1 MW (MW)	1-5 MW (MW)	5-20 MW (MW)	>20 MW (MW)	Total MW
Traditional High Load Factor Market						
Existing Facilities	639	1,140	1,564	582	131	4,055
New Facilities	145	275	295	116	2	833
Total	783	1,415	1,859	698	133	4,888
Traditional Low Load Factor Market						
Existing Facilities	237	90	20	0	0	347
New Facilities	94	32	4	0	0	130
Total	331	122	24	0	0	477
Cooling CHP High Load Factor Market (partially additive)						
Existing Facilities	442	696	959	88	0	2,184
New Facilities	64	113	163	9	0	349
Total	506	809	1,122	97	0	2,534
Cooling CHP Low Load Factor Market						
Existing Facilities	930	988	694	156	0	2,768
New Facilities	718	814	573	131	0	2,236
Total	1,649	1,801	1,267	288	0	5,004
Total Market including Incremental Cooling Load						
Existing Facilities	1,939	2,426	2,565	765	131	7,825
New Facilities	976	1,155	921	250	2	3,304
Total	2,915	3,581	3,486	1,015	133	11,130

Note: High load factor cooling market is comprised of a portion of the traditional high load factor market that has both heating and cooling loads. The total high load factor cooling market is shown, but only 30% of it is incremental to the portion already counted in the traditional high load factor market.

Energy Price Projections

The expected future relationship between purchased natural gas and electricity prices, called the *spark spread* in this context, is one major determinant of the ability of a facility with electric and thermal energy requirements to cost-effectively utilize CHP. For this screening analysis, a fairly simple methodology was used:

Electric Price Estimation

- Existing gas and electric price levels for the industrial market were taken from the EIA 2005 state average price of 7.14 cents/kWh.
- The future electric prices are based on the rate of change in the EIA early release *Annual Energy Outlook 2007* (2006d estimate of average electric prices multiplied by the EIA 2005 Florida actual price. This price track is shown in **Table A-2-1**.
- Based on the average industrial price above, price differentials were estimated for the 5 CHP market size bins covered by the analysis. These price differentials are based on prior detailed utility rate analysis undertaken for a number of utilities in California and New York. The factors applied to the EIA average industrial price are as follows:

- 50-500 kW—116%
- 500-1000 kW—105%
- 1-5 MW—100%
- 5-20 MW—91%
- >20 MW—91%

- Price adjustments for customer load factor were defined as follows:

  - High load factor—100% of the estimated value
  - Low load factor—120% of the estimated value
  - Peak cooling load—179% of the estimated value

- For a customer generating a portion of his own power with CHP, standby charges are estimated at 15% of the defined average electric rate. Therefore, when considering CHP, only 85% of a customer's rate can be avoided.

Natural Gas Price Estimation

- Current industrial natural gas price is defined from the EIA 2005 actual of $7.64/MMBtu.
- Wellhead gas real prices over the forecast period are based on the *Annual Energy Outlook 2007* as shown in **Table A-2-1.** This EIA forecast is very close to the price assumptions used by the Regional Greenhouse Gas Initiative.
- The wellhead gas prices were "marked up" to retail prices using first a city-gate adder of $0.20/MMBtu and then retail adders were included as follows:

  - 50-500 kW—$1.00/MMBtu for boiler fuel, $0.25/MMBtu for CHP fuel
  - 500-1000 kW—$0.40/MMBtu for boiler fuel, $0.25/MMBtu for CHP fuel
  - 1-5 MW—$0.40/MMBtu for boiler fuel, $0.25/MMBtu for CHP fuel
  - 5-20 MW—$0.25/MMBtu for both boiler fuel and CHP fuel
  - >20 MW—$0.25/MMBtu for both boiler fuel and CHP fuel.

Table A-16. Input Price Forecast and Florida Industrial Electric Price Estimation

Year	Wellhead Natural Gas	Average Retail Electricity		Florida Industrial Electricity
	$/MMBtu	$/MMBtu	$/kWh	$/kWh
2005	$7.29	$23.70	$0.0809	$0.0646
2006	$6.47	$24.38	$0.0832	$0.0665
2007	$6.45	$24.32	$0.0830	$0.0663
2008	$6.40	$24.30	$0.0829	$0.0662
2009	$5.88	$24.02	$0.0820	$0.0655
2010	$5.59	$23.66	$0.0808	$0.0645
2011	$5.17	$23.09	$0.0788	$0.0629
2012	$5.02	$22.80	$0.0778	$0.0622
2013	$4.87	$22.66	$0.0774	$0.0618
2014	$4.90	$22.55	$0.0769	$0.0615
2015	$4.84	$22.55	$0.0769	$0.0615
2016	$4.94	$22.69	$0.0774	$0.0618
2017	$5.13	$22.95	$0.0783	$0.0625
2018	$5.05	$23.14	$0.0790	$0.0631
2019	$4.99	$23.09	$0.0788	$0.0629
2020	$5.07	$23.15	$0.0790	$0.0631

Source: EIA 2006d

CHP Technology Cost and Performance

The CHP system itself is the engine that drives the economic savings. The cost and performance characteristics of CHP systems determine the economics of meeting the site's electric and thermal loads. A representative sample of commercially and emerging CHP systems was selected to profile performance and cost characteristics in combined heat and power (CHP) applications. The selected systems range in capacity from approximately 100–20,000 kW. The technologies include gas-fired reciprocating engines, gas turbines, microturbines and fuel cells. The appropriate technologies were allowed to compete for market share in the penetration model. In the smaller market sizes, reciprocating engines competed with microturbines and fuel cells. In intermediate sizes (1 to 20 MW), reciprocating engines competed with gas turbines.

Cost and performance estimates for the CHP systems were based on work previously conducted for NYSERDA (Energy Nexus Group[15] 2002) on peer-reviewed technology characterizations that the Energy and Environmental Analysis (EEA) developed for the National Renewable Energy Laboratory (NREL 2003), and on follow-on work conducted by DE Solutions for Oak Ridge National Laboratory (DE Solutions 2004). Additional emissions characteristics and cost and performance estimates for emissions control technologies were based on ongoing work EEA is conducting for EPRI (2005). Data is presented for a range of sizes that include basic electrical performance characteristics, CHP performance

[15] Energy Nexus Group later became part of Energy and Environmental Analysis, Inc.

characteristics (power to heat ratio), equipment cost estimates, maintenance cost estimates, emission profiles with and without after-treatment control, and emissions control cost estimates. The technology characteristics are presented for three years: 2005, 2010, 2020. The 2005 estimates are based on current commercially available and emerging technologies. The cost and performance estimates for 2010 and 2020 reflect current technology development paths and currently planned government and industry funding. These projections were based on estimates included in the three references mentioned above. NOx, CO and VOC emissions estimates in lb/MWh are presented for each technology both with and without aftertreatment control (AT). NOx emissions are presented with and without a CHP thermal credit (using a displaced emissions approach and displaced boiler emissions of 0.2 lb/MMBtu for all technologies). Which system is applicable in any size category (e.g., with aftertreatment or without) is a function of the specific emissions requirements assumptions for each scenario. The installed costs in the following technology performance summary tables are based on typical national averages.

Table A-17. Reciprocating Engines

Size and Type	Characterization	2005	2012	2020
100 kW Rich Burn	Capacity, kW	100	100	100
	Installed Costs, $/kW	1,550	1,350	1,100
w/three way catalyst	Heat Rate, Btu/kWh	11,500	10,830	10,500
	Electric Efficiency, %	29.7%	31.5%	32.5%
	Power to Heat Ratio	0.61	0.67	0.7
	Thermal Output, Btu/kWh	5593	5093	4874
	O&M Costs, $/kWh	0.018	0.013	0.012
	NOx Emissions, lbs/MWh (no AT)	40	40	40
	NOx Emissions, lbs/MWh (w/ AT)	0.5	0.25	0.2
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, gm/bhp-hr	13.00	10.00	10.00
	CO Emissions w/AT, lb/MWh	1.87	0.60	0.30
	VOC Emissions w/AT, lb/MWh	0.47	0.09	0.05
	PMT 10 Emissions, lb/MWh	0.11	0.11	0.11
	SO2 Emissions, lb/MWh	0.0068	0.0064	0.0062
	AT Cost, $/kW	N/A	N/A	N/A
300 kW Rich Burn	Capacity, kW	300	300	300
	Installed Costs, $/kW	1,250	1,150	1,050
w/three way catalyst	Heat Rate, Btu/kWh	11,500	10,830	10,500
	Electric Efficiency, %	29.7%	31.5%	32.5%
	Power to Heat Ratio	0.61	0.67	0.7
	Thermal Output, Btu/kWh	5593	5093	4874
	O&M Costs, $/kWh	0.013	0.012	0.01
	NOx Emissions, lbs/MWh (no AT)	40	40	40
	NOx Emissions, lbs/MWh (w/ AT)	0.5	0.25	0.2
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, gm/bhp-hr	13.00	10.00	10.00
	CO Emissions, gm/bhp-hr	13	10	10
	CO Emissions w/AT, lb/MWh	1.87	0.60	0.30
	VOC Emissions w/AT, lb/MWh	0.47	0.09	0.05
	PMT 10 Emissions, lb/MWh	0.10	0.10	0.10
	SO2 Emissions, lb/MWh	0.0068	0.0064	0.0062
	AT Cost, $/kW	50	50	45
800 kW Lean Burn	Capacity, kW	800	800	800
	Installed Costs, $/kW	1,200	1,100	950
	Heat Rate, Btu/kWh	10,650	9,750	9,225
AT is SCR	Electric Efficiency, %	32.0%	35.0%	37.0%
	Power to Heat Ratio	0.8	0.9	1.05
% NOx reduction w/AT	Thermal Output, Btu/kWh	4265	3791	3250
2005 - 40%	O&M Costs, $/kWh	0.012	0.01	0.009
2010 - 30%	NOx Emissions, gm/bhphr	0.8	0.4	0.3
2020 - 40%	NOx Emissions, lbs/MWh (no AT)	2.48	1.24	0.93
	NOx Emissions, lbs/MWh (no AT; w/CHP)	1.41	0.29	0.12
	NOx Emissions, lbs/MWh (w/ AT)	1.49	0.87	0.56
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, gm/bhp-hr	3	2.5	2
	CO Emissions w/AT, lb/MWh	0.87	0.45	0.31
	VOC Emissions w/AT, lb/MWh	0.38	0.05	0.05
	PMT 10 Emissions, lb/MWh	0.01	0.01	0.01
	SO2 Emissions, lb/MWh	0.0063	0.0057	0.0054
	AT Cost, $/kW	300	190	140
3,000 kW Lean Burn	Capacity, kW	3000	3000	3000
	Installed Costs, $/kW	950	925	875
	Heat Rate, Btu/kWh	9,700	8,750	8,325
AT is SCR	Electric Efficiency, %	35.2%	39.0%	41.0%
	Power to Heat Ratio	1.04	1.07	1.18
% NOx reduction w/AT	Thermal Output, Btu/kWh	3281	3189	2892
2005 - 30%	O&M Costs, $/kWh	0.0085	0.0083	0.008
2010 - 30%	NOx Emissions, gm/bhphr	0.7	0.4	0.25
2020 - 30%	NOx Emissions, lbs/MWh (no AT)	2.17	1.24	0.775
	NOx Emissions, lbs/MWh (no AT; w/CHP)	1.35	0.44	0.05
	NOx Emissions, lbs/MWh (w/ AT)	1.52	0.87	0.53
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, gm/bhp-hr	2.5	2	2
	CO Emissions w/AT, lb/MWh	0.78	0.31	0.31
	VOC Emissions w/AT, lb/MWh	0.34	0.10	0.10
	PMT 10 Emissions, lb/MWh	0.01	0.01	0.01
	SO2 Emissions, lb/MWh	0.0057	0.0051	0.0049
	AT Cost, $/kW	200	130	100
5,000 kW Lean Burn	Capacity, kW	5000	5000	5000
	Installed Costs, $/kW	925	900	850
	Heat Rate, Btu/kWh	9,213	8,325	7,935
AT is SCR	Electric Efficiency, %	37.0%	41.0%	43.0%
	Power to Heat Ratio	1.02	1.22	1.31
% NOx reduction w/AT	Thermal Output, Btu/kWh	3345	2797	2605
2005 - 20%	O&M Costs, $/kWh	0.008	0.008	0.008
2010 - 30%	NOx Emissions, gm/bhphr	0.5	0.4	0.25
2020 - 30%	NOx Emissions, lbs/MWh (no AT)	1.55	1.24	0.775
	NOx Emissions, lbs/MWh (no AT; w/CHP)	0.71	0.54	0.12
	NOx Emissions, lbs/MWh (w/ AT)	1.24	0.87	0.54
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, gm/bhp-hr	2.5	2	2
	CO Emissions w/AT, lb/MWh	0.75	0.31	0.31
	VOC Emissions w/AT, lb/MWh	0.22	0.1	0.1
	PMT 10 Emissions, lb/MWh	0.01	0.01	0.01
	SO2 Emissions, lb/MWh	0.0054	0.0049	0.0047
	AT Cost, $/kW	150	115	80

CHP thermal credit based on Displaced Boiler Emissions = 0.2 lbs/MMBtu
AT = Aftertreament

Additional O&M Costs for SCR

Size and Type	2005	2012	2020	
800 kW Lean Burn	0.005	0.003	0.002	SCR Adder, $/kWh
	0.017	0.013	0.011	New total O&M w/SCR, $/kWh
3,000 kW Lean Burn	0.003	0.002	0.002	SCR Adder, $/kWh
	0.011	0.011	0.010	New total O&M w/SCR, $/kWh
5,000 kW Lean Burn	0.002	0.002	0.001	SCR Adder, $/kWh
	0.010	0.010	0.009	New total O&M w/SCR, $/kWh

Table A-18. Gas Turbines

Size and Type	Characterization	2005	2012	2020
1 MW Gas Turbine	Capacity, MW	1	1	1
	Installed Costs, $/kW	1,900	1,500	1,300
	Heat Rate, Btu/kWh	15,580	14,500	13,500
AT is SCR	Electric Efficiency, %	21.9%	23.5%	25.3%
	Power to Heat Ratio	0.51	0.61	0.7
	Thermal Output, Btu/kWh	6690	5593	4874
	O&M Costs, $/kWh	0.01	0.013	0.012
	NOx Emissions, ppm	*42.0*	*15.0*	*9.0*
	NOx Emissions, lbs/MWh (no AT)	2.2	0.7	0.4
	NOx Emissions, lbs/MWh (no AT; w/CHP)	0.53	-0.70	-0.82
	NOx Emissions, lbs/MWh (w/ AT)	0.22	0.07	0.04
	CO Emissions, ppm	6	20	20
	CO Emissions, lb/MWh	0.027	0.6	0.56
	VOC Emissions, lb/MWh	0.027	0.025	0.023
	PMT 10 Emissions, lb/MWh	0.32	0.30	0.28
	SO2 Emissions, lb/MWh	0.0092	0.0085	0.0079
	AT Cost, $/kW	300	250	150
3 MW Gas Turbine	Capacity, MW	3	3	3
	Installed Costs, $/kW	1,300	1,200	1,000
	Heat Rate, Btu/kWh	13,100	12,650	11,200
	Electric Efficiency, %	26.0%	27.0%	30.5%
AT is SCR	Power to Heat Ratio	0.68	0.76	0.84
	Thermal Output, Btu/kWh	5018	4489	4062
	O&M Costs, $/kWh	0.006	0.005	0.005
	NOx Emissions, ppm	15.0	9.0	5.0
	NOx Emissions, lbs/MWh (no AT)	0.68	0.38	0.2
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.57	-0.74	-0.82
	NOx Emissions, lbs/MWh (w/ AT)	0.068	0.038	0.02
	CO Emissions, ppm	20	20	20
	CO Emissions, lb/MWh	0.55	0.53	0.47
	VOC Emissions, lb/MWh	0.027	0.025	0.023
	PMT 10 Emissions, lb/MWh	0.21	0.20	0.18
	SO2 Emissions, lb/MWh	0.007	0.0069	0.0069
	AT Cost, $/kW	*210*	*175*	*150*
5 MW Gas Turbine	Capacity, MW	5	5	5
	Installed Costs, $/kW	1,100	1,000	950
	Heat Rate, Btu/kWh	12,590	11,375	10,500
	Electric Efficiency, %	27.1%	30.0%	32.5%
AT is SCR	Power to Heat Ratio	0.68	0.76	0.84
	Thermal Output, Btu/kWh	5018	4489	4062
	O&M Costs, $/kWh	0.006	0.005	0.005
	NOx Emissions, ppm	15.0	9.0	5.0
	NOx Emissions, lbs/MWh (no AT)	0.68	0.38	0.2
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.57	-0.74	-0.82
	NOx Emissions, lbs/MWh (w/ AT)	0.068	0.038	0.02
	AT Cost, $/kW	210	175	150
10 MW Gas Turbine	Capacity, MW	10	10	10
	Installed Costs, $/kW	965	950	850
	Heat Rate, Btu/kWh	11,765	10,800	9,950
	Electric Efficiency, %	29.0%	31.6%	34.3%
AT is SCR	*Power to Heat Ratio*	*0.73*	*0.84*	*0.94*
	Thermal Output, Btu/kWh	4674	4062	3630
	O&M Costs, $/kWh	0.006	0.005	0.005
	NOx Emissions, ppm	15.0	9.0	5.0
	NOx Emissions, lbs/MWh (no AT)	0.67	0.37	0.2
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.50	-0.65	-0.71
	NOx Emissions, lbs/MWh (w/ AT)	0.067	0.037	0.02
	CO Emissions, ppm	20	20	20
	CO Emissions, lb/MWh	0.5	0.46	0.42
	VOC Emissions, lb/MWh	0.022	0.021	0.02
	PMT 10 Emissions, lb/MWh	0.2	0.18	0.17
	SO2 Emissions, lb/MWh	0.0069	0.0064	0.0059
	AT Cost, $/kW	140	125	100
25 MW Gas Turbine	Capacity, MW	25	25	25
	Installed Costs, $/kW	800	755	725
	Heat Rate, Btu/kWh	9,945	9,225	8,865
	Electric Efficiency, %	34.3%	37.0%	38.5%
AT is SCR	Power to Heat Ratio	0.95	1.04	1.1
	Thermal Output, Btu/kWh	3592	3281	3102
	O&M Costs, $/kWh	0.005	0.005	0.004
	NOx Emissions, ppm	15.0	5.0	3.0
	NOx Emissions, lbs/MWh (no AT)	0.6	0.2	0.1
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.30	-0.62	-0.68
	NOx Emissions, lbs/MWh (w/ AT)	0.06	0.02	0.01
	CO Emissions, ppm	20	20	20
	CO Emissions w/AT, lb/MWh	0.05	0.05	0.04
	VOC Emissions w/AT, lb/MWh	*0.01*	*0.01*	*0.01*
	PMT 10 Emissions, lb/MWh	0.17	0.16	0.15
	SO2 Emissions, lb/MWh	0.0058	0.0054	0.0052
	AT Cost, $/kW	100	80	50
40 MW Gas Turbine	Capacity, MW	40	40	40
	Installed Costs, $/kW	700	680	660
	Heat Rate, Btu/kWh	9,220	8,865	8,595
	Electric Efficiency, %	37.0%	38.5%	39.7%
AT is SCR	Power to Heat Ratio	1.07	1.13	1.18
	Thermal Output, Btu/kWh	3189	3019	2892
	O&M Costs, $/kWh	0.004	0.004	0.004
	NOx Emissions, ppm	15.0	5.0	3.0
	NOx Emissions, lbs/MWh (no AT)	0.55	0.2	0.1
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.25	-0.55	-0.62
	NOx Emissions, lbs/MWh (w/ AT)	0.055	0.02	0.01
	CO Emissions, ppm	20	20	20
	CO Emissions w/AT, lb/MWh	0.04	0.04	0.04
	VOC Emissions w/AT, lb/MWh	0.01	0.01	0.01
	PMT 10 Emissions, lb/MWh	0.157	0.15	0.15
	SO2 Emissions, lb/MWh	0.0054	0.0052	0.0051
	AT Cost, $/kW	90	75	40

CHP Thermal credit based on Displaced Boiler Emissions = 0.2 lbs/MMBtu
AT = Aftertreatment

Table A-19. Microturbines

Size and Type	Characterization	2005	2012	2020
70-100 kW	Capacity, kW	70	70	70
	Installed Costs, $/kW	2,200	1,800	1,400
	Heat Rate, Btu/kWh	13,500	12,500	11,375
	Electric Efficiency, %	25.3%	27.3%	30.0%
	Power to Heat Ratio	0.7	0.9	1.1
	Thermal Output, Btu/kWh	4874	3791	3102
	O&M Costs, $/kWh	0.017	0.016	0.012
	NOx Emissions, ppm	3.0	3.0	3.0
	NOx Emissions, lbs/MWh (no AT)	0.15	0.14	0.13
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-1.07	-0.81	-0.65
	NOx Emissions, lbs/MWh (w/ AT)	N/A	N/A	N/A
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, ppm	8	8	8
	CO Emissions, lb/MWh	0.24	0.22	0.20
	VOC Emissions, lb/MWh	0.027	0.025	0.023
	PMT 10 Emissions, lb/MWh	0.22	0.20	0.19
	SO2 Emissions, lb/MWh	0.0079	0.0074	0.0067
	AT Cost, $/kW	N/A	N/A	N/A
250 kW	Capacity, kW	250	250	250
	Installed Costs, $/kW	2,000	1,600	1,200
	Heat Rate, Btu/kWh	11,850	11,750	10,825
	Electric Efficiency, %	28.8%	29.0%	31.5%
	Power to Heat Ratio	0.94	1	1.3
	Thermal Output, Btu/kWh	3630	3412	2625
	O&M Costs, $/kWh	0.016	0.015	0.012
	NOx Emissions, ppm	9.0	5.0	3.0
	NOx Emissions, lbs/MWh (no AT)	0.43	0.24	0.13
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.48	-0.62	-0.53
	NOx Emissions, lbs/MWh (w/ AT)	N/A	N/A	N/A
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	N/A	N/A	N/A
	CO Emissions, ppm	9	9	9
	CO Emissions, lb/MWh	0.26	0.26	0.24
	VOC Emissions, lb/MWh	0.027	0.025	0.023
	PMT 10 Emissions, lb/MWh	0.18	0.18	0.16
	SO2 Emissions, lb/MWh	0.0070	0.0069	0.0064
	AT Cost, $/kW	500	200	90
500 kW	Capacity, kW	-	500	500
	Installed Costs, $/kW	-	1,150	900
	Heat Rate, Btu/kWh	-	10,350	9,750
	Electric Efficiency, %	-	33.0%	35.0%
	Power to Heat Ratio	-	1.3	1.38
	Thermal Output, Btu/kWh	-	2625	2472
	O&M Costs, $/kWh	-	0.015	0.012
	NOx Emissions, ppm	-	5.0	3.0
	NOx Emissions, lbs/MWh (no AT)	-	0.2	0.11
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-	-0.46	-0.51
	NOx Emissions, lbs/MWh (w/ AT)	-	N/A	N/A
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)	-	N/A	N/A
	CO Emissions, ppm	-	9	9
	CO Emissions, lb/MWh	-	0.24	0.23
	VOC Emissions, lb/MWh	-	0.025	0.023
	PMT 10 Emissions, lb/MWh		0.0061	0.0057
	SO2 Emissions, lb/MWh	-	0.0056	0.0053
	AT Cost, $/kW	-	200	90

CHP thermal credit based on Displaced Boiler Emissions = 0.2 lbs/MMBtu
AT = Aftertreament

Table A-20. Fuel Cells

Size and Type	Characterization	2005	2012	2020
150 kW PEMFC	Capacity, kW	150	150	150
	Installed Costs, $/kW	3,800	3,600	2,700
	Heat Rate, Btu/kWh	9,750	9,480	8,980
	Electric Efficiency, %	35.0%	36.0%	38.0%
	Power to Heat Ratio	0.95	0.98	1.04
	Thermal Output, Btu/kWh	3592	3482	3281
	O&M Costs, $/kWh	0.023	0.017	0.015
	NOx Emissions, ppm			
	NOx Emissions, lbs/MWh (no AT)	0.10	0.07	0.05
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.80	-0.80	-0.77
	CO Emissions, ppm	-	-	-
	CO Emissions, lb/MWh	0.07	0.07	0.07
	VOC Emissions, lb/MWh	0.01	0.01	0.01
	PMT 10 Emissions, lb/MWh	0.001	0.001	0.001
	SO2 Emissions, lb/MWh	0.0057	0.0056	0.0053
250 kW MCFC/SOFC	Capacity, kW	250	250	250
	Installed Costs, $/kW	5,000	3,200	2,500
	Heat Rate, Btu/kWh	7,930	7,125	6,920
	Electric Efficiency, %	43.0%	47.9%	49.3%
	Power to Heat Ratio	1.95	1.98	2.13
	Thermal Output, Btu/kWh	1750	1723	1602
	O&M Costs, $/kWh	0.032	0.02	0.015
	NOx Emissions, ppm			
	NOx Emissions, lbs/MWh (no AT)	0.06	0.05	0.04
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.38	-0.38	-0.36
	NOx Emissions, lbs/MWh (w/ AT)			
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)			
	CO Emissions, ppm	-	-	-
	CO Emissions, lb/MWh	0.06	0.05	0.04
	VOC Emissions, lb/MWh	0.01	0.01	0.01
	PMT 10 Emissions, lb/MWh	0.001	0.001	0.001
	SO2 Emissions, lb/MWh	0.0047	0.0042	0.0041
2 MW MCFC	Capacity, kW	2,000	2000	2000
	Installed Costs, $/kW	3,250	2,800	2,200
	Heat Rate, Btu/kWh	7,420	7,110	6,820
	Electric Efficiency, %	46.0%	48.0%	50.0%
	Power to Heat Ratio	1.92	2	2.27
	Thermal Output, Btu/kWh	1777	1706	1503
	O&M Costs, $/kWh	0.033	0.019	0.015
	NOx Emissions, ppm			
	NOx Emissions, lbs/MWh (no AT)	0.05	0.05	0.04
	NOx Emissions, lbs/MWh (no AT; w/CHP)	-0.39	-0.38	-0.34
	NOx Emissions, lbs/MWh (w/ AT)			
	NOx Emissions, lbs/MWh (W/ AT; w/CHP)			
	CO Emissions, ppm	-	-	-
	CO Emissions, lb/MWh	0.04	0.04	0.03
	VOC Emissions, lb/MWh	0.01	0.01	0.01
	PMT 10 Emissions, lb/MWh	0.001	0.001	0.001
	SO2 Emissions, lb/MWh	0.0044	0.0042	0.0040

CHP thermal credit based on Displaced Boiler Emissions = 0.2 lbs/MMBtu
AT = Aftertreament

Market Penetration Analysis

EEA has developed a CHP market penetration model that estimates cumulative CHP market penetration in 5-year increments. For this analysis, the forecast periods are 2010, 2015, and 2020. The target market is comprised of the facilities that make up the technical market potential as defined in this Appendix. The economic competition module in the market penetration model compares CHP technologies (Appendix C) to purchased fuel and power (Appendix B) in 5 different sizes and 4 different CHP application types. The calculated payback determines the potential pool of customers that would consider accepting the CHP investment as economic. Additional, non economic screening factors are applied that limit the pool of customers that can accept CHP in any given market/size. Based on this calculated economic potential, a market diffusion model is used to determine the cumulative market penetration for each 5-year time period. The basic outputs of the model are shown in Table A-21 as follows:

- *Technical potential* represents the total capacity potential from existing and new facilities that are likely to have the appropriate physical electric and thermal load characteristics that would support a CHP system with high levels of thermal utilization during business operating hours.
- *Economic potential*, as shown in the table, reflects the share of the technical potential capacity (and associated number of customers) that would consider the CHP investment economically acceptable according to a procedure that is described in more detail below.
- *Cumulative market penetration* represents an estimate of CHP capacity that will actually enter the market between 2006 and 2020. This value discounts the economic potential to reflect non-economic screening factors and the rate that CHP is likely to actually enter the market.

Table A-21. Summary CHP Market Values for Florida: Technical Potential, Economic Potential, Cumulative 2006-2020 Market Penetration

Region	50–500 kW	500–1,000 kW	1–5 MW	5–20 MW	>20 MW	Total MW
Technical Potential	2,915	3,581	3,486	1,015	133	11,130
Economic Potential	75	0	198	59	25	357
Cumulative 2006–2020 Market Penetration	8	0	49	21	10	88

In addition to segmenting the market by size, as shown in the table, the analysis is conducted in four separate CHP market applications (high load and low load factor traditional CHP and high and low load factor CHP with cooling.) These markets are considered individually because both the annual load factor and the installation and operation of thermally activated cooling has an impact on the system economics.

Economic potential is determined by an evaluation of the competitiveness of CHP versus purchased fuel and electricity. The projected future fuel and electricity prices and the cost and performance of CHP technologies determine the economic competitiveness of CHP in each market. CHP technology and performance assumptions appropriate to each size category and region were selected to represent the competition in that size range (**Table A-4-2**). Additional assumptions were made for the competitive analysis. Technologies below 1 MW in electrical capacity are assumed to have an economic life of 10 years. Larger systems are assumed to have an economic life of 15 years. Capital related amortization costs were based on a 10% discount rate. Based on their operating characteristics (each category and each size bin within the category have specific assumptions about the annual hours of CHP operation (80-90% for the high load factor cases with appropriate adjustments for low load factor facilities), the share of recoverable thermal energy that gets utilized (80%-90%), and the share of useful thermal energy that is used for cooling compared to traditional heating. The economic figure-of-merit chosen to reflect this competition in the market penetration model is simple payback.[16] While not the most sophisticated measure of a project's performance, it is nevertheless widely understood by all classes of customers.

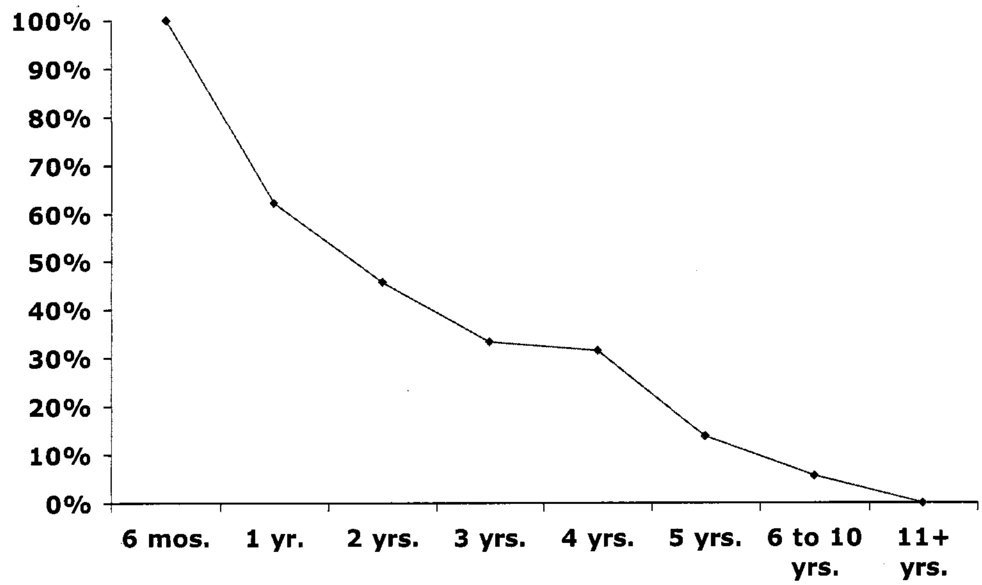
Table A-22. Technology Competition Assumed within Each Size Category

Market Size Bins	Competing Technologies
50–500 kW	100 kW Recip. Engine
	70 kW Microturbine
	150 kW PEM Fuel Cell
500–1,000 kW	300 kW Recip Engine (multiple units)
	70 kW Microturbine (multiple units)
	250 kW MC/SO Fuel Cell (multiple units)
1–5 MW	3 MW Recip Engine
	3 MW Gas Turbine
	2 MW MC Fuel Cell
5–20 MW	5 MW Recip Engine
	5 MW Gas Turbine
20–100 MW	40 MW Gas Turbine

Rather than use a single payback value, such as 3-years or 5-years as the determinant of economic potential, we have based the market acceptance rate on a survey of commercial and industrial facility operators concerning the payback required for them to consider installing CHP. Figure A-3 shows the percentage of survey respondents that would accept CHP investments at different payback levels (CEC 2005). As can be seen from the figure, more than 30% of customers would reject a project that promised to return their initial investment in just one year. A little more than half would reject a project with a payback of 2 years. This type of payback translates into a project with an ROI of between 49-100%. Potential explanations for rejecting a project with such high returns is that the average customer does not believe that the results are real and is protecting himself from this perceived risk by requiring very high projected returns before a project would be accepted, or that the facility is very capital limited and is rationing its capital raising capability for higher priority projects (market expansion, product improvement, etc.).

[16] Simple payback is the number of years that it takes for the annual operating savings to repay the initial capital investment.

Figure A-3. Customer Payback Acceptance Curve



Source: Primen 2003

For each market segment, the economic potential represents the technical potential multiplied by the share of customers that would accept the payback calculated in the economic competition module.

The estimation of market penetration includes both a non-economic screening factor and a factor that estimates the rate of market penetration (diffusion.) The non-economic screening factor was applied to reflect the share of each market size category (i.e., applications of 50 to 500 kW, applications of 500 to 1,000 kW, etc) within the economic potential that would be willing and able to consider CHP at all. These factors range from 32% in the smallest size bin (50-500 kW) to 64% in the largest size bin (more than 20 MW.) These factors are intended to take the place of a much more detailed screening that would eliminate customers that do not actually have appropriate electric and thermal loads in spite of being within the target markets, do not use gas or have access to gas, do not have the space to install a system, do not have the capital or credit worthiness to consider investment, or are otherwise unaware, indifferent, or hostile to the idea of adding CHP. The specific value for each size bin was established based on an evaluation of EIA facility survey data and gas use statistics from the iMarket database.

The rate of market penetration is based on a *Bass diffusion curve* with allowance for growth in the maximum market. This function determines cumulative market penetration for each 5-year period. Smaller size systems are assumed to take a longer time to reach maximum market penetration than larger systems. Cumulative market penetration using a Bass diffusion curve takes a typical S-shaped curve. In the generalized form used in this analysis, growth in the number of ultimate adopters is allowed. The curves shape is determined by an initial market penetration estimate, growth rate of the technical market potential, and two factors described as *internal market influence* and *external market influence.*

The cumulative market penetration factors reflect the economic potential multiplied by the non-economic screening factor (maximum market potential) and by the Bass model market cumulative market penetration estimate.

Once the market penetration is determined, the competing technology shares within a size/utility bin are based on a *logit function* calculated on the comparison of the system paybacks. The greatest market share goes to the lowest cost technology, but more expensive technologies receive some market share depending on how close they are to the technology with the lowest payback. (This technology allocation feature is part of the EEA CHP model that is not specifically used for this analysis.)

APPENDIX B: POLICY CASE ASSESSMENT

Table B-1. Annual Electricity Savings from Policy Recommendations and Cost Assumptions

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Electricity Savings from Recommended Policies																
Million kWh Saved (GWh)																
1 Utility savings target																
Savings from current year programs	0	465	960	1,478	2,021	2,590	2,656	2,722	2,789	2,868	2,950	3,034	3,120	3,209	3,300	3,394
Savings from current & prior years	0	465	1,409	2,838	4,759	7,183	9,587	11,973	14,343	16,709	19,073	21,439	23,809	26,184	28,568	30,962
2 Appliance & equipment standards																
EPAct 2005	383	766	1,149	1,453	1,757	2,061	2,365	2,669	2,973	3,277	3,581	3,885	4,189	4,244	4,299	4,354
New standards	0	0	157	313	470	776	1,082	1,388	1,694	2,000	2,305	2,611	2,917	3,223	3,529	3,680
3 More stringent building codes																
Savings from current yr construction	0	0	0	0	879	897	907	912	1,099	1,131	1,165	1,200	1,236	1,273	1,311	1,351
Savings from current & prior years	0	0	0	0	879	1,760	2,638	3,505	4,544	5,598	6,668	7,755	8,860	9,982	11,124	12,286
4 Advanced building program																
Savings from current yr construction	0	26	45	85	132	179	227	274	384	453	524	600	1,236	1,273	1,255	1,255
Savings from current & prior years	0	26	71	154	284	458	677	939	1,308	1,738	2,233	2,795	3,984	5,189	6,356	7,503
5 Public buildings program	0	307	614	922	1,229	1,536	1,843	2,150	2,457	2,765	3,072	3,379	3,686	3,993	4,300	4,608
6 Short-term public ed and rate incentives	0	0	7,391	5,838	5,024	4,582	4,326	4,163	4,047	3,956	3,878	3,801	3,736	3,673	3,610	3,549
7 Expanded RD&D efforts	0	0	0	0	0	23	43	67	100	167	267	427	684	1,094	1,750	2,800
8 Improved CHP policies	0	219	439	658	878	1097	1316	1536	1755	1974	2194	2413	2633	2852	3071	3291
9 Industrial competitiveness initiative																
Savings from current yr construction	37	38	38	39	40	40	41	42	43	43	44	45	46	46	47	48
Savings from current & prior years	37	75	113	152	191	232	273	315	357	400	445	490	535	581	628	676
10 Renewable portfolio standard																
Savings from current year (total)	0	796	1,571	2,406	3,248	4,090	4,938	5,790	6,671	7,564	8,468	9,381	10,279	11,179	12,079	12,976
11 On-site renewables policy package																
Current year residential SHW	35	70	140	211	281	351	421	492	562	632	702	772	843	913	983	1,053
Current year commercial SHW	2	4	9	13	18	23	29	34	40	47	54	61	69	76	84	91
Current year residential PV	18	36	72	108	144	180	216	252	288	324	360	396	432	468	504	540
Current year commercial PV	26	53	109	169	233	298	366	437	512	594	683	777	874	970	1,066	1,163
Total savings from current year	81	163	330	501	676	852	1,032	1,215	1,402	1,597	1,799	2,007	2,217	2,427	2,636	2,848
Total savings from current & prior years	81	243	569	1,061	1,718	2,542	3,530	4,685	6,007	7,501	9,173	11,024	13,053	15,258	17,635	20,183
Total (GWH)	119	2,131	12,333	14,342	18,679	24,278	30,252	36,510	43,284	50,373	57,776	65,515	74,175	83,209	92,651	102,513
Total from Efficiency	37	873	9,755	10,216	12,836	16,550	20,468	24,500	28,850	33,333	37,941	42,697	48,210	53,920	59,866	66,064
Total from Renewables	81	1,039	2,140	3,467	4,966	6,631	8,468	10,474	12,678	15,066	17,641	20,405	23,332	26,437	29,713	33,159

Notes:

1 Establish mandatory electricity savings targets of 1% of prior year sales effective 2013. Ramp in over prior 4 years (0.2%, 0.4%, 0.6% and 0.8% in 2009, 2010, 2011 and 2012 respectively). For gas, ultimate target is 0.5% of sales and it ramps in over five years. Assumes savings degrade at 3.5%/year (14 year average measure life, half get replaced without intervention). Costs based on a 3 cents/kWh levelized cost, 4.5% real discount rate, and utility paying 1/3 of total costs.

2 From ACEEE 2006 analysis of savings from standards by state. The first line includes standards contained in the federal EPAct 2005. The second line includes additional products featured in ACEEE's 2006 "Leading the Way" report, plus new DOE standards on dishwashers, refrigerators, small commercial AC, PTACs, and vending machines. For Florida state standards, delayed effective date to 2010.

3 Based on 10% savings in residential sector and 20% in commercial sector, effective 2012, as discussed in text. Savings degrade at 1.7%/year (30 year average measure life, half replaced without intervention). Assumes an investment cost of $0.16/kWh for commercial buildings per ACEEE estimate based on discussions with building experts and $0.75/kWh for residential buldings per the economic potential analysis for residential buildings.

4 Based on 30% savings minus savings already counted in the row above per FSEC and federal tax incentive goals. Assume participation of 2.5% in 2009, 5% in 2010, increasing 5% per year until 2020 when new code at this level takes effect. Savings degrade at 1.7%/year per policy above. Costs for residential buildings based on economic potential analysis and for commercial buildings based on personal communication with buildings experts.

5 The Texas Loan STAR program is saving an average of about 15% with an average simple payback of 8-10 years (Haberl et al. 2002, Verdict personal communication). CBECS 1995 finds state and local buildings account for 17.6% of total commercial floor area. We estimate 50% of buildings can be served over a 15-year period based on discussions with TAMU/LoanSTAR experts.

6 California achieved 6.7% energy savings and 11% demand savings in 2001 at a total cost of $893 million (GEP 2003), with savings in 2002 about 1/2 -2/3 of the 2001 figure (Lutzenhiser et al. 2004, Dahlberg 2002). To be conservative, we assume a Florida program will save 3% of energy and 5% of peak in its first full year and degrade by 50% per year. We estimate costs for a FL program at half those of the CA program, based on the fact that our savings estimates are less than half those that CA achieved.

7 Based on NYS program that saved $150 million in tenth year with annual expenditures of $17 million/year. Assume 2/3's of savings are electricity and 1/3 gas, converted to kWh and cf gas using typical NYS rates in past decade. Assume FL program 75% the size, based on relative energy use.

8 Assumes that an incentive equivilent to $600/kW installed in offered which doubles the economic potential and 2/3 of the economic potential is realized. Peak 95% of installed capacity. Incremental Natural Gas is required to generate the output so value is negative.

9 Based on results from U.S.DOE's Industrrial Assessment Center and Save Energy Now programs. Assumes average of 7% identified savings per site, 50% implementation rate, with survyes at 5% of industrial site in the state per year. Assume cost of saved energy is 0.027/kWh and $2.50/MMBtu.

10 Based on weighted averages, RPS costs are assumed be $0.157/kWh in 2008 and decline steadily to $0.116/kWh by 2023 as a result of greater technology advances and experience in the production of these systems.

11 Assumes 0.9% of the state's electricity need comes from onsite small-scale solar hot water systems (10% penetration for residential and 3% for commercial over 15 years) and photovoltaic (PV) systems (3% penetration for residential and 0.75% penetration over 15 years)

APPENDIX C: RENEWABLE PORTFOLIO STANDARDS

Current renewable resources in Florida that don't rely on waste products are largely solar, hydroelectric and biomass, as the wind resources on land is insufficient except perhaps in the Keys and Cape Canaveral area. Electric generation from wastes from landfill methane and from burning trash are growing resources, however classifying them as renewable may be a matter of political debate.

An estimate of current renewable energy capacity derived from a 2006 Florida Public Service Commission utility questionnaire, including generation from waste products, is shown in Table C-1.

Table C-1. Current Florida Renewable Energy Capacity

Resource	Capacity (kW)
Waste-to-energy	386,600
Biomass	493,600
Landfill gas	56,470
Hydroelectric	245,200
Solar thermal	139
Photovoltaics	769
Other (waste wood, heat recovery, hydrogen and wastewater)	61,017
Total	1,243,795

Source: FPSC 2006d

Future renewable generation resources include additional capacity from the technologies currently employed, plus possible offshore wind and ocean current technologies. The 2006 FPSC questionnaire noted above requested identification of renewable generation planned for in-service dates within the next five years and also capacity of currently negotiated renewable generator purchased power agreements (no in-service window given). Table C-2 provides a summary of both these planned and currently negotiated purchased generation capacities by technology.

Table C-2. Planned / Currently Negotiated Florida Renewable Energy Capacity

Resource	Capacity (kW)
Waste-to-energy	53,500
Biomass	130,000
Landfill gas	53,000
Hydroelectric	0
Solar thermal	2,000
Photovoltaics	267
Other (waste wood, heat recovery, hydrogen and wastewater)	20,205
Total	258,972

Questionnaire respondents also noted a number of additional potential projects and in two cases confidential purchase negotiations without providing capacity estimates for them, which may explain why the total planned / currently negotiated total renewable capacity of around 259 MW is significantly lower than the 651 MW near term potential capacity reported to the FPSC (FPSC 2003)

According to the 2006 Florida Public Service Commission 10-year site plan reviews, the current renewable capacity represents 2.2% of present statewide capacity (56,914 MW). Adding the expected future renewable capacity will result in a drop in renewable energy production to 2.05% over 10 years as total capacity requirements are projected to increase to 73,318 MW by 2015.

Current hydroelectric generation capacity in Florida identified in the FPSC questionnaire is approximately 245 MW, of which approximately 200 MW is purchased power. Hydroelectric power generated in Florida is currently provided by two power plants, the Jim Woodruff Lock and Dam on the Apalachicola River and the C.H. Corn Hydroelectric Plant on Lake Talquin. The FPSC (2003) reports an analysis that concludes that an additional 43 MW of potentially undeveloped hydroelectric power is available for Florida.

Future offshore wind and ocean current technologies were not reported by any of the questionnaire respondents. Ocean current energy potential identified in a May 2006 white paper from the U.S. Department of the Interior Minerals Management Service notes that capturing just 1/1000th of the available Gulf Stream energy would supply 35% of Florida's electrical needs. While the potential for this technology is large, the technology is as yet unproven so is not considered as part of the resource potential as discussed in the main body of the report.

Costs of renewable resources will of course be a determining factor in how quickly these technologies are incorporated into Florida's generation capacity. Renewable generation costs were estimated in FPSC (2003) renewable electric generating technologies publication noted above and are provided here in Table C-3.

Table C-3. FPSC Estimated Electric Generation Technology Cost Comparison

Plant Type	Levelized Costs (cents/kWh)
Municipal Solid Waste	3.5–15.3
Biomass (direct combustion)	6.3–11.0
Landfill gas	2.4–6.3
Hydroelectric	No data
Solar Photoelectric	19.4–47
Waste heat facilities using exothermic process	Zero fuel cost
Natural gas combined cycle	3.9–4.4
500 megawatt pulverized coal	5.2–5.5

Source: FPSC 2003

This appendix also includes a detailed analysis of the potential for distributed solar photovoltaic power production and solar thermal power displacement.

A report to the FPSC (REPP 2002) concludes that a cost comparison between photovoltaics and electric service costs per kilowatt-hour will be pivotal to how attractive consumers will see photovoltaics as an option. An analysis performed for this study indicates that with the current $2,000 federal tax credit and $4/peak watt Florida rebate, the levelized cost for a 2kW residential photovoltaic array is $0.1367/kWh while Florida's typical residential retail rate is currently $0.12/kWh, a difference of $0.0167/kWh. Assuming that a combination of future incentives and/or price reductions will keep the photovoltaic cost at the same level, a relatively small increase in electric rates would erase the cost difference. While the cost of PV has increased in the past few years due to strong global demand, this cost is anticipated to resume its decline as additional manufacturing capacity comes online and the price of poly-silicon falls as new dedicated solar capacity comes online. Even at the current prices, a number of consumers may still conclude that photovoltaics is attractive enough to have a system installed.

Fred Beck, Research Manager of the Renewable Energy Policy Project proposed a Residential Photovoltaic (PV) Development program for Florida [testimony to the FPSC, July 2, 2002]. The program would employ modest capital buydowns to allow PV to provide competitively priced electricity to consumers. Buydown funds were suggested to be generated through system benefit charges under a public benefit fund policy.

An FSEC analysis from 2004 that compares estimated output of photovoltaic systems in locations across the country shows that the daily output of a 2kW array ranges from 7.2kWh to 7.5kWh in Florida, compared with the highest outputs of around 8.1kWh to 8.7kWh in the desert southwest.

In 2006, Florida passed legislation to encourage Florida solar installations. Floridians can receive a rebate of up to $500 after purchase and installation of the solar water heating system on a residence ($100 for pool heating system). Rebates on water heating systems on commercial properties will be calculated at $15 per 1000 Btu per day with a maximum $5000 rebate. Also available are rebates for purchase and installation of photovoltaic systems for solar-generated electricity (calculated at $4.00 per rated Watt). Rebates will be allowed at a maximum of $20,000 for residential installations, while systems on commercial property may qualify for up to $100,000 rebate.

Twenty other states and the District of Columbia have mandated utilities meet goals for renewables as shown in Table C-4. These renewable goals are referred to as renewable portfolio standards (RPS). States define renewables differently, administer programs differently and offer various incentives. Most of the states passed legislations with Republican governors. Colorado's RPS was passed by a state petition by the voters; overcoming considerable, well-funded utility opposition.

Table C-4. Renewable Portfolio Standards by State

State	Amount	Year	Organization Administering RPS
Arizona	15%	2025	Arizona Corporation Commission
California	20%	2017	California Energy Commission
Colorado	10%	2015	Colorado Public Utilities Commission
Connecticut	10%	2010	Department of Public Utility Control
District of Columbia	11%	2022	DC Public Service Commission
Delaware	10%	2019	Delaware Energy Office
Hawaii	20%	2020	Hawaii Strategic Industries Division
Iowa	105 MW		Iowa Utilities Board
Illinois*	25%	2017	Illinois Department of Commerce
Massachusetts	4%	2009	Massachusetts Division of Energy Resources
Maryland	7.5%	2019	Maryland Public Service Commission
Maine	10%	2017	Maine Public Utilities Commission
Minnesota	1,125 MW	2010	Minnesota Department of Commerce
Montana	15%	2015	Montana Public Service Commission
New Jersey	6.5%	2008	New Jersey Board of Public Utilities
New Mexico	10%	2011	New Mexico Public Regulation Commission
Nevada	20%	2015	Public Utilities Commission of Nevada
New York	24%	2013	New York Public Service Commission
Pennsylvania	18%	2020	Pennsylvania Public Utility Commission
Rhode Island	15%	2020	Rhode Island Public Utilities Commission
Texas	5,880 MW	2015	Public Utility Commission of Texas
Vermont*	10%	2013	Vermont Department of Public Service
Washington	15%	2020	Washington Secretary of State
Wisconsin	2.2%	2011	Public Service Commission of Wisconsin

Source: DOE (2007c)

*Two states, Illinois and Vermont, have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.

Table C-5. Qualifying Renewable Electricity Sources

State	Wind	Photo-voltaics	Solar Thermal	Biomass	Geo-Thermal	Small Hydro-electric	Fuel Cells	Land Fill Gas	Tidal/ Ocean	Wave/ Thermal	Energy Efficiency
Arizona	✓	✓	✓	✓					✓		
California	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Colorado	✓	✓		✓	✓	✓		✓	✓		
Connecticut	✓	✓	✓	✓			✓	✓	✓	✓	
Delaware	✓	✓	✓	✓	✓		✓	✓	✓	✓	
D C	✓	✓	✓	✓	✓		✓		✓	✓	
Hawaii	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Illinois	✓	✓	✓	✓			✓		✓		
Iowa	✓	✓		✓			✓				
Maine	✓	✓	✓	✓			✓	✓	✓	✓	
Maryland	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Massachusetts	✓	✓	✓	✓				✓	✓	✓	
Minnesota	✓			✓							
Montana	✓	✓	✓	✓	✓		✓	✓	✓		
Nevada	✓	✓	✓	✓	✓		✓		✓		✓
New Jersey	✓	✓		✓	✓		✓	✓	✓	✓	
New Mexico	✓	✓	✓	✓	✓		✓	✓	✓		
New York	✓	✓		✓			✓	✓	✓		
Pennsylvania	✓	✓	✓	✓	✓		✓	✓	✓		✓
Rhode Island	✓	✓		✓	✓	✓		✓	✓	✓	
Texas	✓	✓	✓	✓	✓		✓		✓	✓	
Vermont	✓	✓	✓	✓			✓	✓	✓		
Wisconsin	✓	✓	✓	✓	✓		✓	✓	✓	✓	

Source: Rabe 2006

In 2001, the state of Arizona sought the modest goal of 1.1% of electricity from renewables by 2007 with at least 60% from solar. After three years their commission determined that the cost benefit ratio had not improved sufficiently and they reduced the 2007 requirement.

Massachusetts is one of fifteen states that has enacted a PBF to help support their RPS. In 2005 this $0.0005 per kilowatt hour charge was generating about $40 million per year for renewable and energy efficiency projects.

Hawaii, Nevada and Pennsylvania have included energy efficiency in their RPSs. This is a smart decision to apply efficiency first and then seek the power sources. However, such a move increases the verification efforts of the program.

Hawaii defines renewable energy as electrical energy savings brought about by the use of solar and heat pump water heating, seawater air conditioning, district cooling systems, solar air conditioning and ice storage, quantifiable energy conservation measures, use of rejected heat from small-scale cogeneration, and customer-sited combined heat and power systems. The legislated statute requires the PUC to contract with the University of Hawaii's Hawaii Natural Energy Institute to conduct a peer-reviewed study every five years and to recommend whether to revise the RPS. On the same day the RPS bill was signed, Hawaii Governor Lingle also signed measures to raise the net metering limit for renewable energy systems from 10 kilowatts (kW) to 50 kW and extend the limit on performance contracting from 15 years to 20 years.[17]

[17] See: http://www.eere.energy.gov/state_energy_program/ project_brief_detail.cfm/pb_id=740.

Pennsylvania's RPS has been controversial due to allowing some coal resources in the mix. However, they have established some other key features such as providing different energy credits by tiers as shown in Table C-6, they include energy efficiency/demand side management, and specify geographic region for renewable generation:

Energy derived only from alternative energy sources inside the geographical boundaries of this Commonwealth or within the service territory of any regional transmission organization that manages the transmission system in any part of this Commonwealth shall be eligible to meet the compliance requirements,

Table C-6. Pennsylvania Tiered Program

Tier I	Tier 2
Solar Photovoltaic Solar Thermal Wind Power Low-Impact Hydropower (incremental development only) Geothermal Energy Biomass Energy Biologically Derived Methane Gas Fuel Cells Coal Mine Methane	Large-Scale Hydropower Waste Coal Demand-Side Management/Energy Efficiency Distributed Generation Systems Municipal Solid Waste (existing facilities only) Byproducts of Pulping and Wood Manufacturing Integrated Combined Coal Gasification Technology
May 31, 2021 Minimum Tier 1: 8.0%, at least 0.50 % from Solar PV	May 31, 2021 Minimum of 10.0%

Pennsylvania instituted a net metering law that covers each billing cycle at the full cost of electricity for any tier one or two energy source and at wholesale energy prices for energy generated in excess of the amount used during the billing cycle. Interconnection laws were also written for small-scale producers.

California set one the highest targets of meeting 20% of their electricity with eligible sources by 2017. An energy action plan has set the goal of accelerating this to 2010. California has developed the process for verifying targets are met—something the legislature was silent about. This process includes important steps for any successful renewable program:

- Establishing each utility's initial baseline
- Establishing an annual procurement target
- Approving or rejecting contracts executed to procure RPS-eligible electricity
- Determine if the utility is in compliance with the commission's rules
- Impose penalties for non-compliance [CEC_300-2006-002-CMF, Feb. 2006]

The California Solar Initiative, as part of California's Million Solar Roofs Program, has a goal of creating 3,000 megawatts of new solar-produced generation capacity by 2017, with an overall goal of helping to build a self-sustaining solar market. To achieve these goals, the

California Public Utilities Commission (CPUC), the program's administrator, is providing over $2 billion in incentives over the next 10 years for existing residential and existing and new commercial, industrial and agricultural properties. The California Energy Commission (CEC) has a separate 10-year, $350 million program designed to encourage solar in new residential construction.

The Initiative has initially included photovoltaic incentives starting at $2.50 per watt for systems sized up to one megawatt, and funds for both new and existing low-income and affordable housing installations. In an August 2006 decision that will take effect in 2007, the CPUC shifted the program incentives from being volume-based to performance-based. To ensure wise energy resource use, the Initiative will be coordinated with the state's existing energy efficiency, "smart" metering and building standards programs (Go Solar California 2007).

A recent study by the PEW Charitable Trust indicated "important trends have emerged in RPS development. These include increasingly ambitious levels of renewable energy mandated over future periods, such as 25 percent of New York electricity by 2013 and 20 percent of Nevada electricity by 2015. In turn, many states have begun to differentiate between various sources of renewable electricity, providing special provisions to support certain forms of renewables that have lagged behind others due to high costs, and some are beginning to incorporate energy efficiency as a way to meet RPS goals. In a number of instances, RPSs have clearly played a central role in fostering rapid and significant expansion of the amount of renewable energy provided in a state." (Rabe 2006).

APPENDIX D: MACROECONOMIC IMPACTS ASSESSMENT

The Economic Model

The economic assessment model used in this exercise is a quasi-dynamic, input-output analytical tool we call DEEPER—or the Dynamic Energy Efficiency Policy Evaluation Routine. Although recently given a new name, the model's origins can be traced back to modeling assessments that ACEEE and others first completed in the early 1990s.

The model is "quasi-dynamic" in that it adjusts energy costs based on the level of energy quantities produced in a given year, and it adjusts labor impacts given the anticipated productivity gains within the key sectors of the Florida economy. So, for example, if efficiency measures or alternative generation technologies reduce the amount of natural gas otherwise consumed in Florida, one might naturally expect natural gas prices to be affected. Or if the construction and manufacturing sectors increase their output as a result of the alternative policy scenario, the employment benefits are likely to be affected based on expected labor productivity gains within each of those sectors. DEEPER includes these changes as they might impact the annual costs and benefits of the policy scenario.

Input-output models initially were developed to trace supply linkages in the economy. For example, an input-output accounting framework can show how purchases of lighting technologies or industrial equipment benefit not only the lighting and other equipment manufacturers in a state, but it can also reveal the multiplicative impacts that such purchases are likely to have on other industries and businesses that might supply the necessary goods and services to those manufacturers.

The DEEPER Model is a 15-sector economic impact model of the U.S. economy. Although an updated model with a new name, the model has a 15-year history of development and use for state energy policy assessments. See, for example, Laitner, Bernow, and DeCicco (1998) and Laitner (2007b) for a review of past modeling efforts. The model is generally used to evaluate the macroeconomic impacts of a variety of energy efficiency and renewable energy technologies at both the state and national level. The model now evaluates policies for the period 2008 through 2030. DEEPER is an Excel-based analytical tool that consists generally of six key modules or worksheets. These modules include:

Global data: The information in this module consists of the critical time series data and key model coefficients and parameters necessary to generate the final model results. The time series data includes the projected reference case energy quantities such as trillion Btus and kilowatt-hours, as well as the key energy prices associated with their use. It also includes the projected gross state product, wages, and salary earnings, as well as information on key technology assumptions. The source of data includes both the Energy Information Administration and Economy.com. One of the more critical assumptions in this study is that alternative patterns of consumption will defer conventional power plants that, on average, will cost $1800 per kilowatt of installed capacity. This module also contains annual coefficients to estimate the impact a given scenario or policy will have on air emissions.

Macroeconomic model: This module contains the "production recipe" for the region's economy for a given "base year"—in this case, 2004, which is the latest year for which a complete set of economic accounts are available for the regional economy. The I-O data, currently purchased from the Minnesota IMPLAN Group, is essentially a set of input-output accounts that specify how different sectors of the economy buy (purchase inputs) from and sell (deliver outputs) to each other. In this case, the model is now designed to evaluate impacts for 15 different sectors, including: Agriculture, Oil and Gas Extraction, Coal Mining, Other Mining, Electric Utilities, Natural Gas Distribution, Construction, Manufacturing, Wholesale Trade, Transportation and Other Public Utilities (including water and sewage), Retail Trade, Services, Finance, Government, and Households.

Investment and savings: Based on the scenarios mapped into the model, this worksheet translates the energy policies into physical energy impacts, investment flows, and energy expenditures over the desired period of analysis.

Price dynamics: With the estimated demand for energy consumption established, this module evaluates the impact of those new quantities on wholesale energy prices. Such prices include the minemouth cost of coal, the world oil price, and the wellhead price of natural gas, based on the following economic relationship:

$$\text{Price}_j = \text{EnergyIndex}_j^{\text{Elasticity}_j}$$

In other words, the price of energy for *j* is a function of a new Energy Index (e.g., 0.9 of the reference case) to some elasticity *j*. The assumed elasticities are 0.5, 0.2, and 0.7 for coal, oil, and natural gas, respectively. Given this relationship, for example, a 10% reduction in consumption—or an Energy Index of 0.9—implies a 5%, 2%, and 7% decline in the national wholesale energy price for coal, oil, and natural gas prices, respectively. These values are based on a review of various historical relationships and other modeling assessments found in the literature. Although Florida is a large state, if it is the only state to pursue the kinds of policies envisioned in this report, the impact on national wholesale energy prices will be very small.

Final demand: Once the changes in spending and investments have been established and adjusted within the previous modules of the DEEPER model, the net spending changes in each year of the model are converted into sector-specific changes in final demand, which drives the input-output model according to the following predictive model:

$$X = (I-A)^{-1} * Y$$

where:

X = total industry output by sector
I = an identity matrix consisting of a series of 0's and 1's in a row and column format for each sector (with the 1's organized along the diagonal of the matrix)
A = the production or accounting matrix also consisting of a set of production coefficients for each row and column within the matrix

Y = final demand, which is a column of net changes in final demand by sector

This set of relationships can also be interpreted as

$$\Delta X = (I\text{-}A)^{-1} * \Delta Y$$

which reads, a change in total sector output equals $(I\text{-}A)^{-1}$ times a change in final demand for each sector. Table 2 in the main report provides an illustration of the general approach used in this kind of model.

Results: For each year of the analytical time horizon, the model copies each set of results in this module in a way that can also be exported to the report. These different reports are summarized in Tables 3 through 7 of the main report.

There are other support spreadsheets as well as visual basic programming that supports the automated generation of model results and reporting. For more detail on the model assumptions and economic relationships, please refer to the forthcoming model documentation (Laitner 2007a). For a review of how an I-O framework might be integrated into other kinds of modeling activities, see Hanson and Laitner (2007).