Peak Load Management: Potential Options

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ABSTRACT

This report reviews options that may be alternatives to transmission construction (ATT) applicable both generally and at specific locations in the service area of the Bonneville Power Administration (BPA). Some of these options have potential as specific alternatives to the Shelton-Fairmount 230-kV Reinforcement Project, which is the focus of this study. A listing of 31 peak load management (PLM) options is included. Estimated costs and normalized hourly load shapes, corresponding to the respective base load and controlled load cases, are considered for 15 of the above options. A summary page is presented for each of these options, grouped with respect to its applicability in the residential, commercial, industrial, and agricultural sectors. The report contains comments on PLM measures for which load shape management characteristics are not yet available. These comments address the potential relevance of the options and the possible difficulty that may be encountered in characterizing their value should they be of interest in this investigation. The report also identifies options that could improve the efficiency of the three customer utility distribution systems supplied by the Shelton-Fairmount Reinforcement Project. Potential cogeneration options in the Olympic Peninsula are also discussed. These discussions focus on the options that appear to be most promising on the Olympic Peninsula. Finally, a short list of options is recommended for investigation in the next phase of this study.

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1.0 INTRODUCTION

This is a report on options that may be alternatives to transmission construction (ATT) applicable both generally and at specific locations in the service area of the Bonneville Power Administration (BPA). This document contains the following:

1. a list of 31 peak load management (PLM) options that may have potential as specific alternatives to the Shelton-Fairmount 230-kV reinforcement project described in the BPA Transmission System Facilities, Ten Year Development Plan for the period 1988-1997
2. summaries of 15 of the above measures showing estimated costs and normalized hourly load shapes for the respective base-load and controlled-load cases
3. comments on PLM measures for which load shape management characteristics are not yet available
4. a list, in order of potential cost effectiveness, of options that could improve the efficiency of customer utility distribution systems in the affected area
5. the findings of an examination of software packages for potential alternatives to the CILOC (Conservation-In-Lieu-of-Construction) Code
6. a short list of recommended options that are the primary choices for further investigation.

1.1 PEAK LOAD MANAGEMENT OPTIONS

Alternatives to transmission options are considered to be any conservation or load-management measure together with distribution system improvements that can, in some optimal combination, defer or eliminate the need for additional transmission capacity in a given service area. Table 1.1 lists 31 generic nongenerating PLM measures that should be reviewed for potential value in this study.

1.2 HOURLY BASE LOAD AND CONTROLLED LOAD CURVES

The ATT model known as the CILOC Code, developed previously by The Pacific Northwest Laboratory (PNL) for BPA (Englin et al. 1987), will be used in this study. The model estimates the potential of specific conservation

TABLE 1.1. Conservation and Load Management Options

1. Residential Weatherization Program (RESWX)
2. Super Retrofit Program (similar to Hood River)
3. Currently Proposed Residential Model Conservation Standards (MCS)
4. Enhanced Residential MCS
5. Commercial Light Replacement Program
6. Commercial Ballast or Fixture Replacement Program
7. Commercial EMS Program
8. Currently Proposed Commercial MCS
9. Enhanced Commercial MCS
10. Self-financed Commercial Audits and Measures Installation
11. Commercial Time-of-Day (TOD) Pricing
12. Industrial TOD Pricing
13. Residential TOD Pricing
14. Water Heater Controls
15. Dual Water Heater Control
16. Space Heat Control
17. Whole-house (Smart) Load Limiters
18. Residential Heat Storage
19. Heat Pump Program
20. Commercial Heat Storage
21. Commercial Cool Storage
22. Street Lighting Retrofit
23. Institutional Building Weatherization Program
24. Industrial Motor Replacement
25. Industrial Motor Speed Control
26. Capacitors for Industrial Motors
27. Irrigation Motor Control
28. Irrigation Efficiency Program Lateral Displacement
29. Irrigation Efficiency Program Pump Efficiency Improvement
30. Irrigation Efficiency Program Low Pressure
31. Irrigation Efficiency Program Drip Program

and/or load management (C&LM) measures to reduce or delay the need for new transmission and distribution (T&D) construction required when load growth occurs in part of the system. To evaluate whether each C&LM measure could be a viable ATT option, the model requires, as input, hourly end-use load curves that are representative of each end use. These are referred to as the base-load curves for the end-use load in question. The model also requires input of hourly end-use load curves that represent the effect of applying the C&LM measure(s) under consideration. These curves are referred to as controlled-load curves.

1.3 SELECTED OPTIONS WITH EXISTING HOURLY LOAD DATA

Base-load and controlled-load curves were developed for 15 of the measures shown in Table 1.1 to facilitate studies in the Customer System Efficiency Improvement (CSEI) Project conducted previously by PNL for BPA. Table 1.2 lists these options and compares their peak reduction ratio; initial cost and annual cost per end-use application.

A summary page, including tabulated load shape data, is presented for each of the selected 15 options in Chapters 2.0 through 5.0, grouped with respect to their applicability in the residential, commercial, industrial, and agricultural sectors. In the CSEI study these measures were selected from the list of 31 alternatives to represent the most potentially effective C&LM measures. It would be advisable to review this selection with regard to the needs of the present project. Any measure not among the short list of 15 options would need to be researched to the same level of detail before it could provide useful input to the ATT model (see further comments in Chapter 6.0).

1.4 GENERAL COMMENTS ON SUMMARY PAGE INFORMATION

The base-load curves, shown for each of the selected 15 options, represent hourly end-use electrical loads for a typical, nonholiday weekday in the peak use season. The controlled-load curves were derived from corresponding base-load curves by determining the impact each C&LM option had on its respective end-use load curve. Included in the presentation of each C&LM

TABLE 1.2. Select List of Conservation and Load Management Options

<u>C&LM Option</u>	<u>Peak Reduction Ratio^(a) (Controlled/ Base Load)</u>	<u>Initial Cost (\$)</u>	<u>Yearly Cost (\$)</u>
Residential Weatherization Program	0.72	0 ^(b) /site	0 ^(b) /site
Super Retrofit Program (similar to the Hood River Program)	0.71	59/site	0/site
Currently Proposed Residential MCS	0.72	0 ^(b) /site	0 ^(b) /site
Enhanced Residential MCS	0.57	1,715/site	0/site
Primary Residential Heat Storage	0.0	2450/site	0/site
Backup Residential Heat Storage	0.0	1400/site	0/site
Residential Space Heat Control	0.75	150/site	0.40/site
Residential Gas Back-up Program for Electric Heat Pumps	0.0	1500/site	0/site
Residential Water Heater Control	0.0	150/site	0.40/site
Residential Dual Water Heater Control	0.0	400/site	0.40/site
Residential Whole-house (Smart) Load Limiters	0.8	2500/site	0/site
Commercial Light Replacement Program	0.85	0.89 ^(c) /bulb	0/bulb
Commercial Lighting: Replacement of Ballasts and Lamps	0.65	14 ^(d) /fixture	0/fixture
Agricultural Irrigation Efficiency Program	0.65	0 ^(b) /site	0 ^(b) /site
Capacitors for Industrial Motors	0.82	13.3/hp	0/hp

(a) At hour of original peak.

(b) No additional cost since the program is now in effect

(c) Additional cost when a burned-out 40 watt bulb is replaced. Cost of a new efficient bulb is \$2.64 versus \$1.75 for a standard bulb.

(d) Additional cost when a failed ballast for a 40 watt bulb is replaced. Cost of an energy efficient ballast is \$28.00 versus \$14.00 for a standard ballast.

option is the summary description of the option, specific hourly base and controlled-load information, and cost of the option.

The load curves and C&LM options were evaluated in two steps. The first step was to develop base-load curves representing the hourly load variation of a typical end use. The second step was to derive similar controlled-load curves for each end use, adjusted appropriately to account for the effect of a particular C&LM option.

For consistency in comparison across C&LM measures, all hourly base-load values are normalized to the maximum hourly load value such that the load at the peak hour appears as 1.0 throughout this report. To convert to the actual kW load for any hour, the normalized load is multiplied by a conversion factor equal to the maximum hourly kW load at the peak hour. Conversion factors are reported for each C&LM option analyzed so that the actual kW load for any hour can be easily obtained.

Information relating to the load changing effect of load management options was obtained from several sources. Specific information sources and/or assumptions are documented independently for each of the specific options. However, it is important to note that the 1986 Northwest Conservation and Electric Power Plan (NWPPC 1986) is a principal source of such information.

1.5 BALANCE OF REPORT

Chapter 6.0 contains comments on the measures in Table 1.1 that are not among the 16 selected options. These comments address the potential applicability of these options and the possible difficulty that may be encountered in characterizing their value should they be of interest in this investigation.

Chapter 7.0 contains a list and comments on options that could improve the efficiency of the three customer utility distribution systems supplied by the Shelton-Fairmount reinforcement project. While these options are not expected to contribute a large ATT value, they represent options that should be reviewed to determine their conservation resource value and cost effectiveness in comparison with load-management options.

Chapter 8.0 presents a brief overview of potential cogeneration options. These focus on the options that appear to be most promising on the Olympic Peninsula. One aspect of the overview is that there appears to be a considerable potential for cogeneration in the area. The precise areas where cogeneration is possible ranges from wood products plants to hotels and motels.

Chapter 9.0 contains current recommendations including a short list of recommended options that are the primary, but not necessarily, exclusive, choices for further investigations in this study. In addition, a summary of findings with regard to software tools is included in Chapter 9.0.

2.0 RESIDENTIAL SECTOR

The primary source of residential sector data for the generation of base-case end-use load curves was the hourly end-use database produced by the Pacific Power and Light Company (PP&L). The database was developed by the PP&L Albany-Bend Project in which end uses in approximately 60 residences in Albany and Bend, Oregon were metered from April 1983 to April 1984.^(a) Since most of BPA service area has winter-season peak-power use during weekdays, data for a January 1984 nonholiday weekday were used to develop residential base-load curves. Hourly load models were fitted using regression techniques for three different types of space heating equipment, water heating, and other electricity uses for Albany and for Bend separately. The Albany-Bend areas were analyzed separately (disaggregated) to allow for eastern Oregon (i.e., Bend) and western Oregon (i.e., Albany) regional differences in weather patterns and typical energy use. The fitted models were used with regional average hourly January 1984 temperature data to obtain a set of predicted base-case end-use load curves. Finally, eastern and western Oregon predicted base-case load curves were weighted^(b) and summed to obtain a set of weighted average end-use load curves typical of those in the BPA service area. Thus, given average hourly temperatures for January 1984, a specific residential hourly base-case load value represents the regionally weighted average predicted hourly load.

The development of the heat pump load curve was the one exception to the above methodology. The Albany and Bend heat pump load curves were developed by averaging (i.e., not predicting via a regression model) actual January 1984 weekday loads of customers with heat pumps. Regional weights were then applied to those loads to obtain the base-case weighted-average load curve.

-
- (a) Data from the BPA End-Use Load Conservation Assessment Program (ELCAP) were used in this analysis for the load shapes in the commercial sector.
 - (b) Weights were calculated at PNL by taking the number of residential customers in nongenerating utilities east and west of the Cascade Mountains and dividing each by the total number of residential customers. The eastern weight (0.4471) was applied to the Bend results and the western weight (0.5529) was applied to the Albany results.

2.1 RESIDENTIAL WEATHERIZATION PROGRAM

End use targeted: Space heating in existing residential buildings

Description: Upgrade of weatherization measures

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: NWPPC (1986)

Savings: 45% x average hour load

Peak hour load: 3.374 kW

Cost: Implementation of this program would consist of concentrating the promotion of the current weatherization program in areas where its load control value is most effective in contributing to ATT objectives. The intensified effort in the load control area would be balanced with a decrease in effort in other areas. Therefore, the initial costs of this program are assumed to be zero. Weatherization programs do not incur recurring annual costs.

TABLE 2.1. Residential Weatherization Program Hourly Loads(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.237	13	0.669	0.369
2	0.423	0.233	14	0.617	0.339
3	0.444	0.244	15	0.562	0.309
4	0.468	0.257	16	0.568	0.312
5	0.507	0.279	17	0.635	0.349
6	0.570	0.314	18	0.714	0.393
7	1.822	0.452	19	0.684	0.376
8	1.0	0.550	20	0.626	0.344
9	0.899	0.494	21	0.642	0.353
10	0.814	0.448	22	0.605	0.333
11	0.759	0.417	23	0.487	0.268
12	0.708	0.389	24	0.424	0.233

(a) Normalized to peak hour load; conversion factor = 3.374 kW.

2.2 RESIDENTIAL SUPER RETROFIT PROGRAM

End use targeted: Space heating in existing residential buildings

Description: Upgrade of weatherization measures with the installation of all retrofit weatherization measures identified by the NWPPC (1986, page 5-8).

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: NWPPC (1986)

Savings: 47% x average hour load

Peak hour load: 3.374 kW

Cost: Cost of implementing the program beyond current programs is \$79 per household (NWPPC 1986, Table 5-10).

TABLE 2.2. Residential Super Retrofit Program Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.228	13	0.669	0.355
2	0.423	0.224	14	0.617	0.327
3	0.444	0.235	15	0.562	0.298
4	0.468	0.248	16	0.568	0.301
5	0.507	0.269	17	0.635	0.337
6	0.570	0.302	18	0.714	0.378
7	0.822	0.436	19	0.684	0.363
8	1.0	0.530	20	0.626	0.332
9	0.899	0.476	21	0.642	0.340
10	0.814	0.431	22	0.605	0.321
11	0.759	0.402	23	0.487	0.258
12	0.708	0.375	24	0.424	0.225

(a) Normalized to peak hour load; conversion factor = 3.374 kW.

2.3 CURRENTLY PROPOSED RESIDENTIAL MODEL CONSERVATION STANDARDS

End use targeted: Space heating in new residential buildings

Description: Upgrade of weatherization of new residential buildings with the installation of a set of weatherization measures as identified by the NWPPC (1986, pages 5-11 through 5-26)

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: Office of Conservation, BPA

Savings: 45% x average hour load

Peak hour load: 3.586 kW

Cost: Implementation of this program would consist of concentrating the promotion of the current weatherization program in areas where its load control value is most effective in contributing to ATT objectives. The intensified effort in the load control area would be balanced with a decrease in effort in other areas. Therefore, the initial costs of this program are assumed to be zero. There are no recurring annual costs with this option.

TABLE 2.3. Currently Proposed Residential MCS Hourly Loads(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.237	13	0.669	0.369
2	0.423	0.233	14	0.617	0.339
3	0.444	0.244	15	0.562	0.309
4	0.468	0.257	16	0.568	0.312
5	0.507	0.279	17	0.635	0.349
6	0.570	0.314	18	0.714	0.393
7	0.822	0.452	19	0.684	0.376
8	1.0	0.550	20	0.626	0.344
9	0.899	0.494	21	0.642	0.353
10	0.814	0.448	22	0.605	0.333
11	0.759	0.417	23	0.487	0.268
12	0.708	0.389	24	0.424	0.233

(a) Normalized to peak hour load; conversion factor = 3.586 kW.

2.4 ENHANCED RESIDENTIAL MODEL CONSERVATION STANDARDS

End use targeted: Space heating in new residential buildings

Description: Upgrade of weatherization of new residential buildings with the installation of a set of weatherization measures identified by the NWPPC (1986, Table 5-26).

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: NWPPC (1986)

Savings: 68% x average hour load

Peak hour load: 3.586 kW

Cost: Cost for implementing the program (above the current MCS program) would be \$1715 per structure (NWPPC 1986, Table 5-23). No significant yearly cost after the first year would be incurred.

TABLE 2.4. Enhanced Residential MCS Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.138	13	0.669	0.214
2	0.423	0.135	14	0.617	0.197
3	0.444	0.142	15	0.562	0.180
4	0.468	0.150	16	0.568	0.182
5	0.507	0.162	17	0.635	0.203
6	0.570	0.182	18	0.714	0.228
7	0.822	0.263	19	0.684	0.219
8	1.0	0.320	20	0.626	0.200
9	0.899	0.288	21	0.642	0.205
10	0.814	0.260	22	0.605	0.194
11	0.759	0.240	23	0.487	0.156
12	0.708	0.227	24	0.424	0.136

(a) Normalized to peak hour load; conversion factor = 3.586 kW.

2.5 RESIDENTIAL CERAMIC HEAT STORAGE - PRIMARY SYSTEM

End use targeted: Space heating in new and existing residential buildings

Description: Storage of heat produced overnight for use during the following day. Shifts space heating load to the off peak (nighttime) hours.

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: EPRI (1980)

Savings: With a sufficient sizing or number of units the entire heating load of a residence can be shifted to the 8 hours immediately preceding the beginning of the peak load period. The heat can then be distributed as needed throughout the day. Thus, the sum of all base case hourly loads is divided by 8 and distributed evenly between the hours from 10:00 p.m. to 6:00 a.m..

Peak hour load: 3.374 kW

Cost: The calculated storage requirements of an average home are assumed to be 45.8 kWh, and each storage unit has a capacity of about 6.6 kWh per kW of charging demand (EPRI 1980). Since units are sold on the basis of their charging demand, units drawing a total of 7 kW are assumed to be adequate for an average size home. At \$350/kW, the average cost per site would be \$2450 (deGrasse 1983).

TABLE 2.5. Residential Ceramic Heat Storage Primary System Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	1.886	13	0.669	0.0
2	0.423	1.886	14	0.617	0.0
3	0.444	1.886	15	0.562	0.0
4	0.468	1.886	16	0.568	0.0
5	0.507	1.886	17	0.635	0.0
6	0.570	1.886	18	0.714	0.0
7	0.822	0.0	19	0.684	0.0
8	1.0	0.0	20	0.626	0.0
9	0.899	0.0	21	0.642	0.0
10	0.814	0.0	22	0.605	0.0
11	0.759	0.0	23	0.487	1.886
12	0.708	0.0	24	0.424	1.886

(a) Normalized to peak hour load; conversion factor = 3.374 kW.

2.6 RESIDENTIAL CERAMIC HEAT STORAGE - BACK-UP SYSTEM

End use targeted: Space heating in new and existing residential buildings

Description: Storage of heat produced overnight for use during the following day. Shifts 2-hour space heating load to the off peak (nighttime) hours.

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: EPRI (1980)

Savings: As a back-up system, this measure was assumed to only be required to satisfy the demand of 2 peak hours. The 2-hour space heating load of the peak hours is shifted to the 8 hours immediately preceding the beginning of the peak load period. The heat is then distributed as needed throughout the day.

Peak hour load: 3.374 kW

Cost: It was assumed that 26 kWh would be the maximum heat storage requirement in any 2-hour period (the average undiversified maximum hourly demand from the PP&L database is 12.9 kW) and each storage unit has a capacity of about 6.6 kWh per kW of charging demand (EPRI 1980). Since units are sold on the basis of their charging demand, units drawing a total of 4 kW are assumed to be adequate for an average size home. At \$350/kW, the average cost per site would be \$1400 (deGrasse 1983).

TABLE 2.6. Residential Ceramic Heat Storage Back-up System Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.771	13	0.669	0.669
2	0.423	0.764	14	0.617	0.617
3	0.444	0.784	15	0.562	0.562
4	0.468	0.808	16	0.568	0.568
5	0.507	0.848	17	0.635	0.639
6	0.570	0.910	18	0.714	0.714
7	0.822	0.822	19	0.684	0.684
8	1.0	0.0	20	0.626	0.626
9	0.899	0.0	21	0.642	0.642
10	0.814	0.814	22	0.605	0.605
11	0.759	0.759	23	0.487	0.828
12	0.708	0.708	24	0.424	0.764

(a) Normalized to peak hour load; conversion factor = 3.374 kW.

2.7 RESIDENTIAL DIRECT SPACE HEAT CONTROL

End use targeted: Space heating in new and existing residential buildings

Description: Dispatcher controlled radio signals activate on/off remote control unit affixed to the heating system

Base load data source: PP&L Project for central electric furnaces

Controlled load data source: NWPPC (1986)

Savings: An active system turns off a heating system for 7.5 minutes of each 30 minute interval during the period of peak load on the point of delivery (POD) system. The controlled load shape is obtained by reducing power by 25% (controlling heating 15 minutes per hour) during the peak heating hours between 6:00 a.m. and 9:00 a.m. Payback is needed during noncontrolled periods to compensate for lower heat delivery rates during the direct control period. This compensation is assumed to be a 60% increase of the heating load during the hour preceding the peak period of the control period. This payback takes place in the hours directly following the controlled period. The payback follows a schedule of 20% of the controlled loss in the first succeeding hour and 10% in the second. This schedule assumes a 2.5% loss of consumption that occurs due to an unavoidable lower level of consumption during the control period.

Peak hour load: 3.374 kW

Cost: The cost of installing the controller would be \$150 per site. The annual maintenance cost would be \$0.40 per site.

TABLE 2.7. Residential Direct Space Heat Control Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.431	0.431	13	0.669	0.669
2	0.423	0.423	14	0.617	0.617
3	0.444	0.444	15	0.562	0.562
4	0.468	0.468	16	0.568	0.568
5	0.507	0.507	17	0.635	0.639
6	0.570	0.978	18	0.714	0.714
7	0.822	0.617	19	0.684	0.684
8	1.0	0.75	20	0.626	0.626
9	0.899	0.674	21	0.642	0.642
10	0.814	0.951	22	0.605	0.605
11	0.759	0.827	23	0.487	0.487
12	0.708	0.776	24	0.424	0.424

(a) Normalized to peak hour load; conversion factor = 3.374 kW.

2.B RESIDENTIAL GAS BACK-UP PROGRAM FOR ELECTRIC HEAT PUMPS

End use targeted: Space heating in new and existing residential buildings

Description: Gas fueled back-up heating system to be used in-lieu of an electric resistance system when temperatures are too extreme for efficient heat pump use

Base load data source: PP&L Project for electric heat pump system

Controlled load data source: NWPPC (1986)

Savings: This system allows for a gas heating system's use during the peak demand hours and the use of an efficient heat pump during moderate winter weather and during off-peak hours

Peak hour load: 3.557 kW

Cost: The installed cost for a low efficiency gas furnace is approximately \$1500. No additional cost was assumed for connection to the gas mains since utilities do not charge for the first 80 feet of line and no cost was assumed for the control interface between the gas furnace and the heat pump. However, credit was not taken for the savings resulting from the elimination of the resistance heating unit. It is assumed that these costs are mutually compensatory. These cost estimates are based on information provided by the Cascade Natural Gas Corporation.

TABLE 2.8. Residential Gas Back-up for an Electric Heat Pump Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.696	0.696	13	0.465	0.465
2	0.697	0.697	14	0.478	0.478
3	0.717	0.717	15	0.452	0.452
4	0.778	0.778	16	0.380	0.380
5	0.773	0.773	17	0.492	0.492
6	0.829	0.829	18	0.539	0.539
7	1.0	0.0	19	0.600	0.600
8	0.986	0.0	20	0.708	0.708
9	0.851	0.0	21	0.713	0.713
10	0.839	0.839	22	0.693	0.693
11	0.688	0.688	23	0.769	0.769
12	0.572	0.572	24	0.684	0.684

(a) Normalized to peak hour load; conversion factor = 3.557 kW.

2.9 RESIDENTIAL DIRECT WATER HEATER CONTROL

End use targeted: Conventional electric water heater

Description: Direct control of electric water heaters by on/off radio signals sent to a receiver on the residence's water heater. A POD power dispatcher controls the signal. The system is designed so that a residence's water heater is turned off during the POD peak period.

Base load data source: PP&L Project

Controlled load data source: NWPPC (1986)

Savings: Controlled load is assumed to operate between 6:00 and 9:00 AM. It is also assumed that water heating energy not received during control periods is paid back evenly across the 3 hours following the peak period (i.e., the sum of the losses divided by 3 and added to the normal water heating load for those hours).

Peak hour load: 1.631 kW

Cost: The cost of installing the controller is \$150 per site and the annual maintenance cost is \$0.40 per site.

TABLE 2.9. Residential Direct Water Heater Control Hourly Loads^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.18	0.18	13	0.648	0.648
2	0.152	0.152	14	0.536	0.536
3	0.164	0.164	15	0.448	0.448
4	0.2	0.2	16	0.44	0.44
5	0.208	0.208	17	0.464	0.464
6	0.316	0.316	18	0.64	0.64
7	0.7	0.0	19	0.74	0.74
8	1.0	0.0	20	0.784	0.784
9	0.916	0.0	21	0.732	0.732
10	0.812	1.684	22	0.624	0.624
11	0.72	1.592	23	0.424	0.424
12	0.692	1.564	24	0.12	0.12

(a) Normalized to peak hour load; conversion factor = 1.631 kW.

2.10 RESIDENTIAL DUAL WATER HEATER CONTROL

End use targeted: Conventional electric water heater

Description: Additional water heater installed and direct control of electric water heaters by on/off radio signals sent to a receiver on the residence's water heater. A POD power dispatcher controls the signal. The system is designed so that a residence's water heaters are turned off during the POD peak period.

Base load data source: PP&L Project

Controlled load data source: NWPPC (1986)

Savings: Controlled load is assumed to operate between 6:00 a.m. and noon. It is assumed that because of sufficient hot water storage capacity, which has been doubled by the addition of a second water heating unit, no consumption is lost. The payback of the water heat load lost during the control period is assumed to occur evenly across the 3 hours preceding and the 3 hours following the peak period (i.e., the sum of the losses divided by 6 and added to the normal water heating load for those hours).

Peak hour load: 1.631 kW

Cost: The cost of installing the additional water heater and the controller is \$400 per site. The annual maintenance cost is \$0.40 per site. The cost figures are derived from PNL research and manufacturer data on water heaters.

TABLE 2.10. Residential Dual Water Heater Control Hourly Loads^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.18	0.18	13	0.648	1.455
2	0.152	0.152	14	0.536	1.343
3	0.164	0.164	15	0.448	1.255
4	0.2	1.007	16	0.44	0.44
5	0.208	1.015	17	0.464	0.464
6	0.316	1.123	18	0.64	0.64
7	0.7	0.0	19	0.74	0.74
8	1.0	0.0	20	0.784	0.784
9	0.916	0.0	21	0.732	0.732
10	0.812	0.0	22	0.624	0.624
11	0.72	0.0	23	0.424	0.424
12	0.692	0.0	24	0.12	0.12

(a) Normalized to peak hour load; conversion factor = 1.631 kW.

2.11 RESIDENTIAL SMART WHOLE HOUSE LOAD LIMITERS

End use targeted: Space and water heat, other major electricity end uses

Description: Devices that regulate either a household's instantaneous electrical demand (0 to 5 minute period) or average demand (over a 15 to 60 minute period) by imposing limitations on appliance use in a priority or sequential order. Smart systems are designed to keep the total household load at or below a demand set point selected by the home owner in an appliance regulation scheme.

Base load data source: PP&L Project

Controlled load data source: NWPPC (1986)

Savings: It is assumed that the total household hourly load is restricted to a maximum of 80% of the uncontrolled peak hour load for all hours of the day. The energy which is not consumed during the controlled (i.e., the peak) hours is assumed to be redistributed amongst the nonpeak hours so that total net energy savings are effectively zero.

Peak hour load: 6.353 kW

Cost: The technology is too new to establish a representative cost. However, an energy management system that is less sophisticated costs approximately \$2500 (EPRI 1986). The annual cost is assumed to be zero.

TABLE 2.11. Residential Smart Whole House Load Limiters(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.363	0.363	13	0.711	0.717
2	0.358	0.358	14	0.641	0.641
3	0.379	0.379	15	0.585	0.585
4	0.415	0.415	16	0.579	0.579
5	0.449	0.449	17	0.664	0.674
6	0.523	0.8	18	0.804	0.8
7	0.803	0.8	19	0.807	0.8
8	1.0	0.8	20	0.766	0.766
9	0.919	0.8	21	0.756	0.756
10	0.839	0.8	22	0.679	0.679
11	0.780	0.8	23	0.510	0.510
12	0.743	0.8	24	0.338	0.338

(a) Normalized to peak hour load; conversion factor = 6.353 kW.

3.0 COMMERCIAL SECTOR

The commercial sector is composed of diverse building types used for many different purposes and, consequently, uses electricity in ways that are difficult to characterize. The sector's diversity, along with the paucity of detailed energy-use data, require that load shapes be put together by building type. Unfortunately, there are a limited number of ELCAP-metered buildings in each building type so that end-use load shapes are calculated from a relatively narrow database.

Lighting is a major end use of the total commercial sector load (NWPPC 1986). Recent advancements in the design of lighting systems improve the energy efficiency of lighting. A typical lighting system has the following three basic parts each of which contributes to the energy use of the system: the ballast, the fluorescent tube or lamp, and the fixture. Most commercial lighting systems presently in use already have fluorescent fixtures so fixture replacement is not discussed in this report. The lighting contributions to the total load were estimated by dividing the NWPPC (1986) estimate of yearly lighting energy consumption by annual total electricity consumption.^(a)

For the analyses of the commercial sector, the controlled load was obtained by first determining each building type's normalized average hourly load (i.e., the sum of all normalized base case hourly loads divided by the 24 hours in a day). Next, a percent energy use savings figure was calculated by multiplying a percent estimate of the building type's total load that is the lighting load (NWPPC 1986) by the expected savings of the C&LM option. The percent savings figure was then multiplied by the normalized average hourly load to obtain an average per hour savings figure (i.e., percent

(a) Obtained from the NWPPC via a telephone conversation on October 1, 1986. The NWPPC, in turn, obtained the data from the NWPPC 1986 commercial sector medium-high price driven forecast for the year 1985. The lighting and total electricity use data provided for offices, dry-goods/retail stores, and restaurants in trillion of BTU's are respectively: 10, 33.82; 7.81, 26.93; 1.89, 8.45.

savings x average hour load = average hour load savings). Finally, the controlled load was obtained by subtracting that average load savings from each hour of the day of the normalized base case.

3.1 COMMERCIAL LIGHTING - LIGHT REPLACEMENT PROGRAM

End use targeted: Lighting for three commercial building type categories: offices, dry-goods/retail stores, and restaurants.

Description: Replacement of fluorescent lighting bulbs

Base load data source: BPA End-Use Research Section

Controlled load data source: Moe et al. (1986)

Savings: It should be noted again that the base-load data represents a normalized total (i.e., all end uses combined) hourly load for a representative building of each commercial building type. For office buildings, a 15% savings from a lighting load that is 29.6% of the total load amounts to saving of 4.44% of the total load. For dry-goods/retail stores, a 15% savings from a lighting load that is 29% of the total load amounts to a total load savings of about 4.35%. For restaurants, a 15% savings from a lighting load that is 22.4% of the total load amounts to a total load savings of about 3.36%.

Peak hour load: Office buildings = 1.57 W/ft^2 , dry-goods/retail stores = 1.48 W/ft^2 , restaurants = 1.62 W/ft^2 .

Cost: The cost of a new efficient bulb is \$2.64 versus \$1.75 for a standard bulb. Therefore, the additional cost for a more efficient bulb is \$0.89 when a burned-out 40 watt bulb is replaced.

TABLE 3.1. Commercial Lighting - Office Buildings
Light Replacement Program^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.409	0.347	13	0.978	0.831
2	0.396	0.336	14	0.977	0.831
3	0.380	0.323	15	0.987	0.839
4	0.372	0.316	16	1.000	0.850
5	0.380	0.323	17	0.989	0.841
6	0.392	0.334	18	0.888	0.755
7	0.422	0.358	19	0.771	0.656
8	0.547	0.465	20	0.676	0.575
9	0.806	0.685	21	0.620	0.527
10	1.952	0.809	22	0.551	0.468
11	0.963	0.819	23	0.484	0.412
12	0.977	0.830	24	0.449	0.382

(a) Normalized to peak hour load; conversion factor = 1.57 W/ft^2 .

TABLE 3.2. Commercial Lighting - Dry-Goods/Retail Stores
Light Replacement Program^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.241	0.205	13	0.996	0.847
2	0.237	0.202	14	0.998	0.848
3	0.233	0.198	15	0.999	0.850
4	0.275	0.234	16	1.000	0.850
5	0.276	0.235	17	0.979	0.832
6	0.285	0.242	18	0.791	0.672
7	0.299	0.254	19	0.705	0.599
8	0.426	0.362	20	0.677	0.576
9	0.585	0.497	21	0.564	0.479
10	0.769	0.653	22	0.311	0.264
11	0.864	0.734	23	0.257	0.218
12	0.987	0.839	24	0.246	0.209

(a) Normalized to peak hour load; conversion factor = 1.48 W/ft².

TABLE 3.3. Commercial Lighting - Restaurants
Light Replacement Program^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.439	0.373	13	0.902	0.767
2	0.454	0.386	14	0.899	0.764
3	0.401	0.341	15	0.918	0.780
4	0.267	0.227	16	0.932	0.792
5	0.220	0.187	17	0.949	0.807
6	0.264	0.224	18	1.000	0.850
7	0.378	0.321	19	0.901	0.766
8	0.505	0.430	20	0.848	0.721
9	0.612	0.520	21	0.719	0.611
10	0.634	0.539	22	0.655	0.557
11	0.717	0.609	23	0.585	0.497
12	0.888	0.755	24	0.478	0.406

(a) Normalized to peak hour load; conversion factor = 1.62 W/ft².

3.2 COMMERCIAL LIGHTING - REPLACEMENT OF BALLASTS AND LAMPS

End use targeted: Lighting for three commercial building type categories: offices, dry-goods/retail stores, and restaurants.

Description: Replacement of fluorescent lighting ballasts and lamps

Base load data source: BPA End-Use Research Section

Controlled load data source: Moe (1986)

Savings: The estimated savings from the lighting load of commercial buildings due to the replacement of both ballasts and lamps is 35%. For office buildings, a 35% savings from a lighting load that is 29.6% of the total load amounts to a total load savings of about 10.36%. For dry-goods/retail stores, a 35% savings from a lighting load that is 29.0% of the total load amounts to a total load savings of about 10.15%. For restaurants, a 35% savings from a lighting load that is 22.4% of the total load amounts to a total load savings of about 7.84%.

Peak hour load: Office buildings = 1.57 W/ft^2 , dry-goods/retail stores = 1.48 W/ft^2 , restaurants = 1.62 W/ft^2

Cost: The cost of a new efficient ballast is \$28 versus \$14 for a standard ballast. Therefore, the additional cost for the more efficient ballast is \$14 when a failed ballast is replaced. The additional cost for the more efficient bulb is \$0.89 (\$2.64 versus \$1.75) when a burned-out 40 watt bulb is replaced (Moe 1986).

TABLE 3.4. Commercial Lighting - Office Buildings
Replacement of Ballasts and Lamps^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.409	0.266	13	0.978	0.636
2	0.396	0.257	14	0.977	0.635
3	0.380	0.247	15	0.987	0.642
4	0.372	0.241	16	1.000	0.650
5	0.380	0.247	17	0.989	0.643
6	0.392	0.255	18	0.888	0.578
7	0.422	0.274	19	0.771	0.501
8	0.547	0.356	20	0.676	0.440
9	0.806	0.524	21	0.620	0.403
10	0.952	0.619	22	0.551	0.358
11	0.963	0.626	23	0.484	0.315
12	0.977	0.635	24	0.449	0.292

(a) Normalized to peak hour load; conversion factor = 1.57 W/ft².

TABLE 3.5. Commercial Lighting - Dry-Goods/Retail Stores
Replacement of Ballasts and Lamps^(a)

Hour	Base Load (kW)	Controlled Load (kW)	Hour	Base Load (kW)	Controlled Load (kW)
1	0.241	0.156	13	0.996	0.647
2	0.237	0.154	14	0.998	0.649
3	0.233	0.151	15	0.999	0.650
4	0.275	0.179	16	1.000	0.650
5	0.276	0.180	17	0.979	0.636
6	0.285	0.185	18	0.791	0.514
7	0.299	0.194	19	0.705	0.458
8	0.426	0.277	20	0.677	0.440
9	0.585	0.380	21	0.564	0.366
10	0.769	0.500	22	0.311	0.202
11	0.864	0.562	23	0.257	0.167
12	0.987	0.641	24	0.246	0.160

(a) Normalized to peak hour load; conversion factor = 1.48 W/ft².

TABLE 3.6. Commercial Lighting - Restaurants
Replacement of Ballasts and Lamps^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.439	0.285	13	0.902	0.586
2	0.454	0.295	14	0.899	0.584
3	0.401	0.261	15	0.918	0.597
4	0.267	0.174	16	0.932	0.606
5	0.220	0.143	17	0.949	0.617
6	0.264	0.172	18	1.000	0.650
7	0.378	0.246	19	0.901	0.586
8	0.505	0.328	20	0.848	0.551
9	0.612	0.398	21	0.719	0.467
10	0.634	0.412	22	0.655	0.426
11	0.717	0.466	23	0.585	0.380
12	0.888	0.577	24	0.478	0.311

(a) Normalized to peak hour load; conversion factor = 1.62 W/ft².

4.0 AGRICULTURAL IRRIGATION EFFICIENCY PROGRAM

End use targeted: Electrically driven irrigation systems

Description: Replacement of sprinkler heads with low pressure units thereby reducing the installed horsepower usage or requirements

Base load data source: BPA Division of Power Forecasting

Controlled load data source:

Savings: Current systems operate at approximately 1 kW per rated installed horsepower. This option allows for a potential reduction of electric energy consumption to a level of 650 watts per rated horsepower of motors already in place. Thus, the base loads are reduced to 65% of their base values.

Peak hour load: 1 kW/rated hp

Cost: This option is to be concentrated in areas where its load control value is most effective in contributing to ATT objectives. This intensified effort in the load control area would be balanced by a decrease in effort in other areas. Thus, the initial cost of this program is assumed to be zero. There are no recurring annual costs.

TABLE 4.1. Agricultural Irrigation - Irrigation Efficiency Program^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.948	0.616	13	1.0	0.65
2	0.948	0.616	14	1.0	0.65
3	0.923	0.6	15	0.974	0.633
4	0.923	0.6	16	0.974	0.633
5	0.897	0.583	17	0.974	0.633
6	0.897	0.583	18	0.974	0.633
7	0.897	0.583	19	0.974	0.633
8	0.923	0.6	20	1.0	0.65
9	0.974	0.633	21	1.0	0.65
10	0.974	0.633	22	0.974	0.633
11	1.000	0.65	23	0.974	0.633
12	1.000	0.65	24	0.949	0.616

(a) Normalized to peak hour load; conversion factor = 1 kW/hp.

5.0 INDUSTRIAL MOTOR CAPACITANCE

End use targeted: Chemical, lumber and metal, and total sector electric motors

Description: Capacitance is inserted to enhance the power factor of motors

Base load data source: BPA Division of Power Forecasting and the Tennessee Valley Authority

Controlled load data source:

Savings: Reduces motor load to 82% of its base load

Peak hour load: 20.96 kVA/20 hp

Cost: It was calculated that 6.6534 kVAr of capacitance is needed for correction to a 0.95 power factor. At \$40 per kVAr, the total cost of the correction is \$266.

TABLE 5.1. Industrial Motor Capacitance - Chemical, Metals and Lumber^(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.711	0.583	13	0.907	0.744
2	0.676	0.555	14	0.931	0.764
3	0.673	0.552	15	0.919	0.754
4	0.666	0.546	16	0.892	0.732
5	0.673	0.552	17	0.855	0.701
6	0.725	0.595	18	0.842	0.691
7	0.805	0.660	19	0.870	0.714
8	0.916	0.751	20	0.871	0.715
9	1.000	0.820	21	0.864	0.709
10	0.992	0.814	22	0.850	0.697
11	0.986	0.809	23	0.829	0.680
12	0.954	0.783	24	0.790	0.648

(a) Normalized to peak hour load; conversion factor = 20.96 kVA/20 hp.

TABLE 5.2. Industrial Motor Capacitance - Total(a)

<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>	<u>Hour</u>	<u>Base Load (kW)</u>	<u>Controlled Load (kW)</u>
1	0.880	0.723	13	0.976	0.801
2	0.857	0.703	14	1.000	0.820
3	0.833	0.684	15	1.000	0.820
4	0.833	0.684	16	0.952	0.781
5	0.833	0.684	17	0.952	0.781
6	0.857	0.703	18	0.952	0.781
7	0.952	0.781	19	0.952	0.781
8	1.000	0.820	20	0.952	0.781
9	1.000	0.820	21	0.952	0.781
10	1.000	0.820	22	0.952	0.781
11	0.976	0.801	23	0.928	0.762
12	0.952	0.781	24	0.928	0.762

(a) Normalized to peak hour load; conversion factor = 20.96 kVA/20 hp.

6.0 LOAD MANAGEMENT OPTIONS LACKING DATA

The following discussion relates to ATT options that have been identified but for which there are no readily available information or data that indicate their peak load reduction capabilities in the area of interest. These comments relate to the applicability of the option and/or anticipated level of difficulty in obtaining relevant information.

1. Commercial EMS Program: Unknown value vis-a-vis commercial programs considered in Table 1.2.
2. Enhanced Commercial MCS: It is expected that available assessments of commercial MCS program potential could be adjusted to reflect an enhanced program rather easily.
3. Self-financed Commercial Audits and Measures Installation: Unknown value at present.
4. Commercial TOD Pricing: This option would be likely to involve estimation of price elasticities that could exceed resources of the present study.
5. Industrial TOD Pricing: This option would be likely to involve estimation of price elasticities that could exceed resources of the present study.
6. Residential TOD Pricing: This option would be likely to involve estimation of price elasticities that could exceed resources of the present study.
7. Commercial Heat Storage: Unknown value at present.
8. Commercial Cool Storage: Unknown value at present.
9. Street Lighting Retrofit: There do not appear to be many "large" population or urban centers in the study area, thus it is not expected that this measure would contribute significantly to peak load reduction.
10. Institutional Building Weatherization Program: cursory review suggests that this is not a large resource in comparison to other weatherization options.
11. Industrial Motor Replacement: The industrial base appears to be limited to a number of wood, pulp, and/or paper mills in the region. It is believed that these types of operations run on a continuous basis, 24 hours a day and probably on a fairly constant basis with motors that may have been acquired when energy costs were lower than at present.

The study area may contain an industrial motor stock of lower than currently cost-effective efficiency. This resource should be evaluated to determine its place in the priority of options.

12. Industrial Motor Speed Control: Related to Item 11, motors used in certain processes are either "off" or "on" and generally not fitted with control proportional to load. If the energy saving potential of Option 11 were significant, Option 12 should be considered as an associated measure.
13. Irrigation Motor Control: The study area does not appear to contain a significant amount of irrigated agriculture. This measure would be probably only a small incremental value to other irrigation measures enumerated in Chapter 4.0.

7.0 EFFICIENCY IMPROVEMENT OF CUSTOMER UTILITY SYSTEMS

The CSEI studies, conducted by PNL for BPA, showed that several T&D system improvement measures, including distribution voltage upgrades, conservation voltage regulation (CVR), transformer replacement, reconductoring lines, and capacitor addition, can be cost-effective alternatives to new generating capacity valued at 5 cents/kWh (based on 1985 dollars). The total conservation resource available from efficiency improvements on BPA customer utility systems was estimated to be in the range between 460 and 550 AMW. At the time that analysis was performed, the corresponding total load represented by the utilities studied was the order of 16,000 AMW. The results suggested an average cost-effective conservation resource equal to about 3% of the total end-use load.

Table 7.1 shows sales (latest available at the time of this report) of the three customer utilities affected by the Shelton-Fairmount Project. Assuming that no substantial change has taken place, a first-order estimate of the value of applying CSEI-type measures in this area would be a conservation resource of approximately 2.5 to 3 average megawatts. This is the resource that would potentially offset new generation needs. As ATT options must be valued at approximately one order of magnitude less than alternates to generation, there appears, even from cursory analysis, little value in CSEI measures as ATT options.

There is, however, an important exception to this conclusion. The cost of a large portion of the conservation derived from applying CVR measures is very low (0.001 to 0.1 cent/kWh). Conservation at this level of cost appears to be viable as an ATT option. Similarly, the supply curves PNL

TABLE 7.1. Customer Utility Sales

<u>PUD</u>	<u>Sales (MWh)</u>	<u>Year</u>	<u>Average Megawatts</u>
Mason County #1	44,008	1983	5.02
Mason County #3	374,946	1984	42.80
Clallam County	357,928	1984	40.90

generated for other CSEI options show parts of their respective conservation potential costing less than 1 cent/kWh (Tepel et al. 1987; De Steese et al. 1987). In view of this, there appears to be value in considering the CSEI potential of the following options (in order of expected value) applied specifically to the three PUD systems:

1. CVR
2. distribution voltage increase
3. transformer replacement
4. capacitor addition.

The principal value of these analyses will be to establish the value of the best CSEI measures as ATT options and, therefore, for the first time, to create an ability to rank such options in priority against load management measures. An additional value that can result from such system-specific assessments would be the guidance provided on how far PUD-type utilities have gone in applying conservation measures at the distribution-system level.

8.0 COGENERATION ALTERNATIVES

A technique for deferring peak capacity improvements is through encouraging cogeneration. Cogeneration defers or eliminates the need for increasing the size of the T&D system by providing power from within the grid itself. The use of cogeneration in the area under study depends on both the latent capacity for installation of cogeneration resources and the economic incentives needed to convert that latent capacity into generation resources.

As part of its examination of cogeneration potential BPA has commissioned an assessment of voluntary commercial and industrial cogeneration potential in the Pacific Northwest. That assessment focused on the amount the cogeneration that was likely to be produced in different areas of the Pacific Northwest under different pricing scenarios. The information resulting from that assessment can be used to infer the quantity of industrial cogeneration available in the Olympic Peninsula (BPA 1987).

One difficulty that plagues that report in its application to virtually any peak reduction analysis is that the areas studied will not match precisely with the areas served by a particular T&D system. In that case, the area studied included all of the Olympic Peninsula plus Gray's Harbor and Tacoma. The imperfect geographic match is an important technical limitation to the simple application of the report's findings. Table 8.1 provides a selected listing of the technically feasible megawatts available for the entire area.

TABLE 8.1. Selected Technically Feasible Quantities
of Industrial Cogeneration

<u>SIC Code Group</u>	<u>Cogeneration Potential (MW)</u>
Food Industry	222
Wood Industry	1061
Paper Industry	4950
Restaurants	639
Retail Trade	1573
Office Buildings	772
Hotel/Motel	281
Hospitals	147

As can be seen, nearly 10,000 megawatts are available in the overall area studied. Several observations about the total can be made. First, Tacoma is likely to account for much of the office buildings and retail trade. In addition, a considerable part of the hospitals and food industry is likely to be located in Tacoma. Several large wood and paper product plants are located in Gray's Harbor. The wood products industry cogeneration available to BPA is likely to be considerably less than the total shown in Table 8.1.

If, however, only 5% of the area's cogeneration capacity resided in the study area, nearly 500 megawatts of technically available cogeneration would be possible to draw upon. If a mere 10% of that could be purchased economically, an as yet not well understood criteria, then 50 megawatts of peak demand could be removed from the forecasted needs. Clearly, cogeneration could play a major role in the analysis of peak load reduction options.

9.0 INTERIM RECOMMENDATIONS

From consideration of information in the preceding chapters and from limited knowledge of both the load type and distribution on the Olympic Peninsula, the following measures are considered preferred candidates for further analysis in this project:

1. residential heat storage
2. industrial cogeneration
3. residential water heater controls
4. residential space heat control
5. residential heat pump program.

The above choices reflect an expectation that the highest payback will come from measures that effect load control of the residential contribution to the peak load.

As discussed above, other options are of interest even if their potential contribution is expected to be lower than that of the preferred options. In many cases, ranking of these options against the obviously better choices has not been done before. Some of the less-obviously desirable options should be reviewed, at least at a general level, to determine: 1) where they rank on an overall priority basis and 2) that there are no unusual circumstances that give a particular measure an unexpected advantage. For these reasons the general value of the following measures should be established for the study area:

6. residential dual water heater control
7. enhanced residential MCS
8. residential TOD pricing
9. whole-house (Smart) load limiters
10. commercial heat storage
11. commercial light replacement program

12. commercial ballast or fixture replacement program
13. enhanced commercial MCS
14. industrial motor replacement
15. industrial motor speed control
16. capacitors for industrial motors
17. industrial TOD pricing.

Finally, and for similar reasons, the following CSEI measures should be evaluated at a level of detail sufficient to establish their place in the PLM priority list:

18. CVR
19. distribution voltage increase
20. distribution transformer replacement
21. shunt capacitor addition.

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