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OAK RIDGE
NATIONAL LABORATORY
MANAGED BY UT-BATTELLE
FOR THE DEPARTMENT OF ENERGY

CHP REGIONAL APPLICATION CENTERS: A PRELIMINARY INVENTORY OF ACTIVITIES AND SELECTED RESULTS

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CONTENTS

Page

LIST OF FIGURES……...……v

LIST OF TABLES……..……vii

EXECUTIVE SUMMARY……..…….ix

1. INTRODUCTION……...1
   1.1 BACKGROUND…….....1
   1.2 SCOPE OF REPORT……...…2

2. METHODS……..3

3. EDUCATION AND OUTREACH……..…5
   3.1 TARGETED WORKSHOPS AND WEBINARS……...5
   3.2 CONFERENCES……...……..…6
   3.3 PARTNERSHIP MEETINGS…….....7
   3.4 TRAINING…….……....8
   3.5 COLLEGE COURSES……....9
   3.6 WEBSITE ACTIVITY……....9
   3.7 E-MAIL BLASTS……....9
   3.8 INVOLVEMENT IN SPECIFIC SEO ACTIVITIES……...10

4. MATERIALS PRODUCED……..11
   4.1 PROJECT PROFILES……...11
   4.2 MARKET ANALYSES……..…..11
   4.3 REGIONAL ROADMAPS AND ACTION PLANS……...……....…11
   4.4 APPLICATION GUIDEBOOKS…….…13
   4.5 TECHNICAL PAPERS……..…13

5. POLICY-RELATED ACTIVITIES AND RESULTS……...15
   5.1 WORKSHOPS AND EDUCATION SESSIONS……..…15
   5.2 POLICY-RELATED COMMUNICATIONS……...15
   5.3 POLICY RESULTS……...16

6. TECHNICAL ASSISTANCE AND RESULTS…….17
   6.1 TECHNICAL SITE EVALUATIONS AND ASSOCIATED PROJECTS……..17
   6.2 TECHNICAL SUPPORT CONTACTS AND ASSOCIATED PROJECTS……18

7. CHP INSTALLATIONS AND ASSOCIATED OUTCOMES……....21
   7.1 CAPACITY INSTALLED……21
   7.2 INVESTMENT IN CHP INSTALLATIONS……....22
   7.3 ENERGY SAVINGS…….23
   7.4 CARBON EMISSIONS REDUCTIONS……..24

8. SUMMARY AND RECOMMENDATIONS……....25
8.1. SUMMARY OF FINDINGS…….....25
8.2. RECOMMENDATIONS….....26

9. REFERENCES……..…….27

10. ACKNOWLEDGEMENTS……..…….29

LIST OF FIGURES

Figure		Page
ES.1.	Selected policy-related activities, fiscal years 2005-2008	x
1.1.	Geographic area served by each Regional Application Center	1
3.1.	Number of workshop materials downloaded, by year	6
3.2.	Number of partnership meetings, by year	8
3.3.	Number of State Energy Office activities, by year	10
4.1.	Number of market analyses performed, by year	12
4.2.	Number of technical papers published, by year	13
5.1.	Number of policy results achieved, by type and year	16
6.1.	Number of technical support contacts, by year	18
7.1.	Investment in CHP installations, by year	22
7.2.	Annual energy savings from CHP installations, by year	23
7.3.	Annual carbon emissions reductions from CHP installations, by year	24

LIST OF TABLES

Table		Page
ES.1.	Number of projects and capacity associated with technical assistance provided, fiscal years 2004-2008	xi
3.1.	Number of targeted workshops and attendees, by year	5
3.2.	Description of conference participation and attendance, by year	7
3.3.	Number of training sessions and attendees, by year	8
3.4.	Number of college courses and students, by year	9
3.5.	Number of website hits and downloads, by year	9
3.6.	Number of e-mails and recipients, by year	10
4.1.	Number of project profiles developed and downloaded, by year	11
4.2.	Number of regional roadmaps and action plans developed, by year	12
4.3.	Number of application guidebooks developed and downloaded, by year	13
5.1.	Number of policy workshops, by topic and year	15
5.2.	Number of policy-related communications, by type and year	16
6.1.	Number of technical site evaluations performed and associated activities, by year	17
6.2.	Activities associated with technical support contacts, by year	19
7.1.	Number of CHP installations and capacity installed, by year	21

EXECUTIVE SUMMARY

Eight Regional CHP Application Centers (RACs) are funded by the U.S. Department of Energy (DOE) to facilitate the development and deployment of Combined Heat and Power (CHP) technologies in all 50 states. The RACs build end-user awareness by providing CHP-related information to targeted markets through education and outreach; they work with the states and regulators to encourage the creation and adoption of favorable public policies; and they provide CHP users and prospective users with technical assistance and support on specific projects.

The RACs were started by DOE as a pilot program in 2001 to support the National CHP Roadmap developed by industry to accelerate deployment of energy efficient CHP technologies (U.S. Combined Heat and Power Association 2001). The intent was to foster a regional presence to build market awareness, address policy issues, and facilitate project development.

Oak Ridge National Laboratory (ORNL) has supported DOE with the RAC program since its inception. In 2007, ORNL led a cooperative effort involving DOE and some CHP industry stakeholders to establish quantitative metrics for measuring the RACs' accomplishments. This effort incorporated the use of logic models to define and describe key RAC activities, outputs, and outcomes. Based on this detailed examination of RAC operations, potential metrics were identified associated with the various key sectors addressed by the RACs: policy makers; regulatory agencies; investor owned utilities; municipal and cooperative utilities; financiers; developers; and end users. The final product was reviewed by a panel of representatives from DOE, ORNL, RACs, and the private sector. The metrics developed through this effort focus on major RAC activities as well as on CHP installations and related outcomes.

All eight RACs were contacted in August 2008 and asked to provide data for every year of Center operations for those metrics on which they kept records. In addition, data on CHP installations and related outcomes were obtained from an existing DOE-supported data base. The information provided on the individual RACs was summed to yield totals for all the Centers combined for each relevant item.

It should be noted that this is the first systematic attempt to collect quantitative information on the RACs' accomplishments and that the information provided by the various Centers has a number of gaps due to the incompleteness of the records kept, especially for past years. Also, while 2008 installation data are available, they should be considered incomplete because some information will not get incorporated into the data base until later in the year. Despite these limitations, the data compiled here still represent the most complete picture of RAC accomplishments provided to date and provide a good start toward understanding how the Centers operate.

The RACs' undertakings and accomplishments can be grouped into the following major categories: education and outreach activities; materials produced; policy-related activities and results; and technical assistance. Brief highlights from each of these broad areas are presented below.

A huge variety of education and outreach activities have been performed by the RACs with the goal of informing potential end-users, policy-makers, and other stakeholders about the benefits and applications of CHP technologies. These activities include targeted workshops and webinars, training sessions, partnership meetings, conferences, college courses, website activity, e-mail blasts, and involvement in State Energy Office activities. Among other things, the RACs have hosted over 120 workshops with more than 6,700 attendees, have helped plan over 60 conferences involving nearly 5,000 participants, and have made 200 conference presentations for over 10,500 attendees. Targeted markets have included the industrial sector, commercial buildings, hospitals, universities, military facilities, schools, and waste water treatment plants.

The RACs have also produced substantial amounts of informational materials in pursuit of their mission. These include over 100 CHP project profiles, 67 technical papers, 37 market analyses, 14 action plans, and 10 regional roadmaps. In addition, RAC websites have received over five million hits and have had almost 620,000 documents downloaded from them. Specifically, tools have been downloaded about 230,000 times, presentations more than 192,000 times, and CHP application guides over 150,000 times

In addition to the targeted workshops and webinars mentioned above, the RACs have held over 120 policy-related workshops and engaged in a wide variety of policy-related communications. As shown in Figure ES.1, those policy communications include issuing 25 white papers, holding 123 workshops, developing 123 sets of comments on relevant issues, and delivering testimony on CHP-related issues 138 times. During the years of RAC operations, a number of CHP-related rules, standards, and regulations have been enacted by various states. The most common of those are renewable portfolio standards, incentive programs, and interconnection rules. It is important to note that the kinds of data and analysis needed to establish a causal relationship between the RACs' policy-related activities and the enactment of state policies were not provided by this study.

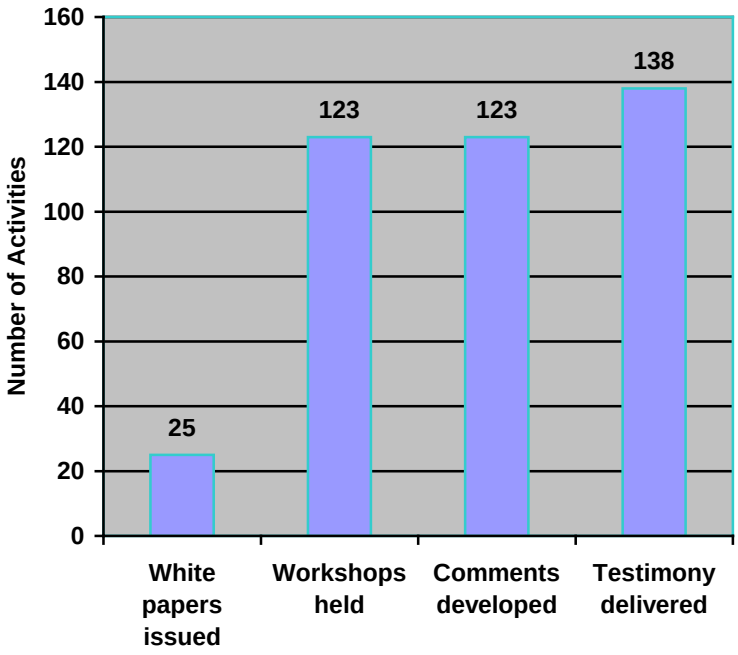


Figure ES.1. Selected policy-related activities, fiscal years 2005-2008

For the years for which records are available, the RACs reported performing 225 technical site evaluations and making 731 technical support contacts such as e-mails, phone calls, and face-to-face meetings. Because the project life cycle for CHP installations is often three to five years, there can be a substantial lag from the time that technical support is first provided until development is completed.

Through their technical assistance activities, the RACs recommended 169 CHP projects representing 1,467 MW of capacity. Of those, 101 projects with 1,229 MW of capacity were considered by developers and 44 projects with 1,045 MW of capacity proceeded to development during the time period examined (Table ES.1).

Table ES.1. Number of projects and capacity associated with technical assistance provided, fiscal years 2004-2008

	Number of projects	MW of capacity
Projects recommended	169	1,467
Projects considered by developers	101	1,229
Projects proceeding with development	44	1,045

ICF International, working with ORNL, has compiled data on CHP installations and associated outcomes for the regions served by the various RACs for those calendar years (as opposed to fiscal years) that the relevant RACs have been in existence. During that period, more than 670 installations were made with slightly greater than 5,000 MW of capacity. Over $7.5 billion of investment was made in those CHP units. Altogether, those installations resulted in estimated annual energy savings of nearly 200 trillion source BTUs and carbon emissions reductions of more than 20 million metric tons. While it is likely that RAC activities (which, as described above, include education and outreach, the production of informational materials, policy-related efforts, and technical assistance) have influenced those outcomes, the kinds of data and analysis needed to establish and quantify such a relationship were not provided by this study.

Because the current study was designed to catalog what the RACs have accomplished rather than to establish relationships between those activities and CHP installations, the recommendations that we can make about future program operations are limited. We do suggest that each RAC consider the feedback it has received from its region's stakeholders (and advisory board, if applicable) concerning the services provided and make near-term decisions based on that input. In addition, we recommend the establishment of a nationally-coordinated feedback mechanism to solicit input from stakeholder groups regarding the types of services that have been most helpful.

To increase the usefulness of future data collection efforts and help inform subsequent decisions about Center operations, we recommend that future studies be designed to identify relationships between RAC activities and the magnitude of CHP installations. Specifically, we recommend that future studies examine possible relationships between: (1) policy activities and policies enacted; (2) policies enacted and CHP installations (normalized by state population, state domestic product, state industrial energy use, or similar measure); (3) targeted educational and outreach efforts and CHP installations; and (4) other selected RAC activities and CHP installations.

To facilitate this search for relationships and to improve our ability to describe RAC accomplishments, we recommend that the collection of data from the RACs be enhanced by taking the following five steps: encouraging the RACs to keep more complete records on key topics; asking for data on a state-by-state basis; requesting activity data by calendar year (instead of fiscal year) to match the way in which CHP installation data are kept and other Industrial Technologies Program efforts track their progress; creating a mechanism for collecting the needed information online; and providing explicit definitions for key items.

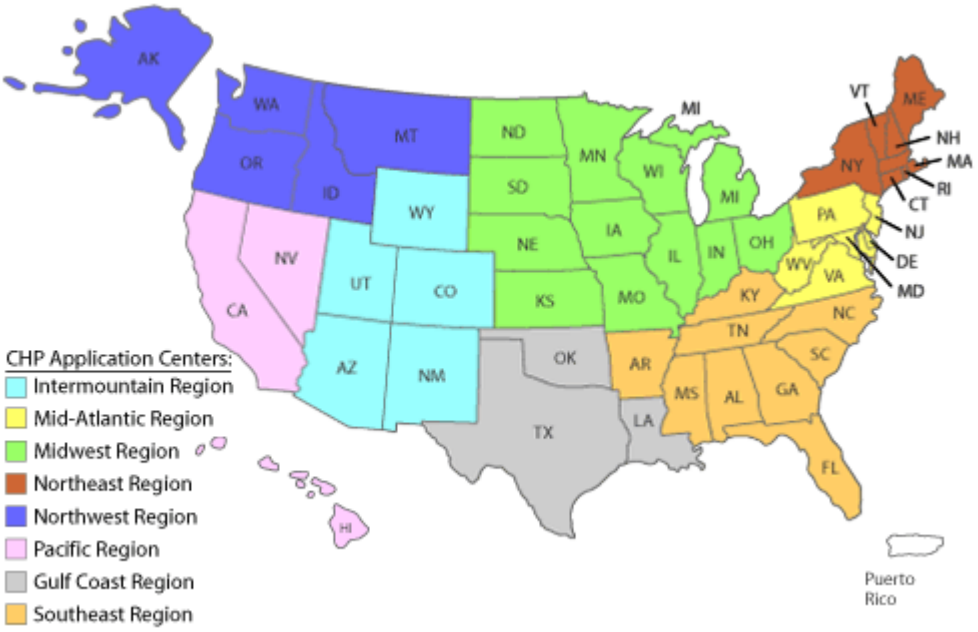
On a national level, we recommend that surveys be conducted with those who have received RAC services to explore the value of those services and how they influenced the recipient's CHP installation decisions. Such surveys could also measure certain interim outcomes not covered by the previous data collection instrument such as the awareness, knowledge, and attitudes of key actors. It might also be helpful to survey a sample of those who recently installed CHP units and ask how their decision was influenced by RAC services.

1. INTRODUCTION

1.1. BACKGROUND

The U.S. Department of Energy (DOE) funds eight Regional Application Centers (RACs) to facilitate the development and deployment of Combined Heat and Power (CHP) technologies (U. S. Department of Energy 2008; U.S. Combined Heat and Power Association 2001). The RACs' primary activities include: building end-user awareness by providing CHP-related information to targeted markets through education and outreach; working with the states and regulators to encourage the creation and adoption of public policies that are favorable to CHP; and providing CHP users and prospective users with technical assistance and support on specific projects (U.S. Department of Energy 2007). The regional nature of the RACs allows each one to provide services that are most relevant to the specific conditions in its particular area.

The RACs were started by DOE as a pilot program in support of the CHP Roadmap developed by industry to accelerate the deployment of CHP technologies (U.S. Combined Heat and Power Association 2001). The Midwest RAC was established in mid 2001, and this was followed by the creation of five other RACs (Intermountain, Mid-Atlantic, Northeast, Northwest, and Pacific) in 2004. Two more RACs (Gulf Coast and Southeast) were created in 2005, for a current total of eight. Between them, these eight RACs provide services to all 50 states and the District of Columbia. Figure 1.1, taken from a DOE website on CHP applications, shows the geographic area served by each Center.



Source: U.S. Department of Energy 2007

Figure 1.1. Geographic area served by each Regional Application Center

Oak Ridge National Laboratory (ORNL) has supported DOE with the RAC program since its inception. In 2007, ORNL led a cooperative effort involving DOE and some CHP industry stakeholders to establish quantitative metrics for measuring the RACs' accomplishments. The metrics developed through this effort focus on major RAC activities as well as on CHP installations and the associated capital investment, energy savings, and carbon reductions.

In August of 2008, ORNL contacted all eight RACs and asked them to provide data for each year of Center operations for those metrics on which they kept records. In addition, information on CHP installations and the associated investment, energy savings, and carbon reductions were taken from an existing DOE-supported data base. The resulting information was summed to yield totals for all RACs combined for each relevant item.

This report presents key findings from the data collection effort described above. It gives individual year and all-year totals for all RACs combined for all items on which adequate data were available. The reader should note that this is the first attempt to collect comprehensive information on the RACs' activities and related outcomes and that the information provided by the various Centers has a number of gaps due to the incompleteness of the records kept, especially for past years. Also, the 2008 installation data should be considered incomplete because some information will not get incorporated into the data base until later in the year. Nonetheless, the information presented here is the most complete picture of RAC accomplishments available to date and provides a good start toward understanding how these entities operate and what they have done.

1.2. SCOPE OF REPORT

This report documents the findings from our initial efforts to track RAC activities and accomplishments. **Chapter 2** discusses the research methods used to collect and analyze the necessary information. **Chapter 3** describes the education and outreach activities undertaken by the Regional Application Centers since their inception. In **Chapter** 4, we list the various informational materials produced by the RACs in pursuit of their mission. **Chapter** 5 depicts the policy-related activities carried out by the RACs and the regulatory and legislative results of those efforts. In **Chapter 6,** we discuss the RACs' technical assistance efforts and the CHP projects associated with those actions. **Chapter** 7 presents information on the CHP capacity installed nationwide since the RACs' inception, the financial investment made in those installations, and the resulting energy savings and carbon emissions reductions. Finally, **Chapter 8** summarizes the major findings of this study and recommends improvements for future efforts to collect and analyze data on RAC activities and accomplishments.

2. METHODS

A data collection spreadsheet soliciting information on all important activities undertaken by the various Regional Application Centers was developed and sent to the eight RACs in mid August of 2008. The contents of that data collection instrument were based on a metrics development effort initiated in 2007 which involved DOE, ORNL, and some CHP industry stakeholders. That effort incorporated the use of logic models to define and describe key RAC activities, outputs, and outcomes. Based on that detailed examination of RAC operations, potential metrics were identified associated with the various key sectors addressed by the RACs: policy makers, regulatory agencies, investor owned utilities; municipal and cooperative utilities; financiers; developers; and end users. The final product was reviewed by a panel of representatives from DOE, ORNL, RACs, and the private sector.

The RACs were asked to fill in the spreadsheet for all past fiscal years by mid September 2008 and to provide data for the then-current fiscal year (2008) by the end of October . Seven of the eight RACs provided the requested information by early November 2008, with the final RAC submitting the necessary data in June of 2009. About half of the RACs entered the relevant data into the spreadsheet that had been sent to them and the other half provided text description of the activities in question.

After data were received from the RACs, ORNL staff reviewed the information provided, identified missing data and items needing clarification, and conducted telephone interviews with all respondents. Follow-up information was requested as necessary, and most of that was received by early February of 2009. ORNL staff entered the additional data and finalized a comprehensive Excel data base containing the information provided by all eight RACs. The information provided by the individual RACs was summed to yield totals for all the Centers combined for each relevant item. Because comprehensive and accurate records were not available for all of the items requested, the information reported here is incomplete for a number of topics, especially for the years preceding 2008.

In addition to the above-described information on RAC activities, data on the number and size of regional RAC installations and the associated capital investment, energy savings, and carbon emissions reductions were also collected. Those data came from a state-by-state data base maintained for DOE by ICF International. A first data set focusing primarily on the years 2002 to 2007 was provided in early November, and additional information on 2008 activities was made available in January 2009. Those data describe CHP installations and related outcomes by calendar year (January through December) rather than by federal fiscal year (October through September) as was done for RAC activities. It should be noted that the 2008 installation data are incomplete because typically much information does not get incorporated into the data base until well into the following calendar year.

3. EDUCATION AND OUTREACH

The Regional Application Centers engage in a wide variety of activities to build market awareness that fall under the broad umbrella of Education and Outreach. They include: presenting targeted workshops and webinars; leading, planning and otherwise participating in conferences; organizing partnership meetings; sponsoring training sessions; sponsoring college courses; developing websites containing educational materials for downloading; contacting relevant parties via e-mail; and assisting in specific State Energy Office (SEO) activities. Each of these topics is discussed separately below.

3.1. TARGETED WORKSHOPS AND WEBINARS

Table 3.1 shows the number of workshops and webinars presented by all the RACs combined in each year since 2004 and the number of people attending. The specific end-use sectors targeted by those workshops and webinars were not always reported, but the most commonly mentioned were the industrial sector, commercial buildings, hospitals, universities, military facilities, schools, and waste water treatment plants. As with all RAC activities reported in this document, the numbers presented in Table 3.1 are expected to understate actual activity because several of the Centers did not have complete records on all their actions, especially for past years. Still, more than 120 targeted workshops were reported, with over 6,700 attendees.

Table 3.1. Number of targeted workshops and attendees, by year

Fiscal year	Number of workshops/webinars	Number of attendees
2004	14	358
2005	28	1,003
2006	17	1,041
2007	20	1,704
2008	43	2,604
All years	122	6,710

For slightly less than half of the people attending targeted workshops and webinars, their general type (public, business, or end user) was known. For this subset of attendees, 50% were CHP end users (or potential end users), 27% were classified as representing public entities, and 23% were from the business community.

Informational materials were prepared in conjunction with some of the CHP workshops and webinars sponsored by the RACs and were made available for download on the Center's website. Only a single RAC reported such activity but it is unclear whether it was the only RAC providing such materials or if it was just the only one with access to those records. Even for that single RAC, the number of workshop materials downloaded was substantial, as shown in Figure 3.1. That figure also indicates that, in each year for which data were available, the number of downloads increased markedly from the previous year. For the four years combined, the total number of materials downloaded for the one RAC reporting such activity was slightly greater than 300,000.

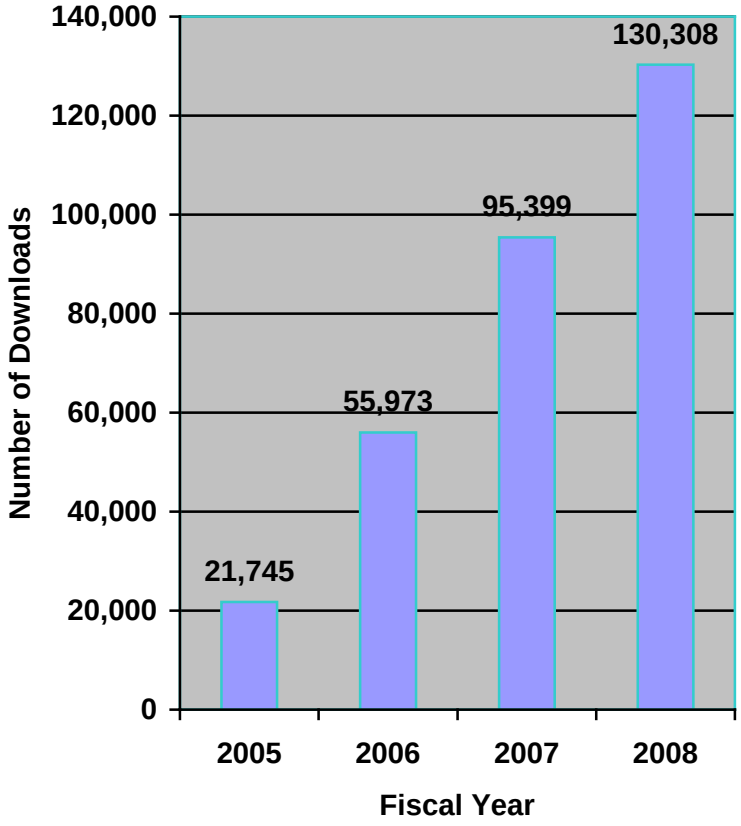


Figure 3.1. Number of workshop materials downloaded, by year

3.2. CONFERENCES

Table 3.2 describes the full range of conference-related activities reported by the RACs from 2004 to 2008. For all years combined, the RACs reported leading 31 conferences, serving on planning committees for 63 conferences, and leading 68 conference sessions. They also made 200 conference presentations, participated in 104 sessions, and operated booths at 13 conferences. The attendance numbers shown below are not cumulative because there is some overlap in the conferences involved (e.g., a RAC might have planned a conference and also led specific sessions or made a presentation at the same event). However, the total number of people at RAC-supported conference presentations alone exceeded 10,500.

Table 3.2. Description of conference participation and attendance, by year

	Fiscal year					
	2004	**2005**	**2006**	**2007**	**2008**	**All years**
Number of conferences led	3	8	6	6	8	31
Number of attendees at conferences led	100	310	306	689	503	1,908
Number of conferences planned	7	13	12	15	16	63
Number of attendees at conferences planned	271	690	749	1,723	1,459	4,892
Number of conference sessions led	6	16	25	9	12	68
Number of attendees at conference sessions led	271	657	1,308	809	675	3,720
Number of presentations made at conferences	17	48	64	19	52	200
Number of attendees at presentations	558	1,950	2,995	2,109	2,941	10,553
Number of conference sessions in which participated	11	23	35	18	17	104
Number of attendees at conference sessions in which participated	211	785	1,505	1,254	1,195	4,950
Number of conference booths operated	--	5	3	1	4	13
Number of visitors at conference booths	--	300	385	--	150	835

3.3. PARTNERSHIP MEETINGS

The number of partnership meetings reported by the RACs, by year, is shown in Figure 3.2. These meetings are where the RACs engage local industry, with common outcomes being a prioritization of RAC efforts and the development of regional CHP roadmaps. The number of meetings increased substantially from the first year to the last. The total number of partnership meetings reported for all years combined was 211, with two RACs accounting for over three-quarters of those. Those two Centers might have been much more active in this area than the other RACs, but it is also possible that the stakeholder interactions and coalition-building activities that they counted as partnership meetings were not considered to be partnership activities by some of the other RACs.

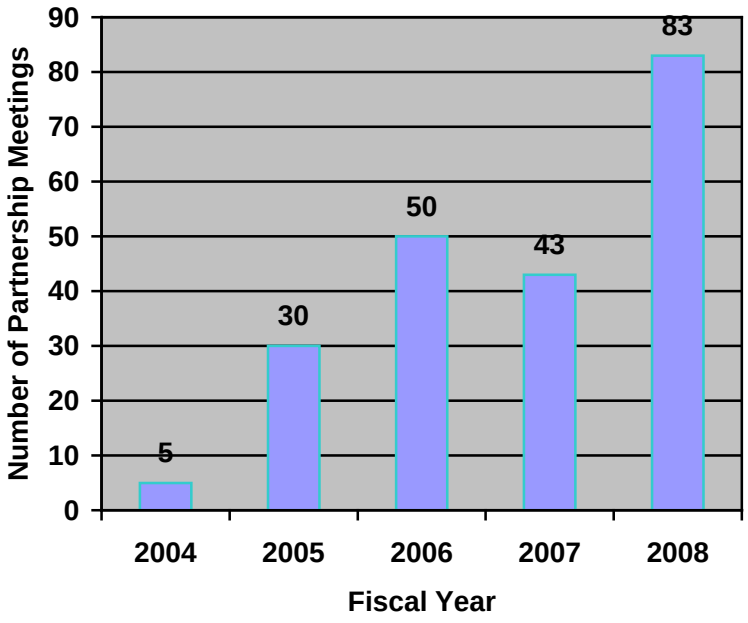


Figure 3.2. Number of partnership meetings, by year

3.4. TRAINING

The number of training sessions reported by the RACs in the four years for which records were available and the number of people attending those sessions are show in Table 3.3. Only three of the eight RACs reported engaging in this type of activity but, as always, it is unclear whether they were the only ones involved or just the only ones with good records on this topic. It should be noted that the numbers of training sessions and attendees increased substantially from 2005 to 2008.

Table 3.3. Number of training sessions and attendees, by year

Fiscal year	Number of training sessions	Number of attendees
2005	5	180
2006	8	500
2007	9	501
2008	16	711
All years	38	1,892

3.5. COLLEGE COURSES

A couple of the RACs reported that they taught CHP-related college courses at the undergraduate or graduate level. As shown in Table 3.4, 11 such courses were reported for all years combined, with a total of 130 students registered. The distribution of courses and attendance was fairly even over all four years for which such activity was reported.

Table 3.4. Number of college courses and students, by year

Fiscal year	Number of college courses	Number of students
2005	2	27
2006	3	36
2007	3	31
2008	3	36
All years	11	130

3.6 WEBSITE ACTIVITY

Table 3.5 shows the activity reported, by year, for all the RAC-operated websites. The number of hits and downloads was relatively small in the first year or two of website operation but increased substantially after that and held relatively steady in subsequent years. In total, the RACs reported over five million website hits and more than 600,000 downloads of various materials. It should be noted that while most of the RACs reported activity in this area, a large portion of the website hits and downloads shown in Table 3.5 was associated with a single well-established RAC. This could mean that the other RACs' websites were not as well utilized but it could also indicate that the records kept by some of the other Centers were less complete.

Table 3.5. Number of website hits and downloads, by year

Fiscal year	Number of website hits	Number of tools downloaded	Number of presentations downloaded	Number of application guides downloaded	Number of other materials downloaded	Total number of downloads
2004	25,000	--	--	--	--	--
2005	874,776	12,944	6,741	17,855	--	37,540
2006	1,601,764	58,507	33,125	30,816	3,239	125,687
2007	1,390,528	81,940	74,706	63,520	15,323	235,489
2008	1,395,468	77,443	78,304	39,443	24,580	219,770
All years	5,287,536	230,834	192,876	151,634	43,142	618,486

3.7 E-MAIL BLASTS

The number of e-mail blasts sent by the RACs from 2004 to 2008 and the number of recipients of those communications are shown in Table 3.6. E-mail blasts typically are announcements or news bulletins relating to CHP that are sent to a RACs' stakeholders. Common topics are the description of a new policy or notification of a CHP project funding opportunity. Nearly two-thirds of the blast recipients

listed in the table were reached by a single RAC. This could mean that the RAC in question has a better-developed network, but it could also indicate that it keeps more complete records on this topic.

Table 3.6. Number of e-mails and recipients, by year

Fiscal year	Number of e-mails or news blasts	Number of recipients
2004	9	12,500
2005	20	18,800
2006	15	4,500
2007	74	10,350
2008	60	31,400
All years	178	77,550

3.8 INVOLVEMENT IN SPECIFIC SEO ACTIVITIES

Several of the RACs reported being involved with specific CHP-related State Energy Office activities. As shown in Figure 3.3, the number of those activities increased each year, with a five-year total of 43.

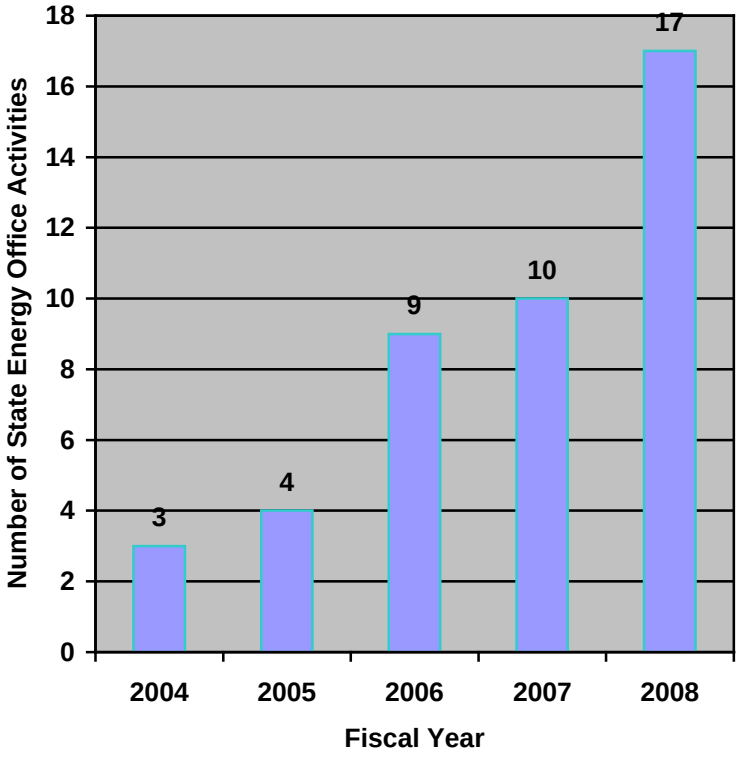


Figure 3.3. Number of State Energy Office activities, by year

4. MATERIALS PRODUCED

A number of different types of informational materials are produced by the Regional Application Centers to help encourage and facilitate the use of Combined Heat and Power. These materials include: project profiles; market analyses; regional roadmaps and action plans; application guidebooks; and technical papers. A brief discussion of each is presented below.

4.1. PROJECT PROFILES

All eight RACs reported developing project profiles that describe specific CHP installations. As shown in Table 4.1, the RACs reported developing 104 project profiles over a five year period. They also reported that nearly 180,000 such profiles were downloaded from their websites. It should be noted that most of those downloads involved a single RAC, which could indicate more interest by potential CHP users in that geographic area, a more user-friendly website, or more complete record-keeping by the Center in question.

Table 4.1. Number of project profiles developed and downloaded, by year

Fiscal year	Number of project profiles developed	Number of project profiles downloaded
2004	8	--
2005	21	67,056
2006	29	28,328
2007	18	51,156
2008	28	31,683
All years	104	178,223

4.2. MARKET ANALYSES

Another common RAC activity is to perform market analyses examining the potential demand for Combined Heat and Power in the region and the conditions and participants affecting CHP development. Figure 4.1 shows the number of such market analyses performed by all RACs combined between 2004 and 2008. Altogether, 37 such analyses were performed over the five year period.

4.3. REGIONAL ROADMAPS AND ACTION PLANS

Regional roadmaps and action plans have been developed by most of the RACs, often in conjunction with regional stakeholders, to help guide CHP development in their region. As shown in Table 4.2, 10 regional roadmaps were developed between 2004 and 2008 and 14 actions plans were created during the same period.

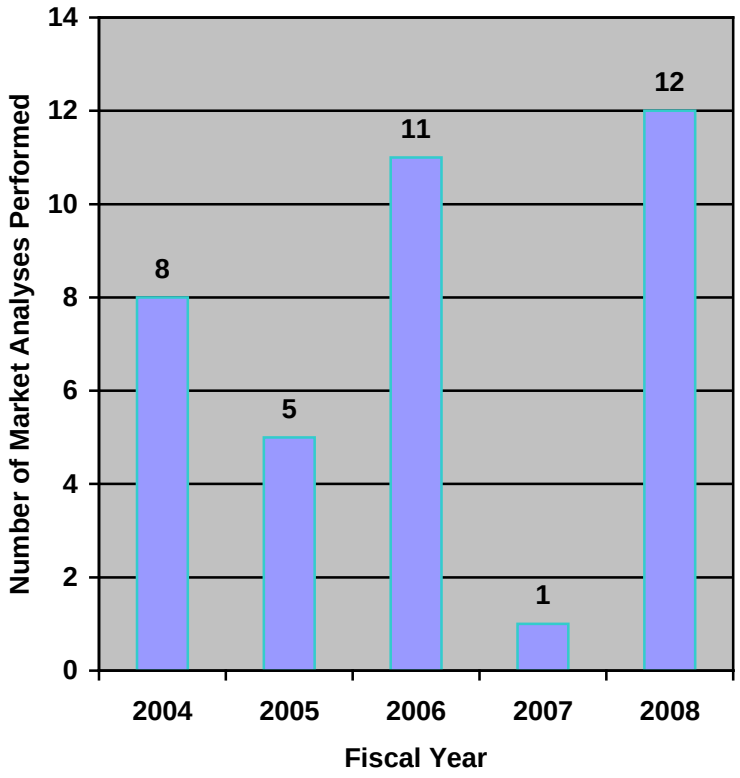


Figure 4.1. Number of market analyses performed, by year

Table 4.2. Number of regional roadmaps and action plans developed, by year

Fiscal year	Number of regional roadmaps developed	Number of action plans developed
2004	2	3
2005	3	1
2006	3	2
2007	--	4
2008	2	4
All years	10	14

4.4. APPLICATION GUIDEBOOKS

Two RACs reported producing Application Guidebooks and having such documents downloaded from their website, with a single Center accounting for nearly all of the downloads. As shown in Table 4.3, seven guidebooks were developed by the two RACs in question and nearly 115,000 guidebooks were downloaded in a four year period.

Table 4.3. Number of application guidebooks developed and downloaded, by year

Fiscal year	Number of application guidebooks developed	Number of application guidebooks downloaded
2005	2	17,855
2006	1	30,816
2007	1	26,772
2008	3	39,456
All years	7	114,899

4.5 TECHNICAL PAPERS

Nearly all of the RACs have written or supported the writing of technical papers on CHP topics. As shown in Figure 4.2, the number of papers prepared with RAC support has increased substantially over the years. In the period from 2004 to 2008, 67 such papers were published.

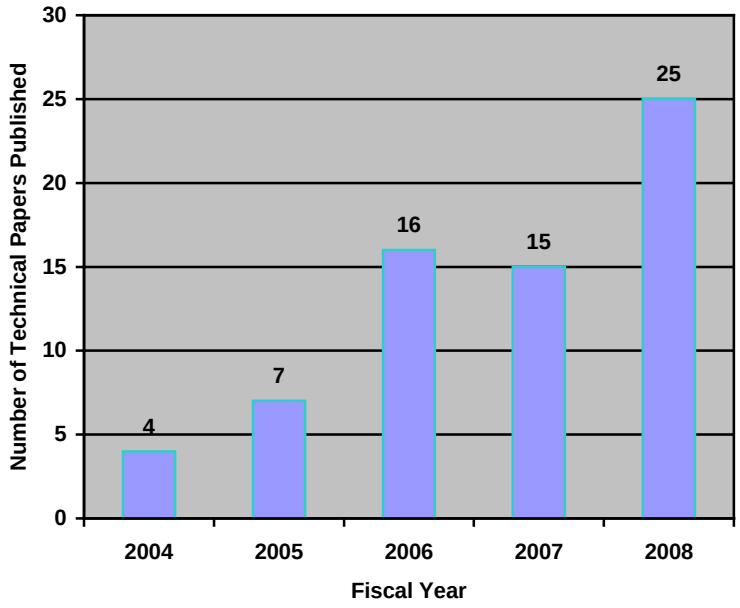


Figure 4.2. Number of technical papers published, by year

5. POLICY-RELATED ACTIVITIES AND RESULTS

The Regional Application Centers engage in a number of policy-related activities that often culminate in the enactment of regulations and statutes that facilitate the use of Combined Heat and Power. The most common activities are workshops and education sessions and various policy-related communications. Each of these topics, as well as the results of such efforts, is discussed separately below.

5.1. POLICY WORKSHOPS AND EDUCATION SESSIONS

Nearly all RACs reported holding policy workshops or educational sessions on CHP-related topics, and it was not uncommon for a RAC to address several different subjects or to hold multiple workshops on a single topic. As shown in Table 5.1, the most frequently addressed subject was incentive programs, followed by "other topics", renewable portfolio standards, and emissions rules. Interconnection issues and standby rates were addressed less frequently. Altogether, the RACs reported holding over 120 policy-related workshops and education sessions over a five year period.

Table 5.1. Number of policy workshops, by topic and year

	Number of workshops on:						
Fiscal year	Incentive programs	Renewable portfolio standards	Emissions rules	Interconnection	Standby rates	Other topics	All topics combined
2004				1			1
2005	5	--	2	1	2	1	11
2006	16	4	2	2	--	8	32
2007	16	4	2	--	--	11	33
2008	11	2	3	2	1	27	46
All years	48	10	9	6	3	47	123

5.2. POLICY-RELATED COMMUNICATIONS

In addition to holding workshops and educational sessions, RACs address policy-related issues through a number of other communication channels. These include: issuing white papers; holding conference calls; responding to queries via e-mail; developing comments; and delivering testimony. Table 5.2 shows the number of policy-related communications reported for 2004 to 2008, by type and year. E-mail responses and conference calls were by far the most common types of policy-related communications. A substantial number of comments and testimony were also developed and delivered but, due to the substantial effort involved, these were considerably less common than the first-named items. It should be noted that a single RAC was responsible for nearly all of the conference calls and e-mail responses reported, indicating that its representative might have understood this item differently than did the other respondents. That same RAC also accounted for a majority of the reported comments and testimony.

Table 5.2. Number of policy-related communications, by type and year

Fiscal year	Number of white papers	Number of conference calls	Number of e-mail responses	Number of comments developed	Number of testimony delivered
2004	4				
2005	5	1,744	3,905	12	3
2006	7	1,789	3,791	30	15
2007	6	3,191	5,624	37	61
2008	3	1,598	2,700	44	59
All years	25	8,332	16,020	123	138

5.3. POLICY RESULTS

Figure 5.1 shows the number of rules, standards, or regulations enacted on a variety of policy-related topics from 2004 to 2008. Renewable portfolio standards were put in place more frequently than any other type of policy; in many cases CHP was not specifically mentioned in the standard but it was implied by the fuels involved. Incentive programs and interconnection rules were also relatively common. Overall, more CHP-related policies were put in place in 2008 than in all other years combined, and few CHP policies were enacted prior to 2007. It is important to note that the kinds of data and analysis needed to establish a causal relationship between the RACs' policy-related activities and the enactment of state policies were not provided by this study.

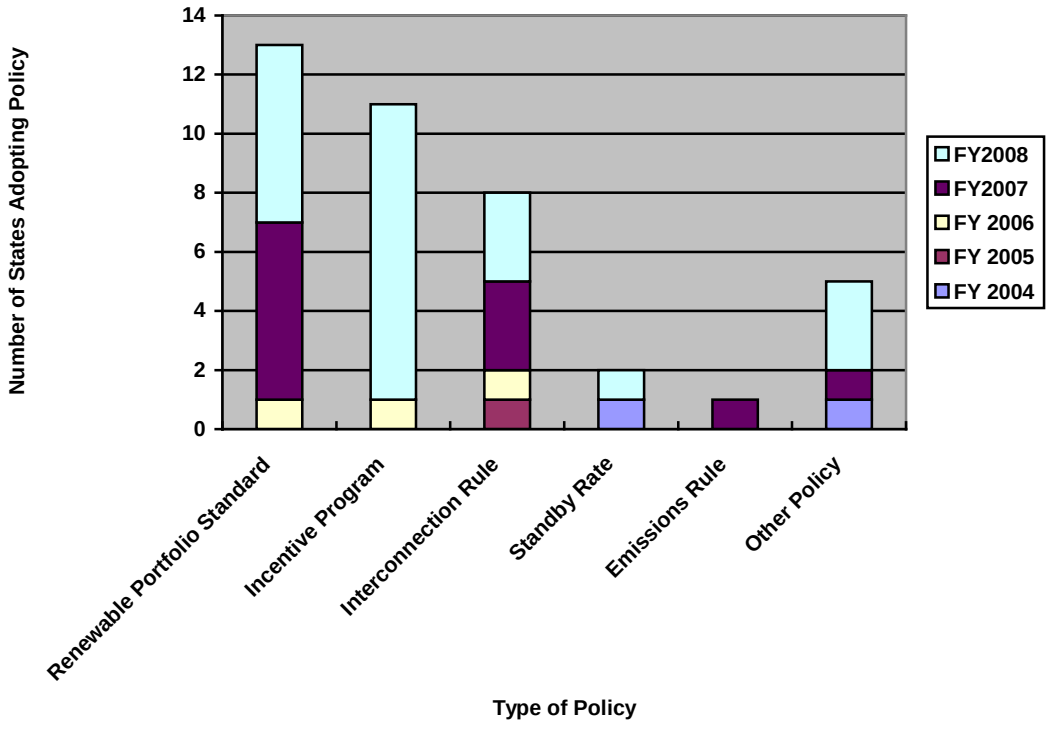


Figure 5.1. Number of policy results achieved, by type and year

6. TECHNICAL ASSISTANCE AND RESULTS

An important component of the RACs' activities is the provision of project-specific technical assistance to CHP users and prospective users. This assistance can be grouped into two broad categories: technical site evaluations and other technical support contacts (e.g., meetings, phone calls, e-mails). The assistance provided in each of these general areas is discussed separately below.

6.1. TECHNICAL SITE EVALUATIONS AND ASSOCIATED PROJECTS

Table 6.1 shows the number of technical site evaluations performed annually from 2004 to 2008 as well as the number of CHP projects recommended by those evaluations. It is important to note that the project life cycle for CHP installations is often three to five years, meaning that there can be a substantial lag from the time a technical site evaluation is performed until development is completed. Altogether, 225 site evaluations were performed and 133 CHP projects were recommended. Of those, 75 projects were considered by potential developers and 24 proceeded with development within the time period examined. For all years combined, there were 397 megawatts (MW) of capacity associated with recommended projects, 217 MW associated with projects considered by potential developers, and 46 MW associated with projects that proceeded to development.

Table 6.1. Number of technical site evaluations performed and associated activities, by year

	Fiscal year					
	2004	**2005**	**2006**	**2007**	**2008**	**All years**
Number of technical site evaluations performed	18	42	63	40	62	225
Number of CHP projects recommended	12	24	36	25	36	133
MW of capacity associated with recommended projects	23.9	107.9	123.5	78.9	62.4	396.6
Number of recommended projects under consideration	10	10	21	13	21	75
MW of capacity associated with projects under consideration	19.6	49.3	95.2	26.7	26.2	217
Number of recommended projects currently being developed	5	2	6	3	8	24
MW of capacity associated with projects currently being developed	19.3	1.1	8.9	10.0	6.9	46.2

6.2. TECHNICAL SUPPORT CONTACTS AND ASSOCIATED PROJECTS

Technical support can be provided through meetings, phone calls, and e-mails as well as through a number of other channels. The support provided can include the provision of expert help and guidance in technical matters (e.g., design and performance issues) as well as assistance in dealing with legal and regulatory issues. That support can be, and often is, provided at various stages throughout the project design and development process. The number of technical support contacts made by the RACs from 2004 to 2008 is shown in Figure 6.1. The big increase in number of contacts in 2008 was due largely to a sudden jump in activity by two RACs and does not indicate an across-the-board increase. Altogether, 731 technical support contacts were made in the five year period, more than half of them by a single RAC. The specific type of contact is known in a large majority of the cases. For those, 49% were phone calls, 39% were e-mails, 9% were meetings, and the remaining 3% were other types of contact.

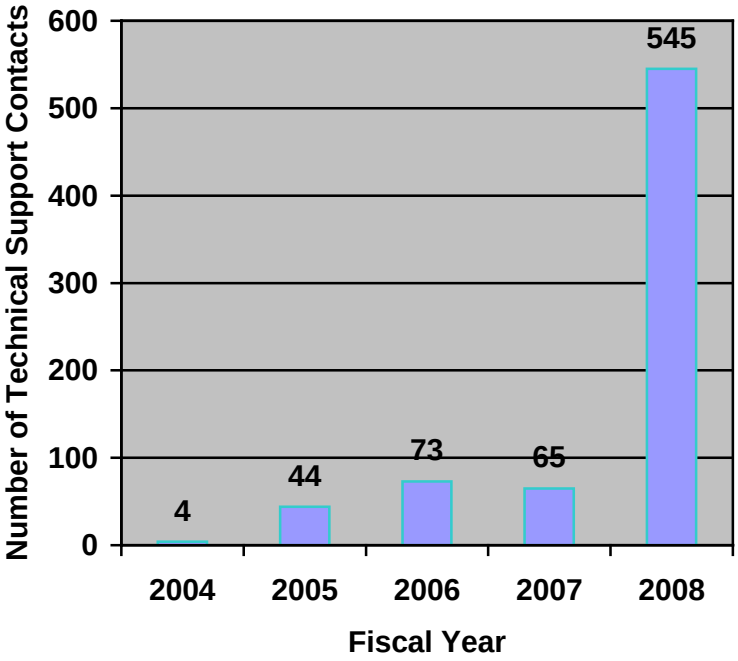


Figure 6.1. Number of technical support contacts, by year

Table 6.2 shows the number of CHP projects recommended by the technical support contacts described above and their associated capacity. For all years combined, 38 CHP projects were recommended, representing 1,077 MW of capacity. Of those, 28 projects with 1,019 MW of capacity were considered by potential developers and 22 projects with 1,006 MW of capacity proceeded to development. A majority of that capacity is associated with a single very large project. Most of the remaining capacity comes from four other sizable projects assisted by three RACs.

Table 6.2. Activities associated with technical support contacts, by year

	Fiscal year					
	2004	**2005**	**2006**	**2007**	**2008**	**All years**
Number of CHP projects recommended	3	6	2	8	19	38
MW of capacity associated with recommended projects	746.7	17.4	1	98.1	214.2	1,077.4
Number of recommended projects under consideration	2	5	2	8	11	28
MW of capacity associated with projects under consideration	8.7	754.8	1	98.6	155.4	1,018.5
Number of recommended projects currently being developed	1	1	4	5	11	22
MW of capacity associated with projects currently being developed	1.5	7.2	750.3	93.6	153.3	1,005.9

Nearly all of the projects associated with technical support contacts are different undertakings than those associated with the technical site evaluations discussed previously. The only exception to this is two projects with a combined capacity of 7 MW that were reported for both technical site evaluations *and* technical support contacts. When that overlap is eliminated and the numbers for technical site evaluations and other technical support contacts are summed, we find that technical assistance of all kinds resulted in recommendations for 169 projects with 1,467 MW of capacity. One hundred one of those projects with 1,229 MW of capacity were considered by developers, and 44 projects with 1,045 MW of capacity proceeded to development during the period examined.

7. CHP INSTALLATIONS AND ASSOCIATED OUTCOMES

Information on CHP installations and the associated outcomes was taken from a national database maintained by ICF International for the U.S. Department of Energy (ICF 2009). That database provides a comprehensive list of CHP installations nationwide. The information used in this report concerns the installations made in each region of the country during the years that the Regional Application Center serving that region has been in existence. For the geographic region served by the first RAC, which had its first full year of operation in 2002, data going back to that year were used. For five other RACs, the information reported in this Chapter date to 2004, the year in which those RACs were created. The last two RACs began operation in 2005, so data on installations in those regions are reported from that year forward. Accordingly, the information on RAC installations and associated outcomes reported below cover one geographic region for 2002 and 2003, six regions for 2004, and all eight regions for 2005 through 2008. It should be noted that much of the information needed to provide a complete picture of CHP installations in 2008 are not yet available, so actual installations for that year are likely to be greater than what is described here.

The CHP installation database tracks activity by calendar year (January through December) so that is the convention that is used in this chapter as well. In contrast, the RAC activities discussed in the preceding chapters were reported for the federal government's fiscal year (October through September) because the funds that support those activities are provided on a fiscal year basis.

The following sections provide information on the number and capacity of CHP installations in the U.S. during the years of RAC operation, the amount of investment made in those facilities, the magnitude of energy savings, and the amount of carbon emissions reductions associated with those savings. While it is probable that the RACs were responsible for influencing or expediting some of the CHP installations described here, the kinds of data and analysis needed to establish and quantify a causal relationship between RAC activities and CHP installations were not provided by this study.

7.1. CAPACITY INSTALLED

Table 7.1 shows the number of CHP installations and MW of capacity installed for each year that the RACs have been in existence. The number of installations and the associated capacity was lowest in 2003 (when only a single RAC was in existence) and highest in 2005 (the first year that all eight RACs were in operation). Altogether, 673 CHP installations were made in the various regions during the years that their RACs were in existence, totaling over 5,000 MW of installed capacity.

Table 7.1. Number of CHP installations and capacity installed, by year

Calendar year	Number of CHP installations	MW of CHP capacity installed
2002	29	909.1
2003	24	111.1
2004	137	1,309.9
2005	156	1,599.6
2006	121	352.4
2007	123	490.2
2008	83	265.8
All years	673	5,038.2

7.2. INVESTMENT IN CHP INSTALLATIONS

The magnitude of the investment made in CHP installations during the time that the RACs were in operation is illustrated in Figure 7.1. As with number of installations and installed capacity, the amount of money invested in CHP was lowest in 2003 and highest in 2005. For all years combined, total investment amounted to over $7.5 billion.

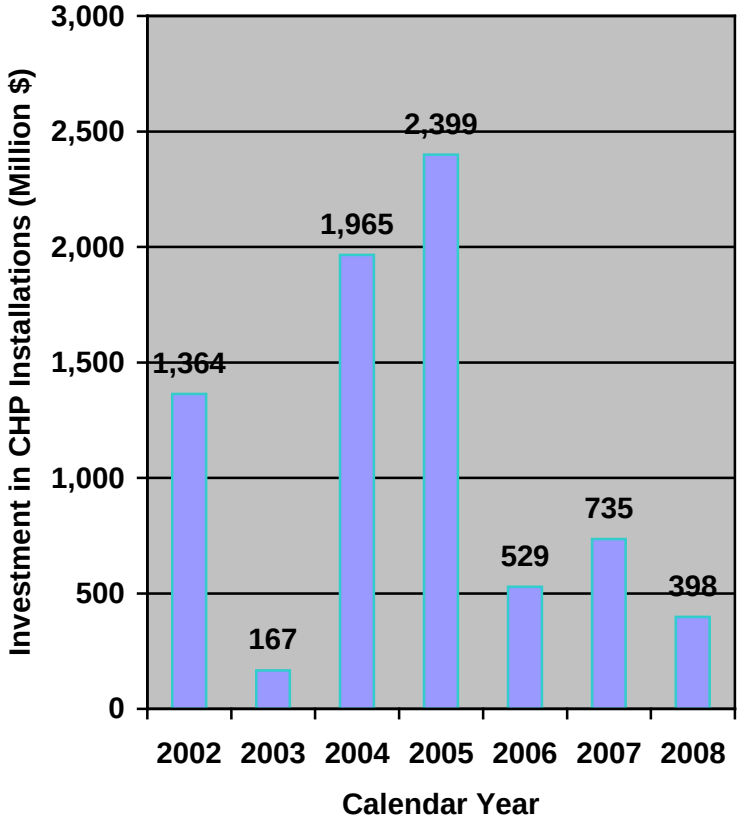


Figure 7.1. Investment in CHP installations, by year

7.3. ENERGY SAVINGS

Combined Heat and Power installations can save substantial amounts of energy compared to more traditional technologies by utilizing the thermal energy that is normally wasted when electricity is produced at central generating stations. In addition, the location of CHP facilities at or near the point of consumption greatly reduces or eliminates electric transmission and distribution losses (Shipley et al 2008). Figure 7.2 shows estimated annual energy savings associated with the CHP installations discussed above. As with the other factors discussed in previous sections, savings were lowest for 2003 and highest for 2005. It is important to note that these numbers represent annual savings from the installations made in each designated year. Estimated annual savings from the relevant installations made in all years combined was nearly 200 Trillion source BTUs.

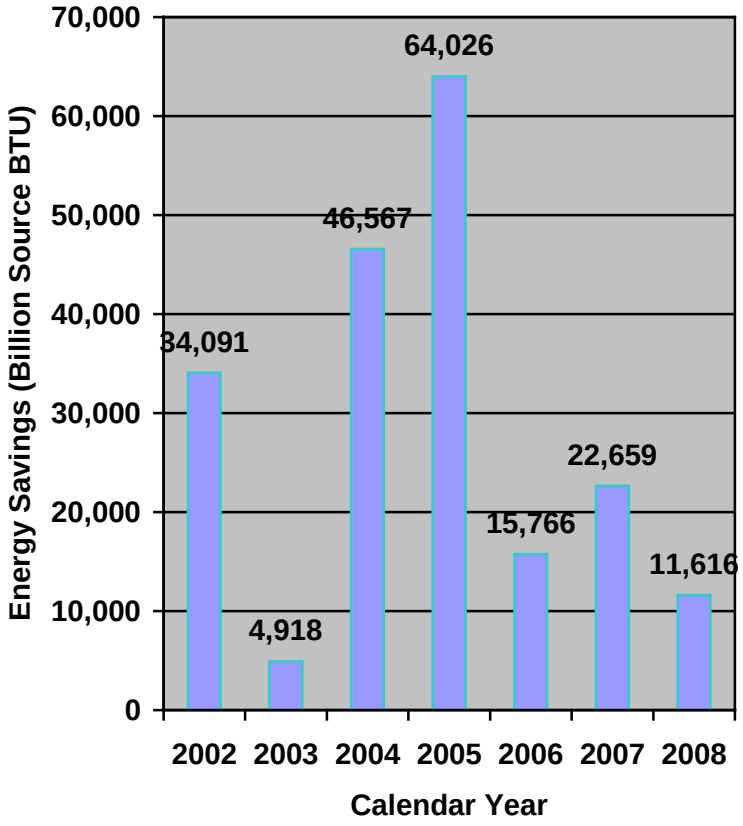


Figure 7.2. Annual energy savings from CHP installations, by year

7.4. CARBON EMISSIONS REDUCTIONS

The energy savings discussed in the previous section result in a reduction in carbon emissions. The magnitude of those emissions reductions was calculated based on information and assumptions about the displaced fuels and their emissions characteristics (ICF 2009). Annual carbon emissions reductions associated with the relevant CHP installations made in each year from 2002 to 2008 are shown in Figure 7.3. These were lowest for 2003 and highest for 2004, although emissions for 2005 ranked a very close second. Although more CHP capacity was installed in 2005 than in 2004, there were greater carbon emissions reductions in 2004, indicating that the installations made in that year displaced more high carbon-emitting fuels. For all years combined, carbon emissions reductions totaled nearly 21 million metric tons.

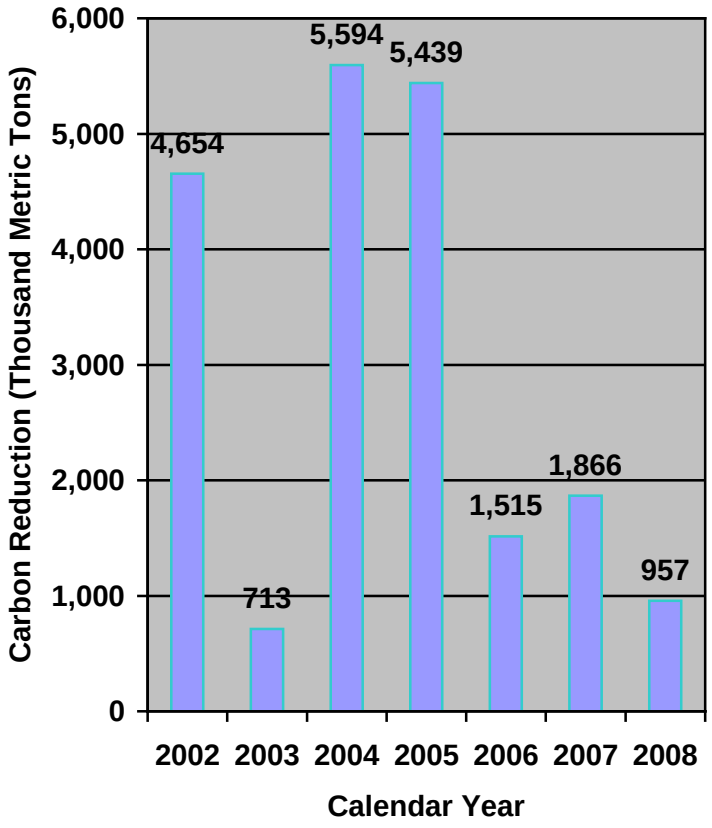


Figure 7.3. Annual carbon emissions reductions from CHP installations, by year

8. SUMMARY AND RECOMMENDATIONS

SUMMARY OF FINDINGS

The information presented in the preceding chapters describes the following key elements of the Regional Application Centers' undertakings and accomplishments: education and outreach activities; materials produced; policy-related activities and results; and technical assistance. In addition, we described CHP installations and associated outcomes for the years of RAC operations, although the kinds of data and analysis needed to establish and quantify a causal relationship between RAC activities and CHP installations were not provided by this study. Brief highlights from each of the broad areas covered in this report are presented below. It is important to reiterate that the data reported by the Centers contain some gaps due to the incompleteness of available records. Despite that, the information presented in this report provides the most comprehensive picture of RAC accomplishments offered to date.

A huge variety of education and outreach activities have been performed by the RACs to inform potential end-users, policy-makers, and other stakeholders about the benefits and applications of CHP technologies. These include targeted workshops and webinars, conferences, partnership meetings, training sessions, college courses, website activity, e-mail blasts, and involvement in State Energy Office activities. Among other things, the RACs have hosted more than 120 workshops with over 6,700 attendees, have helped plan over 60 conferences involving nearly 5,000 participants, and have made 200 conference presentations for over 10,500 attendees. Targeted markets have included the industrial sector, commercial buildings, hospitals, universities, military facilities, schools, and waste water treatment plants.

The RACs have also produced substantial amounts of informational materials in pursuit of their mission. These include over 100 CHP project profiles, 67 technical papers, 37 market analyses, 14 action plans, and 10 regional roadmaps. In addition, RAC websites have received over five million hits and have had almost 620,000 documents downloaded from them. Specifically, tools have been downloaded about 230,000 times, presentations more than 192,000 times, and CHP application guides over 150,000 times.

In addition to the targeted workshops and webinars mentioned above, the RACs have held over 120 policy-related workshops and engaged in a wide variety of policy-related communications. Those policy communications include issuing 25 white papers, holding 123 workshops, developing 123 sets of comments on relevant issues, and delivering testimony on CHP-related issues 138 times. During the years of RAC operations, a number of CHP-related rules, standards, and regulations have been enacted by various states. The most common of those are renewable portfolio standards, incentive programs, and interconnection rules.

For the years for which records are available, the RACs reported performing 225 technical site evaluations and making 731 technical support contacts such as e-mails, phone calls, and face-to-face meetings. Through those technical assistance activities, the RACs recommended 169 CHP projects representing 1,467 MW of capacity. Of those, 101 projects with 1,229 MW of capacity were considered by developers and 44 projects with 1,045 MW of capacity proceeded to development during the time period examined.

Data have been compiled on CHP installations and associated outcomes for the regions served by the various RACs for those calendar years that the relevant RACs have been in existence. During that period, more than 670 installations were made with slightly greater than 5,000 MW of capacity. Over $7.5 billion of investment was made in those CHP units. Altogether, those installations resulted in estimated

annual energy savings of nearly 200 trillion source BTUs and carbon emissions reductions of more than 20 million metric tons. While it is likely that RAC activities (which, as described above, include education and outreach, the production of informational materials, policy-related efforts, and technical assistance) have influenced those outcomes, the kinds of data and analysis needed to establish and quantify such a relationship were not provided by this study.

RECOMMENDATIONS

Because the current study was designed to catalog what the RACs have accomplished rather than to establish relationships between those activities and CHP installations, the recommendations that we can make about future program operations are limited. We do suggest that each RAC consider the feedback it has received from its region's stakeholders (and advisory board, if applicable) concerning the services provided and make near-term decisions based on that input. In addition, we recommend the establishment of a nationally-coordinated feedback mechanism to solicit input from stakeholder groups regarding the types of services that have been most helpful.

To increase the usefulness of future data collection efforts and help inform subsequent decisions about Center operations, we recommend that future studies be designed to identify relationships between RAC activities and the magnitude of CHP installations. Specifically, we recommend that future studies examine possible relationships between: (1) policy activities and policies enacted; (2) policies enacted and CHP installations (normalized by state population, state domestic product, state industrial energy use, or similar measure); (3) targeted educational and outreach efforts and CHP installations; and (4) other selected RAC activities and CHP installations.

To facilitate this search for relationships and to improve our ability to describe RAC accomplishments, we recommend that the collection of data from the RACs be enhanced by taking the following five steps: encouraging the RACs to keep more complete records on key topics; asking for data on a state-by-state basis; requesting activity data by calendar year; creating a mechanism for collecting the needed information online; and providing explicit definitions for key items. The availability of more complete records would allow future studies to present a fuller picture of RAC accomplishments. Asking the RACs to provide information on their activities in each state that they serve, rather than for the entire region, would allow analyses to be conducted with 50 separate data points (the states) instead of only eight (the RACs). Obtaining data on RAC activities by calendar year (instead of fiscal year, as was done in the current study) would match the way in which CHP installation data are kept and allow any future analyses of relationships between RAC activities and CHP installations to be conducted with data from identical time periods. This would also be consistent with the reporting period used by other Industrial Technologies Program efforts to track their progress. Collecting information online could be less burdensome for the RACs than entering the data into a spreadsheet or word processing program, as was done in the current study, and more standardized responses could be elicited. Finally, providing respondents with explicit definitions for key items would help avoid confusion and ensure more consistent answers.

On a national level, we recommend that surveys be conducted with those who have received RAC services to explore the value of those services and how they influenced the recipient's CHP installation decisions. Such surveys could also measure certain interim outcomes not covered by the previous data collection instrument such as the awareness, knowledge, and attitudes of key actors. It might also be helpful to survey a sample of those who recently installed CHP units and ask how their decision was influenced by RAC services.

9. REFERENCES

ICF International, 2009. *CHP Regional Application Center Metrics: Energy Savings, Carbon Emission Reductions, and CHP Investment*. Energy and Environmental Analysis, Inc., an ICF International Company, Arlington, Virginia, January.

Shipley, A., A. Hampson, B. Hedman, P. Garland, and P. Bautista, 2008. *Combined Heat and Power. Effective Energy Solutions for a Sustainable Future*, ORNL/TM-2008/224. Oak Ridge National Laboratory, Oak Ridge, TN, December.

U.S. Combined Heat and Power Association, 2001. *National CHP Roadmap. Doubling Combined Heat and Power Capacity in the United States by 2010.* Washington, DC, March.

U.S. Department of Energy, 2007. *CHP Regional Application Centers (RACs).* www.eere.energy.gov/de/chp/chp_applications/chp_application_centers.html

U.S. Department of Energy, Industrial Technologies Program, 2008. *Powering Progress in Combined Heat and Power (CHP), For Now…For the Future*, Washington, DC.

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