Central Maine Power Company
Chapter 321 Methodology Report #2

INTRODUCTION

The Maine Public Utilities Commission (MPUC) sets the rules governing load obligation and settlement calculations in Chapter 321. The Chapter establishes the requirements for reporting the hourly and monthly load obligations of competitive electricity providers operating in Maine to the Independent System Operator - New England (ISO-NE). It also sets forth the conditions for telemetering as well as the general methods and requirements for load profiling, information access, and data transfer.

Chapter 321 Section 9 specifies that utilities file two methodology reports: a report on sampling and data validation, and a report on profiling and load estimation methodology. The first was filed on December 1, 1998 and was accepted by the MPUC. This report is submitted to satisfy the second methodology report requirement in Chapter 321.

BACKGROUND

The necessity for load profiling derives from the settlement functions performed by ISO-NE for competitive electricity providers serving load in New England. ISO-NE compares the hourly demand placed on the system to the resources delivered by each provider. The comparison is for purposes of settling each hourly and monthly capacity and energy market. Thus, accurate load information must be available to the ISO-NE for each hour of a day and for each provider to allocate providers' share of cost. Since most customers do not have hourly metering, load profiling is necessary for the customers to participate in retail choice.

The following sections describe the software that Central Maine Power (CMP) will use to perform the load profiling and settlement function, the load profiling methods that will be used, the calculation for estimating hourly and monthly load obligations, and reporting to ISO-NE and suppliers.

LOAD PROFILING AND SETTLEMENT SOFTWARE

CMP purchased Load Vision, a product of ICF Consulting, Inc., to perform load profiling and load estimation calculations. Load Vision is a profiling, scheduling, and settlement tool that is currently used by utilities and energy suppliers to forecast and settle loads in open access markets. The tool offers many capabilities, one of which is auditability. Information flowing into Load Vision is "time-stamped" so that prior settlement runs can be recalculated at any time. The Load Vision product is being used by all investor owned utilities in Maine.

PROFILING METHODS

The method of load profiling will have a direct impact on the load estimation calculations and consequently on financial settlements at ISO-NE. There are six general types of profiling methods available to estimate hourly loads:

- Dynamic Metering
- Dynamic Modeling
- Proxy Day
- Static
- Calendar Rotation
- Deemed

Dynamic metering is done by installing telemetering on a sample of customers from each profile group. The meters are interrogated daily, providing a profile for the day that represents actual load.

Dynamic modeling is a relationship between load and weather. Typically this would be a regression of the historical load of customers in a sample against the weather that occurred during the time of the load. The regression could be either a daily regression or an hourly regression for any season and day type combination.

Proxy day profiling is accomplished by selecting a day in history that most closely matches the day being estimated. The proxy day can be chosen based on either system load or weather. Actual data from the sample for the selected proxy day is then used to create the profile.

Static profiles are typical day representations for any season and day type combination. Static profiles do not reflect operating conditions of the day being estimated.

Calendar rotation is simply rotating a calendar of historical interval data to reflect the calendar of the time being estimated. Calendar rotation also does not reflect operating conditions of the day being estimated.

The last approach is deemed profiles. Deemed profiles are engineering estimates and are typically used for very predictable loads such as street lights or area lights.

Each of these methods varies in terms of cost, accuracy and predictability. Dynamic is most accurate but also most costly. As you move down the list shown above, the cost decreases but the accuracy decreases as well. Predictability is also extremely important because the financial settlement at ISO-NE will reconcile what was scheduled ahead of time to the after-the-fact load estimation reported by CMP. Predictability helps in this regard. The lower cost methods are the most predictable but the unpredictability gets shifted to the "unaccounted-for energy" (described later). The best method for profiling should strike a balance between cost, accuracy, and predictability.

PROFILE SELECTION CONCERNS FROM STANDARD OFFER BIDDERS

Competitive electricity providers that were interested in bidding on Standard Offer expressed concern that the methodology to derive load profiles would not be available until after their bids were submitted. An additional concern was that each utility could choose a different methodology and thereby increase the complexity to a supplier operating in multiple service territories.

CMP considered the concerns of competitive electricity providers regarding profiling methodology and was interested in meeting suppliers' needs in the transition to a competitive electricity market. However, there was a risk that choosing a method early in the analysis process could result in selection of a methodology that may not be the most accurate. Despite this, CMP and the MPUC supported making a decision in time for Standard Offer bidders to use the information in their bid. Selecting a profiling method during the bid process allowed Standard Offer bidders to have the necessary information to prepare their bids.

SELECTED PROFILING METHODOLOGY

Bangor Hydro-Electric, Central Maine Power, Maine Public Service, and the MPUC agreed that the utilities would use the same load profiling methodology for the three profile groups defined in Chapter 321. Each utility will generate static profiles that represent a typical weekday or typical weekend day for each month of the year for each of the three profile groups. Holidays will be modeled using a weekend profile.

Since CMP is using Load Vision and a static profiling methodology, it is important to understand how Load Vision calculates a static profile. Traditional static profiles are created by simply averaging hourly values for each season and day type combination. However, this results in a flattened load shape. That is, the average load shape's peak is generally too low and the trough is generally too high. Load Vision improves on the traditional calculation by using a rank average method, described in Appendix A. Load Vision's method results in a static profile that more accurately reflects a typical day usage pattern, including the height of the peaks and depth of the troughs.

The static profiling approach is the one of the most straightforward profiling methodologies as well as one of the most predictable. CMP will use a static profiling methodology for the first year of retail competition. During this time, CMP will evaluate other approaches to determine which best balance accuracy, cost, and predictability. A report will be provided to the MPUC by June 2000 that details any recommended changes in profiling methodology or profile groups that would become effective March 1, 2001.

CMP will utilize a deemed profile for unmetered load (street and area lighting). Since street and area lighting load is so consistent and it differs from the three profile groups, it

is reasonable to create another profile type, as allowed by Chapter 321. The profile will be based on the number of daylight hours on the 15th day of each month.

ESTIMATION OF MISSING TELEMETERED DATA

CMP will use actual load for customers that are telemetered (400 kW and above). However, there will be times when the actual data is not available due to problems with remote meter reading equipment and meter malfunctions. In these instances, Load Vision will estimate data based on individual profiles for the telemetered loads. The individual profiles will be calculated using a proxy day that is selected based on system load. Load Vision requires a calendar definition so that only days from the appropriate season/day type are used in selecting the proxy day. CMP will use a calendar of 12 seasons and 7 day types for the proxy day selection. When there is not sufficient historical data on an individual customer to use this calendar definition, CMP will use the next most refined calendar definition based on available load data. The customer's individualized profile will be used only when the actual data is not available. This approach allows the estimate to be based on the customer's actual historical load, not a class profile.

ESTIMATION OF DAILY LOAD

The daily estimation process begins by loading various types of data into Load Vision. The data loading is an automated process and includes system load data, weather data, telemetered load data, load research sample data, account administration data (supplier enrollments and drops) and billing data. Customer meters are read in cycles throughout the month. CMP has 20 cycles; so, approximately 1/20th of all customers will have billing data loaded into Load Vision after each billing cycle. Load research sample data is read on the sampled customer's cycle meter reading. Thus, load research data will be loaded into Load Vision as it becomes available throughout the month.

Once CMP verifies that all available data loaded correctly (using Load Vision's log files), the next step is to calculate the daily load estimate for each supplier. Estimating hourly loads can be more easily understood by seeing the actual calculations Load Vision performs. ICF Consulting, Inc., prepared a description of supplier hourly load calculations. The following steps are based on their documentation, modified to reflect CMP terminology.

The load estimation process can be broken down into four major steps:

- Profiled Load Estimation
- Telemetered Load Determination
- Aggregation of Hourly Loads by Supplier
- Reconciliation of Supplier Hourly Loads

PROFILED LOAD DETERMINATION

Step 1. Determine an hourly profiled load for each customer profile class. A static profile will be used for each of the three profile classes defined in Chapter 321 and a deemed profile will be used for unmetered load.

Step 2. Scale the profiled load by the relevant Loss Factor. The loss factor is assigned to the customer depending on the season and voltage level.

Loss-adjusted Profile Load for customer i by hour h	=	**Profile Load** for customer i by profile class by hour h	**x**	**Loss Factor** for customer i by loss class s

Step 3. Determine each customer's Usage Factor. The Usage Factor (UF) characterizes how the customer's usage relates to the average usage for their profile class. It is defined as the ratio of the metered usage to the aggregate hourly profiled loads for the customer's profile class for a billing period. If a new customer has no historic or billed usage, an hourly Usage Factor of 1.0 will be assigned to that customer.

Usage Factor for customer i by profile class p	=	$\frac{\textbf{Metered Usage for Billing Period i}}{\textbf{Profile Load for Billing period i,p}}$ where Profile Load for Billing Period is the sum of hourly profile loads for the billing period by profile class p assigned to customer i

Step 4. Derive the usage-adjusted profile load for each customer. The usage-adjusted profile is the loss-adjusted profile from Step 2 multiplied by the customer Usage Factor from Step 3.

Usage-Adjusted Profile Load for customer i by hour h	=	**Loss-Adjusted Profile Load** for customer i by profile class p and hour h	**x**	**Usage Factor** for customer i by profile class p

TELEMETERED LOAD DETERMINATION

For a telemetered customer, if interval meter data is available for the day being estimated, the hourly load is the metered usage multiplied by the customer's Loss Factor. The Loss Factor assigned to the customer depends on the season and voltage level.

Hourly Telemetered Load for customer i by hour h	=	**Metered Hourly Usage** for customer i by hour h	x	**Loss Factor** for customer i by loss class

If a telemetered customer's interval data is not available for the day being estimated, the missing data will be estimated using the customer's historical usage and a proxy day profile. The hourly loads using the proxy day profile will be calculated using the method for profiled load detailed above.

AGGREGATION OF HOURLY LOADS BY SUPPLIER

This step aggregates customer hourly loads created in the previous procedures into total loads for each supplier.

$$\textbf{Supplier Hourly Load}_{\text{for Supplier S, for hour h}} = \sum_{i} \textbf{(Hourly Telemetered Load)}_{\text{for customer i assigned to Supplier S by hour h}} + \sum_{i} \textbf{(Hourly Profiled Load)}_{\text{for customer i assigned to Supplier S by hour h}}$$

RECONCILIATION OF SUPPLIER HOURLY LOADS

The reconciliation process is conducted in five steps:

- Determine the difference between the known metered system load and total estimated hourly load
- Determine each Supplier's total profile load
- Calculate each Supplier's profile Load Allocation Ratio
- Allocate the Difference to the supplier's non-telemetered customers using the Load Allocation Ratio, thereby deriving each Supplier's reconciled profile load
- Calculate the Supplier's Hourly Load Obligation as the sum of each supplier's reconciled profile load and telemetered load.

Step 1. Determine the Hourly Load Difference using the hourly system load as the baseline.

Hourly Load Difference	=	**Actual Hourly System Load**	**- Estimated Hourly Load**
by hour h		for hour h	for hour h

Note: The Estimated Hourly Load is the sum of all Supplier Hourly Loads calculated earlier

Step 2. Determine the Supplier profile load. Allocating the Hourly Load Difference to profiled customers only requires that all telemetered loads for a Supplier be subtracted from that Supplier's total hourly load. The resulting value is the Supplier's hourly profile load.

Supplier Hourly Profile Load	=	**Supplier Hourly Load**	**- Total Hourly Telemetered Load**
for Supplier S for hour h		for Supplier S by hour h	for Supplier S by hour h

Step 3. Calculate the Load Allocation Ratio. The Hourly Load Difference from Step 1 is allocated to a Supplier based on the ratio of the Supplier's profile load to the aggregate profile load of all Suppliers.

Load Allocation Ratio	=	**Supplier Hourly Profile Load**	**/*Sum***	**(Total Hourly Profile Load)**
for Supplier S for hour h		for Supplier S by hour h	S	for Supplier S by hour h

Step 4. Allocate the Hourly Load Difference to the Supplier's non-telemetered customers. This reconciliation step distributes the Hourly Load Difference back to the non-telemetered customers using the Load Allocation Ratio. The allocated amount is the product of the Hourly Load Difference and the Load Allocation Ratio. This allocation amount is added to the Supplier's hourly profile load from Step 2 to derive the Reconciled Profile Load.

Reconciled Profile Load =
for Supplier S
for hour h

Supplier Hourly Profile Load	+	**(Hourly Load Difference**	**x**	**Load Allocation Ratio)**
for Supplier S for hour h		for Supplier S for hour h		for Supplier S for hour h

Step 5. Calculate the Supplier Hourly Load Obligation. The Supplier Hourly Load Obligation is the sum of the Supplier's hourly telemetered load and the reconciled profile load from Step 4.

Supplier Hourly Load Obligation = for Supplier S for hour h

Supplier Hourly Telemetered Load for Supplier S for hour h + **Reconciled Profile Load** for Supplier S for hour h

MONTH-END ADJUSTMENTS

After all meter readings for each month have been obtained, CMP will re-estimate the hourly load for the month. The process will be identical to the daily process but the month-end calculation will use available data collected subsequent to the original calculation. The usage factors will be recalculated to reflect each customer's most recent billing period's usage. This usage will better reflect usage during the month being re-estimated. The calculations for the month-end adjustment are the same as described in the daily process: total profiled load with losses is added to total telemetered load with losses and compared to total system load. Any hourly differences are allocated back to suppliers based on their proportion of the total profiled load.

The total month-end energy will also be adjusted to reflect Net Energy Billing customers. Excess generation (or negative usage) cannot be reported in the daily load settlement process but it is possible to adjust the month end numbers to reflect excess generation by net energy billing customers. The adjustment would reduce the supplier's load obligation by the amount of the excess generation and would proportionately increase the load obligation of all other suppliers. The result is that the excess generation will be used to reduce supplier load obligation at ISO-NE in the month the excess occurs. Historically, the average monthly excess generation from Net Energy Billing customers has been less than 0.02% of average monthly energy.

REPORTING

Daily estimates of supplier load obligation will be reported to ISO-NE within 37 hours after the end of the day being reported. The load obligation will be reported by Load Asset ID. CMP will send suppliers their load obligation at the same time it is sent to ISO-NE. Month end numbers will be reported to ISO-NE within 90 days after the end of the month. Month-end numbers will be the revised total energy for the month, reported

by Load Asset ID. CMP will send suppliers their hourly loads that comprise this new estimate within 2 days after reporting to ISO-NE.

SUMMARY

In summary, CMP will use a static profiling methodology for the three profile groups defined in Chapter 321. The profile will represent 12 seasons and 2 day types (weekday and weekend). Holidays will be estimated using a weekend profile. Unmetered load will be estimated using a deemed profile that is determined by the number of daylight hours on the 15th day of each month. Telemetered customers will be settled using their actual load. If the actual data is not available, a proxy day profile for the individual customer will be used. The proxy day will be selected using system load as the determining factor and the calendar representation will be 12 seasons, 7 day types.

APPENDIX
STATIC PROFILING METHODOLOGY

The rank average method Load Vision uses to create typical day or static profiles improves on traditional static profiling methods by preserving the levels of the peaks and valleys in the final load shape. The rank average approach involves various steps that are detailed below. **The following is paraphrased from documentation on Load Vision The example is based on one provided by ICF Consulting, Inc. but modified to reflect CMP's calendar definition and terminology. The example is for illustrative purposes only.**

Step 1: Group Load Research sample meter data based on season and day-type combination.

The load data will be grouped into 12 seasons and 2 day types for each profile group. Holidays will be put into the weekend bin.

Example:

12 Season/2 Day-Type Calendar

Season 1 (January)	Season 7 (July)
Season 2 (February)	Season 8 (August)
Season 3 (March)	Season 9 (September)
Season 4 (April)	Season 10 (October)
Season 5 (May)	Season 11 (November)
Season 6 (June)	Season 12 (December)

Day Type 1 (Weekday): Mon, Tue, Wed, Thurs, Fri
Day Type 2 (Weekend): Sat, Sun, Holiday

Step 2: Create a weighted average of all observations for the profile for each day.

Example:

Weights must be assigned by the user in Load Vision:

Profile	Load Research Meter	Weight
Residential	R123	1
Residential	R456	1
Residential	R789	1

(Note: actual weights will reflect weights assigned to each meter in the sampling process)

Illustrative Observations from the meter:

Load Research Meter	Day	Hour1	Hour2	Hour3	Hour4	…
R123	12/1/98	30	50	40	60	…
R456	12/1/98	35	55	45	65	…
R789	12/1/98	40	60	50	70	…

Result:

Profile	Day	Hour1	Hour2	Hour3	Hour4	…
Residential	12/1/98	35	55	45	65	…
Residential	12/2/98	60	70	50	55	…
Residential	12/3/98	55	70	55	60	…
Residential	12/4/98	32	60	45	50	…

Step 3: Average the load values to create an Average Load Shape

Example:

Season 12, Day-Type 1

Profile	Day	Hour1	Hour2	Hour3	Hour4	…
Residential	12/1/98	35	55	45	65	…
Residential	12/2/98	60	70	50	55	…
Residential	12/3/98	55	70	55	60	…
Residential	12/4/98	32	60	45	50	…

Result:

Profile	Day Type	Hour1	Hour2	Hour3	Hour4	…
Residential	Weekday	45.5	63.75	48.75	57.5	…

Step 4: Sort the load values in descending order to create a Load Duration Curve

Example:

Season 12, Day Type 1

Profile	Day	Hour1	Hour2	Hour3	Hour4	…
Residential	12/1/98	65	55	45	35	…
Residential	12/2/98	70	60	55	50	…
Residential	12/3/98	70	60	55	55	…
Residential	12/4/98	60	50	45	32	…

Step 5: Average the Load Duration Curve values to create an Average Load Duration Curve

Example:

Result:

Profile	Day Type	Hour1	Hour2	Hour3	Hour4	…
Residential	Weekday	66.25.	56.25	50	43	…

Step 6: Map the Average Load Duration Curve to the Average Load Shape

Example:

Average Load Shape:

Profile	Day Type	Hour1	Hour2	Hour3	Hour4	…
Residential	Weekday	45.5	63.75	48.75	57.5	…

Average Load Duration Curve:

Profile	Day Type	Hour1	Hour2	Hour3	Hour4	…
Residential	Weekday	66.25	56.25	50	43	…

Resulting Load Profile:

Profile	Day Type	Hour1	Hour2	Hour3	Hour4	…
Residential	Weekday	43	66.25	50	56.25	…

This approach preserves the same usage pattern as a traditional static profiling approach (the average load shape shown above) but also preserves the level of peaks and troughs obtained through the average load duration curve. The result is a static profile that better represents a "typical day."