NGL Supply Modelling - Lessons Learned, Challenges Ahead

EIA Global Hydrocarbon Supply Project

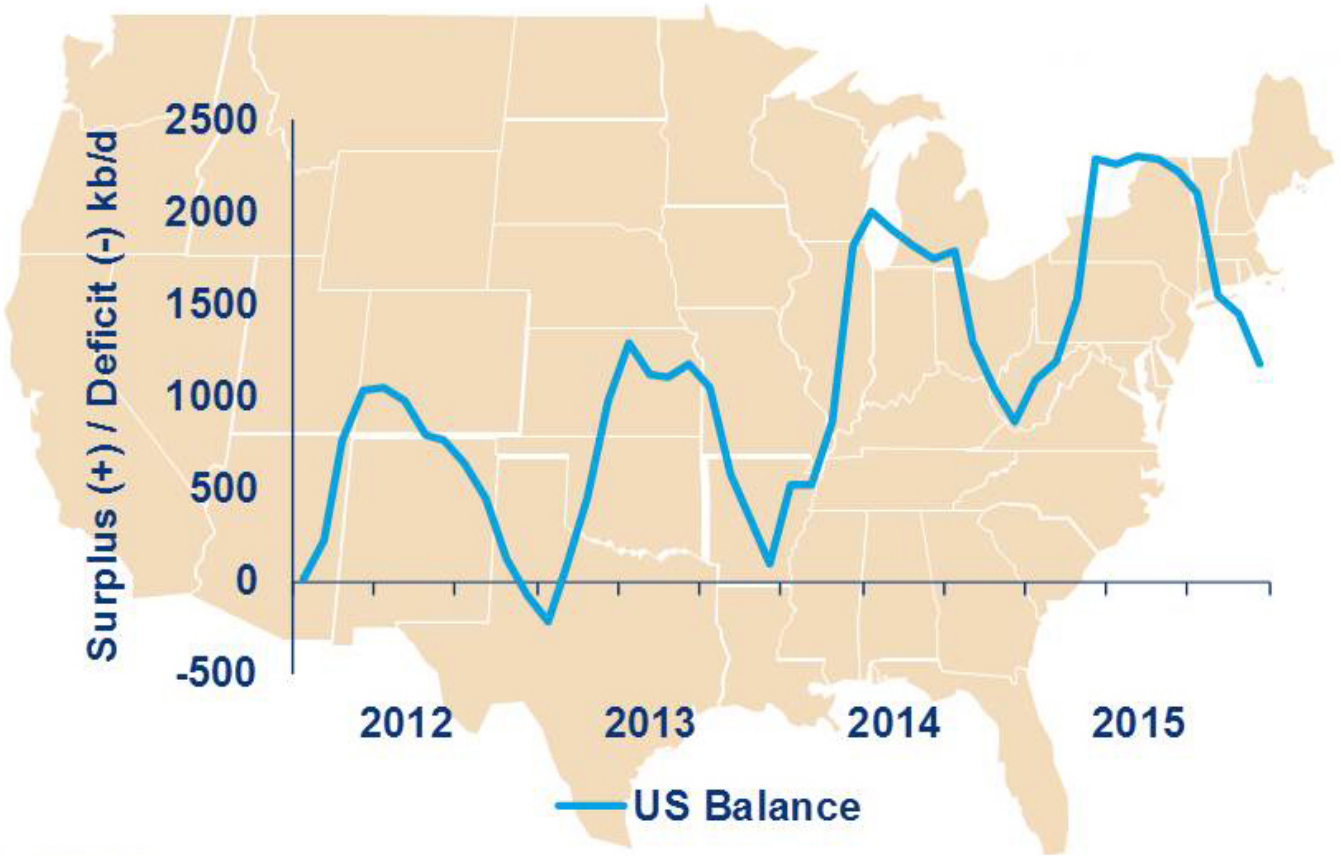
Anne B. Keller

4/09/2014

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing the world – flow mapping
6. Conclusions

Introduction
Increasing Supply of NGL from Shale Creates US Surplus
US Gulf Coast Shifts from Price Setter to Price Taker in the Global Market

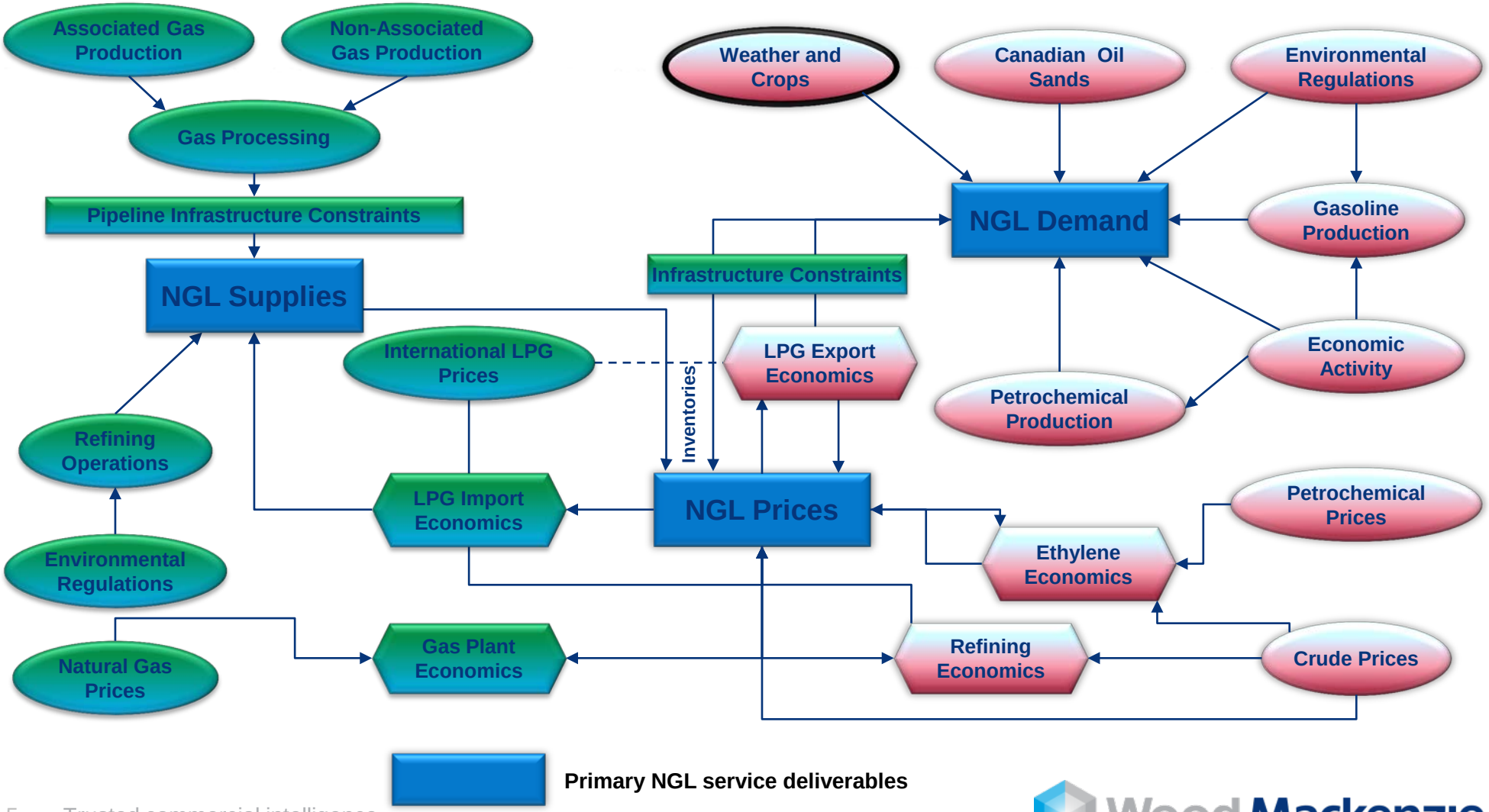


Source: WoodMackenzie NGL Service March 2014 Update

First Response - North America NGL Modelling Philosophy
Client need for better knowledge of NGL value add to oil & gas sales
Insight driven by fundamental analysis of the NGL value chain

- Modelling objectives:
  - » Short and long term forecasts
  - » Time intervals no greater than monthly for short term, annually for long term – eliminates some of the daily noise factor from the analytical approach, focuses on calling 'turn points' in the commodity cycle
- Wood Mackenzie's approach:
  - » Inputs from Wood Mackenzie's proprietary data, natural gas, power, upstream, downstream, LNG, oil, and petrochemical markets teams for cross-commodity insights and integration with our primary commodity forecasts
  - » Fundamental demand forecasts based on detailed bottom-up analysis of markets
  - » Maximum use of databases to automate routine content updates and expand the amount of data used in modelling
  - » Transparency of data and assumptions, modular design
  - » Integrated, capable of running scenarios to allow creation of decision trees or strategy guides
  - » Insight into the impact of energy and environmental regulatory policy and market competitiveness issues on the markets

NGL Service Overview
Inputs and Modelling Goals



Wood Mackenzie

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing regional supply/demand – flow mapping
6. Conclusions

NGL Service Overview - WoodMackenzie
Comparison of Model Structural Elements to Existing Data Framework

Element of Supply/Demand	EIA Current Data Framework	WoodMackenzie Term
Supply:		
NGL from Gas Plants	Field Production	Gas Plant Supply
NGL from Refineries	Refiner/Blender Net Production of Liquefied Refinery Gases	Refinery Supply (Yield)
Imports	Imports	Imports (shown under trade)
Regional Transfers	Net Receipts	Transfers (shown under flows)
Sub-Total Supply:		= Sum of gas plant NGL + Refinery NGL
Demand:		
Refinery Demand	Refinery Net Inputs	Total Refinery Demand
Blender Demand	Blender Net Inputs	Blending
Petrochemical Demand	None	Petrochemical Demand
Odorized Propane (LPG) Demand	“Prime Supplier Sales”	Odorized Propane Demand
Sub-Total Demand:	“Products Supplied” = Field Production + Refiner/Blender Inputs + Imports+ Net Receipts +/- Stock Change	= Sum of demand elements
Regional Flows:	Net Receipts	Transfers In/Out
Trade Flows:	Imports/Exports	Imports/Exports
Inventory Change:	Stock Change	“Net Change” = Regional Balance +/- Net inflows/outflows +/- Net imports/exports

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing regional supply/demand – flow mapping
6. Conclusions

Definitions of Components Included in Supply Model

Modeling Philosophy – forecast by separated components, not by end use

- Use of process (asset) models to generate supply at the component level from our production forecasts:
  - US and Canada – well level
  - Rest of World – project level

- Adopting the definitions of components used by the US gas processing industry (ie. the gas plant operators) – currently GPA Standard 2108 – “Fractionation Grade Product Specifications” as the working definition of a “product”

- Global supply of propane and butane is typically reported as LPG – creates interesting challenges in using the US model structure for the world market

NGL Service - WoodMackenzie
Definitions of Components – Lessons Learned

Continued confusion over condensate exists, and it matters - volumes are growing

This is a North American issue – look to global markets for specifications

- There are 3 primary sources of condensate production: lease, field, and plant
- Current US production surveys do not include the term “field condensate”, which may result in a gap in historical data (estimated production < refinery inputs)
- Significant amounts of field condensate are now produced between the wellhead and the gas plant due to the practice of using bigger plants farther from the wells, requiring more line “pigging” and compression
- Markets outside North America are more conversant with definitions and condensate related assets: as condensates are not treated as crude oil subject to export quota, the specifications have been better defined in order to separate them as a product globally

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing regional supply/demand – flow mapping
6. Conclusions

NGL Service - WoodMackenzie
Modelling Approach – Summary of Workflow

Benchmarking, ongoing data validation, and use of asset models improves results

- Identification and selection of data considered reliable, finding alternatives if it isn't
- Aggregation – defining the appropriate level of detail to be included and how to co-ordinate inputs from multiple sources at the same level
- Simulation – generating forecasts for subsets of data elements via asset modeling
- Validation – comparing model outputs to other sources to identify variances for further analysis and adjustment of the simulation assumptions
- Calibration – includes comparison, triangulation, and sanity checks to assess predictability and usability of results

NGL Service - WoodMackenzie
Modelling Approach – Lessons Learned from US Model –Data

- Challenges with identification and selection of data:
  - » Data is still scarce in this portion of the hydrocarbon chain; focus is on the major commodities, high lack of transparency
  - » Niche service providers can fill in some gaps:
    - Contacts and data built up over years when the industry was low profile are very useful today
    - These teams are now being acquired by larger groups; overall access is reduced by competition and cost increases beyond the reach of some research budgets

- Necessity incents creativity and new approaches:
  - » Increased use of simulations
  - » Triangulation - using what we do know to model the unknowns:
    - » Example – ship movements are widely tracked, contents are less certain; comparison to customs records and 'typical' cargoes can fill in the blanks
    - » One side of a transaction price may be published – the other can be derived for long term ceiling and floor price calculations

NGL Service - Wood Mackenzie
Modelling Approach – Lessons Learned from US Model
Data Aggregation Levels

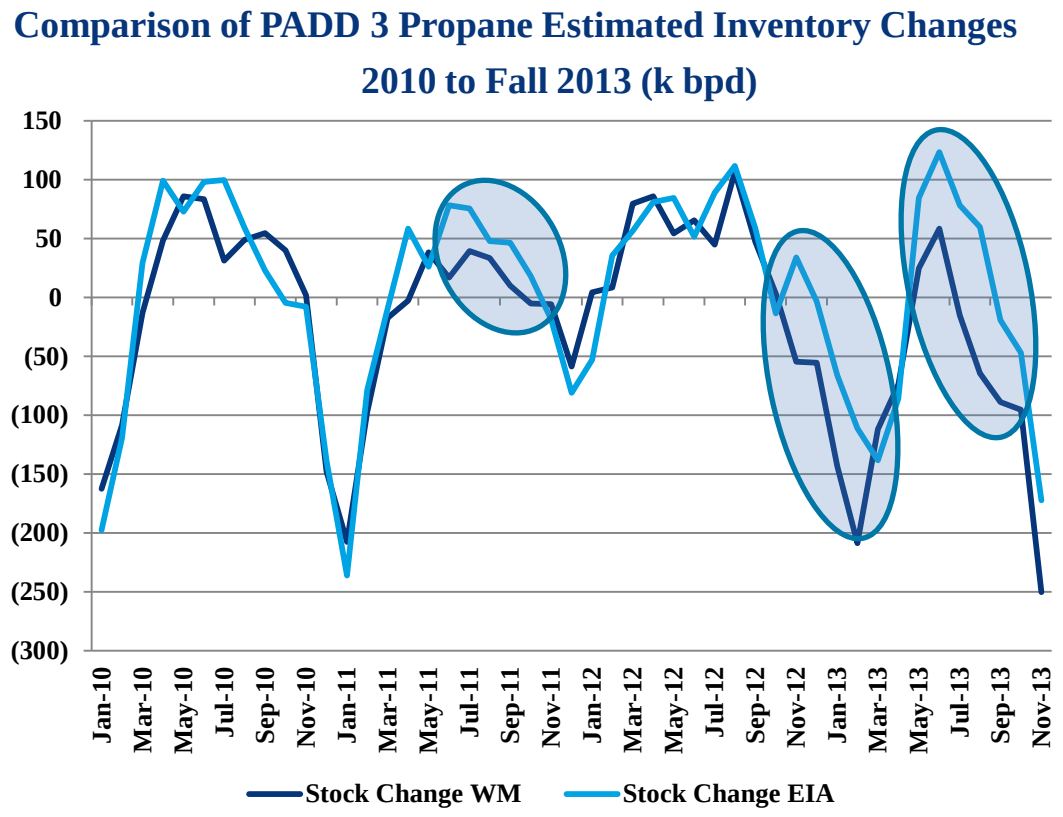
- Challenges with aggregation of detailed observations:
  - In the US, supply is from the well up, but aggregated into and reported by regions (PADD's) for common comparisons with peers and industry
  - In the rest of the world, the target is country level balances for data gathering, "trade zones" for balancing global markets (ie, Middle East, NW Europe, Mediterranean, China, "Far East", etc.)
  - Consider simplifying assumptions to focus on determining "best" and "worst" case scenarios for basic modeling – US examples:
    - Floor price determination – fuel value in the domestic market (can't ship it, can't store it, still making it, what happens?)
    - Ceiling price determination – sale to residential/commercial sector; least price sensitive market

NGL Service - WoodMackenzie
Modeling Approach – Lessons Learned from US Model
Use of Simulations

- Challenges with simulation - US:
  - » Short term – constant updating of changing conditions – plant downtime, feedstock changes, shifts in utilization
  - » Long term: requires monitoring infrastructure closely to identify constraints and technology shifts
  - » Need for cross-disciplinary expertise to produce realistic results – commercial or operating experience lends real world insight into what is truly possible
  - » A key example in the US this winter was the failure to consider the design basis for gas plants in N Dakota and the Marcellus/Utica – freeze conditions cause major issues with newer plants, inexperienced operators, remote operations
- Challenges with simulation - Global:
  - » Monitoring local conditions in emerging markets is an undeveloped opportunity
  - » Strong connections within the banking and engineering communities are needed to properly adjust long term assumptions

NGL Service - WoodMackenzie
Modelling Approach – Lessons Learned from US Model Validation – Is the Model Achieving the Goal?

- We were looking to our model to help predict emerging trends and forecast turn points
- Initial results were positive – propane shortage indicator proved accurate:



Wood Mackenzie

NGL Service - WoodMackenzie
Modelling Approach – Lessons Learned from US Modeling Calibration

- Need for built in feedback loops:
  - A robust feedback process needs to be in the requirements definition
  - Time will tell – but the sooner you know the model isn't working, the faster you can make corrections and retain credibility and utility

- The "Black Swan" hunt:
  - By definition they don't exist – therefore, if you can imagine it, it could happen, so assign a probability for it in the model
  - The rest is unknowable
  - Protecting clients (society) from the risk of ruin is our primary modeling goal – the rest is upside

- Choosing the indicators to follow is critical:
  - Achieving consensus isn't helpful if everyone else is wrong – what do the contrarians say?
  - Are there other seemingly unrelated data sources you should be including in the process?
    - Examples – National Geographic, video games, social media

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing regional supply/demand – flow mapping
6. Conclusions

NGL Service - WoodMackenzie
4 Steps to Balancing Regional Markets

Use of physical constraints and optimization to balance regions, forecast exports

- First step is forecasting of physical balances by region – regional supply less regional demand
- Optimization begins with determination of inventory targets based on physical capacity and estimated market demand requirements – imposes constraints on moves
- Surplus or shortfall for regions outside PADD 3 is cleared via least cost logistics assumptions
- Remaining surplus is transferred to US Gulf Coast for export or storage

NGL Service - WoodMackenzie
Balancing Regional Markets – Calibration Steps

- Comparison - forecast transfers to EIA reported Net Transfers and FERC Form 6 transfers for pipeline movements

- Triangulation – comparing calculated Net Changes to reported stock changes helps identify regions where flow pattern assumptions may be incorrect (example – the sum of Net Changes for 2 regions is close to the reported totals for those regions, but individual regional changes don’t match)

- Sanity checks – regional transfer volumes are tested against estimated available logistics capacity, remaining balances are compared to historical stocks and capacity limits

NGL Service - WoodMackenzie
Lessons Learned from US Model – Balancing the Markets

- The market will ultimately clear by price – NGL is a by-product, so short term supply elasticity is limited to ethane; capacity constraints will be resolved by conversion to fuel

- The waterborne market is the balancing mechanism for global supply
  - » Tracking these trends is a shortcut to understanding global markets for NGL macro level modelers
  - » Added bonus – ships are hard to hide; lots of data available

- A deep understanding of storage and logistics costs will produce a much more accurate model of this sector

Agenda

1. Introduction and background
2. Wood Mackenzie NGL Service – Model Structure
3. Defining terms – what commodities are in the models
4. Modeling approach – creating checks and balances
5. Balancing regional supply/demand – flow mapping
6. Conclusions

NGL Supply Forecasting – Going Global
Lessons Learned – Summary

- The modeling objective is the most important aspect of the design process and the key benchmark by which its success should be defined
- Rapid growth in NGL supply and the US NGL market's rapid transition from net buyer to net seller into a global market increases the need for timeliness and transparency in supply reporting for this sector worldwide – highlighted dramatically by unexpected winter shortages in 2013-2014.
- Absent the ability to survey stock levels outside the US as a tool for estimating "Product Supplied" on a global scale, another structure should be considered for use in forecasting global demand.
- US supply survey tools should be expanded to include a specific category for field condensates – look to the Middle East for more robust definitions to apply here – standardization around this would be very helpful to global markets
- Use of engineering tools such as asset simulation and the concept of system balancing and process control loops can add robustness and structure to the modeling process.
- Understanding waterborne logistics is the most direct route to balancing global supply.

Anne Keller
Head, Midstream Research

T +1 713 470 1879
E anne.keller@woodmac.com

- Anne Keller joined Wood Mackenzie in August 2012, managing the NGL Research team.
- Prior to joining Wood Mackenzie, she was Founder and President of Midstream Energy Group, a strategy consultancy focused on transaction advisory services to the gas midstream and NGL distribution and marketing sectors, private equity investors, and banks. Anne's industry experience also includes positions in corporate finance, asset management, NGL supply and trading, and project development with Conoco and DuPont.
- Anne holds a BS in Accounting and Business Administration and an MBA in Finance. She is a CPA, is a member of the Business Valuation and Forensics section of the American Institute of CPA's, and currently serves on the Boards of Directors of the Gas Processors' Suppliers Association and the Petrochemical Feedstock Association of the Americas.

Europe	+44 131 243 4400
Americas	+1 713 470 1600
Asia Pacific	+65 6518 0800
Email	contactus@woodmac.com
Website	www.woodmac.com

INVESTORS IN PEOPLE | Gold

Wood Mackenzie