Distributed Energy Technology Simulator

Microturbine Demonstration

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1. Introduction

The National Rural Energy Cooperative Association (NRECA) and Sandia National Laboratories have supported an effort to develop a device that will simulate the technical and economic performance of distributed energy technologies. NRECA's Cooperative Research Network (CRN) is taking the lead in this project to eventually provide its co-op members and customers with a means of assessing competitive distributed energy technologies for their peak-shaving capabilities. This low-cost, portable device is connected at a customer's site and will mimic up to five different onsite generation and storage technologies:

- Peak-shaving battery
- Peak-shaving diesel generator
- Power quality battery
- Microturbine
- Phosphoric acid fuel cell

Energetics, Inc. has developed and validated these five modules. This validation stage involves comparing the module to an operating distributed energy device with the goal of creating a module that properly characterizes its operation. Once a module has been validated, it is ready for demonstration. At this stage, the simulator is placed at a site that could benefit from distributed technologies. Up to five technologies are simulated for about a month, with the purpose of demonstrating the energy savings that could be gained through the use of each technology. This report presents the demonstration of the microturbine module at two sites: a large hardware store in Shallotte, NC, and a corporate office building in Herndon, VA.

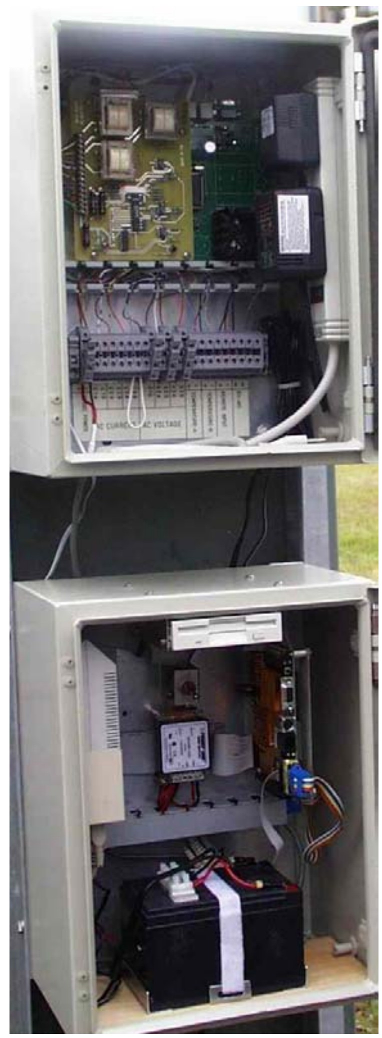


Figure 1. Simulator Components: AC Monitor (top) and Embedded Controller (bottom)

The simulation device consists of an AC monitor and an embedded controller, each of which are contained in separate boxes that are connected by wires (see Figure 1). The AC monitor watches the power used by the facility, usually through a secondary utility meter, and the embedded controller uses this information to produce the virtual power generated by a distributed energy technology. This data is recorded and used to display the peak and off-peak energy demands that would result from the use of each technology. Economic data such as peak demand charges and energy savings are calculated to determine the net benefits of each technology. This report presents the details and results of this microturbine demonstration.

2. Demonstration Sites

The microturbine module was demonstrated at two sites. One simulation took place at the National Rural Utilities Cooperative Finance Corporation (CFC) headquarters in Herndon, VA, and the other simulation was performed at a Lowe's store in Shallotte, NC.

2.1. Cooperative Finance Corporation

CFC is a non-profit organization that provides its member utility owners with financial products and business management services. Its owners consist of electric cooperative distribution systems, power supply systems, statewide associations, and service organizations, providing service to more than 13 million consumers.

CFC's mission is to utilize the collective strength of the member co-ops to supply a source of low-cost capital and competitively priced financing. Many of the co-ops take advantage of the loans and bonds available through CFC. In 2000, CFC's loans and guarantees outstanding to members totaled $18.7 billion. In addition, CFC trains co-op staff in new technologies and developments. It installed a test bed to showcase four technologies for members.

Because CFC believes there is a lot of growth potential in distributed generation, they wanted first-hand experience with it. The Honeywell Parallon 75 microturbine was installed in 1999 at no cost to CFC, though CFC is responsible for operating and maintenance costs. It is the first of two microturbines to be installed at CFC for education and training purposes. CFC plans to install a second microturbine, a 60-kW Capstone, which will also be used for peak shaving. The Parallon 75 currently contributes energy during peak demand, which occurs from 11 am to 9 pm during the spring and summer. During the winter, the utility has two separate peak periods: 6 am to 12 pm and 5 pm to 9 pm. This demonstration explores different operating algorithms that can be used to turn on and off these microturbines in order for CFC to maximize savings.

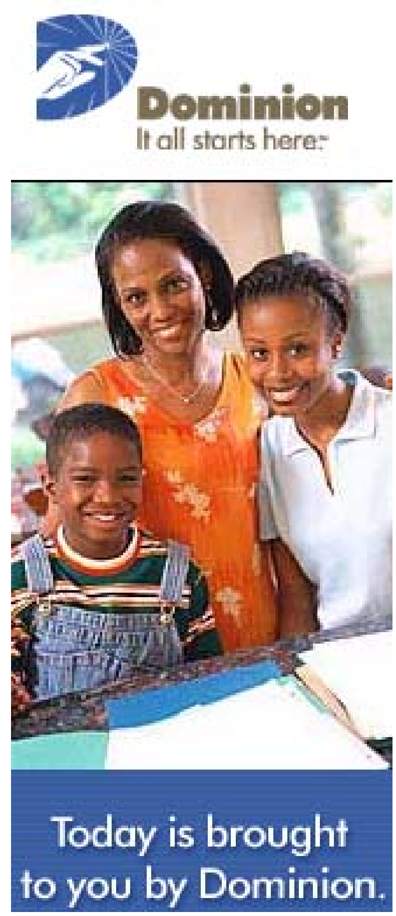


Figure 2. Dominion Logo

CFC purchases its electricity from Dominion Virginia Power (see Figure 2), whose rates are 21.9¢/kWh peak and 1.42¢/kWh off-peak. Headquartered in Richmond, VA, Dominion supplies over 21,000 MW of electricity to homes and businesses in the Midwest, Mid-Atlantic and Northeast regions of the U.S. Dominion was very cooperative throughout the demonstration. The specific employees who contributed to the demonstration are: Rachel Saunders, key customer account representative; Pat Wormley, metering manager; Jim Nystrom, lineman meterman; and

Randy Inge, manager of key customer accounts. They met with Energetics on July 12, 2001 to learn about the simulator and determine appropriate connection to their meter at CFC. Santa Vigil, Mario Sorto, James Howard from CFC and Jim Nystrom from Dominion, participated in the installation of the simulator on August 15, 2001.

2.2. Lowe's

The microturbine module was also demonstrated at a Lowe's in Shallotte, NC. Lowe's is a hardware store that provides a wide variety of home improvement items. There are more than 700 stores in 40 states across the U.S. The Shallotte Lowe's was chosen as a demonstration site because the utility is interested in using Lowe's back-up diesel generator and other distributed energy device to supply the entire store load when the utility is faced with peak demand periods. Lowe's purchases electricity from Brunswick Electric Membership Cooperative (BEMC) (see Figure 3). BEMC is a local electric cooperative, serving rural areas that contain an average of only 12-13 consumers per mile of line. BEMC, consisting of four counties in North Carolina: Brunswick, Columbus, Robeson, and Bladen.

Figure 3. BEMC in Shallotte, NC

Several people from BEMC contributed to the success of the demonstration at Lowe's: JC Evans, Lineman; Lewis Shaw, Systems Engineer; James Green, Coordinator of Field Services; and Earl Andrews, Coordinator of Energy Services. Lowe's manager, Carson Durham was also very helpful with special logistics required to make the installation work (see Figure 4).

Lowe's experiences peak periods on weekdays between 4 pm and 8 pm during summer months and between 6 am and 8 am during winter months. BEMC would like to shed completely the store's load during their peak periods but prefers not to buy back any power from Lowe's. This forced Energetics to size the distributed energy devices to match the peak load as closely as possible. The sizing and operation of the devices at each site will be discussed in a later section of this report.

Figure 4. Carson Durham (Lowe's) Beside Simulator

3. Customizing the Simulator

Typical load data and energy cost information were gathered for each site to serve as a basis for choosing the number and sizes of the microturbines. Table 1 lists this information for the summer months, during which the demonstration was performed.

Table 1. Facility Demand and Electric Rates

CFC/Dominion	**Peak**	**Off-Peak**
Hours	11 am - 9 pm weekdays	12 am – 11 am, 9 pm – 12 am, & all day weekends & holidays
Electricity cost ($/kWh)	0.219	0.0142
Demand charge ($/kW)	2.24	N/A
Peak AC load (kW)	750	N/A
AC energy (kWh/day)	5,000	10,000
Lowe's/BEMC		
Hours	4 pm – 8 pm weekdays	12 am – 4 pm, 8 pm – 12 am, & all day weekends & holidays
Electricity cost ($/kWh)	0.0395	0.0395
Demand charge ($/kW)	22.87	N/A
Peak AC load (kW)	707	N/A
AC energy (kWh/day)	2,121	8,090

This energy demand and cost information was entered in the simulator as the facility input data for each respective site. Costs for diesel and natural gas as well as emissions costs were also entered. Figures 5 and 6 display the facility input screens for each demonstration.

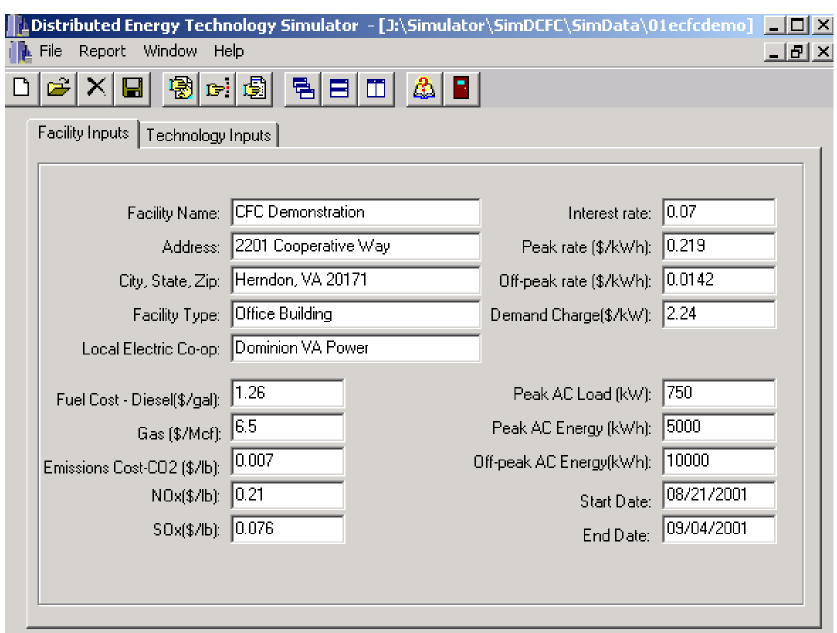


Figure 5. Simulator Facility Input Screen for CFC Demonstration

In addition to calculating energy costs for each facility, the facility inputs are used as a basis for choosing the sizes and algorithms of the distributed energy devices that are simulated.

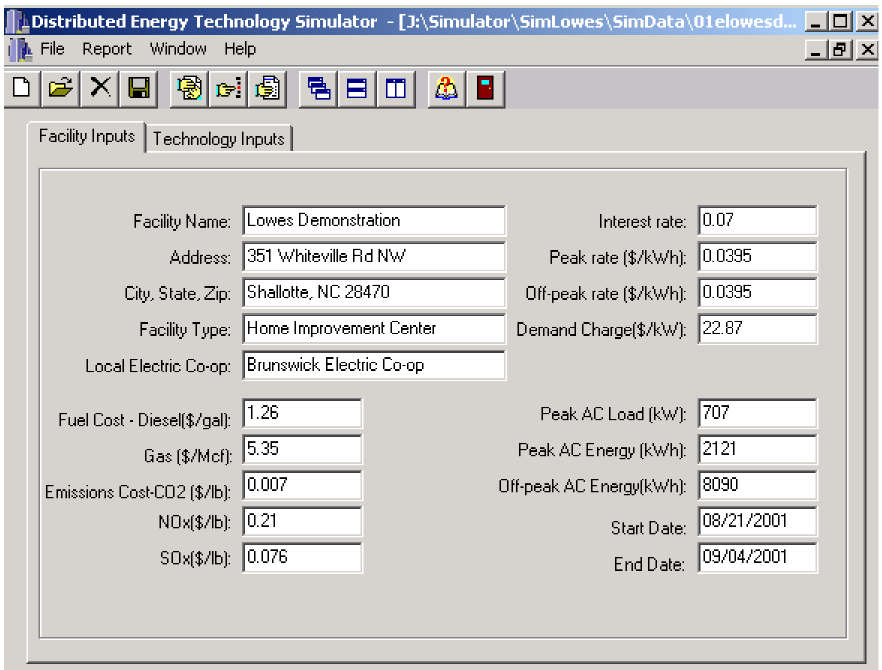


Figure 6. Simulator Facility Input Screen for Lowe's Demonstration

BEMC wanted 1,000 kW of distributed generation to fully shed Lowe's peak demand. They proposed converting Lowe's emergency 400-kW diesel generator to peaking and adding microturbines. Multiple microturbines were simulated as linked devices to supply high amounts of energy. Energetics proposed 300 kW of microturbines in addition to the 600-kW option sought by BEMC. One simulation represented ten 30-kW microturbines to supply 300 kW of energy. A second microturbine simulation linked twenty 30-kW microturbines to supply 600 kW.

At CFC, it was not necessary to provide a distributed energy supply that would cover the entire load. The goal was to decrease peak energy purchases and demand charges. In this demonstration, both microturbine simulations represented seven 30-kW microturbines. Each simulation operated under a different algorithm.

The simulator is capable of demonstrating the operation of the devices under several different algorithms:

- Timed discharge- the device is turned on and off at scheduled times each day, usually the same times as the peak period
- Auto bulk peaking- a maximum peak energy demand is chosen, and the device is triggered to provide full power whenever the energy demand rises above this threshold

- Auto variable peaking- a maximum peak energy demand is chosen, and the device turns on whenever energy demand rises above this threshold; however, the device provides just enough power to keep the energy demand below threshold
- Peak shave signal- the device turns on when the facility receives a peak-shave signal from the utility, notifying its customer that peak demand is in effect

Table 2 displays the devices and corresponding algorithms simulated at each demonstration. The simulator was validated against a Honeywell Parallon 75 microturbine in July 2001. However, as of August 2001, Honeywell decided to close their power generation division. All of their units in the field are being recalled, resulting in the use of 30-kW and 60-kW Capstone microturbines as the models in the demonstrations.

Table 2. Microturbine Sizes and Algorithms

	CFC		Lowe's	
Microturbines	Seven 30-kW	Seven 30-kW	Ten 30-kW	Ten 60-kW
Total Size (kW)	210	210	300	600
Algorithm	Timed discharge	Auto bulk peaking	Auto bulk peaking	Timed discharge

4. Installation of the Simulator

The installations involved connecting the AC monitor to the site's meter, allowing it to read the facility's load. Current Transformers (CTs) and Potential Transformers (PTs) were used to step down the currents and voltages to values that could be read by the AC monitor. Load information read by the AC monitor was sent to the embedded controller, which processed the information and simulated the operation of the distributed energy technologies. The data from the facility and simulated technologies were sampled every second, and a snapshot of the data at the end of each minute was used to create averages for every fifteen minutes. The data was recorded in fifteen-minute intervals to an Excel output file. The data was then compiled in an economic module to determine the energy savings incurred by each microturbine simulation.

4.1. Cooperative Finance Corporation

The simulator was installed at CFC on July 30, 2001. The demonstration began on August 21, 2001, and continued for two weeks, ending on September 4, 2001. CT selection and connection authorization at CFC delayed the starting date of the demonstration, reducing the planned one-month long demonstration. The simulator could be connected at two places to monitor CFC's current supply. The current could be monitored from the switchgear on the load side or from Dominion's meter. Connection to the switchgear side required total shutdown of the building; therefore, to avoid such an intrusive installation, Energetics decided to connect to the meter box at CFC. The current inside the meter box fluctuates between zero and five amps and the simulator board can only process current measurements smaller than one amp. Therefore, CTs with a 5:1 ratio were needed to make the hardware connection. This ratio is only available with wounded primary CTs. The metering department at Dominion did not authorize Energetics to use the wounded primary CTs needed to obtain accurate current readings from the simulator.

Dominion was concerned that the connection in series needed with wounded primary CTs would affect their meter recordings and revenue.

The simulator was connected using split-core CTs with a 100:5 ratio. The CTs stepped down the meter current too much and the accuracy of the simulator measurements was greatly reduced. The simulator limitations at reading current values between zero and one amp will soon be solved as Energetics is in the process of changing its power monitoring board. The new board will enable the use of very accurate and small clamp-on CTs. The ratio of PTs was 480:120, because the simulator only processes voltage inputs up to 120 volts. Figure 7 shows Jim Nystrom (Dominion) installing CTs at the CFC site.

Figure 7. Jim Nystrom (Dominion) Installing CTs at CFC

4.2. Lowe's

BEMC authorized the installation on July 30, 2001, and the simulator was installed at Lowe's on August 15, 2001 (see Figure 8). Lowe's demonstration began on August 21, 2001, because delays were experienced with the direct phone line connection needed to monitor the simulator. Moreover, the battery supplying power to the two boards of the simulator died two days after first connection, resulting in further delay. The demonstration ended on September 4, 2001. Wounded primary CTs with a ratio of 10:5 were used at Lowe's. They were connected in series with the meter's current leads (see Figure 9). PTs with a ratio of 2.5:1 were used to step down the simulator input voltage to 120 volts.

Figure 8. Lewis Shaw and James Green (BEMC) Connecting Simulator to Lowe's Meter

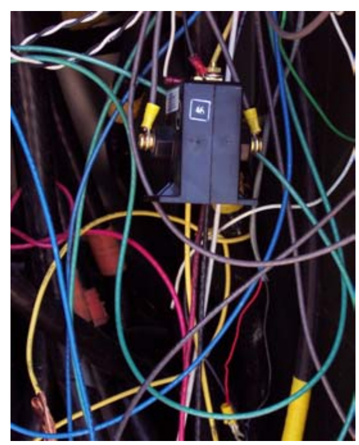


Figure 9. CT Installed Inside Lowe's Meter Box

5. Demonstration Results

Load data from each site was collected and the energy costs with and without the simulated technologies were calculated and compared. Figure 10 compares the load profiles for each site on a typical weekday, August 30, 2001, during the demonstration period.

Both profiles exhibit an energy demand increase during the late morning and through the afternoon. CFC's peak rates extend from 11 am through 9 pm. This is an unusually long peak that would create high fuel costs should the microturbines operate for the entire peak period. Consequently, the microturbines were turned on for a portion of the peak period, 11 am – 5 pm, during which the highest demand is seen. This allows the microturbines to decrease the peak demand charge while still eliminating some of the peak energy purchases.

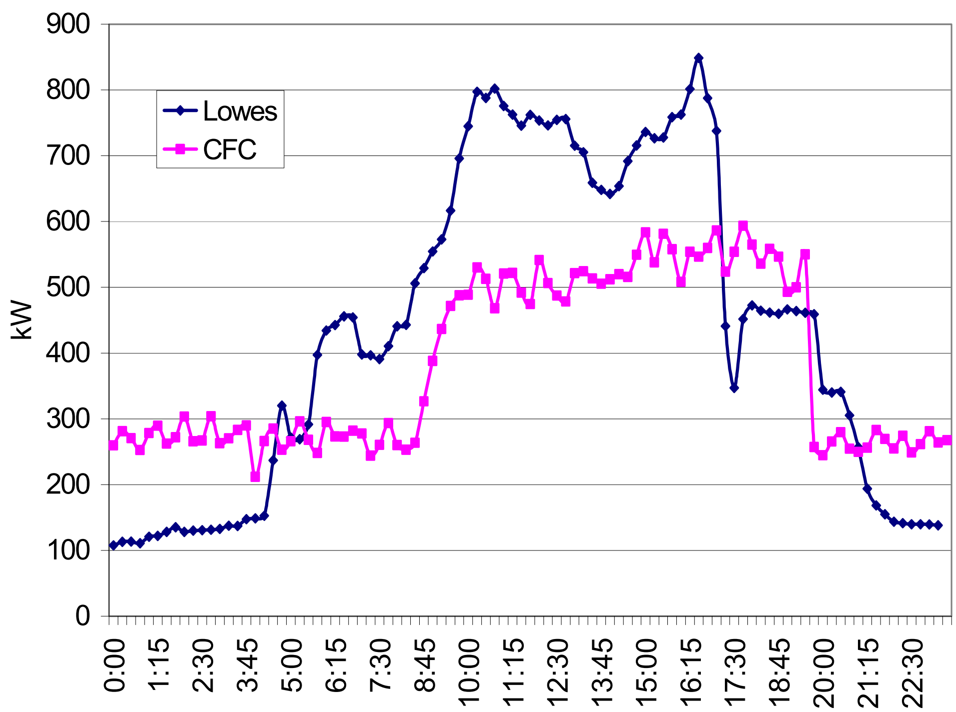


Figure 10. August 30, 2001, Load Profile for Demonstration Sites

5.1. Lowe's Demonstration Results

At Lowe's, the simulated microturbines were activated during the entire four-hour peak period, between 4 and 8 PM. Because BEMC would like to shed the load produced by Lowe's during this time, the data was analyzed to show the ability of the microturbines to match the load. Figure 11 shows the peak kWh purchases made by Lowe's without any distributed energy and compared to the kWh output of the simulated technologies. A 400-kW diesel generator and a collection of ten microturbines for a maximum output of 700 kW, is shown to cover the load pretty closely. The ten 60-kW microturbines are shown to also be capable of covering the load. However, these microturbines stay on full power for the entire peak period, regardless of the load level exceeding demand. BEMC would prefer not to buy back any extra power from Lowe's; as a result, excess energy would be wasted. The 300 kW of microturbines were operated on the auto bulk algorithm, turning off when the load was low. They were able to follow the load a little better than the microturbines on timed discharge, creating more power when it was needed and less when the load was smaller.

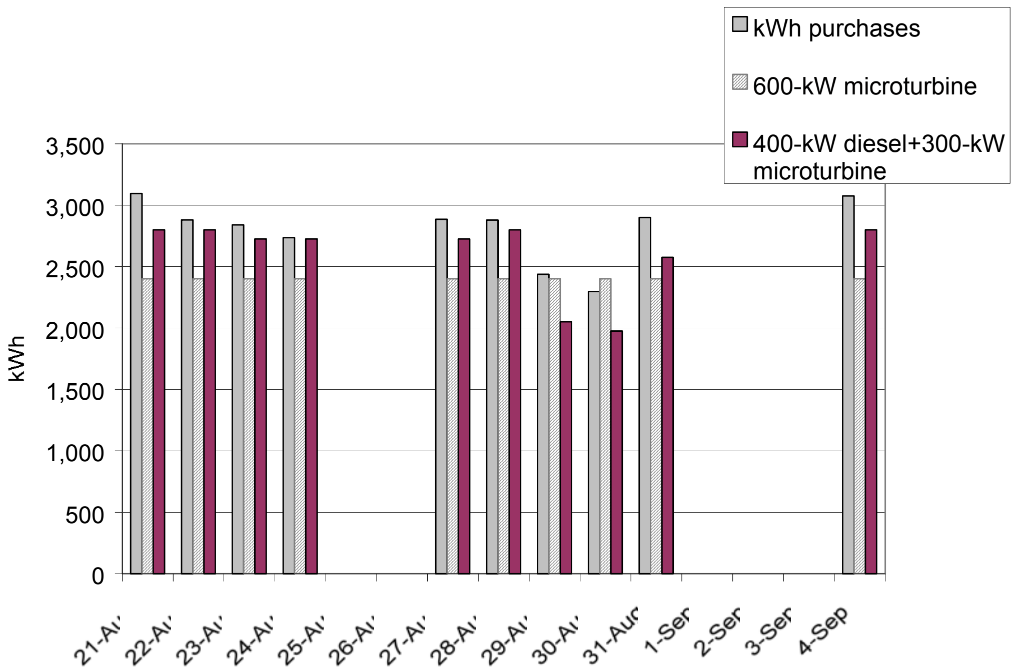


Figure 11. Lowe's Peak Energy Purchases Compared to Distributed Energy Output

The Lowe's data was also analyzed in the simulator's economic module, which produced technical and economic comparisons (Figures 12 and 13). In addition to the simulated technologies previously discussed, the comparisons show the results of two other diesel generators. These two generators were simulated to provide other options with which to compare the microturbines; however, these generators were operated under the peak shaving signal algorithm. During the two week demonstration, BEMC did not activate its peak signal because its generation and transmission supplier did not notify them of peak pricing. As a result, these two technology options did not record any output or savings.

When comparing the technologies individually, the 400-kW diesel generator or 600-kW microturbine would be a good choice, depending on the facility's needs. The cost to convert the back-up diesel generator to a peak-shaving device could be paid back in a fraction of a year and still provide significant savings; however, the microturbine can provide much more savings and be paid back in under three years.

Looking at the scenario of using the 300-kW collection of microturbines to supplement the diesel generator does not work out as well. The total savings produced by the two technologies does not even equal the savings of the 600-kW microturbines by themselves. The cost to purchase and maintain the two technologies is also greater and has a longer payback period.

Distributed Energy Technology Simulator - [Biweekly Economic Comparison]

File Report Window Help

Biweekly Economic Comparison

Facility Name: Lowes Demonstratio Dates: 08/21/2001 To: 09/04/2001

Technology:	Diesel	Diesel	Diesel	Micro	Micro
Size (kW):	400	1000	400	600	300
Energy Cost Savings ($):	0.00	0.00	663.89	1,096.33	497.99
Demand Charge Savings ($):	0.00	0.00	4,859.42	9,433.42	2,572.42
Fuel Costs($):	0.00	0.00	1,572.78	2,078.47	943.74
Emissions Costs($):	0.00	0.00	206.51	347.32	157.70
Monthly Savings($):	0.00	0.00	3,744.02	8,103.95	1,968.97
Discounted Payback (years):	0.00	0.00	0.74	2.66	5.42
NPV Overhaul Cost($):	26,653.69	53,307.38	26,653.69	78,609.49	38,202.74

Figure 12. Biweekly Economic Comparison at Lowe's

Distributed Energy Technology Simulator - [Biweekly Technical Comparison]

File Report Window Help

Biweekly Technical Comparison

Facility Name: Lowes Demonstration Dates: 08/21/2001 to: 09/04/2001

Technology:	Diesel	Diesel	Diesel	Micro	Micro
Size (kW):	400	1000	400	600	300
Hours of Operation:	0.00	0.00	40.00	44.00	32.00
Peak kW Demand:	0.00	0.00	494.52	294.52	594.52
Peak kWh Purchases:	0.00	0.00	12,465.99	3,647.60	12,450.38
Off-peak kWh Purchases:	165,540.55	165,018.21	135,764.45	133,635.11	139,980.06
Peak Output (kWh):	0.00	0.00	16,800.00	27,750.00	12,600.00
Off-peak Output (kWh):	0.00	0.00	0.00	0.00	0.00
Fuel Use (MMBtu):	0.00	0.00	173.13	396.27	179.93
Energy Cost Savings ($):	0.00	0.00	663.89	1,096.33	497.99

Figure 13. Biweekly Technical Comparison for Lowe's

5.2. CFC Demonstration Results

CFC does not require the load to be eliminated, so the goal of this demonstration was to simply reduce the peak kWh purchases and demand charges as much as possible. Figure 14 displays the peak kWh purchases by CFC with no distributed generation and compares this to the reduced peak purchases of the microturbine simulations.

Peak demand levels and peak kWh purchases for the CFC demonstration are presented in the Appendix. A glitch was found in the auto bulk algorithm that caused the microturbines to be turned on less as the demonstration progressed. The auto bulk algorithm uses a target peak to decide whether or not to turn on. When the load rises above this target peak, the device is turned on in order to limit the value of the peak demand. Should the peak demand become higher than the target peak, the program was built to increase the target peak so that the technologies would operate only when they are effective in decreasing the peak demand. Because the peak period at CFC is so long, the microturbines were set to operate for only part of the peak period. However, demand peaked outside the period of operation, which caused the target peak to become very high. As a result, the microturbines turned on much less toward the end of the demonstration, resulting in fewer peak energy savings.

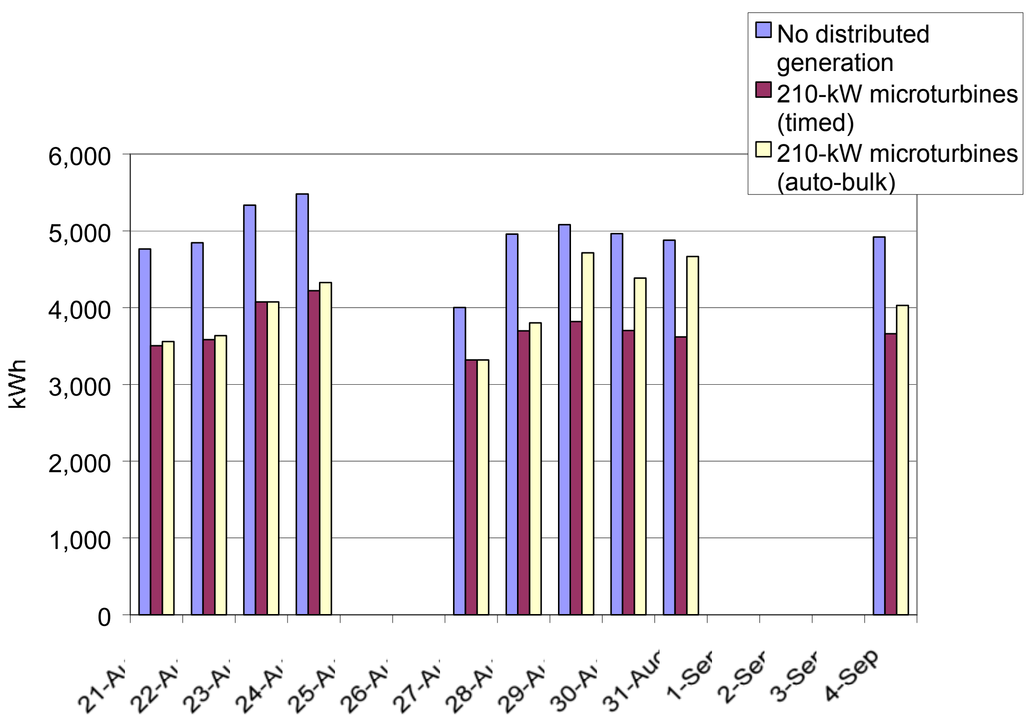
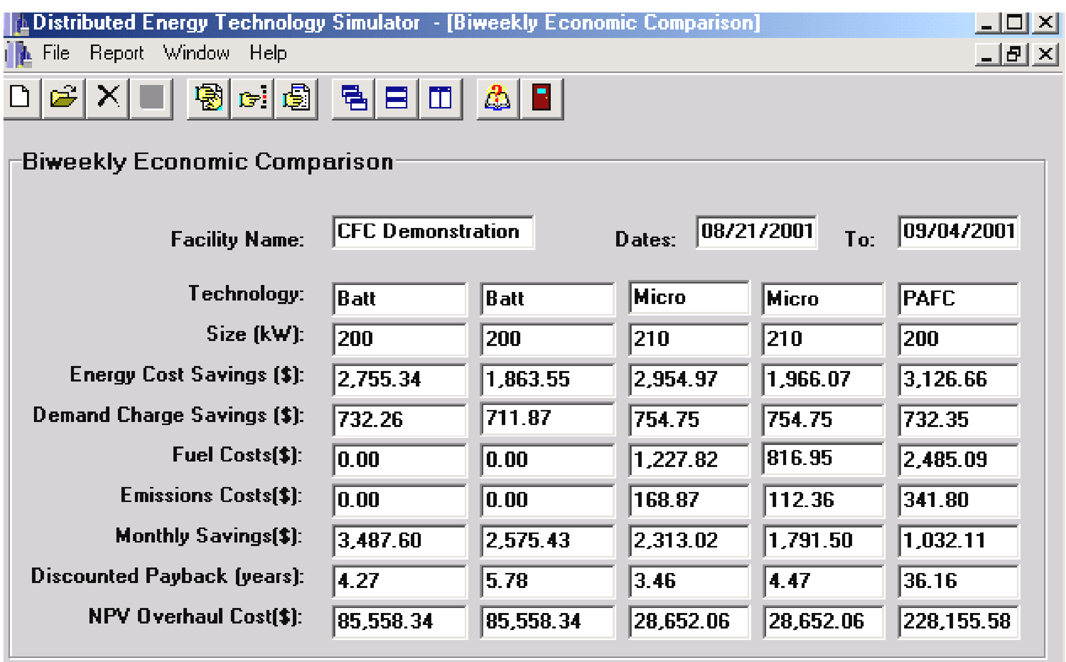


Figure 14. CFC's Peak kWh Purchases

A second glitch was in the auto bulk algorithm that caused the peak demand resulting from the timed and auto bulk algorithms to be the same, which should not be the case. Because the microturbines operating on the auto bulk algorithm were not turning on properly, their peak demand should have been higher than the peak demand created by the microturbines on timed discharge. It was found that the program was producing the instantaneous peak demand based only on times in which the devices turned on. The program is being modified to include all data during peak periods, preventing this glitch from occurring in future demonstrations.

The results of the simulator's analysis in the economic module are displayed in Figures 15 and 16. In addition to the microturbines, two batteries and a phosphoric acid fuel cell (PAFC) were simulated at CFC to provide examples of other options and to provide other technologies with which to compare the microturbines. The microturbines competed well against the batteries, resulting in a slightly lower payback period despite high fuel costs. The microturbines proved to be much more cost effective than the PAFC. Of the two microturbines simulations, the microturbines operating on a timed discharge provided higher savings and a lower payback period. This result was affected by the fact that the microturbines on auto bulk did not turn on as much as they should have, creating lower savings in the peak kWh purchases.



Distributed Energy Technology Simulator - [Biweekly Economic Comparison]

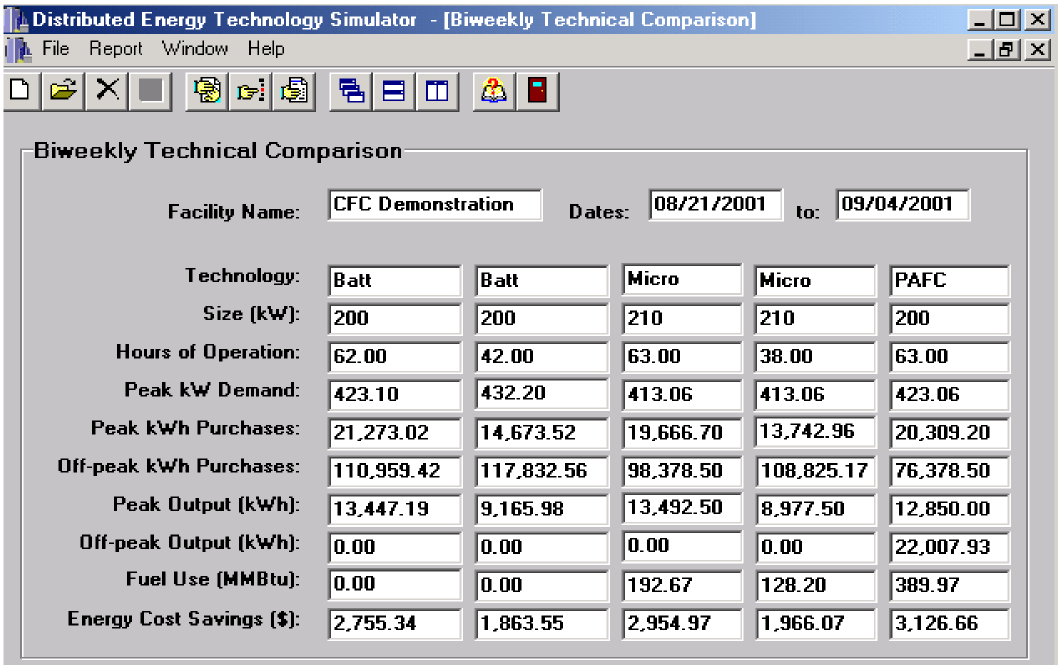
File Report Window Help

Biweekly Economic Comparison

Facility Name: CFC Demonstration Dates: 08/21/2001 To: 09/04/2001

Technology:	Batt	Batt	Micro	Micro	PAFC
Size (kW):	200	200	210	210	200
Energy Cost Savings ($):	2,755.34	1,863.55	2,954.97	1,966.07	3,126.66
Demand Charge Savings ($):	732.26	711.87	754.75	754.75	732.35
Fuel Costs($):	0.00	0.00	1,227.82	816.95	2,485.09
Emissions Costs($):	0.00	0.00	168.87	112.36	341.80
Monthly Savings($):	3,487.60	2,575.43	2,313.02	1,791.50	1,032.11
Discounted Payback (years):	4.27	5.78	3.46	4.47	36.16
NPV Overhaul Cost($):	85,558.34	85,558.34	28,652.06	28,652.06	228,155.58

Figure 15. Biweekly Economic Comparison for CFC


Distributed Energy Technology Simulator - [Biweekly Technical Comparison]

File Report Window Help

Biweekly Technical Comparison

Facility Name: CFC Demonstration Dates: 08/21/2001 to: 09/04/2001

Technology:	Batt	Batt	Micro	Micro	PAFC
Size (kW):	200	200	210	210	200
Hours of Operation:	62.00	42.00	63.00	38.00	63.00
Peak kW Demand:	423.10	432.20	413.06	413.06	423.06
Peak kWh Purchases:	21,273.02	14,673.52	19,666.70	13,742.96	20,309.20
Off-peak kWh Purchases:	110,959.42	117,832.56	98,378.50	108,825.17	76,378.50
Peak Output (kWh):	13,447.19	9,165.98	13,492.50	8,977.50	12,850.00
Off-peak Output (kWh):	0.00	0.00	0.00	0.00	22,007.93
Fuel Use (MMBtu):	0.00	0.00	192.67	128.20	389.97
Energy Cost Savings ($):	2,755.34	1,863.55	2,954.97	1,966.07	3,126.66

Figure 16. Biweekly Technical Comparison for CFC

This report analyzed the microturbine demonstrations at CFC and Lowe's. The information gathered during the demonstrations will be used to improve the auto bulk algorithm and develop hybrid technology analysis.

Appendix

Table A-1. Peak Energy Requirements at CFC Demonstration

Date	Peak Demand (kW)			Peak Energy Purchases (kWh)		
	No distributed generation	Reduced by 210-kW microturbine		No distributed generation	Reduced by 210-kW microturbine	
		Timed	Auto-bulk		Timed	Auto-bulk
21-Aug	606	396	396	4,764	3,504	3,557
22-Aug	568	358	358	4,843	3,583	3,636
23-Aug	595	385	385	5,335	4,075	4,075
24-Aug	623	413	413	5,481	4,221	4,326
27-Aug	543	333	333	4,002	3,320	3,320
28-Aug	577	367	367	4,957	3,697	3,802
29-Aug	583	373	373	5,080	3,820	4,712
30-Aug	583	373	373	4,963	3,703	4,385
31-Aug	619	409	409	4,877	3,617	4,667
4-Sep	536	326	326	4,920	3,660	4,027

Table A-2. Daily Peak Energy Demand at Lowe's Demonstration

Date	Peak Demand (kW)			
	No distributed generation	Reduced by 400-kW Diesel	Reduced by 600-kW microturbine	Reduced by 300-kW microturbine
		Timed	Timed	Auto-bulk
21-Aug	828	428	228	528
22-Aug	853	453	253	553
23-Aug	837	437	237	611
24-Aug	796	396	196	612
27-Aug	830	430	230	579
28-Aug	840	440	240	540
29-Aug	754	354	154	630
30-Aug	848	448	248	738
31-Aug	895	495	295	595
4-Sep	804	404	204	504

Table A-3. Daily Peak Energy Purchases at Lowe's Demonstration

Date	Peak Energy Purchases (kWh)				
	No distributed generation	Reduced by 400-kW Diesel	Reduced by 600-kW microturbine	Reduced by 300-kW microturbine	Reduced by 400-kW Diesel & 600-kW microturbine
		Timed	Timed	Auto-bulk	Timed
21-Aug	3,095	1,495	695	1,895	295
22-Aug	2,880	1,280	480	1,680	80
23-Aug	2,840	1,240	440	1,715	115
24-Aug	2,736	1,136	336	1,611	11
27-Aug	2,886	1,286	486	1,761	161
28-Aug	2,879	1,279	479	1,679	79
29-Aug	2,438	838	38	1,988	388
30-Aug	2,296	696	-104	1,921	321
31-Aug	2,899	1,299	499	1,924	324
4-Sep	3,076	1,476	676	1,876	276

Table A-4. CFC and Lowe's Load Data for August 30, 2001

Time	Load (kW) CFC	Load (kW) Lowe's
12:15 AM	259.67	107.59
12:30 AM	281.41	113.11
12:45 AM	270.71	113.49
1:00 AM	252.71	110.85
1:15 AM	278.46	120.75
1:30 AM	289.58	122.03
1:45 AM	262.44	128.12
2:00 AM	271.90	135.17
2:15 AM	303.56	128.11
2:30 AM	265.89	130.30
2:45 AM	267.17	130.79
3:00 AM	303.74	131.32
3:15 AM	262.97	132.70
3:30 AM	270.37	137.61
3:45 AM	283.21	137.35
4:00 AM	290.01	147.57
4:15 AM	211.75	148.79
4:30 AM	266.09	152.63
4:45 AM	285.24	236.85
5:00 AM	252.87	320.08
5:15 AM	265.85	271.70
5:30 AM	295.96	269.10
5:45 AM	268.18	291.51
6:00 AM	248.20	397.39
6:15 AM	295.06	434.31
6:30 AM	273.35	442.50
6:45 AM	272.92	455.68
7:00 AM	281.74	454.25
7:15 AM	277.69	397.90
7:30 AM	243.92	396.60
7:45 AM	260.34	390.82
8:00 AM	293.31	410.45
8:15 AM	260.00	440.57
8:30 AM	252.91	442.93
8:45 AM	263.45	505.95
9:00 AM	326.48	529.08
9:15 AM	387.89	554.34
9:30 AM	436.62	572.92
9:45 AM	471.51	616.39
10:00 AM	487.74	695.83
10:15 AM	488.71	744.83
10:30 AM	529.89	797.29
10:45 AM	512.81	787.85
11:00 AM	467.94	802.05
11:15 AM	520.72	775.68
11:30 AM	521.68	762.44
11:45 AM	491.82	745.69
12:00 PM	474.57	762.12
12:15 PM	541.30	753.34
12:30 PM	506.38	746.16
12:45 PM	487.28	754.27
1:00 PM	478.36	755.52
1:15 PM	521.50	715.13
1:30 PM	524.10	705.26
1:45 PM	513.32	658.83
2:00 PM	505.18	648.06
2:15 PM	511.89	641.74
2:30 PM	519.64	653.80
2:45 PM	515.71	691.73
3:00 PM	549.46	715.58
3:15 PM	583.39	736.22
3:30 PM	537.65	726.45
3:45 PM	581.14	727.63
4:00 PM	557.57	758.52
4:15 PM	508.16	762.33
4:30 PM	553.75	801.40
4:45 PM	546.30	848.67
5:00 PM	559.61	787.43
5:15 PM	586.44	737.69
5:30 PM	523.70	441.10
5:45 PM	553.67	347.07
6:00 PM	593.45	451.57
6:15 PM	564.67	472.37
6:30 PM	535.70	464.42
6:45 PM	558.39	461.52
7:00 PM	546.32	459.76
7:15 PM	492.94	466.42
7:30 PM	499.89	463.84
7:45 PM	549.92	461.30
8:00 PM	257.23	459.16
8:15 PM	244.48	344.19
8:30 PM	265.49	340.19
8:45 PM	279.58	340.89
9:00 PM	254.42	305.29
9:15 PM	249.75	256.78
9:30 PM	256.08	193.88
9:45 PM	282.77	168.44
10:00 PM	269.29	155.07
10:15 PM	254.93	143.77
10:30 PM	274.11	141.27
10:45 PM	248.86	139.88
11:00 PM	261.28	139.91
11:15 PM	281.08	139.46
11:30 PM	263.96	138.26
11:45 PM	267.57	8.34