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THE NATURAL GAS VALUE CHAIN
“RESOURCES, INFRASTRUCTURE, SUPPLY AND DEMAND”

By: Alexander MacKay

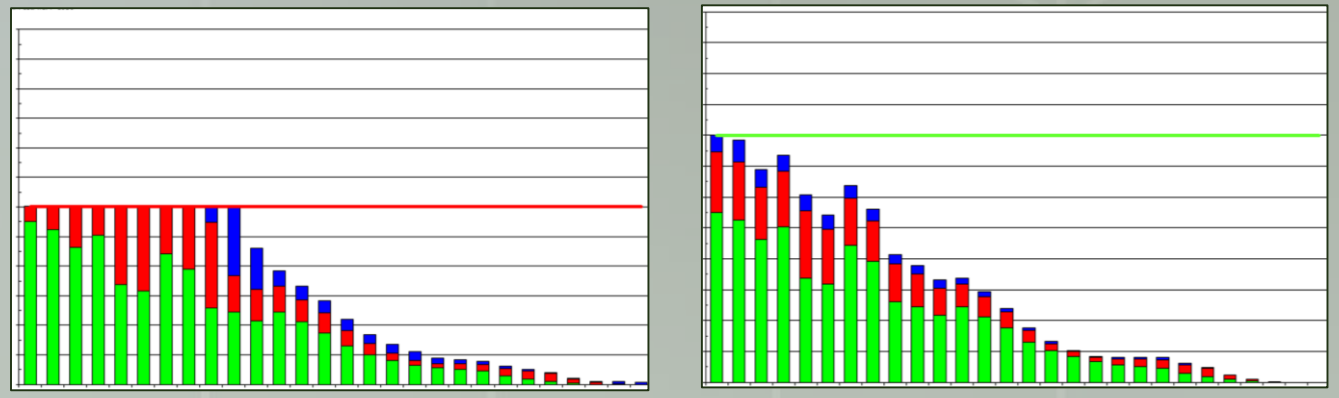
ABSTRACT

- This presentation covers the natural gas value chain. It introduces and summarizes each value chain component, the process for developing and maintaining gas supply, natural gas products and commercial considerations. It focuses on the value chain for a region and its interaction with the global market.
- It provides insight to participating entities business drivers throughout the value chain and their relationship to resources.
- Aspects covered:
  - Introduction to the natural gas value chain.
  - Phases of development for a regional value chain.
  - Case study:
    - Cost of gas supply including upstream, midstream and downstream components.
    - Local and global demand, market overview and margin analysis for natural gas products.

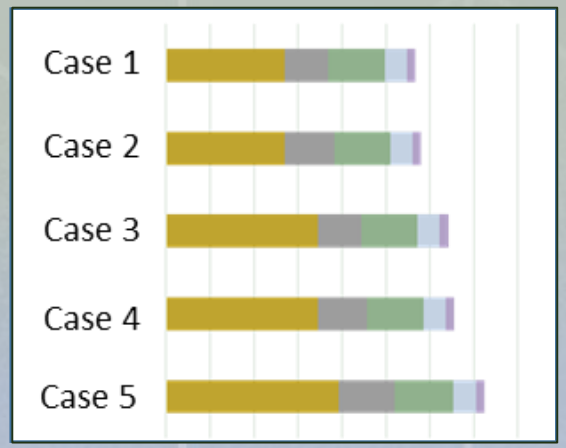
CASE STUDY OVERVIEW

- Clients included large petrochemical chemical companies in the process of negotiating new gas supply contracts.
- Scope of the case study is as follows:
  - Developed regional gas supply curves.
  - Reviewed domestic capacity, balanced with supply curves and provided demand forecasts.
  - Determined future cost of gas in the region.
  - Performed value chain analysis for all natural gas products.
- Primary value added is as follows:
  - Increased client confidence in regional gas supply.
  - Provided insight into the relative competitive position of each product.
  - Framed negotiating position for future gas contracts.

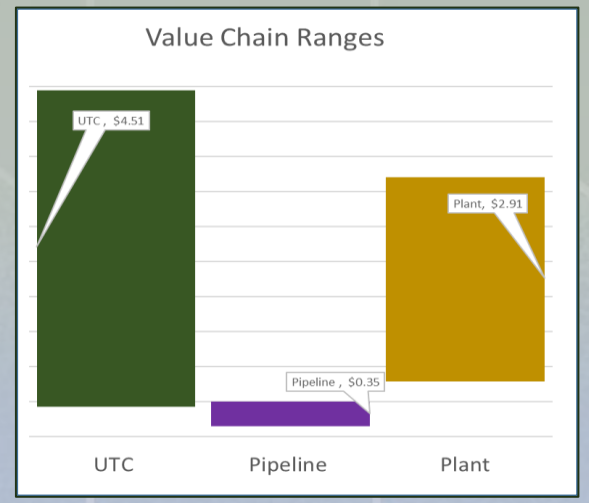
Gas Supply Curves



Local Demand Scenarios



Cost of Supply Ranges

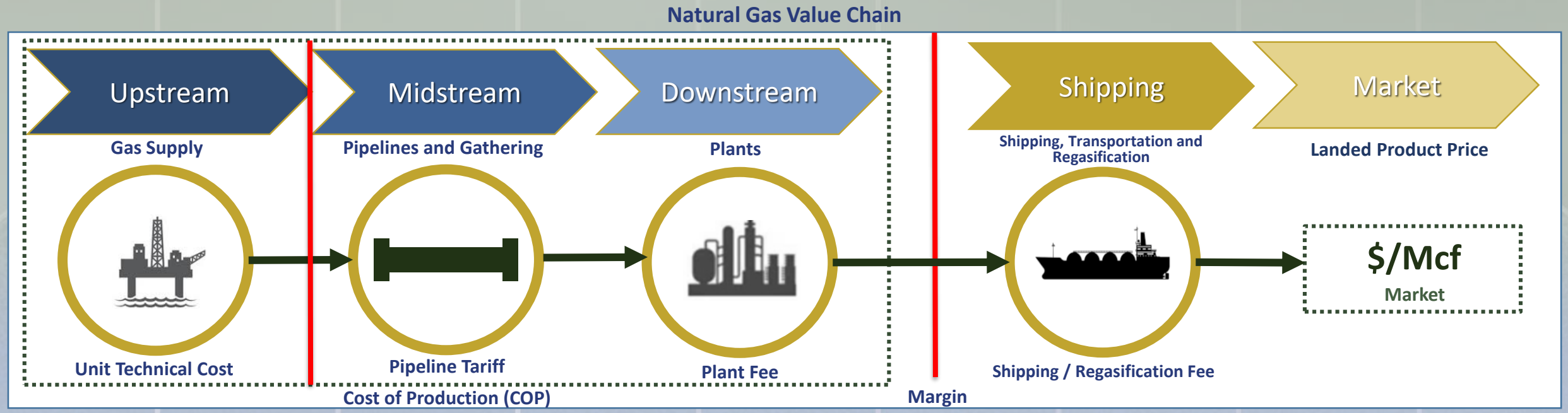


AGENDA

- Natural Gas Value Chain
- Regional Value Chain Phases
- Case Study – Cost of Supply and Value Chain Analysis

NATURAL GAS VALUE CHAIN COMPONENTS

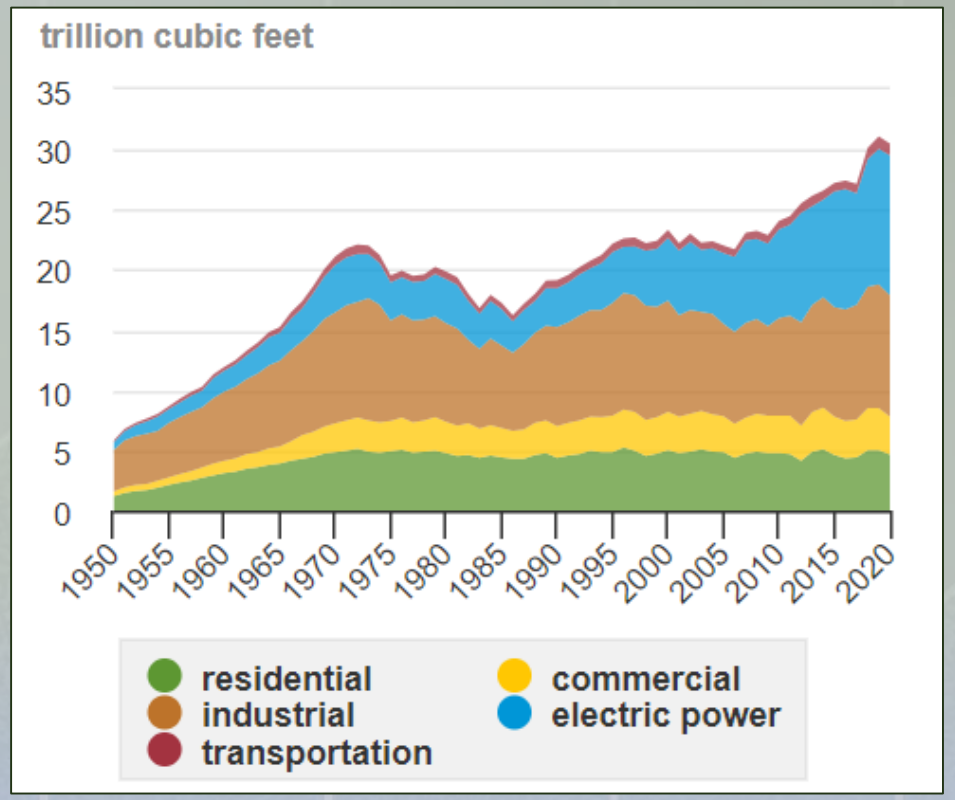
- Terminology for components of the natural gas value chain varies by source. The definitions utilized in the Natural Gas Value Chain diagram will be applied in this presentation.
- This presentation presents definitions through the lens of value chain analysis, where the commerciality of products is evaluated by accounting for unitized costs ($ / Mcf) for each component and calculating margin(s) for product comparison.
- Value chain analysis is defined as the process of identifying primary and supporting processes that add value during the generation of an end product, and then identifying areas to reduce cost or increase differentiation.



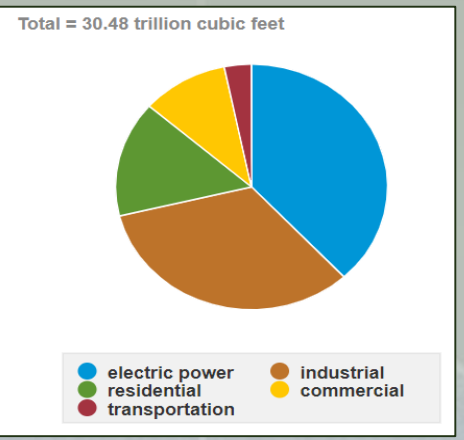
NATURAL GAS USERS AND ALLOCATION – UNITED STATES

- The United States Energy Information Administration (EIA) classifies natural gas users as follows:
  - Electrical power generation
  - **Industrial – feedstock for natural gas products**
  - Residential and commercial
  - Transportation
- Natural gas currently accounts for 38% of electricity generation in the US.
- In addition to traditional industrial consumers, natural gas as a feedstock for hydrogen production is a growing segment.

Natural Gas Use By Year, United States (EIA)

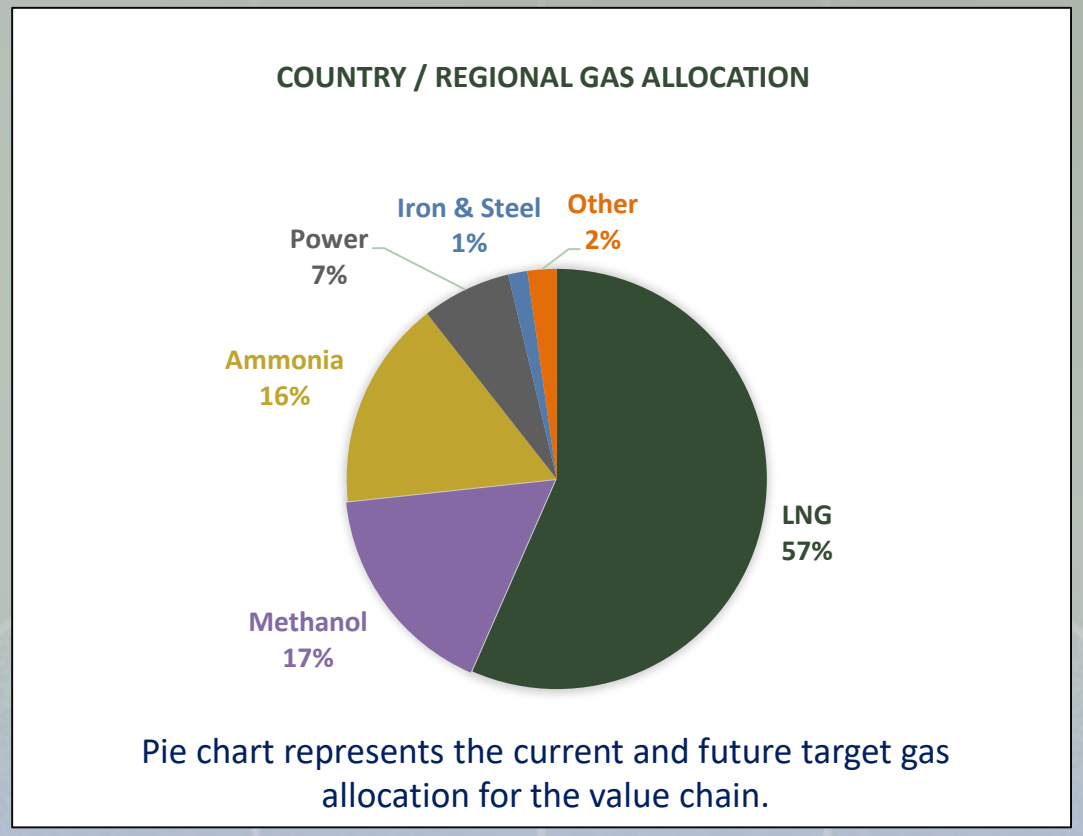


Natural Gas Use in 2020
United States (EIA)



NATURAL GAS ALLOCATION – CASE STUDY

- The value chain of interest in this presentation is a large gas exporting region.
- For the purposes of this presentation, industrial users (LNG, methanol, and ammonia) will be the focus.
- Allocation of gas depends on the balance of supply and demand for various domestic and industrial consumers as well as strategy from participating entities and policy from government entities.



Pie chart represents the current and future target gas allocation for the value chain.

UNIT TECHNICAL COST

- UTC is an indicator used in the energy industry to determine the profitability of upstream developments on a volumetric basis.

UTC Formula

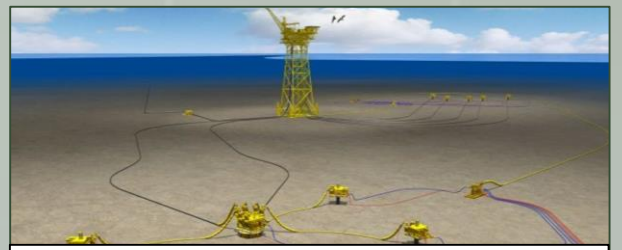
$$UTC\left(\frac{\$}{Mcf}\right) = \frac{Technical\ Cost\ (CAPEX+OPEX)}{Recoverable\ Resources - Royalty}$$

- Calculations are performed on a 'field life' basis.
- Recoverable resources are net of shrinkage (i.e. fuel consumption).
- Royalty volumes as defined by the Production Sharing Contracts (PSC) are accounted for by subtracting these volumes from the recoverable resources.
- Calculations take into account for operator profit using a discount rate.

UPSTREAM INFRASTRUCTURE

- Infrastructure utilized for upstream production and processing varies based on field conditions
  - Onshore / Offshore
  - Shallow water versus deepwater
  - Step out distance from existing infrastructure
- Upstream cost of production is accounted for by calculating UTC.
- The accuracy of UTC calculations is dependent on maturity for undeveloped fields and is based on the American Association of Cost Engineers (AACE) guidelines.

Production Platform and Hub
(Offshore Technology)



Subsea Tie-back (Offshore Magazine)

Onshore Production (Energy Central)

PIPELINE TARIFF

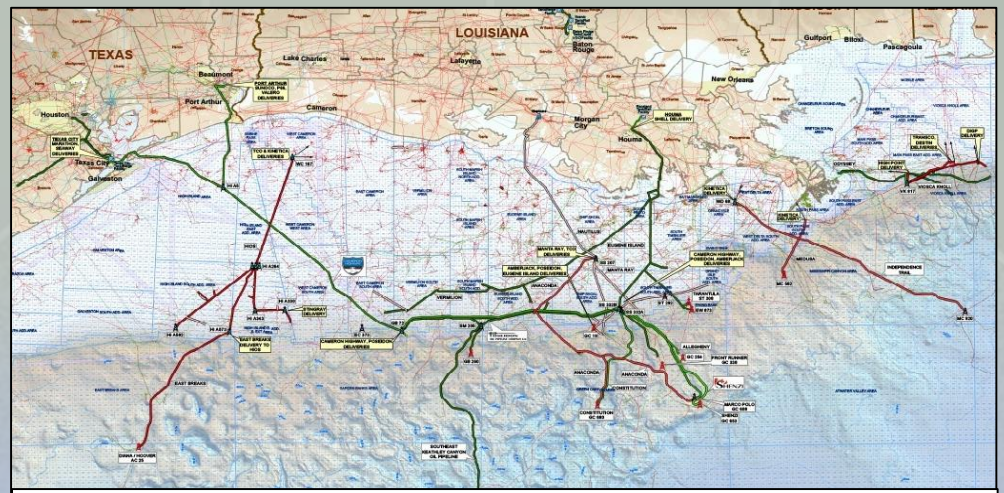
- This pipeline component value chain is accounted for by calculating a midstream tariff.

Midstream Tariff Formula

$$Pipeline\ Tariff\left(\frac{\$}{Mcf}\right) = \frac{Regulated\ Return + OPEX}{Total\ Volume}$$

- The regulated (annual) return is analogous to the cost of capital determined by assessing the original CAPEX for the pipeline system and applying a flat yearly rate of return.
- For certain regions the value chain ends here, as the primary demand center is the export market via international pipelines.

Onshore Transmission Lines



(Genesis Energy) **Gulf of Mexico Pipeline Network**

PLANT FEE

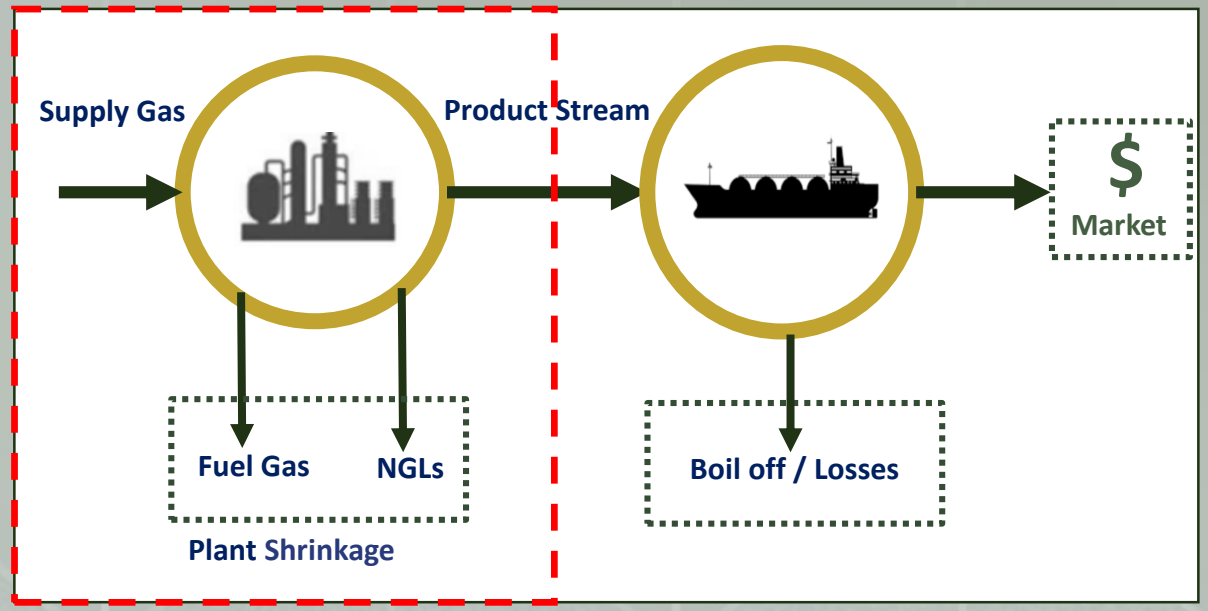
- For the plant component of the value chain, cost is accounted for by calculating a plant fee.

Plant Fee Formula

$$Plant\ Fee\ \left(\frac{\$}{Mcf}\right) = \frac{Technical\ Cost\ (CAPEX + OPEX)}{Supply\ Gas\ -\ Fuel\ Gas}$$

- Plant shrinkage is accounted for by subtracting fuel gas from supply gas.
- For the purpose of this presentation, all primary consumers of natural gas are referred to as plants.

Typical Flow Diagram – Plant



The flow diagram is general and applies to the following products:

- LNG
- Methanol
- Ammonia

SHIPPING FEE

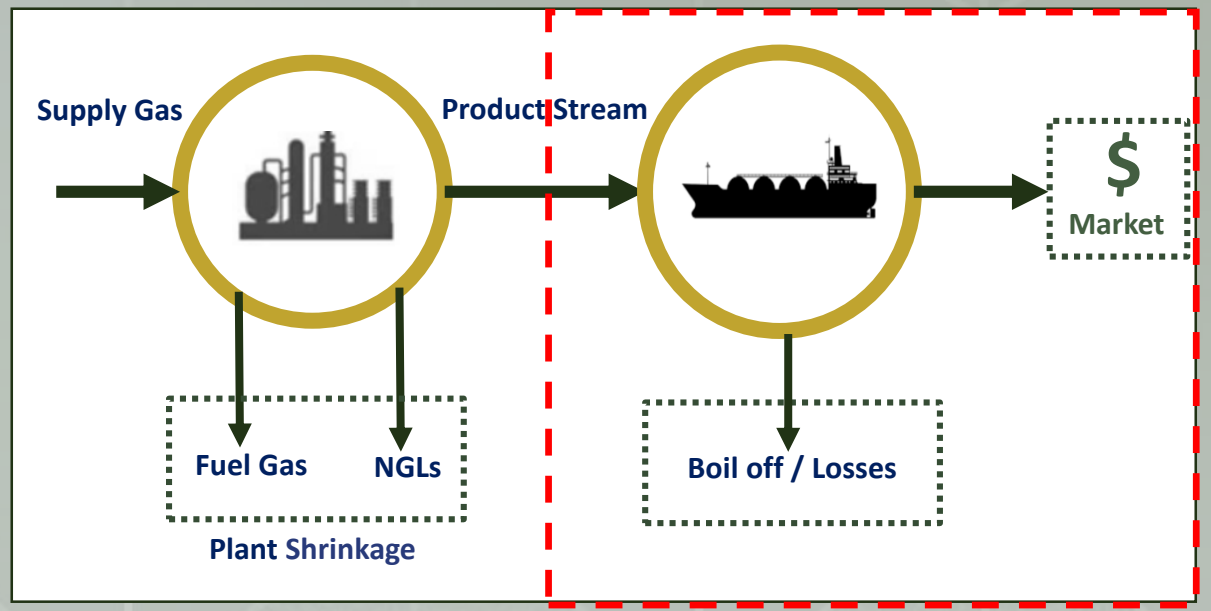
- For export to global markets, carrier fleets transport products to the sales destination.

Shipping Fee Formula

$$Shipping\ Fee\ \left(\frac{\$}{Mcf}\right) = \frac{Total\ Cost}{Transported\ Volume}$$

- When modelling shipping fees, the following are accounted for:
  - Tanker volume (economics of scale)
  - Charter fees and port calls
  - Duration of voyage
  - Product type
    - LNG requires regasification and has a high boil-off rate relative to other products

Typical Flow Diagram – Shipping



Typical LNG Tanker (Wartsila)

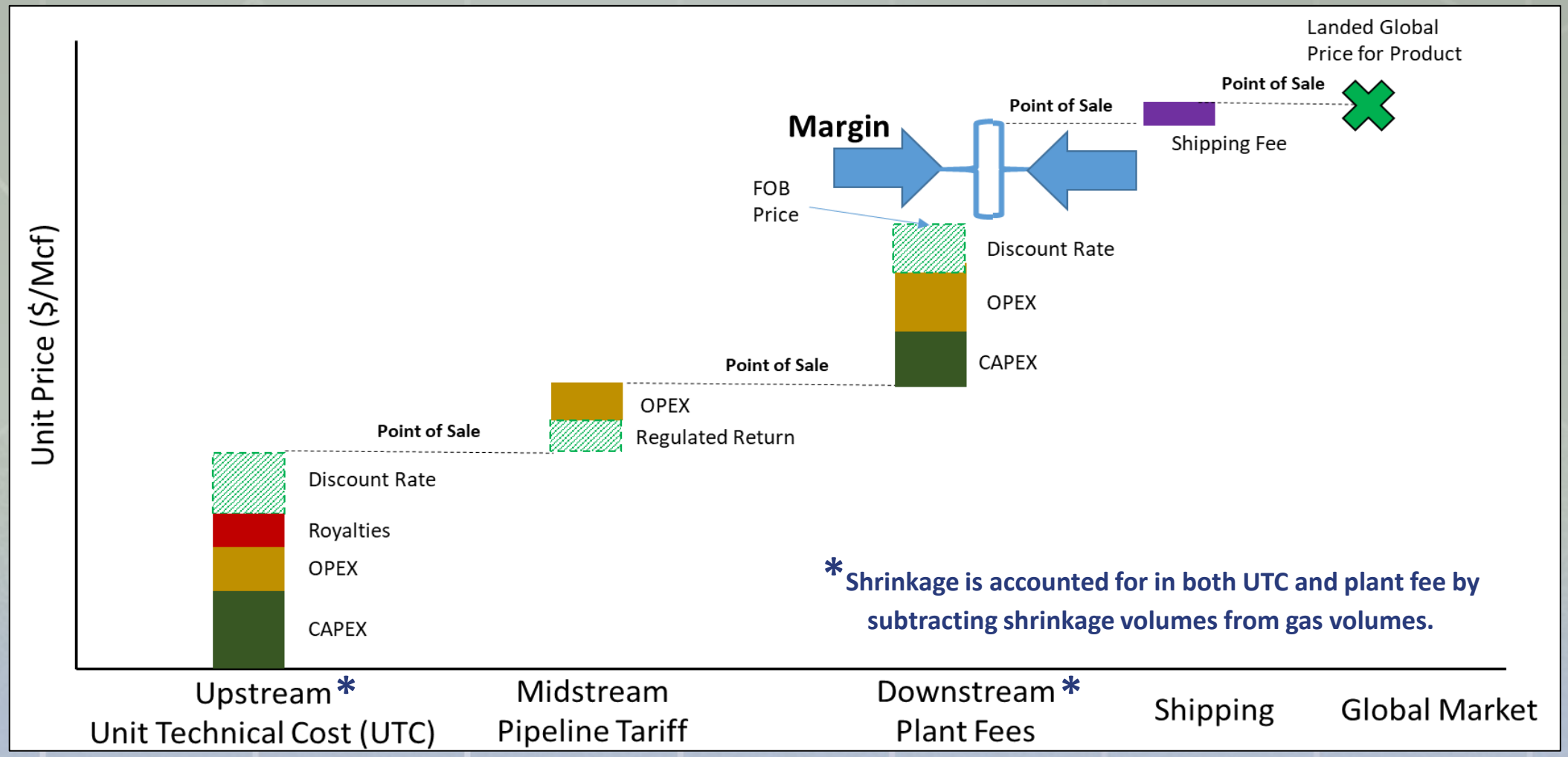
MARKETS

- The final component in the value chain is landed market price.
- For natural gas and natural gas products, pricing can be volatile and follows energy market cycles.
  - Demand shock in 2020 due to COVID and subsequent recovery is a prime example of this.
- Selecting pricing basis to accurately account for this volatility is important for value chain analysis.

Global LNG Prices ($/MMBtu), 2020

Global LNG Prices ($/MMBtu), 2021

NATURAL GAS VALUE CHAIN – SAMPLE MARGIN CALCULATION



AGENDA

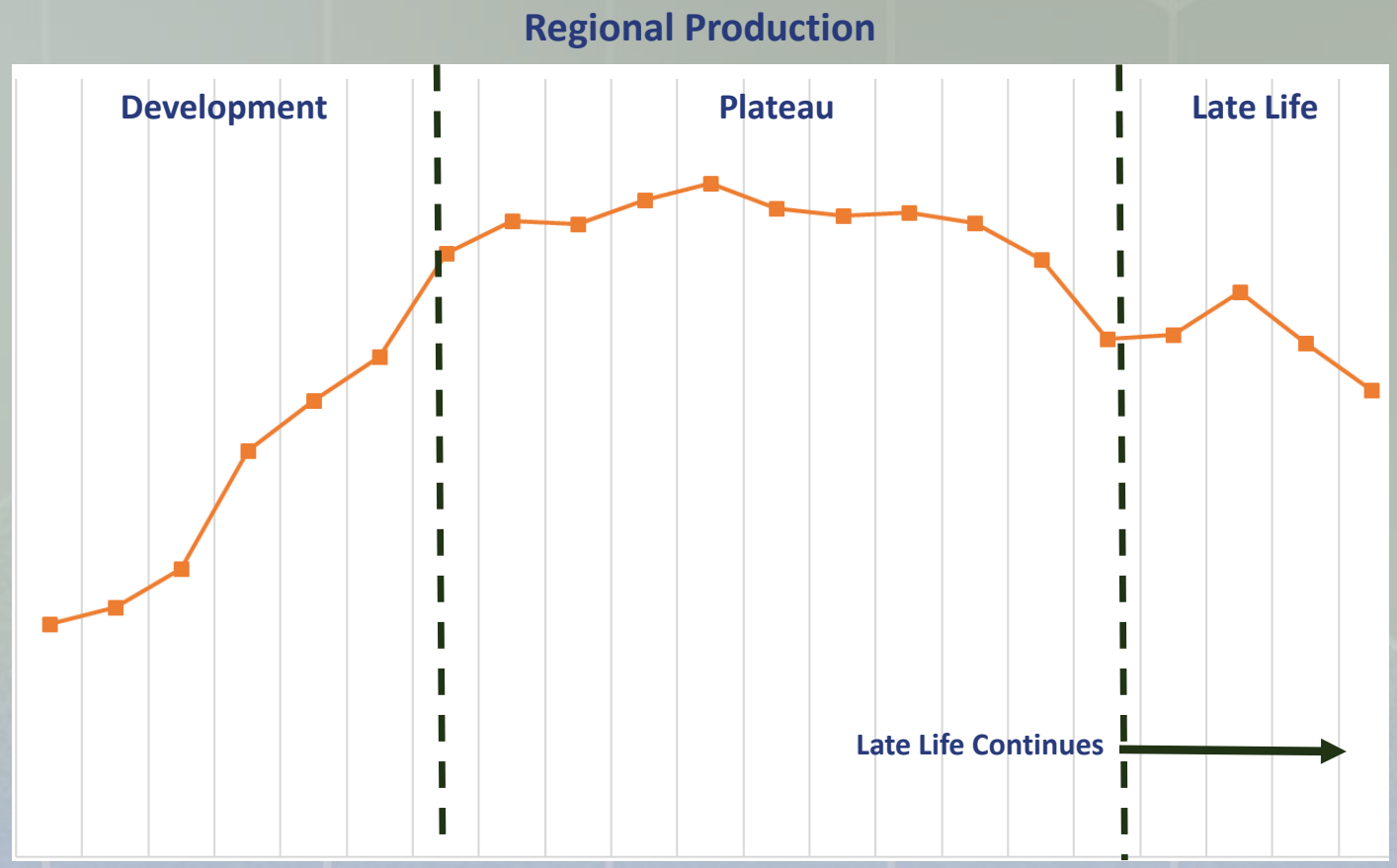
Natural Gas Value Chain

Regional Value Chain Phases

Case Study – Cost of Supply and Value Chain Analysis

VALUE CHAIN PHASES - OVERVIEW

- For gas exporting regions, the following phases typically apply:
  - Development – Gas Supply Increases
  - Plateau – Maintain Gas Supply
  - Late Life – Gas Supply Decreases
- The case study value chain is in the late life phase.



VALUE CHAIN PHASES – DEVELOPMENT

Upstream

- PSC terms are developed.
- Operators establish presence in the region.
- Significant exploration to quantify regional resources.
- UTC is generally highest in this phase.
- First major capital projects sanctioned.

Midstream

- Preliminary midstream infrastructure is developed.
- Entities to manage production (government or private) are established.
- Preliminary production contract structure is developed.

Downstream

- Operators establish presence in the region.
- First plants are sanctioned.

Markets / General

- **Gas Supply Increases. It first satisfies local demand, then export commences.**
- Dramatic capacity increases across the value chain.
- First volumes are allocated to downstream Operators for refining and export.
- Preliminary relationships and export contracts with global markets are established.

VALUE CHAIN PHASES – PLATEAU

Upstream

- Operators identify and sequence Projects to maintain supply.
- UTC is typically lowest during this phase.
- Wider range of technologies utilized.

Midstream

- Capacity added to midstream network if required.
- Contract structure is stable.

Downstream

- Plants continue to be sanctioned until downstream capacity is balanced with upstream supply.
- Plants typically operate at capacity.

Markets / General

- **Production is controlled / maintained.**
- Sufficient resources remain to maintain gas supply plateau.
- Development is more important than exploration in this phase.
- Relationships mature between regional entities and global markets.
- Typically the phase with the lowest volatility.

VALUE CHAIN PHASES – LATE LIFE – CASE STUDY PHASE

Upstream

- Life extension Projects for existing production hubs may be required.
- UTC may be the highest in the phase (reserve locations / environment).
- Enabling technologies may be considered.
- M&A opportunities as legacy Operators consider sales.

Midstream

- Operational conditions change as throughput drops.
- Compression may be added.
- More volatility in tariff contracts.

Downstream

- Life extension Projects for plants may be required.
- Competition for volumes increases.

Markets / General

- **Gas supply declines.**
- Remaining resources no longer sufficient to maintain plateau.
- Final push for exploration.
- Allocation of gas and PSC terms review becomes the focus for government entities.
- Typically the phase with the highest volatility.

AGENDA

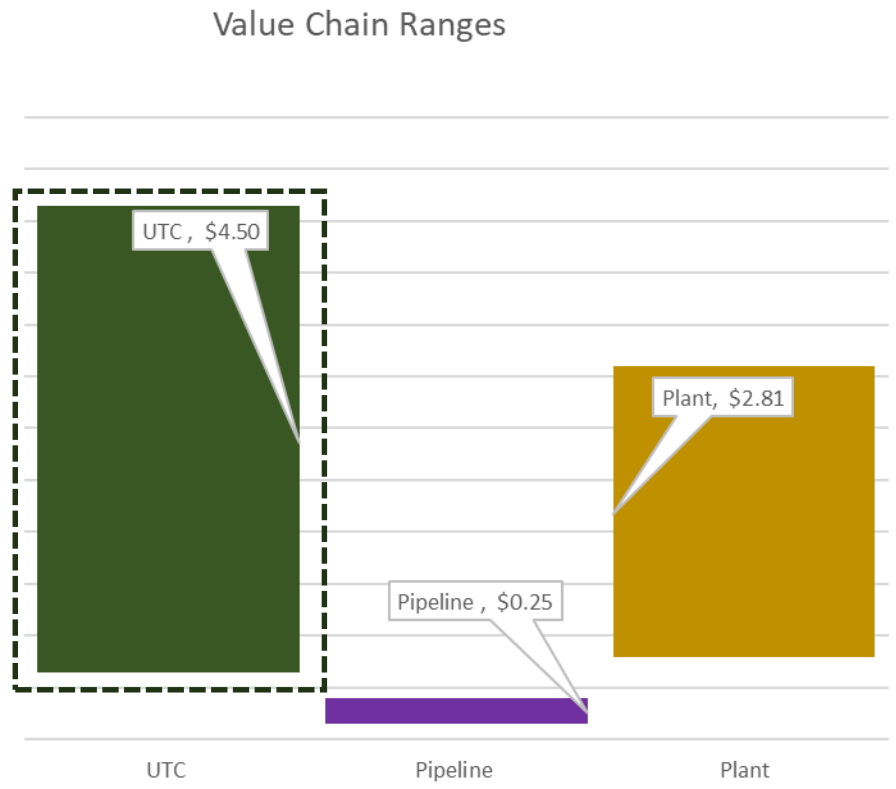
Natural Gas Value Chain

Regional Value Chain Phases

Case Study – Cost of Supply and Value Chain Analysis

UNIT TECHNICAL COST RANGE

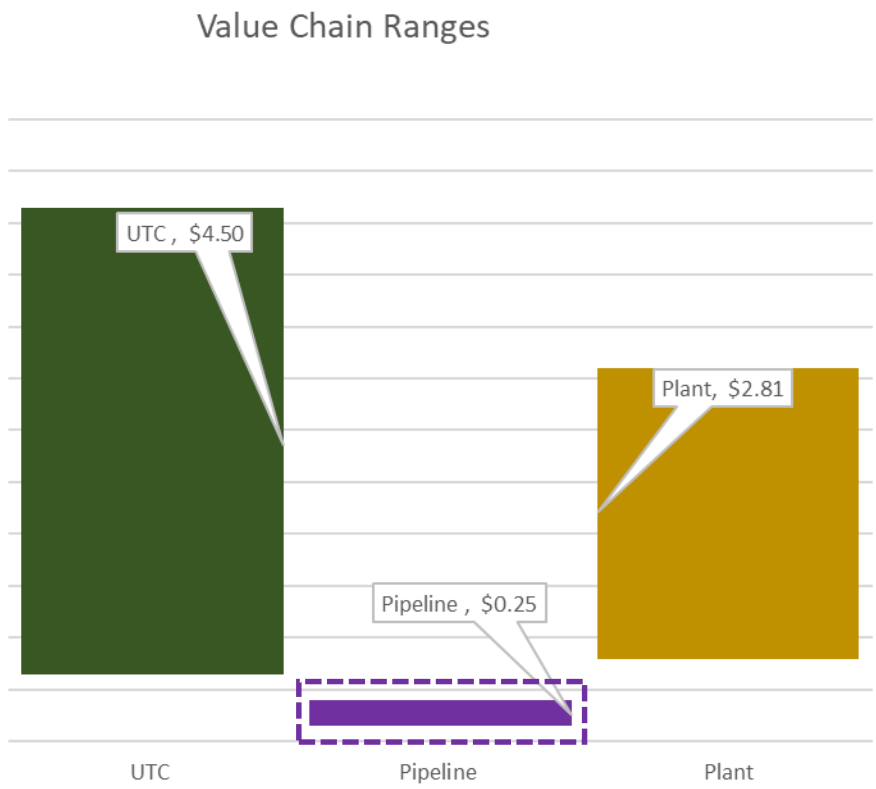
- Understanding the range in value chain components is important to understanding Operator drivers for developing currently ‘uncommitted’ fields.
- The UTC range is driven by:
  - Development status (developed, undeveloped)
  - Reservoir (depth, complexity)
  - Environment (onshore / offshore)
  - Water depth (shallow vs. deep)
  - Infrastructure maturity and step out distance
  - Resource size



Ranges shown are based on a Ryder Scott case study and will vary based on local conditions.

PIPELINE TARIFF RANGE

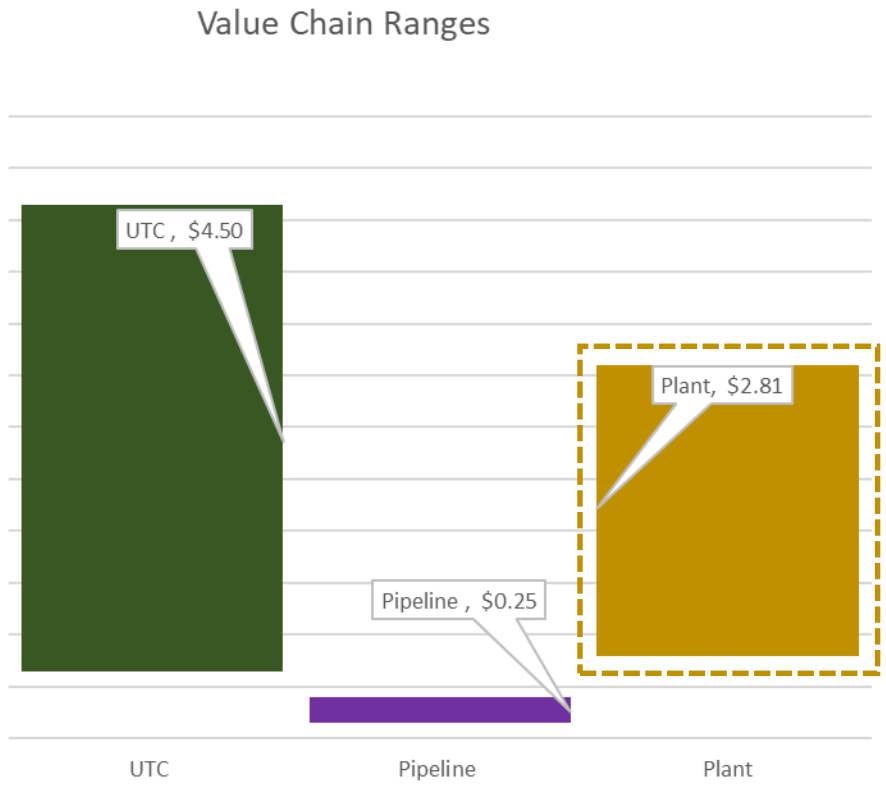
- Relative to UTC and plant fees, the pipeline tariff range is narrow and has a minor impact on total cost of production.
- The tariff range is driven by:
  - Contract length
  - Total throughput
  - Market conditions at the time of negotiation



Ranges shown are based on a Ryder Scott case study and will vary based on local conditions.

PLANT FEE RANGE

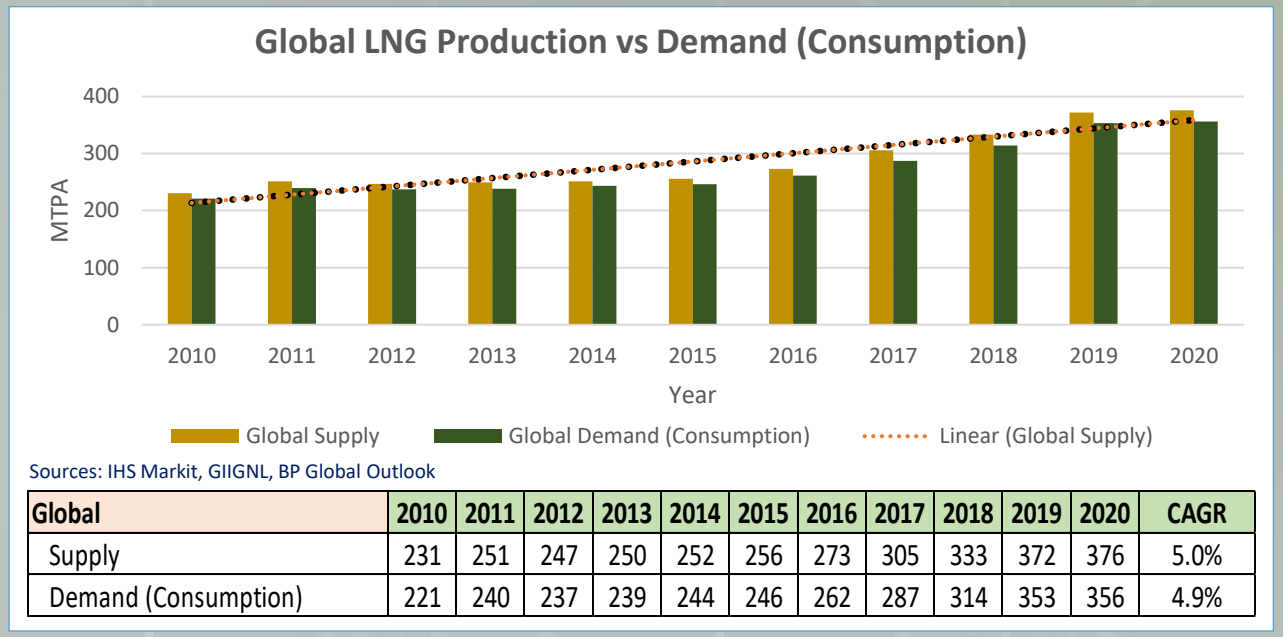
- The ranges associated with UTC and plant fee are the most significant for overall cost of production.
- Plant fees range is driven by:
  - Product type (i.e. LNG vs. Methanol)
  - Plant capacity (economics of scale)
  - Plant design life / extension required
- Understanding the plant fee and pipeline tariff range (in addition to UTC) provides the complete picture for assessing commerciality.



Ranges shown are based on a Ryder Scott case study and will vary based on local conditions.

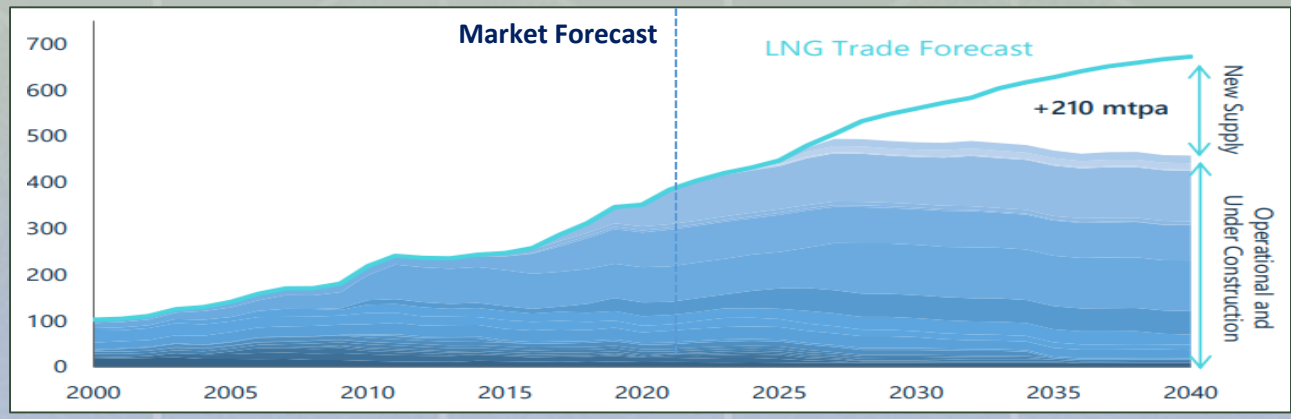
DEMAND

- Both 'local' and global demand are important considerations for value chain analysis.
  - Local demand is defined as the cumulative name capacity of plants in the region.
  - Global demand is by product and defined as the cumulative consumption of the product globally.
- For all natural gas products, the global market has historically operated at a capacity surplus.



Sources: IHS Markit, GIIGNL, BP Global Outlook

Global	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	CAGR
Supply	231	251	247	250	252	256	273	305	333	372	376	5.0%
Demand (Consumption)	221	240	237	239	244	246	262	287	314	353	356	4.9%



VALUE CHAIN ANALYSIS – MODEL AND SCENARIO DEVELOPMENT

Value Chain Model Development:

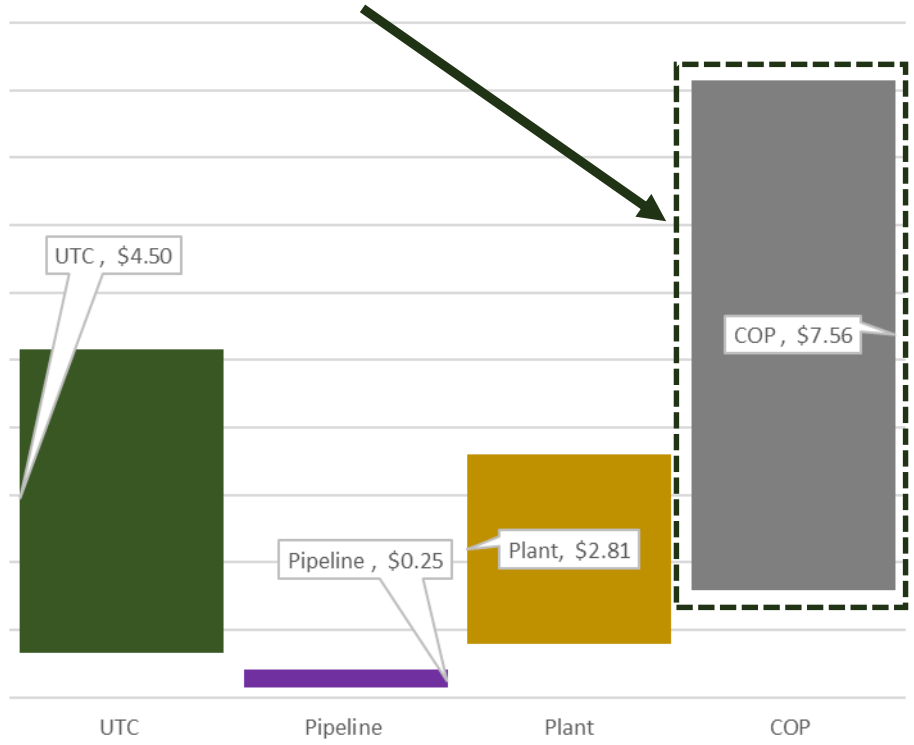
- We developed a value chain with the capability of calculating margins for natural gas products.
- The model:
  - Stores cost ranges for each value chain component on a product by product basis.
  - Allows the user to toggle conditions for each component and product to develop scenarios.
  - Generates margins based on user input in table and graphically form.

Scenario Development – Case Study:

- We developed scenarios from the perspective of industrial consumers securing future gas contracts in a late life value chain.

Value Chain Ranges

The model captures all intermediate points at the COP range and allows the user to define cases and select parameters.



Ranges shown are based on a Ryder Scott case study and will vary based on local conditions.

VALUE CHAIN ANALYSIS – CASE STUDY HIGHLIGHTS

Scenario Overview:

- UTC (constant)
- Pipeline tariff (constant)
- Plant fees (varied)
- Aggregate shipping fee (constant)
- Product pricing (varied)

Value Added:

- The subsurface study provided the client with a high confidence range of gas supply going forward.
- Margin analysis provided negotiation support to the client during gas contract negotiation and demonstrates the competitive standing of gas products in the value chain.
- The demand study outlined likely allocation of future gas supply.

Product 1
Lowest Margin
Negative Margin

Product 2
Middle Margin

Product 3
Highest Margin
Low Pricing
No Upgrades

Product 1
Lowest Margin
Negative Margin

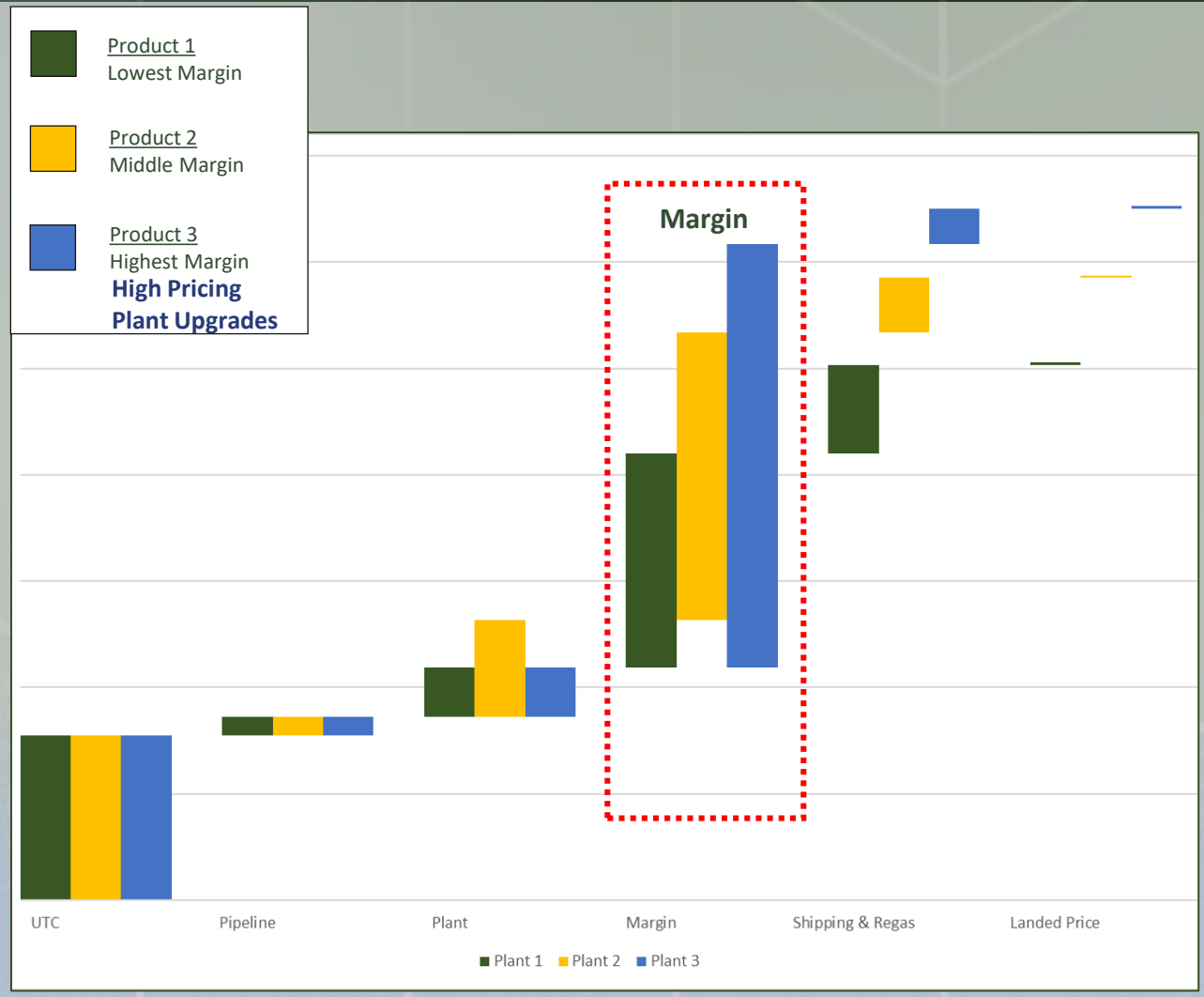
Product 2
Middle Margin

Product 3
Highest Margin
Low Pricing
Plant Upgrades

Product 1
Lowest Margin

Product 2
Middle Margin

Product 3
Highest Margin
High Pricing
No Upgrades



OTHER APPLICATIONS AND CONCLUSIONS

- Value chain models and margin analysis have wide applications for all participants in the natural gas value chain.

- Alternate applications include:
  - Upstream – provide insight into relative profitability of downstream products to inform the sell side of future natural gas contracts.
  - Midstream – provide confidence in future gas supply through midstream systems and insight on cost of gas from fields to inform future tariff contract structures.
  - Government / Regulatory bodies – provide insight on Operator incentives for future developments for the review of PSC terms as regional value chains move into the late life phase.