e-Fuel Forecasting compared to Degree Day

How does e-Fuel improve on Degree Day with Non-Monitored tanks?

(1) Temperature balance point: Since we are indexing the actual historical usage for the customer to the actual historical weather data from the nearest weather station we don't have to worry about having a user that fits into the degree day standard tables for building heat transfer properties. The balance point issue is removed. The e-Fuel system does a regression analysis on the actual historical usage and weather data for each tank to calculate inputs for a standard equation that relates usage to weather for forecasting individual future customer usage. The real time commercial weather forecast is then used as an input to the equation to get the related future usage estimates. This replaces the degree day tables as a more accurate representation of the actual customer's usage and related weather historical data and local weather forecast.

(2) K factor: Since e-Fuel re-evaluates the statistical regression frequently, the system is automatically adjusting the usage forecast parameter inputs to the standard forecasting equation for changes in usage pattern and weather. This is the relative equivalent of the system automatically recalculating the K factor. In addition the e-Fuel system maintains seasonal forecast parameters for each season in the current and the prior 18 month period. These current and 'same season last year' rates are automatically used in the forecast to expand the range of usage rates available for forecasting. Based on a reasonable assumption that if the usage is weather based it most likely is seasonal or at least driven by the time of year. This offers the ability to have a reasonable usage rate (same season last year) to forecast several seasons into the future and offer better planning and delivery management tools based on a more complete picture of the delivery and product requirements.

(3) Non heating usage: Since e-Fuel maintains seasonal parameters for forecasting the current and future periods it does a better job than Degree Day of automatically adjusting to non heating load such as pools and spas. In addition one of the parameters into the forecasting equation is a weather response. In the case of a usage that is not related to weather this parameter is 0 or almost zero and results in little effect on the forecasted usage. So the e-Fuel standard forecasting equation is effective at forecasting non weather based load and the related usage.

(4) Degree Day Tables are out of date: since e-Fuel uses a constantly updated statistical relationship for each tank, the accuracy and timeliness of usage rates from standard usage tables is not a concern. The system automatically relates local weather to local usage for each customer and uses live automated weather feeds for historical data and weather forecast to be as timely as possible.

(5) DD average daily temp based on 1 reading of high and 1 of low: e-Fuel receives live weather historical data on 30 minute intervals allowing calculation of a much truer value for average temperature by which to index the usage.

(6) User response to outside temperature changes: e-Fuel's seasonal forecast parameters do a better job of capturing user indoor temperature preferences then Degree Day as many user driven temperature settings vary with changes in season.

(7) Seasonal usage: e-Fuel's set of seasonal forecast parameters do a better job of capturing user indoor temperature preferences as they are more specific to the seasonal temperature changes then either heating or hot water only DD tables.

How does e-Fuel improve on Degree Day with Monitored tanks? (In additional to the advantages outlined above for Non Monitored tanks.)

(1) Using e-Fuel Tank Monitors:
    a. 48 readings per day, every day - outdoor, indoor and weather
        i. Lots of data greatly increases the confidence level of the statistical fit for each specific user, eliminating the need to choose a degree day table.
        ii. Having local temperature at the tank, in the user's home and automatically coming in from the local weather feed allows e-Fuel to automatically determine the relationship between the indoor temp, outdoor temp, local weather feed and fuel usage. This effectively accounts for different user preferences for indoor temperature relative to outdoor temperature as well as the heat transfer and internal heating patterns of the building. This approach takes the intent of degree day and greatly improves it with timely, local and accurate data, makes the usage and weather relationship local and specific to each user, updates the relationships frequently and uses professional weather forecast to estimate future usage.
(2) K factor is replaced with features outlined above in 1.a.ii
(3) The large amount of data from the tank monitors allows the e-Fuel system to not only provide overall usage profiles and seasonal profiles but also weekly or even daily statistical relationships for use in future forecasting. This finer grain usage history data allows the e-Fuel system to better capture usage that is a combination of response to outside temperature changes and non heating loads or either individually. This combined with the 'same period last year' statistical sets provides a more robust method of capturing usage that is not weather related.
(4) Since the statistical relationships are built from actual local data, the DD tables are replaced with a standard forecast equation with parameters for each user.
(5) DD average daily temp based on 1 reading of high and 1 of low: with tank monitors providing 48 readings per day of local temperature and truer value for average temperature can be calculated.
(6) See (1) and (3)
(7) See (1) and (3)

Additionally:

- In the e-Fuel system the forecast parameters from one or more monitored tanks can be used to establish a set of standard usage rates for use by customer service to setup forecasting for New or Non-Monitored tanks. In e-Fuel this is referred to as **Impersonation**. An impersonating tanks forecast uses the forecast parameters of the assigned standard usage rate from the tank being impersonated. This effectively allows the propane company to use tank monitors to establish its own localized statistical relationships for forecasting Non Monitored tanks and also provides a way to handle new and rental customers.

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Back ground Information on Degree Day use

1 degree day = One 24 hr period where the avg temperature was 1 degree below 65 °F, or 64°F.

- So, for 3 days of weather, the accumulated degree days are is:

Day	Avg temp	# DD
1	63	2
2	64	1
3	60	5
Total DD	62.3	8

Degree day tables allow the lookup of the typical fuel usage for a corresponding temperature change in degree days from a set standard industry table established for the user.

There are many degree tables available, tables can be geographic based, can have different temperature balance points and are available for different types of load periods, ie- heating, heating and hot water and hot water only. The availability and selection of the table to use is ideally done for each user. Typically, in the US, 65 °F is used as the balance point for all Degree Day tables along with standard tables of usage per degree day established by the heating industry decades ago.

The tables are based on 30 year historical temperature normals and can be obtained specific to many geographic regions.

Some systems allow the entry of daily high and low or average temperatures for a location at or near the customer. These real temperature values can then be used by the DD system to adjust the 30 year temperature averages to compensate for local weather temperature differences.

Also, some degree day systems allow for an adjustment to the table usage rate values per degree for a particular user by applying a K factor to the standard rate from the tables. The K factor is typically recalculated after each point where a new usage rate can be determined by the system (i.e., after a delivery) and is applied to future usage estimates to adjust the compensation to the standard usage rate for the particular user.

How aggressively the propane company manages the choice of Degree Day tables by user and the timely updating of K factor and weather actual greatly affects the accuracy of the Degree Day system.

Problems with degree day:

(1) Balance point for each building is different than the typically used standard of 65°F in the U.S. If the actual balance point for the building varies from 65 °F then the DD calculation will be off by that number of °F for each day and can result in dramatic over or under usage estimates. The balance point is critical because:

   i. Each building heats up at a different rate
   ii. Different buildings are heated at different temperatures
   iii. the balance point can change depending on the season and weather patterns

- The selection the degree day table with the correct balance point is required.

(2) Typically the K factor for the most recent period with data is used to adjust the usage forecast for the immediate future period. While this is OK in the middle of a period of constant usage, it is not reasonable going into or out of the shoulder seasons where the most recent usage pattern is not indicative of the future pattern. Particularly, when forecasting usage further out then 1 or 2 weeks.

(3) Non Heating usage: DD tables assume all load is heating or hot water or both and does not reflect non heating usage such as pools or spa's.

(4) Degree Day Tables are out of date: DD tables do not reflect modern building methods and their effect on indoor temperature response to outdoor temperature and internal heating rate. The tables are difficult to maintain and provide no way to relate actual local usage to actual local temperatures and forecast.

(5) Degree Day average daily temperatures are based on average of the highest and lowest temperature for the day without regard to the time vs temperature profile required to get the real average temperature.

(6) User response to outside temperature changes: variability in thermostat settings throughout the day is not taken into account with the DD method

(7) User response to seasonal weather changes by adjusting thermostat is not reflected in the DD method.