CME Group

CME Group Petroleum Intraday Index Calculation Guide

CME Group Benchmark Administration Limited

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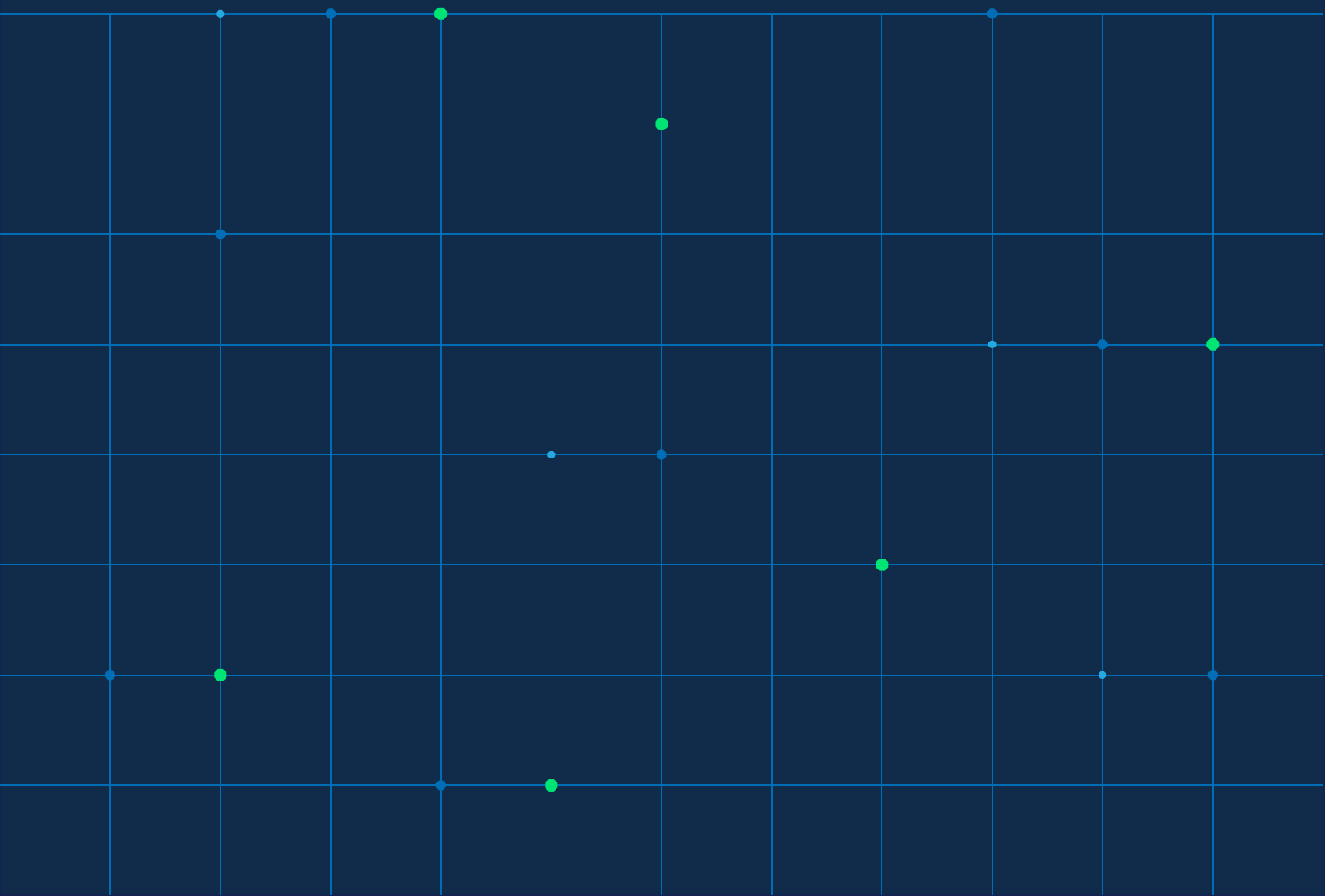

Version Control

VERSION	KEY CHANGES	APPROVAL DATE
1.0.0	CME Group Petroleum Index – Real Time Methodology	March 22nd, 2021
1.0.1	Minor updates and clarifications	June 15th, 2021
1.0.2	Minor updates and clarifications	June 16th, 2021
1.0.3	Minor updates and clarifications	August 16th, 2021
1.0.4	Added clarification to Boundaries Conditions rule	August 20th, 2021
1.0.5	Business calendar definition – Re-named “Intraday” instead of “Real Time”	August 25th, 2021
1.0.6	Future contracts re-balancing	April 1st, 2022
1.0.7	Calculation and publication frequency	June 6th, 2022
1.0.8	Updated roll period	June 5th, 2023
1.0.9	Upadated weights	February 29th, 2024

Contents

CME Group Petroleum Index

CME Group Petroleum Intraday Index. is a Volume Weighted Average Price (VWAP) of the top five levels of the CME Globex order book for each of the underlying components.

The Intraday Index is based on a starting value of 100.00 on launch date of the main CME Group Petroleum Index (3rd August 2020) and, based on settlement prices of the underlying components on launch day, corresponds to a synthetic value of $43.968396.

The calculation is performed every 5 (five) minutes during CME Globex market hours, Sunday - Friday 6:00 p.m. - 5:00 p.m. ET (5:00 p.m. - 4:00 p.m. CT) with a 60-minute break each day beginning at 5:00 p.m. ET (4:00 p.m. CT).

The Intraday Index is calculated on CME Settlement business days, as per the following calendar

https://www.cmegroup.com/tools-information/holiday-calendar.html#settlementNotices.

This calendar includes Columbus Day and Veterans Day as additional holidays.

The Calculation Agent of the CME Group Petroleum Intraday Index is CME Group, in conjunction with Bantix[1].

Input data

The CME Group Petroleum Intraday Index is a weighted basket of the following energy futures contracts traded on CME Globex. The CME Globex order book is available on CME Direct.

- NYMEX WTI Crude Oil futures (CME Group Commodity code CL)[2]
- NYMEX RBOB Gasoline futures (CME Group Commodity code RB)[3]
- NYMEX NY Harbor ULSD futures (CME Group Commodity code HO)[4]

To ensure the consistency of calculation, the underlying components are represented in USD per barrel. Therefore, RB and HO contracts are converted from “cents/gallon” to “USD/barrel” using a standard conversion factor of 1 barrel = 42 US gallons.

Input data to the Index calculation is the mid price of the VWAPs (volume weighted average prices) separately calculated for the bid and the offer sides, up to 5 (five) order-book levels.

Calculated mid-VWAPS are rounded to 4 decimal places for the three Futures constituents.

$$TotalVolume_{Offer} = \sum_{n=1}^{5} OfferV_n$$

$$TotalVolume_{Bid} = \sum_{n=1}^{5} BidV_n$$

$$BidVWAP = \sum_{n=1}^{5} \frac{BidV_n}{TotalVolume_{Bid}} BidP_n$$

[1] http://www.bantix.com/
[2] https://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_contractSpecs_futures.html
[3] https://www.cmegroup.com/trading/energy/refined-products/rbob-gasoline.html
[4] https://www.cmegroup.com/trading/energy/refined-products/heating-oil.html

$$OfferVWAP = \sum_{n=1}^{5} \frac{OfferV_n}{TotalVolume_{Offer}} OfferP_n$$

$$VWAP = \frac{BidVWAP + OfferVWAP}{2}$$

where:

n	= Order book level
$BidV_n$	= Bid volume at level n
$OfferV_n$	= Offer volume at level n
$BidP_n$	= Bid price at level n
$OfferP_n$	= Offer price at level n

Example:

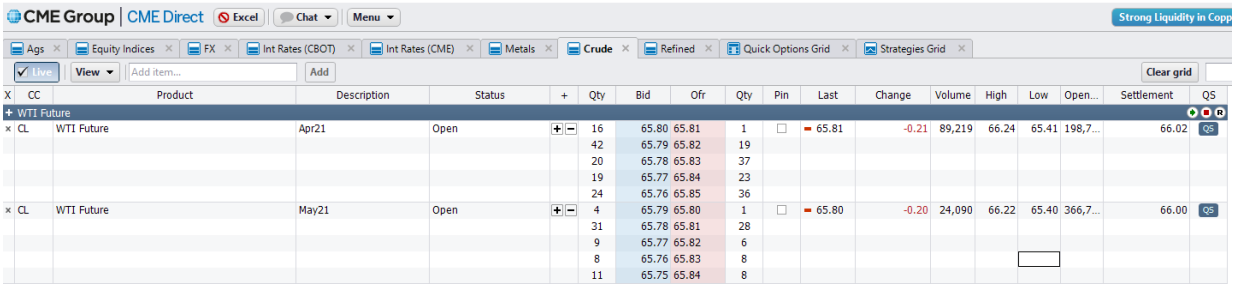

Figure 1 - CME Direct snapshot of WTI market

WTI order book

	Quantity	Bid	Offer	Quantity	
1052.8	16	65.8	65.81	1	65.81
2763.18	42	65.79	65.82	19	1250.58
1315.6	20	65.78	65.83	37	2435.71
1249.63	19	65.77	65.84	23	1514.32
1578.24	24	65.76	65.85	36	2370.6

a	b	Bid VWAP (a / b)	Offer VWAP (d / c)	c	d
7959.45	121	65.78057851	65.83637931	116	7637.02

mid-price of VWAPs	**65.80847891**
rounded to 4 decimals	**65.8085**

Boundaries condition

The calculated mid-VWAP must be between the best Bid and the best Offer quotes at the moment of calculation; if such boundary condition is broken for the 5 (five) order book levels calculation, the mid-VWAP will be re-calculated using 4 (four) order-book levels and, if still outside the bid-offer spread, 3 (three) order-book levels.

If the mid-VWAP remains outside the boundaries using 3 (three) order-book levels, the nearest best Bid or best Offer quote will be used.

- If $VWAP_3 < BidP_1$
  - $BidP_1$ is used as the input price for the component.
- If $VWAP_3 > OfferP_1$
  - $OfferP_1$ is used as the input price for the component.
- Otherwise:
  - $VWAP_3$ is used as the input price for the component.

Where:
$VWAP_3$ = the mid-VWAP from the top 3 levels of the order book.
$BidP_1$ = the Bid price from level 1 of the order book.
$OfferP_1$ = the Offer price from level 1 of the order book.

Example:

WTI order book			
Best Bid	Best Offer	Calculated VWAP	
65.80	65.81	65.82	use offer = 65.81
65.80	65.81	65.79	use bid = 65.80

The boundary condition rule is applied to each contract used in the calculation, including additional contracts used during the roll period.

Insufficient Input Data

In scenarios where there are fewer than 3 order book levels for either the bid or offer for one of the components; the mid VWAP is set as the mid of the top of order book for that component. If there are either no bids or offers, the last available calculated mid VWAP is used (e.g. if the Sunday 6pm orderbook is insufficient for one of the components, the last available VWAP from the previous Friday/trading day is used for that component).

Weighting of Input Data

The percentage weight of each futures contract within the Index is based on the respective average open interest volumes for the last quarter of the calendar year, from October 1st to December 31st inclusive. The weights of each component at the end of the calendar year are calculated by the Administrator and communicated to the Calculation Agent at least 14 days in advance of implementation date.

The weights history of each component are as follows:

Dates	CL Weight	NYHO Weight	RBOB Weight
3rd Aug 2020 – 31st Mar 2022	72%	15%	13%
1st Apr 2022 – 31st Mar 2024	75%	14%	11%
1st Apr 2024 onwards	72%	14%	14%

Petroleum Real Time Index Calculation

CME Group Petroleum Real Time Index is calculated and published every 5 (five) minutes, as per the following formulae:

$$CPRT^t = \frac{WAP^t}{WAP^0} * 100$$

where

CPRT^t = CME Group Petroleum Real-Time Index
WAP^t = Volume Weighted Average Price as calculated in Input data
WAP^0 = Weighted Average of settlement prices at rebase date (3rd August 2020)

3rd August 2020, the CME Group Petroleum Index was launched at the base value of 100, for the following settlement prices:

NYMEX WTI Crude Oil	$41.01
NYMEX NY Harbor ULSD	$1.2409
NYMEX RBOB Gasoline	$1.2131

Weighted Average Prices calculation:

$$\text{WAP}^t = CL^w * CL^t + ULSD^w * 42\ \frac{gal}{bbl} * ULSD^t + RBOB^w * 42\ \frac{gal}{bbl} * RBOB^t$$

Weightings:

CL^w = NYMEX WTI Crude Oil weighting
ULSD^w = NYMEX NY Harbor ULSD weighting
RBOB^w = NYMEX RBOB Gasoline weighting

Input Prices (more details in section Input data):

CL^t = NYMEX WTI Crude Oil mid-VWAPs in USD/bbl
ULSD^t = NYMEX NY Harbor ULSD mid-VWAPs in USD/gal
RBOB^t = NYMEX RBOB Gasoline mid-VWAPs in USD/gal

Roll Period

Trading liquidity of futures contracts tends to transfer from the front month to the second month starting around 6 days prior to the expiry of the front month contract. During those roll periods, the VWAP used for the Index calculation, is the weighted sum of the respective VWAPs of the front month contract and the second month contract, smoothed according to the following weights.

Roll Period weights	1st month	2nd month
Expiry Day -7	100%	0%
Expiry Day -6	80%	20%
Expiry Day -5	60%	40%
Expiry Day -4	40%	60%
Expiry Day -3	20%	80%
Expiry Day -2	0%	100%
Expiry Day -1	0%	100%
Expiry Day	0%	100%

Hence, two days before expiry of the front month contract, only the second month contract is used in the calculation and so thereafter, until the next roll period.

- NYMEX WTI Crude Oil futures (CME Group Commodity code CL) expires on the 25th calendar day of the month.

- NYMEX RBOB Gasoline futures (CME Group Commodity code RB) and NYMEX NY Harbor ULSD futures (CME Group Commodity code HO) expire on the last business day of the month.

The rolling weights are applied by trading day, remaining constant from market opening to market close of the day. As stated above, CME Globex market hours are Sunday - Friday 6:00 p.m. - 5:00 p.m. ET (5:00 p.m. - 4:00 p.m. CT) with a 60-minute break each day beginning at 5:00 p.m. ET (4:00 p.m. CT).

For additional clarity, business days are defined as follows:

Trading day	Business day
Sunday 6:00pm – Monday 5:00pm ET	Monday
Monday 6:00pm – Tuesday 5:00pm ET	Tuesday
Tuesday 6:00pm – Wednesday 5:00pm ET	Wednesday
Wednesday 6:00pm – Thursday 5:00pm ET	Thursday
Thursday 6:00pm – Friday 5:00pm ET	Friday

Weighted Input Price calculation during roll period

During roll periods the Petroleum Real Time Index is calculated applying input data determined as follows:

$$CL^t \text{ or } ULSD^t \text{ or } RBOB^t = (mth^1 * D^r * 0.20) + mth^2 * (1 - (D^r * 0.20))$$

where

mth^1 = month 1 mid-VWAP
mth^2 = month 2 mid-VWAP
exp^1 = expiry date of month^1
D^r = (exp^1 -2) – today

The input: (exp^1 -2), accounts for the day-count adjustment needed to reflect front month contract roll two days before its expiry.

Calculation Agent and Publication

Calculation agent of the CME Group Petroleum Intraday Index is Bantix.

The Index is calculated and published every 5 minutes during each CME Group trading day as per the official schedule available on the CME Globex Trading Schedule. This includes days where there is an early close or unusual trading hours.

If an error is reported in the input data or in the calculation, the Index is not re-calculated.


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