Promoting Combined Heat and Power (CHP) for Multifamily Properties

Robert Groberg, U.S. Department of Housing and Urban Development (HUD)
Mike MacDonald and Patti Garland, Oak Ridge National Laboratory (ORNL)

ABSTRACT

HUD multifamily programs assist five million renters—approximately 20% of multifamily rental housing in the nation. More than $5 billion is spent annually for utilities in public and private property involved in HUD affordable housing programs. HUD's *Energy Action Plan*[1] has an initiative to promote the installation of combined heat and power (CHP) (also known as "cogeneration") systems in existing multifamily buildings. HUD and the Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) developed preliminary feasibility (Level 1) screening software and enlisted the DOE CHP Regional Application Centers (RACs) to help run utility data and estimate paybacks. The paper describes the software and provides case studies of CHP installed in multi-family housing (e.g. Cambridge MA, Danbury CT). It outlines the roles of RACs in screening for feasibility and in considering a more detailed Level 2 analysis. It summarizes EPA support for CHP. It discusses the growth of the industry infrastructure needed to scope, design, finance, install, monitor, and reliably maintain CHP systems in multifamily buildings. It cites State Housing Finance Agency support for CHP. It reviews program obstacles, lessons learned and a future HUD role, including the Mark to Market Green Initiative and the 2007 Energy Independence and Security Act[2] (EISA) that authorizes technical and financing assistance for CHP that can include public housing.

Introduction

The average efficiency of the fossil-fuel power plants in the U.S. is approximately 33%. This means that in the process of generating electricity two-thirds of the energy in the fuel is lost as heat. An average of 8% of the remainder is lost in the transmission and distribution of electricity to users. CHP is the production of electricity and use of the heat created in that process. CHP systems recycle waste heat that would normally be released to the surroundings. In residential applications the heat can be used for domestic hot water, space heating, absorption cooling, or dehumidifying at the building where it is produced. CHP systems consist of a package of equipment with a prime mover (for apartment buildings, most often a reciprocating engine or microturbine) driving an electric generator. If all of the recoverable heat is used, they can achieve overall efficiencies of about 80%.[3] This efficiency is in contrast to more typical systems where electricity is produced at central power plants and on-site boilers provide needed thermal energy. These more typical systems operate at an overall efficiency of approximately 30% to 50% depending on the relative amounts of electric and thermal energy that are required. In addition to greater efficiency, there are environmental benefits from CHP, fewer emissions of CO_2 and other gases. CHP is recognized as a "key mitigation technology currently commercially

[1] http://www.hud.gov/energy/energyactionplan.pdf
[2] Energy Independence and Security Act of 2007, P.L. 110-140, Part E Industrial Energy Efficiency.
[3] Additional information about CHP systems and operating efficiencies can be found in DOE reports at http://www.ornl.gov/sci/engineering_science_technology/eere_research_reports/der_chp/subindex.html

available" by the Intergovernmental Panel on Climate Change (IPCC)[4] The European Union Building Directive introduced a system requiring posting a certificate indicating overall energy consumption in buildings which requires identifying electricity produced from CHP.[5] The U.S. Congress recognized the benefits of CHP in the 2007 EISA.[6]

HUD's Combined Heat and Power Initiative. HUD's initiative to promote the installation of CHP systems in existing multifamily buildings[7] aims at a primary market with almost 7,300 projects with 100 or more units.[8] To introduce building owners to the value of CHP and help them with initial site screening, HUD and DOE/ORNL developed two CHP Guides[9] and preliminary feasibility screening software.[10] They enlisted the DOE CHP Regional Application Centers (RACs) to help analyze utility data and estimate potential paybacks.[11] HUD programs have begun to incorporate material on CHP.[12] Note that these CHP systems generally produce only a portion of the total electricity needed by the building, and they remain connected to the grid, but it is possible for CHP to run off the grid.

EPA-DOE CHP Partnership. Since 2000 DOE and the Environmental Protection Agency (EPA) have supported work in the area of CHP. DOE efforts were primarily aimed at increasing the efficiency of CHP equipment, reducing their emissions, and integrating CHP systems. The EPA focused on their CHP Partners Program—a voluntary program that seeks to reduce the environmental impact of power generation by fostering the use of highly-efficient CHP. The HUD CHP initiative has worked to focus their attention on multifamily apartment buildings. DOE and the EPA maintain the CHP Partnership which supported the National CHP Roadmap.[13] Its goal is to double the amount of CHP installed capacity in the United States by the year 2010 (utilizing 1999 as the base year). This translates to the equivalent of 92,000 MW of

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[4] IPCC Fourth Assessment Report: "Climate Change 2007: Mitigation of Climate Change". http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_topic4.pdf

[5] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, Official Journal of the European Communities. Article 5 requires "a technical, environmental and economic feasibility study'' on "alternative systems such as… CHP" before a new building with a useful floor area over 1000 square meters is constructed

[6] Op. cit. 2. Subtitle D amends the Energy Conservation Policy Act by adding Section 375 Clean Energy Centers and Section 399A Energy Sustainability and Efficiency Grants and Loans for Institutions.

[7] For an overview of the HUD CHP initiative, see the May 17, 2007 web cast summary of CHP at HUD: http://www.hud.gov/webcasts/archives/envirhealth.cfm Bring up Part 2; CHP begins after the 51 minute point and runs about 20 minutes.

[8] 1,790 public housing and 5,490 active multifamily properties that are either insured or Section 202 (senior) and Section 811 (handicapped) assisted housing developments. [Source: HUD Public Housing and Housing Offices.]

[9] HUD CHP Guide #1: "Q and A on Combined Heat and Power for Multifamily Housing"; HUD CHP Guide #2: "Feasibility Screening for Combined Heat and Power in Multifamily Housing." www.hud.gov/offices/cpd/library/energy/index.cfm

[10] http://eber.ed.ornl.gov/HUD_CHP_Guide_version_2.1/

[11] http://www.eere.energy.gov/de/chp/chp_applications/chp_application_centers.html

[12] CHP has been included in the update of the HOME Program Energy Training Guide, in the "Green Building Features" of the Mark-to-Market Green Initiative, in Public Housing training, the *Public Housing Environmental and Conservation Clearinghouse* (PHECC), forthcoming revised utility regulations and a Notice, "Renewable Energy and Green Construction Practices."

[13] CHP Roadmap, March 2001: PDF 2.3 MB

CHP capacity installed. EPA's web site has an overview of a process for determining feasibility at preliminary and advanced levels and for procurement of CHP systems for facilities in general.[14] EPA and DOE also present Energy Star CHP Awards and Certificates to multifamily buildings with high efficiency CHP installations.[15] DOE's website also has material on CHP technologies.[16]

Regional CHP Application Centers (RACs) (Clean Energy Centers). To facilitate deployment of CHP systems, since 2003 DOE has developed and supported eight CHP RACS covering all regions of the country, mostly based at universities.[17] The RAC activities include: educating regional players on benefits of CHP technologies; working to reduce barriers and risks; providing project-specific support; providing feedback to DOE and industry regarding future R&D program needs; and interacting with states to encourage a favorable policy environment for CHP. Their major efforts have aimed at large industrial, agricultural and commercial installations. But during the past five years, RAC activities have included: analysis of the versions of the HUD CHP Feasibility Screening Tool software developed by the ORNL; assistance in analyzing building utility data using the software; analysis—including use of more advanced initial site screening tools[18]--of proposals for installing CHP in public and assisted multifamily housing; briefings and presentations at national, regional and local housing meetings; assistance to a developer of new multifamily housing; and exploration of the opportunities for encouraging CHP in multifamily housing in their regions. For regions where the economics for CHP seemed promising, RACS were enlisted to exercise the software model using utility data and analyze the results. In some cases they may be involved with a follow-up evaluation. Section 451 of the Energy Independence and Security Act of 2007 (EISA) re-designated the RACs as "Clean Energy Application Centers" and authorized appropriation of $10 million a year for fiscal years 2008 through 2012 for five-year grants "to ensure their continued operations and effectiveness."[19]

Example of CHP Installed in a 30 Year Old Apartment Building. A 301 unit apartment development in Cambridge, MA was built in 1975 with MassHousing financing. HUD provides assistance for 76 units for seniors, including rent supplements. The building was evaluated and modeled for the cogeneration system; pre- and post cogeneration energy uses were estimated along with savings. In 2004 a cogeneration package was installed under a turnkey fixed price contract. Maintenance for the system is handled by the installer who monitors operations remotely from its offices. MassHousing helped the CHP financing with a $175,000 loan and allowed the use of reserves to cover it. The financing included a $30,000 capital

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[14] http://www.epa.gov/chp/project-development/index.html The times and cost figures here are for larger installations. See next page for discussion of the process as it relates to apartment buildings.

[15] http://www.epa.gov/chp/public-recognition/awards.html In 2005 EPA CHP awards went to the multifamily Sea Rise I and II Projects in New York City, using 110-kW-rated natural gas-fired internal combustion engines.

[16] http://www.eere.energy.gov/de/chp/chp_technologies/tech_status.html

[17] Op.cit. 11

[18] ORNL also has BCHP Screener. It uses hourly data but the publicly available version does not currently handle multifamily properties. It may be updated in 2008 to include multifamily buildings. The public download site for BCHP Screener and supporting files is: http://eber.ed.ornl.gov/bchpsc/

[19] See also p.10 below: "Other Assistance for CHP" about authorization for grants and loans.

contribution from the gas utility's conservation fund charges to customers. It is being paid back in less than four years. Utility data for 2003, the year before cogeneration was installed, was provided for a demonstration of the HUD CHP Feasibility Screening software. Payback was calculated as 5.7 years using "low" for installation cost and including the utility's conservation fund payment. The vice-president for maintenance of the management company said he now has installed CHP in twelve developments. He described the company's cogeneration strategy as "evaluate other properties annually, install cogeneration when economics and budget justify installation; optimize the operation of cogeneration based on utility rates and energy supply costs." The company considers that an acceptable payback threshold for straight cogeneration installation might be 2-6 years, or 10-15 years when financed with the replacement of a major system.

Steps for Preliminary Consideration of CHP for Multifamily Buildings. The development process for CHP is multidisciplinary and iterative. It involves the building management, engineers, electricians, plumbers, the local electric utility and gas distribution utility companies and local permitting agencies, and finally building owners and their sources of financing. EPA identifies five stages.[20]

The first question for building owners is whether it is worth looking into the prospect for CHP for a particular building. EPA offers a check-list: "Is my facility a good candidate?" There are 11 simple questions that can be answered by an owner or manager without resort to extensive, additional data collection, such as "Do you pay more than $.07 kilowatt-hour on average for electricity (including generation, transmission, and distribution)?" If the answer to three of the questions is positive, EPA invites an inquiry to the CHP Partnership technical assistance group. The HUD feasibility analysis, costing very little, may then be applied. Some other preliminary questions are:

- Is it a single building with 100 or more units? (There are examples of installations in smaller buildings.)
- Is it master metered for electricity? (If not, there is the possibility of switching to master billing from the utility with advanced sub-meters in the apartments that display the varying electricity rates, thus enabling occupants to schedule consumption and reduce their bills).[21]
- Is there a central domestic hot water system rather than a unit in each apartment?
- Is it an all-electric building? These are good prospects for installing CHP, e.g. profile of Danbury[22], but the HUD CHP feasibility screening software program will not analyze all-electric buildings.
- Is the "spark spread" sufficient? For a CHP system, spark spread is the difference between the cost of gas to produce power and heat on site and the reduced amount of electricity purchased from the grid. A common rule of thumb puts it at no less than $12 per

[20] Op. cit. 14. Stage 1: Qualification ; Stage 2: Level 1 Feasibility; Stage 3: Level 2 Feasibility; Stage 4: Procurement and Stage 5: Operations & Maintenance . The DOE/HUD focus on preliminary or initial screening falls somewhere between EPA Stages 1 and 2. Note that the time and cost figures shown by EPA are for very large megawatt installations compared to the kilowatt sized systems needed to serve apartment buildings.

[21] http://www.oeb.gov.on.ca/documents/cases/EB-2005-0252/boardstaffdiscussionpaper_26405.pdf

[22] www.hud.gov/offices/cpd/energyenviron/energy/library/hudchpDanburyCt.pdf

million Btus (MMBtus), but it can vary. Spark spread is highly dependent on the efficiency of conversion. It is expressed in terms of the maximum cost differential between electricity and fuel cost in dollars per MMBtu. What works in New York may not work in California. A good format for calculating spark spread is found in the Midwest Regional Application Center "CHP Resource Guide".[23]

There are many software packages for determining feasibility for CHP, but only a few are designed specifically for multifamily housing. Steven Winter Associates (SWA) with support from the New York State Energy Research and Development Authority (NYSERDA) has developed Multicogen, a Level 1 screening tool designed specifically to assess the potential for CHP in multifamily buildings in New York State.[24] See the article by Dominique Lempereur, (SWA), in *Home Energy Magazine* for a description and status report. NYSERDA has a pending contract with SWA to develop MultiCogen into a web-based application. The tool is presently being used by NYSERDA's Multifamily Performance Program in determining eligibility for NYSERDA incentives to install efficient, clean, commercially available CHP systems.

HUD Feasibility Screening for CHP. The HUD CHP Feasibility Screening Tool is aimed at filling this need in all states. The optimum building prospect would be one that satisfied the preliminary considerations noted above: 100 or more units with central space and hot water system and access to gas. To enable managers and owners of these buildings to determine whether it is worthwhile spending the time and money to look into installing CHP, HUD and DOE/ORNL developed preliminary feasibility screening software.[25] HUD started with the paper worksheets from the 1989 NYSERDA "Cogeneration Manual,"[26] which was limited to New York and to the load for domestic hot water. Version 2.1 of the HUD CHP Feasibility Screening Tool is now available for use in any region to consider also the loads for space heating and cooling. This feasibility screening software will roughly calculate (± 30%) the potential return on investment (simple payback) for installing CHP in a multifamily building. The software is linked to the HUD web site, along with the two HUD CHP Guides.[27] The Q&A Guide is also based on the NYSERDA "Cogeneration Manual."

The HUD CHP Feasibility Screening Tool has three tabbed screens for the input of information: 1.Monthly Utility Data, 2.Utility Rate Data, and 3. Miscellaneous Input Information.

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[23] http://www.chpcentermw.org/pdfs/Resource_Guide_10312005_Final_Rev5.pdf
Table 3-1 Estimating "Spark Spread" is found in Section 3 of the "CHP Resource Guide" (page 39).
Table 3-2 "Rules-of-Thumb for acceptable Average Annual Fuel Cost."

[24] https://www.homeenergy.org/article_full.php?id=323 Nonsubscribers who are unable to access the article should contact dlempereur@swinter.com .

[25] Op. cit. 10. It was prepared by Steve Fischer, ORNL (ret.). The following description draws heavily on the Help file that accompanies the software.

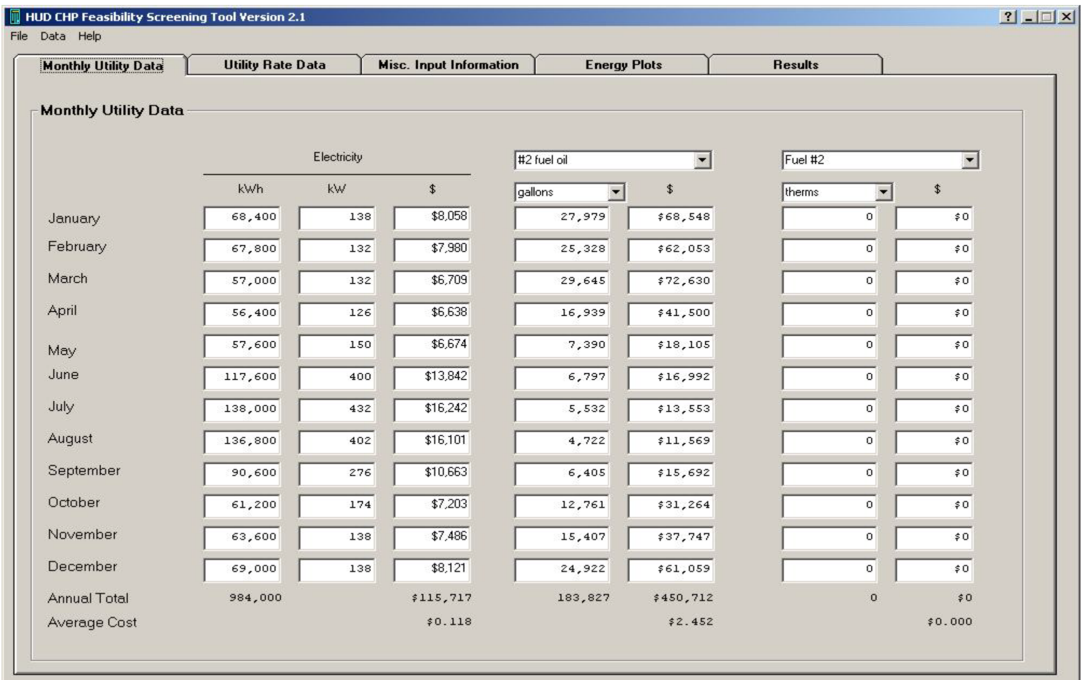
[26] Hirschfeld and Stone, NYSERDA,"Cogeneration Manual," City of New York Office of Rent and Housing Maintenance, Energy Conservation Division, October 1989

[27] Op. cit. 9.

Monthly Utility Data: The user can enter on Screen 1 (tab 1) information from monthly utility bills for cost and level of consumption and on Screen 2 *Utility Rates Data* for gas and
3. Misc. Input Information.

The user can enter on Screen 1 information from monthly utility bills for cost and level of consumption and enters Utility Rate Data for gas and electricity and other fuels used in the building under tab 2 (click top tab shown in the figure to access). This includes the energy charge ($kWh), demand charge ($/kW), standby charges for installed generator capacity ($kW) and any supplemental or fuel adjustment surcharges. The Average Cost per kWh at the bottom of the $ column shown here is the blended rate that incorporates all these charges.

Good management practice for multifamily buildings includes tracking utility costs by recording monthly data from the electric and/or gas distribution utility and any



	Electricity kWh	Electricity kW	Electricity $	#2 fuel oil gallons	#2 fuel oil $	Fuel #2 therms	Fuel #2 $
January	68,400	138	$8,058	27,979	$68,548	0	$0
February	67,800	132	$7,980	25,328	$62,053	0	$0
March	57,000	132	$6,709	29,645	$72,630	0	$0
April	56,400	126	$6,638	16,939	$41,500	0	$0
May	57,600	150	$6,674	7,390	$18,105	0	$0
June	117,600	400	$13,842	6,797	$16,992	0	$0
July	138,000	432	$16,242	5,532	$13,553	0	$0
August	136,800	402	$16,101	4,722	$11,569	0	$0
September	90,600	276	$10,663	6,405	$15,692	0	$0
October	61,200	174	$7,203	12,761	$31,264	0	$0
November	63,600	138	$7,486	15,407	$37,747	0	$0
December	69,000	138	$8,121	24,922	$61,059	0	$0
Annual Total	984,000		$115,717	183,827	$450,712	0	$0
Average Cost			$0.118		$2.452		$0.000

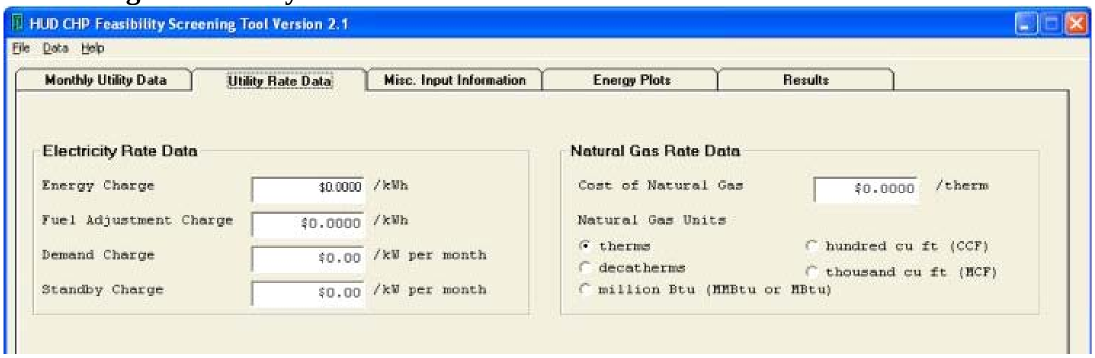
Fig. 1. Monthly Utility Data

additional fuel oil bills. They can be analyzed and compared from year to year after adjusting for the differences in annual degree days. One format for this tracking resembles the first screen, above. A good source of format and discussion of its use is found in a Canadian guidebook.[28] Having this data handy will facilitate periodic analysis of the potential for CHP.

The monthly electricity consumption (kWh) and actual demand (kW) are used in sizing an on-site generator to provide heat and power so that it does not exceed the amount of electricity that can be used by the apartment building. (Although many people would like to, it rarely makes sense to sell excess power back to the utility because the price paid is so low.) In states where net metering is allowed (e.g. CA) the meter may run backwards when the system generates more electricity than it needs. That means that the price "paid" by the utility is the same retail price charged by the utility. This generally is a favorable rate for the CHP system.

[28] Canada Mortgage and Housing Corporation, "Energy and Water Efficiency in Multi-Unit Residential Buildings: A User Guide and Technical Manual for Property Managers and Owners", July 2002, www.cmhc.ca

Figure 2. Utility Rates Data



The consumption, type, and cost of fuels consumed on-site are used to estimate hot water loads and potential savings from producing hot water using engine heat. Some facilities use more than a single fossil fuel, perhaps to qualify for interruptible gas rates, so space is provided for two different fuels.

The *Miscellaneous Input Information* screen asks for the state-city location of the building, square feet to be heated and cooled and approximate number of occupants (for estimating the potential use of the waste heat for domestic hot water). To help with the calculations for domestic hot water, the user chooses among three levels of use ranging from 27 to 54 gallons per day per person depending on the nature of the occupants, e.g. families or individuals. This screen also permits the user to change some default parameters used in calculations, including the type of Prime Mover equipment. The most common type of

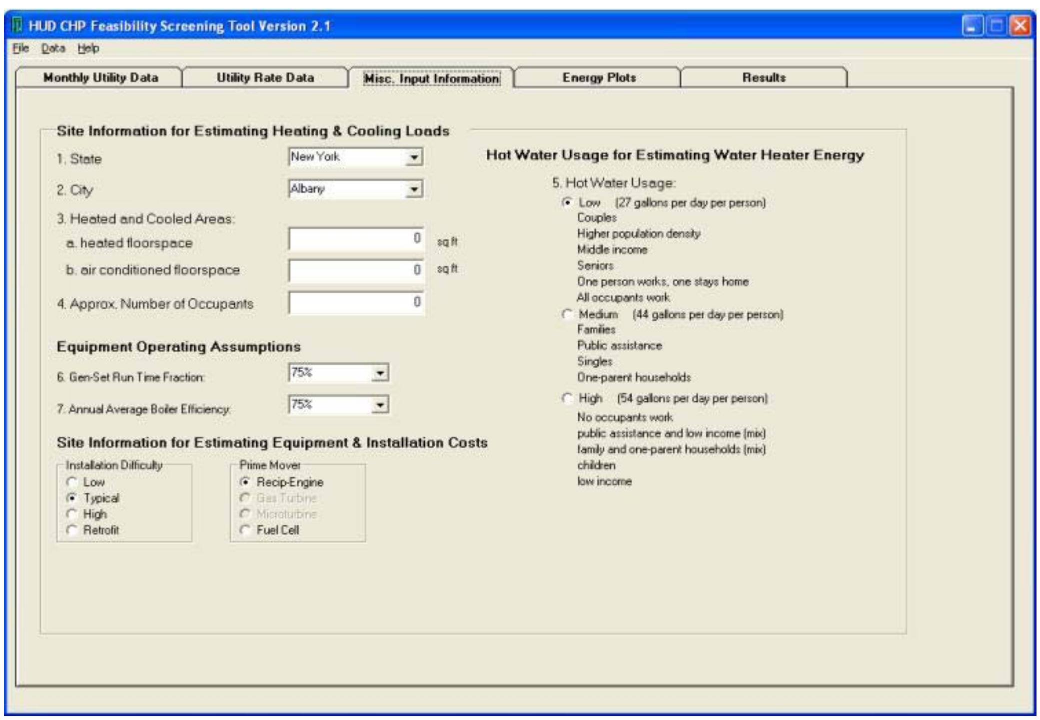
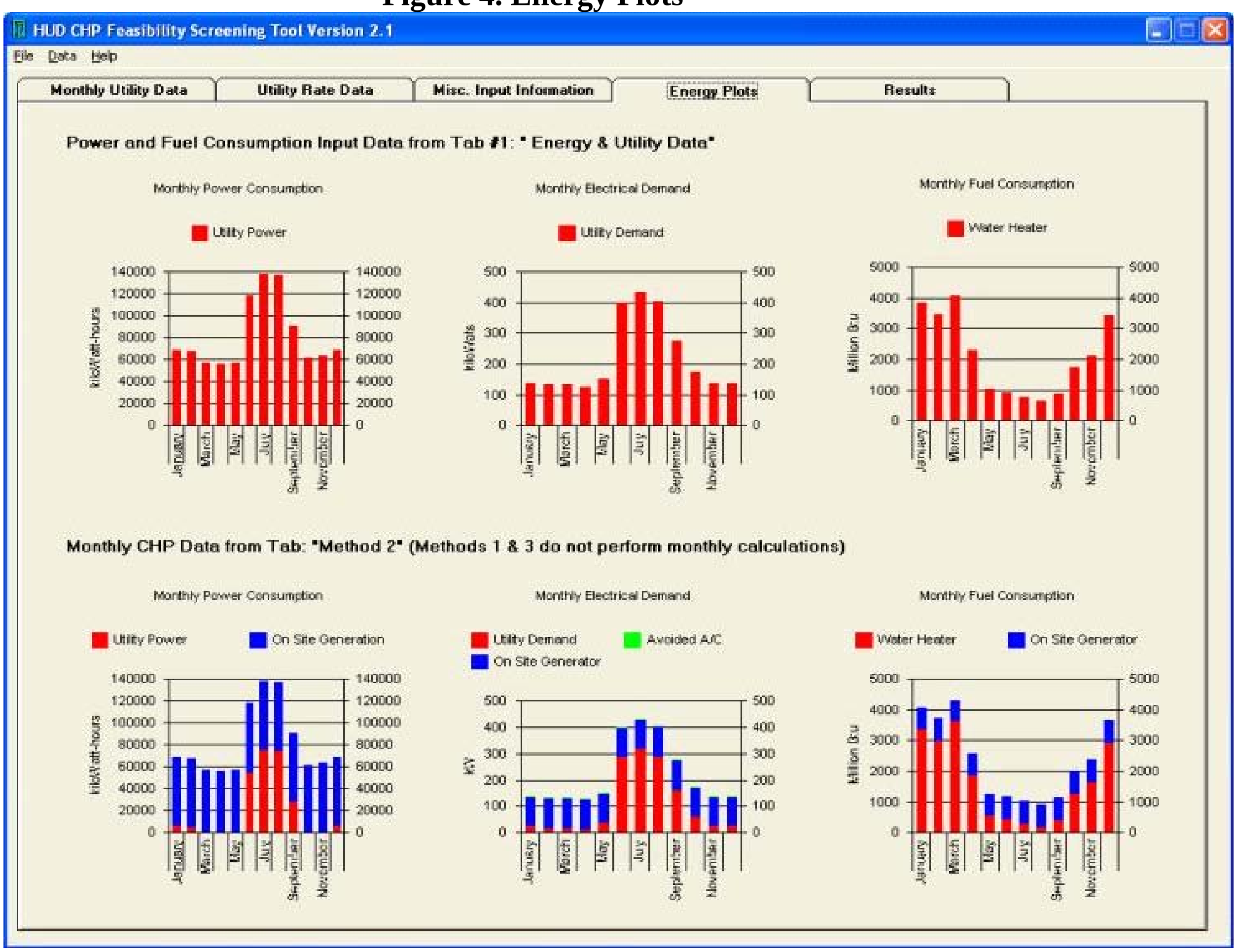


Figure 3 Miscellaneous Input Information

equipment for apartment buildings has been reciprocating engines, but the use of microturbines is increasing. Full size gas turbines require a load of at least a Megawatt and fuel cells are currently too expensive for use in this type of installation. The user can choose one type of prime mover and run the calculations, and then choose the other for a comparison of results. The choices of entries for Installation Costs range from “Low” to “Retrofit." Using “Retrofit” will roughly double the installation cost and payback period when compared to “Low”. Difficulties that may be encountered include lack of space in the boiler room, lack of a clear path to move the equipment into the building, and locations of utility meters.

The *Energy Plots* screen shown below displays graphs of the power and fuel consumption data entered on the first tab. A review of these graphs may reveal a spike or gap that indicates an error in an entry for Monthly Utility Data or perhaps an error in the actual billing!

Figure 4. Energy Plots



Results Calculations. Three different methods are used to compute the CHP engineering and economic results, drawing on data built into the program for generator equipment cost, installation, maintenance cost and operating efficiency. Method 1 is limited to domestic hot water. Methods 2 and 3 calculate performance for domestic hot water, space heating and air conditioning provided by a recovered heat "fired" absorption chiller. Method 2 draws on the utility data entered by the user to estimate heating and cooling loads. Method 3 Space Heating and Cooling loads are computed using algorithms based on Heating and Cooling Degree Days; with Domestic Hot Water loads computed from hot water consumption reported in ASHRAE and average annual temperature for the location. The Method 1 and 2 calculations provide the user with a range of estimated simple payback periods for investing in the installation of CHP in the building, while Method 3 indicates what a conceptual design calculation would show. (Method 3 results can be obtained without entering data on tab 1, but only entering the electric and fuel rates on tab 2 and the building intermediate information on tab 3). Methods 1 and 2 require monthly data entered in tab 1 to produce results.

The software considers use of recovered heat from the engine-generator for domestic hot water, space heating and cooling. Method 1 estimates annual domestic hot water loads by assuming that all summertime fuel consumption is to produce hot water. Fuel consumption from the monthly utility data for May-September is then used to estimate annual fuel consumption for water heating and annual hot water load. Method 2 uses the monthly data for "summer" and "winter" electricity consumption to estimate air conditioning loads. The graphs of electricity and fuel consumption can be used to identify whether or not there are distinct "summer" and "winter" patterns to energy consumption. Method 1 or Method 2 results should be used when actual monthly utility data are available. Method 3 results are more theoretical and can be used to obtain an estimate when monthly data are not available.

Method 3 employs a built-in table of heating and cooling degree days accessed by selecting a state and city. These are correlated by "energy intensity factors" (e.g. Btu/sq ft/year) using information from the Energy Information Administration in DOE. Domestic hot water loads are estimated using an average per capita daily hot water usage and annual average ground temperature for the selected city, based on a paper by Lawrence Berkeley National Laboratory published many years ago in the *ASHRAE Transactions*.[29]

The program provides the ability to manipulate and print the data screens and create a Word file with the images of six screens showing the data entered and all results. You can bring up Sample Data to illustrate how the screens look when filled. You can clear data to prepare for entering new data. The software contains a lengthy and detailed Help file that explains how to get started, describes characteristics of reciprocating engines and driven generators, microturbines and gas turbine generators. It gives the Algorithms & Methodology for the three Methods and additional information on building and electric loads, space heating and hot water loads.

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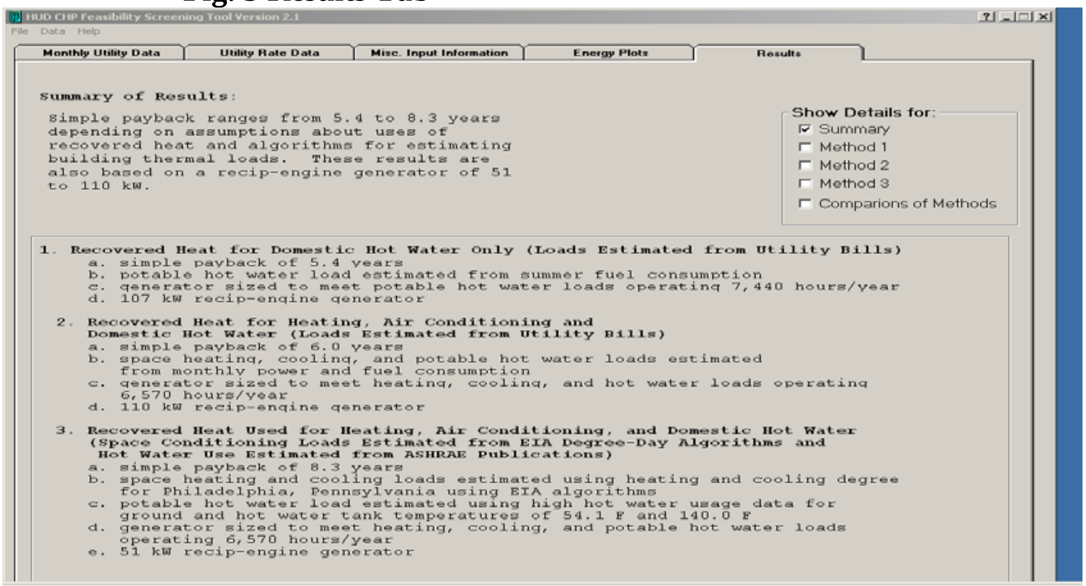
[29] Goldner, F.S. "DHW System Sizing Criteria for Multifamily Buildings." ASHRAE Transactions 100, No.1 (January 1994): 147-65**.** See also Goldner, F.S. in: http://homeenergy.org/archive/hem.dis.anl.gov/eehem/96/960713.html

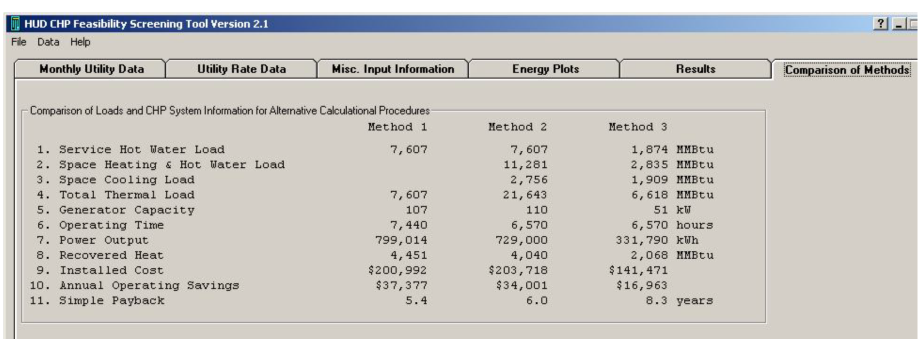
Fig. 5 Results Tab



Use of Results Data. Results are shown on six screens, and they may be printed. They show the input data, a summary of the three methods, a comparison of loads and CHP system information for alternative calculation procedures and details for each of the three sets of calculations. Results screens to be displayed are selected on the Results tab (fifth tab), as shown in the Figure 2, above.

Building owners and managers may only be interested in the level of detail given under *Summary of Results* as shown above with its statement of estimated simple payback in years. The key elements in each of the three sets of calculations can be displayed by selecting the “Summary” results checkbox.

Another array that may be useful for building owners and managers is found in the “Comparison of Methods” Results screen. It lists data for ten components of the analysis. When the software program is open, the user can change the settings, e.g. shifting from “Low” to “Retrofit” for Installation Difficulty and immediately go to the “Side-by-Side” Results screen to see the differences in installation costs and simple payback periods.

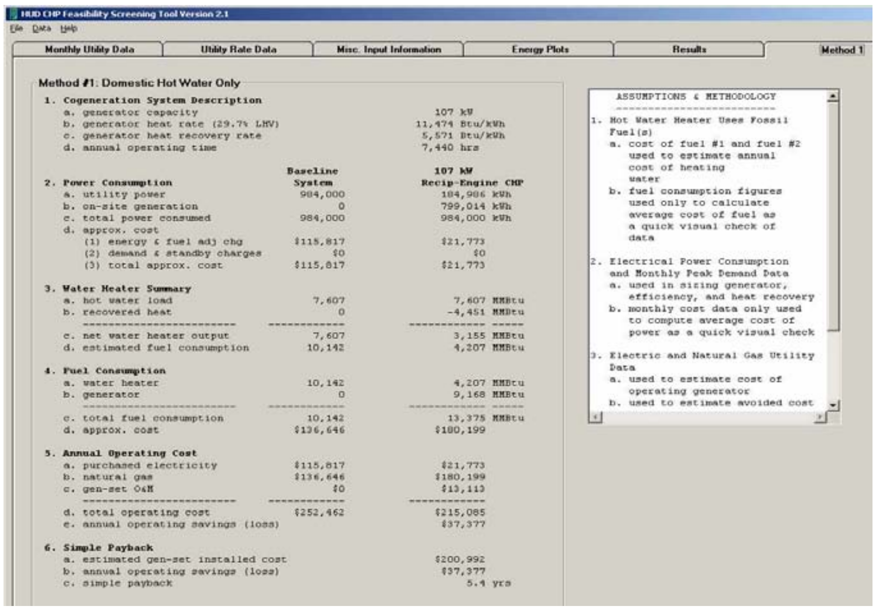


	Method 1	Method 2	Method 3	
1. Service Hot Water Load	7,607	7,607	1,874	MMBtu
2. Space Heating & Hot Water Load		11,281	2,835	MMBtu
3. Space Cooling Load		2,756	1,909	MMBtu
4. Total Thermal Load	7,607	21,643	6,618	MMBtu
5. Generator Capacity	107	110	51	kW
6. Operating Time	7,440	6,570	6,570	hours
7. Power Output	799,014	729,000	331,790	kWh
8. Recovered Heat	4,451	4,040	2,068	MMBtu
9. Installed Cost	$200,992	$203,718	$141,471	
10. Annual Operating Savings	$37,377	$34,001	$16,963	
11. Simple Payback	5.4	6.0	8.3	years

Fig. 6 Comparison of Methods Tab

The details behind these conclusions are found on the screens for Methods 1, 2 and 3. Figure 4 below is one page of the very detailed material in the algorithms that back up the calculations for Method 1. They may be of interest to engineers for sensitivity analysis and for checking assumptions and methodology, such as efficiency levels and the value of recovered heat. In these screens you can examine the Assumptions and Methodology underlying the calculations. For example, the use in Method 1 of electrical power consumption and monthly peak demand data in sizing generator, efficiency and heat recovery. When you run the cursor over these lines, additional information appears, such as the hot water load will show in red.

Figure 7. Method 1 Tab



The analysis performed by this program is adequate for a coarse screening to let building operators know whether or not they should consider CHP seriously. Discouraging results--a long payback--may save building owners and operators' time and effort by eliminating CHP as a viable option for their building. Despite the payback calculated, some CHP developers may reach other conclusions. In any event, encouraging results are only a prelude to a more rigorous analysis to be performed by engineering professionals using much more detailed information on building heating and electricity loads and CHP equipment.

Other Assistance for CHP. Subtitle F of the 2007 EISA, Institutional Entities, Section 471 establishes Energy Sustainability and Efficiency Grants and Loans for Institutions.[30] It authorizes appropriations of $250 million per year for grants and $500 million per year for a revolving fund for loans to implement energy efficiency improvements and sustainable energy infrastructure loans for fiscal years 2009 through 2013 to support institutions, including public housing. The support may include information and grants for technical assistance, paying a portion of the cost of feasibility studies and detailed engineering of sustainable energy infrastructure.

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[30] Op. cit. 2 and 6.

State Housing Finance Agencies (SHFA). SHFAs can be a good source of support for CHP. MassHousing finds cogeneration to be an effective tool in keeping operating costs low, maintaining affordability. They believe that energy investment early pays back down the line. They have supported installation of CHP in older projects ranging from 98 units in a single building to 1,283 units in several buildings By 2007 they had cogeneration serving 5,795 units in 18 older developments and one new one. Their projects contribute to reserve and replacement accounts every month, and they tap into them for installing cogeneration. Under Mass law ratepayers have funded energy conservation programs and services via surcharges on their gas bills (but not on their electric bills). Mass housing stresses the importance of the company that determines feasibility, designs and installs the system, monitors and maintains it. A survey of State assistance for CHP in the U.S. is described in ACEEE 2003 Report**.**[31] See, also, the summary of support in NY, OR, CA per Ryan Gardner in *Home Energy* Nov/Dec 2006**.**[32]

CHP in HUD Programs. To sustainably preserve the privately-owned affordable housing HUD insures and subsidizes, HUD's Office of Affordable Housing Preservation (OAHP) launched in July of 2007 their Green Initiative pilot program for owners and purchasers of HUD properties that are eligible for the Mark-to-Market (M2M) Program. The Initiative offers owners substantial financial incentives to pursue green alternatives and sustainability principles in the rehabilitation already required by the M2M program. These principles comprise sustainability, energy efficiency, recycling, and indoor air quality, and incorporate the "Healthy Housing" approach pioneered by HUD. Ultimately, the owner's out-of-pocket contribution to the rehabilitation of the property can be reduced by 85% and incentives increased via participation, earning up to 4.5% of the Effective Gross Income annually. Additional incentives are available to owners who secure grants from federal, state, and local sources, utility companies, appliance manufacturers etc. to support the funding of the Greening of the property undergoing M2M restructuring. To earn these operational incentives, in addition to the usual performance requirements, there must be one property management staff person who has completed a recognized green building certification program, and the property must operate in accordance with the Green O&M plan for the life of the M2M use agreement. Each property undergoing an M2M restructuring is subject to a Physical Condition Assessment (PCA) which is a detailed inspection used to identify rehabilitation needs and estimate repair and replacement needs. For projects in the Green Initiative, the PCA scope has been expanded to explore all Greening opportunities, including CHP**.**[33] To help educate property owners about CHP, the program Guidelines include material on CHP provided by HUD and EPA, and include a Combined Heat & Power Checklist intended to help owners determine if their property is a strong candidate.

In addition to Mark to-Market Green, public housing has begun to include CHP in its training, regulations and guides. A Notice on green development will include references to CHP, which can be financed by public housing authorities with an energy performance contract

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[31] Brown and Elliott, State Opportunities for Action: Update of States' Combined Heat and Power Activities, ACEEE Report Number IE032, October 2003.

[32] Op. cit. 24. The summary is a sidebar in the *Home Energy* article.

[33] http://www.hud.gov/offices/hsg/omhar/paes/greenini.cfm At this site under "Helpful Tools" you can register for access to all M2M green documents, including the Checklist

running up to 20 years. The HOME Program has completed an update of its energy training course with text on green development that includes CHP. [34]

Experience, Lessons Learned and Major Challenges for HUD

Experience*:* In the past five years there has been significant growth in the number of CHP installations in multifamily housing. A list of 71 installations four years ago has grown to 150 in basically the same 8 states.[35] Pre-designed CHP systems have been introduced as consumer products with thermal and electrical capabilities suitable for multifamily housing applications that produce electricity, hot water for heating, and chilled water for air conditioning. In some regions, notably the Northeast, there have been improvements in the industry infrastructure, which includes companies with demonstrated experience capable of sizing, installing, monitoring and maintaining CHP. Software is now available specifically for preliminary screening of CHP feasibility for multifamily housing. Some states have begun to provide support and Federal assistance has been authorized by Congress, as cited above.

The Lessons Learned*:*

- Many building managers don't seem to have ready access to the type of data needed for a preliminary consideration of CHP.
- HUD needs to work more closely with RACs to focus their attention on the new version of the HUD CHP Feasibility Screening Tool prepared by ORNL.
- Even when the software produces reasonable payback periods, owners and management companies are reluctant to spend upwards of $5,000 for level 2 analyses.
- There are limits to our ability to access the multifamily market. The trend in the multifamily real estate industry and at HUD over the past 20 years of promoting individual metering creates an obstacle to consideration of CHP. Advances in digital sub-metering technology may offer a solution.

The Major Challenges:

- Getting more owners and managers to track utilities in a way that enables them easily to analyze its costs and to consider the potential for CHP.
- Informing building owners and managers and HUD staff about determining feasibility of CHP and training and assisting with the use of the CHP Feasibility Screening Tool.
- Making the more advanced ORNL BCHP software ready for use for apartment buildings.
- Reaching out through the publications and meetings of the organizations that represent multifamily housing to promote understanding of the opportunities for installing CHP.
- Involving public housing with the DOE implementation of the EISA grants and loans.
- Increasing familiarity with sub-metering and the use of advanced digital meters.

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[34] Op. cit. 12.

[35] *Combined Heat and Power Installation Database.* Energy and Environmental Analysis, an ICF International Company, maintained for DOE/ORNL. 2008. http://www.eea-inc.com/chpdata/index.html. . CA, CT, HI, MA, NJ, NY, PA, RI. AZ and MI dropped out.

- Establishing greater visibility for CHP in multifamily buildings on the websites of DOE, EPA, HUD, Clean Energy Application Centers, state agencies and private associations.
- Exploring the potential for CHP in multifamily housing in the other 42 states.

HUD recognizes that while CHP is an economically appropriate technology for many locations, it is not necessarily appropriate for all sites. HUD is promoting the evaluation of CHP at its many sites in order to fully implement mandates to conserve energy and reduce demand. This tool is available to help you get started; the important thing is to get started.

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