

### C-I Ground Loop Pump Calculations

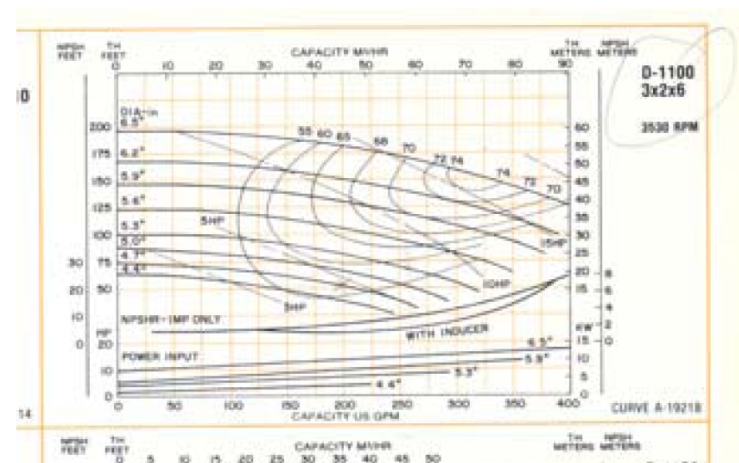
#### Central Geothermal System

building load on loop, Btuh	Bin	Count	hours of the year	heat rejected to loop	Condenser Loop, Pump A.							Ground Loop, Pump B						
					gpm	percent hour	delta T	ft head	hp	kw	kwhr	gpm	percent hour	ft head	hp	kw	kwhr	
-100000	3	3	274	-140000	70	1	4	35	1.3	0.9698	266	150	0.2	160	26	4.310222	1180	
0	35	32	2920	0	0	1	4	35	0	0	0	150	0.0	160	26	0	0	
50000	48	13	1186	70000	35	1	4	35	1	0.746	885	150	0.1	160	26	2.155111	2557	
150000	64	16	1460	210000	105	1	4	35	1.3	0.9698	1416	150	0.3	160	26	6.465333	9440	
250000	79	15	1369	350000	175	1	4	35	2.3	1.7158	2349	150	0.6	160	26	10.77556	14751	
350000	89	10	913	490000	245	1	4	35	3	2.238	2042	150	0.8	160	26	15.08578	13767	
450000	96	7	639	630000	315	1	4	35	4.2	3.1332	2002	250	1.0	160	30	22.38	14297	
550000	96	0	0	770000	385	1	4	35	4.5	3.357	0	460	1	160	32	23.872	0	
											8959							55992

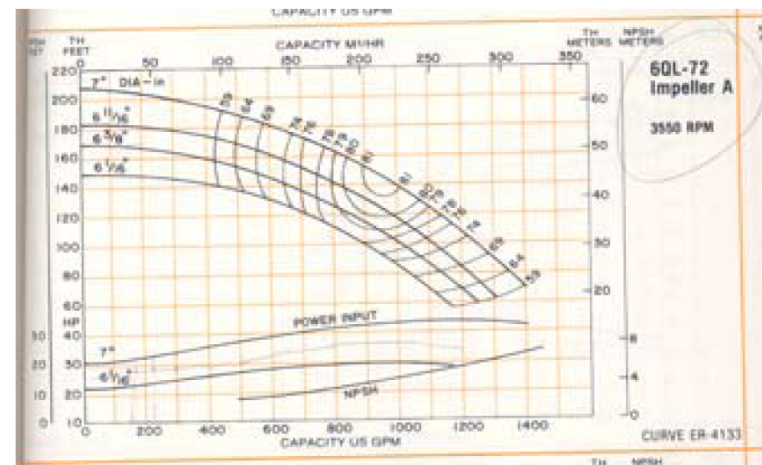
#### Decentral Geothermal System

building load on loop, Btuh	Bin	Count	hours of the year	heat rejected to loop	Condenser Loop, Pump C							Ground Loop, Pump B						
					gpm	percent hour	delta T	ft head	hp	kw	kwhr	gpm	percent hour	ft head	hp	kw	kwhr	
-100000	3	3	274	-140000	255	1	-1	100	7	5.2199	1429	160	0.3	160	26	6	1517	
0	35	32	2920	0	255	1	0	100	0	0	0	160	0.0	160	26	0	0	
50000	48	13	1186	70000	255	1	1	100	7	5.2199	6193	160	0.1	160	26	3	3286	
150000	64	16	1460	210000	255	1	2	100	7	5.2199	7622	160	0.4	160	26	8	12133	
250000	79	15	1369	350000	255	1	3	100	7	5.2199	7146	160	0.7	160	26	14	18958	
350000	89	10	913	490000	255	1	4	100	7	5.2199	4764	160	1	160	26	19	17694	
450000	96	7	639	630000	255	1	5	100	7	5.2199	3335	212	1	160	28	21	13338	
550000	96	0	0	770000	255	1	6	100	7	5.2199	0	283	1	160	30	22	0	
											30487.56							66925

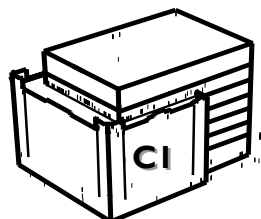
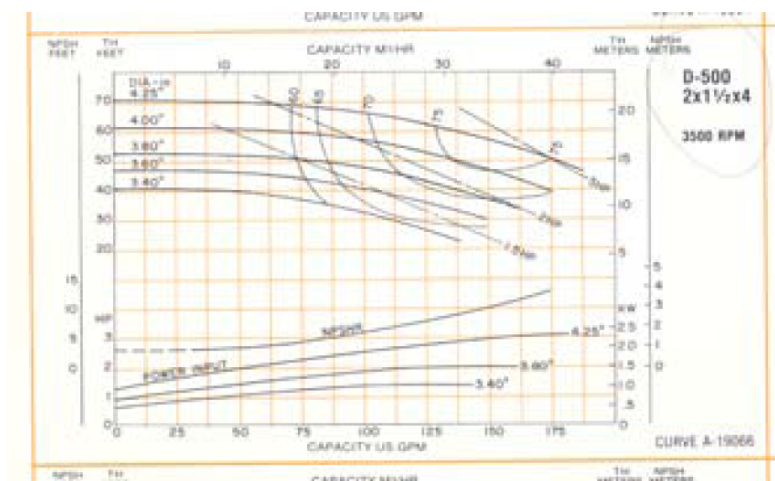
A. End-suction cast iron centrifugal circulation pump



B. Double Suction Vertical Pump



C. End-suction cast iron centrifugal circulation pump

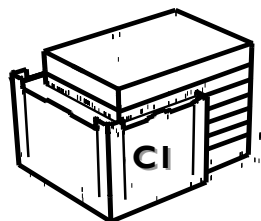
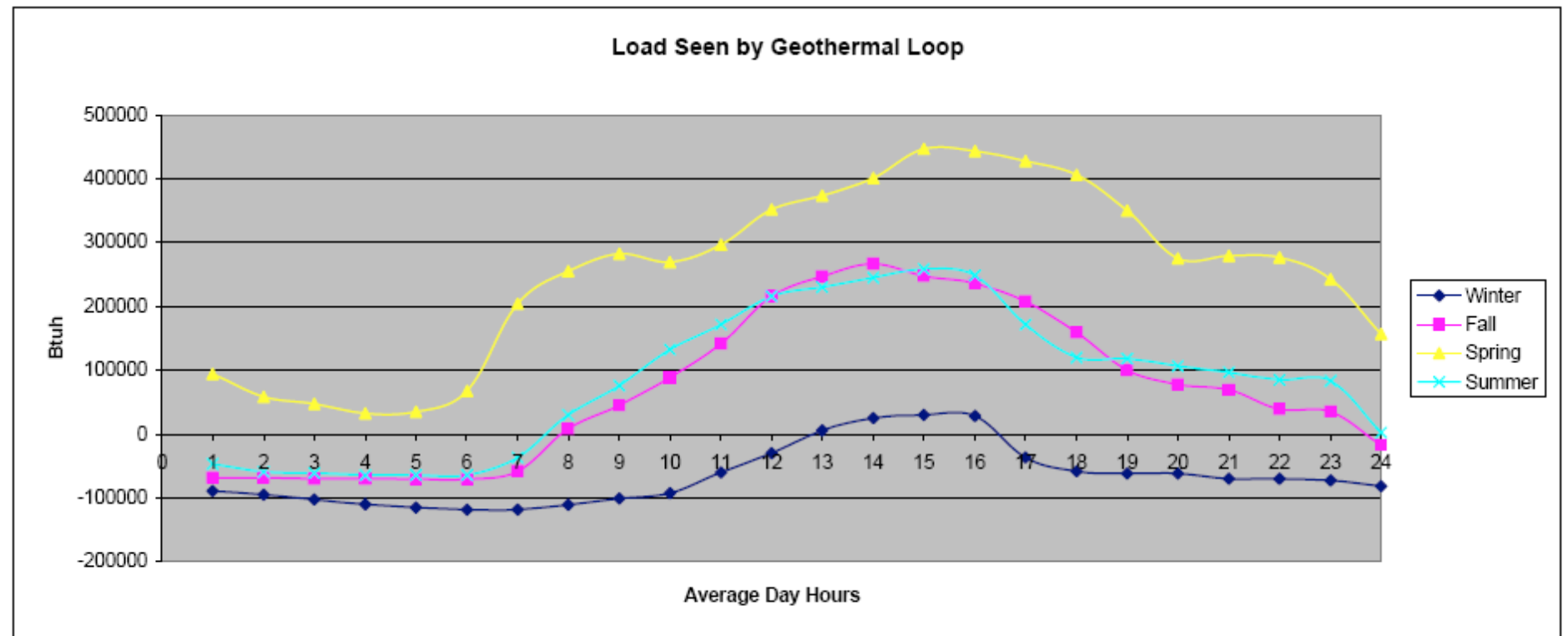


Pump Electricity Profile, Inserted into TRACE

	Dec-Feb	March-May	June-Augus	Sept-Nov
1	0.13	0.00	0.13	0.00
2	0.13	0.00	0.13	0.00
3	0.13	0.00	0.13	0.00
4	0.13	0.00	0.13	0.00
5	0.13	0.00	0.13	0.00
6	0.13	0.00	0.63	0.00
7	0.13	0.25	0.63	0.25
8	0.13	0.25	0.63	0.25
9	0.13	0.25	0.63	0.25
10	0.13	0.25	1.00	0.25
11	0.13	0.50	1.00	0.50
12	0.13	0.50	1.00	0.50
13	0.13	0.50	1.00	0.50
14	0.13	0.50	1.00	0.50
15	0.13	0.50	1.00	0.50
16	0.13	0.50	1.00	0.50
17	0.13	0.50	1.00	0.50
18	0.13	0.25	1.00	0.25
19	0.13	0.25	0.75	0.25
20	0.13	0.25	0.75	0.25
21	0.13	0.00	0.75	0.00
22	0.13	0.00	0.75	0.00
23	0.13	0.00	0.50	0.00
24	0.13	0.00	0.25	0.00

2680.469

	kwh	Peak kW
central	64951	24.23132
decentral	97412	36.34156



## C-2 Rate Structure Summary

### Electric Rate Tarrifs

PSE&G Totals

Residential	October Thru	June Thru	
	May	September	
first 600 kwh	\$0.11913	\$0.12287	per kwh
in excess of 600	\$0.11913	\$0.13609	per kwh
and \$2.14/ Month			

Commerical	October Thru	June Thru	
	May	September	
Peak	\$0.05825	\$0.07185	per kwh
Offpeak	\$0.04130	\$0.04275	per kwh
and	\$2.09240	\$3.28895	per kw of summer peak

### Gas Rates

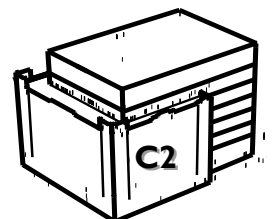
Predicted From Energy Information Administration

#### Residential

\$14	per 1000 cf
\$1.4	per therm

#### Commercial

\$9.4	per 1000 cf
\$0.94	per therm



# Rate Structure Sources, Residential:

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

Thirteenth Revised Sheet No. 67

Superseding

B.P.U.N.J. No. 14 ELECTRIC

Twelfth Revised Sheet No. 67

## BASIC GENERATION SERVICE – FIXED PRICING (BGS-FP) ELECTRIC SUPPLY CHARGES

### APPLICABLE TO:

Default electric supply service for Rate Schedules RS, RSP, RHS, RLM, WH, WHS, HS, BPL, BPL-POF, PSAL, GLP and LPL-Secondary (less than 1,250 kilowatts).

### BGS ENERGY CHARGES:

Applicable to Rate Schedules RS, RHS, RLM, WH, WHS, HS, BPL, BPL-POF and PSAL

Charges per kilowatthour:

Rate Schedule	For usage in each of the months of <u>October through May</u>		For usage in each of the months of <u>June through September</u>	
	Charges		Charges	
	Charges	Including SUT	Charges	Including SUT
RS – first 600 kWh	6.0220 ¢	6.3833 ¢	7.1396 ¢	7.5680 ¢
RS – in excess of 600 kWh	6.0220 ¢	6.3833 ¢	8.0048 ¢	8.4851 ¢
RHS – first 600 kWh	5.7817 ¢	6.1286 ¢	6.7876 ¢	7.1949 ¢
RHS – in excess of 600 kWh	5.7817 ¢	6.1286 ¢	7.9445 ¢	8.4212 ¢
RLM On-Peak	7.4746 ¢	7.9231 ¢	10.4593 ¢	11.0869 ¢
RLM Off-Peak	4.7979 ¢	5.0858 ¢	4.6972 ¢	4.9790 ¢
WH	5.3780 ¢	5.7007 ¢	6.2663 ¢	6.6423 ¢
WHS	4.9804 ¢	5.2792 ¢	5.3713 ¢	5.6936 ¢
HS	5.8008 ¢	6.1488 ¢	7.8972 ¢	8.3710 ¢
BPL	4.7139 ¢	4.9967 ¢	4.7258 ¢	5.0093 ¢
BPL-POF	4.7139 ¢	4.9967 ¢	4.7258 ¢	5.0093 ¢
PSAL	4.7139 ¢	4.9967 ¢	4.7258 ¢	5.0093 ¢

42.4  
B

The above Basic Generation Service Energy Charges reflect costs for Energy, Generation Capacity, Transmission, and Ancillary Services (including PJM Interconnection, L.L.C. (PJM) Administrative Charges). The portion of these charges related to Network Integration Transmission Service, including the PJM Seams Elimination Cost Assignment Charges and the PJM Reliability Must Run Charge, may be changed from time to time on the effective date of such change to the PJM rate for these charges as approved by the Federal Energy Regulatory Commission (FERC).

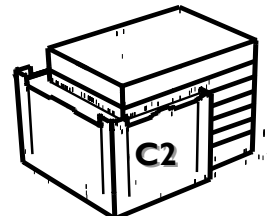
Kilowatt threshold noted above is based upon the customer's Peak Load Share of the overall summer peak load assigned to Public Service by the Pennsylvania-New Jersey-Maryland Office of the Interconnection (PJM). See Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions of this Tariff.

Date of Issue: December 22, 2005

Effective: January 1, 2006

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated June 22, 2005  
in Docket Nos. ER05040368 and EO04040288





PUBLIC SERVICE ELECTRIC AND GAS COMPANY

First Revised Sheet No. 80

B.P.U.N.J. No. 14 ELECTRIC

Superseding

Original Sheet No. 80

**RATE SCHEDULE RS  
RESIDENTIAL SERVICE**

**APPLICABLE TO USE OF SERVICE FOR:**

Delivery service for residential purposes. Customers may either purchase electric supply from a Third Party Supplier (TPS) or from Public Service's Basic Generation Service default service as detailed in this rate schedule.

**DELIVERY CHARGES:**

**Service Charge:**

\$2.27 in each month [\$2.41 including New Jersey Sales and Use Tax (SUT)].

**Distribution Charges per Kilowatthour:**

First 600 hours used in each of the months of:

<u>October through May</u>		<u>June through September</u>	
Charge	Charge Including SUT	Charge	Charge Including SUT
3.6234¢	3.8408¢	2.8590¢	3.0305¢

In excess of 600 hours used in each of the months of:

<u>October through May</u>		<u>June through September</u>	
Charge	Charge Including SUT	Charge	Charge Including SUT
3.6234¢	3.8408¢	3.2411¢	3.4356¢

1,688¢  
11.913  
12.2869  
+ 3.13/Mo  
+ 2.41/Mo

**Societal Benefits Charge:**

This charge shall recover costs associated with activities that are required to be accomplished to achieve specific public policy determinations mandated by Government. Refer to the Societal Benefits Charge sheet of this Tariff for the current charge.

**Non-Utility Generation Transition Charge:**

This charge shall recover above market costs associated with non-utility generation costs and other generation related costs as may be approved by the Board. Refer to the Non-Utility Generation Transition Charge sheet of this Tariff for the current charge.

**Securitization Transition Charges:**

These charges include the Transition Bond Charge and the MTC-Tax charge and shall recover costs and associated taxes for transition bonds collected by PSE&G as servicer on behalf of PSE&G Transition Funding LLC. Refer to the Securitization Transition Charges sheet of this Tariff for the current charges.

**System Control Charge**

This charge is designed to provide recovery of costs associated with the operation of certain programs as approved by the BPU. Refer to the System Control Charge sheet of this Tariff for the current charge.

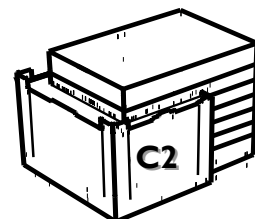
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Date of Issue: March 1, 2004

Effective: June 1, 2004

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated February 11, 2004  
in Docket No. EO03050394



PUBLIC SERVICE ELECTRIC AND GAS COMPANY  
 B.P.U.N.J. No. 14 ELECTRIC

First Revised Sheet No. 81  
 Superseding  
 Original Sheet No. 81

**RATE SCHEDULE RS  
 RESIDENTIAL SERVICE  
 (Continued)**

**Amortization of Excess Depreciation Reserve**

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This charge shall amortize an excess depreciation reserve that shall be amortized over 29 months beginning August 1, 2003 and is intended to expire December 31, 2005. Refer to the Amortization of Excess Depreciation Reserve sheet of this Tariff for the current charge.

The Distribution Charges, Societal Benefits Charge, Non-Utility Generation Transition Charge, Securitization Transition Charges, System Control Charge, and the Amortization of Excess Depreciation Reserve Charge shall be combined for billing.

**ELECTRIC SUPPLY CHARGES:**

A customer may choose to receive electric supply from either:

- a) A TPS as described in Section 14 of this Tariff, or
- b) Public Service through its Basic Generation Service – Fixed Pricing (BGS – FP) default service.

**Third Party Supply:**

A customer that receives electric supply from a TPS will be charged for electric supply according to any agreement between the customer and the TPS. The customer will not be charged for electric supply by Public Service.

**Basic Generation Service:**

Customers that do not receive electric supply from a TPS will be supplied under the Basic Generation Service – Fixed Pricing (BGS – FP) default service.

The BGS Energy Charges and the BGS Reconciliation Charge, as applicable, will be applied to all kilowatthours billed each month. Refer to the Basic Generation Service sheets of this Tariff for the current charges applicable to Rate Schedule RS.

**MINIMUM CHARGE:**

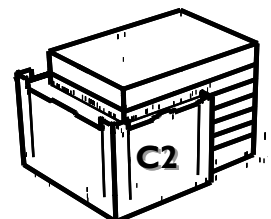
Where all or part of the electricity utilized by the customer is produced from on-site generation equipment and not delivered by Public Service, a Monthly Minimum charge of \$2.95 (\$3.13 including SUT) per kW of Measured Peak Demand shall be applied. The customer's Measured Peak Demand in any month shall be the greatest average number of kilowatts delivered by Public Service during any thirty-minute interval as registered by a demand meter furnished by Public Service. Revenue to satisfy the Monthly Minimum requirement shall be derived solely from Distribution Kilowatthour Charges.

**GENERATION CAPACITY AND TRANSMISSION OBLIGATIONS:**

**Generation Obligation:**

The customer's Generation Obligation, in kilowatts, is determined by Public Service no less frequently than once a year. The Generation Obligation for existing customers or for new customers utilizing an existing building or premise is based upon the customer's share of the overall summer peak load assigned to Public Service by the Pennsylvania-New Jersey-Maryland Office of the Interconnection (PJM) as adjusted by PJM assigned capacity related factors and shall

Date of Issue: March 1, 2004 Effective: June 1, 2004  
 Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
 80 Park Plaza, Newark, New Jersey 07102  
 Filed pursuant to Order of Board of Public Utilities dated February 11, 2004  
 in Docket No. EO03050394





PUBLIC SERVICE ELECTRIC AND GAS COMPANY

B.P.U.N.J. No. 14 ELECTRIC

Original Sheet No. 82

**RATE SCHEDULE RS  
RESIDENTIAL SERVICE  
(Continued)**

be in accordance with Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions. The Generation Obligation for customers taking service in a new building or premise, as determined by Public Service, is based upon the load requirements, as estimated by Public Service, of the customer's building or premise. The Generation Obligation represents the generator capacity that PJM requires an electric supplier to have available to provide electric supply to a customer.

**Transmission Obligation:**

The customer's Transmission Obligation, in kilowatts, is determined in a similar manner to the Generation Obligation described above. The Transmission Obligation represents the level of transmission network service that must be procured by the customer's electric supplier from PJM to provide service to the customer.

Costs associated with the Generation and Transmission Obligations are included in the charges for Basic Generation Service and may affect the price offered by a Third Party Supplier.

**TERMS OF PAYMENT:**

Bills are due on presentation.

**TERM:**

Customer may discontinue delivery service upon notice.

**SPECIAL PROVISIONS:**

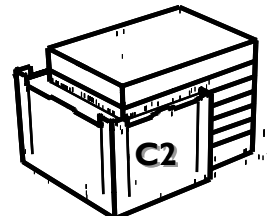
- (a) **Limitations on Service:** This rate schedule is available where all service is measured by one meter, except for service provided under Rate Schedules WH or WHS:
- (a-1) In individual residences and appurtenant outbuildings;
  - (a-2) In residential premises where customer's use of electric service for purposes other than residential is incidental to its residential use;
  - (a-3) On residential farms;
  - (a-4) For rooming or boarding houses where the number of rented rooms does not exceed twice the number of bedrooms occupied by the customer;
  - (a-5) To a customer in a two- or three-family building who has the service for incidental common-use equipment registered on its meter.
  - (a-6) In individual flats or apartments in multiple-family buildings;
  - (a-7) In multiple-family buildings of two or more individual flats or apartments where electric service is furnished to the tenants or occupants of the flats or apartments by the owner without a specific charge for such service, provided that the number of kilowatthours in each block of the Distribution Charge are multiplied by the number of individual flats or apartments, whether occupied or not.

Date of Issue: August 4, 2003

Effective: August 1, 2003

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated July 31, 2003  
in Docket No. ER02050303



PUBLIC SERVICE ELECTRIC AND GAS COMPANY

B.P.U.N.J. No. 14 ELECTRIC

Original Sheet No. 83

**RATE SCHEDULE RS  
RESIDENTIAL SERVICE**

(Continued)

- (b) **Resale:** Service under this rate schedule is not available for resale.
- (c) **TPS Supply:** Customers who desire to purchase their electric supply from a TPS may request an enrollment package from Public Service that describes the process necessary for the customer to obtain a TPS for electric supply. This package will be provided to the customer at no charge by Public Service.
- (c-1) The customer must contract with a TPS to arrange for deliveries to Public Service of the electric supply. A customer is limited to one TPS for electric supply for each account for which the customer receives delivery service.
- (c-2) The customer's TPS is required to notify Public Service of the customer's selection prior to 20 days before the customer's scheduled Public Service meter reading date for deliveries to commence on such scheduled meter reading date, and such selection shall remain in effect for the entire billing month. Customer can change TPSs effective only on the date of the customer's scheduled Public Service meter reading date.

**STATE OF NEW JERSEY AUTHORIZED TAXES:**

The Transitional Energy Facility Assessment and the New Jersey Sales and Use Tax are applied in accordance with P.L. 1997, c. 162 and are included in the appropriate charges in this rate schedule. See Section 16 of the Standard Terms and Conditions for additional details and/or exceptions.

**STANDARD TERMS AND CONDITIONS:**

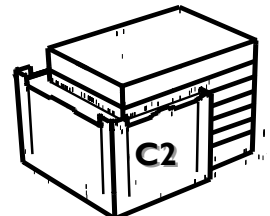
This rate schedule is subject to the Standard Terms and Conditions of this Tariff.

Date of Issue: August 4, 2003

Effective: August 1, 2003

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated July 31, 2003  
in Docket No. ER02050303





**Rate Structure Sources,  
Commercial:**

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

First Revised Sheet No. 67A

B.P.U.N.J. No. 14 ELECTRIC

Superseding  
Original Sheet No. 67A

**BASIC GENERATION SERVICE – FIXED PRICING (BGS-FP)  
ELECTRIC SUPPLY CHARGES  
(Continued)**

**BGS ENERGY CHARGES:**

Applicable to Rate Schedules GLP and LPL-Sec.

Charges per kilowatthour:

Rate Schedule	For usage in each of the months of October through May		For usage in each of the months of June through September	
	Charges	Charges Including SUT	Charges	Charges Including SUT
	GLP	5.4921 ¢	5.8216 ¢	6.7786 ¢
GLP Night Use	4.1632 ¢	4.4130 ¢	4.0329 ¢	4.2749 ¢
LPL-Sec. under 750 kW				
On-Peak	6.5705 ¢	6.9647 ¢	8.7655 ¢	9.2914 ¢
Off-Peak	4.1632 ¢	4.4130 ¢	4.0329 ¢	4.2749 ¢
LPL-Sec. equal to or greater than 750 kW but less than 1,250 kW				
On-Peak	7.0705 ¢	7.4947 ¢	9.2655 ¢	9.8214 ¢
Off-Peak	4.6632 ¢	4.9430 ¢	4.5329 ¢	4.8049 ¢

The above Basic Generation Service Energy Charges reflect costs for Energy and Ancillary Services (including PJM Administrative Charges).

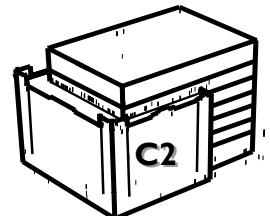
Kilowatt thresholds noted above are based upon the customer's Peak Load Share of the overall summer peak load assigned to Public Service by the Pennsylvania-New Jersey-Maryland Office of the Interconnection (PJM). See Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions of this Tariff.

Date of Issue: May 31, 2005

Effective: June 1, 2005

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated February 17, 2005  
in Docket No. EO04040288



PUBLIC SERVICE ELECTRIC AND GAS COMPANY  
 B.P.U.N.J. No. 14 ELECTRIC

Twelfth Revised Sheet No. 68  
 Superseding  
 Eleventh Revised Sheet No. 68

**BASIC GENERATION SERVICE – FIXED PRICING (BGS-FP)  
 ELECTRIC SUPPLY CHARGES  
 (Continued)**

**BGS CAPACITY CHARGES:**

Applicable to Rate Schedules GLP and LPL-Sec.

Charges per kilowatt of Generation Obligation:

Charge applicable in the months of June through September .....	\$ 1.3420
Charge including New Jersey Sales and Use Tax (SUT) .....	\$ 1.4225
Charge applicable in the months of October through May .....	\$ 0.2126
Charge including New Jersey Sales and Use Tax (SUT) .....	\$ 0.2254

The above charges shall recover each customer's share of the overall summer peak load assigned to the Public Service Transmission Zone by the PJM Interconnection, L.L.C. (PJM) as adjusted by PJM assigned capacity related factors and shall be in accordance with Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions.

**BGS TRANSMISSION CHARGES**

Applicable to Rate Schedules GLP and LPL-Sec.

Charges per kilowatt of Transmission Obligation:

Currently effective Annual Transmission Rate for Network Integration Transmission Service for the Public Service Transmission Zone as stated in the FERC Electric Tariff of the PJM Interconnection, LLC.....	\$ 17.631 per MW per year
PJM Seams Elimination Cost Assignment Charges .....	\$ 124.13 per MW per month
PJM Reliability Must Run Charge .....	\$ 167.86 per MW per month
Above rates converted to a charge per kW of Transmission Obligation, applicable in all months .....	\$ 1.7613
Charge including New Jersey Sales and Use Tax (SUT) .....	\$ 1.8670

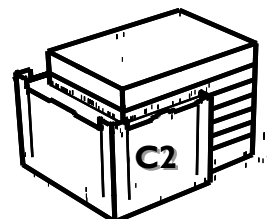
The above charges shall recover each customer's share of the overall summer peak transmission load assigned to the Public Service Transmission Zone by the PJM Interconnection, L.L.C. (PJM) as adjusted by PJM assigned transmission capacity related factors and shall be in accordance with Section 9.1, Measurement of Electric Service, of the Standard Terms and Conditions. These charges will be changed from time to time on the effective date of such change to the PJM rate for charges for Network Integration Transmission Service, including the PJM Seams Elimination Cost Assignment Charges and the PJM Reliability Must Run Charge, as approved by Federal Energy Regulatory Commission (FERC).

Date of Issue: December 22, 2005

Effective: January 1, 2006

Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
 80 Park Plaza, Newark, New Jersey 07102

Filed pursuant to Order of Board of Public Utilities dated June 22, 2005  
 in Docket Nos. ER05040368 and EO04040288



PUBLIC SERVICE ELECTRIC AND GAS COMPANY

Thirtieth Revised Sheet No. 69

B.P.U.N.J. No. 14 ELECTRIC

Superseding

Twenty-Ninth Revised Sheet No. 69

BASIC GENERATION SERVICE – FIXED PRICING (BGS-FP)

BASIC GENERATION SERVICE – FIXED PRICING (BGS-FP)

ELECTRIC SUPPLY CHARGES

(Continued)

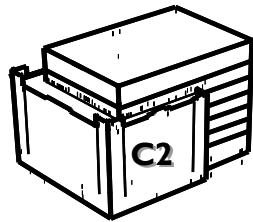
BGS RECONCILIATION CHARGES:

Charges per kilowatthour:

Basic Generation Service Reconciliation Charge.....	0.0028 ¢
Charge including New Jersey Sales and Use Tax (SUT) .....	0.0030 ¢

The above charges shall recover the difference between the monthly amount paid to Basic Generation Service (BGS) suppliers and the total revenue from customers for BGS for the preceding months for the applicable BGS supply. These charges include all applicable taxes and are charged on a monthly basis for all usage in the month indicated. These charges shall be combined with the BGS Energy Charges for billing.

Date of Issue: February 28, 2006 Effective: March 1, 2006  
 Issued by FRANCIS E. DELANY, Jr., Vice President and Corporate Rate Counsel  
 80 Park Plaza, Newark, New Jersey 07102  
 Filed pursuant to Order of Board of Public Utilities dated February 6, 2003  
 in Docket No. EX01110754

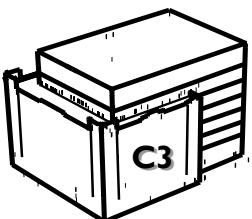




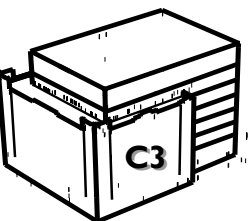
### C-3 Load Calculation Outputs Energy Consumption Results

		January	February	March	April	May	June	July	August	September	October	November	December	\$	kwhr	kw	Therms
<b>Central Geo Building Energy</b>																	
Shared Space Lighting	Electric (kWh)	4,215.20	3,807.30	4,215.20	4,079.30	4,215.20	4,079.30	4,215.20	4,215.20	4,079.30	4,215.20	4,079.30	4,215.20	-	49631	-	-
Ground Water Pumps	Electric (kWh)	2,343.50	2,116.70	3,755.70	3,634.50	3,755.70	9,936.70	10,268.00	10,268.00	3,634.50	3,755.70	3,634.50	2,343.50	-	59447	-	-
FCU Supply Fans	Electric (kWh)	34.5	34.5	35.7	53.7	92.9	159.4	193.5	189.7	117.4	60.3	50.2	35.8	-	1058	-	-
Heat Pump Cooling	Electric (kWh)	873.3	779	782.6	2,003.20	3,716.50	6,177.20	7,335.30	7,585.50	4,891.50	2,530.80	1,918.00	905.2	-	39498	-	-
Chilled Water Circulating	Electric (kWh)	45.1	40	40.2	99.5	177.3	281.5	328.1	335.3	227	125.3	94.9	46.7	-	1841	-	-
Heat Pump Heating	Electric (kWh)	1,883.20	1,730.90	1,730.70	194.7	0	0	0	0	0	57.6	578.8	1,969.60	-	8146	-	-
Hot Water Circulating	Electric (kWh)	1,667.00	1,501.40	1,457.30	242.9	0	0	0	0	0	77.3	690	1,606.30	-	7242	-	-
Above Combined	Cost	644	583	700	600	697	1,483	1,605	1,623	930	631	644	648	10788	166862	84	-
	kw	74	72	78	73	76	83	84	84	82	76	68	77				
Outdoor Air Conditioning	Electric (kWh)	18,111	16,200	18,430	12,645	8,052	4,463	4,428	4,315	4,712	10,422	14,088	18,389	8068	134255	16	-
(Supply return and exhaust fans, pumps, reg coils with EW)	Cost	1,055	944	1,074	737	469	321	318	310	339	608	821	1,072				
	kw	16	16	16	15	12	9	10	11	8	13	15	16				
Above Combined Demand	kw	90	88	94	88	88	92	94	95	90	89	83	93	18856	301117	95	-
Domestic Hot Water Heating	(therms)	34	32	36	20	0	0	0	0	0	2	23	33	170	-	-	180
	Cost	32	30	34	19	0	0	0	0	0	2	22	31				
Apartment Lighting	Electric (kWh)	29,295.00	26,460.00	29,295.00	28,350.00	29,295.00	28,350.00	29,295.00	29,295.00	28,350.00	29,295.00	28,350.00	29,295.00	NA	344925	NA	-
	kw	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5				

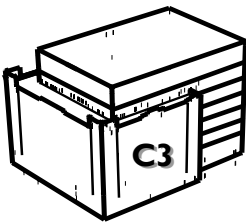
		January	February	March	April	May	June	July	August	September	October	November	December	\$	kwhr	kw	Therms
<b>Packaged Terminal Heat Pumps</b>																	
Apartment Lighting	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	NA	344925	68	-
	kw	68	68	68	68	68	68	68	68	68	68	68	68				
Domestic Hot Water Heating	(therms)	43	38	43	41	43	41	43	43	41	43	41	43				
	kwhr	2076	1876	2076	2008	2076	2008	2076	2076	2008	2076	2008	2076	-	24,438	-	-
Air to air Heat Pumps	kwhr	12,869	44,007	12,869	68,550	30,158	36,060	44,840	47,476	27,858	51,386	85,670	12,869	-	474,611	-	-
Hallway Lighting		4,215	3,807	4,215	4,079	4,215	4,079	4,215	4,215	4,079	4,215	4,079	4,215	-	49,631	-	-
	On-Pk Demand (kW)	362	391	359	333	269	312	317	317	294	297	340	355	391	548,680		



Decentral Geo Energy														TOTALS			
		January	February	March	April	May	June	July	August	September	October	November	December	\$	kwhr	kw	Therms
Shared Space Lighting	Electric (kWh)	4,215	3,807	4,215	4,079	4,215	4,079	4,215	4,215	4,079	4,215	4,079	4,215	-	49631	-	-
Ground Water Pumps	Electric (kWh)	3,515	3,175	5,633	5,451	5,633	14,903	15,400	15,400	5,451	5,633	5,451	3,515	-	89158	-	-
Shared Spaces Conditioning HP	Electric (kWh)	2,974	2,662	2,556	2,344	2,408	1,400	1,357	1,435	2,271	2,414	2,359	2,930		27110	-	-
Above Combined	\$	606	546	708	679	701	1,457	1,499	1,504	833	701	680	604	10518	165899	66	-
	kw	66	66	66	66	66	66	65	65	65	66	66	66				
Outdoor Air Tempering, all costs	On-Pk Cons. (\$)	890	796	908	602	385	313	353	340	293	481	679	906	6946	114993	15	-
	kwhr	15,287	13,663	15,579	10,329	6,615	4,352	4,907	4,731	4,083	8,256	11,648	15,543				
	kw	15	15	15	14	11	11	12	14	8	12	14	15				
Above Combined Demand	kw	81	81	81	80	77	77	77	79	73	78	80	81	17464	280892	81	-
																	-
Water to Air Heat Pumps (see unit selections for grouping)																	
18	Electric (kWh)	131	99	120	177	244	356	426	483	358	226	167	117		2904	-	-
18 N	Electric (kWh)	536.7	335.2	354.5	186.9	369.3	637.4	710.1	697.1	386.6	193	176.5	557.7		5141	-	-
24	Electric (kWh)	164	132	144	161	234	351	420	462	344	205	150	165		2930	-	-
24 N	Electric (kWh)	669	484	555	191	443	796	913	881	460	192	202	685		6471	-	-
30	Electric (kWh)	311	283	298	323	418	604	726	803	639	411	322	325		5461	-	-
18/24	Electric (kWh)	850	630	691	561	962	1,579	1,876	1,953	1,352	654	500	879		12485	-	-
18/24 N	Electric (kWh)	2,262	1,715	1,888	380	948	1,833	2,126	1,994	1,028	368	615	2,326		17485	-	-
24/30	Electric (kWh)	339	268	307	187	272	426	520	563	424	228	195	371		4099	-	-
Domestic Hot Water Heating	(therms)	34	32	36	20	0	0	0	0	0	2	23	33				
	kwhr	1661	1563	1758	977	0	0	0	0	0	98	1123	1612	-	8792	-	180
Above Combined														NA	346659	NA	-
Apartment Lighting	Electric (kWh)	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	NA	344925	NA	
	kw	68	68	68	68	68	68	68	68	68	68	68	68				



Central Traditional														TOTALS			
Buro Happold Design		January	February	March	April	May	June	July	August	September	October	November	December	\$	kwhr	kw	Therms
Shared Space Lighting	Electric (kWh)	4,215	3,807	4,215	4,079	4,215	4,079	4,215	4,215	4,079	4,215	4,079	4,215	-	49631	-	-
FCU Supply Fans	Electric (kWh)	35	35	36	54	93	160	199	208	117	60	50	36	-	1082	-	-
Chiller Cooling	Electric (kWh)	0	0	0	212	1,722	5,502	8,104	9,974	3,572	448	0	0	-	29534	-	-
Cooling Tower	Electric (kWh)	0	0	0	647	3,946	9,259	10,843	11,896	7,788	1,615	484	0	-	46478	-	-
Condensor Loop Pump	Electric (kWh)	0	0	0	1,273	5,698	9,757	10,520	10,520	8,767	2,870	424	0	-	49829	-	-
Chilled Water Circulating	Electric (kWh)	0	0	0	18	121	327	446	516	225	37	5	0	-	1694	-	-
Boiler Forced Draft Fan	Electric (kWh)	1,116	1,008	1,116	702	74	0	0	0	0	428	1,004	1,116	-	6563	-	-
Hot Water Circulating	Electric (kWh)	2,567	2,318	2,567	1,615	169	0	0	0	0	983	2,308	2,567	-	15094	-	-
Exhaust Fans	Electric (kWh)	153	140	154	156	168	168	180	186	164	163	155	154	-	1940	-	-
Above Combined	elec cons \$	493	445	493	527	953	2,109	2,485	2,701	1,782	644	503	493	<b>13628</b>	<b>201845</b>	<b>130</b>	-
	kw	72	73	72	80	101	118	125	130	116	90	80	72				
Boiler	Gas (therms)	816	719	816	272	198	190	196	196	190	217	359	871	-	-	-	5040
DHWH	Gas (therms)	43	38	43	41	43	41	43	43	41	43	41	43	-	-	-	500
Above Combined	On-Pk Cons. (\$)	807	712	807	295	226	217	224	224	217	244	376	859	<b>5208</b>	-	-	<b>5540</b>
	water \$	0	0	0	5	39	128	187	225	82	11	1	0				
Apartment Lighting	Electric (kWh)	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	<b>NA</b>	<b>344925</b>	<b>68</b>	-
	kw	68	68	68	68	68	68	68	68	68	68	68	68	-	-	-	-





Trane TRACE peak loads for Base Case model

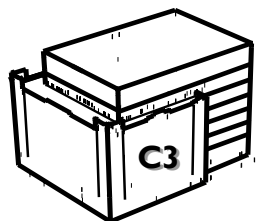
System Checksums

By ae

BUILDING

Packaged Terminal Air Conditioner

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time: Mo/Hr: 5 / 16					Mo/Hr: 5 / 16					Mo/Hr: 13 / 1					Cooling Heating		
Outside Air: OADB/WB/HR: 79 / 65 / 71					OADB: 79					OADB: 0					SADB 61.2 116.1		
															Plenum 76.0 69.0		
															Return 75.1 69.9		
															Ret/OA 77.1 43.6		
															Fn MtrTD 0.0 0.0		
															Fn BldTD 0.1 0.0		
															Fn Frict 0.2 0.0		
Envelope Loads	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat. Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)	Envelope Loads	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)	AIRFLOWS						
Skylite Solar	0	0	0	0.00	0	0.00	Skylite Solar	0	0	0.00	Vent	Cooling Heating					
Skylite Cond	0	0	0	0.00	0	0.00	Skylite Cond	0	0	0.00	Infil	13,870 13,870					
Roof Cond	30,276	0	30,276	4.90	30,276	6.17	Roof Cond	-31,774	-31,774	1.06	Supply	1,062 1,062					
Glass Solar	144,790	0	144,790	23.44	144,790	29.52	Glass Solar	0	0	0.00	MinStop/Rh	37,638 37,638					
Glass Cond	18,679	0	18,679	3.02	18,679	3.81	Glass Cond	-343,598	-343,598	11.41	Return	0 0					
Wall Cond	34,032	0	34,032	5.51	34,032	6.94	Wall Cond	-100,054	-100,054	3.32	Exhaust	24,691 24,691					
Partition	-102,942		-102,942	-16.67	-102,942	-20.99	Partition	-98,040	-98,040	3.26	Rm Exh	924 1,062					
Exposed Floor	0		0	0.00	0	0.00	Exposed Floor	0	0	0.00	Auxiliary	13,870 13,870					
Infiltration	8,592		8,592	1.39	4,771	0.97	Infiltration	-82,873	-82,873	2.75		0 0					
Sub Total ==>	133,428	0	133,428	21.60	129,607	26.42	Sub Total ==>	-656,340	-656,340	21.80	ENGINEERING CKS						
Internal Loads					Internal Loads										% OA 36.9 36.9		
Lights	148,213	0	148,213	24.00	148,213	30.22	Lights	21,173	21,173	-0.70	cfm/ft²	0.86 0.86					
People	21,538		21,538	3.49	14,176	2.89	People	0	0	0.00	cfm/ton	562.47					
Misc	30,717	0	30,717	4.97	30,717	6.26	Misc	0	0	0.00	ft²/ton	652.26					
Sub Total ==>	200,467	0	200,467	32.46	193,106	39.37	Sub Total ==>	21,173	21,173	-0.70	Btu/hr-ft²	18.40 -89.85					
Ceiling Load					Ceiling Load										No. People 192		
Ventilation Load	0	-2,709	0	0.00	2,943	0.60	Ventilation Load	-2,686	0	0.00							
Ov/Undr Sizing	164,831	0	108,479	17.56	0	0.00	Ov/Undr Sizing	0	-1,082,295	35.95							
Exhaust Heat		-159	-159	-0.03	164,831	33.61	Exhaust Heat	-1,294,546	-1,294,546	43.00							
Sup. Fan Heat			10,627	1.72	OA Preheat Diff.					1,224 -0.04							
Ret. Fan Heat		0	0	0.00	RA Preheat Diff.					0 0.00							
Duct Heat Pkup		0	0	0.00	Additional Reheat					0 0.00							
Reheat at Design			0	0.00	Grand Total ==>					-1,932,399 -3,010,783 100.00							
Grand Total ==>	501,435	-2,868	617,673	100.00	490,487	100.00	Grand Total ==>	-1,932,399	-3,010,783	100.00							
COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR	Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg							
ton	MBh	cfm	°F °F gr/lb	°F °F gr/lb		ft² (%)	MBh	cfm	°F	°F							
Main Clg	66.9	803.0	728.4 37,638 77.2 63.8 67.4	61.1 56.9 62.7	Floor	43,646	Main Htg	-3,921.8	37,638	22.6	116.1						
Aux Clg	0.0	0.0	0 0.0 0.0 0.0	0.0 0.0 0.0	Part	4,300	Aux Htg	0.0	0	0.0	0.0						
Opt Vent	0.0	0.0	0 0.0 0.0 0.0	0.0 0.0 0.0	ExFlr	0	Preheat	-0.1	37,638	44.2	61.0						
					Roof	7,205	Humidif	0.0	0	0.0	0.0						
Total	66.9	803.0			Wall	25,193	Opt Vent	0.0	0	0.0	0.0						
							Total	-3,921.8									



# C-4 Emissions Calculations

## Assumptions:

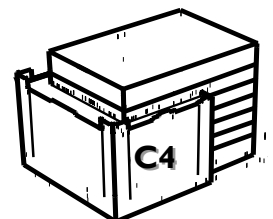
Estimating Emissions Associated with On-Site Electricity Use								
U.S. Power Generation Mix								
Fuel	kWh(1999)	Short Tons	NO <sub>x</sub>	CO <sub>2</sub>	lbm Pollutant, /kWh			
		SO <sub>2</sub>			Particulates	SO <sub>2</sub> /kWh	NO <sub>x</sub> /kWh	CO <sub>2</sub> /kWh
Coal	1.77E+12	1.13E+07	6.55E+06	1.90E+09	1.10E-03	1.28E-02	7.41E-03	2.15E+00
Oil	8.69E+10	6.70E+05	1.23E+05	9.18E+07	1.10E-03	1.54E-02	2.83E-03	2.11E+00
Nat. Gas	2.96E+11	2.00E+03	3.76E+05	1.99E+08	0.00E+00	1.35E-05	2.54E-03	1.34E+00
Nuclear	7.25E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hydro/Wind	3.00E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<b>Totals</b>	<b>3.18E+12</b>	<b>1.20E+07</b>	<b>7.05E+06</b>	<b>2.19E+09</b>	<b>6.42E-04</b>	<b>7.54E-03</b>	<b>4.44E-03</b>	<b>1.38E+00</b>

Source: Electric Power Annual 1999, Vol.II, October 2000, DOE/EIA-0348(99)/2, Energy Information Administration, US DOE, Washington, D.C. 20585-065 <http://www.eia.doe.gov/eneaf/electricity/epav2/epav2.pdf>

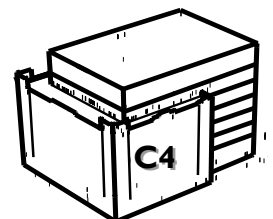
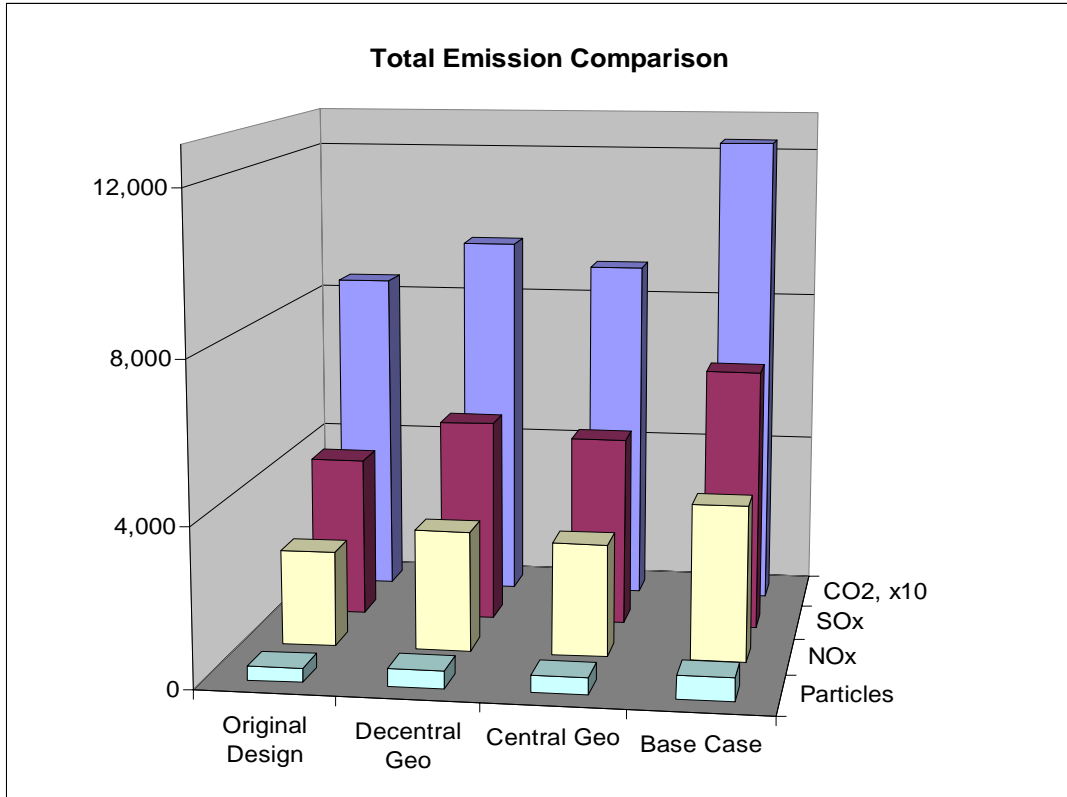
Boiler Emissions				
Defined as	Particles	SOX	NOX	CO2
6 lb/hr*	1.35E-5 lbm/kWh*	60 mg/kWh *	0.566 lb/kw-hr*	
lb/kwhr	0	4.50E-06	2.20E-06	0.566
lb/therm	0	0.000131882	6.46104E-05	16.58782079
	*NJ Code for particles for 1 - 10 mill btuh devices is 6 lb/hr, but there are no expected particles from a	*Assumed from sulfur in fuel and 98% efficient boiler, linear to 30% eff elec producton	*Estimated Nox from Blue Angel Rating	*Molar Balance (2702 MBH input and 609 kw output)
New Jersey Dept of Environmental Protection's only emissions report requirement for the 1-10 mill Btuh boiler range is a particle report. Since the Vessiman boiler specified in the original design is compliant to Blue Angel requirements, those emissions were estimated here for the 96% efficiency rating The same ratings were used for the DHWH.				

## Calculations:

	Electricity						NG Boiler and DHWH				
	Heating, Cooling, Shared Electricity and elec DHWH	Apartment Lights	lb Particulates	lb SO2	lb NO2	lb CO2	Input Therms	Particles	SO2	NO2	CO2
Base Case	548,680	344,925	5.74E+02	6.73E+03	3.97E+03	1.23E+06	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Central Geo	301,117	344,925	4.15E+02	4.87E+03	2.87E+03	8.91E+05	180	0.00E+00	2.37E-02	1.16E-02	2.99E+03
Decentral Geo	346,659	344,925	4.44E+02	5.21E+03	3.07E+03	9.54E+05	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Original Design	201,845	344,925	3.51E+02	4.12E+03	2.43E+03	7.54E+05	5,540	0.00E+00	7.31E-01	3.58E-01	9.19E+04
	Pounds Particles per Year	Pounds SO2	Pounds NO2	Pounds CO2	Pounds CO2 x10	Total Pounds					
Base Case	574	6,734	3,965	1,232,789	12,328	1,244,062					
Central Geo	415	4,869	2,867	894,245	8,942	902,395					
Decentral Geo	444	5,212	3,069	954,088	9,541	962,813					
Original Design	351	4,121	2,426	846,201	8,462	853,100					
	Total kwhr site	Total Mbtu site	Source kwhr	Mbtu Source							
Base Case	548,680	1,872,096	1,646,040	5,616,288							
Central Geo	306,393	1,045,412	908,627	3,100,236							
Decentral Geo	346,659	1,182,802	1,039,978	3,548,407							
Original Design	364,210	1,242,685	767,900	2,620,076							



	Total Decrease of Energy Consumption Over Base Case	Predicted LEED Credit Rating	Decrease In Pounds of Emissions
Base Case	0%	0	0%
Central Geo	27%	2 to 3	27%
Decentral Geo	23%	1 to 2	23%
Original Design	21%	1	31%





### C-5a Utility Bill Calculation Assumptions

#### Apartment Utility Cost Assumptions

Apartment Rating*		Percent of Shared Expenses
2A	7	3.1%
2B	8	3.6%
2C	5	2.2%
2D	6	2.7%
2E	6	2.7%
2F	7	3.1%
6A7A	12	5.4%
6B7B	13	5.8%
6C	10	4.5%
6D	11	4.9%
7C	10	4.5%
7D	11	4.9%

#### Additional Shared Expenses:

One full time management of 6 buildings, costs 50,000/yr and 1700 equipment repairs and replacement

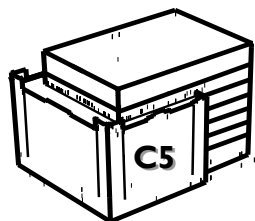
\$ 8,843 yearly, all buildings (except PTHP)

One full time building expense billing job, costs 50,000/yr, can charge 20 full utility buildings and 50 partial utility

\$ 2,500 yearly, BH and Central Geo

\$ 1,000 yearly, PTHP and Decentral Geo

\*Typically, when building fees are charged to condominiums, they are charged on a value basis rather than just a percentage of floor area. Here, arbitrary ratings have been given to each apartment to simulate this to determine the actual utility.



**C-5b Utility Bill Calculations, apartment 2C (1.67% Percent of Floor Area, 2.20% Percent of Building Expenses)**

Rate Structure	Percent of Given Attributed to this Apartment	Consumption Source	Loads Represent	Units	January	February	March	April	May	June	July	August	September	October	November	December	Yearly
residential	1.67%	lighting	all apartments	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	29,295
residential	25.00%	hp cooling	4 apartments	kwhr	536.7	335.2	354.5	186.9	369.3	637.4	710.1	697.1	386.6	193	176.5	557.7	
commerical	2.20%	rooftop unit	whole building	kwhr	890	796	908	602	385	313	353	340	293	481	679	906	
			demand	kw	15	15	15	14	11	11	12	14	8	12	14	15	
commerical	2.20%	Remaining Bldg Elec Cons	whole building	\$	606	546	708	679	701	1457	1499	1504	833	701	680	604	
			demand	kw	66	66	66	66	66	66	65	65	65	66	66	66	
commercial			demand total	kw	81	81	81	80	77	77	77	79	73	78	80	81	
commerical	2.20%	kw demand charge	building	\$	165	165	165	165	165	260	260	260	217	165	165	165	
residential	1.67%	DHWH Electric	building	kwhr	57	53	60	33	0	0	0	0	0	3	38	55	
charges	2.20%	manag and maint	whole building	\$	820	820	820	820	820	820	820	820	820	820	820	820	
			residential total	kwhr	650	551	606	536	581	632	666	663	569	538	535	655	
			residential metering	\$	80	68	74	66	71	80	85	84	72	66	66	80	
			building fees	\$	35	34	37	37	37	56	57	57	41	37	37	35	

**Decentral Geothermal** total monthly **115 101 112 103 108 136 142 141 113 103 103 115 1392**

residential	1.67%	lighting	whole building	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
				kw	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	
commercial	2.20%	Remaining Bldg Elec Cons	building	\$	493	445	493	527	953	2109	2485	2701	1782	644	503	493	
				kw	72	73	72	80	101	118	125	130	116	90	80	72	
commercial	2.20%	demand charge	building	\$	272	272	272	272	272	428	428	428	428	272	272	272	
commercial	2.20%	dhw and boiler	building	\$	807	712	807	295	226	217	224	224	217	244	376	859	
charges	2.20%	manag and maint	whole building	\$	945	945	945	945	945	945	945	945	945	945	945	945	
commerical	2.20%	water	whole building	\$	0	0	0	5	39	128	187	225	82	11	1	0	
			residential total	kwhr	506	458	507	483	489	473	489	489	473	490	485	505	
			residential metering	\$	62	57	63	60	60	60	62	62	60	61	60	62	
			building fees	\$	55	52	55	45	53	81	90	95	74	46	46	57	

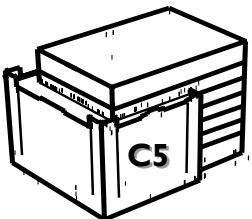
**BH Design** total monthly **118 109 118 105 114 145 156 162 136 107 106 119 1494**

residential	1.67%	lighting	all apartments	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
				kw	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	
commerical	2.20%	Bldg Clg and Htg, Hall lighting	building	\$	644	583	700	600	697	1,483	1,605	1,623	930	631	644	648	
				kw	74	72	78	73	76	83	84	84	82	76	68	77	
commerical	2.20%	rooftop unit	whole building	kwhr	1055	944	1074	737	469	321	318	310	339	608	821	1072	
			demand	kw	16	16	16	15	12	9	10	11	8	13	15	16	
			total demand	kw	90	88	94	88	88	92	94	95	90	89	83	93	
commerical	2.20%	demand charge	building	\$	199	199	199	199	199	312	312	312	312	199	199	199	
commerical	1.67%	DHWH gas	building	therms	34	32	36	20	0	0	0	0	0	2	23	33	
charges	2.20%	manag and maint	whole building	\$	945	945	945	945	945	945	945	945	945	945	945	945	
			residential total	kwhr	506	458	507	483	489	473	489	489	473	490	485	505	
			residential metering	\$	62	57	63	60	60	60	62	62	60	61	60	62	
			building fees	\$	40	39	41	39	41	60	63	63	48	39	40	40	

**Central Geothermal** total monthly **102 95 104 99 101 121 125 126 108 100 100 102 1283**

residential	1.67%	lighting	whole building	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
residential	1.67%	All clg and Htg	building	kwhr	19,160	49,690	19,160	74,637	36,449	42,147	51,131	53,767	33,945	57,677	91,757	19,160	
				apart kwhr	809	1,272	809	1,720	1,098	1,177	1,343	1,387	1,040	1,452	2,006	809	
				kw	57	53	60	33	0	0	0	0	0	3	38	55	
charges	2.20%	manag and maint	whole building	\$	452	452	452	452	452	452	452	452	452	452	452	452	
			residential total	kwhr	837	1,298	839	1,736	1,098	1,177	1,343	1,387	1,040	1,454	2,025	836	
			residential metering	\$	102	157	102	209	133	154	177	183	136	175	243	102	
			building fees	\$	10	10	10	10	10	10	10	10	10	10	10	10	

**Base Case** total monthly **112 167 112 219 143 164 187 193 146 185 253 112 1992**



**C-5b Utility Bill Calculations, duplex 6B7B (3.97%percent of floor area, 5.83% percent of building expenses)**

January February March April May June July August September October November December

Rate Structure	Percent of Given Attributed to this Apartment	Consumption Source	Loads Represent	Units	January	February	March	April	May	June	July	August	September	October	November	December	Yearly
residential	3.97%	lighting	all apartments	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
residential	100.00%	hp cooling	whole apartment	kwhr	339	267.7	306.6	187.4	272.2	426.2	519.7	562.5	424.4	227.7	195	370.9	
commerical	5.83%	rooftop unit	whole building	kwhr	890	796	908	602	385	313	353	340	293	481	679	906	
				kw	15	15	15	14	11	11	12	14	8	12	14	15	
commerical	5.83%	Remaining Bldg Elec Cons	whole building	\$	606	546	708	679	701	1457	1499	1504	833	701	680	604	
			demand	kw	66	66	66	66	66	66	65	65	65	66	66	66	
commercial			commercial demand	\$	81	81	81	80	77	77	77	79	73	78	80	81	
commerical	5.83%	kw demand charge	building	\$	165	165	165	165	165	260	260	260	217	165	165	165	
residential	5.83%	DHWH Electric	building	kwhr	57	53	60	33	0	0	0	0	0	3	38	55	
charges	5.83%	manag and maint	whole building	\$	820	820	820	820	820	820	820	820	820	820	820	820	
				apart kwhr	1600	1410	1573	1371	1436	1553	1684	1726	1551	1397	1387	1629	
				residential metering	193	170	190	165	173	206	223	229	205	169	167	196	
				building fees	93	89	99	97	98	148	150	151	109	98	97	93	

**Decentral Geothermal** total monthly 286 259 288 262 272 353 374 380 314 267 264 289 3609

residential	3.97%	lighting	all apartments	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
				kw	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	
commerical	5.83%	Bldg Clg and Htg, Hall lightin	building	\$	644	583	700	600	697	1,483	1,605	1,623	930	631	644	648	x
				kw	74	72	78	73	76	83	84	84	82	76	68	77	
commerical	5.83%	rooftop unit	whole building	kwhr	1055	944	1074	737	469	321	318	310	339	608	821	1072	
				kw	16	16	16	15	12	9	10	11	8	13	15	16	
			total demand	kw	90	88	94	88	88	92	94	95	90	89	83	93	
commerical	5.83%	demand charge	building	\$	199	199	199	199	199	312	312	312	312	199	199	199	x
commerical	5.83%	DHWH gas	building	\$	34	32	36	20	0	0	0	0	0	2	23	33	x
charges	5.83%	manag and maint	whole building	\$	945	945	945	945	945	945	945	945	945	945	945	945	x
				apart kwhr	1164	1051	1164	1126	1164	1126	1164	1164	1126	1164	1126	1164	
				residential metering	141	127	141	136	141	148	153	153	148	141	136	141	
				building fees	106	103	110	103	107	160	167	168	128	104	106	106	

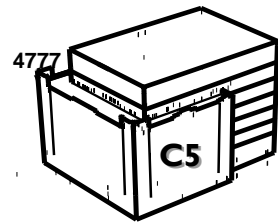
**Central Geothermal** total monthly 247 230 250 239 248 307 319 321 275 244 242 247 3171

residential	3.97%	lighting	whole building	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
				kw	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	
commercial	5.83%	Remaining Bldg Elec Cons	building	\$	493	445	493	527	953	2109	2485	2701	1782	644	503	493	
				kw	72	73	72	80	101	118	125	130	116	90	80	72	
commercial	5.83%	demand charge	building	\$	272	272	272	272	272	428	428	428	428	272	272	272	
commercial	5.83%	dhwh and boiler	building	\$	807	712	807	295	226	217	224	224	217	244	376	859	
charges	5.83%	manag and maint	whole building	\$	945	945	945	945	945	945	945	945	945	945	945	945	
commerical	5.83%	water		\$	0	0	0	5	39	128	187	225	82	11	1	0	
				apart kwhr	1164	1051	1164	1126	1164	1126	1164	1164	1126	1164	1126	1164	
				individual metering	141	127	141	136	141	148	153	153	148	141	136	141	
				building fees	147	138	147	119	142	223	249	264	201	123	122	150	

**BH Design** 5.83% percent of building expenses total monthly 288 266 288 256 283 371 401 416 349 264 259 291 3730

residential	3.97%	lighting	whole building	kwhr	29,295	26,460	29,295	28,350	29,295	28,350	29,295	29,295	28,350	29,295	28,350	29,295	
residential	3.97%	All clg and Htg	building	kwhr	19,160	49,690	19,160	74,637	36,449	42,147	51,131	53,767	33,945	57,677	91,757	19,160	
				apart kwhr	809	1,272	809	1,720	1,098	1,177	1,343	1,387	1,040	1,452	2,006	809	
	3.97%	DHWH Electric	building	kwhr	57	53	60	33	0	0	0	0	0	3	38	55	
charges	5.83%	manag and maint	whole building	\$	452	452	452	452	452	452	452	452	452	452	452	452	
				apart kwhr	1,990	3,085	1,993	4,127	2,610	2,799	3,193	3,298	2,473	3,457	4,813	1,988	
				individual metering	239	370	240	494	313	375	429	443	331	414	575	239	
				building fees	26	26	26	26	26	26	26	26	26	26	26	26	

**Base Case** total monthly 265 396 266 520 339 401 455 469 357 440 602 265





# C-6 First Costs and Construction Breadth

**BH Design**

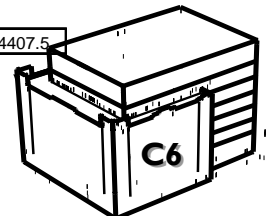
item	Size	Quantity	Crew	Labor Hours	Price, Mat & Instal	Total Labor Hours	Total Price	Location Adjustment
DHWH Gas	550 gpm	2	Q-6	80	44000	160	88000	
Multi Stage Scroll Chillers	110 ton	2	Q-7	190	72500	380	145000	
Centrifugal Cooling Towers	125 ton	2	Q-7	24.43	19000	48.86	38000	
Rooftop AHU	15000 cfm	1	Q-6	61.538	21100	61.538	21100	
Exhaust Fan	815 cfm	5	Q-20	4	635	20	3175	
Exhaust Fan	1450 cfm	9	Q-20	4.762	790	42.858	7110	
Exhaust Fan	2050 cfm	3	Q-20	5	805	15	2415	
Fan Coil Unit	1.5 ton	14	Q-5	2.909	1075	40.726	15050	
Fan Coil Unit	2 ton	13	Q-5	3.048	1325	39.624	17225	
Fan Coil Unit	2.5 ton	22	Q-5	3.2	1875	70.4	41250	
Fan Coil Unit	3 ton	6	Q-5	4	2100	24	12600	
Fin tube Radiators	1 ft	835	Q-5	0.348	50	290.58	41750	
Boiler	1275 MBh	2	Q-7	89.9	18600	179.8	37200	
						1373.386	469875	516862.5

**Central Geothermal**

item	Size	Quantity	Crew	Labor Hours	Price, Mat & Instal	Total Labor Hours	Total Price	Location Adjustment
DHWH	50 gal	30	Q-6	1.6	600	48	18000	
Brazed Plate Heat Exchanger	400 gpm	1	Q-6	30	29700	30	29700	
Pressure Tank		1	PLUM		2000	0	2000	
Rooftop AHU	15000 cfm	1	Q-6	61.538	21100	61.538	21100	
Enthalpy Wheel	20000 cfm	1	Q-10	30	17000	30	17000	
Additional Duct	20000 cfm	2	Q-10	7	10000	14	20000	
Vertical Turbine Pump	500 gpm	1	Q-1	26.23	9075	26.23	9075	
Test well		1	B-23	26.49	4375	26.49	4375	
Well and Casing and screen		2	B-23	333	76500	666	153000	
Humidifier	200 lb/hr	1	Q-5	261	6550	261	6550	
Water to Water Heat Pumps	6 ton	2	Q-7	38.005	7175	76.01	14350	
Water to Water Heat Pumps	30 ton	7	Q-7	96.96	17600	678.72	123200	
Condensor Loop Pump	3 HP	4	Q-1	8	1584	32	6336	
Fan Coil Unit, coil and preheat coil	1.5 ton	14	Q-5	4.3635	1612.5	61.089	22575	
Fan Coil Unit, coil and preheat coil	2 ton	13	Q-5	4.572	1987.5	59.436	25837.5	
Fan Coil Unit, coil and preheat coil	2.5 ton	22	Q-5	4.8	2812.5	105.6	61875	
Fan Coil Unit, coil and preheat coil	3 ton	6	Q-5	6	3150	36	18900	
						2212.113	553873.5	609260.85

**Decentral Geothermal**

item	Size	Quantity	Crew	Labor Hours	Price, Mat & Instal	Total Labor Hours	Total Price	Location Adjustment
DHWH		2	Q-6	80	44000	160	88000	
Brazed Plate Heat Exchanger	400 gpm	1	Q-6	30	29700	30	29700	
Pressure Tank		1	PLUM	10	2000	10	2000	
Rooftop HP	30 ton	2	Q-6	102	23000	204	46000	
Rooftop AHU	10000 cfm	2	Q-6	46.154	15600	92.308	31200	
Enthalpy Wheel	10000 cfm	2	Q-10	26.7	10000	53.4	20000	
Additional Duct	20000 cfm	2	Q-10	7	6000	14	12000	
Vertical Turbine Pump	500 gpm	1	Q-1	26.23	9075	26.23	9075	
Test well		1	B-23	26.49	4375	26.49	4375	
Well and Casing and screen		2	B-23	333	76500	666	153000	
Humidifier	200 lb/hr	1	Q-5	261	6550	261	6550	
Water to air HP	1.5 ton	20	Q-5	8.89	1900	177.8	38000	
Water to air HP	2 ton	19	Q-5	9.412	1975	178.828	37525	
Water to air HP	2.5 ton	4	Q-5	10	2100	40	8400	
						1940.056	485825	534407.5



**Packaged Terminal Heat Pumps**

item	Size	Quantity	Crew	Labor Hours	Price, Mat & Instal	Total Labor Hours	Total Price	Location Adjustment
Packaged Terminal Air Conditioner	12000 Btuh	90	Q-5	4	1400	360	126000	
Split system rooftop unit	50 ton	1	Q-7	213	111000	213	111000	
OA supply ducts	20000 cfm	2	Q-10	15	9000	30	18000	
Exhaust Fan	815 cfm	5	Q-20	4	635	20	3175	
Exhaust Fan	1450 cfm	9	Q-20	4.762	790	42.858	7110	
Exhaust Fan	2050 cfm	3	Q-20	5	805	15	2415	
Exhaust Ducts and Vents	815 cfm	5	Q-10	18	9000	90	45000	
Exhaust Ducts and Vents	1450 cfm	9	Q-10	19	10000	171	90000	
Exhaust Ducts and Vents	2050 cfm	3	Q-10	20	13000	60	39000	
						1001.858	441700	485870

**Crew Hours**

	1 Plum	Q-1	Q-5	Q-6	Q-7	Q-10	Q-20	B-23	Mechanical Schedule Additional Hours	Well Drilling Hours
BH	0	0	465	62	609	0	78	0	0	0
Central Geo	0	58	523	140	755	44	0	692	306	692
Decentral Geo	10	26	261	486	0	67	0	692	-362	692
PTHP	0	0	360	0	213	351	78	0	-212	0

Per Apartment Average

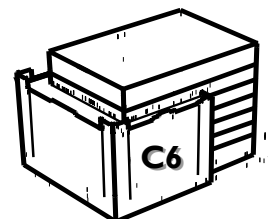
Original Design Mechanical Cost	1,200,000	41,379
Central Geothermal Mechanical Cost	1,292,398	44,565
Decentral Geothermal Mechanical Cost	1,217,545	41,984
Packaged Unitary Mechanical Cost	485,870	16,754

**Conclusion of Construction Study**

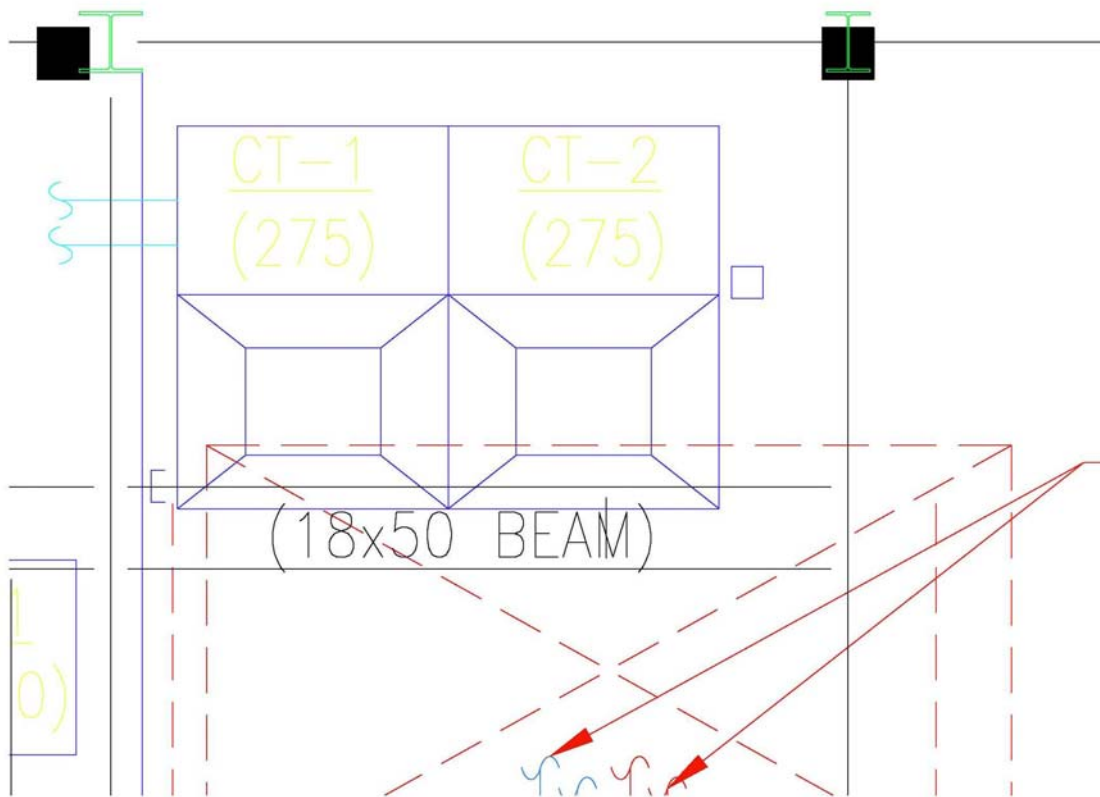
The central geothermal system adds 300 hrs to the mechanical schedule compared to the Buro Happold design, but since these tasks can be done simultaneously, this does not appear to affect the critical path. The wells takes 8 full days to install, and may or may not add several days to the critical path.

The domestic geothermal system takes 400 less hours for the mechanical schedule, but since the mechanical system is not the critical item for finishing, this does not appear to affect the critical path. The wells take 8 full days to install, and may or may not add several days to the critical path.

The total installed costs of the Buro Happold model and the domestic geothermal models are roughly equivalent. The Central Geothermal system could be \$100,000 more due to the extra coils needed in the fan coil units. They are all approximately four times the installed cost of packaged terminal heat pumps.



## Structural Study



The geothermal system does not require cooling towers, which weigh more than 7000 a piece. Since this beam can be likely removed after the cooling tower load is removed, it is an immediate indicator of some of the cost reductions in the structure construction if it were redesigned without the cooling towers.

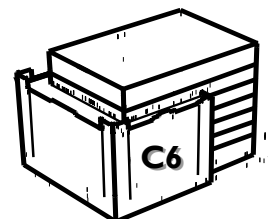
Area of 18x50 beam  
14.7 in<sup>2</sup>

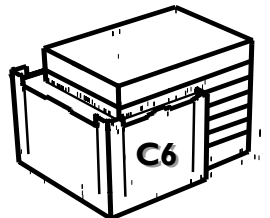
Length of beam  
13' 6.5"

Means cost per linear foot  
44

Work hours to install  
0.088

Predicted Minimum Savings:  
594 dollars  
14 hrs







**C-7 Rooftop unit, Sensible wheel life-cycle costs**

<b>Central Geothermal</b>		January	February	March	April	May	June	July	August	September	October	November	December	Totals	Yearly Savings	Payback Period
with EW	kwhr	18,111	16,200	18,430	12,645	8,052	4,463	4,428	4,315	4,712	10,422	14,088	18,389	134,255		
		29	29	29	24	17	11	12	14	12	19	24	29	29		
	monthly \$	1,055	944	1,074	737	469	321	318	310	339	608	821	1,072	8,066		
	first cost													58100		
without	kwhr	34,513	29,326	35,105	17,868	10,533	5,066	5,017	4,758	5,498	17,085	23,063	39,363	227,196		
		52	51	54	35	24	13	16	18	16	35	43	64	64		
	monthly \$	2,010	1,708	2,045	1,041	614	364	361	342	395	996	1,345	2,295	13,515	5,449	7
	first cost													21100		
<b>Decentral Geothermal</b>																
with EW	kwhr	15,287	13,663	15,579	10,329	6,615	4,352	4,907	4,731	4,083	8,256	11,648	15,543	114,993		
		25	25	25	20	14	12	16	18	10	16	20	25	25		
	monthly \$	890	796	908	602	385	313	353	340	293	481	679	906	6,946		
	first cost													109200		
without	kwhr	30,274	25,661	30,809	15,113	8,149	3,455	4,427	4,233	3,774	11,611	17,299	32,070	186,875		
		45	45	48	30	20	15	23	26	13	23	31	50	50		
	monthly \$	1,763	1,495	1,795	880	475	248	318	304	271	677	1,009	1,870	11,105	4,159	18
	first cost													36000		

This shows that there is not a good pay back on constructing a sensible wheel heat recovery rooftop unit. This is partially because we can only reclaim heat from 50% of our exhaust by code, and because there are no commercially available sensible wheel rooftop units.

