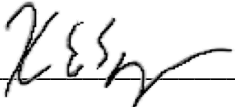
	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	Cover
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

FOREWORD

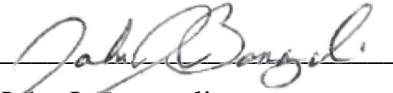
The purpose of this document is to define the process of developing the ten year electric system load forecasts.

Any questions or inquiries regarding information provided in this document should be referred to the Manger, Distribution Engineering.



 Kevin E. Sprague
 Vice President, Engineering

12/17/2021
 Date




 John J. Bonazoli
 Manager, Distribution Engineering

Dec. 15, 2021
 Date

REVISION HISTORY

Revision #	Date	Description of Changes
0	05/26/2009	Original Issue
1	02/10/2016	Revised to Update Procedures
2	11/05/2018	Revised Template, updated to reflect new spreadsheet tools, revised note in 4.1 and updated section 4.4.
3	11/15/2019	Updated to include minimum daytime load projections. All references to Director, Engineering updated to Vice President, Engineering. Revised Updates to Document (section 1.3) to Responsibilities. Removed Request for Procedure/Change Form
4	11/19/2019	Removed load factor forecasting (section 4.5)

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	Cover
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

5	7/2/2021	Updated Minimum Daytime Load Forecasting. Updated to include the incorporation of EV and DER.
6	12/15/2021	Updated saved file locations and removed weather station websites. Revised Minimum Daytime Load Forecasting Process. Incorporated the use of the relationship factor between DER less than 500kW and 500kW or more into the process of incorporating DER into Peak Load Forecasts. Removed reference to Non-Utility Generators (NUG's).



	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	TOC
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

Table of Contents

1.0	Introduction.....	1
1.1	.....Purpose.....	1
1.2	.....Applicability & Scope.....	1
1.3	.....Responsibilities.....	1
1.4	.....Availability.....	1
2.0	General Information.....	1
2.1	.....Abbreviations and Acronyms.....	1
2.2	.....Definitions.....	2
3.0	Base Peak Load Forecasting Methodology.....	3
4.0	Base Peak Load Forecasting Procedure.....	3
4.1	.....Peak Load vs. Weighted Temperature-Humidity Index Model.....	4
4.2	.....Ten Year Historical Boltzmann Peak WTHI Adjustment Model.....	7
4.3	.....Ten Year Base Peak Load System Forecasting Model.....	7
4.4	.....Distributed Energy Resources and Standby Service Agreements.....	8
5.0	Final Electric System Peak Load Forecasts.....	9
5.1	.....Hourly Base Load Forecasts.....	10
5.2	.....Incorporation of DER.....	10
5.3	.....Incorporation of EV.....	11
5.4	.....Final Load Forecasts.....	11
6.0	Minimum Daytime Load Forecasting Methodology.....	11
7.0	System Load Forecast Publications.....	12

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	1
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

1.0 Introduction

This document details the procedures to be followed during the process of developing the ten year electric system load forecasts.

1.1 Purpose

The purpose of this procedure is to assist Distribution Engineering personnel in the process of developing the ten year electric system load forecasts for use in planning system improvements in order to ensure the reliability of the electric system. The following procedure is to be used as a general guide in the mechanics of system load forecasting and outlines the process of data collection, file management, and the statistical analysis used to develop the forecasting models. This guideline is not intended to be an all-inclusive step-by-step procedure and may need to be modified where engineering judgment deems necessary.

1.2 Applicability & Scope

This document applies to the overall system load forecasts for the Unitil electric systems. This procedure is not applicable for forecasting individual distribution circuit loads.

1.3 Responsibilities

This procedure is written and maintained by the Distribution Engineering Department to whom any questions relating to its content or application should be addressed.

1.4 Availability


Current copies of this procedure can be found on the Engineering Department Only Drive. Hard copies are not version controlled.

NOTE: Only up-to-date versions of the documents are posted on the Engineering Department Only Drive. All other revisions (both electronic and hardcopy) should not be referenced.

2.0 General Information

2.1 Abbreviations and Acronyms

DG	Distributed Generation
DER	Distributed Energy Resources
EV	Electric Vehicles

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	2
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

2.2 Definitions

2.2.1 Forecasting Study Period

Unitil has adopted the summer peak period for forecasting purposes. This period is defined as being June 1 – September 30.

2.2.2 Base Peak Load Forecasts

Base Peak Load Forecasts are system load forecasts that are developed based on historical summer load and weather conditions. These load forecasts do not include the incorporation of additional DER or EV penetration above and beyond what is inherent in historical loads.

2.2.3 Average Peak Load

The Average Peak Load levels are used as a guide for general load growth decisions not related to system infrastructure planning. The Average Peak Design Load forecasts are set at a 50% probability limit meaning there is an equal likelihood of that year's peak demand load being either higher or lower than the Average Peak Load level.

2.2.4 Peak Design Load


The Peak Design Load levels are used for the purpose of assessing the adequacy of system infrastructure when performing system planning and contingency studies for the loss of major system elements. The Peak Design Load projections are set at a 90% probability limit. This is intended to roughly equate to a 1-in-10 year likelihood that the Peak Design Load level will be exceeded.

2.2.5 Extreme Peak Load

The Extreme Peak Load levels are used for evaluation of system constraints under these higher conceivable load conditions, but without the loss of major equipment. The Extreme Peak Load projections are set at a 96% probability limit. This is intended to roughly equate to a 1-in-25 year likelihood that the Extreme Peak Load level will be exceeded.

2.2.6 Minimum Daytime Load

The Minimum Daytime Load levels are used for evaluation of system constraints and potential back feed concerns with all generation in-service and without the loss of major equipment. The minimum daytime load is the annual minimum hourly sum of all measured tie point metering and large DG metering between 7AM and 7PM.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	3
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

2.2.7 Statistical Outlier

A Statistical Outlier, for the purposes of this guideline, is considered to be any value greater than 3 standard deviations from the reference value.


3.0 Base Peak Load Forecasting Methodology

The historical basis for each system is a series of yearly regression models developed to correlate actual daily loads to a weighted temperature-humidity index (WTHI) derived from the average temperature and average dew point temperature of each day and the previous two days. Once a model is established, an estimated peak load can be derived for that season for any value of WTHI. There are two dimensions of variability introduced with this modeling. First is the highest WTHI experienced within a season, which varies with short-term weather trends from one year to another. Second is the model estimate of peak load at any specific WTHI. This estimate has its own variation of possibilities due to the influence of other existent factors not incorporated into the model. These variations are characterized as randomness in making future projections. The probability distribution for annual highest WTHI is assumed to follow the discrete distribution of past historical highest WTHI. The random possibilities of peak load outcomes for any specific WTHI are assumed to follow a standard probability distribution model with a mean centered on the point estimate of the peak load at that WTHI and varying based on its individual standard deviation according to the fit of the seasonal model to the actual historical values.

To establish load projections, a Monte Carlo simulation is run to produce random annual highest WTHI and random peak load estimates at those WTHI from each year's seasonal model that makes up the historical basis. Each trial in the simulation is projected forward using linear trending. This results in a range of peak load possibilities for each future year assuming linear growth, and varying due to annual highest WTHI possibilities and variability in loads versus WTHI. The likelihood of specific peak load levels occurring in any particular future year can be estimated from an assumed probability distribution using the mean and standard deviation of the trial results for that year. The Average Peak Load, Peak Design Load and Extreme Peak Load forecasts are set at specific probability limits per the intent of planning guidelines.

4.0 Base Peak Load Forecasting Procedure

The Base Electric System Peak Load Forecasts are developed using three distinct Excel models. Each model and the process of annual updates are described below. Each of the three models builds upon the previous model. Therefore, it is essential that this process be completed in the sequential order given below.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	4
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

4.1 Peak Load vs. Weighted Temperature-Humidity Index Model

The first step in the process is to develop a model of peak load vs. WTHI for the previous year. Unitil utilizes the Boltzmann Curve to model this relationship. Each DOC has a separate Excel spreadsheet file to develop this model. Each file shall be named indicating the DOC and year (e.g. ‘UES Seacoast 2015 - Boltzmann WTHI.xls’). Models are saved in the current year’s forecast folder as shown in the example below:

S:\Departments\Engineering\DepartmentOnly\PLANNING\Electric System Design Forecasts\Electric System Design Forecasts - 2017-2026\Load vs WTHI models

The ‘Data Analysis’ tab of the ‘Boltzmann WTHI’ workbook performs the necessary calculations to develop the load vs. WTHI model and provide upper and lower peak load prediction limits for any given WTHI. Note that conditional formatting is applied to the ‘residual’ column whereby the cell will become highlighted magenta if the absolute value of the difference between the actual measured peak kW and the model’s predicted peak kW for a given WTHI (residual value) is greater than 3 standard deviations of the residual values. The purpose of this formatting is to assist in identifying Statistical Outliers.

The following procedure shall be used as a guide in updating this model:

Obtain daily system peak data for the Forecasting Study Period:


- Tie point metering for each DOC is obtained from the Energy Measurement Information System (EMIS) accessed through WebOps. Data is entered throughout the year into EMIS Excel spreadsheets for Fitchburg Gas & Electric (FG&E) and Unitil Energy Systems (UES). The path to the root directory for these spreadsheets are located in the following directory:

S:\Departments\Engineering\DepartmentOnly\LOADDATA\Load Data by DOC

FG&E and UES have separate sub-directories. Each EMIS spreadsheet file is named indicating the system and year (e.g. EMIS UES 2015.xls)

- A separate tab exists for each individual tie point meter and large DER facility. Peak load data from EMIS is entered into the tab for the respective tie point meter and hourly peak load data is totaled in the ‘Summary’ tabs of each workbook.
- Transpose the summer season daily peak kW load data into the ‘Data’ tab of the ‘Boltzmann WTHI’ workbook.

Obtain daily average temperature and average dew point temperature data for the Forecasting Study Period:

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	5
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

- Obtain daily average temperature and the average dew point temperature from weather stations local to each DOC. The following Weather Underground (www.wunderground.com) weather stations are typically used for each DOC:

UES-Seacoast (Portsmouth)

KPSM – Portsmouth International Airport at Pease

UES-Capital (Concord)

KCON – Concord Municipal Airport

UES-FGE (Fitchburg)

KFIT – Fitchburg Municipal Airport

- Data for the Forecasting Study Period is copied into the weather data spreadsheet for each DOC located in the following directory:

S:\Departments\Engineering\DepartmentOnly\Weather Data

One weather data spreadsheet file is utilized for all three DOCs (e.g. Weather Data 2018.xlsx). There are separate tabs for each DOC and two summary tabs within the spreadsheet. This spreadsheet is used to calculate a 3-day WTHI for each day. The basis for the daily WTHI is the average dry bulb temperature and average dew point temperature of the current day and the previous two days.


The formula below is used to calculate each day's temperature-humidity index is as follows:

$$THI_d = (0.5 * Avg Dry Bulb Temp) + (0.3 * Avg Dew Point Temp) + 15$$

The formula below is used to calculate each day's 3-day WTHI is as follows:

$$WTHI = \left[\frac{10 * THI_d + 5 * THI_{d-1} + 2 * THI_{d-2}}{17} \right] - 55$$

- Copy the daily WTHI from the 'Weather Data' spreadsheet into the 'Data' tab of the 'Boltzmann WTHI' workbook.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	6
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

Update Boltzmann model to eliminate weekends and holidays and Statistical Outliers:


- Create a copy of the ‘data analysis’ tab and remove all weekends and holidays during the Forecasting Study Period.
- Copy the non-holiday weekday data in the date, daily peak kW, and daily WTHI columns into the ‘Data Analysis’ tab of the ‘Boltzmann WTHI’ workbook.
- Delete the previous year’s outliers at the bottom of the workbook and confirm formula ranges refer to the entire data range.

Optimize Boltzmann constants to maximize r-squared (coefficient of determination):

- In the ‘Data Analysis’ tab of the ‘Boltzmann WTHI’ workbook, the constants a1, a2, dx, & x0 in the Boltzmann equation will be optimized by using the Excel Solver add-in to maximize the value SSR/SST (r-squared). The following procedure shall be followed in the sequence given below:
 1. Maximize SSR/SST by varying a1 & a2. Run multiple trials of Solver until the value is maximized.
 2. Maximize SSR/SST by varying dx. Run multiple trials of Solver until the value is maximized.
 3. Maximize SSR/SST by varying x0. Run multiple trials of Solver until the value is maximized.
 4. Maximize SSR/SST by varying all 4 constants. Run multiple trials of Solver until the value is maximized.
 5. Look at the ‘residual’ column of the data set and remove any outliers.
 6. Repeat steps 1-5 until constants are maximized and all outliers have been removed.

Inspect and update charts and graphs:

- Confirm the model’s “goodness of fit” by inspecting charts and graphs.
NOTE: The ‘Residuals’ tab in the ‘Boltzmann WTHI’ workbook shows a graphical depiction of the residual values vs. WTHI. Confirm the plotted residual values are a scatter plot that is generally centered the horizontal axis (approximately an equal number positive and negative points). A steeply sloped scatter plot (positive or negative) may indicate that the model may not represent an accurate load vs. WTHI correlation.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	7
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

- Update chart titles and scales as necessary.

4.2 Ten Year Historical Boltzmann Peak WTHI Adjustment Model

The next step in the forecasting procedure is to consolidate the past ten years of Boltzmann load vs WTHI models, develop linear peak load growth rates for any given daily WTHI, and to trend changes in the Boltzmann constants. This is done using the ‘Boltzmann peak WTHI adjustments’ Excel workbook. Each DOC has a separate Excel spreadsheet file. Each file shall be named indicating the DOC and year (e.g. ‘UES Seacoast 2006-2015 - Boltzmann WTHI.xlsx’). Models are saved in the current year’s forecast folder as shown in the example below:

S:\Departments\Engineering\DepartmentOnly\PLANNING\Electric System Design Forecasts\Electric System Design Forecasts - 2017-2026

The following procedure shall be used as a guide in updating this model:

- Copy the ‘analysis’ tab from the ‘Boltzmann WTHI’ workbook to the ‘Boltzmann Peak WTHI Adjustment’ file. Rename tab to include year.
- Change the confidence interval in the analysis tab to 50%.
- Update cell references and column headings for the Boltzmann model constants a1, a2, dx, x0, and SSR/SST in the ‘analysis summary’ tab.
- Update cell references and column headings in the ‘Growth Rates’ tab as necessary.
- Update cell references and column headings for the upper, lower, and mean prediction limits in the ‘application’ tab.
- Update chart titles and confirm scaling as necessary.


4.3 Ten Year Base Peak Load System Forecasting Model

The final step is forecasting the base peak load levels for specific probability limits which define the Average Peak Load, Peak Design Load and Extreme Peak Load.

This is done using the ‘Monte Carlo w WTHI adjustments’ Excel workbook. Each DOC has a separate Excel spreadsheet file. Each file shall be named indicating the DOC and year (e.g. ‘UES-Seacoast 2006-2015 Monte Carlo WTHI.xlsx’). Models are saved in the current year’s forecast folder as shown in the example below:

S:\Departments\Engineering\DepartmentOnly\PLANNING\Electric System Design Forecasts\Electric System Design Forecasts - 2014-2023

The following procedure shall be used as a guide in updating this model:

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	8
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

- Update the formulas and cell references for the upper and lower predication limits in the ‘Historical Model Average’ tab.
- Update the formulas and cell references for the predicted model mean loads and standard deviations in the ‘Load-vs-Temp Model Data 2’ tab.
- Update the cell references for the model constants in the ‘Load-vs-Temp Model Data 1’ tab.
- Update historical WTHI data to include most recent year in the ‘WTHI Data’ tab.
- Run successive Monte Carlo trials to ensure the model solves and is stable.

Note: There are two Monte Carlo tabs in this workbook; ‘Monte Carlo (working)’ and ‘Monte Carlo (frozen)’. The ‘Monte Carlo (working)’ tab actively updates when calculations are refreshed. All graphs and charts are based off the ‘Trial Results’ tab which references the ‘Monte Carlo (frozen)’ tab. When determining model stability, replace all cell references in the ‘Trial Results’ tab to the ‘Monte Carlo (working)’ tab. Once results are stable and satisfactory, copy the results from the ‘Monte Carlo (working)’ tab into the ‘Monte Carlo (frozen)’ tab and re-reference the ‘Trial Results’ tab to the ‘Monte Carlo (frozen)’ tab to lock the results.


4.4 Distributed Energy Resources and Standby Service Agreements

Distribution Energy Resources (DER) that are operating during peak load conditions will offset system tie point power flows consequently reducing system load forecasts. Therefore, the power offset or produced from all known significant DER units must be accounted for in the load forecasts. The method on how this is accomplished will depend on the configuration of the interconnection. Some common examples are outlined below:

- A customer owned 1 MW natural gas DER is found to be operational during peak load conditions at its full output rating. This interconnection is offsetting the customer’s load only. The interconnection agreement does not allow export onto the distribution system but includes standby service of 1 MW.

Load forecasts are completed based on the system tie point interchange. The standby service amount of 1MW is added to each year’s forecast to account for the customer’s 1MW load offset by the DER.

- A 3 MW PV DER is interconnected at the distribution circuit level and approved as a Qualified Facility permitting 100% export. Export power during the system peak hour was measured to be 2 MW.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	9
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21


The 2MW output of the DER is added to the system tie point interchange prior to forecasting future system loads. This ensures that the loads offset by the DER included in the system forecast.

- A customer has a standby service agreement of 3 MW. The customer is found to be consuming 1 MW during peak load conditions. The 1 MW of load is subtracted from the system tie point interchange. The standby service amount of 3 MW is added to each year’s forecast to account for the customer’s standby service agreement.
- A customer has a standby service agreement of 1 MW and owns a 1.5 natural gas DER. The generator is found to be generating during peak load conditions and is exporting 0.5 MW onto the Unitil system. The exported load of 0.5 MW is added to the system tie point interchange and the standby service amount of 1 MW is added to each year’s forecast to account for the customer’s standby service agreement.
- The aggregate amount of small scale “behind the meter” DER, such as residential inverter based PV interconnections, has significantly increased over the last couple of years. The effect that these interconnections have on future load projections tends to lag the actual load reduction experienced since the forecasting procedure is based on ten years of historical data. Historical comparison of peak day load cycles have shown a “flattening” of the curve during the peak hours in recent years that can be attributed to the amount of PV interconnections that have occurred. Prior to finalizing load projections, the impact of installed PV as well as the aggregate amount of applications being processed should be considered. Engineering judgement should be used to determine if load projections should be reduced due to PV on a case by case basis. It is not anticipated that this process will be required long term since the PV offset will become inherent in the forecasting process over time and once the amount of interconnection applications drops off.

5.0 Final Electric System Peak Load Forecasts

The Final Electric System Peak Design and Extreme Peak load forecasts shall include the incorporation of additional DER and EV penetration that is above and beyond what is inherent in base load projections. Additional DER and EV penetration will not be incorporated into Average Peak load forecasts.

The incorporation of DER and EV is performed in the ‘System Load Forecasts with EV and DER’ Excel workbook.

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	10
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

5.1 Hourly Base Load Forecasts

The first step in the process to incorporate DER and EV into system load forecasts is to develop hourly base load forecasts. Hourly load forecasts are needed to calculate the overall system load forecast as the incorporation of EV and DER may shift the peak hour the system.

Hourly base load forecasts are developed by calculating the average hourly load from the three peak days of the previous three years for each DOC. The average hourly peak load is then normalized to the average peak hour load.

Each hour of normalized average hourly peak load is then multiplied by the base Peak Design and Extreme Peak loads to calculate hourly base load forecasts.

5.2 Incorporation of DER

DER forecasts shall be developed per the Distributed Energy Resource Projection Guideline (GL-DT-DS-12)

To incorporate Unitil's system DER forecast into the System Load Forecasts the projected incremental DER (DER projection minus the in-service DER) shall be used to develop hourly DER projections.

Similar to the hourly base load forecasts normalized hourly peak DER output is calculated using the average hourly DER output of the large DG on the Unitil (all three DOCs) system for three peak days of the previous three years. Each hour of normalized average hourly peak DER output is then multiplied by the projected new DER.


The calculated relationship factor between DER with a nameplate capacity of less than 500kW and DER with a nameplate capacity of 500kW or more is utilized to calculate the expected peak output of the incremental forecasted DER for each hour.

Engineering judgement shall be used to determine a DER inherency factor. This factor is used to reduce the amount of forecasted DER that gets included in the forecast that is in addition to what is inherent in base forecasts. A general starting point is to use:

$$1 - (\text{Year 1 New Projected DER} / \text{Total-In-service DER})$$

The hourly DER projections are then subtracted from the hourly base Design Peak and Extreme Peak Load Forecasts to create system load forecasts with DER and without EV.

Due to the scheduling of the planning cycle system load forecasting shall utilize the previous year's DER forecasts. For example the 2021-2030 DER forecasts shall be incorporated into the 2022-2031 Electric System Load Forecasts. For the purposes of system load forecasting the DER Forecasts for the final year of the

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	11
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
		Supersedes Date:	7/2/21

Electric System Load Forecast period (2031 in the example) should be assumed to be the same percentage increase for the final DER Forecast year and the N-1 final DER Forecast year (percentage increase from 2029 to 2030 in the example).

5.3 Incorporation of EV

EV forecasts shall be developed per the Electric Vehicle Load Projection Guideline (GL-DT-DS-13). The Baseline EV forecasts should be the utilized when incorporating EV into system load projections until Unitil implements proposed EV make-ready, TOU EV rates and other incentive programs to promote EV adoption. At such time, the High Rate EV forecast could be utilized.

The forecasted hourly increase to daily load shall be copied from the calculations tab in the EV projections spreadsheet to the System Load Forecasts with EV and DER spreadsheet.

Engineering judgement shall be used to determine an EV inherency factor. This factor is used to reduce the amount of forecasted EV that gets added to the forecast in addition to what is inherent in base forecasts. With EV penetration in its infancy this factor should be set 100% and should be reduced as EV penetration increases throughout Unitil's system.

The hourly EV projections are then added to the hourly base Design Peak and Extreme Peak Load Forecasts to create system load forecasts with EV and without DER.


As is the case with the incorporation of DER the incorporation of EV projections shall utilize the previous year's EV forecasts. For example the 2021-2030 EV forecasts shall be incorporated into the 2022-2031 Electric System Load Forecasts. For the purposes of system load forecasting the EV Forecasts for the final year of the Electric System Load Forecast period (2031 in the example) should be assumed to be the same percentage increase for the final EV Forecast year and the N-1 final DER Forecast year (percentage increase from 2029 to 2030 in the example).

5.4 Final Load Forecasts

Final System Design Peak and Extreme Peak Load Forecasts are developed by subtracting the hourly DER forecasts from the hourly base Design Peak and Extreme Peak Load Forecasts and adding the hourly EV forecasts. The resulting maximum hourly load forecast for each is the System Peak Design and Extreme Peak Forecasts that incorporates both DER and EV projections.

6.0 Minimum Daytime Load Forecasting Methodology

Ten year minimum daytime load forecasts shall be developed for each of Unitil's electric systems (Fitchburg Gas & Electric, UES-Seacoast, UES-Capital). Minimum daytime

	Engineering Procedures	Procedure No.	PR-DT-DS-08
	Distribution Engineering	Page No.	12
		Revision No.	6
	Electric System Load Forecasting	Revision Date	12/15/21
Supersedes Date:		7/2/21	

load forecasts shall be developed utilizing minimum system load information for the previous three years and the ten year system DER forecasts (without large and utility scale units). For the purposes of minimum daytime load forecasts the load data shall include the output of distributed generation with a nameplate capacity of 500kW or more.

This is done using the ‘System Minimum Daytime Load Forecasting’ Excel workbook. One workbook is utilized for the minimum daytime load forecasts for all three DOCs.

The EMIS Excel spreadsheets shall be utilized to obtain minimum hourly historical daytime load data for each of the past three years for each DOC. This shall be done by summing the hourly interval load data of each tie point meter (transmission interfaces and large DER facilities) to obtain hourly system interval load information. The minimum daytime load shall be the minimum hourly system loads between 7AM and 7PM. Minimum loads associated with large outages and/or exclusionary outage events shall be excluded from this analysis.

Normalized hourly peak DER output for the months included in the historical minimum daytime loads is calculated using the maximum hourly DER output of the large DG on the Unitil (all three DOCs) system for the previous three years. Each hour of normalized maximum DER output is then multiplied by the projected DER (without large and utility scale units).

The workbook multiplies the forecasted DER (without large and utility scale units) by the calculated relationship factor between DER with a nameplate capacity of less than 500kW and DER with a nameplate capacity of 500kW or more to establish the expected peak output of the forecasted DER. The forecasted DER (without large and utility scale units) is then reduced by the percentage of DER output and is subtracted from the historical minimum daytime load for each daytime hour to calculate the forecasted ten year minimum daytime load for each day time hour.

The minimum daytime hourly load projection for each year is utilized as the Minimum Daytime Load Forecast for the year.

7.0 System Load Forecast Publications

A publications shall be issued annually that documents the final system Peak Design, Extreme Peak and Minimum Daytime Load forecasts for each operating company. Average Peak forecasts can be provided upon request and will not be included in the annual publication. The base load forecasts and forecasts with and without DER and/or EV shall be included in the appendices of the publication.