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

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CONTENTS

Contents i
Acknowledgments iii
About the American Council for an Energy-Efficient Economy (ACEEE) iii
Executive Summary i
  Opportunities for Energy Efficiency and Renewable Energy i
  Policy Recommendations ii
  Conclusions iv
Introduction 1
  Scope and Purpose of this Project 2
Overview of Analysis 3
  Analysis Approach 3
  Energy Demand Reference Case 4
    Residential Sector 4
    Commercial Sector 5
    Industrial Sector 5
The Potential for Cost-Effective Efficiency Energy Savings 6
  Residential Efficiency 6
  Commercial Efficiency 8
  Industrial Efficiency 10
  Combined Heat and Power Systems 12
Efficiency Policies and Achievable Efficiency Potential 12
  Summary of Achievable Potential 13
  Description of Individual Policy Recommendations 15
    Utility Sector Energy Efficiency Policies and Programs 15
    Appliance and Equipment Standards 17
    More Stringent Building Energy Codes 18
    Advanced Building Program 18
    Improved CHP Policies 19
    Industrial Competitiveness Initiative 20
    State and Municipal Buildings Program 20
    Short-Term Public Education 21
    Expanded Research, Development, and Demonstration (RD&D) Programs 21
    Renewable Portfolio Standard and Onsite Renewable Energy Policies 22
  Investments, Costs, and Benefits of Policies 24
  Additional Work Planned 26
Demand Response 26
  Demand Response Background 26
  Cost-Effectiveness and Investment in Demand Response 27
  Demand Response Recommendations 28
    Verify Demand Response Resource 28
    Accelerate DSM goals under Florida Energy Efficiency and Conservation Act 28
    Set Mandatory Demand Response Targets for all Florida Utilities 29
    Require Direct Load Control Devices on All New Residential and Commercial Buildings 29

FRCC Should Use DLC for Spinning Reserve 29
Redesign Programs for Greater Impact and Penetration 29
Advanced Meters and Time of Use Rates 30
Estimated Impacts of Demand Response 30
Summary and Conclusions 31
References 32
Appendix A: Economic Potential Assessment Approach and Detailed Tables 36
A.1 Residential Efficiency 36
A.2 Commercial Efficiency 37
A.3 Combined Heat and Power Systems 38
A.3.1 Technical Potential for CHP 38
A.4.2 Energy Price Projections 44
Appendix B: Policy Case Assessment 56
Appendix C: Renewable Portfolio Standards 57

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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.

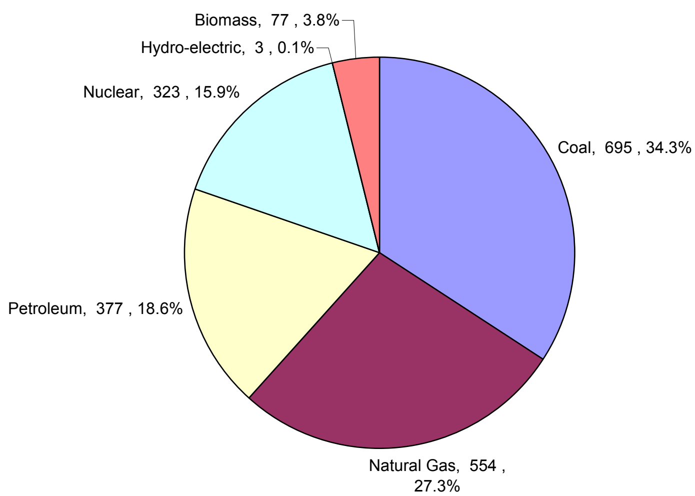
ACEEE is not a membership organization. Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

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 economic growth, Florida needs to take action – now – to meet the increased energy demand. A particular challenge is peak demand – those times when extreme heat or extreme cold crank up air conditioners and heaters. Peak demand is growing even faster than Florida's regular day-to-day electricity demand, and it is the most expensive type of electricity.

Florida's energy vulnerabilities have become more 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 (see Figure ES-1). 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 more than 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. The state now faces plans for major investments in new power plants. While many of the new power plants will be coal- or nuclear-powered, Florida will still need more natural gas plants to meet the peak electricity demand.

Figure ES-1. Florida 2003 Utility Fuel Consumption by Fuel Type (Trillion Btu)



The state is currently focused on building new natural gas, coal, and nuclear power plants to meet the growing demand. Little consideration has been given to treating the underlying cause for these energy market challenges – rapid growth in electricity demand.

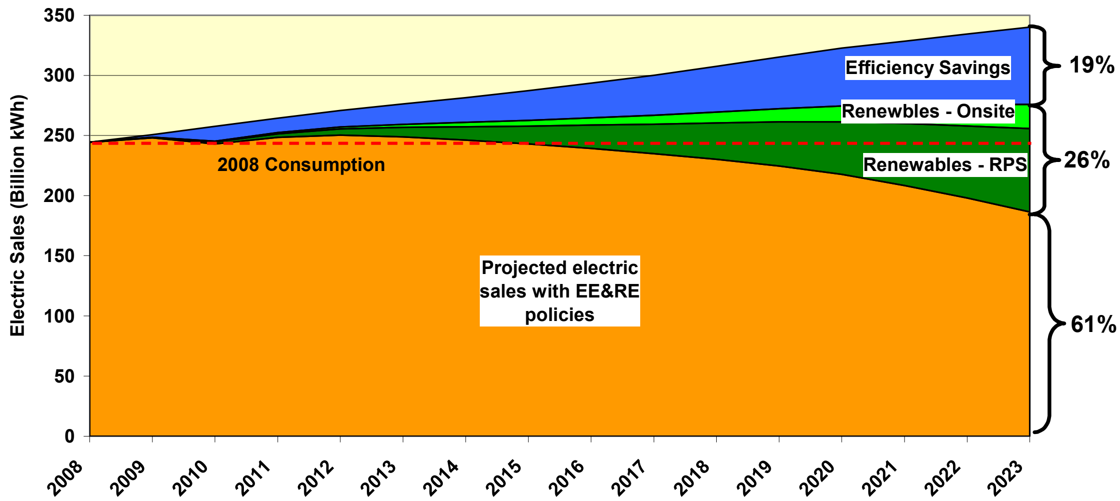
Opportunities for Energy Efficiency and Renewable Energy

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 over 45% in the next 15 years (see Figure ES-2). Renewable energy accounts for almost two-thirds of the 2023 total 153,595 Million kWh electricity reductions, with the energy efficiency provisions accounting for the balance.

Figure ES-2. Impact of Energy Efficiency and Renewable Energy Policies on Florida Electricity Sales

Cumulative 2023 Savings = 153,595 Million kWh



Policy Recommendations

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 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
11. Onsite Renewables Program

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, in our recommendations an Energy Efficiency Resource Standard (EERS) (a utility savings target similar to the RPS concept), which accounts for over 20% of the total savings(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 11.6% toward the total.

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

		Cumulative Savings from 2008			
		2013		2023	
	Policy	Electricity Savings (million kWh)	Demand Savings (MW)	Electricity Savings (million kWh)	Demand Savings (MW)
1	Renewable portfolio standard	7,871	1,530	69,206	13,527
2	Utility savings target (EERS)	7,513	1,462	31,519	6,149
3	On-site renewables policy package	2,542	494	20,183	3,945
4	More stringent building codes	4,321	842	11,953	2,333
5	Advanced building program	440	842	5,795	2,333
6	Public buildings program	1,497	291	4,491	885
7	Appliance & equipment standards	776	233	3,680	990
8	Improved CHP policies	1,097	172	3291	517
9	Expanded RD&D efforts	23	6	2,800	756
10	Industrial competitiveness initiative	232	45	676	133
11	Short-term public ed & rate incentives	966	308	0	0
	Total (GWH)	**27,278**	**6,224**	**153,595**	**31,568**

These energy efficiency and renewable energy policies can also reduce peak demand for electricity by 22%. A robust suite of demand response measures can reduce the peak even further, countering trend to more rapidly growing peaks.

In addition, we also recommend that the state consider implementing a robust demand response effort, which could save an additional 8% demand reduction in 2013 and 14% in 2023. 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 slow the rapid growth in peak demand reported by the state's utilities

Our study objectively proves that energy efficiency, coupled with renewable energy, can slow the future electricity demand. It would also diversify the state's energy resources, making Florida less vulnerable to global markets. The ACEEE study shows that implementing energy efficiency policies alone, such as efficient windows, compact fluorescent light bulbs, and Energy Star appliances can almost offset the future growth in electric demand.

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 over 45% 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 policies recommended in this report can cut Florida consumers' electricity bills by over $7 billion in 2013 and $84 billion in 2023. While these savings will require substantial investments, they cost less than the projected cost of electricity from conventional sources.

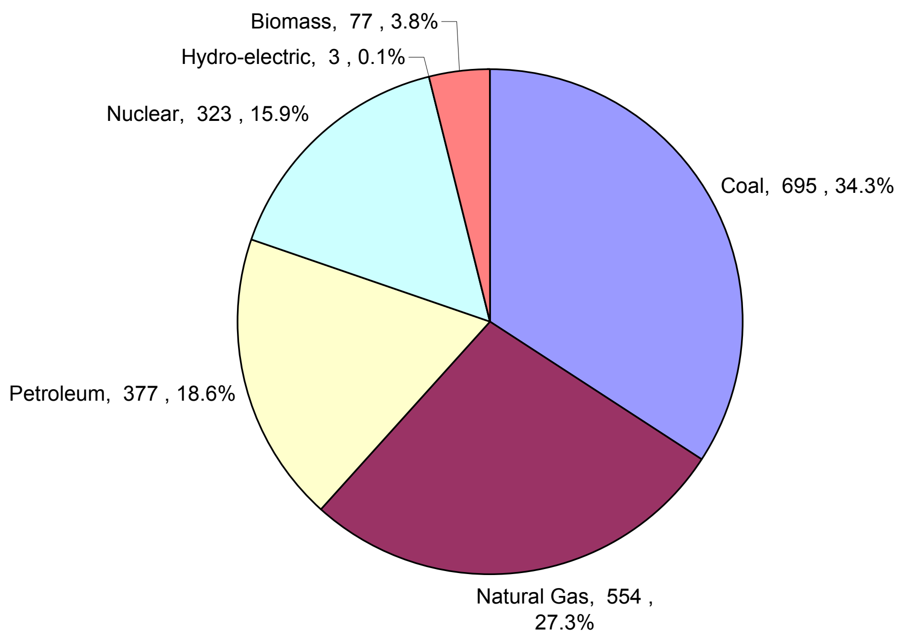
Reducing demand for electricity with efficiency and renewables will also reduce emissions from the combustion of fossil fuels at utility power plants, offering the state a more sustainable environmental future at an affordable cost.

Florida faces important decisions on 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 offer a lower cost, cleaner, and more stable energy path, without sacrificing Florida's quality of life or its economic growth. An upcoming report will examine the possibilities of enhancing economic growth through the clean energy future we have described.

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 27.3% of its electricity (see Figure 1) from natural gas, in contrast to a national average of 13.7% (EIA 2006a).

Figure 1. Florida 2003 Utility Fuel Consumption by Fuel Type (Trillion Btu)



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 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 surging demand. The Florida Public Service Commission (FPSC) projects summer peak demand to grow at 2.24% per year and winter peak to grow at 2.21% annually over the next ten years.[6] The growth in winter peak demand is an especially crucial

[5] For more information, see Energy and Environmental Analysis, Inc. (2005) on the effect of the hurricanes.
[6] Florida Public Service Commission, "Annual Report on Activities Pursuant to the Florida Energy Efficiency and Conservation Act", February 2006, p. 3.

concern (FPSC 2006). This means that the state will need to find additional energy resources (Economy.com 2007).

The utility industry's response to the challenge of meeting the growth in demand has been to propose construction of 10,000 MW of new coal and 5,200 MW of new natural gas capacity. In addition, two new nuclear power plants are being considered. The Florida PSC has, however, called for greatly increased resource commitments in energy efficiency, demand response and renewable generation (FPSC 2006a). As a 2004 report prepared for the Department of Community Affairs stated: "Cost-effective energy-efficiency and renewable energy technologies are under-utilized in Florida." (FSEC 2004).

The state has taken 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 exclusively on conventional power supply resources. The legislation established a solar rebate program, grant and tax credit opportunities, and established 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 opportunities have been exhausted in order to obtain a need determination order for new electric generating capacity."[7]

Although total peak demand and energy saved by Florida's investor-owned utilities have increased over the past decade, total expenditures in demand-side management 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.[8]

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, these 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. A subsequent report will explore the larger impacts of these savings to the State of Florida, including the effect on the gross state product and job growth.

[7] Op. cit, p. 5.
[8] Op. cit, p. 7.

OVERVIEW OF ANALYSIS

The remainder of this report is divided into four 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; and
4. Suggestions on how these policies might be implemented in Florida.

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

Analysis Approach

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.
- 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.
- 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 et al. 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 of policy recommendations. While the economic potential reported in this report 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 a disaggregated reference case energy consumption forecast. There are currently no publicly available energy consumption forecasts that include both statewide and end-use sector (residential, commercial, and industrial) breakdowns. We used publicly available data from the U.S. Bureau of the Census (Census), the U.S. Department of Energy's Energy Information Administration (EIA), and Florida sources. We also purchased data from economy.com for other economic information to produce the reference case forecast (see Table 1 and Figure 2). The methodologies were slightly different for each sector and are described in more detail below.

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

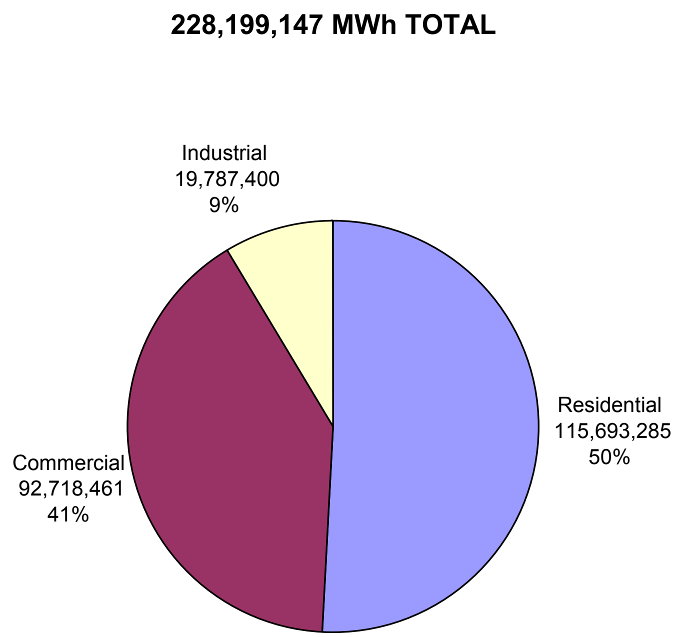
	MWh			
Sector	**2005**	**2012**	**2025**	**Average Growth Rate**
Residential	115,693,285	143,361,967	213,492,125	3.1%
Commercial	92,718,461	119,568,701	191,752,636	3.7%
Industrial	19,787,400	21,779,843	26,027,621	1.4%
TOTAL	228,199,147	284,710,511	431,272,382	3.2%

Residential Sector

Detailed information for the four most populous states, of which Florida is one, is available in EIA's *2001 Residential Energy Consumption Survey* (EIA 2001). The data includes statewide electricity and gas use by end-use (space heating, air conditioning, water heating, etc.). We assumed that the fraction of energy consumed by each end-use would remain constant. We then calibrated the total consumption to Florida residential energy consumption in 2004 as stated in the *Electric Power Annual* (EIA 2006c). To calculate the growth rate of energy consumption, population forecast data from economy.com (2007) was used along with the projected per-capita increase in electricity consumption as stated in the

Florida 10-year site plan (FPSC 2006a). The growth rate in residential consumption is expected to be 3.1% annually.

Figure 2. 2005 Florida Electricity Consumption (MWh)



Commercial Sector

For the commercial sector, data was obtained from the *Commercial Building Energy Consumption Survey* (EIA 2003), the *Electric Power Annual* (EIA 2006c), and the 1993 Synergic Research Corporation Survey of Commercial Building End-Uses (Rose et. al. 1993). Total 2004 Florida commercial sales were obtained from the *Electric Power Annual* and we applied to that figure the end-use data (as percent) as provided from FSEC. We assumed that the commercial electricity consumption growth rate would follow the same slope as the growth rate in Florida commercial consumption between 1990 and 2005 (3.7%).

Industrial Sector

Comprehensive, highly disaggregated electricity data for the industrial sector is not available at the state level. To estimate the electricity consumption, this study drew upon a number of resources, all using the same classification system[9] 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).

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

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???).

THE POTENTIAL FOR COST-EFFECTIVE EFFICIENCY ENERGY SAVINGS

As noted above, the economic potential represents an assessment of the overall resource potential that exists from energy efficiency and renewable energy. 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 et al. 2004). In the next section on suggested policies, we will explore the fraction of this resource potential that can be realistically achieved.

Residential Efficiency

In 2005, Florida's residential sector consumed 115,693 GWh of electricity, or 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 existing homes in Florida, we looked at twenty-four efficiency measures and bundled several of these measures into two separate packages. For new homes, we estimated the potential for ENERGY STAR new homes, which achieve 15% savings, tax credit eligible new homes, which achieve about 25% energy savings, and homes that achieve 40% energy savings. See Table 2 for a list each efficiency measure.

Existing homes can achieve significant energy savings through more efficient air conditioners, insulation improvements, and more efficient lighting and appliances. Efficiency measures in Package 1 includes six replacement measures: SEER 15 air 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 $0.065 or less per kWh saved, homeowners can reduce electricity consumption by up to 36% by implementing these measures. We assume that 50% of homes can cost-effectively implement Package 1 measures by 2023, for a total savings of 27,597 GWh statewide by

2023. Package 2 achieves even greater savings: about 53% electricity savings per home at a cost of less than $0.06 per kWh saved. In addition to the measures included in Package 1, Package 2 also includes the replacement of an old refrigerator with an ENERGY STAR® unit, ENERGY STAR ceiling fans, the replacement of a standard roof with a cool roof (high performance roofing materials), high-efficiency windows, and white walls. We assume that by 2023, 25% of homes can cost-effectively achieve Package 2 efficiency measures, resulting in statewide savings of 16,395 GWh.

New homes built in the 15-year period between 2008 and 2023 can achieve significant additional savings. A high level of adoption of new efficiency measures in new buildings is achievable through building energy codes. Assuming that new Florida building codes mandating 15% savings above today's code go into effect in 2009 and can be implemented in all new homes cost-effectively, new homes can achieve savings of 5,764 GWh by 2023. 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. We assume that 50% of new homes built between 2008 and 2023 can achieve this level of savings, resulting in additional savings of about 2,715 GWh. A third option for new homes is a more aggressive package of measures that reaches 40% total energy savings at a cost of about $0.06–0.07 per home. We assume that 10% of new homes can achieve these savings cost-effectively, resulting in an additional 584 GWh of electricity savings by 2023.

We estimate that there is an economic potential (i.e., potential for cost-effective energy efficiency measures) of 53,054 GWh statewide electricity savings by 2023, or 34% of the projected electricity consumption of 157,726 GWh in the same year. See Figure 3 for the breakdown of potential savings.

Figure 3. Fraction of Potential Savings by Residential Efficiency Measures

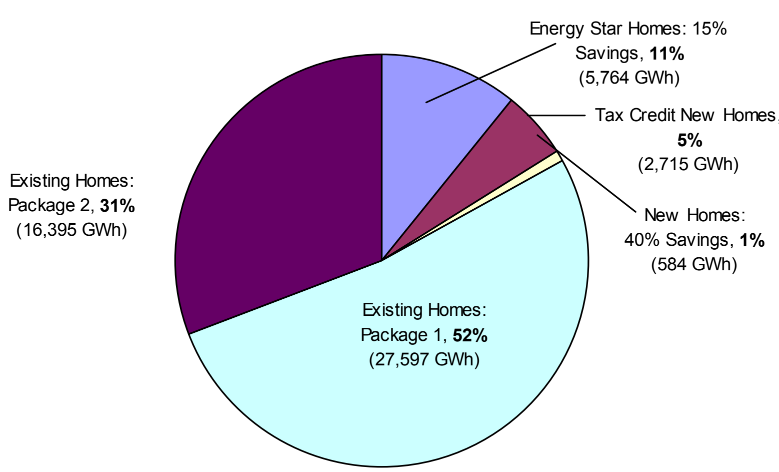


Table 2. Residential Energy Efficiency Measures

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 1	*6167*	*27,597*	*52%*	*$ 0.06*
High-efficiency Air Conditioner (SEER-15; HSPF-9)	2785			$ 0.03
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 2[a]	*9159*	*16,395*	*31%*	*$ 0.05*
Cool Roof	353			$ 0.00
Energy Star Refrigerator	1066			$ 0.01
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*	*5,764*	*11%*	*$ 0.06*
Tax Credit Eligible Home (25% savings)[b]	*1,857*	*2,715*	*5%*	*$ 0.03*
40% Savings Home[c]	*1,998*	*584*	*1%*	*$ 0.07*
Total Savings (GWh)		**53,054**	**100%**	**$ 0.049**
% Savings (% of 2023 Projected Sales)		**34%**		

[a] Package 2 efficiency measures also include measures in Package 1.
[b] Savings are incremental to Energy Star Homes.
[c] Savings are incremental to Tax Credit Eligible Homes.

Commercial Efficiency

In 2005, Florida's commercial sector consumed 92,718 GWh of electricity, or 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 8 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 8 commercial building types were simulated and analyzed by this study. These prototypes were developed by LBNL (Haung 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 4 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 28%, or 43,398 GWh by 2023. The majority of the savings come from energy efficiency improvements in existing buildings (25,257 GWh), while significant additional savings can be achieved through advanced new buildings (18,141 GWh). See Appendix Table A.2 for a breakdown of savings by region.

Table 4. Economic Potential for Energy Efficiency in Commercial Buildings

	Economic Savings Potential (kWh/Building)	% Economic Potential Attributable to Each Building Type	Economic Savings Potential in 2023 (GWh)	Economic Savings Potential (% of Total Commercial Electricity Potential)
Existing Buildings				
Small Office	*27,396*	4.9%	4,986	11%
Large Office	*388,694*	3.9%	4,007	9%
Large Hotel	*945,314*	3.6%	3,704	9%
Small Retail	*37,728*	3.4%	3,490	8%
Large Retail	*394,704*	2.6%	2,683	6%
Restaurant	*58,416*	2.9%	2,959	7%
School	*46,383*	1.7%	1,772	4%
Hospital	*1,617,549*	1.6%	1,657	4%
Total - Existing Buildings		25%	25,257	58%
New Construction				
Small Office	*21,639*	5.6%	3,014	7%
Large Office	*319,177*	4.5%	2,393	6%
Large Hotel	*960,224*	5.0%	2,674	6%
Small Retail	*41,367*	4.8%	2,578	6%
Large Retail	*643,586*	4.7%	2,524	6%
Restaurant	*74,890*	4.3%	2,291	5%
School	*42,904*	2.4%	1,275	3%
Hospital	*2,517,695*	2.6%	1,391	3%
Total - New Construction		34%	18,141	42%
Total Savings (GWh)			**43,398**	100%
Total Savings (% of 2023 Projected Sales)			**28%**	

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.

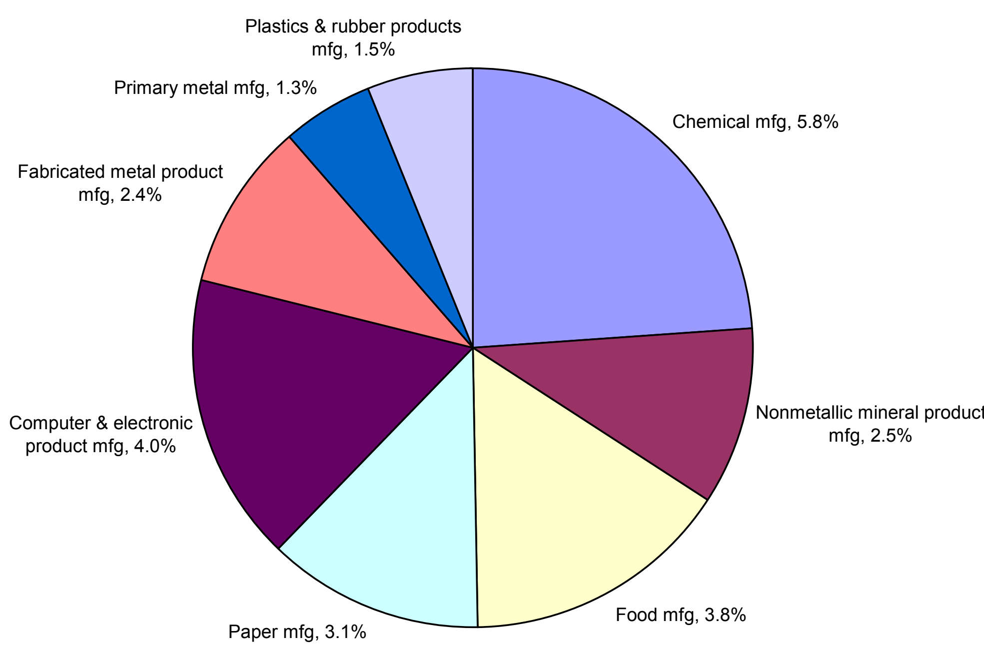
We accomplished our analysis of electricity savings potential in a series of steps. First, the project team characterized the industrial electricity market in Florida. Then energy-saving technologies were selected for analysis based on prior ACREE analyses, and we estimated the economic potential based 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 twenty-two 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 3.

Figure 3. Fraction of Potential Savings by Industry Type



Combined Heat and Power Systems

Combined heat and power (CHP), also know 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, utility policies have significantly discouraged expansion of this capacity (Brooks, Eldridge, and Elliott 2006; Davis 2007). For example, Florida Power and Light helped pass legislation that makes new grid-interconnected CHP projects (non-PURPA-qualifying facilities) illegal in the state unless they are owned by a regulated utility. 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.

EFFICIENCY POLICIES AND ACHIEVABLE EFFICIENCY POTENTIAL

As noted in the 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. As a result, there are many opportunities for policies to encourage savings. We recommend the consideration of eleven specific policies that provide a significant turn on investment and put Florida on the path to true diversity and cost savings.

12. Utility Sector Energy Efficiency Policies and Programs
13. Appliance and Equipment Standards
14. Building Energy Codes
15. Advanced Building Program
16. Improved CHP Policies
17. Industrial Competitiveness Initiative
18. State and Municipal Buildings Program
19. Short-Term Public Education and Rate Incentives

20. Expanded Research, Development, and Demonstration Efforts
21. Renewable Portfolio Standard
22. 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 discuss 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 reduce its projected future use of electricity from conventional sources (i.e., natural gas, coal, oil, and nuclear fuels) by almost half in the next 15 years (see Figure 5).

As can be seen from Figure 6, the Renewable Portfolio Standard (RPS) represents the largest contributor to the savings at over 45% of the 153,595 Million kWh 2023 savings. When combined with onsite renewable policies, renewable energy accounts for over 58% of the total 2023 electricity reductions.

The most significant energy efficiency recommendation is for an Energy Efficiency Resource Standard, a utility savings target similar to the RPS concept, which accounts for over 20% of the total savings; it is discussed later in this section. 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 another 11.6% toward the total.

These policies can also reduce peak summer demand for electricity by 22%, not including demand resource programs discussed later in this report. The cumulative 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 5. Impact of Energy Efficiency and Renewable Energy Policies on Florida Electricity Sales
Cumulative 2023 Savings = 153,595 Million kWh

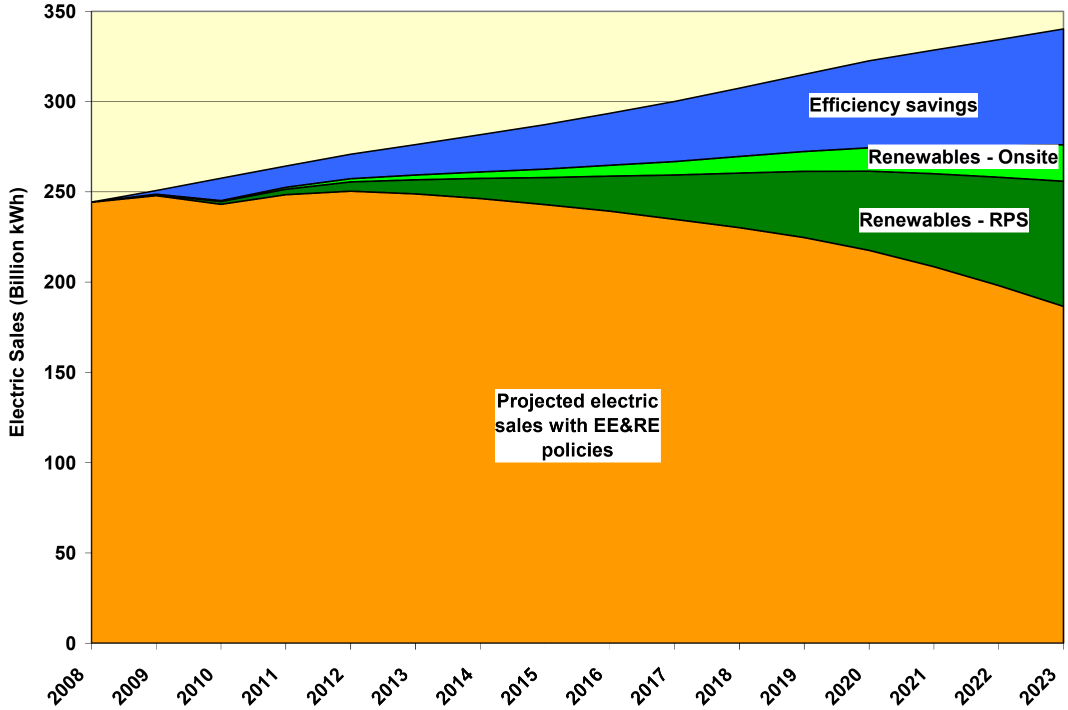


Figure 6. Cumulative Electricity Savings from Policies in 2023
Cumulative 2023 Savings = 153,595 Million kWh

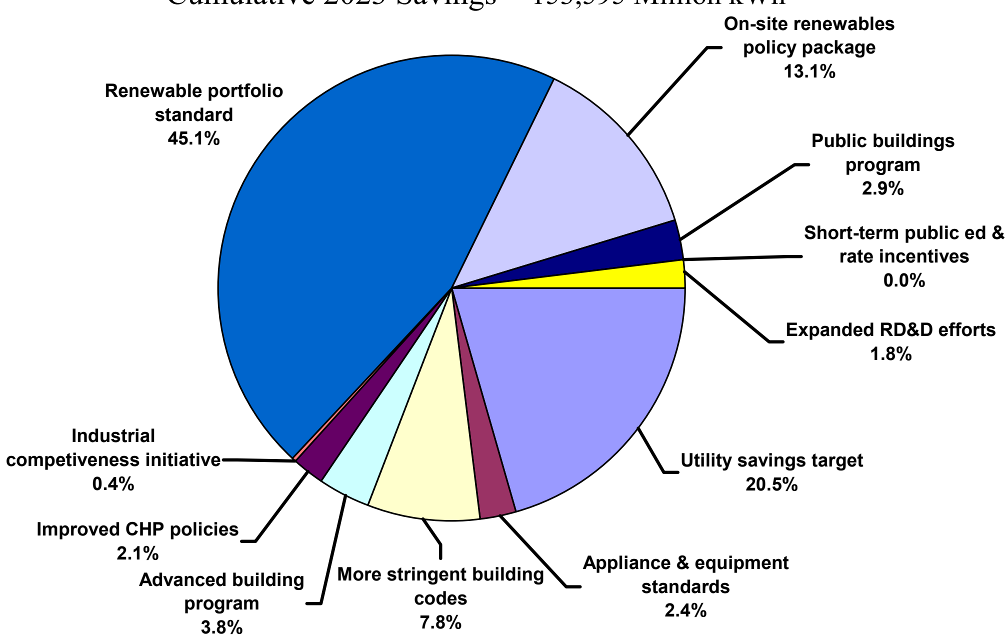


Table 5. Summary Cumulative Results from Analysis of Recommended Policies

		Cumulative Savings from 2008			
		2013		2023	
	Policy	**Electricity Savings (million kWh)**	**Demand Savings (MW)**	**Electricity Savings (million kWh)**	**Demand Savings (MW)**
1	Renewable portfolio standard	7,871	1,530	69,206	13,527
2	Utility savings target	7,513	1,462	31,519	6,149
3	On-site renewables policy package	2,542	494	20,183	3,945
4	More stringent building codes	4,321	842	11,953	2,333
5	Advanced building program	440	842	5,795	2,333
6	Public buildings program	1,497	291	4,491	885
7	Appliance & equipment standards	776	233	3,680	990
8	Improved CHP policies	1,097	172	3291	517
9	Expanded RD&D efforts	23	6	2,800	756
10	Industrial competitiveness initiative	232	45	676	133
11	Short-term public ed & rate incentives	966	308	0	0
	Total (GWH)	**27,278**	**6,224**	**153,595**	**31,568**

Description of Individual Policy Recommendations

Utility Sector Energy Efficiency Policies and Programs

Florida's utilities do operate programs to help manage customer loads, but most of the emphasis is on load management (shifting loads from peak to off-peak periods) and much less emphasis is 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). Given the energy problems facing Florida, there is an imperative for Florida to become a leader in this area.

A major reason for Florida's poor performance is that Florida is the lone state which relies on the Rate Impact Measure (RIM) cost-effectiveness test often referred to as the "no-losers" test, which holds that if participating customers receive 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 is typically only used for energy efficiency and is not, for example, used for power plant resource decisions. If there were a RIM test for power plant construction, then only plants that reduce rates would be approved, fewer 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 what is called the Total Resources Cost (TRC) test for assessing efficiency programs. This test compares the total costs of a program to customers and the utility, with the avoided-cost benefits of using less power. We recommend that the Florida PSC employ the TRC test as its primary vehicle for assessing energy efficiency programs. If this test were used, many more programs would be found to be cost-effective and much more energy could be saved.

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

- **Traditional Demand-Side Management (DSM).** 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 (EERS).** 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. Most recently, this process played out in the federal *Energy Policy Act of 2005* (EPAct 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 that ducts be tested for leakage or placed entirely within conditioned space, in order to assure that duct losses are reduced. Mandating low solar-gain windows, as the Texas energy code does, would also reduce energy use significantly, and would especially reduce peak cooling loads. The code should also start to address lighting and appliance energy use, perhaps building on provisions now in the California new home code. 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 an economic potential to reduce energy use in new Florida homes and commercial buildings by as much 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 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.[10] For commercial buildings, a good information source is the New Buildings Institute, which has a website on "Getting to Fifty" [percent savings].[11] 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

[10] See http://www.eere.energy.gov/buildings/highperformance/
[11] See http://www.advancedbuildings.net/

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 from the Florida state budget, or perhaps could be included in electric and gas rates.

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.

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 Florida PSC has adopted interconnection rules only for photovoltaic systems up to 10 kilowatts. 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, a program that brings industry-specific expertise to manufacturing facilities to identify efficiency opportunities has proven effective. One long-running example is the Industrial Assessment Center 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 et al. 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 U.S. Department of Energy (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 of calendar 2006, the program surveyed 200 facilities, finding an average of over 7% savings per facility with a payback of less than 2 years. 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.[12] 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 personal communication).

Short-Term Public Education

As has been noted by the FPSC (2006), the state is facing a short-fall available generation over the next five years. To "get over this hump" of when power shortages are most likely, and before many of the other initiatives discussed in this report have fully taken effect, we recommend that Florida consider a public education initiative to encourage energy-saving actions through a wide array of media to promote calls by the governor for energy conservation. In 2001, California and other western states used such 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. 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).

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. States such as New York, Wisconsin, Iowa, and California have major research, development, and demonstration 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 7 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

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

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 renewable portfolio standards and on-site renewable energy incentives. Details on Florida's current renewable production and the policies that other states have pursued in the realm of renewable portfolio standards are given in Appendix C.

According to the 2006 Florida Public Service Commission 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. 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 2kW 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
- Impose 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 on-site, grid-connected power sources.

In a press release issued by the Florida Public Service Commission on December 5, 2006 (FPSC 2006b), the Commission announced permanent approval of a renewable ("green") energy voluntary purchase program for Tampa Electric Company (TECO), offering renewable power at a premium price of $5.00/200kWh block or 2.5 cents/kWh. This price was used as the levelized incremental cost of renewable energy in ACEEE's analysis of the renewable portfolio standard.

We recommend the following policies to support renewable energy development in Florida:

1. **Renewable Portfolio Standard (RPS)**

   The RPS should be designed to require utilities to generate or acquire 5% of their total electricity supply in 2023 from qualified renewable sources. Of this amount, at least 10% should be required to come from Florida-based solar electric systems. The state should set penalties for missing a target in any tier in any year, at levels at least twice as large as prevailing prices qualifying resources in that year. Such funds should be used to increase incentives for energy efficiency and 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 On-Site Solar**

   Florida should provide 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. 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 would provide significant reductions in the need for conventional generation. The RPS offers the largest potential for energy and demand savings of the policy recommendations and the on-site solar incentives offers the 3rd largest energy and demand savings. Combined, these two policy options offer almost 90 billion kWh in cumulative energy savings and 17,500 MW in demand savings.

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 on-site 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 public benefits funds 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 by this report. There is considerable evidence that, like Colorado citizens, Florida citizens would strongly support the creation of aggressive renewable energy standards and the public benefits 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
Utility savings target	2,283	342	11,134	1,670
Appliance & equipment standards	186	0.20	651	0.70
More stringent building codes	1,797	44	5,340	801
Advanced building program	164	270	2,121	318
Public buildings program	190	28	2,843	426
Short-term public ed. & rate incentives	447	179	447	179
Expanded RD&D efforts	79	12	237	36
Improved CHP policies	102	5	306	15
Industrial competitiveness initiative	8	1	23	3
Renewable portfolio standard	509	76	4,733	710
On-site renewables policy package	4,535	680	38,619	5,793
Total	10,299	1,637	66,453	9,952

Because of the importance of understanding the benefits that will result from these programs and policies, we have also attempted to project these savings based on estimated electricity prices for Florida. These savings will be estimated with greater sophistication in a subsequent report that will look at the savings and investments using a macro-economic model that will capture both economic impacts of the investment, as well as market price effects. As a result, these polices are likely to appear more attractive in this macro-economic analysis. The projected cumulative customer cost savings from the combined energy efficiency and renewable energy policies are presented in Table 7 for 2013 and 2023.

Table 7. Expenditure Savings at 8.7¢/kWh

	Million $	
Policy Bundles	**2013**	**2023**
Energy Efficiency Policies	4,978	41,143
Renewable Energy Policies	2,139	43,295
	7,118	84,438

The ratios of benefits to costs for the bundles of energy efficiency and renewable energy policies, plus for the combined measures, are presented in Table 8. We have estimated these two different ways:

1. Investment-only cost, in which we consider only the investments made to implement the savings or renewable resource, and
2. Total resource cost, in which we also add in any program and administrative costs associated with the policies.

The benefit-cost ratio over the 15-year period for energy efficiency is 1.64 when considering only the investment costs and 1.43 when including administrative costs. The benefit-cost ratio for renewable resources is 0.95 when considering only the investment costs and 0.83 when including administrative costs. Overall, the combined ratios of benefits to costs are 1.2 when considering only the investment costs and 1.05 when including administrative costs. As can been seen in Table 8, the benefit cost ratios improve over the 15-year period explored in this report.

Table 8. Estimated Benefit Cost Ratios for Energy Efficiency and Renewable Energy Policies

		Benefit-Cost Ratio over Selected Periods		
	From:	**2008**	**2014**	**2020**
	To:	**2013**	**2019**	**2023**
Investment-only	**electric efficiency**	**0.81**	**1.70**	**2.60**
	renewables	**0.42**	**0.86**	**1.25**
Investment with program costs	**electric efficiency**	**0.70**	**1.49**	**2.27**
	renewables	**0.36**	**0.75**	**1.08**

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 saving long after 2023, and the benefits of these savings are not captured in these benefit calculations. In addition, these benefit-cost ratios do not consider the impact of reduced natural gas consumption in the electric power sector—the state's majority consumer—that would likely reduce prices of natural gas and electricity for all customers (see Elliott and Shipley 2005).

Additional Work Planned

Following this report, as was mentioned above in the previous section, we will be estimating the economic impacts from the recommended policies using ACEEE's macro-economic model DEEPER (Laitner 2007). The result of this analysis will estimate the net effects of the policies on the state of Florida. This analysis of the policy results will estimate the projected net impact on consumer energy expenditures and gross state product (GSP), and assess the relative impacts on employment for the state. The analysis will also explore the impact of reduced consumption on energy 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). While we would anticipate that we might see a small decrease in energy savings due to reduced energy prices, we would also anticipate an increase in the dollar savings that consumer would experience as a result of the price reductions. The results of this macro-economic analysis will be presented shortly in a forthcoming companion report.

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 – 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.[13]
- 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.[14]
- 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.[15]

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

[13] Federal Energy Regulatory Commission, Staff Report, "Assessment of Demand Response and Advanced Metering", Docket AD-06-2-000, August 2006, Appendix I-5, Figures IV-6 and IV-7.
[14] Op. cit., Figure IV-8.
[15] Op. cit., Figures IV-10 and IV-11.

actually delivered to meet summer 2006 demand.[16] Florida resource plans project 3,504 MW of interruptible load and residential, commercial and industrial load management to meet winter peak demand for 2006-07; however, since they report only 164 MW of actual demand reduction for the winter of 2005-06 (0.4% of peak), and 446 MW for the summer of 2005 (0.9% of peak),[17] 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 (Cherick 2007); Florida policy-makers do not presently add a premium for transmission and distribution avoidance because they believe energy efficiency and demand response have

[16] Op. cit., Figure V-5.
[17] Florida Reliability Coordinating Council, "2006 Regional Load and Resource Plan", June 16, 2006 memo from Linda Campbell, FRCC to Bob Trapp, Florida Public Service Commission, pages 3 and 4.

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 9).

Table 9. Savings in Demand Cost fro Demand Response Program

	Benefits (1000 $)	
Avoided Cost	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 2004-06, 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 2004-05 – 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.[18] 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

[18] FPSC, "Annual Report on Activities Pursuant to the Florida Energy Efficiency and Conservation Act," op. cit., Section 3, and Edison Electric Institute, "Highlights of EEI Member and Non-Member Residential/Commercial/Industrial Efficiency and Demand Response Programs for 2006", updated May 8, 2006.

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 state-wide marketing and education plans about the value and importance of demand response, enable more third-party vendors to support the programs across a near-state-wide market, and simplify equipment and communications protocols. This would also simplify the FPSC's review and approval process.

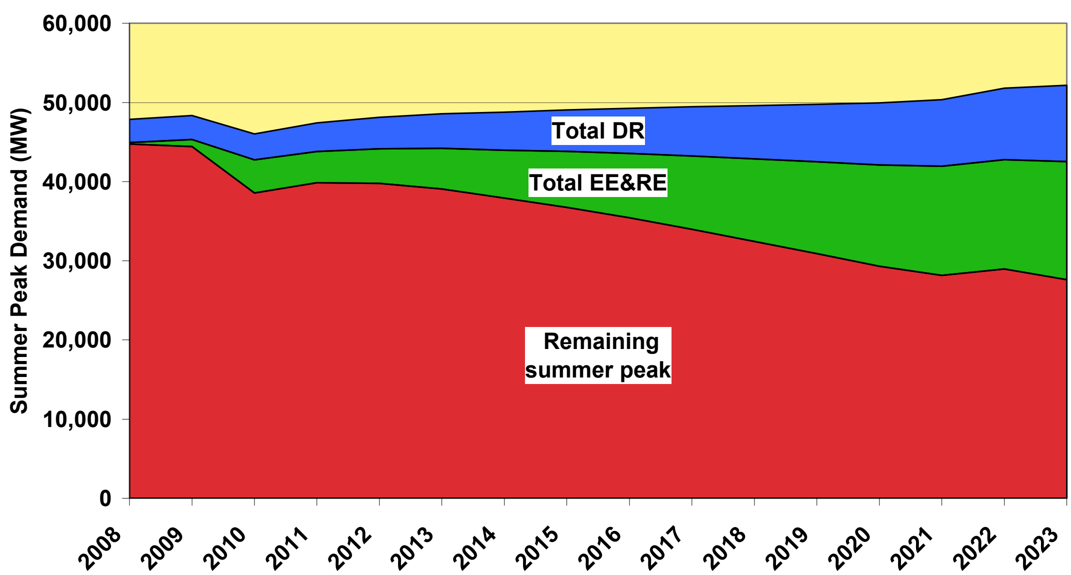
Advanced Meters and Time of Use Rates

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 8.1% in 2013 and 14.4% in 2023. When combined with the load reductions from energy efficiency and renewable energy, we can reduce the peak by 17.7% in 2013 and 36.6% in 2023 as can be seen in Figure 8.

Figure 8. 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 over 45% 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 policies recommended in this report can cut Florida consumers' electricity bills by over $7 billion in 2013 and $84 billion in 2023. While these savings will require substantial investments, they cost less than the projected cost of electricity from conventional sources.

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. Energy efficiency and renewable energy policies reduce peak demand by over 22% in 2023, while demand response reduces demand by another 14%.

Florida faces important decisions on 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 offer a lower cost, cleaner and less risky course, without sacrificing Florida's quality of life or its economic growth. An upcoming report will examine the possibilities of enhancing economic growth through the clean energy future we have described.

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APPENDIX A: ECONOMIC POTENTIAL ASSESSMENT APPROACH AND DETAILED TABLES

A.1 Residential Efficiency

To estimate the economic potential for energy efficiency in residential buildings in Florida, we focused on three geographic regions: North (Jacksonville), Central (Tampa), and South (Miami). Table A.1 shows the breakdown of economic potential savings in 2023 by efficiency package and region.

Table A.1. 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)	Economic Savings Potential (% of Total Residential Electricity Potential)	Cost per kWh Saved
	Jacksonville	Tampa	Miami	Statewide Average[1]				
Package 1	*5395*	*6192*	*6536*	*6167*	*50%*	*27,597*	*52%*	*$ 0.06*
High-efficiency Air Conditioner (SEER-15; HSPF-9)	2,205	2,746	3,122	2785				$ 0.03
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 2[3]	*7779*	*9176*	*9848*	*9159*	*25%*	*16,395*	*31%*	*$ 0.05*
Cool Roof	255	380	375	353				$ 0.00
Energy Star Refrigerator	950	1055	1137	1066				$ 0.01
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%*	*5,764*	*11%*	*$ 0.06*
Tax Credit Eligible Home (25% savings)[4]	*1,075*	*1,616*	*2,507*	*1,857*	*50%*	*2,715*	*5%*	*$ 0.03*
40% Savings Home[5]	*2,426*	*1,886*	*1,894*	*1,998*	*10%*	*584*	*1%*	*$ 0.07*
Total Savings (GWh)	**10,649**	**21,579**	**20,827**			**53,054**	**100%**	**$ 0.049**
% Savings (% of 2023 Projected Residential Sales)	**7%**	**14%**	**13%**			**34%**		

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.

A.2 Commercial Efficiency

Our analysis shows a total economic potential for energy efficiency in commercial buildings of 43,398 GWh, or 28% of projected commercial electricity sales in 2023. The breakdown of savings by building type and region are shown in Table A.2.

Table A.2. Economic Potential for Energy Efficiency in Commercial Buildings by Building Type and Region

	Economic Savings Potential (kWh/Building)	% Electricity Sales by Building Type	Projected 2008 Statewide Elec Sales by Bldg Type (GWh)	% Economic Potential Attributable to Each Building Type	Economic Savings Potential in 2023 (GWh)				Economic Savings Potential (% of Total Commercial Electricity Potential)
Existing Buildings		Statewide		Statewide	Orlando	Jacksonville	Miami	Statewide	
Small Office	*27,396*	*16%*	*15,934*	4.9%	2,241	732	2,014	4,986	11%
Large Office	*388,694*	*16%*	*15,934*	3.9%	1,786	587	1,634	4,007	9%
Large Hotel	*945,314*	*18%*	*18,446*	3.6%	1,457	648	1,598	3,704	9%
Small Retail	*37,728*	*10%*	*10,645*	3.4%	1,560	525	1,406	3,490	8%
Large Retail	*394,704*	*10%*	*10,645*	2.6%	1,200	398	1,085	2,683	6%
Restaurant	*58,416*	*14%*	*13,964*	2.9%	1,355	444	1,159	2,959	7%
School	*46,383*	*7%*	*6,767*	1.7%	639	350	783	1,772	4%
Hospital	*1,617,549*	*9%*	*9,184*	1.6%	927	210	520	1,657	4%
Total - Existing Buildings		100%		25%	11,165	3,893	10,199	25,257	58%
New Construction									
Small Office	*21,639*	*16%*	*8,309*	5.6%	1,348	451	1,215	3,014	7%
Large Office	*319,177*	*16%*	*8,309*	4.5%	1,072	353	968	2,393	6%
Large Hotel	*960,224*	*19%*	*10,038*	5.0%	1,049	469	1,156	2,674	6%
Small Retail	*41,367*	*10%*	*5,574*	4.8%	1,170	397	1,012	2,578	6%
Large Retail	*643,586*	*10%*	*5,574*	4.7%	1,132	379	1,012	2,524	6%
Restaurant	*74,890*	*14%*	*7,342*	4.3%	1,056	352	883	2,291	5%
School	*42,904*	*7%*	*3,815*	2.4%	468	265	543	1,275	3%
Hospital	*2,517,695*	*9%*	*4,610*	2.6%	777	176	438	1,391	3%
Total - New Construction		*100%*		34%	8,072	2,842	7,227	18,141	42%
Total Savings (GWh)					**19,237**	**6,735**	**17,425**	**43,398**	100%
Total Savings (% of 2023 Sales)					**12%**	**4%**	**11%**	**28%**	

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 (SRC 1993). Regions are weighted by commercial electricity sales: 45% in Orlando, 16% in Jacksonville, and 40% in Miami.

A.3 Combined Heat and Power Systems

A.3.1 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 meet 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. ACEE 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-1-1. 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-1-2. 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-1-3. 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-1-4.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.

A.4.2 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* (2006e) 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.

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Table A-2-1.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-AEO 200

A.4.3 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[19], on peer-reviewed technology characterizations that Energy and Environmental Analysis (EEA) developed for the National Renewable Energy Laboratory[20] and on follow-on work conducted by DE Solutions for Oak Ridge National Laboratory.[21] Additional emissions characteristics and cost and performance estimates for emissions

[19] *Combined Heat and Power Potential for New York State*, Energy Nexus Group (later became part of EEA), for NYSERDA, May 2002.

[20] "Gas-Fired Distributed Energy Resource Technology Characterizations", NREL, November 2003, http://www.osti.gov/bridge

[21] "Clean Distributed Generation Performance and Cost Analysis", DE Solutions for ORNL. April 2004.

control technologies were based on ongoing work EEA is conducting for EPRI.[22] Data is presented for a range of sizes that include basic electrical performance characteristics, CHP performance 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.

[22] "Assessment of Emerging Low-Emissions Technologies for Distributed Resource Generators", EPRI, January 2005.

Table A-3-1. 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	Additional O&M Costs for SCR			
	SO2 Emissions, lb/MWh	0.0068	0.0064	0.0062				
	AT Cost, $/kW	50	50	45	2005	2012	2020	
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	0.005	0.003	0.002	SCR Adder, $/kWh
% NOx reduction w/AT	Thermal Output, Btu/kWh	4265	3791	3250				
2005 - 40%	O&M Costs, $/kWh	0.012	0.01	0.009	0.017	0.013	0.011	New total O&M w/SCR, $/kWh
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	0.003	0.002	0.002	SCR Adder, $/kWh
% NOx reduction w/AT	Thermal Output, Btu/kWh	3281	3189	2892				
2005 - 30%	O&M Costs, $/kWh	0.0085	0.0083	0.008	0.011	0.011	0.010	New total O&M w/SCR, $/kWh
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	0.002	0.002	0.001	SCR Adder, $/kWh
% NOx reduction w/AT	Thermal Output, Btu/kWh	3345	2797	2605				
2005 - 20%	O&M Costs, $/kWh	0.008	0.008	0.008	0.010	0.010	0.009	New total O&M w/SCR, $/kWh
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

Table A-3-2. 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-3-3. 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-3-4. 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

A.4.4 Market Penetration Analysis

EEA has developed a CHP market penetration model that estimates cumulative CHP market penetration in 5-yrar 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 Appendix A. Thee 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-4-1** 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-4-1. 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.[23] While not the most sophisticated measure of a project's performance, it is nevertheless widely understood by all classes of customers.

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

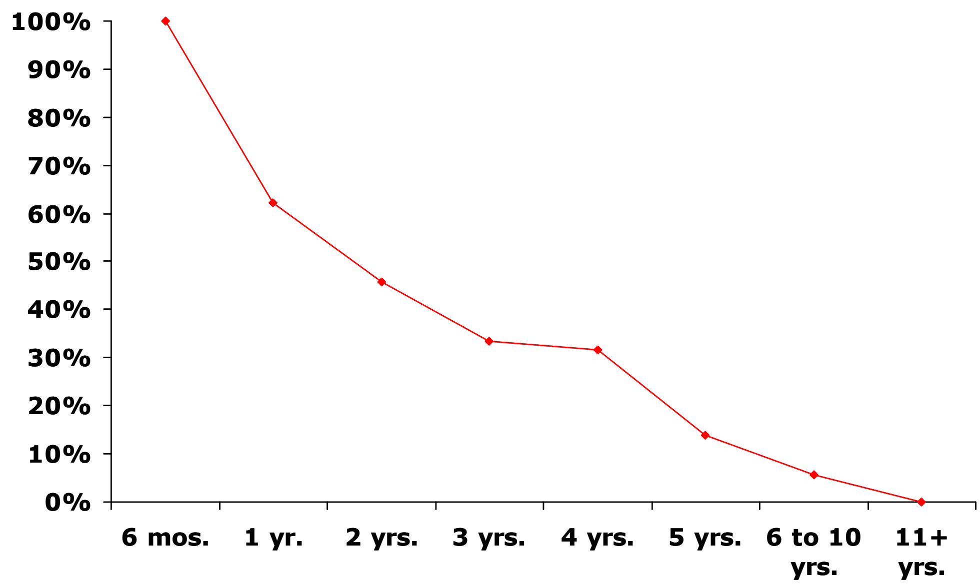
Table A-4-2. Technology Competition Assumed within Each Size Category

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 C-4-1** shows the percentage of survey respondents that would accept CHP investments at different payback levels[24]. 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.).

[24] "Assessment of California CHP Market and Policy Options for Increased Penetration", California Energy Commission, July, 2005.

Figure C-4-1. Customer Payback Acceptance Curve



Source: *Primen's 2003 Distributed Energy Market Survey*

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

	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	489	1,003	1,546	2,115	2,708	2,762	2,816	2,872	2,935	3,000	3,075	3,152	3,227	3,285	3,343
Savings from current & prior years	0	489	1,474	2,968	4,979	7,513	10,012	12,477	14,913	17,326	19,720	22,105	24,483	26,853	29,198	31,519
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	900	987	949	911	730	760	788	875	906	1,049	1,090	1,061	822	807	804
Savings from current & prior years	0	900	1,872	2,789	3,653	4,321	5,008	5,711	6,489	7,285	8,211	9,161	10,067	10,718	11,342	11,953
4 Advanced building program																
Savings from current yr construction	0	22	49	95	137	146	190	236	131	363	472	545	1,061	822	942	942
Savings from current & prior years	0	22	71	165	299	440	623	848	965	1,312	1,761	2,276	3,299	4,065	4,938	5,795
5 Public buildings program	0	299	599	898	1,197	1,497	1,796	2,096	2,395	2,694	2,994	3,293	3,592	3,892	4,191	4,491
6 Short-term public ed & rate incentives	0	0	7,728	3,864	1,932	966	483	242	121	60	30	0	0	0	0	0
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	0	501	1,030	1,586	2,167	2,762	3,379	4,021	4,696	5,401	6,150	6,934	7,744	8,541	9,361	10,206
Savings from current & prior years	0	501	1,523	3,083	5,198	7,871	11,116	14,949	19,391	24,461	30,196	36,616	43,737	51,535	60,020	69,206
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	2,749	14,545	15,952	20,516	27,278	35,283	44,312	54,187	65,182	77,296	90,416	105,000	120,071	136,303	153,595
Total from Renewables	37	2,005	12,453	11,808	13,599	16,865	20,636	24,679	28,789	33,219	37,927	42,777	48,210	53,277	58,648	64,206
Total from Efficiency	81	744	2,092	4,144	6,916	10,413	14,646	19,633	25,397	31,963	39,368	47,639	56,790	66,793	77,655	89,389

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 buildings 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 Assumes 3.1% of the state's electricity need comes from large-scale solar plants. Based on levelized incremental cost of $0.025/kWh.

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 (FPSC) utility questionnaire, including generation from waste products, is shown in Table E-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 Renewable Energy Questionnaire, August 2006

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 E-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 in the 2003 FPSC publication.

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 2003 FPSC publication 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 $1/1000^{th}$ of the available Gulf Stream energy would supply 35% of Florida's electrical needs.

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 the 2003 FPSC renewable electric generating technologies publication noted above and are provided here in Table E-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: An Assessment of Renewable Electric Generating Technologies for Florida, FPSC and DEP

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

A July 2002 report to the FPSC from the Renewable Energy Policy Project 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. 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 PSC, 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.

Florida Power and Light's alternative energy website on the other hand notes that Florida's geography and land use limits its opportunities for land-intensive technologies such as solar power, and then states that "Florida has too much cloud cover to make large-scale solar power production a cost effective alternative" [FPL web site, Jan. 19, 2007].

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 E-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: Department of Energy Web site 1/29/2007
*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: Barry G. Rabe, *The Expanding Role of U.S. State Renewable Portfolio Standards,* June, 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 public benefits fund 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. [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 E-5, 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-5. 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. [The California Solar Initiative page of the Go Solar California web site accessed 1/30/07 http://www.gosolarcalifornia.ca.gov/csi/index.html]

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." (Barry G. Rabe, *The Expanding Role of U.S. State Renewable Portfolio Standards,* June, 2006).