Load Forecaster

Setup Guide

Version 1.1

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Contents

About Load Forecaster

Load Forecaster is a stand alone application that receives required information regarding meteorological forecasts, historical, and actual zone data from the Data Manager application.

You are recommended to view the topic Before You Begin - Workflow, page 5 for information on the proper configuration of Load Forecaster.

The Load Forecaster generates a short term load forecast on an hourly basis typically for the next 12 to 48 hours.

The Load Forecaster is designed to estimate forecasts for models that encompass

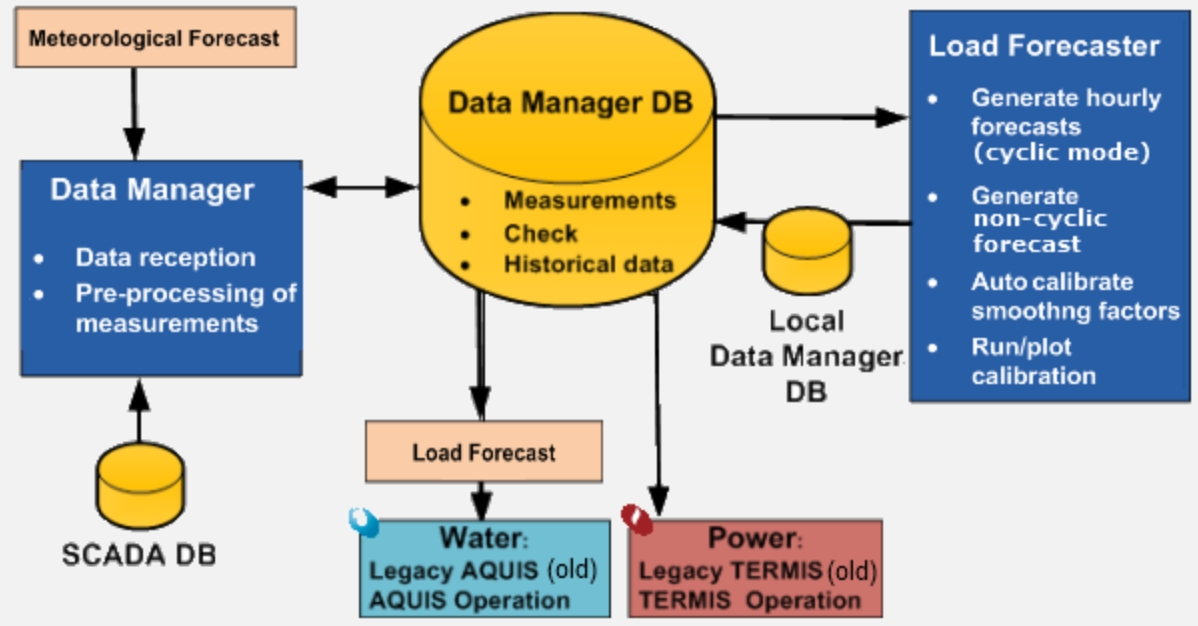
- Power time series (as configured under legacy (old) TERMIS and TERMIS Operation)
- Flow time series (as configured under legacy (old) AQUIS and AQUIS Operation)

You can switch between the two options power and flow on the fly. For details *How To: Switch Between Power or Water Modes, page 27*.

The load forecast model is based on adaptive principles that include

- A typical time dependent term. This is the hot tap water fraction in district heating systems or the hourly variations over the week in water supply systems.
- Power mode: A degree-day model term estimating the required amount of room heating based on a meteorological forecast. This is only used in district heating forecasts.
- A remainder term using a black box approach where both stochastic variation and explanatory factors are taken into account.

The ensuing figure provides an overview of the component and data flow for the Load Forecaster.



The illustration shows (to the left) how data from a SCADA database and meteorological data (for example from a national weather forecast center) are fed into a Data Manager database and processed in the Load Forecaster whereafter the results are sent to either legacy (old) TERMIS/AQUIS or TERMIS/AQUIS Operation.

Next

Before You Begin - Workflow, page 5

How To: Start Load Forecaster Using Recover Application

The Load Forecaster installs as two instances under the installation path in the **Start** menu.

- Load Forecaster
- Load Forecaster (Cyclic)

The two installations are identical, except that the latter (named Load Forecaster (Cyclic)) includes a command line that allows startup in cyclic mode in the event that the Load Forecaster should terminate. By default Load Forecaster automatically loads the last model or session in use.

You must add the Load Forecaster (Cyclic) to the Startup menu folder to enable automatic restart after reboot, if required.

Manual start of Load Forecaster

You can manually start the application in cyclic mode and decide to open

- Last used configuration (database).
- A specific configuration.

Open last session

Open a command prompt and enter **Loadforecaster.exe RECOVER** and press **Enter** on the keyboard.

Open a specific configuration

Open a command prompt and enter **LoadForecaster.exe c:\<folder>\<configuration>.lfc RECOVER** and press **Enter** on the keyboard.

Before You Begin - Workflow

This topic provides a suggested logical flow for the correct configuration of Load Forecaster and Data Manager to handle meteorological, historical, and actual zone data.

The load forecast is stored in a Microsoft Access database (results database) including the two or three terms of the forecast, and a query that includes the total forecast.

Assumptions

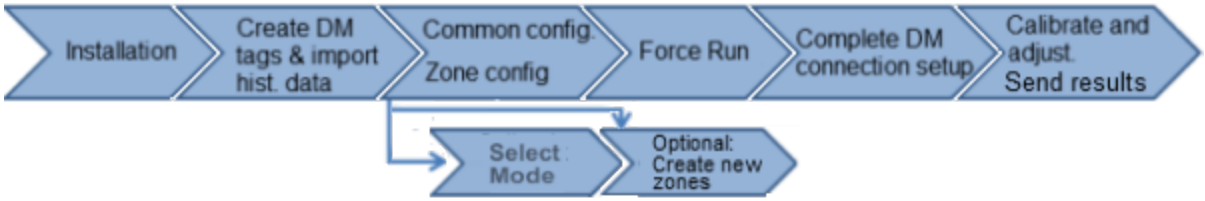
The configuration of Data Manager assumes the following:

- You have working knowledge of Data Manager.
- You have a fully configured Data Manager database with proper setup to access SCADA data and meteorological data. You must create at least one data source tag for each of these data sources.

For general information about handling Data Manager you are referred to the documentation provided with the Data Manager product.

Setup flow - checklist

Each step in the workflow is described in-depth in the documentation. The table in the following suggests a setup approach for the Load Forecaster and there are pointers to topics with details.



Installation

By separate mail you should have received all pertinent information in regards to the installation of Load Forecaster.

In the event that the Load Forecaster terminates due to an error, you can recover from this situation as explained in the topic How To: Start Load Forecaster Using Recover Application, page 4.

Print the ensuing table and use it to help you during the setup process.

Step	Application	What	Steps - or where to find information
1	Data Manager	Create data tags in Data Manager.	a. **Create historical and meteorological tags** for power or water supply in Data Manager. **The tags must correspond to the settings configured for the zone under the Data tab in the Current Zone dialog.** See the instructions under the topic How To: Create Data Tags in Data Manager, page 12. b. Upon completion of tag definitions proceed to step 2.

Step	Application	What	Steps - or where to find information
2	Load Forecaster	Select mode Determine the load forecast for either water (AQUIS Operation) or power (TERMIS Operation).	• From the menu bar select **Help** and select either **Switch to water** or **Switch to power**. Default is **power**. However, the latest saved session mode applies onwards.
3	Load Forecaster	Create new configuration.	a. From the menu bar select **File** and then **New**. The Load Forecaster opens in a blank configuration. The name is later changed from that of unnamed to the name you define for the zone during configuration (see step 4). By default the application opens in Power mode. To change this refer to the topic How To: Switch Between Power or Water Modes, page 27. b. Proceed to step 3.
4	Load Forecaster	Perform Common Configuration.	a. Define basic and required setup configuration. The configuration performed under **Common Configuration** is a prerequisite for the successful connection to Data Manager. For details How To: Perform Common Configuration, page 15. b. Upon completion proceed to step 4.
5	Load Forecaster	Perform Zone Configuration.	a. Perform **zone configuration** and settings to associate forecast data with the Data Manager tags. For details How To: Perform Zone Configuration, page 19. b. Upon completion proceed to step 5. Optional: You can add as many zones to the Load Forecaster configuration as required. **Each zone must be properly configured in Data Manager to ensure a successful transfer of data. See the description under step 7 in this workflow.**
6	Load Forecaster	Perform a Forced Run.	a. Perform a **Forced Run**, Load Forecaster to create the database with the proper format, including tables and queries. Under the Common Configuration you defined

Step	Application	What	Steps - or where to find information
			a connection to the Results Database. For details How To: Run a Forecast, page 25. b. Upon completion proceed to step 6 or go directly to the completing of the Data Manager connection setup to the results database as explained in step 7.
7	Load Forecaster	Perform Auto Calibrate or Calibrate Run.	This is where the rubber meets the road and you can define and adjust the accuracy of the calibration and forecasts. This step is most likely an iterative process until you get the right setup. For details How To: Run a Calibration, page 33. Proceed to step 7.
8	Data Manager	Complete the connection setup of the Data Manager Result Database. Transfer of results.	a. Complete the setup of the **Results database** as explained in the topic How To: Set Up Data Manager Result Database, page 23. As the last step in the configuration of Load Forecaster you transfer the data for power or flow time series first to Data Manager and subsequently to either legacy (old) AQUIS/TERMIS or to the AQUIS/TERMIS Operations products. Naturally, this depends on whether you have run the Load Forecaster for power or water supply.

About Simulation Methods

Load Forecaster supports the following simulation methods.

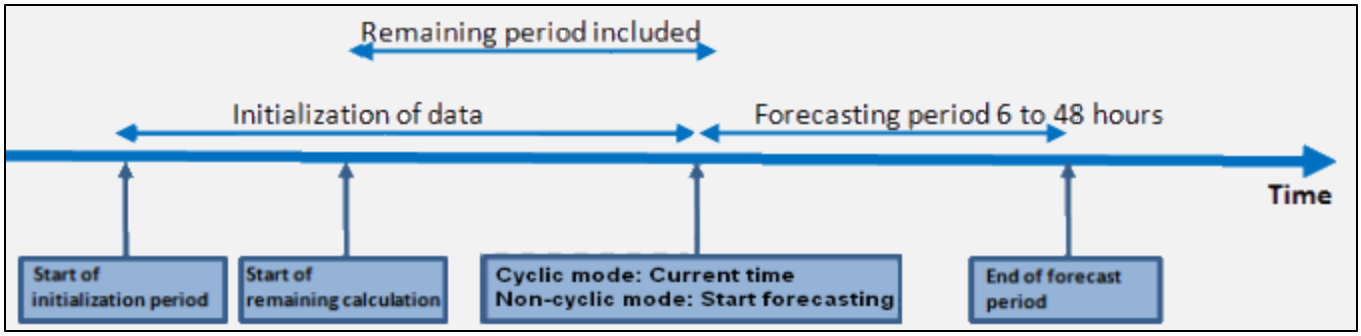
Method	Description
Forced Run	This method creates a non-cyclic load forecast that starts at a date and time defined by you. The method runs for a specified period.
Cyclic simulation	This method starts (or stops) the Load Forecaster in cyclic mode and creates a load forecast at regular intervals defined by you. The cyclic process includes an option to conduct an automated auto-calibration.
Calibration Run	**The method requires historical data for an extended period (several months).** Use this function to conduct a calibration that applies the current defined smoothing factors. This method evaluates the accuracy of the load forecast over a period. The simulation simulates a cyclic operation of Load Forecaster for a period and allows you to compare the estimated load for a time horizon ahead of the pseudo actual time.
Auto-calibration	Load Forecaster is based on three smoothing factors that determine the estimated load forecasts. These factors are configured under the Common Configuration dialog. For details How To: Perform Common Configuration, page 15. Auto-calibration allows you to calculate the best fit of smoothing and other parameters to minimize the root mean square difference of the estimated and measured load as it is calculated using the method Calibration Run. This means that you can select a certain time horizon and range of smoothing factors. Subsequently, the system locates the optimal smoothing factors and defines the best estimate for the given horizon. The auto-calibration is conducted for discrete values of calibration parameters defined by you. The process starts at a minimum value and ends at a maximum value in certain interval steps. You can run several iterations of the calibration and for which the results from the latest iteration is used as basis for the next. However, in doing so the previous interval is reduced to define new min. and max. values and a reduced set of interval steps. This allows you to determine the calibration parameters first at a rough level and second for a fine tuning of the parameters.

Method	Description
	You must use due diligence when you configure the parameters. If you define short time steps and large ranges for min and max values, you risk a heavy performance load on your PC and likely a long time to run the auto-calibration (could be even up to several hours).

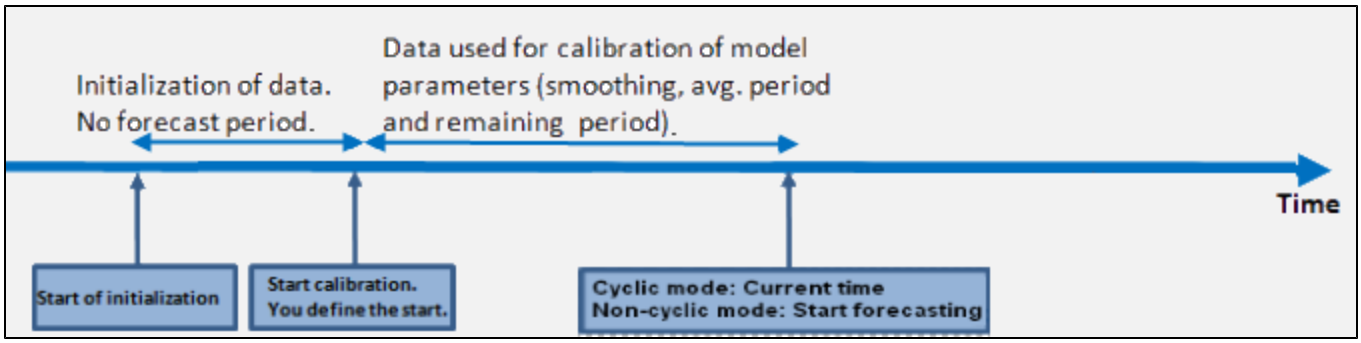
About Time Definition

Load Forecaster operates with different time periods as illustrated in the ensuing two figures.

Time periods used to define initialization and cyclic forecast



Time periods used to define an auto-calibration



You define the following dates /periods:

- Start date/time for a forced run or for a single calibration (defined under the dialog Current Zone).
- Initialization period (defined under the dialog Current Zone).
- Forecasting period (defined under the dialog Current Zone).
- Calibration period (defined in hours under the dialog Common Configuration).
- Remaining period (defined in hours (observations) under the dialog Current Zone).

Load Forecaster moreover applies the following time definitions:

- Temp/wind averaging period.

  For district heating models it is used to define the circumstances in regards to the buildings and their reaction to changing outdoor conditions. The value depends on the building material and insulation.

- Suppression period (days).

  In district heating systems it is used to define a typical switch between a room heating season and no room heating season.

  If the outdoor temperature has been above the reference temperature for the degree day model in this period, then the Load Forecaster ignores the degree day period. This situation stops when the outdoor temperature has been below the reference temperature for the same period.

- Horizon.

  This is used for auto-calibration purposes and marks the time difference between actual time and forecast time.

How To..... in Load Forecaster

The How To.... section provides guidelines to the functionality in the Load Forecaster.

You can find particular areas of interest using Ctrl F.

How To: Create Data Tags in Data Manager

This topic explains how to create the necessary data tags in Data Manager to allow the exchange of historic and meteorological data between Load Forecaster and Data Manager.

For general information about handling Data Manager you are referred to the documentation provided with the Data Manager product.

The tags must correspond to the settings configured for the zone under the Data tab in the Current Zone dialog. The tag type depends on whether you select Power or Water supply.

Before

- Select either Power or Water supply mode in Load Forecaster. Both options are explained in the ensuing.
- You must create a source tag for the data tags to connect to.

  As a minimum define the following options for the source tag

Name	You can choose just to enter a dummy source name at this point in time and then properly configure the source when you configure the results database. For details How To: Set Up Data Manager Result Database, page 23.
Connection type	OLE DB.

To create data tags in Data Manager

1. Open Data Manager and the database that will contain the tags.
2. Create the following data tags according to the ensuing table.

Applying power supply

Historical Data		
Power consumption	Name	Name of tag; for example LF_PH_Power
	Source	SCADA system
	Parameter	Power (W)
	Status	Used directly
Outdoor temperature	Name	Name of tag; for example LF_PH_TempOut
	Source	SCADA system
	Parameter	Temperature (K)
	Status	Used directly
Wind speed	Name	Name of tag; for example LF_PH_Wind
	Source	SCADA system
	Parameter	Velocity (m/s)
	Status	Used directly

Meteorological Data	
Outdoor temperature	Name: Name of tag; for example LF_PM_TempOut Source: Meteorological data (in the form of time series) Parameter: Temperature (K) Status: Used directly
Wind speed	Name: Name of tag; for example LF_PM_Wind Source: Meteorological data (in the form of time series) Parameter: Velocity (m/s) Status: Used directly

Applying water supply

Historical Data	
Water demand	Name: Name of tag; for example LF_WH_Water Source: SCADA system Parameter: Mass flow or Volumetric Flow (m/s) Status: Used directly
Outdoor temperature	Name: Name of tag; for example LF_WH_Wind Source: SCADA system Parameter: Temperature (K) Status: Used directly
Meteorological Data	
Outdoor temperature	Name: Name of tag; for example LF_WM_Out Source: Meteorological data (in the form of time series) Parameter: Temperature (K) Status: Used directly

3. Import historical data into Data Manager for the defined tags with respect to total power, wind speed, and outdoor temperature.

   All data must be defined for an hourly basis and for several months.

4. This completes the first part of the Data Manager configuration.

Create new configuration in Load Forecaster

- Open Load Forecasterand from the menu bar select **File** and then **New**.

  The Load Forecaster opens in a blank configuration. The name is later changed from that of unnamed to the

name you define for the zone during configuration (see step 4 under the topic Before You Begin - Workflow, page 5).

By default the application opens in Power mode. To change this refer to the topic How To: Switch Between Power or Water Modes, page 27.

Proceed to How To: Perform Common Configuration, page 15.

How To: Perform Common Configuration

This topic explains how to perform basic configuration settings in Load Forecaster.

Before

Ensure that you have defined the tags as explained under How To: Create Data Tags in Data Manager, page 12.

To perform basic configuration

1. From the menu bar select **Edit** and then **Common Configuration**.
2. Under the **Common Configuration** dialog you must configure settings under the four tab pages. Each tab page setting is described in-depth in the ensuing.

   The configuration values for day types, holidays, and auto configuration are saved to files and stored in the following location
   My Documents\7T\Load Forecaster\Session

   - General
   - Calibration
   - Day Types
   - Holidays

General

On the **General** tab page you configure the connection to the Data Manager database and determine the cyclic intervals following the guidelines in the ensuing table.

You must configure all fields under the General tab page.

Item	Description
Setup	
Data Manager connection	a. Point to the location of the relevant Microsoft Access database for Data Manager. b. Select the check box for **Use connection string** to define the Data Manager connection using the general OLE DB provider.
Results database connection	c. Define the location of the Microsoft Access database that includes the results. At this point in time the database can just be a dummy database, identified solely by the name under Common Configuration. When you perform a Forced Run, the Load Forecaster creates the database with the proper format, including tables for the forecast and queries for the total forecast.
Cyclic	
Forecast start time	The Load Forecaster is designed to run sequentially every hour or

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td></td><td>full, multiple hours.
d. Define the start time in hours and minutes.
Example:
If the time is defined to 01:10, the period is set to 2 hours, and the actual time is 04:20, then the load forecasts will be generated as follows:<table><tr><td>1st</td><td>5:10</td></tr><tr><td>2nd</td><td>7:10</td></tr><tr><td>3rd</td><td>9:10</td></tr><tr><td>.</td><td></td></tr><tr><td>.</td><td></td></tr></table></td></tr>
<tr><td>Auto-calibration start time</td><td>The Load Forecaster is designed to automatically start an auto-calibration of smoothing factors in a separate thread that will not stop the cyclic thread. A typical setup is to initiate an auto-calibration once per day or once per week.</td></tr>
<tr><td>Period</td><td>Forecast: Define the period between each simulation in cyclic mode.
Auto-calibration: Define the period between each auto-calibration.</td></tr>
</table>

Calibration

You must configure all fields under the Calibration tab page.

Perform configurations for manual and automatic calibrations only following the guidelines in the ensuing table

The values you insert for the calibration are calculated and the results displayed under the current zone.

- To access the current zone setup select **Edit** and then **Current Zone** and view the **Model** tab page.

Item	Description
Horizon	The time difference between actual time and the forecast time, when running an Auto Calibrate or Calibration Run. You can perform several calibrations with different values of horizon. The result is a difference in the smoothing factors. You must then manually select the best fit for your operation. Suggested horizon: 8.
Period	The period for the calibration simulation is conducted to start at the defined time and run for a recommend period of minimum 1 month.

Item	Description
	Suggested period: 672 hours. This is equal to a one (1) month period.
Passes	The number of passes to be conducted in the calibration. For background information see Auto-calibration under Auto-calibration, page 8. The number must be greater than 0.
Calibration ranges (Min - Max - Steps) **You must enter a value for each of the steps Minimum and Maximum - and the Step length.** For values near 1: No historic data. For values near 0.0: Substantial historic data. **) (asterisk) indicates that the entry can be included in the auto-calibration process and will automatically adjust to best fit. In the application this is also marked by an asterisk.*	
Smoothing factor 1 - local trend *)	Enter a value for the smoothing factor for local trend to gauge the daily average change. Suggested steps: 0.001; 0.05; 0.01 Enter a smoothing factor to determine the influence for new measurements relative to old measurements on the actual average level of estimated average level of daily variation, including heat loss from system. Generally speaking, the higher the smoothing factor, the more weight is put on new measurements and hence faster adaptation of the components are obtained. The drawback is a higher degree of sensitivity in regards to the accuracy. This value will normally be in the interval between 0.0 and 0.05.
Smoothing factor 2 - trend slope *)	Enter a value for the smoothing factor for trend slope to gauge the seasonal change over time. Suggested steps: 0.001; 0.005; 0.01
Smoothing factor 3 - day profiles *)	Enter a smoothing factor to determine the influence that new measurements relative to old measurements will have on the estimated day profiles. The value is normally between 0.0 and 0.05. Suggested steps: 0.01; 0.05; 0.12

Day Types

On the Day Type tab page you can define different day types following the guidelines in the ensuing table; or you can

apply the default values (see the ensuing table).

The definition process is based on a week profile that allows you to indicate week days with the equivalent demand profile. The demand profile naturally varies from country to country. As an example the first four days of the week in Scandinavia (Monday, Tuesday, Wednesday Thursday) typically share the same profile whereas Friday may be somewhat different in the demand profile. Saturdays and Sundays also typically share the same profile.

The day type is defined as a simple number between 1 and 7. In addition, you can determine the day type for holidays.

Default values:

Item	Description
Sunday	1
Monday	2
Tuesday	3
Wednesday	3
Thursday	3
Friday	4
Saturday	5
Holiday	1

Holidays

On the Holidays tab page you can define the holiday periods.

Adding holidays

You can add holidays in the following ways:

- Select the date(s) in the calendar and press **Add**. The holidays are added to the file named **Holidays.cfg** in the format **dd/mm/yyyy**.

  You can add multiple days using CTRL + left mouse button.

- Add a new or edit existing **Holidays.cfg** file so that it contains all your relevant holidays.

  Make sure that the date format is **dd/mm/yyyy**.

  You can for example take a file with holidays from Microsoft Outlook and import the data (with the proper date format) into the Holidays.cfg file.

  You can also create country specific holiday files and add to the Load Forecaster. However, the name of the file must still be Holidays.cfg.

Next

How To: Perform Zone Configuration, page 19

How To: Perform Zone Configuration

Under the zone configuration you can make adjustments to the calibration results. The calibration results come from the settings made under the Common Configuration. For details How To: Perform Common Configuration, page 15.

To perform zone configuration

1. a. For new configurations: Under **Name** enter an appropriate name for the zone. This will change the default **unnamed** title to the new title.
1. b. For existing configurations you can either double-click the zone from the list or from the menu bar select **Edit** and then **Current Zone**.
2. Under the **Zone Configuration** dialog you can configure settings under the four tab pages. Each tab page setting is described in-depth in the ensuing.

    - Forecast
    - Model
    - Data
    - Defaults

The tab pages Model, Data and Defaults differ depending on whether you have chosen Power or Water. The ensuing table reflects this distinction.

Forecast

The dialogs for Power and Water are similar.

Item	Description
Forecast (in hours)	The requested look-ahead time for the forecast in hours.
Start time	The start time for the initialization.
Initialization period	This data is used to define the initialization period for available historical data. Data is used in all non-cyclic simulations (Forced Run, Calibration and Auto Calibrate). In cyclic mode the configured end time is ignored and the current system time is used in stead.

Model

This tab is used to define basic parameters for the Load Forecaster model.

Item	Description
Degree Day model (District heating (Power)) only.	
Reference temperature	For any temperature above the reference temperature value, the room heating is defined as zero (no heating is expected).
Coefficient a, b	• a: First basic coefficient of degree day model. Default value: 20 s/K/m. • b: Second basic coefficient of degree day model. Default value: 40 s/K/m.

Item	Description
	For details see the description for degree day model under the topic About Power in District Heating Systems, page 39.
Annual average number	Enter a value for the average number of degree days per day calculated over a year. This number depends on local data. As an example the average number for Scandinavia is typically between 6 and 8.
Suppression period	Define a switch value between the room heating season and no room heating season.
Contribution factor	The contribution factor is a factor that is multiplied on the degree day term (room heating) and in addition considers the accuracy of the calculation of this. Suggested value: The contribution factor will normally be 1.0 or at least between 0.75 and 1.25.
Hot Water Production Modeling - Water demand modeling	
Smoothing factor 1 (local trend)	The value in this field is auto-calibrated per the settings made under the Calibration tab page for Common Configuration for the time dependent terms. If you change the value manually it may be overridden at the next auto-calibration cycle. For details How To: Perform Common Configuration, page 15.
Smoothing factor 2 (trend slope)	The value in this field is auto-calibrated per the settings made under the Calibration tab page for Common Configuration. For details How To: Perform Common Configuration, page 15.
Smoothing factor 3 (day profile)	The value in this field is auto-calibrated per the settings made under the Calibration tab page for Common Configuration For details How To: Perform Common Configuration, page 15.
Update during heating	District heating (Power) only. Select the check box to suppress updates during the heating season. It is possible to suppress the update of the parameters used for hot water production modeling provided the room heating term is positive (which means the heating season).
Remainder	
Smoothing factor 4	Enter a smoothing factor to determine the influence that new measurements relative to old measurements will have on the remainder period.

Item	Description
	Generally speaking, the higher the smoothing factor, the more weight is put on new measurements and the adaptation of the components will be faster. The drawback is of course a higher level of inaccuracy in the results. This value is normally between 1.0 and 0.0. The value 1.0 causes use of only the last set of regression values (fastest).
Remainder modeling observations	The number of observations to be included in the remainder term of the forecast. This term can be removed from the model if the remainder is defined to 0. The recommended value for this term is between 0 and 1440 (60 days worth of hours). The value is a parameter to be calibrated manually when the system is configured.

Data

This tab is used to define references to input measurements and generated forecasts in Data Manager.

Notice the difference from Power to Water.

Item	Description
Historical data - Defines input tag names for the tags defined under Data Manager database as explained in the topic How To: Create Data Tags in Data Manager, page 12. The input assumes a time resolution of one hour.	
Power consumption (Power) Water demand (Water)	Define the tag name of the actual total power/water supplied to the zone, using W for district heating or m3/s for water supply systems in Data Manager.
Outdoor temperature	Define the tag name of the outdoor temperature used for historical values. The values stored in Data Manager must have the unit **K** (Kelvin).
Wind speed	District heating (Power) only. Define the tag name of the speed used for historical values. The values stored in Data Manager must have the unit **m/s** (meters per second).
Meteorological prognosis data - Defines input tag names for meteorological forecast data in the relevant Data Manager database. The time resolution is assumed to be set to one hour.	
Outdoor temperature	Define the tag name of the meteorological forecast outdoor temperature.

Item	Description
	Unit is assumed to be K.
Wind speed	District heating (Power) only. Define the tag name of the meteorological forecast wind speed. Unit is assumed to be m/s.

Defaults

You can set default values under this tab page to be used if the system is unable to run due to incomplete data.

The following rules apply to default values set for **temperature data**

- Data exist: the system applies the last known temperature value.
- Data is non-existing: the system uses 1 degree below the reference temperature.

The following rules apply to default values set for **wind speed data**

- Data exist: the system applies the last known wind speed value.
- Data is non-existing: the system applies 0 m/s.

In Power

Item	Description
Heating	Enter a value for the average heating.
Hot water	Enter a value for the annual hot water production.
Use	Select the check box for the option that applies to use the defined values.

How To: Set Up Data Manager Result Database

This topic explains how to create the results tags that enable you to store the results from the Load Forecaster.

The load forecast is stored in a Microsoft Access database (results database) including the two or three terms of the forecast, and a query that includes the total forecast.

For general information about handling Data Manager you are referred to the documentation provided with the Data Manager product.

To create results tags in Data Manager

1. Open the database that contains data tags for the historical and meteorological data.
2. Complete the configuration for the data source that you previously created for the data tags to connect to.

Configure	Definition
Source name	Enter a name that is easy to identify in regards to Load Forecaster. For example LoadForecaster.
Connection type	OLE DB
Connection string	Select the database you define for the Results database under the **Common Configuration** dialog for the Data Manager connection. Test the connection before you proceed.

3. Open the tag defined with the parameter **Power** that you created previously.
4. On the **Extract** tab page select **SQL** and enter the following connection string

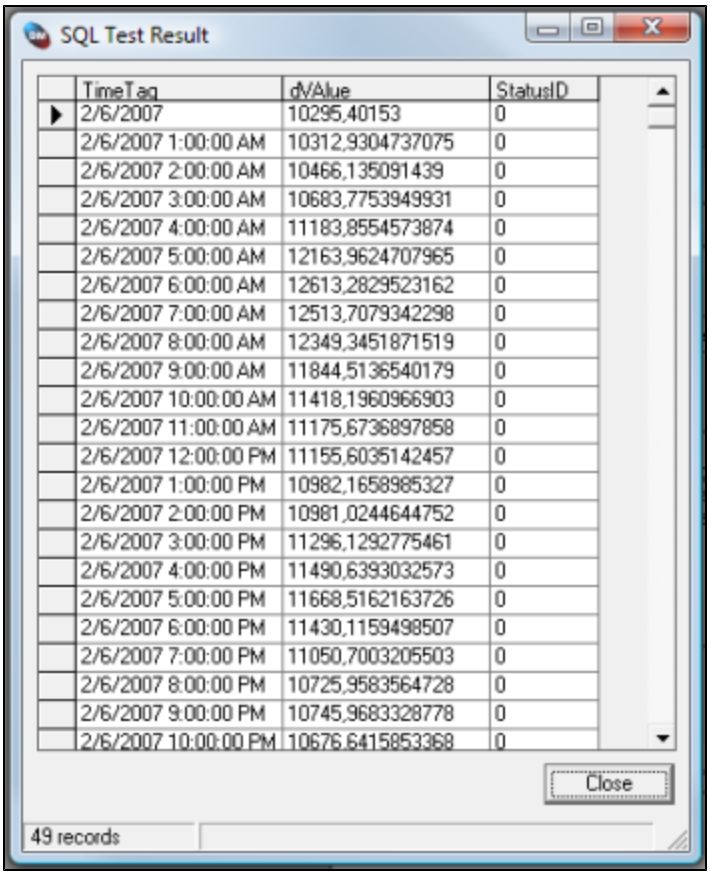
   SELECT qryLFHeating.Time AS TimeTag, qryLFHeating.[Total Power]/1000 AS dVAlue, 0 AS StatusID

   FROM qryLFHeating

   WHERE (((qryLFHeating.Name)="**ZONE NAME**"))

   ORDER BY qryLFHeating.Time;

   You must replace the bold ZONE NAME with the zone defined in Load Forecaster.
5. Test the connection.
6. If the connection is successful, Data Manager displays the number of selected records.



7. On the **Conversion** tab define a conversion factor, if required.
    - For Power select unit **W** (for legacy (old) TERMIS or TERMIS Operation).
    - For Water select unit **kg/s** (for legacy (old) AQUIS or AQUIS Operation).
8. On the **Other** tab
    - Select the check box **Store historical data**.
    - Under the heading **Data insert mode** select the check box **Replace**.
9. **Important**: Repeat the **steps 4 through 8** for all the zones in the configuration.

How To: Run a Forecast

Before you can view any forecast results under the Forecast Data tab page you must either run in cyclic mode or perform a forced run.

After you have performed a Forced Run you can for example view the predefined query (qryLFHeating) in the results database as shown in the ensuing figure.

qryLFHeating

Name	Time	Heating	HotWater	Remainder	Total Power
Zone 2	2/6/2007 11:00:00 AM	7052445,74218031	4185184,18773227	-61956,2401267388	11175673,6897858
Zone 2	2/6/2007 10:00:00 PM	7049227,66569609	3695915,17433226	-68501,254691504	10676641,5853368
Zone 2	2/6/2007 9:00:00 PM	7029801,39884368	3784180,32185161	-68013,3878174928	10745968,3328778
Zone 2	2/6/2007 8:00:00 PM	7011205,89063355	3782495,47497676	-67743,0091375572	10725958,3564728
Zone 2	2/6/2007 7:00:00 PM	6987499,92199462	4130014,29539933	-66813,8968436857	11050700,3205503

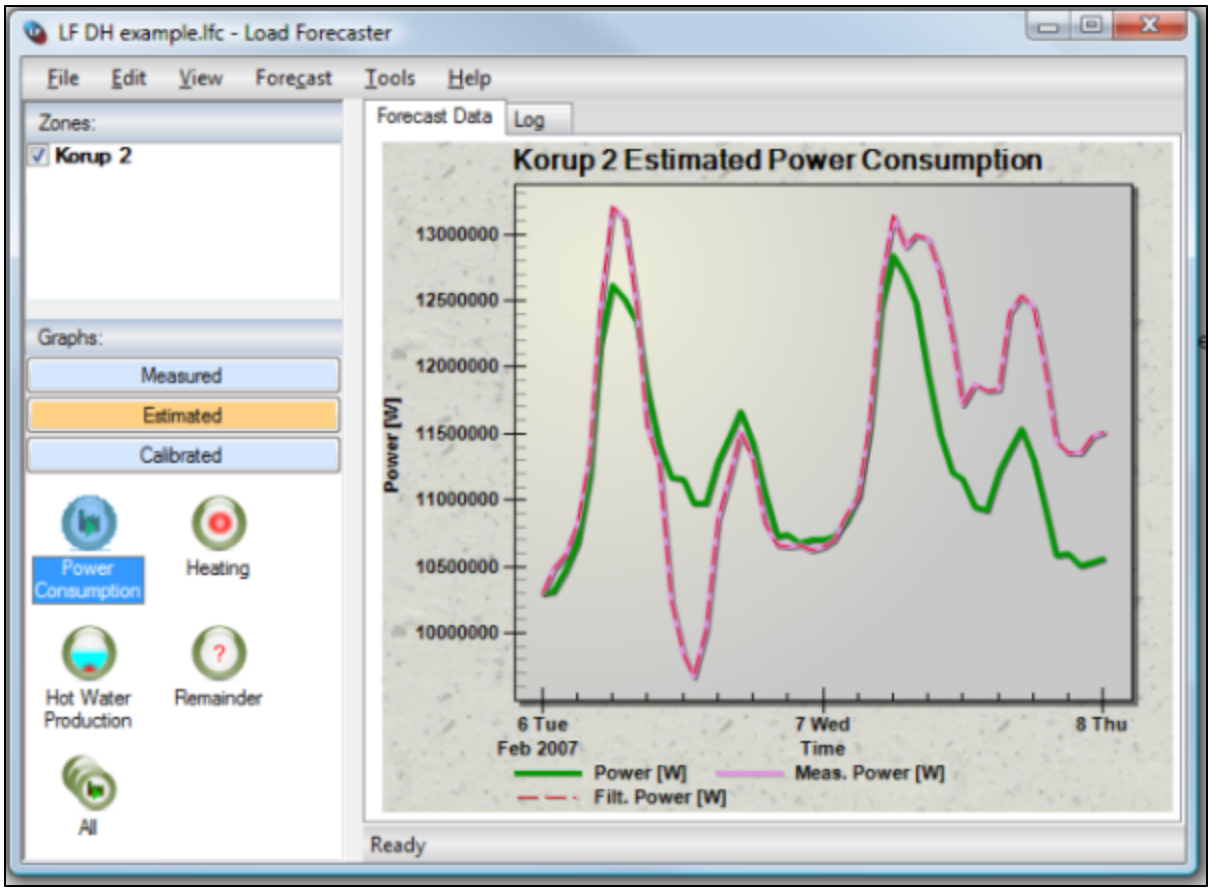
To run a forecast

1. From the menu bar select **Forecast** and select either **Forced Run** or **Start Cyclic**.

   This action displays the estimated forecast results under the graph button named **Estimated**.

   To view more forecast results select the icons under the **Estimated** button and observe the variation and the difference between the actual measurements and the forecast.

The following figure displays the measurements and forecast for Power consumption in a district heating system.



The plot gives an impression of the validity of the forecast.

You can change or modify the following key parameters under the Zone configuration and run a new Forced Run process to plot the results.

- Smoothing factors (1 through 4)
- Temp/Wind Averaging period (in hours)
- Remainder modeling observations

The smoothing factors 1 through 3 can be included in the auto-calibration process and automatically will adjust to best fit.

Right-click menu under Forecast Data area

If you right-click within the Forecast Data area, you can access a menu that contains options to customize the display of forecast data just as you can import or export the graph setup.

How To: Switch Between Power or Water Modes

Load Forecaster supports the forecasting for both power and water. The results can subsequently be transferred to either legacy (old) TERMIS/AQUIS or TERMIS/AQUIS Operation.

By default Load Forecaster opens in Power mode.

To switch mode

- From the menu bar select **Help** and then either **Power** or **Water**.

  The change happens on the fly.

Each mode is described in-depth in regards to the underlying calculation formula.

For details

About Power in District Heating Systems, page 39

About Flow in Water Supply Systems, page 41

How To: Edit Units

You can edit the default units supplied with the application.

To edit units

1. From the menu bar select **Edit** and then **Units**.
2. Under the **Select Units** dialog make the appropriate changes following the guidelines in the ensuing table

Column	Description
Property type	Read-only. This is the name of the unit.
Unit	The measurement for the unit. Select a new unit from the drop-down menu.
Factor	Read-only. The calculation factor for the unit.
Offset	The decimal position for the unit.
Format	The display format for the unit.

Tips and Tricks

The How To.... section provides guidelines to the functionality in the Load Forecaster.

You can find particular areas of interest using Ctrl F.

How To: Set Current Zone

You must define one of your (many) zones as the current zone. The current zone displays the graphs to the right.

To set as current zone

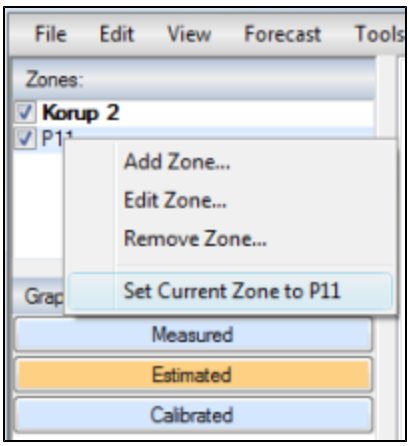
There are two ways to set the current zone

A:

- With the cursor point to the required zone and double-click.

B:

1. From the left pane under **Zones** locate the zone you want as current.
2. Right-click and select **Set Current Zone to <**name of zone**>**.



How To: Create a Log File to Hold Auto Calibrated Values

This topic explains how to create a string under Registry to automatically log any auto-calibrated values. The output is a Microsoft Excel spreadsheet that displays the values.

To create a log file

1. Open the **Registry Editor** and locate the following folder

   HKEY_CURRENT_USER\Software\7T\LoadForecaster\1.1.0\FileNames

2. Create a string value and enter the following

   Name: Enter the name **AutoCalLog**

   Data: Enter the path to where you want to store the log file and add the file name **lf.csv**. Example C:\TEMP\lf.csv

3. Perform an auto-calibration. For test purposes you should limit the scope for the calibration. View the result in the ensuing figure.

   Every time you repeat the auto-calibration, the log file will add a new row. The example thus shows to iterations.

Output example

lf.csv

	A	B	C	D	E	F	G	H
1	----------AUTO CALIBRATION RESULTS----------							
2								
3	Time	Zone	Avg perio	Tref	Smoothing Factor 1	Smoothing Factor 2	Smoothing Factor 3	Heating Contrib
4	6/16/2010 13:02	Korup 2	9	10013	0,046	0,001	0,01	0,75
5	6/16/2010 13:02	Korup 2	9	10013	0,046	0,001	0,01	0,75
6								

How To: Create New Zones

You can add as many zones to your configuration as required.

Each zone must be configured properly in Data Manager as described in the topic How To: Set Up Data Manager Result Database, page 23.

To create a new zone

1. From the left pane make a right-click under **Zones** and point to **Add Zones**.
2. This opens the **Zone Configuration** dialog from where you can configure settings under the four tab pages. Each tab page setting is described in-depth in the topic How To: Perform Zone Configuration, page 19.

How To: Run a Calibration

Based on the configuration you have completed under the Common Configuration dialog as explained in the topic How To: Perform Common Configuration, page 15 you can perform a calibration to generate a result plot. Before you can view any calibration results you must perform either a manual or automatic calibration.

To run a calibration

1. From the menu bar select **Tools** and then either **Calibration Run** or **Auto-Calibrate**.

   This process takes some time depending on the number of divisions. The higher value of divisions the longer the simulation time. If you set the smoothing factor 4 (remainder) to a value below 1.0, the calculation time increases significantly.

2. Press the **Calibrate** button on the left pane and then for example **Power Consumption**.

   Evaluate this plot as it displays the accuracy of the load forecaster at the defined horizon for the selected calibration period.

   Under the **Common Configuration** dialog you can modify the parameter Horizon, as the smoothing factors produce the best fit at this time ahead. You can conduct several calibrations with different values for the Horizon parameter. The result will be different variation of the smoothing factors. You must then manually adjust the smoothing factors under the Common Configuration dialog to determine what is the most optimal configuration for you.

3. When the calibration parameters have been sufficiently adjusted then start the application in cyclic mode.

   This requires access to a meteorological forecast of outdoor temperature and wind speed data.

View calibration status

You can view the status for the auto-calibration in the status bar at the bottom of the application. View the following information:

- Pass number.
- Total defined number of passes.
- Actual calibration simulation number.
- Total number of simulation in each pass.
- The actual root mean square deviation between estimated load and measured load in the calibration period.

Log file

In cyclic mode, a log appears for each abnormal event. In addition, the log data includes the actual regression coefficients for the remainder period.

For auto-calibration the log successively displays the best choice of smoothing coefficients.

When you right-click within the log file you can select **Clear** to discard the contents of the log.

Appendix Section

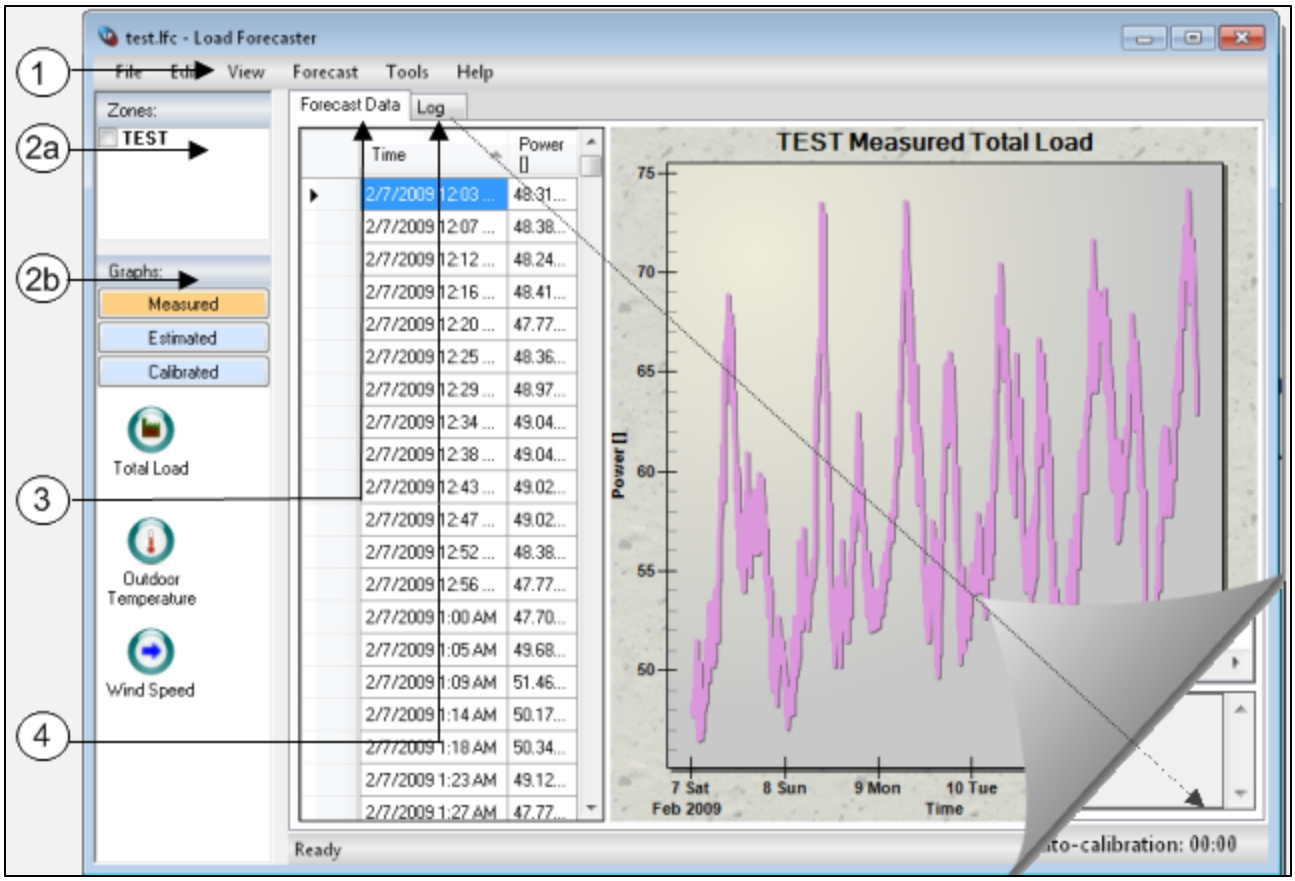
The Appendix section contains contents that is intended as reference material only or otherwise fall beyond the natural framework for the functionality in the Load Forecaster.

You can find particular areas of interest using Ctrl F.

Navigate the Load Forecaster User Interface

The following shows the Load Forecaster user interface. In the ensuing you will find pointers to further information about the various interface elements.

Sample user interface (in power mode)



Notation

Element	Description
1. Menu bar	The menu bar allows you to access configuration menus to handle input data, and control different simulations. For details Menu Bar, page 38.
2a. Upper left pane	This section lists all the configured zones. *When you hover the cursor over certain areas in this pane (such as the menu accordions), you will see a tool-tip with additional information.*
2b. Lower left pane	Under this section you can select a view that covers actual values with time marks and a graph. Choose from the following views: Measured — Displays either historically metered load,

<table>
<tr><th>Element</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>historical outdoor temperature, or historical wind speed.</td></tr>
<tr><td>Estimated</td><td>To view the forecast results you must either be in cyclic mode or perform a Forced Run action.

For details How To: Run a Forecast, page 25.

You can follow the results for the forecast in the graphs that display under the Forecast Data tab page.
Total forecast (power consumption).
Heating part of the forecast.
Time dependent part (hot water production).
Remainder part.
All curves.
If you perform a forced run then the calculated total forecast is shown together with the metered values.</td></tr>
<tr><td>Calibrated</td><td>You must run a calibration before you can see any results under the Forecast Data tab page.

For details How To: Run a Calibration, page 33.

When you have completed a calibration you can see the results of the latest conducted calibration compared to the actual measured value. This plot gives a good overall view of the forecast accuracy using the defined parameters.

If you select the All button you get the entire display of forecast data.</td></tr>
</table>
</td></tr>
<tr><td>3. Forecast Data</td><td>This view displays the results in graphs for the selected views with time mark and actual values.

Right-click menu: If you right-click within the Forecast Data area, you can access a menu that contains options to customize the display of forecast data just as you can import or export the graph</td></tr>
</table>

Element	Description
	setup.
4. Log	In cyclic mode, a log appears for each abnormal event. In addition, the log data includes the actual regression coefficients for the remainder period. For auto-calibration the log successively displays the best choice of smoothing coefficients. When you right-click within the log file you can select **Clear** to discard the contents of the log.

Menu Bar

The ensuing table provides an overview to the various functions in the Load Forecaster.

Main Menu	Submenu	Description
File	New (CTRL+N)	Create a new configuration.
	Open (CTRL+O)	Open an existing configuration.
	Save (CTRL+S)	Save the current configuration.
	Save As	Save the current configuration under a new name.
	Exit	Save and exit the system.
Edit	Common Configuration (CTRL+C)	Edit basic, common configuration parameters.
	Current Zone (CTRL+E)	Edit zone specific basic configuration parameters.
	Zone (CTRL+Z)	Maintain list of zones and names.
	Units	Allow the presentation of data in common units.
View	Show Data Grid (CTRL+D)	Enable or disable data grid with numerical background for graphs.
	Refresh Data (F5)	Reload Data Manager data and refreshes the presented data.
Forecast	Forced Run (CTRL+F)	Force a calculation of a forecast for the next period starting at the end of the initialization period.
	Start/Stop Cyclic	Start or stop the activation of the cyclic update of the forecast.
Tools	Calibration Run	Conduct a calibration run using the settings under the smoothing factors.
	Auto-Calibrate	Conduct a number of calibration runs varying the smoothing factors with the object of minimizing the root mean square error between the actual and estimated load.
Help	Help Topics	Access the product documentation. You can also use the F1 function key on your keyboard to access context sensitive Help.
	License	Display license information and load new license information.
	Shift to (Power/Water)	Select either water supply systems or district heating systems.
	About Load Forecaster	Information about the application version.

About Power in District Heating Systems

Power consumption at consumer level can be divided into energy used for heating and energy consumption for hot water production. The load forecast for a district heating system is estimated using the following formula

$$E(t,T,w) = E_H(T,w) + E_W(t) + y_{T,w}(t)$$

where

$E(t,T,w)$	is the total power consumption (W).
$E_H(T,w)$	is the weather dependant power consumption due to heating (W) and is entirely determined by nature.
$E_W(t)$	is the time dependant power consumption for the production of hot water in zones including time dependency for each 7 week days (W). It is stochastic by nature.
$y_{T,w}$	is the remaining power consumption.
t	is the time (s).
T	is the ambient temperature (K).
w	is the wind speed (Beaufort).

Degree day model

The power consumption for heating is estimated using the degree day model. To use this model you must observe the following assumptions.

- The average daily load of heating and ventilation depends on the seasonal variation expressed via the outdoor temperature and wind speed.
- The time dependent load includes heating for hot tap water heating and a basic heat loss from network. The daily variation of load for hot tap water has no seasonal variation.
- The remaining power consumption (Remainder) is a small fraction that does not relate to neither degree day model nor hot tap water heating.

The degree day model is expressed via the following formulas:

$$E_H(T,w) = \frac{E_{H,Avg}}{D_{Avg}} \cdot D(T,w)$$

$$D(T,w) = G + K_w$$

$$G = Max(0, \quad T_{ref} - T)$$

$$K_w = Max\left(0, \quad \frac{G \cdot w - b}{a}\right)$$

where

$E_H(T,w)$	is the actual estimated load (W).
$E_{H,Avg}$	is the annual average weather depending power.
D_{Avg}	is the annual average degree-day number.
$D(T,w)$	is the actual degree day number.
G	is the temperature dependent term (K).
K_w	is the wind correction term heating (W).
T_{ref}	is a reference temperature (Normally 290 K).
b	is a parameter (Normally ~20 s/K/m).
a	is a parameter (Normally ~40 s/K/m).

To calculate the time depending power consumption for production of hot water you use an initialization process. This process is based on a week profile that allows you to indicate week days with the equivalent demand profile. The demand profile naturally varies from country to country. As an example the first four days of the week in Scandinavia (Monday, Tuesday, Wednesday Thursday) typically share the same profile whereas Friday may be somewhat different in the demand profile. Saturdays and Sundays also typically share the same profile. The initialization process is conducted in cyclic mode even though the period moves as time goes by. The initialization period is defined by you and can be subject to evaluation for each model. However, it should as minimum include a summer period.

About Flow in Water Supply Systems

The load forecast for a water district system is estimated using the following formula

$$E(t) = E_W(t) + y\ (t)$$

where

E(t)	is the total consumption (kg/s).
$E_W(t)$	is the time dependant demand in zone including time dependency for each 7 week days (kg/s).
y	is the remaining demand that is not stochastic. The remainder is calculated based on the formula shown in the ensuing section.
t	is the time (s).

The above formula assumes:

- The demand is typically time dependent and following a weekly profile.
- A remaining demand is a small fraction that does not relate to time.

To calculate the time depending power consumption for production of hot water you use an initialization process. This process is based on a week profile that allows you to indicate week days with the equivalent demand profile. The demand profile naturally varies from country to country. As an example the first four days of the week in Scandinavia (Monday, Tuesday, Wednesday Thursday) typically share the same profile whereas Friday may be somewhat different in the demand profile. Saturdays and Sundays also typically share the same profile. The initialization process is conducted in cyclic mode even though the period moves as time goes by. The initialization period is defined by you and can be subject to evaluation for each model. However, it should as minimum include a summer period.

Remainder formula

Formula to calculate the remainder volume

y (t)= b0 + b1T(t)

where T is the ambient temperature.