



MENNTA
ENERGY SOLUTIONS

NGLs Trading Execution
Session 2 & 3

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Once again, welcome, and thank you for choosing Mennta Energy Solutions.

Sincerely,


C.M. Lippert Glenn
President & CEO

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MENNTA ENERGY SOLUTIONS

COURSE LECTURER

Mary Jackson has over twenty-five years' experience in the energy industry. After university she began her career at BP, working in the information management group, before joining the Manufacturing, Supply and Trading department. She subsequently worked at Saladin as a consultant, working closely with clients throughout the world and providing consultancy advice on energy market analysis, trading and risk management. In several senior roles at Saladin, she managed the energy consulting team, ran the energy market information service and directed strategy for new software and information product development.

Since 2000, Mary has worked as an independent energy market consultant and she formed Kingston Energy Consulting with Nigel Harris in 2002. Kingston Energy provides consultancy services to companies involved in energy markets and trading. A key area of work has been the European natural gas market - Kingston Energy has researched and authored a well-respected report on European natural gas trading which has been published annually since 2004.

Mary has lectured regularly for Mennta Energy Solutions on energy markets, trading and risk management and is also a regular speaker and panel member at public conferences. She has written articles for industry publications including Harts Energy Markets, Energy Risk, Global Energy Business and Petroleum Review.

Nigel Harris is a director and principal consultant at Kingston Energy Consulting, which he founded with Mary Jackson in 2002. He has been helping energy traders to analyse and understand the markets for over 25 years, initially as a developer of market analysis software systems, and more recently as a consultant.

At Kingston Energy Consulting, his main focus is on providing education and information transfer to participants in the energy trading business, through instructor-led classroom training, web-based training development, research projects, workshops, briefings and research-based report writing.

In his work with Mennta Energy Solutions, he has created a library of new instructor-led and web-based courses on European gas and power markets and trading. In 2005, he worked with Mary Jackson to develop the popular Oil Trading Orientation course, which has since been presented at venues all over the world. He has also extensively revised and updated many existing courses on derivatives, hedging and risk management. He regularly presents this material both at public venues and as in-house, often customised, courses.

He is co-author of a series of highly regarded reports on European natural gas trading and has also contributed to reports on power markets and oil trading.

In previous roles, he was a key member of the team that initially designed and developed Saladin's innovative Petroleum Analysis Workstation, a system that became an industry standard for historical price analysis during the 1990s and remained in use in the industry for two decades. During this period, he worked closely and extensively with oil and gas traders around the world to understand their information

and analytical requirements. He also spent some years as an independent consultant, working mainly with software and information providers to help them better understand the oil and gas trading sectors.

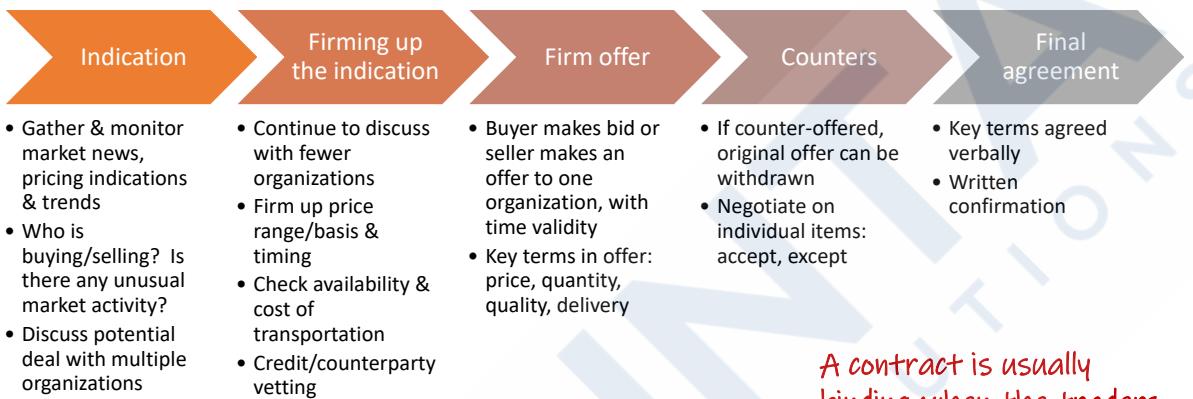


NGL Trading Execution: Physical Market





Trade Negotiations



Transactions start in conventional ways, with general discussions on availabilities, requirements, timing, market conditions and price ideas. Their early stage discussions are termed indications. These are usually circulated verbally from trader to trader or via brokers. Brokers are usually well versed in who has product to sell and who wants to buy. If indications show a possible match, a second more serious, detailed stage is entered between traders looking to do a deal. This stage is more specific – the buyer and seller identify price levels and terms they would consider. The trader will also check credit, performance, legal and operational issues.

A firm offer is given when a time, place, volume, and price is named by one party (including a time interval for a response). This stage involves negotiating all facets of the deal. The other party may respond with a counter offer. Counter offers are very common – the trader who went “firm” should generally expect this response. Acceptance of a firm offer, without conditions, concludes the transaction. After an offer has been accepted, withdrawal is not possible.

Once the verbal deal is agreed, traders exchange a deal confirmation through written communication. This should summarize key conditions – buyer, seller, price, volume, product payment terms, specifications, special conditions, etc. The trader will also prepare a deal sheet – he/she is responsible for the accuracy of what has been agreed.



Trade Negotiations

Bilateral deals

- Deals can be negotiated directly, through a broker, or through an electronic trading platform
- Brokers can enable OTC trades (physical, forwards, swaps, options) & place exchange trades
 - *Voice or electronic broking*

Brokers offer voice broking, hybrid broking (where brokers and customers interact over the phone, supported by electronic tools, such as price and analytics screens), and electronic broker platforms (e.g. Trayport).

Trades can be executed by:

Name passing: the broker acts as an agent, and the trader then settles directly between counterparties.

Exchange give-up: broker places a derivatives order on behalf of his/her client & then “gives up” the trade.



Why Trade via a Broker?

Convenience / trader preference

Market insight

Price discovery: brokers can help identify best price

Discretion & pre-deal anonymity

Non-standard trades: can help find counterparties for unusual transactions

Credit Risk Management



Responsibilities include:

- Establishing counterparty credit policy & standards
- Establishing and monitoring credit limits
- Monitoring counterparty creditworthiness
 - *Internal & external credit ratings*
- Reviewing credit concentrations
- Reviewing risk reduction (credit enhancement) arrangements
 - *e.g. collateral, prepayment, letters of credit*

It is a front office responsibility (trader) to ensure credit issues are defined and handled before a transaction is executed

A well-functioning credit control system requires that credit limits be established before any deal is done with a counterparty, and then that all parties can check on available credit whenever needed. It is the front office's responsibility (the trader) to make sure credit issues are completely defined and handled before the transaction is executed.

Ongoing reviews should be conducted either on a pre-established schedule, or whenever there is a reason to suspect that a company's ability to live up to their obligations could be compromised.

Trading Controls for Credit Risk

Counterparty constraints

- Mutually acceptable legal basis for trade
- Approved & vetted counterparties
 - No international sanctions etc.

Credit controls

- Max. acceptable exposure to counterparty (based on credit ratings, tangible net worth)
- Credit watch thresholds
 - *Alert traders when a line of credit is near capacity*
- Collateral requirements



You should only trade with counterparties that have been approved and vetted. Sanctions with a particular country may include trade restrictions and asset freezes.

A company's exposure to individual trading counterparties, and their willingness to trade with them will be governed by their legal and credit arrangements. In some cases, exposure will be strictly limited by agreed lines of credit, or by the limits of guarantees provided by bank instruments. In other cases, a company may choose not to extend their exposure to a counterparty beyond a certain level, based on assessment of the level of credit risk involved.

Credit rating agencies such as Standard & Poors, Fitch and Moody's assess the risk of debt instruments issued by governments (sovereign risk) and corporations around the world, but with a strong focus on public companies listed on US and European stock exchanges. Sovereign risk can be used as a proxy when assessing the risk of unrated, government-owned entities such as national oil companies.

The initial credit evaluation (and ongoing or regularly scheduled re-evaluations afterward) should include all available information that would materially contribute to assessing a company's ability to live up to their contractual commitments. Internal assessments may include consideration of a company's size, net assets, liquidity, profitability, and earnings.

Limits should be established on both current and potential exposure. A "watch" threshold should be set that alerts all parties that a line of credit is near capacity. This can put traders on alert to be more careful with future transactions, and should trigger a re-evaluation of the counterparty.



Contracts - Master Agreements

Transactions with each counterparty governed via a single master agreement

- Each deal is an addendum to the master deal
- Most contract terms defined in advance

Agreements include provisions for:

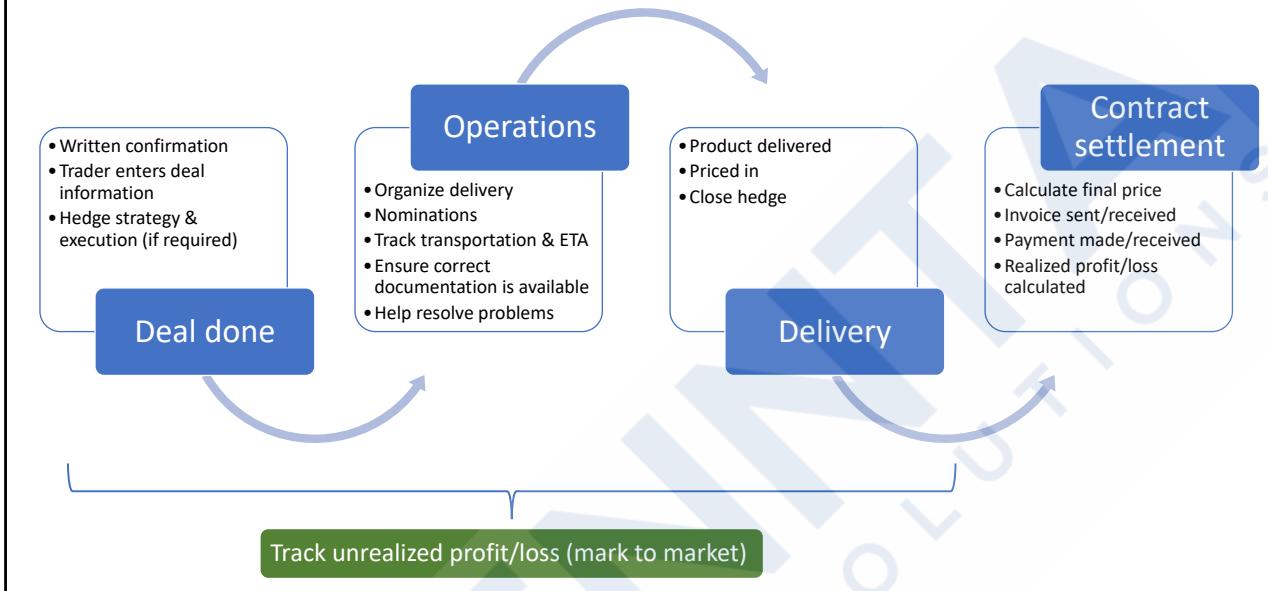
- Netting of payments
- Close out netting
- Collateralization thresholds

Under a master trade agreement, each deal is an amendment or addendum to the existing “umbrella” deal, rather than a stand-alone transaction. This simplifies the contract-writing process substantially, as contract terms will be defined in advance.

Two-way netting of payments, regularly and scrupulously adhered to, is highly recommended.



Physical Trading Transactions



Operations (also known as distribution or scheduling) manage a deal after the trader has concluded it, always keeping in mind the importance of maximizing profit and minimizing loss. Operations add value to trading, ensuring that the movement of the commodity between the seller and buyer happens smoothly. Operations should always maintain communication with all the key parties (e.g. counterparty, trader, terminal, inspector, vessel, pipeline company) throughout the deal. Where appropriate they organize inspections at key title transfer points, and ensure that correct documentation is available on a timely basis.

Settling an EP mix trade is complicated by the need to determine ("true-up") the exact percentage of ethane that has been delivered. Typically the buyer pays for the ethane, but settles for the propane in the EP mix either through a cash payment, an in-well book transfer, or by delivering physical propane back to the seller.

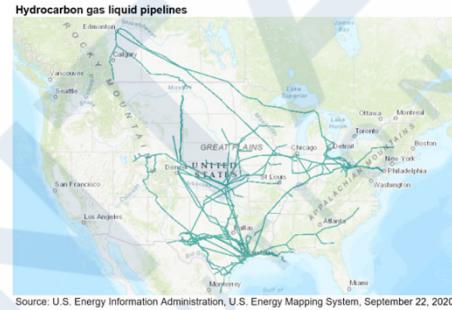
Pipeline Operations

FERC regulates tariffs (rates & rules) for US interstate pipelines; most pipelines operate as common carrier & provide third-party access

Pipelines can specify minimum shipment size

Typically shippers submit nominations on or before 15th of month, for delivery in the next month

Apportionment: if pipeline capacity is oversubscribed, pipeline can allocate capacity between shippers by different means, e.g. based on historical volumes, proration



Source: U.S. Energy Information Administration, U.S. Energy Mapping System, September 22, 2020

Pipeline scheduling is carried out according to each pipeline's operating procedures.

Nominations are supply or loading instructions and information sent by the operations team of the buyer or seller in order to arrange the logistics for a contract delivery.

For pipelines, shippers submit a nomination (also known as a notice of tender or notice of shipment – NOS) for movements in the following month.

Shippers inform the pipeline of their intended movements several weeks ahead of the cycle. For many NGL pipelines, final nominations are submitted on or before the 15th of the preceding month prior to the month in which delivery will take place.

Sometimes there is no physical movement, for example when material is traded “in place” within a storage facility, or on a pipeline using a Product Transfer Order (PTO).

On a monthly basis, the pipeline allocates a share of losses to individual shippers.

Shipping Operations

Laytime: total time allowed for loading and discharging a cargo

Demurrage: charge for excess laytime

Chartering

- Identify suitable vessel: passes vetting, fits port requirements, meets required ETA at load port
- Owner makes firm offer via broker including vessel details, cargo, load/disports, laytime, demurrage, freight rate
- Different types of charter party, e.g. voyage, time
- Contract provisionally agreed & put on subjects until lifted when required approvals received

Nominations

- Trading contracts include detailed nomination clauses, e.g. the information to be provided, to whom, by when
- In Europe ToT contracts are common: 10 days notice of 3 day delivery window
- Nomination information may include:
 - *Grade(s) & approximate quantity (including tolerance) to be loaded, name of vessel & description, load port, loading date range, destination, documentary instructions*
- Receiver must confirm or reject by a certain date
 - *Receiver must have reasonable grounds to reject nomination*

Who nominates a vessel depends on the Incoterm. In a FOB sale, usually the buyer (who arranges the transportation) will send the nomination (loading instructions) to the seller. The seller has to confirm or reject the nomination by a certain date. In a CIF or DAP sale, the seller (who arranges the transportation) will send the nomination including planned supply information, timing etc. The seller has to nominate the vessel to the buyer.

Failure to make a timely nomination is a breach of contract, but could also cause a vessel to be late berthed and lead to unrecoverable demurrage.

Laytime

The total amount of time allowed for loading and discharge a cargo.

Demurrage

The charge for excess laytime incurred in loading or discharging a vessel. It is incurred when the used laytime exceeds the allowed laytime. There are separate laytime and demurrage provisions in oil purchase/sale contracts, and in the freight charter party, which can be an exposure. For example, if the charterer pays demurrage to a shipowner, can the charterer recover it as contract demurrage? Some contracts specify that demurrage is only payable if the charterer has to pay it to the shipowner.



Trading Strategies I



Trading Strategies

Supply trading

- Trading for physical supply chain imbalances on behalf of the rest of the company, e.g.
- *Sell NGL production*
- *Buy feedstocks for refinery or chemical plant*
- *Buy for marketing needs*
- Aim to improve margins by optimizing location, quality, timing & logistics
- Trade around flexible physical assets, e.g. storage

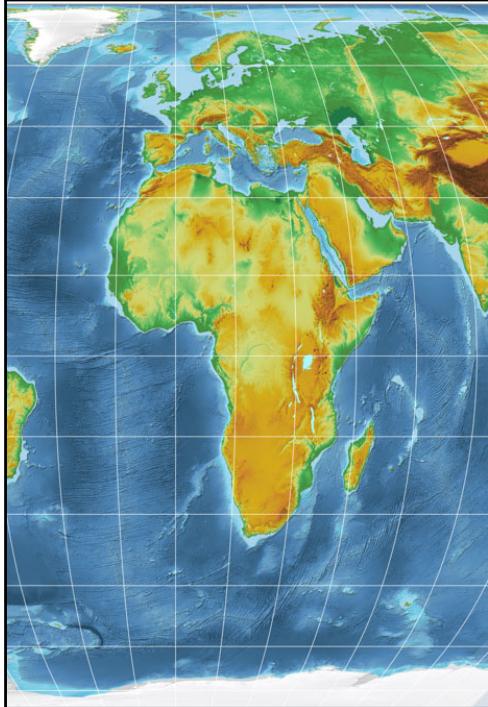


The balance of quality, location, and volume of international and locally sourced NGLs is a massive operation undertaken by trading teams. Physical trading is focused on transit, around infrastructure, and on balancing supply and demand.

Location trades are transacted to save the transportation costs of moving NGLs to desired locations.

Volume imbalances exist due to production not matching marketing requirements. This results in a net long or short position which requires outright purchase or sale requirements into the marketplace.

If a company has physical assets that have flexibility, and if that flexibility is available to traders (i.e. not fully committed to meeting operational requirements) this opens up a world of opportunities to make money by trading around this flexibility.



Locational (Geographic) Arbitrage

Profit from geographic price differences

- Price difference for the same product in different regions must exceed cost of transportation & transaction costs
- Availability of transportation is essential
- Monitor how many other traders are seeking to profit from the same arbitrage

Arbitrage is the simultaneous purchase and sale of two products to capture a favorable price differential.

There are three types of arbitrage:

- Location arbitrage
- Quality arbitrage
- Time arbitrage

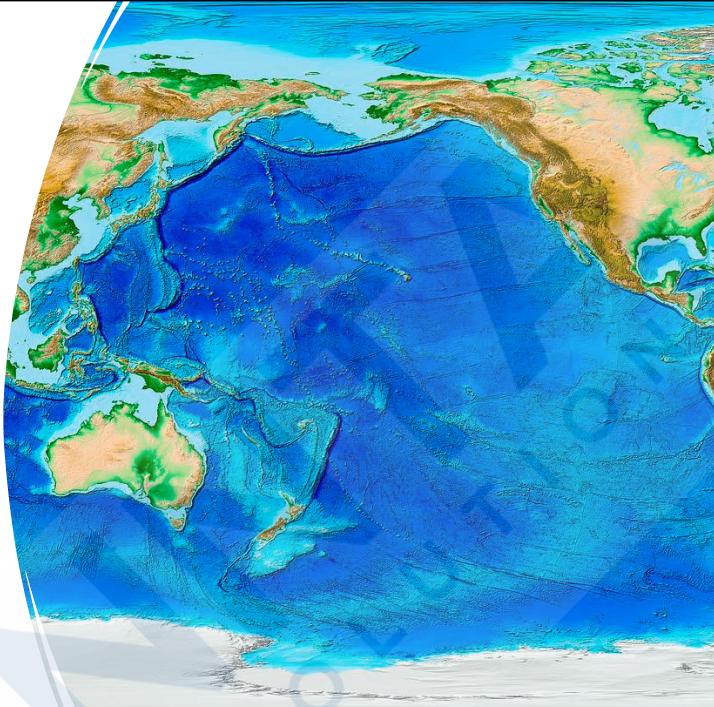
Trade flows represent the result of supply, demand and regional pricing factors at work. As prices strengthen in one global region, traders anticipate (or observe) the strengthening trend, position product and shipping, and move the product to the stronger market. This same analysis helps traders find the lowest prices when sourcing (buying) products to meet system demand. These trade flows are driven by the economics of arbitrage (price differentials) between regions, or by companies seeking outlets in distant markets simply to move the barrels because local markets are saturated.

Pricing differences among international market regions are the economic engines that cause products to move globally between markets. When a product needs to be bought and sold, and pipeline and/or marine delivery is feasible, the trader should check to see where the best value can be obtained. It may be a local market or a distant market arbitrage.

NGLs Trading

Key arbitrage opportunities

- Within regions
- US to Europe
- US to Asia
- US to Latin America/Caribbean
- Middle East to Asia



The US exports primarily to Europe, to the Pacific basin (especially South Korea, China and Japan), and Latin America. The Middle East exports to Asia, including to India. Europe competes for supplies with Asia.

The expansion of the Panama Canal in 2016, which permitted the passage of VLGCs for the first time, led to increased exports from the USA to Asia because of the significantly shorter distance and transit time compared to going round the Cape of Good Hope. Going to Asia via Panama cuts the distance by more than a third. The Panama Canal widening also increased movements to the west coast of Latin America.

There is growing potential for arbitrages to sub-Saharan Africa, especially as new infrastructure is built.

Evaluation of Arbitrage Opportunities



The basic equation is that there must be sufficient trading profit (which can ideally be near-perfectly hedged) to more than cover all the costs involved in making the trade.

A key part of arbitrage calculations for US exports is terminal fees: buyers from the main export hubs agree a volume of product and the associated term fees to cover the costs of loading from a storage facility.



Factors Affecting Freight Rates

Overall tanker market

- Market supply: availability of vessels, new build rates, scrappage rates, dry docking schedules, weather-related disruptions, transit delays (e.g. Panama)
- Market demand: arbitrage trade, import/export flows
- Operating costs, especially cost of bunker fuel

Specific voyages

- Size of vessel
- The voyage and route
- Flexibility, e.g. multi-port discharge optionality
- Laytime and anticipation of delays

Long wait times at Panama can disrupt loadings in the US Gulf. [Baltic Exchange has VLGC rates and LPG Index]

VLGC rates are driven by US to Asia and Middle East to Asia trade flows.

The two biggest constraints on ship supply are Panama Canal congestion and LPG maintenance drydockings. If Panama Canal congestion gets high enough, then volumes go via the Cape, leading to higher rates. This tends to only affect spot trades, as term trades tend to have transit reservations at Panama.

Traders want as much flexibility as possible, for example not specifying the destination when the cargo loads (as the sale is not yet agreed). The charter party might not have a final destination port, but might include different rates for different destinations.

A larger cargo size will provide economies of scale. However, smaller vessels may need less laytime. If you have less than the standard 72 hours laytime, you would get a lower freight rate.

Laytime: the total amount of time allowed in the charter party for loading and discharging a cargo. Tanker charter party contracts provide a single allowance, commonly 72 hours, for loading and discharging.

Sources of Arbitrage Trading Profit

Take advantage of regional supply/demand imbalances, but also...

- Use pricing terms to benefit from spreads between benchmarks
- Make bulk to improve transport economics
- Trade to attract high-paying buyers
 - e.g. resolve credit issues



Arbitrage Trading Assessment

Do we have a buyer?

- If not, is there a risk of not finding a willing buyer?
- If so, could our buyer possibly reject the cargo?

Are there likely to be operational delays?

- What level of demurrage is likely or possible?
- Would a delay in bill of lading or notice of readiness to discharge affect the deal price?
- Is our hedging plan flexible enough to cope with delays?

Is there any doubt over shipping availability or cost?

What are the opportunity costs of this trade?

- Where/how else could this material be sold or used or blended?
- Is this the best use of available shipping capacity?

Resale differentials

- Is it more profitable to resell a term cargo than cancel it?
- Does sales price exceed the lifting cost minus cancellation fee?

There are many potential pitfalls in arb trading, and a single major loss could offset the profits of several individual trades.



Trading Contracts



Physical Market Instruments

Spot

- Single parcel, to be delivered within days/weeks

Term

- Series of deliveries over longer period

Forwards

- Single parcel to be delivered in a future calendar month (beyond spot time horizon)



Trading Contracts

Establishes the responsibilities and obligations of both parties regarding transferring title

A contract usually requires an offer, acceptance & consideration

Physical trading contracts typically contain two parts:

- Specific terms
- Industry standard general terms & conditions (GT&Cs)



Specific Contract Terms

The parties, i.e. the buyer and seller

Description of the commodity

- Grade & quality specification

Quantity

- Volume & units

Delivery

- Where, when, who pays for carriage etc.

Price or mechanism for calculating it

Payment & credit terms



Contracts

Many companies have their own GT&Cs, which anyone can use

Industry standard general terms and conditions (GT&Cs)

- The precise point at which risk and title passes from the seller to the buyer
- Transportation requirements
- Quantity measurement and quality sampling
- Responsibility for acquiring insurance
- Nominations: timing & information required
- Laydays, time allowed (laytime), delays and demurrage
- ...plus claims, taxes and duties, applicable law, force majeure, dispute resolution, notices etc.

The GT&Cs cover all remaining aspects of the contract. Standard GT&Cs are issued by most producers, major oil and gas companies and some trading houses, but are freely available for anyone to use. These terms typically do not change from deal to deal.

Ideally when buying and selling, you should back to back the GT&Cs to limit your exposure.

Pricing Mechanisms

Trades can be fully fixed, fully floating, or partly fixed & partly floating (e.g. 50% at \$800/t + 50% July swap + \$4/t)

	Negotiable
Fixed (flat/outright) price	<ul style="list-style-type: none">Derivatives (futures, swaps)Some spot contractsPosted and official selling prices (OSPs): non-negotiable offers by a buyer or seller
Floating (formula) price	<ul style="list-style-type: none">Some spot contractsMany term contracts

Fixed price contracts name a price in cents per gallon (or other currency and units) which is agreed when the deal is struck and does not change. In fixed price deals, the price is set at the time of the deal by negotiation or by accepting a trader's bid or offer price. Fixed prices are commonly found in forward and spot markets for all commodities.

Floating price contracts define a mechanism by which the deal price will be calculated, but the actual price is not known until a later date, typically when the cargo is loaded or discharged. Spot trades usually use a simple negotiated fixed premium or discount to an agreed published benchmark price (e.g. OPIS Conway, calculated as a monthly average).

Many national oil companies (NOCs) publish posted (or official selling prices) prices for their term sales, which are (in theory) non-negotiable. OSPs are the prices they wish to receive when selling, and are (in theory) non-negotiable. Posted prices are usually published on a monthly basis. Key OSPs include those published by Saudi Aramco, Sonatrach and Kuwait Petroleum Company. Product postings for sales in different locations and using different modalities are common in USA and China.

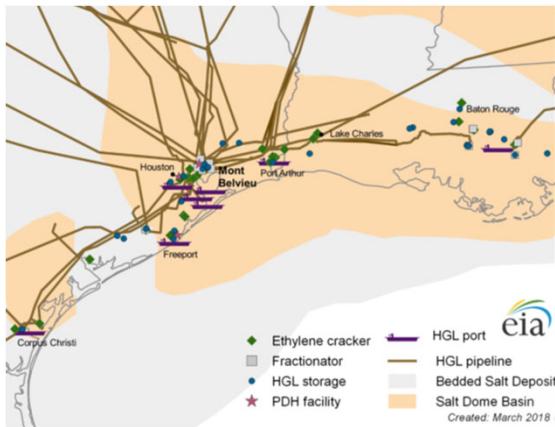
Pricing Mechanisms

You don't know the purchase or sale price now, but you agree the formula for calculating the price in the future

Floating / formula / index price

- Price formula agreed at the time of the trade
- Price becomes fixed on a particular date/period in the future
 - *Usually linked to loading or discharge of cargo, or pipeline movement*
- Market index is usually a published benchmark, e.g. Argus NW Europe large cargoes, or OPIS Conway
- Traders negotiate a premium or discount to the benchmark, reflecting difference in quality, location, quantity or timing

Benchmark Locations



Features

- Transit/trans-shipment hub
- Physical infrastructure e.g. storage, gas processing/fractionation, petrochemical crackers
- Price transparency
 - *Published prices used in contracts indexation*
- Liquid spot & forward trading market
 - *Diverse group of buyers & sellers, not dominated by a few players*
- Standardized trading practices, including contracts

Most benchmark locations are key transit points, with a range of different options (for example pipeline, rail, truck and/or waterborne) allowing the transportation of NGLs to domestic or export markets. Pipeline interconnections are also important, linking the hub to other areas of supply and demand, allowing the commodity to move in and out of the hub as supply and demand fundamentals change. Many hubs also have physical infrastructure, including gas processing and fractionation, storage, and petrochemical cracking. It is key that any essential infrastructure, such as terminals and storage facilities, provides third party access thereby enabling the hub to be accessible to all market participants.

The most well traded benchmark hubs are used a reference prices for physical and financial trading. Prices that are published by price reporting agencies is essential, allowing companies to use those prices in their contracts.

Key Benchmark Locations for NGLs

North America: Mont Belvieu, Conway

Europe: ARA, Argus North Sea Index (ANSI)

Asia: Argus Far East Index (AFEI), Argus Ningbo Index (ANI), Japan

Middle East/North Africa: Saudi contract price (CP), Sonatrach CP



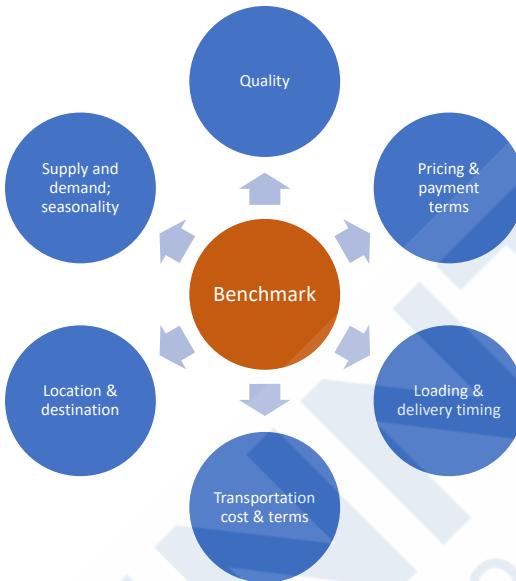
NGLs also benchmarked against other commodities, e.g. WTI crude oil, Henry Hub natural gas, RBOB gasoline, naphtha

Mont Belvieu is the most mature NGL trading hub,

ANSI is a monthly index based on assessments of the last five days of the previous month large cargo CIF ARA trades less freight (for mid size cargoes on North Sea routes). AFEI is calculated as the calendar month average of Japan CFR prices. The official selling prices of Saudi Aramco and Sonatrach are published monthly.

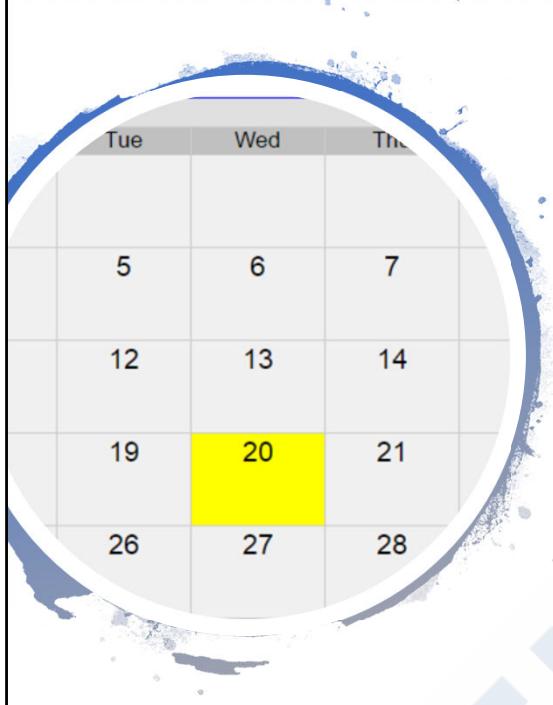


Assessing Differentials



When products are traded at a premium or discount to a benchmark, then the traded differentials represent a number of factors including:

- Quality: how the quality of the traded grade compares to the benchmark.
- Pricing terms.
- Payment terms: longer payment terms could lead to a premium being added to the price, as could a transaction where a payment is made fully or partly in a local currency.
- Timing of cargo loading/delivery: when the commodity will load or be delivered compared to the timing of the benchmark. The forward curve structure influences these differentials.
- Transportation cost & terms: for example, if the basis of the benchmark is FOB, and the traded contract is CIF. Factors also include the size of the cargo and the length of voyage.
- Fundamentals: relative availability of and demand for different grades. Logistics include constraints on transportation types e.g. pipeline congestion.
- Location and destination: local market conditions will also affect grade differentials – prices will vary in different locations.



Floating Price

Pricing dates

- Fixed price is often calculated as an average of spot price quotations, e.g. calendar month average (CMA)
- Can also be linked to a reference date, e.g. loading or discharge
- High, low or mean price quotations
- Specify handling of non-publication days, e.g. public holidays and weekends

A calendar month average is the average of prices from the first to the final day of the month.

The date or period that a floating price becomes fixed is detailed in the contract. It can be around the time the cargo loads or discharges, for example, or at the same time as the title transfer.

Contracts must define how weekends and public holidays are to be dealt with in calculating averages.

Price Sources

Price information sources

- Global markets: S&P Global Platts, Argus Media, ICIS
- Regional markets: RIM Intelligence, OPIS
- Others:
 - Real-time services: Refinitiv Eikon, Bloomberg
 - Futures exchanges: ICE, CME

S&P Global

Platts



Price transparency is a major issue in the physical oil and gas markets as prices for physical market transactions are not reported by an official body, and wholesale trades are bilateral and confidential transactions.

To provide indications of prices being traded in the spot market, a number of different price reporting agencies (PRAs) provide daily price assessments of different grades of oil, gas and petrochemicals, including Platts, Argus Media, OPIS, ICIS and RIM Intelligence. The PRAs provide news and price assessments in a range of different markets.

OPIS is the key pricing source used for benchmarking NGLs in North America, and Argus in other areas of the world. Platts is the leading PRA for most other oil grade assessments (e.g. crude oil, naphtha, gasoline).

Price Reporting Agencies

Spot market reporting

- Physical market trades are mostly bilateral & confidential
- Providing price transparency is essential, but complex
- Issues:
 - *Where there is little standardization in the physical market, information collected must be normalized to a standard quality, quantity & timing*
 - *Prices must be published daily (for settling floating deals) but some markets are illiquid, and do not trade every day*
 - *Many deals are traded as a premium/discount to benchmark prices, but PRAs report absolute prices*



The PRAs aim to collect information from market participants about the price levels in concluded spot market deals. If no deals have been done in a particular market, however, the PRAs will make market assessments based on confirmed bids and offers.

In illiquid markets, price assessments are calculated by looking at prices for similar grades, and then adjusting these prices using differentials to reflect the grade, location, timing or other factors.

Price assessments are made based on a defined and standardized quality specification, for a certain volume and loading with a specified time frame. Although reporters collect information on a wide range of deals, prices will be normalized to this standard specification.

Price Reporting Agencies



Different methodologies

- Timing of price assessments, e.g.
 - Whole-day range
 - Time-stamped, e.g. deals done in last 5 mins of a trading window (Market-on-Close), or specific time
- Average of deals done, e.g. simple or volume weighted
- Assessments of illiquid markets
- “Standard” deal size, spec & timing

The PRAs use different methodologies for the periods over which they assess oil prices: all-day assessments represent the full day of trading, providing the highest and lowest price of deals done, as well as volume-weighted average prices throughout the day; time-stamped assessments are assessed at a precise time.

Because of the different methodologies used by the PRAs, prices for the same grade are often different.





e.g. 44,000 metric tonnes, plus or minus 5% buyer's operational tolerance"

Quantity Clauses

Typical units

- Volume at a standard temperature or weight (air or vac)

Point of measurement

- When and where quantity to be measured
 - e.g. shore measurements at loading (bill of lading)

Flexibility

- Operational tolerance
 - Agreed volume +/- 5% or 10%, or +/- a fixed amount
 - At buyer's or seller's option
 - Opportunity to make or save money
- Minimum or maximum, or range

Standard temperature is 60 deg F or 15 deg C. The weight measured in air is reduced by the buoyancy of the air. The true density of oil (which is by weighing in a vacuum) is approximately 1.1 kg/m³ higher than that measured in air.

Outturn: the buyer only pays for the actual amount of received, rather than the amount loaded.

Operational tolerance (optol) refers to the buyer's or seller's ability to adjust the contracted volume or it may also apply to a ship captain's action to top off a vessel's loaded volume to avoid deadfreight (extra room in the cargo tanks for more volume of product). For the seller, operational tolerance can be used to maximise profits or minimise losses. For example, if the contract price is favourable to the seller (depending on the contango or backwardation), the trader will strive to see that maximum volume (or weight) is delivered. Operational tolerances represent an area of profitability management opportunity – so traders need to monitor this closely. Contracts will specify whether the tolerance is in the seller's or buyer's option – in most FOB sales the buyer has the operational tolerance.

Incoterms® 2020



International Commercial Terms

- Standardized trade terms which are widely used in commodity sales and purchase contracts
- Describes how obligations, costs & risks of delivery are split between buyer and seller

Commonly used terms in oil trading

- F-terms, e.g. FOB, FCA
 - *Risk & costs transfer at loading point*
 - C-terms, e.g. CFR, CIF
 - *Risk passes at load port, costs transfer at destination*
 - D-terms, e.g. DAP
 - *Risk & costs transfer at destination*
- Incoterms from previous publications can be used, e.g. DES & DAF (Incoterms® 2000) are still popular in oil/gas trading

FOB = Free on Board, FCA = Free Carrier

CFR = Cost and Freight, CIF = Cost, Insurance and Freight

DAP = Delivered at Place, DES = Delivered ex Ship, DAF = Delivered at Frontier

Incoterms® were first published by the International Chamber of Commerce (ICC) in 1936. The current revision came into effect at the beginning of 2020. Each Incoterm® clarifies how obligations, costs and risks are split between the buyer and seller in connection with the delivery of goods.

There are eleven Incoterms® split into two categories – rules for any mode of transport (EXW, FCA, CPT, CIP, DDP, DPU, DAP), and rules for sea and inland waterways only (FAS, FOB, CFR, CIF).

Rules for any mode of transport can be used where there is no maritime transport, or where maritime transport is used for only part of the carriage. Rules for sea and inland waterways are used where the delivery and destination are both ports.

The Incoterms® Rules are protected by copyright owned by ICC. Further information on the Incoterm® Rules may be obtained from the ICC website iccwbo.org. Incoterms® and the Incoterms® 2020 logo are trademarks of ICC. Use of these trademarks does not imply association with, approval of or sponsorship by ICC unless specifically stated above.

Incoterms®

The general principle is that the seller is responsible for the costs up to the point of delivery

Specify...	Do not...
<ul style="list-style-type: none">• Who arranges carriage• Who pays for which delivery costs• When risk for the goods passes from the seller to the buyer• When & where delivery occurs• Who procures insurance, export & import clearance	<ul style="list-style-type: none">• Determine ownership, or when title to the goods is transferred• Provide detail on payment obligations (when, how, what security, against what documents)• Protect the goods from risk or loss before or after delivery• Specify details of the transfer, transport and delivery of the goods• Specify where quantity and quality should be measured

Incoterms are concerned with:

Arrangement of carriage

Risk transfer

Cost transfer

There are many aspects relating to delivery which are not covered by the Incoterm® rules, and which must be specified in the sales contract.

The general principle of the rules is that the seller is responsible for the costs up to the point of delivery, and the buyer for costs beyond that. Delivery generally occurs when the seller makes the goods available to the buyer.



Incoterms® - Considerations

Industry practice is for the sales contract to specify:

- When title passes from the seller to the buyer
 - Often specified that title passes as per Incoterm®, i.e. at load for F and C terms, at discharge for D terms
 - Exact location e.g. ship's rail, loading flange, discharge terminal flange
- Who pays duties
- When quantity and quality are determined
 - Usually at the same place where title passes
- Contracts do not have to adopt all of the provisions of each rule

Completeness

- Contract and connected documents must give the term plus a named place, and refer to which version of the rules
 - e.g. FOB Flushing, Incoterms 2020

Note that Incoterms® don't specify where the delivered quantity should be measured, and where the title passes from the seller to the buyer. These should be specified precisely in the GT&Cs. Industry practice is that title passes to the buyer as per the Incoterm®.

The rules are incorporated into contracts by express reference as Incoterms® rule + named place, e.g. FOB Flushing, Incoterms 2020, or are referred to in standard contracts, e.g. FOB means free on board as defined by Incoterms 2020. The named place is essential and should be specified as precisely as possible. There must also be reference to which version of the rules is being used. Any reference to the rules is assumed to be the latest edition. It is also essential for the destination to be specified as precisely as possible.

Contracts do not have to adopt all of the provisions of each Incoterm® rule, but it must be clearly stated which specific provisions are included or not.

Other Trade Terms

Other terms (including hybrids)

- FOB origin, FOB destination
- CIF outturn/CIF landed
- FIP: free into pipeline/free in pipe
- ILX: in-line transfer
- Pipeline delivered, ex pipeline
- Into tank
- Ex tank
- ITT: in/into tank transfer
- In situ, in well, in place
- TTT: tank to tank/tanker to tanker transfer, STS: ship to ship

All the terms listed above are not Incoterms®. The buyer and seller can agree any terms but, if these are not Incoterms®, there is a risk that the buyer and seller may interpret the responsibilities in different ways.

The term FOB can be used for domestic US transactions (for example, FOB origin). However this is not an Incoterm®, but derives from sources including the Uniform Commercial Code (UCC) and industry usage.

FIP is often used when oil is supplied from a storage terminal by pipeline transfer. Risk passes to the buyer when the oil enters the pipe. The buyer pays the pipeline fees. In-situ is typically used for a stock transfer. Where material is delivered, for example delivered ex tank, the seller pays all the costs.

Delivery

Where?

- Physical delivery
- In place (book/stock transfer)



When?

- Prompt (wet): within 24 hours or by close of next business day
- Any: any day in specified month
- Ratable



Where: Delivery can be through physical movement of barrels, or in place in a storage facility (where barrels in common storage are reassigned to the buyer) or pipeline or rail terminal, or on a vessel (tanker or barge).

When:

Wet is delivery on the trade date - within 24 hours or by the end of the next business day

Any time in a specified month (e.g. at seller's option)

Ratable – across several dates within a specified date range, e.g. across 3 calendar months of a quarter



Credit Terms in Physical Trading

Payment terms depend on region, Incoterm, counterparty etc.



Credit assessment of the counterparty, the relationship between the buyer and seller, and the purchases/sales contract (e.g. the value of the transaction and timing) will determine what method of payment will be used for any transaction. All payment types have different amounts of credit risk, as well as costs.

Prepayment or advance payment would require payment to be made before the goods are supplied. This is rare but is used when the buyer cannot get a letter of credit, or for small volumes (e.g. barge or road transactions).

Collateral, for example in the form of a cash deposit which, in event of non-performance, will be forfeited.

Documentary letter of credit

Standby letter of credit

A bank guarantee is similar to a standby letter of credit

A parent company guarantee is a financial guarantee from a parent company for the trading activities of a subsidiary. The parent company guarantees that, in the event of its subsidiary not paying, the parent company will be liable for its debts.

Open account (also known as open credit) is unsecured, i.e. the seller has no financial guarantee that payment will be made except through the terms of the sales contract. Open account is usually used for counterparties assessed as having low credit risk, such as major and state-owned oil and gas companies. If you buy on open account and the seller opens a letter of credit to his supplier, a bank can ask you for an irrevocable payment undertaking – essentially an assurance that the letter of credit will be funded by a sale to you.

Trading Strategies II



Storage

Storage provides trading options

- Protect against supply interruptions & infrastructure constraints
- Improve transport economics
 - *Break bulk, make bulk*
- Flexibility
 - *Choose timing of sale/delivery*
- Take advantage of market price structure
 - *Storage play*
 - Benefit from seasonal price spreads



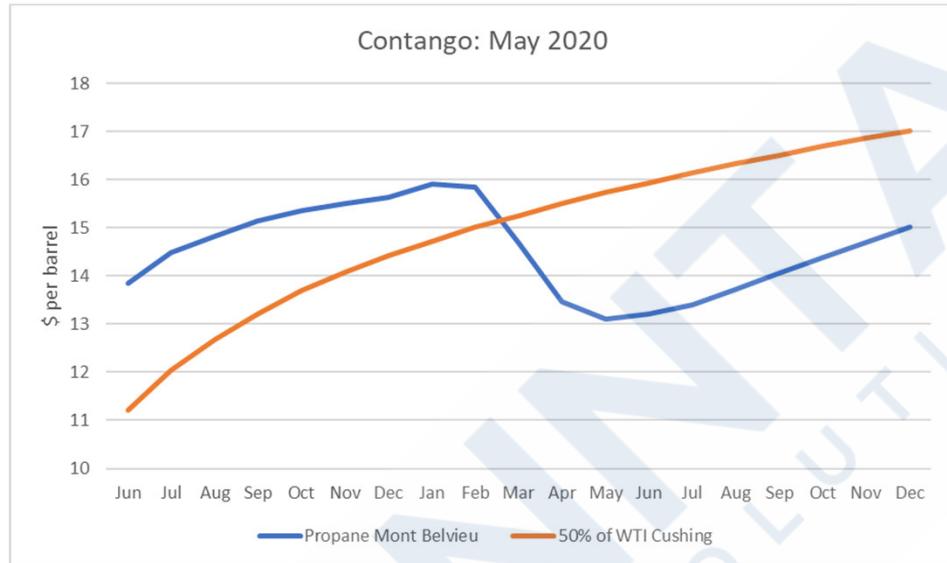
A storage play is a form of time arbitrage

Storage is a necessity in trading, whether in tanks, caverns, ships at anchor, bulk terminals, pipeline terminals, or at refineries. Storage gives the trader flexibility, which is needed for accumulation, blending, holding, and shipping product. Commercial storage is tradable, whereas working (operational) storage is needed for contractual obligations.

Storage buys the trader a vital commodity – TIME: time to think, time to take advantage of price trends, time to take advantage of price curve configurations.



Market Structure



In a contango market, prices for immediate delivery are *lower* than prices for future delivery.

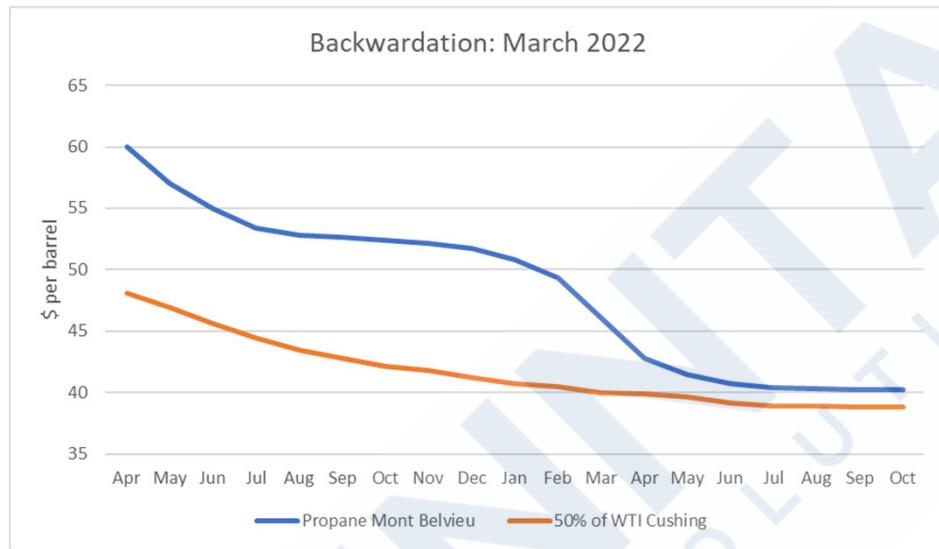
This is considered classic, theoretically correct, market behavior. Traders should be prepared to pay more for future delivery, as their alternative would be to buy the spot commodity and store it, in which case they would have to pay for the cost of storage and the cost of the money tied up in the spot purchase.

Contango markets indicate a relatively well-supplied spot market with an expectation of tighter supply conditions ahead.

The shape of the forward price curve is an important input to the decision making of the trader. In some cases, the contango may be steep enough to more than pay for the cost of storing product rather than selling it now – a form of time arbitrage.

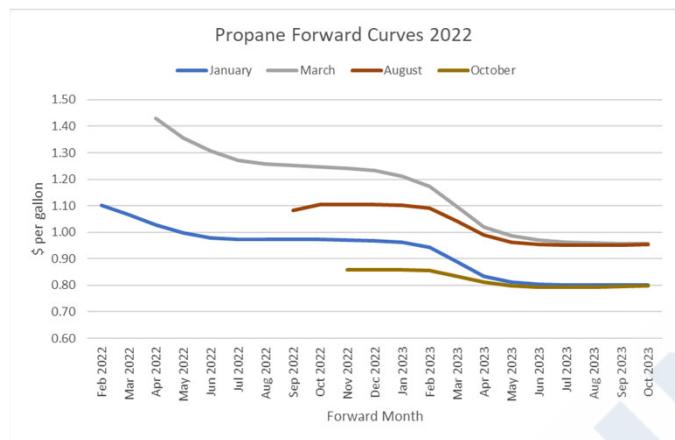
Market Structure

Backwardation is sometimes called an inverted market



In a backwardated market, prices for immediate delivery are higher than prices for future delivery. In a theoretical world with infinite storage capacity and no constraints on production, this should never happen. In practice, commodity markets can be in backwardation, reflecting relatively tight supply (and the extra value that traders put on having the commodity now) with an anticipation of easing of the market.

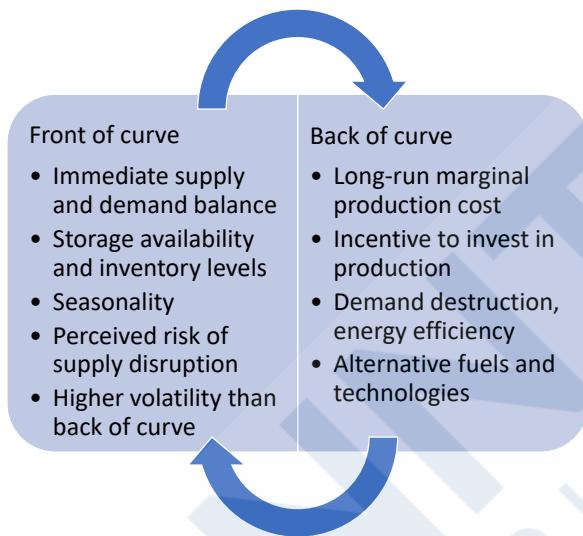
Forward Curve



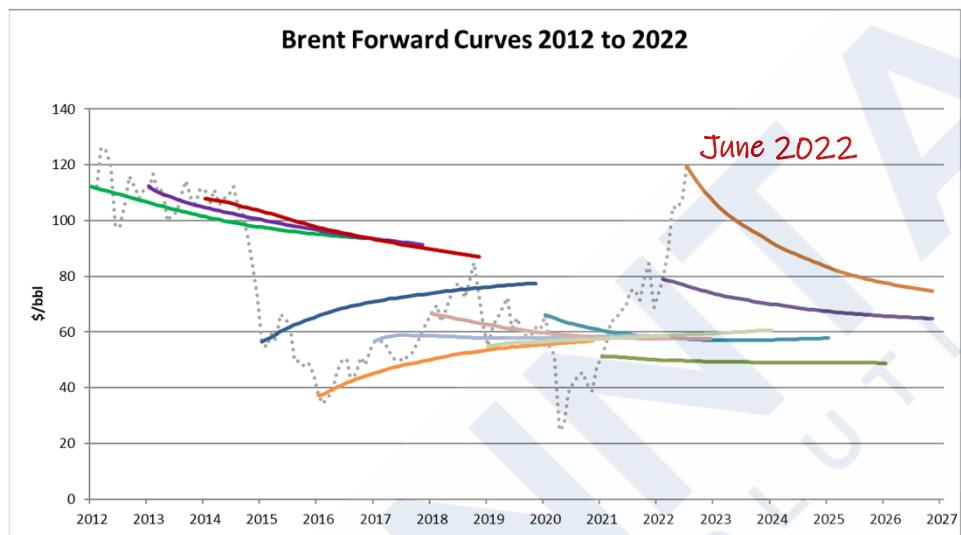
Structure

- Forward curve represents trading prices for future periods, based on market expectation
- The forward curve is not a price forecast
- Persistent patterns, slow to change
- Independent of day-to-day price moves
- Each commodity will have a different shaped curve
- Majority of trading occurs at the front of the curve

Forward Curve Drivers



Market Structure



Market structures are sometimes more complex than simple contango or backwardation (although the “front” of the market is always in one or the other state). Some energy commodities, such as natural gas and some refined products, show the influence of predictable seasonal demand patterns in their forward curves.



Time Arbitrage

Storage play in a contango market

- Market has intrinsic value if forward price exceeds cost of storage, financing & other transaction costs
- Commercial storage rates vary depending on supply/demand, product type, location, amount of storage required & for how long
- Long-haul transportation can benefit from time arbitrage
- A backwardated (inverted) market does not encourage speculative stockholding & favors short-hauls



Trading Strategies

Other arbitrage opportunities

- Price reporting agencies, e.g. OPIS vs Argus
- Price timing, e.g. which month
- Payment periods
- Laytime & demurrage

Optionality

- Freight, e.g. multiport optionality
- Volume tolerances
- Adjust timing to advance/defer loading or delivery if it affects pricing window (but there may be other operational implications)



Costs of Trading

Bid-offer spread

Broker commissions

Taxation & duties

Financing

- Credit instrument
- Cost of money

Operations/logistics

- In-transit quantity losses
- Shipping costs, including unrecovered demurrage
- Storage costs
- Insurance
- Inspection costs

Hedging

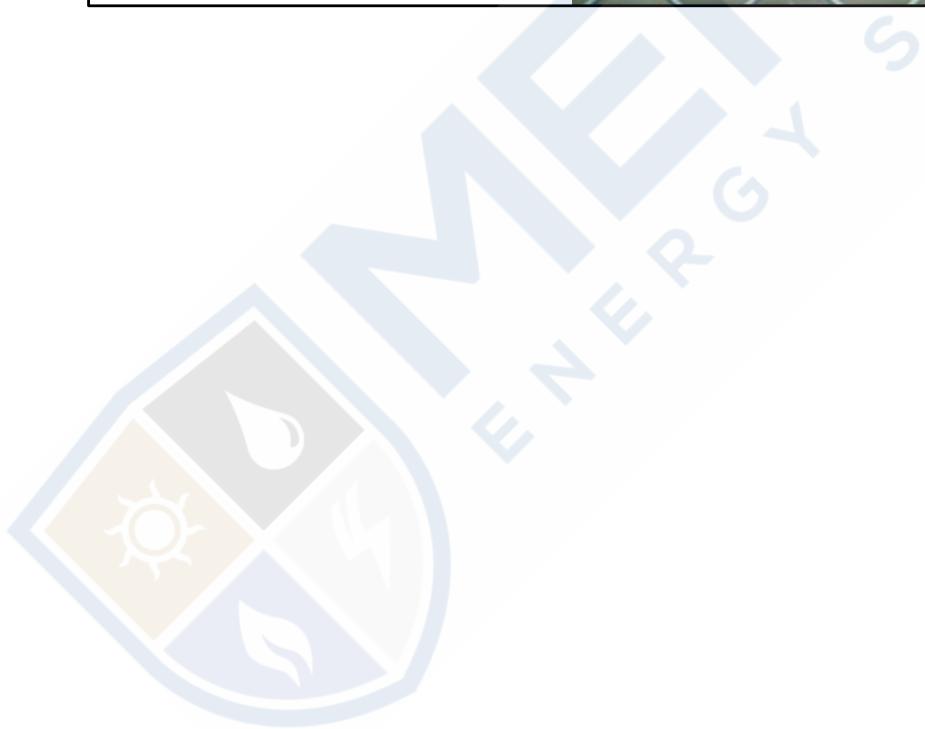
- Exchange fees
- Instrument costs, e.g. options premia

Always keep profit and loss in mind

NGL Trading Execution: Derivatives Market



Risk
Management,
Exposure and
Hedging



Risk Management

Level of risk can be considered as probability vs. impact/severity

RISK: chance of bad consequences or loss

- Key part: chance or probability
- If a loss is certain, that is not a risk



Any event that has some measurable probability of occurring has risk irrespective of how large or small the probability.

Gambling is a risk.

Driving a car entails risk, which is why insurance exists.

A risk exists that a hurricane will hit Montana.



Sources of Risk

Price risk

- *Changes in market prices*

Basis risk

- *Price movements in different instruments*

Credit risk

- *Seller not being paid*
- *Buyer not being able to finance transaction*

Operational risk

- *For example transportation delay, rogue trading*

Exchange rate risk

- *Adverse currency movements*

Liquidity risk

- *Inability to enter/exit position at an acceptable price when you want*

Price Risk: Changes in market prices

Basis Risk: Different price movements in different commodities

Credit Risk: Counterparty risk (e.g., broken contracts, bankruptcy, etc.)

Operational Risk: System problems (e.g., off-spec cargoes, transportation delays, refinery problems, rogue trading, keypunch errors, etc.)

Exchange Rate Risk: Adverse currency movements

Liquidity Risk: Inability to enter into desired positions



Price Risk Exposure

Long exposure

- Own commodity and have not yet fixed sales price
- At risk of price falling
- Benefit if price rises

Short exposure

- Need to buy commodity and have not yet fixed purchase price
- At risk of price rising
- Benefit if price falls

Spread exposure

- At risk of spread widening or narrowing

Price Risk Exposure

Measuring exposure

- Buy a product, ship it to a different location, sell the product
 - *Have price exposure when you buy it*
 - *Exposure eliminated when you sell it*
- Exposure for different pricing structures

- Fixed price—exposure is immediate.
- Indexed price—exposure is taken when the indexing period occurs. For multi-day indexing periods, a portion of the total exposure is taken each day of the period.
- Trigger prices—exposure occurs when the pricing is triggered, on the volume that is triggered that day.

Examples of Price Risk Exposure

Gas producer:
continuous price
exposure, long-term
planning horizon

Refinery: continuous
daily spot price
exposure, program
month planning horizon

Indefinite duration
Large, variable volumes

Trader: Tactical cargo
trade, floating pricing
structure

Defined duration
Fixed volume, e.g. cargo

Some energy market participants have continuous exposure to changing prices, and may engage in strategic, long-term hedging for large volumes of fuel or energy. They are usually seeking protection against rises or falls in the average price over a period of time. That period could be very long, in the case of an airline or an oil/gas producer. Other participants focus on month-to-month price fluctuations, such as the program month planning of a refinery.

Physical market traders may have a quite different pattern of market price exposures that are mainly short-term, relatively small volumes and where the exposure is linked to a specific, short period of time, such as the short pricing windows (around the loading date, for example) used in oil trading.

Measuring and Controlling Risk

Traditional measures and controls

- Volume exposure limits: e.g. barrels or tonnes long/short or spreads
- Position limits: by commodity, country, exchange etc.
- Loss limits: maximum allowable loss

Can't measure complex derivatives risk

Can't be added across markets and commodities

Traditional measures of exposure, e.g. barrels long or short, are measures of the degree of exposure to market price movements. They don't attempt to quantify the probability or probable size of loss.

Position limits are usually expressed in the units of trading (barrels, tonnes, etc.) but may also be in monetary terms. Traders may be restricted in the size of individual trades, of total book exposures, and of exposures to any individual commodity, trading venue, country, type of counterparty, etc. Position limits place constraints on the maximum size of position that a trader is allowed to hold on his book; loss limits force the trader to close positions or reduce his exposure if the mark-to-market loss of open positions exceeds an agreed limit.

Loss limits trigger a review if the mark-to-market value of an individual position, a trading strategy, or an entire trading book, exceeds an acceptable limit for losses held overnight.

Traditional measures and controls only really work for individual assets.

Value at Risk - VaR

You can choose a different holding period & confidence interval when calculating VaR

In energy trading 95%, one-day is most common

Estimate of risk exposure over a specified time horizon under normal market conditions with a given level of confidence

A trading company might say the one-day VaR of its portfolio is \$27 million at the 95 percent confidence level

VaR does not predict future realized losses, but the predicted change in the portfolio value

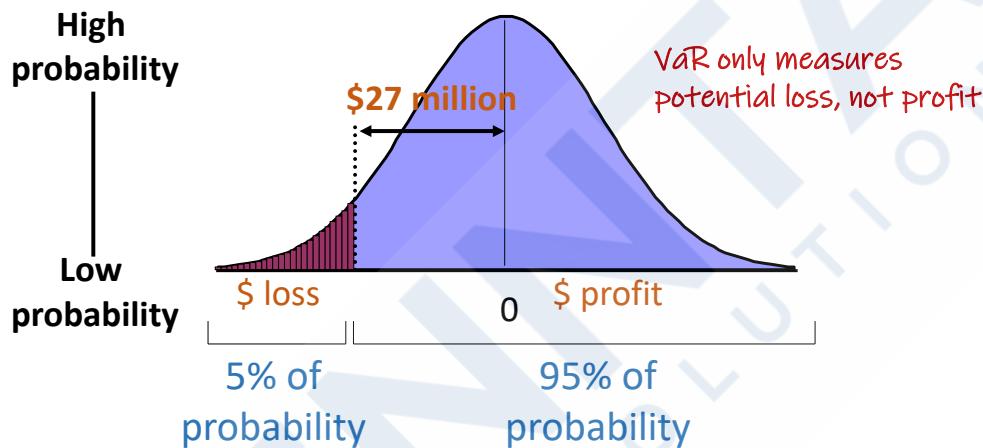
Some other definitions:

- An estimate of the level of loss on a portfolio which is expected to be equaled or exceeded with a given, small probability.
- A forecast of a given percentile, usually in the lower tail, of the distribution of returns on a portfolio over some period.

In this example, we can be 95% confident that we will lose no more than \$27 million under expected market conditions over the next trading day.

What Does That Mean?

VaR at 95% confidence interval



The range of possible outcomes for a trading portfolio over 24 hours is almost infinite. But we can say quite a lot about it. Small profits or small losses are far more likely than large profits or large losses. We can't say what the largest possible loss (or profit) might be, but we can draw some dividing lines. The 95% VaR figure defines the boundary between the worst 5% of outcomes and the best 95% of outcomes.

In VaR, we're only concerned with losses, so we only care about the left-hand end of the distribution.

Estimating Value at Risk

Three main approaches

Closed form, analytical solutions	Historical Simulation	Monte Carlo Simulation
<ul style="list-style-type: none">• “Classic” approach<ul style="list-style-type: none">• Linear VaR• Variance-Covariance• Delta-Normal• Non-linear approaches, e.g. quadratic	<ul style="list-style-type: none">• Value portfolio against actual historical price change scenarios	<ul style="list-style-type: none">• Value portfolio against realistic, imaginary scenarios• Scenarios generated using model• Correlation, volatility inputs

Closed form means that we can use a math formula to calculate the result; simulation means analyzing actual results from an iterative process. Closed form is simply a solvable formula; simulation is a mark-to-scenario process (using *many* scenarios).

Classic VaR (variance-covariance) is quick to calculate and can be useful for simple, small portfolios. However it can't capture the complexity of markets that exhibit mean reversion, seasonality etc., and is inaccurate for options.

Historical simulation VaR uses actual historical price changes as hypothetical scenarios for changes in portfolio value. It requires no modelling or assumptions about price behavior. However it assumes that historical behavior is an indicator of all future possibilities.

Monte Carlo VaR is, by far, the most common for risk measurement in energy. It is favored mainly because it can be done without complete historical data (for historical simulation) and without having to make heroic, simplifying assumptions about the behavior of options contracts. Monte Carlo simulation generates many scenarios for possible changes in the portfolio value, and determines the change in portfolio value for each scenario. You can find 95% VaR by picking out the 95th percentile loss. Its advantages are that scenarios are not limited by historic data, and it can reflect more complex price behaviors. However, the results are only as good as the assumptions.

Value at Risk

Advantages	Disadvantages
<ul style="list-style-type: none">• Summarizes market risk in a single number• Includes the probability of loss• Dynamic – it will change as volatility & trading activities change	<ul style="list-style-type: none">• Does not tell us the maximum loss or when a loss will occur• Does not model extreme events – use stress testing to do this

VaR takes account of the volatilities of each price index, the correlations between them, and the size of positions. It is easily understood, and is good for comparing risks (e.g. today's risk vs last month's, oil trading vs LNG, or actual risk taken vs risk target).

It reflects normal (historical) market conditions. It is just an estimate, often a fairly rough one.

Uses of VaR in Trading

A measure of potential trading loss

Allocate VaR limits to traders and trading groups

Evaluate trader performance

Risk disclosure, e.g. in annual reports

VaR is quite useful as a relative measure of risk, and as a risk control. Risk can be allocated to profit centers, trading desks, and individual traders, and controlled through a hierarchy of VaR limits.

VaR allows us to set a limit that defines what we want traders to do (the maximum allowable risk exposure), to run daily calculations that tell us what traders are doing (risk exposure of open positions in today's market conditions), and then if the limit is exceeded, to take action.

Risk Management

Taking actions with the deliberate aim of controlling the amount of risk in the physical market



Key word here is "control" – we are not trying to eliminate risk

In the stock market, the key risk management tool is portfolio diversification. By investing in several diverse stocks, the hope is that an adverse move in one will be balanced by unrelated moves in others.

In the energy market, the key risk management tool is *hedging*. By taking opposite positions in related commodities, the hope is that an adverse move in one will be balanced by a related move in the other.



Risk Management

What is hedging?

- Using forward prices to protect against major adverse price changes
- Buy/sell at fixed price for future delivery
- Or take a market position that will result in a cash settlement that offsets price changes



Hedging can be as simple as buying or selling in the forward market, to fix a price today for a commodity that will be delivered during some period in the future.

A more complex form of hedging involves establishing a position that is intended to offset a risk exposure that arises in the course of the business. Such a position is usually, in some sense, an **OPPOSITE** position to the physical exposure (it must make money when the physical exposure becomes loss-making for the hedge to work). It is usually also, in some sense, **EQUAL** in volume or size to the physical exposure so that losses incurred as a result of physical price moves are offset by equally large profits from the hedging instrument.

Hedging is a financial tool for reducing price and profit risk. Ideally, if we lose money on the physical position that we are hedging, we will make a corresponding amount on the financial instrument. Hedging effectively locks in a price and reduces the potential for unanticipated loss.



Reasons to Hedge

Protect against loss on a trade

- Lock-in margins / profits / costs
- Allows profitable market opportunity to be taken
- Financing bank may insist on hedging

Guarantee a return on investment

- Hedging may be essential to attract and underpin investment

Maintain competitive position

- Match hedging to competitors
- Frequent hedging objective for retail suppliers

All hedges, to some degree, replace uncertainty with certainty, allowing companies to plan better, to raise money more cheaply, and to invest in projects without fear of devastating losses arising from unexpected commodity price movements.

Tactical vs Strategic Hedging

- Defined exposure
 - Usually fixed volume (e.g. cargo)
 - Often known duration
- Hedge once
 - Hedge when exposure starts
 - Unwind when exposure ends
- Accuracy is important
 - Must protect fine trading margins
 - Choice of instrument: basis risk

Tactical

e.g. opportunistic trader



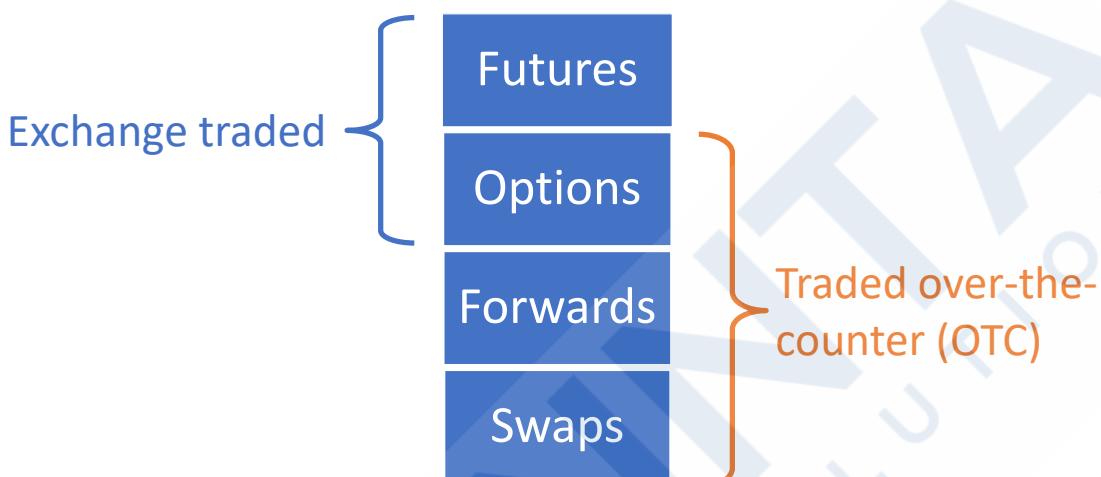
- Open ended exposure
 - No fixed end-point
 - Decide when and how much to hedge
- Hedge periodically
 - Decide frequency of hedging actions
 - Decide how far forward to hedge
- Accuracy may matter less
 - Aim is reduced variance
 - Choice of instrument: liquidity, credit

Strategic

e.g. airline, refinery, producer



Paper Markets



There is a wide variety of different ‘paper’ trading instruments including:

- Futures
- Forwards
- Options
- Swaps

In the paper markets, contracts for the purchase or sale of oil at some point in the future are traded. The contracts can be for physical delivery, or they can be purely financial instruments that are settled by a transfer of cash. Relatively little paper trading results in physical delivery, as most traders “close their position” by making an offsetting trade before the delivery period arrives.

Paper instruments provide a way to reduce the risk of price fluctuations by hedging, although they are also widely used for speculation. The paper markets are now a very important part of the oil trading market, which provides an essential forward pricing framework.

OTC means “Over The Counter”, a market in which deals result in direct legal agreements between buyers and sellers, often settled by cash flows, rather than delivery of physical oil or gas.

Exchange Traded Markets

Contract with exchange, not directly between buyer and seller

- All trading is anonymous
- Performance guaranteed by the exchange

Highly regulated

- e.g. Financial Conduct Authority (FCA) in UK for ICE; Commodity Futures Trading Commission (CFTC) in USA for CME
- Market abuse rules
- Position limits

Standardized contracts (no negotiation)

Exchange-traded markets are organized and regulated markets, in which highly standardized products are traded, with only the price being negotiable. Government regulators have full oversight of all trading activity and have powers to intervene if they suspect market manipulation. Positions are subject to both hard limits (which can never be exceeded by any trader) and softer oversight (the regulator may query an unusually large position, especially if held close to contract expiry and physical delivery).





Historically exchanges traded using "open outcry" as in this photo; now most exchanges only trade electronically

Futures Trading and Hedging

Exchange Traded Futures

Purchase or sale of a commodity for future delivery	Key features	
<ul style="list-style-type: none">• Standardized: for physically settled contracts = location & quality of deliverable oil• Defines payment terms & expiry rules• Oil futures: typical lot size of 1,000 barrels (42,000 gals) or 100 tonnes• Natural gas futures: 10,000 mmbtu	<ul style="list-style-type: none">• Requires margin payments & transaction fees• Most contracts are closed out (cash settled) before expiry• Mainly used for risk management & speculation; occasionally for physical delivery	

Futures contracts enable companies to buy and sell oil of an agreed standardised quality, quantity and delivery terms for future delivery within the regulated framework of a futures exchange. Futures deals are usually entered into with the intention of making a purely financial settlement, at or before the start of the agreed delivery period.

Historically, futures contracts have been traded via “open outcry” (or shouting) to communicate the buying or selling of futures contracts. However, European exchanges are paving the way for all-electronic trading as many new contracts are trading electronically from their inception.

The futures markets are sometimes looked at as pricing references (markers) for the physical markets. This is due in part to the large volume of paper that is executed. Paper is bought and sold at fixed prices, and then the wet barrels are traded at floating prices using a fixed differential to the paper.

Exchange Traded Futures

Major futures exchanges

- Exchanges offering oil/gas contracts which are traded internationally: ICE, CME (NYMEX)
- Other exchanges which are mainly traded locally or regionally include TOCOM, DME, IFAD, INE, MCX
- Dalian Commodity Exchange (DCE) in northeast China trades an LPG futures contract



ICE = International Commodity Exchange

CME = Chicago Mercantile Exchange

NYMEX = New York Mercantile Exchange

TOCOM = Tokyo Commodity Exchange

DME = Dubai Mercantile Exchange

IFAD = ICE Futures Abu Dhabi

INE = Shanghai International Energy Exchange

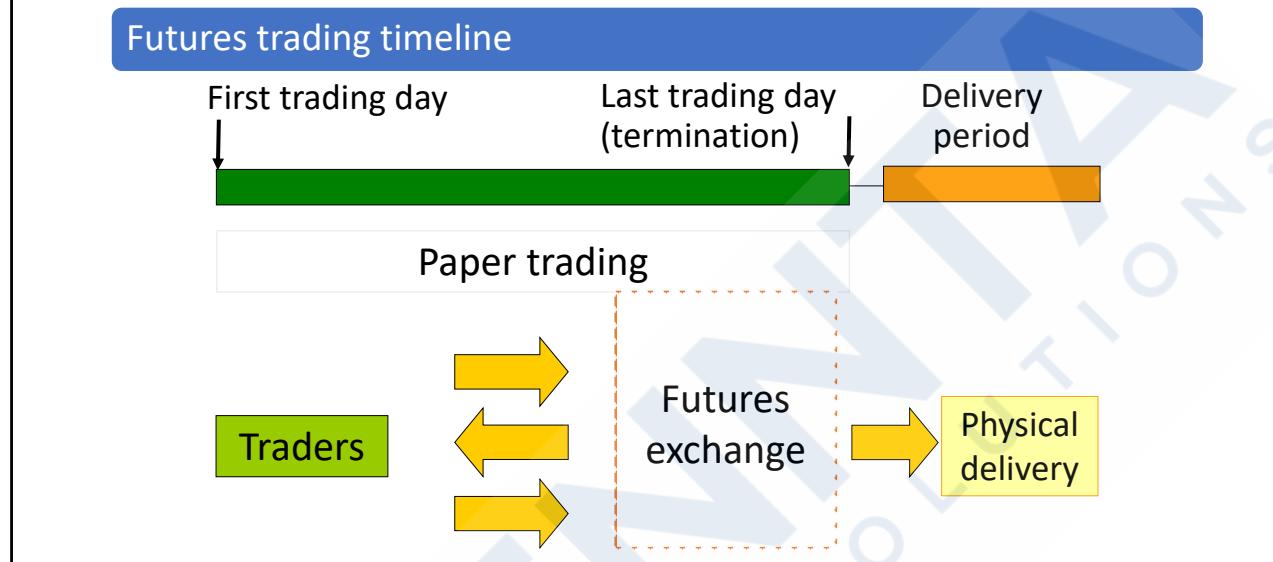
MCX = Multi Commodity Exchange of India



Futures – Main Contract Specifications

	Units	Contract Size	Delivery	Specification
CME (NYMEX)				
Crude oil	\$/barrel	1,000 bbls	FOB Cushing, Oklahoma	US crudes: API 37-42, max. 0.42%
RBOB gasoline	\$/gallon	42,000 gals	FOB New York Harbor	Reformulated regular gasoline blendstock
ULSD	\$/gallon	42,000 gals	FOB New York Harbor	Colonial pipeline grade 62
Natural gas	\$/mmBtu	10,000 mmBtu	Henry Hub	Pipeline specification
ICE				
Brent	\$/barrel	1,000 bbls	Cash settlement	(BFOET forward price)
LS Gasoil	\$/tonne	100 tes	Antwerp, Rotterdam, Amsterdam	Diesel, max 10 ppm sulfur, min 41 cetane

Futures



Delivery periods for energy futures are usually a single calendar month. Futures are initially offered for trading by the exchange up to five years before the delivery period. Traders buy and sell futures as *paper* contracts up to the last trading day (which is published in advance by the exchange), also called the *termination date* or *maturity date* of the futures contract. Any traders still holding open positions after this date are obliged to take or make delivery of the physical commodity, which is arranged by the exchange.



Futures – Termination Rules

CME Light Sweet Crude Oil

- Three business days before 25th of the month before the delivery month

ICE Brent Crude Oil

- Last business day of the 2nd month before delivery

ICE LS Gasoil

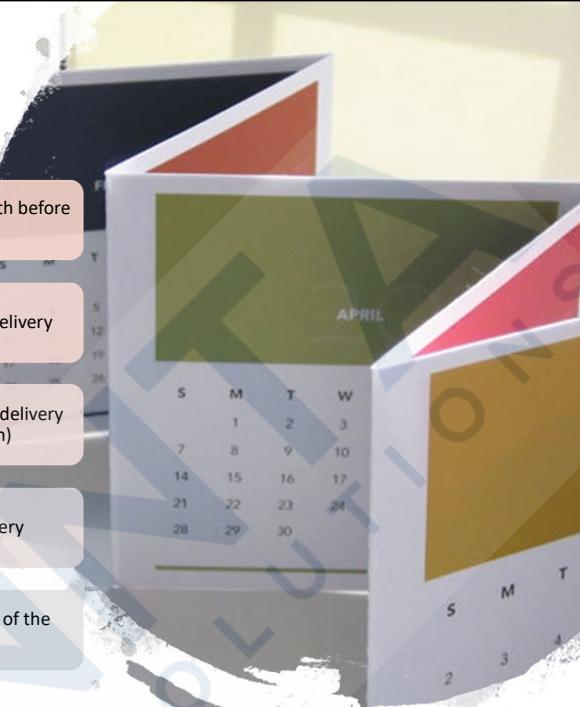
- 12:00, two business days before 14th of the delivery month (delivery occurs 16th to end of month)

CME Refined Products

- Last business day of the month before delivery

CME Natural Gas

- Three business days before 1st calendar day of the delivery month



For physically settled contracts, termination of futures trading must occur with sufficient time for traders who hold positions to maturity to make the necessary arrangements for physical settlement. For CME crude oil, settled by delivery at Cushing Oklahoma, the contract termination allows three business days before the final notification deadline for pipeline and storage movements for the delivery month.

ICE Brent is cash-settled against the value of physical forward BFOET contracts on the day of futures termination. So it needs to terminate early enough that physical forward trading is still occurring. As North Sea loading schedules are now arranged a full calendar month in advance, this requires the futures contract to terminate with at least one clear month before the notional delivery period.



Futures

Relationship to physical market

Most of the most active oil & gas futures contracts allow physical deliveries, with the exception of Brent which is cash settled

- The futures contract must tie into an underlying physical commodity with an active spot market
- Holders of futures contracts must be able to take delivery of the physical commodity or equivalent cash settlement
- If held to expiry, the exchange pairs up long and short traders who take/make delivery

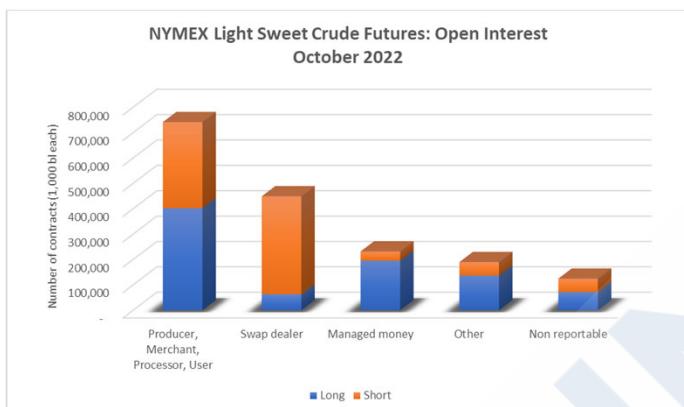
The delivery rules (e.g. quality, location, timing) can only be changed if both parties agree to an Alternative Delivery Procedure (ADP).

Most energy futures contracts are tied into the underlying physical market by the possibility of physical delivery. Buyers of futures contracts take on a contractual obligation to pay for and take delivery of the physical commodity, and sellers of futures contracts take on a contractual obligation to make delivery of the physical commodity in return for a cash payment.

Some futures contracts, where physical delivery would be difficult to achieve, are settled using cash payments linked to the price at which the physical commodity is traded in the spot markets.



Liquidity



Oil & gas futures

- Wide range of market participants including hedgers & speculators trading
- Trading volumes far exceed physical supply
- Liquidity statistics:
 - *Open interest*
 - *Volume*

Data source: CFTC Commitment of Traders Report

Open interest is the total number of open (outstanding) contracts at a particular time. It is used as an indicator of market liquidity, and market sentiment. Volume is the total number of all contracts that have been traded each day, including trades that resulted in positions being closed.





Hedging with Futures

Long price risk exposure

- Sell futures when exposure starts
- Close (buy back) position when exposure ends

Short price risk exposure

- Buy futures when exposure starts
- Close (sell back) position when exposure ends

Hedging with Futures

Trader selling natural gasoline from Midwest US to Edmonton

Units: cts/gal	Now	Pricing Date (down)	Pricing Date (up)
Cost to buy and ship	158 c/gal		
Natural gasoline spot price Edmonton	166 c/gal	140 c/gal	180 c/gal
Unhedged P/L		-18 c/gal	+22 c/gal
CME WTI futures	Sell at \$88.20/b (210 c/gal)	Buy at \$77.28/b (184 c/gal)	Buy at \$94.08/b (224 c/gal)
Payout from hedge		+26 c/gal	-14 c/gal
Hedged P/L		+8 c/gal	+8 c/gal

A trader in the Midwest US spots an arbitrage opportunity to sell natural gasoline in Edmonton. He can buy the natural gasoline and transport it to Edmonton for a delivered cost of 158 cts/gal.

As he contemplates the deal, the spot price for natural gasoline in Edmonton is trading at 166 cts/gal, indicating a possible 8 cts/gal profit. But by the time the natural gasoline arrives in Edmonton and prices in, the spot market price will have changed.

If the trader takes the risk of leaving the selling price unhedged, he faces a wide range of possible outcomes. In the case above where the spot market price in Edmonton rises further, he would have a profit of 22 cts/gal, but in the case where the natural gasoline price drops, he would lose 18 cts/gal.

To try to lock in the 8 cts/gal profit, the trader can hedge his sale price by taking a short futures position (selling now to buy back later). In this example, when the natural gasoline price falls by 26 cts/gal to 140, the futures price also falls by 26 cts/gal, offsetting the trader's loss exactly and bringing him back to an 8 cts/gal profit. Similarly, when the natural gasoline price rises by 22 cts/gal to 180, the futures price also rises by 22 cts/gal, giving the trader a loss in the futures market that reduces his profit back to 8 cts/gal.

Futures

Functions of the clearing house

- Match and process all trades
- Keep track of traders' net positions
- Assure financial security for all trades
- Calculate and collect margins



The clearing house ensures anonymity to both buyers and sellers.

In a futures deal, the exchange stands between the buyer and seller, who each enter into a separate transaction with the exchange. The buyer and seller remain anonymous to each other. The exchange takes on the risks of non-performance and non-payment. The clearing house underwrites these risks, but does so by requiring traders to "post margin."

Futures Margins

Mark-to-market: value position using current market prices to determine theoretical profit/loss

Initial margin

- A returnable deposit
- Percentage of initial position value (as set by the clearing house)

Variation margin

- Also known as maintenance margin
- Daily mark-to-market (based on exchange settlement price) captures full profit or loss to date

An initial margin is a returnable deposit required by any trader with an open futures position. Initial margin amounts are set by the exchange and varied from time to time, as market conditions (primarily volatility) change.

Mark to market (M2M) profits are added to the margin account, but M2M losses are taken from it. If the margin account falls below the required maintenance level, a margin call is made, requiring the trader to add cash to bring the account back to the maintenance level. Mark-to-market gives an estimate of what the profit or loss would be if a position was closed now. The futures settlement price is the price at the end of each trading day.

At any point, the trader will have received payments equal to the difference between the price at which the position was originally opened, and the most recent settlement price. If held to maturity for physical delivery, delivery is made and paid for at the futures contract's final settlement price.

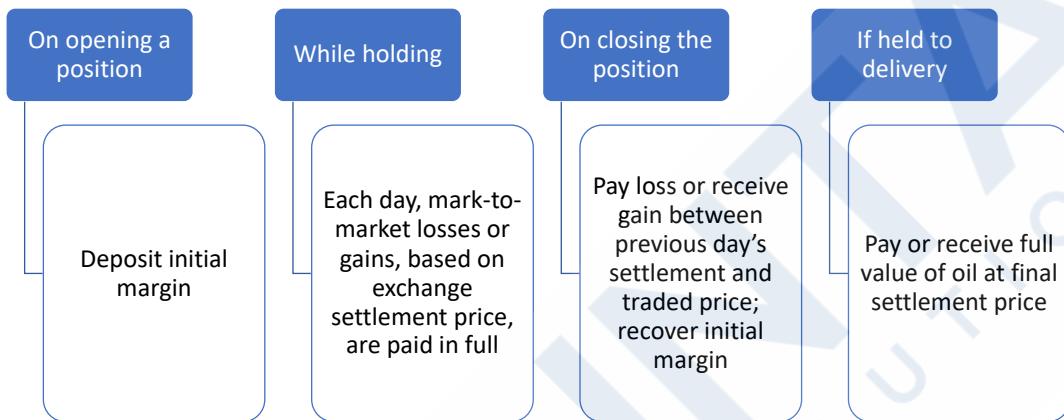
Margining Example

Margin call - when the margin account falls below the required maintenance level and trader is required to deposit more cash.

Date	Action	Margin Account
Friday December 4	Buy 1 contract (1,000 barrels) of CME WTI June futures at \$80.35/bl	Deposit \$6,100
Monday December 7	Futures settlement is \$80.60; notional profit of \$0.25/bl x 1000 barrels (\$250)	Balance \$6,350
Tuesday December 8	Futures settlement is \$79.96; notional loss of \$0.64/bl x 1000 barrels (\$640)	Balance \$5,710 Margin call \$390
Wednesday December 9	Futures settlement is \$80.20; notional profit of \$0.24 x 1000 barrels (\$240)	Balance \$6,340

Standard Portfolio Analysis of Risk® (SPAN®) is a market scenario-based system which is used by many of the world's exchanges, including CME and ICE, to calculate the appropriate level of margin needed for traders with portfolios of futures and options positions. SPAN evaluates how much value a particular contract will gain or lose under various market scenarios. Most exchanges use 16 scenarios in which futures prices remain unchanged, move up or down by certain amounts and volatility increases, decreases or remains unchanged, also known as SPAN risk arrays. Margins cover the largest likely loss that a position is likely to incur in one day based on the volatility of historical prices.

Futures – Cash Flows



An initial margin is a returnable deposit required by any trader with an open futures position. Initial margin amounts are set by the exchange and varied from time to time, as market conditions (primarily volatility) change.

Mark to market (M2M) profits are added to the margin account, but M2M losses are taken from it. If the margin account falls below the required maintenance level, a margin call is made, requiring the trader to add cash to bring the account back to the maintenance level.

At any point, the trader will have received payments equal to the difference between the price at which the position was originally opened, and the most recent settlement price. If held to maturity for physical delivery, delivery is made and paid for at the futures contract's final settlement price.

Hedging with Futures

Basis or residual risk is the risk associated with imperfect hedging, e.g. the futures price is not perfectly correlated with the physical price

Advantages	Disadvantages
<ul style="list-style-type: none">• Credit risk protection• Liquid market• Ability to fix revenues, costs or margins• Flexible e.g. how/when to open and close a position	<ul style="list-style-type: none">• Limited number of contracts• Basis risk: quality, location, calendar• Cashflow implications of margining• Cannot benefit from favorable physical price movements



Since hedging with futures fixes prices and margins in advance, the hedger foregoes any potential for windfall gains while reducing the potential for unanticipated losses.

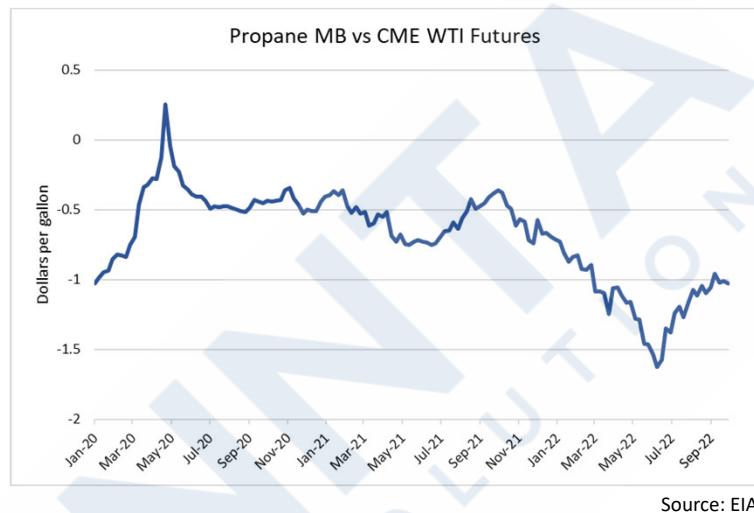
The windfall gain from a rising market is foregone by the short futures hedge, which commits to the future sale of the commodity at a fixed price.

The windfall gain from a falling market is foregone by the long hedge, which commits the purchaser to a fixed cost.

Basis Risk

A perfect hedge would need a stable basis.
The volatile basis in the chart below will
affect how the hedge performs

Basis risk is the risk left over after using an imperfect hedging instrument



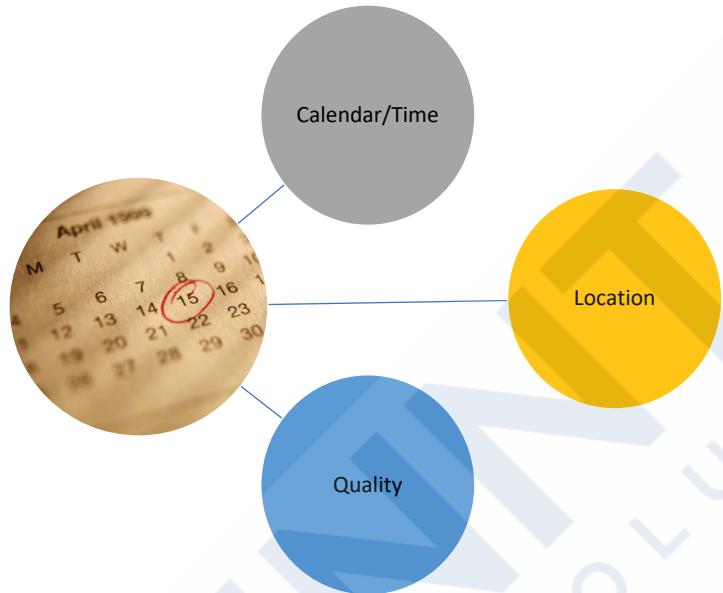
In an ideal world, physical and futures prices would be perfectly correlated, and would go up and down in step. But there are no perfect hedges and the futures price will not exactly track the physical price, which leads to basis risk. The problem with futures is that there is a lack of contracts and so almost everyone hedging with futures is exposed to basis risk.

Hedging with futures provides price risk protection and counterparty risk protection, but not basis risk protection. If you trade futures, you are implicitly trading basis – it is an inherent exposure.

Basis risk is also known as correlation risk, and is a key consideration when hedging with futures. Traders should view hedging as the transfer of outright price risk to basis risk.



Types of Basis Risk



Basis is the difference between the physical or cash market price of a commodity and the price of the futures contract most closely tied to that commodity.

Location Risk – When the physical market is a different location than that specified by the futures contract.

Quality Risk – When the physical commodity is a different grade or quality than that specified by the futures contract.

Calendar Risk – Backwardation and contango. The price of the nearby futures contract and the underlying physical market changes over time.

Basis Risk

Trader selling natural gasoline from Midwest US to Edmonton

Units: cts/gal	Now	Pricing Date (down)	Pricing Date (up)
Cost to buy and ship	158 c/gal		
Natural gasoline spot price Edmonton	166 c/gal	140 c/gal	180 c/gal
Unhedged P/L		-18 c/gal	+22 c/gal
CME WTI futures	Sell at \$88.20/b (210 c/gal)	Buy at \$78.12/b (186 c/gal) (basis weakens)	Buy at \$92.82/b (221 c/gal) (basis strengthens)
Payout from hedge		+24 c/gal	-11 c/gal
Hedged P/L		+6 c/gal	+11 c/gal

If the futures price always changed by exactly the same amount as the natural gasoline price (i.e. if there were no basis risk) then the trader would lock in a fixed 8 cts/gal profit.

In the first case, the natural gasoline price has fallen by 26 cts/gal, but the futures prices has fallen by only 24 cts/gal, so the profit made from closing the futures position is insufficient to cover the whole of the trader's loss in the physical market, leaving him with a reduced profit of 6 cts/gal.

In the second case, there is also a discrepancy between the movement of the physical and futures prices, but this time it goes in the trader's favor and he is able to make a larger profit on the deal than the 8 cts/gal that he was hoping to lock in.

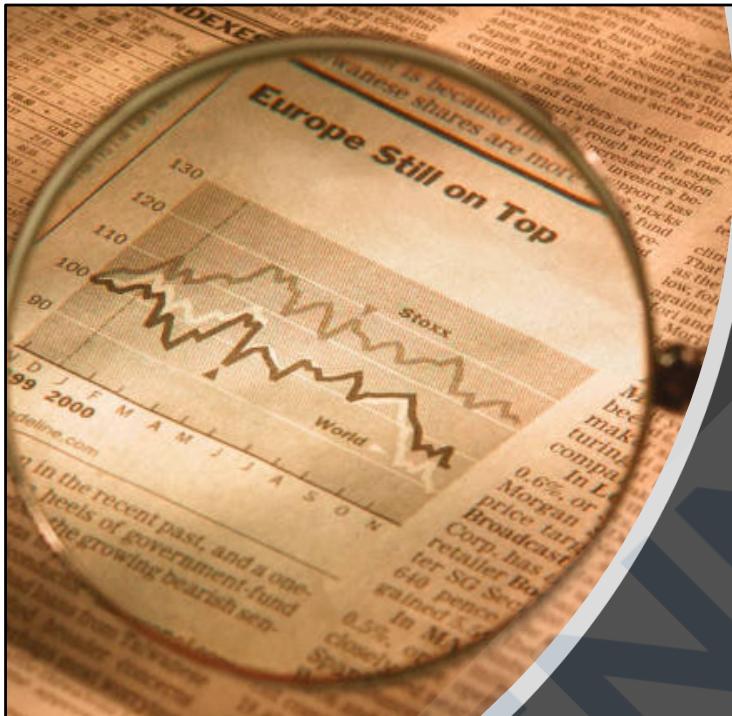
Forwards vs. Futures

	Forward	Futures
<i>Contract size</i>	Negotiated	Small volumes, e.g. 1,000 barrels, 42 gallons, 100 tonnes
<i>Type</i>	OTC	Exchange-traded
<i>Clearing</i>	None	Clearing house
<i>Credit protection</i>	Letter of credit if required	Margin
<i>Settlement</i>	Physical delivery or cash settlement	Physical delivery, cash settlement or EFP
<i>Regulation</i>	No direct oversight	Rigorous e.g. by CFTC/FCA
<i>Active trading horizon</i>	Up to 21 months forward	Very active up to 3 years forward; nominally can be traded many years into the future
<i>Contract</i>	Can be customized	Standardized
<i>Participation</i>	Limited number of participants	Hundreds of participants – all types of physical and financial traders

Forward deals are bipartite, over-the-counter (OTC) deals, that is, they are made directly between two trading counterparties, rather than through an exchange. The parties to the trade make a mutual commitment to deliver and receive the commodity at the price specified in the deal. Each takes on the risk that the other will be able to meet their commitment to physically deliver or receive if required, and the seller takes the risk that the buyer will pay. Financial security may be required of the buyer, for example, using a letter of credit.

Futures contracts are traded on an exchange, and the system of margin payments and daily settlement protects all participants against credit risk. Many futures traders have no capability of making physical delivery.

OTC Derivatives: Swaps



OTC Markets

Features

- Direct bilateral contract buyer ↔ seller
 - *Make bilateral credit arrangements*
 - *Or submit for clearing by an exchange*
- Potentially tailor-made
 - *Allows hedging of exposures for which no standard products exist*
- Standard OTC products widely traded
 - *Not all markets are highly liquid*
- Market regulators may require reporting of OTC trades

OTC instruments offer a tailor-made solution to the problem of hedging products, such as fuel oils, for which there are few exchange-traded futures markets.

In response to the financial crisis of 2007-09, the Group of Twenty finance ministers and central bank governors agreed that all OTC trading of financial derivatives should take place through a central clearing counterparty, whenever this is possible. The US legislators' response to this was the Dodd-Frank Wall Street Reform and Consumer Protection Act (July 2010). The EU's response is the EMIR regulation (September 2010). The EU has also revised its Markets in Financial Instruments Directive (MiFID) and extended its scope to energy trading. Equivalent rules exist in other jurisdictions such as Singapore.

In both US and European regulations, non-financial traders using OTC derivatives in modest quantities and entirely for hedging purposes may be exempted from some of the more onerous reporting and clearing requirements.

OTC Trading Methods

Bilateral (private and confidential)

- OK for physical hedging
- Financial traders may have clearing obligation

Brokers ("voice" or screen)

- Multilateral trading; true "OTC"
- May be bilaterally settled (if allowed)
- May be cleared by give-up to exchange

OTC matching and execution platforms

- e.g. CME Globex, ICE Connect, Joule (Trayport)



Ten years ago, OTC trades in oil swaps and options were mostly settled bilaterally, with no involvement of exchanges or trading houses. A broker may or may not have been involved in the matching of buyer and seller and execution of the trade.

Now, some market participants are obliged by regulations (Dodd Frank Act in the USA, EMIR in Europe) to submit their OTC trades to an exchange or clearing house for clearing and settlement. Physical traders using derivatives for bona fide hedging purposes are usually exempt from this requirement.

Traders executing deals through brokers may be able to mutually choose between bilateral settlement or submission of the trade to an exchange for clearing. The main clearing providers for oil swaps and options are ICE and CME (NYMEX). CME's Clearport facility allows trades matched bilaterally or by a broker to be submitted for clearing, which essentially converts them to equivalent futures contracts. ICE provides similar services, but also has a trading platform on which bids and offers can be matched.

Trading platforms providing bid and offer matching ("click and trade"), and allow participants to post bids and offers, and execute transactions.

OTC Clearing

Traders or broker “give up” trade for clearing

Exchange or clearing house acts as central clearing counterparty (CCP)

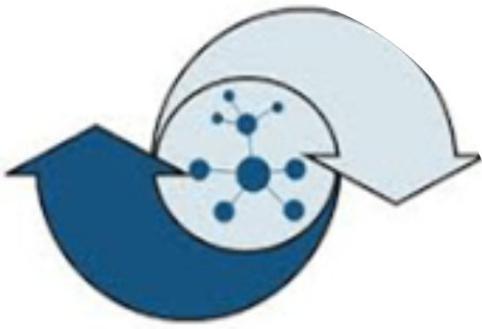
- Operates margin payments as for futures
- Credit risk shared among clearing members

Clearing effectively converts OTC trades to futures contracts

“Traditional” Futures vs “Swap” Futures

	Traditional Futures	Swap Futures
<i>Trading method</i>	Electronic through exchange trading screen	Bilateral, via broker, OTC matching/execution platform, with mutually agreed submission to exchange for clearing
<i>Trade matching</i>	Bids & offers matched electronically; anonymity	OTC trading; not anonymous
<i>Clearing</i>	Clearing house	Clearing house
<i>Credit protection</i>	Margin	Margin
<i>Contracts</i>	Limited number of oil contracts	100s of available contracts covering most oil grades & benchmark locations
<i>Settlement</i>	Most contracts result in physical delivery if held to expiration	Cash settlement
<i>Liquidity</i>	High	Variable, and lower than traditional futures

Swaps are sometimes known as Contracts for Differences



Swaps

A swap is a financial transaction that is designed to transfer price risk between two trading parties

Typically fixed price for floating price

In a swap deal, trading counterparties agree to a future exchange of cash, based on the difference between two agreed pricing indices over an agreed future period. These can be two variable prices or a variable price and a fixed price.

Swaps are custom-made, individually negotiated transactions. Like forwards, they are agreed directly between two parties and are not guaranteed by an exchange. Swaps do not have margin requirements. The parties involved accept an unsecured credit exposure on their counterparties.

Fixed for Floating Price Swaps

Also known as Fixed Swaps

Define and agree:

- Floating price index (e.g. OPIS)
- Price averaging period
- Notional quantity of commodity
- Settlement date(s)

Negotiate the fixed price

At maturity, settlement is the difference between the floating price index over the averaging period multiplied by the quantity, and the fixed price

Swaps contracts are direct legal agreements between two trading counterparties. Typically, where one party is a hedger, the other is likely to be a bank or large trading company. Brokers provide the service of matching buyers with sellers, and for standard, frequently traded contracts, electronic screen-based trading is available.

A swap is an agreement to exchange the difference between two prices. One price is defined as a floating price index (e.g. the Argus Far East Index price for propane to be calculated as an arithmetic average of all daily price assessments for the calendar month of June.) The other is a fixed price, which is negotiated when the swap deal is entered into. This could be a bilateral negotiation, or the hedger could accept a bid price made by a dealer.

Swaps involve no initial payment. At maturity, the settlement payment is the difference between the swap price and the average physical market price during the averaging period, multiplied by the volume. A swap settlement can involve both positive and negative payments.

NGL Swaps

When traded or cleared on an exchange, these are often called "financial futures"

Settlement periods

- Usually calendar month average
- Also Balance of current Month (BALMO)

Common price indices

- OPIS in North American NGL markets
- Argus in other NGL markets

NGL swaps typically settle against an index price, usually OPIS or Argus. Common swap benchmarks include Mont Belvieu LST, NW Europe, Saudi CP and AFEI.

Calendar month periods are the most common. Swaps covering longer periods (quarters, years) usually have settlement payments due after the end of each calendar month.

BALMO = balance of the month average.

Note: when traded or cleared on an exchange, these instruments are often called "financial futures".

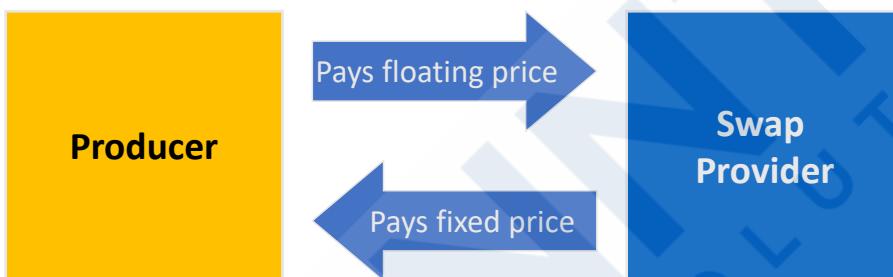


Swaps

The swap provider will offset his/her risk by selling a swap to an end user or by hedging with futures

Short swap position (receive fixed)

- Someone with a long price risk exposure, e.g. a producer, might enter a short swap position to receive a fixed value for his/her commodity



One party to the swap deal agrees to pay the other a fixed price which is negotiated when the deal is entered into. This party can be thought of as the “buyer” of the swap but is also referred to as having entered into a “pay-fixed” swap deal.

The other party to the swap deal agrees to pay a floating price, the calculation of which is defined and agreed when the deal is entered into (e.g. the arithmetic average, calculated over the calendar month of August, of the daily normal butane price in Conway as quoted by OPIS). The eventual value of this floating price is not known when the deal is struck, but it is determined at the end of the pricing period (e.g., at the end of August).

No cash changes hands at deal inception; when the end of the pricing period is reached, the swap is settled by a cash transfer equal to the difference between the agreed fixed price and the eventual floating price, multiplied by the notional quantity of the commodity for which the swap was written.

A market participant with a long physical position can effectively lock in a fixed price for future sale of a commodity by selling a swap to a trader.

Swaps

Long swap position (pay fixed)

- Someone with a short price risk exposure, e.g. a consumer, might enter a long swap position to effectively lock in a fixed value for the commodity



A market participant with a short physical position can effectively lock in a fixed price for future purchase of a commodity by buying a swap from a trader.

Hedging with Swaps

Supply trader buys propane through term contract indexed to Mont Belvieu spot price. Propane is sold to consumers on fixed price contracts.

Units: c/gal	Now	Q2 average (high case)	Q2 average (low case)
Propane Mont Belvieu (LDH) Spot	90 c/gal	95 c/gal	80 c/gal
Unhedged Price		95 c/gal	80 c/gal
Q2 Propane Swap	Long at 85 c/gal		
Payout from hedge		10 c/gal	-5 c/gal
Effective Price		85 c/gal	85 c/gal

A supply company is a net buyer of propane for sale through its marketing system in the US Gulf Coast region. Most of the propane is purchased through a term contract indexed to the OPIS Mont Belvieu (LDH) price assessment. The propane is sold to end-user customers on fixed quarterly contracts, which the marketing team price using forward curve information supplied by the traders.

A dealer is offering a Q2 propane (basis OPIS Mont Belvieu LDH quote) in a suitably large volume at 85 c/gal. The company decides to enter a long swap position, locking in an effective purchase price for the next 3 months of 85 c/gal.

By doing this, the company foregoes the possible additional profit it might make as an unhedged player if the spot price falls over the quarter. But it also protects itself against the possible losses that it might make if the spot price were to rise over the quarter, which would lead to reduced margins or outright losses on the fixed price sale contracts.

Floating for Floating Price (Basis/Diff) Swaps

Swap fixed price for floating basis differential

Define and agree:

- Two floating price indices
- Price averaging period
- Notional quantity of commodity
- Settlement date(s)

Negotiate the fixed price (premium/discount)

At maturity, settlement is the difference between two floating price indices over the averaging period multiplied by the quantity, and the fixed price

Basis swaps can be thought of in two ways:

As a swap deal which exchanges one floating price (usually a physical price index) for another floating price (usually a futures settlement price) plus a negotiated fixed premium or discount; or

As a swap deal which exchanges a negotiated fixed price for a floating price that is calculated as the price difference between two price indices (usually one physical and one futures)

Futures + Basis Swap

Trader selling natural gasoline from Midwest US to Edmonton

Units: cts/gal	Now	Pricing Date (down)	Pricing Date (up)
Cost to buy and ship	158 c/gal		
Natural gasoline spot price Edmonton	166 c/gal	140 c/gal	180 c/gal
Unhedged P/L		-18 c/gal	+22 c/gal
CME WTI futures	Sell at 210	Buy at 186	Buy at 221
Natural gasoline vs WTI swap	Short at -43.5	+2.5 c/gal	-2.5 c/gal
P/L without swap		+6 c/gal	+11 c/gal
P/L with swap		+8.5 c/gal	+8.5 c/gal

This slide revisits an example that we met earlier in the course, of a trader selling natural gasoline to Edmonton. Hedging with CME WTI futures alone, he faced the risk that the natural gasoline price might fall more than the WTI futures price, causing the hedge to be less than fully effective. By entering into a swap of natural gasoline vs WTI, it is possible to provide protection against this occurrence.

In effect, the diff swap converts an imperfect hedge, with significant basis risk, into something closer to a perfect hedge.



Basis Swaps – NGLs

Calendar Swaps	Locational Swaps	Quality Swaps
<ul style="list-style-type: none">M1 diff to physical: physical/wet value for benchmark locations vs front month swap at same locationse.g. CIF ARA vs CIF ARA swap	<ul style="list-style-type: none">Arbitrage:<ul style="list-style-type: none">Mont Belvieu vs ARAMont Belvieu vs AFEIEast-West: AFEI vs ARAAFEI vs CP	<ul style="list-style-type: none">Propane ARA Argus vs ICE BrentPropane ARA swap vs Naphtha ARA swapPropane AFEI vs Naphtha Japan PlattsNatural gasoline Mont Belvieu OPIS vs CME WTIButane CP vs Propane CP

- Basis swaps settle against the price differential between a physical price exposure and a futures hedging instrument
- Crack swaps settle against the spread between a product and crude oil
- Locational swaps settle against differences between markets, and include arb swaps. .
- Quality swaps help manage exposures to spreads between different products.

Swap Choices

Fixed for floating swap

- One simple transaction
- Large credit risk (unless cleared)
- No margins (unless cleared)
- Lower liquidity than futures

Futures + basis swap

- Two transactions
- Futures: highly liquid; no credit risk; flexible
- Basis swap: credit risk (unless cleared) but on much smaller scale
- Lower cost?

Why use a combination of futures and basis swaps, rather than simply approaching a bank for a single fixed-for-floating swap contract that covers all your price risk?



Hedging with Swaps

Advantages

- Flexible – all aspects of the instrument are negotiable
- Minimize basis risk by matching floating price index to price exposure
- Simple cash settlement

Disadvantages

- Credit risk if instrument is not cleared
- Lower liquidity than futures



OTC instruments eliminate much of the detailed day-to-day position management that is required with exchange instruments (e.g. establishing positions in several contract months, unwinding the positions ratably, etc.). A single cash flow at settlement (or multiple cash flows at defined settlement dates) provides the hedge cover needed.



Risks of Hedging

The Hedge Works

- Opportunity costs
- Hedging costs

The Hedge Fails

- Losses not fully offset (basis)
- Didn't hedge correctly (operational)
- OTC partner fails to pay (credit)
- Can't afford margin calls (cash flow)



Hedging doesn't involve "eliminating" risk. It involves modifying and transferring risk from one risk "warehouse" (price risk) to other forms in which the hedger is more comfortable warehousing the risk (e.g. credit risk, operational risk, basis risk). Credit risk is extremely important, because it is the main form into which price risk is transformed when hedged.

Even when a hedge works perfectly, it may in retrospect seem to be the wrong thing to have done.

- Large favorable price move – potential profits negated by large hedging "losses";
- No substantial price move – hedging was unnecessary, but costly;
- Large adverse price move – only in this case is hedging unequivocally the right thing to have done.



NGL Conversion Factors

Weight to Volume

NGLs are traded in cts/gal in USA and in \$/tonne in international markets. The density of NGLs vary with composition and temperature. These are the "industry standard" factors used in derivatives markets and by price reporting agencies.

	1 Metric tonne in Gallons	1 Metric tonne in Barrels	cts/gal to \$/t multiply by
Ethane	739	17.6	7.39
Propane	521	12.4	5.21
Normal Butane	452.8	10.78	4.528
Isobutane	469.6	11.18	4.696
Natural Gasoline	420	10	4.20

Energy Content

The energy content (heating value) of NGLs is needed for frac spread calculations, which compare the value of NGLs (cts/gal) with natural gas (\$/MMbtu). The heating value of NGLs varies with their composition and state. The factors here are those used by OPIS for propane and normal butane, and from GPA Midstream Association's Standard 2145-16 for others.

	btu per gallon	cts/gal to \$/MMbtu multiply by
Ethane	65,897	0.1518
Propane	90,830	0.1101
Normal Butane	102,916	0.0972
Isobutane	98,924	0.1011
Nat. Gasoline (Pentane)	110,020	0.0909

A factor of 91,500 btu per gallon is commonly used for propane in end-use markets. This reflects the approximate heating value of propane as a gas at 60°F.

Storage Capacity

Commercial storage is usually sold by the barrel in USA and by the cubic meter (cm or m³) elsewhere.

	Barrels	Cubic Meters	US Gallons	Litres	Cubic Feet
1 Barrel	1	0.15899	42	158.987	5.6146
1 Cubic Meter	6.2898	1	264.17	1,000	35.31
1 US Gallon	0.0238	0.003785	1	3.7854	0.13368
1 Litre	0.0062898	0.001	0.26417	1	0.03531
1 Cubic Foot	0.17811	0.02832	7.4806	28.317	1

NGL Trading Glossary

11+11: In Asian LPG cargo trading, a standard 23,000 tonne cargo divided equally between propane and butane.

AFEI: Argus Far East Index, a benchmark price for Asian LPG cargoes traded for CFR delivery to Japan. Also known simply as FEI, these daily prices reflect the value of 23,000 tonne, fully-refrigerated cargoes of field-grade propane or butane for delivery 25-40 days forward. The FEI price is widely used as a reference in Asian spot LPG trading.

AG: Arab Gulf. Also known as Middle East. A market for FOB cargoes loading at ports including Yanbu and Ras Tanura in Saudi Arabia, and Mina al Ahmadi in Kuwait.

Alkylation: a refinery process that produces alkylate, a high-value, high-octane motor gasoline blending component. The feeds to an alkylation unit are isobutane (IC4) and olefinic refinery gases.

ANSI: Argus North Sea Index, a monthly benchmark price assessment of the value of propane and butane for FOB loading at North Sea terminals. The assessment is based on prices in the CIF ARA market during the final five days of each month, with freight cost subtracted to give a FOB price.

Any: in North American NGL (and refined products) trading, a deal for delivery at any time (or on any pipeline cycle) within a named month. Often the current calendar month 'any current month'.

ARA: the Amsterdam / Rotterdam / Antwerp region of Northwest Europe (NWE). A collection of ports on the coast of Belgium and the Netherlands, at which liquids and gases are traded. For NGLs, the key port within the ARA region is Flushing (Vlissingen) in the Netherlands.

Arbitrage: a trading strategy designed to profit from an existing difference in market prices, typically between one location and another. In energy markets, arbitrage is usually a physical trading activity, involving the movement of material by pipeline or cargo. Occasionally, an arbitrage profit can be captured without moving product, by buying on one price index and selling on another.

Argus Media: a price reporting agency whose published prices are commonly used as benchmark / reference prices in European and Asian NGL trading. The US market uses OPIS prices.

Ask: a motion to sell at a named price. Also called an offer.

Associated gas: natural gas produced from an oilfield, as a by-product of oil production.

Autogas: A term used in some countries for LPG, when sold as a fuel for road vehicles.

Backwardation: a market situation in which material for forward delivery trades at a discount to prompt or spot prices. Also called an 'inverted market'. The opposite of contango.

Back office: the part of a trading organization responsible for accounting, payables/receivables, financial settlement, analysis and reporting, information technology and administration.

Barge: barge markets are for quantities delivered via inland waterways, on small vessels that use pressurized containment. These are usually much smaller than the volumes traded in *cargo* markets, typically around 1,000 tonnes or 10,000 barrels.

Basis Risk: the risk that the price of a derivative instrument, such as a futures contract, used to hedge a physical price risk, changes by an amount that does not exactly match the change in value of the physical commodity being hedged, during the lifetime of the hedge. This leaves an imprecise hedge which may fail to provide full protection against losses.

Basis Swap: a swap whose payment at settlement is determined by the difference between two floating price indexes. Typically, one price index represents the value of physical material (e.g. OPIS Non-TET Butane), and the other a hedging instrument (e.g. NYMEX RBOB futures). Basis swaps can thus be used by hedgers to protect against *basis risk*.

Barrel (b, bl or bbl): a unit of volume exactly equal to 42 US gallons, and approximately equal to 159 liters. The standard unit of measurement for NGL storage and trading in the USA.

Benchmark: a published price that is commonly used as a reference price in floating price contracts, or widely used as an indication of the value of a commodity.

Bid: a motion to buy at a named price.

Bill of lading (BOL, B/L or BL): a document issued by a ship owner or agent on completion of loading of a cargo, which acts as a receipt for cargo received on board. In cargo trading, the date on which the BL is issued is commonly used to determine the pricing dates for a deal.

Biopropane, BioLPG: see *renewable propane*.

Blendstock: a substance that can be blended with other materials to create a finished product. The material forms part of a blended product and is not chemically transformed in the blending process. Normal Butane (NC4) is a blendstock for gasoline production.

Book Trade: in North American NGL trading, a trade that involves the transfer of title/ownership of material held in common storage, with no physical movement.

Brine compensation: a method of operating salt cavern storage in which the storage space is partly filled with brine, which is displaced as stored gas or liquid is injected. Brine is pumped back into the cavern when stored gases are withdrawn.

British thermal unit (btu): a unit of energy, commonly used to describe the heat content of fuels in the USA. It is the energy required to increase the temperature of one pound of water by one degree Fahrenheit.

Broker: an agent who facilitates trading by introducing buyers and sellers, or by placing and executing orders on an exchange. Brokers do not participate in markets as buyers or sellers, but make money by charging fees (commissions) for their services.

Butane: a paraffinic hydrocarbon (alkane) with four carbon atoms, which is found in natural gas. It has two isomers, *normal butane* and *isobutane*, which are used for different purposes.

Cargo: cargo markets are for quantities loaded on ocean-going ships, usually fully refrigerated or semi-refrigerated. These can range from small vessels (coasters) that carry only 2,000 tonnes to very large gas carriers (VLGC) that carry 44,000 tonnes or more. Cargoes of around 20,000 to 23,000 tonnes are common in European and Asian spot and forward trading.

C2: Ethane.

C3: Propane.

C5+: Pentanes plus, also called *natural gasoline*.

Calendar spread: A position created by taking a long position in one delivery month and a short position in another, for the same commodity.

Calorific value: the heat energy released by burning a fuel. Also called heating value. The gross calorific value (GCV) or higher heating value (HHV) of a fuel is the total heat energy theoretically available, including energy (enthalpy) recovered by condensation of produced water vapor. The net calorific value (NCV) or lower heating value (LHV) is just the heat of combustion. In natural gas trading, prices (e.g. \$/MMbtu) reflect the GCV/HHV of the gas.

CFR – Cost & Freight: a contractual basis for sale and purchase of a cargo, in which the price paid includes the cost of the cargo and the cost of shipping to an agreed destination. Under this *incoterm*, risk of loss or damage to the cargo passes from the seller to the buyer at the load port.

Chiba: A Japanese port which is the main destination for LPG cargoes travelling to Japan, and the benchmark pricing basis for the CFR Japan market.

CIF – Cost, Insurance, Freight: a contractual basis for sale and purchase of a cargo, in which the price reflects the cost of the cargo, insurance, and freight to its agreed destination. Under this *incoterm*, the seller is obliged to procure marine insurance against the buyer's risk of loss or damage to the cargo during the voyage. Risk of loss or damage passes from the seller to the buyer at the load port.

Clearing: a process by which a clearing house becomes the counterparty to a trade (acting as a buyer to the selling trader and a seller to the buying trader) and operates a system of *margin* payments and daily settlements of profits and losses, to provide mutual protection against credit risk. *Futures trades* are always cleared. *OTC* derivative trades may be cleared by mutual agreement of the traders involved, or at the insistence of a market regulator.

CMA: calendar month average, an average of all prices published during a specified month, used in some contracts to establish the final price paid.

CME: a financial and commodity exchange group, which operates the CME NYMEX exchange on which *WTI* and *RBOB* futures are traded.

Contango: a market situation in which material for forward delivery trades at a premium to prompt or spot prices. The opposite of backwardation.

Conway: the USA's second most important trading and pricing hub for NGLs, after Mont Belvieu. Located 700 miles north of Mont Belvieu, in Kansas.

CP: contract price. In Asian LPG trading markets, this means the contract price which Saudi Arabia sets monthly for FOB cargo sales. Kuwait uses the same contract price. The Saudi/Kuwait CP is an important benchmark for Middle East export sales and for Asian CFR import cargo trading, particularly term contracts.

Crack spread: a price spread between a refined product (or basket of refined products) and crude oil.

DAF – Delivered at Frontier: a contractual basis, used in the Eastern Europe market for rail deliveries of LPG from Russia. DAF Brest prices are for LPG delivered to the Belarus/Poland border.

Denaturant: a substance added to ethanol to make it unfit (and undesirable) for human consumption. Natural gasoline may be used as a denaturant for fuel ethanol in North America.

Derivative: any financial instrument, such as a swap or option, that derives its value from the value of an underlying security or physical commodity.

Differential (diff): a term traders use for the difference between two market prices. Also, the negotiated premium or discount to a benchmark price used in a trade. A cargo of propane for delivery to Japan might trade at a differential of +4 \$/t to the Argus FEI price.

Diluent: a substance used to dilute something else. In petroleum markets, a light material such as naphtha, natural gasoline, or natural gas condensate, that can be mixed with heavy crude oil to reduce its viscosity for pipeline transport. When Canadian oilsands bitumen is diluted, the resulting mix is called dilbit.

Dry gas: natural gas with a low quantity of NGL, typically the gas produced in a processing plant to meet pipeline specifications, but sometimes the direct output of fields that produce mostly methane.

Edmonton: a trading and storage hub, and benchmark pricing location for NGL in Alberta, in Canada's major oil and gas producing region.

EPD: the stock ticker of Enterprise Products Partners, sometimes used to indicate a price for NGLs traded at Enterprise's Mont Belvieu storage caverns. OPIS labels these prices 'Non-TET'.

EP Mix: a mixture of 80% ethane and 20% propane, traded in the USA, particularly in the Conway/Midwest markets. EP mix is easier to produce and store than purity ethane. It can be used for ethylene cracking or processed to separate the ethane and propane. Published EP Mix prices are for the ethane component only. The buyer must either pay an additional fee for the propane content, or make an offsetting sale or delivery of propane to the EP mix seller.

Ethane (C2): a paraffinic hydrocarbon (alkane) with two carbon atoms, which is found in natural gas. Ethane is a gas at standard conditions. It can be liquefied by pressure, but only if its temperature remains below about 90°F. Ethane is used as a petrochemical feedstock, for ethylene production.

Ethane rejection: the decision to allow ethane to remain in a natural gas stream (or to blend it back in after separation), for sale as heat energy (\$/MMbtu), rather than separating it for sale as a petrochemical feedstock.

Exchange: an organization regulated by its own rules and with external regulatory oversight, which offers trading in derivative instruments (futures and options) that are traded anonymously and are subject to mandatory clearing. CME NYMEX in the USA and ICE Futures in Europe are the main operators of exchange-based trading in energy commodities.

Feedstock: a substance used as an input to a process that will transform it to something else. Isobutane (IC4) is a feedstock for alkylation to produce alkylate. Ethane is a feedstock for steam cracking to produce ethylene.

FEI: Far East Index, an important benchmark price in Asian spot LPG trading (see AFEI).

Field Grade: NGL derived entirely from natural gas processing, containing no refinery gases. Field grade NGL is olefin-free, making it more valuable as a petrochemical feedstock. Refinery gases contain olefins. Field grade mixed butane is an unfractionated normal butane/isobutane mix.

Fixed Price: a price (in cts/gal or \$/tonne, etc.) that is agreed when a trade is entered into, and cannot contractually be changed. Cargoes can be traded on a fully fixed basis (the agreed price applies to the entire cargo quantity) or partly fixed basis (the agreed price applies to maybe 50% of the cargo volume, or to a fixed minimum quantity), with the remainder traded at a *floating price*.

Floating Price: a price that is defined by a formula that is agreed when a trade is entered into, but which will not be finally determined until a later date. Typically, traders agree a fixed 'differential' (premium or discount) to a published *benchmark* price, and also agree when the formula will be applied. Some deals use 'whole month average' pricing, in which the final price paid is the average of the benchmark prices published on every day of the month, plus the agreed differential. Others use shorter averaging periods, such as a five-day pricing window that starts when the cargo is loaded.

Flushing: a port in the Netherlands (locally 'Vlissingen') with LPG storage and handling facilities. Part of the ARA market.

FOB – Free On Board: a contractual basis for sale and purchase of a cargo, in which the price paid is purely the cost of the cargo. Under this *incoterm*, the buyer is responsible for arranging and paying for shipment, and bears all risks once the cargo has been loaded.

FoF: a standard forward contract for European CIF cargo trading of propane, which requires the seller to give fifteen days' notice of a five-day delivery window.

Forward contract: an agreement for a one-time purchase and sale of a commodity for delivery at an agreed future time, beyond the normal *spot* trading horizon. A *futures* contract is a standardized, exchange-traded forward contract.

Frac spread: a calculation of the profitability of processing and *fractionation* of natural gas, representing the difference between the value of NGLs and natural gas, usually expressed in terms of \$/mmbtu.

Fully refrigerated: descriptive of gas storage or vessels in which an NGL at a temperature close to its atmospheric boiling point, so that it can be held as a liquid with little or no positive pressure applied. Large vessels, such as VLCCs, are fully refrigerated, while smaller vessels may use pressure containment.

Fungible: descriptive of material that is interchangeable or mixable. A batch of propane that meets purity specs is fungible with, and has equal value to, other similar batches of propane. This allows them to be commingled for pipeline transport or storage.

Futures contract: a standardized forward contract, traded on a regulated futures exchange. Futures are traded anonymously, and buyers and sellers have contractual obligations to the exchange, rather than to each other. Credit risk protection is ensured by a system of margin payments and daily settlement of profits and losses arising from changes in contract value.

Gallon: a unit of volume equal to 231 cubic inches, used in the trading and pricing of NGLs and oil products in the USA. US LNG prices are in cents per gallon (cts/gal). There are 42 gallons in one barrel.

Gas Processing: the conversion of wellhead gas to pipeline specification natural gas, by removal of contaminants such as water, sulfur and acid gases, and by removal of NGLs from the natural gas stream. Gas plants produce two valuable hydrocarbon products: natural gas and a stream of mixed NGLs (called Y-grade or ‘raw make’ in the USA). Gas plants are usually located close to wellheads (field plants) or on pipeline systems (straddle plants). The mixed NGL stream is often transported elsewhere by pipeline for *fractionation*.

IC4: Isobutane.

ICE: Intercontinental Exchange, a financial exchange operating group, which operates the ICE Futures exchange in Europe, and also provides *clearing* services for a wide range of energy swaps and derivatives traded in North American, European and Asian markets.

Incoterm: one of a set of internationally recognized rules which define the responsibilities of the buyer and seller in a deal. Incoterms define who is responsible for paying for and managing the shipment and insurance, and where and when certain risks pass from the seller to the buyer.

Isobutane (IC4): a branched-chain paraffinic hydrocarbon (alkane) with four carbon atoms, which is found in natural gas. It is also manufactured in refinery butane isomerization (isom) units. Also called IC4. Isobutane is mostly used as a feed to refinery alkylation units, to produce a high-octane gasoline blend stock.

Isoparaffin: a *saturated* branched chain hydrocarbon containing only single carbon-carbon bonds. Isobutane is the smallest possible isoparaffin, as four carbons are needed to create a branched chain.

Isomerization (isom): a refinery process that converts straight-chain hydrocarbons (paraffins) to branched chain molecules (isoparaffins). Butane isomerization (BI) units are used to create isobutane for use as an alkylation feedstock.

Long: a trading position that will benefit if a price rises. A gas producer is naturally long NGL; a trader with unsold butane in storage is long butane; a trader who has bought futures contracts is long futures.

LPG - Liquefied Petroleum Gas: propane and/or butane, particularly when transported and sold as pressurized liquids, for use as fuel gases. In North America, LPG is synonymous with propane. In other parts of the world, LPG may be a mix of propane and butane.

LPG Mix: a 50:50 propane/butane mix, traded in Russia and Eastern Europe.

LP-Gas: a name used in some countries for LPG sold as a vehicle fuel.

LST: Lone Star NGL, Energy Transfer Partners’ salt cavern storage facility at Mont Belvieu. Prices for NGL traded at LST are labelled ‘TET’ by OPIS, and ‘Energy Transfer’ by other price reporting agencies.

Margin: money lodged with a futures exchange or clearing house to provide security against credit risk. *Initial margin* is a deposit made when a position is opened and recovered when it is closed. *Variation margin* is paid into or taken from a trader’s margin account as the value of his position rises and falls each day. A *margin call* is a request for additional cash to be added to the margin account, when, as a result of variation margin payments, it falls below a required *maintenance margin* level.

MMbtu (also MMBtu, mmBtu, etc.): million British thermal units. In the USA, and in some international LNG markets, natural gas is priced in US dollars per MMbtu.

Mont Belvieu (MB): the main trading market and benchmark pricing location for US NGL. Located close to Houston, TX, Mont Belvieu has the world's largest concentration of NGL fractionation plants and underground salt-cavern storage capacity for NGLs. Multiple pipelines bring mixed and separated NGLs to Mont Belvieu and take material off to end-use markets and to nearby export terminals.

Naphtha: the lightest liquid fraction (cut) produced in an oil refinery by atmospheric distillation of crude oil. Light naphtha has similar characteristics to natural gasoline. As a straight-run product, which has undergone no chemical transformations, it is *field grade*, olefin free material. Naphtha is a key feedstock and blend stock for gasoline production, but it is also an important chemical feedstock, especially in Europe.

Natural Gasoline (C5+): the heaviest of the natural gas liquids, consisting of the molecules that remain after ethane, propane and butanes have been removed by fractionation from a mixed NGL stream. Also known as *pentanes plus* or C5+. Natural gasoline can be used as a gasoline blend stock, as a *diluent* for heavy oil, or as a *denaturant* for ethanol.

NC4: Normal butane.

Netback: an estimate of the value of a commodity, derived from the value of another commodity and the costs of transforming one into the other. The FOB value of an LPG cargo in one location can be estimated from the known delivered price of LPG in another location, minus the cost of freight between the locations. The value of the mixed NGL stream at a gas plant can be calculated from the prices at which individual purity products are trading at a hub location, minus the costs of transportation and fractionation (T&F).

NGL: Natural Gas Liquid(s). Material separated from natural gas at a gas processing plant (mixed NGL), or an individual component separated from this stream at a *fractionation* plant (purity product). Almost all NGL consists of some combination of hydrocarbons with two to five carbon atoms, including ethane, propane, butanes and pentanes.

Ningbo: a port in Eastern China which is an important destination for LPG cargoes travelling to China.

Non-TET: in OPIS price reports of Mont Belvieu NGL trading, 'non-TET' prices reflect the value of material traded in storage at facilities operated by Enterprise Products Partners (ENT/EPD/EPC). The OPIS 'Other Non-TET' prices are for material traded at Targa Resources facilities.

Normal Butane (N-Butane, NC4): a straight-chain paraffinic hydrocarbon (alkane) with four carbon atoms, which is found in natural gas. Also called NC4. N-butane is a gas at standard conditions. It can be liquefied by pressure or by cooling to around 30°F (-1°C). N-butane is a gasoline blend stock, but because of its high vapor pressure, is used seasonally, in winter gasoline. Butane can also be a fuel gas (LPG) or a chemical feedstock.

NWE: North-west Europe, a trading and pricing benchmark region for NGL and oil trade. NWE is not limited to the ARA ports, and can include destinations in UK, France and Germany.

Olefin: a linear or branched hydrocarbon whose molecular structure includes carbon-carbon double bonds. Also called alkenes. Most plastics are made from small olefins: ethylene and propylene. Ethane and propane are used to make these olefins in ethylene crackers and propane dehydrogenation (PDH) plants. Ironically, the presence of olefins in NGL products makes them less desirable as chemical feed stocks. *Field grade* material is olefin-free, while *refinery grade* products contain olefins.

OPIS: Oil Price Information Service, a price reporting agency whose market prices are used as benchmarks and reference prices in floating price trades for NGLs throughout the US market. European and Asian markets use Argus pricing.

OTC: Over the Counter. Broadly, any form of trading that results in a direct legal contract between the buyer and seller. This definition would include physical trading of gases and liquids, together with bilateral and broker trading of swaps and options. It would exclude exchange-based futures and options trading. More narrowly, OTC refers to the trading of derivative instruments, in a multilateral market where deals result in a direct contract between buyers and sellers. This could be a market facilitated by brokers, or an electronic trading platform for OTC instruments.

Other Non-TET: in OPIS price reports of Mont Belvieu NGL trading, 'Other non-TET' prices reflect the value of material traded in storage at facilities operated by Targa Resources.

Paraffin: a *saturated* straight or branched chain hydrocarbon containing only single carbon-carbon bonds. Pure ethane, propane, normal butane, and isobutane are all paraffins.

PDH: Propane dehydrogenation, a process that converts propane to propylene, which is used to make polypropylene (PP) and other petrochemicals. PDH technology is relatively recent (compared to *steam cracking*) and capacity is growing strongly around the world.

Pentanes Plus (C5+): see *natural gasoline*.

Propane (C3): a paraffinic hydrocarbon (alkane) with three carbon atoms, which is found in natural gas. Propane is a gas at standard conditions. It can be liquefied by pressure or by cooling to -44°F (-42°C). Propane is used as a petrochemical feedstock, as a heating fuel (LPG), or as a motor fuel. In the North American market, LPG is synonymous with propane.

Purity: an NGL product that consists almost entirely of a single substance. In the US market, the minimum purity level for ethane, normal butane and isobutane is 95%, while propane is 90%. Ethane is often described as Purity Ethane, to distinguish it from EP Mix.

Ratable / Rateable: spread equally over a period of time. Ratable delivery means supply of material on a continuous or daily basis, with the same quantity being delivered each day. Ratable unwinding of a futures hedge position involves closing a portion of the hedge quantity each day, such that the entire hedge is gradually closed over a calendar month or other defined period.

Raw Make: see *Y-Grade*.

RBOB: Reformulated Blendstock for Oxygenate Blending, a 'suboctane' gasoline grade traded in the New York Harbor market, which requires the addition of ethanol to convert it to finished product. The CME NYMEX exchange offers RBOB futures which can be used for pricing and hedging of butane.

Refinery Grade: NGL products produced at a refinery, typically propane or normal butane. Refinery gases usually contain quite high levels of olefins (propylene, butylene) and are unsuitable for use as petrochemical feed stocks, so trade at a lower value than *field grade* material. LPG traded in Europe is often refinery grade, containing up to 20% olefins in propane and 30% in butane.

Renewable Propane: propane produced as a by-product of renewable diesel production. Also called biopropane or bioLPG. Renewable diesel (called HVO in Europe) is a drop-in replacement fuel for petroleum diesel, produced from vegetable oils or waste. Its production is rapidly growing in USA and Europe, as refiners switch from petroleum diesel production.

Salt Cavern: an underground storage facility created by dissolving away parts of a natural underground salt formation (a salt dome or bedded salt deposit). The resulting caverns can be hundreds of feet in diameter and over 1000 feet tall. They are deep below ground, so their natural pressure is high enough to keep NGLs in liquid form. *Brine compensation* is used to move NGLs in and out of storage.

Sarnia: a trading and storage hub, and benchmark pricing location for NGL in Ontario, an important refining and consumption region of Canada.

Saturated: a saturated hydrocarbon molecule is one that carries the maximum number of hydrogen atoms that its carbon backbone can accommodate. It contains only single bonds between carbon atoms and no double bonds. Paraffins and naphthenes are saturated, olefins and aromatics are not.

Semi-Refrigerated: descriptive of a gas carrier ship that uses a combination of refrigeration and pressure to contain NGLs. The pressure containment means the cargo does not have to be cooled to as low temperature as on a fully refrigerated vessel.

Short: a trading position that will benefit if a price falls. A steam cracker operator is naturally short ethane; a refiner who needs butane for gasoline blending is short butane; a trader who has sold some futures contracts (without any previous position) is short futures.

Speculation: trading that aims to capture a profit from a predicted or expected change in market prices that may or may not actually occur.

Spot Contract: a contract for a one-time purchase and sale of a commodity for delivery as soon as reasonably possible. In some markets, spot trades can result in almost immediate transfer (a *book trade* or a *wet trade* for NGL in the US market); in some international cargo markets, physical delivery may not occur until several weeks after the trade is agreed.

Spread: any difference between two prices. Spread trading is the simultaneous buying of one commodity or contract and selling of another, to create exposure to the spread between their prices. A spread swap is one whose payment at settlement is determined by the difference between two prices.

Steam Cracking: a chemical process that converts *paraffins* (alkanes) to *olefins* (alkenes). With an ethane feed, steam cracking creates ethylene. With heavier feed stock (propane, naphtha), it can also be used to create propylene and butylenes, or aromatics such as benzene. North American steam crackers are often *ethylene crackers* optimised to crack ethane. European and Asian steam crackers often use heavier feeds. Some steam crackers have the flexibility to use either NGL or naphtha feed stocks, depending on their price.

Straddle Plant: a gas processing plant located on a pipeline system, rather than at the producing field.

Swap: a derivative instrument used to manage price risk, settled by a cash payment at maturity. The settlement payment of a fixed-for-floating or outright swap reflects the difference between a defined price index (e.g. OPIS TET Propane) and a fixed price, negotiated when the swap was entered. The settlement is usually determined by the calendar month average of the index price.

Targa: Targa Resources, an operator of NGL storage caverns at Mont Belvieu. Some price reporting agencies use 'Targa' as a label for the price of NGLs traded in Targa storage. OPIS labels these prices 'other non-TET'.

Term Contract: an agreement for the purchase and sale of a commodity for continuous pipeline delivery, or for multiple rail, barge or cargo deliveries, usually on a regular repeated basis, over a period of weeks, months, or years.

TET: in OPIS price reports of Mont Belvieu NGL trading, 'TET' prices reflect the value of material traded in storage at facilities operated by Lone Star NGL, a subsidiary of Energy Transfer Partners. Other price reporting agencies call these Lone Star (LST) or Energy Transfer (ETR/ETP) prices.

Tonne (Metric Ton, t, MT): a unit of weight, equal to 1,000 kilograms and approximately 2,205 pounds. One tonne is approximately 521 gallons of propane or 453 gallons of butane.

ToT: a standard forward contract for European CIF cargo trading of propane, which requires the seller to give ten days' notice of a three-day delivery window.

VLGC: Very Large Gas Carrier, a ship capable of carrying a *fully refrigerated* cargo of 50,000 cubic meters or more of NGL. The standard traded VLGC quantity is 44,000 tonnes, around 550,000 barrels of propane or 475,000 barrels of butane.

Wet: in North American NGL pricing, a price for immediate delivery.

WTI: West Texas Intermediate crude oil, a light, sweet (low sulfur) crude produced in the Permian Basin. This grade is the main benchmark and pricing reference for all North American pipeline crude oil trading. The CME NYMEX exchange offers crude oil futures, which are commonly referred to as WTI, although the contract allows settlement by delivery of other grades. These 'WTI' futures can be used in pricing and hedging of NGL, particularly natural gasoline.

Y-Grade: in the US market, the mixed, unfractionated NGL stream produced from a natural gas processing plant. Also known as mixed NGL or 'raw make'. The composition of Y-grade varies from plant to plant, but a traditional US industry assumption is 42% ethane, 28% propane, 11% n-butane, 6% isobutane and 13% natural gasoline.