



# Understanding Temperature Correction Factors and Fuel Pricing

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**More disruptive weather events have been happening and will likely continue to happen at an increased frequency over the coming decades.**

Because local temperatures can vary dramatically, the density of a gallon of gasoline can fluctuate by more than two percent over a week at a given location — and more than five percent over the course of a year.

Failing to consider temperature variation can impact your margins. This is especially true in northern states, where suppliers buy in bulk markets based on net (temperature-corrected) volume and are required to sell and report to tax authorities based on gross (actual) volume.

For example, let's say it's a typical January day somewhere in the north. For every gallon a supplier buys on a net basis, they're only able to sell 0.97 gallons on a gross basis. If the supplier doesn't properly adjust the sales price per gallon to account for temperature, they could easily lose money on every gallon sold.

Experienced marketers have a general feel for the net-gross spread and can make rough price adjustments. However, at this time, it's nearly impossible to get adjustments "just right" when the temperature — and thus the net/gross spread — varies, sometimes dramatically, each day.

The net/gross spread is even harder to determine when you are negotiating contract sales. Historically, contracts contained a single temperature correction factor designed to "cover" the term of the contract. Today, many contracts are adjusted monthly, based on monthly temperatures. Neither method is accurate.

This variation is such a significant problem that some suppliers and refiners refuse to market their products in gross-gallon states because they lack an effective tool to adjust pricing based on temperature fluctuations.



## Why temperature matters

Like all liquids, when refined fuels cool, they condense and occupy less space. Conversely, when they warm, they expand and occupy more space.

If you are buying or selling fuel based on gross volume — the actual volume at the current temperature — you need to understand how the temperature affects the value of each gallon. After all, the ultimate value of the fuel is the power it provides an engine, which is driven by its mass.

Think of mass as the number of molecules in a given amount of fuel, regardless of the amount of space or volume that the fuel takes up. One gallon of gasoline at 40 degrees Fahrenheit (F) has 1.4% greater mass, 1.4% more molecules, and 1.4% greater ability to power an engine than a gallon at 60 degrees F.

## Temperature fluctuation and the billing process

Sales in the bulk market are measured and priced in net gallons. Northern states typically require transactions to use gross gallons for tax reporting. This leaves wholesalers in those states in a tough position. They purchase fuel in the bulk market based on net gallons and sell in the wholesale market based on gross gallons. Depending on the temperature of the fuel, the number of gross gallons they sell may be less than or greater than the number of net gallons they purchased.

## Added complexity in contract negotiations

For many decades, buyers and sellers routinely decided that as the weather changed and their margins grew or narrowed, it was an unavoidable cost of doing business.

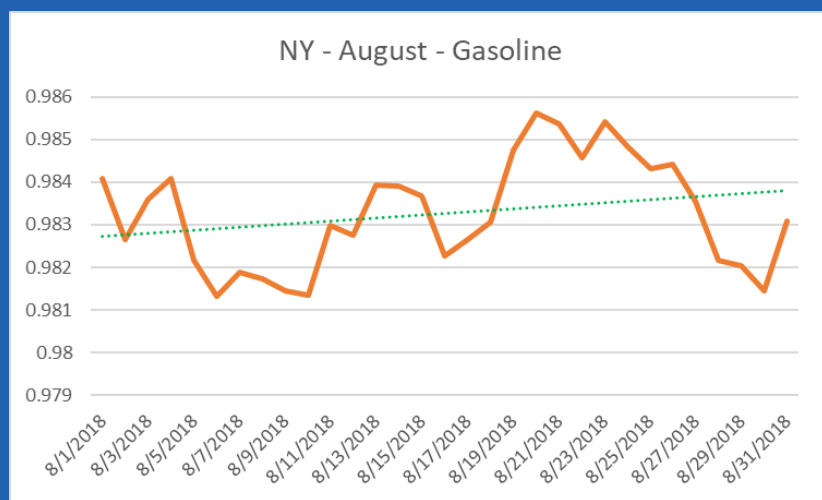
Some businesses compensated for seasonal temperature variations by adjusting their price differentials throughout the year to account for density changes in the fuel they sold. However, it was only a rough improvement and didn't reflect day-to-day fluctuations.

With the advent of annual formula-based price contracts, many sellers began to encourage ratable liftings. However, during the early use of these contracts, little consideration was given to the net-vs-gross problem, so the contracts locked in an added layer of risk and complexity for businesses required to sell in gross gallons.

While there was no industry-wide, accurate solution, some buyers and sellers developed ways to deal with the problem in their contracts.

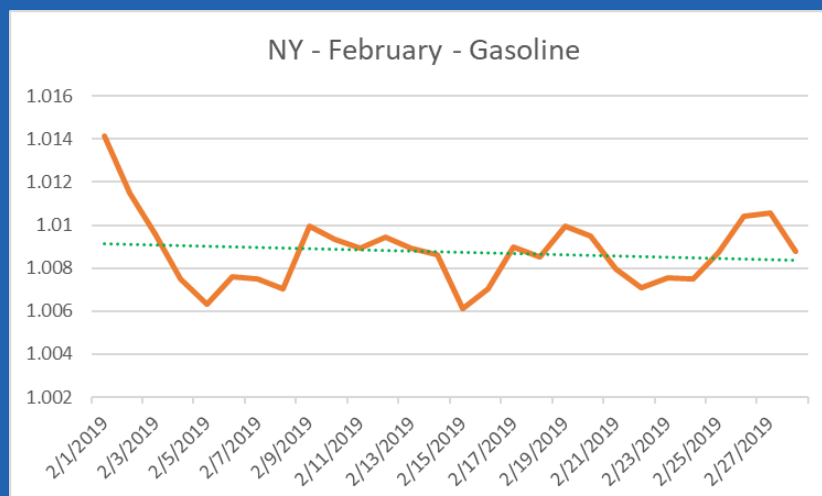
To account for temperature-related variations in fuel density, some businesses included an "add" to prices based on the annual average temperature at a terminal market. Others used a similar "monthly add" based on the historical monthly temperature at a terminal market. Some chose to manually reconcile at the end of the month based on its actual temperatures. Others made no adjustments.

## Seasonal temperatures and volume



**Figure 1.** Summer temperature fluctuation. On August 1, 2018, 10,000 gallons decreased to 9,840 gallons when it hit the colder underground tank at the retail location.

TCF = 0.984083. Without temperature correction, the buyer loses volume.



**Figure 2.** Winter temperature fluctuation. On February 1, 2019, 10,000 gallons increased to 10,141 gallons when it hit the warmer underground tank at the retail location.

TCF = 1.014137. Without temperature correction, the supplier gives away volume.



## What exactly is temperature correction?

To best leverage temperature correction data, it helps to understand how it works. In terms of measurement, U.S. gallons are precisely 231 cubic inches, which is essential information when fuel temperatures fluctuate. There is more energy — and value — in a gallon of 30-degree fuel than in 80-degree fuel.

To help, the American Society of Testing and Measurement (ASTM) provides formulas and calculations for the accurate correction of volume based on temperature. Without correction, there can be a one percent discrepancy in volume, which on a \$2 gallon is an error of \$0.02 per gallon (2 CPG).

Every evening, pricing managers post gasoline and diesel prices at terminals across the country. The majority contain a “best estimate” of temperature correction, but they are never perfect. The degree of imprecision creates financial risk.

One way to generate temperature correction estimates is to compensate for the weather and ambient temperature fluctuations. This is the common method for estimating product temperature, however, it can lead to a long list of inaccuracies.

## A true temperature correction solution

Now there's a better way. DTN has engineered a modern solution that delivers accurate, real-time temperature data, right from the terminal.

Real-time information is critical to accurate temperature correction. When counterparties are equipped with the data, they can aggregate the gross and net volumes at the terminal level. Outlier BOLs can be filtered out, reports can run at set intervals throughout the day, and near real-time data reflecting all daily activities in all time zones can be achieved.



Factor Date	Factor Price	PClass	Grade	TCN	ZIP	State	Terminal Name	Term Type	Factor
2/1/19	0	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.021667
2/1/19	1	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.016979
2/1/19	3	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.017551
2/1/19	4	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.017259
2/1/19	0	Gas	M	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.0225
2/1/19	1	Gas	M	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.02375
2/1/19	4	Gas	M	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.023056
2/1/19	0	Gas	P	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.025087
2/1/19	1	Gas	P	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.024316
2/1/19	2	Gas	P	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.022823
2/1/19	3	Gas	P	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.024514
2/1/19	4	Gas	P	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.023976
2/1/19	0	Gas	R	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.020427
2/1/19	1	Gas	R	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.019604
2/1/19	2	Gas	R	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.019328
2/1/19	3	Gas	R	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.020326
2/1/19	4	Gas	R	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.019825
2/1/19	0	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.017765
2/1/19	1	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.01691
2/1/19	2	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.014088
2/1/19	3	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.014
2/1/19	4	Distillates	2	T-06-CT-1262	06512	CT	CT-NewHaven-Gulf Oil	Marine	1.015864

Precisely rating and reporting gallons at lifting provides a consistent, reliable source for temperature-based volume adjustment. This enables better pricing decisions and improves margins.

All purchasers and suppliers should ensure they have access to consistent, accurate volumetric fuel measurements. Industry research shows that many overlook this important detail. That oversight has serious implications. Small measurement errors or

a lack of consideration for temperature correction can result in unanticipated risks for both buyers and sellers. Although there have been temperature correction methods used for decades, there is considerable room to improve the frequency, specificity, accuracy, and calculation of temperature adjustments. New innovations leverage real-time information from terminals to offer the most accurate data possible.



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and the impact it can have on your  
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