

Shale Gas as an Alternative Petrochemical Feedstock

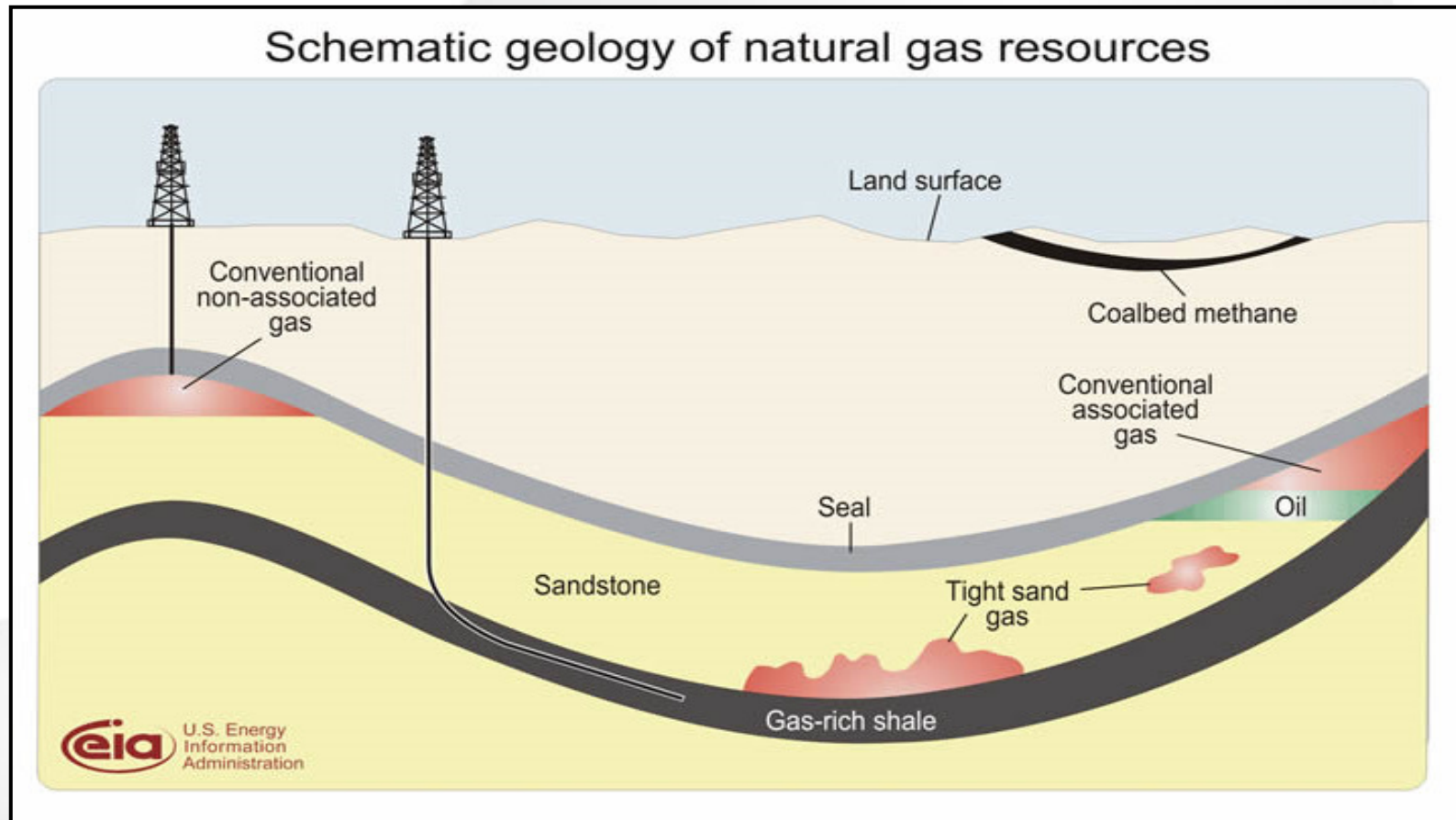
Tecnon OrbiChem Marketing Seminar at APIC 2013

Taipei, 9 May 2013

Roger Lee

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SHALE GAS – WHERE DOES IT COME FROM?



- **Watch this clip:** <http://www.oerb.com/Default.aspx?tabid=242>

Source: EIA

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SHALE GAS EXPLOITATION

Commercial Shale Gas Exploitation Requires:

- Advanced seismic & modelling techniques
- Accurate directional and horizontal drilling methods
- Safe & effective hydraulic fracturing procedures

US Shale Gas Timeline:

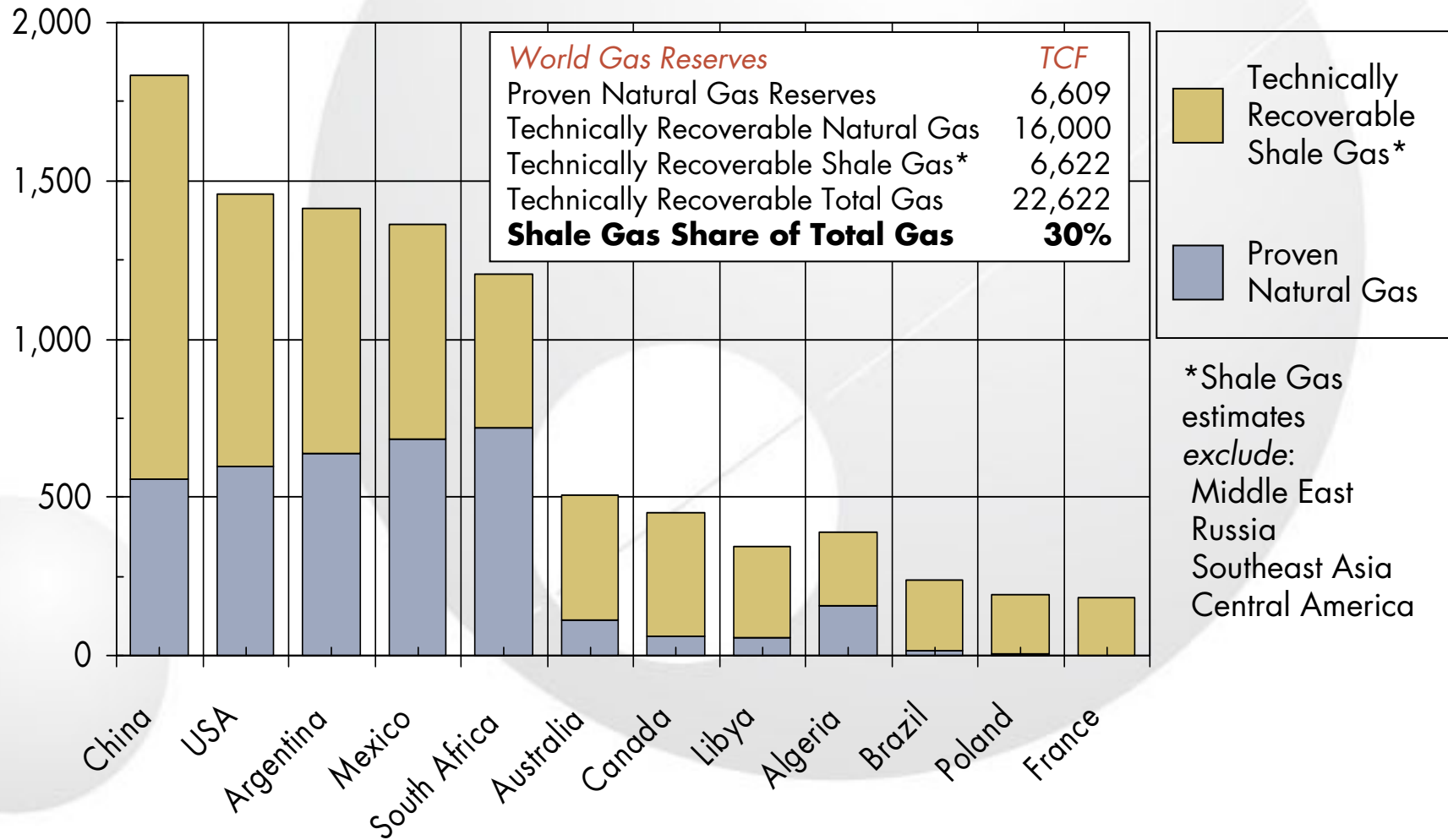
- 1950s Fracturing started as oilfield technique
- 1970s Main developments
- 1980-90s Exploitation of Barnett shale in North Texas
- 2005 Barnett shale output 0.5 trillion ft³/year
- 2010 US shale gas output 4.8 trillion ft³/year (23% of total)
- 2035 Shale gas 46% of US total output

Source: Tecnon OrbiChem

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ESTIMATED SHALE GAS* vs. PROVEN NATURAL GAS

Trillion Cubic Feet (TCF)

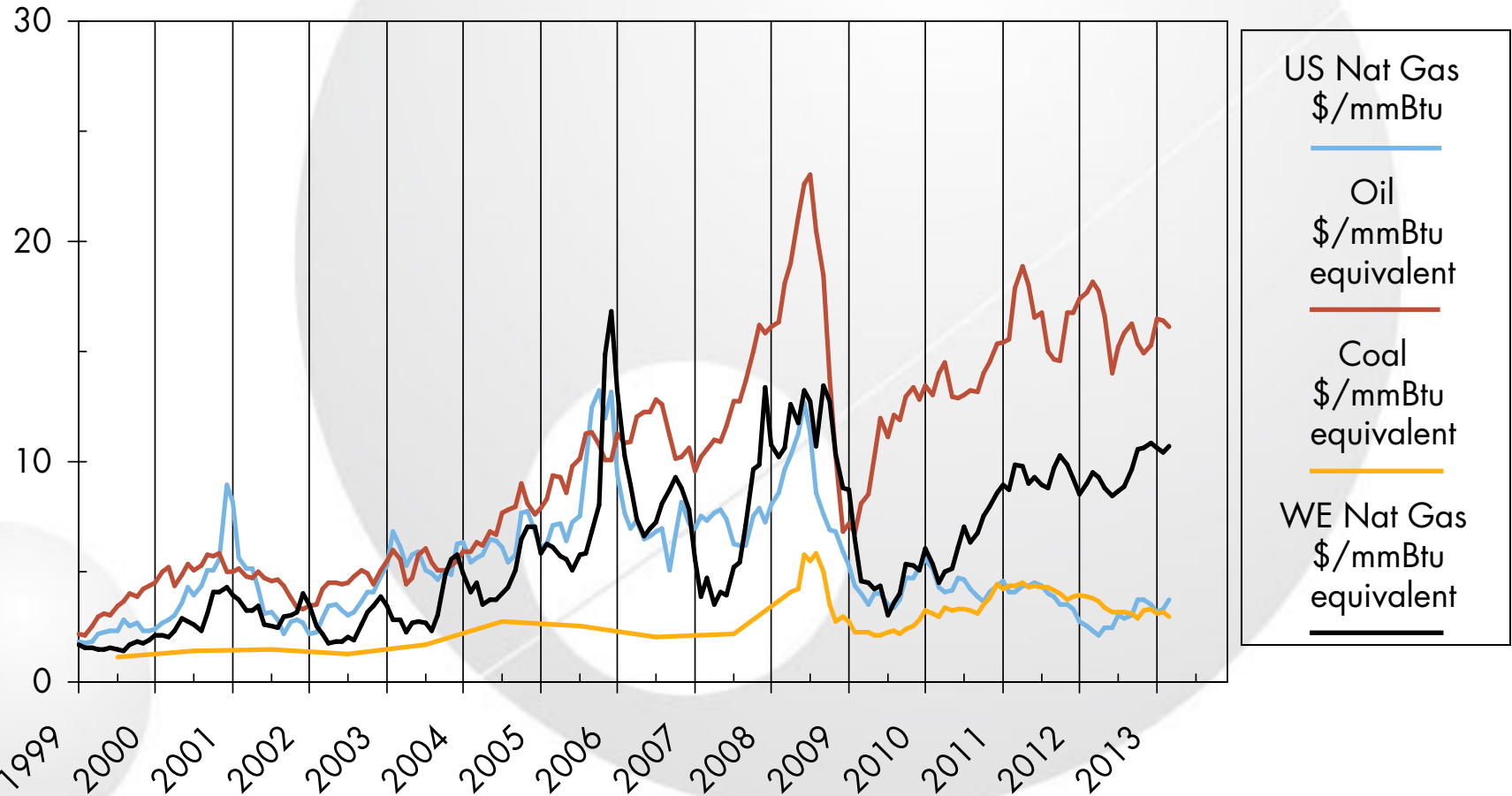


Source: EIA

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NATURAL GAS, CRUDE OIL & COAL PRICES

\$/mmBtu

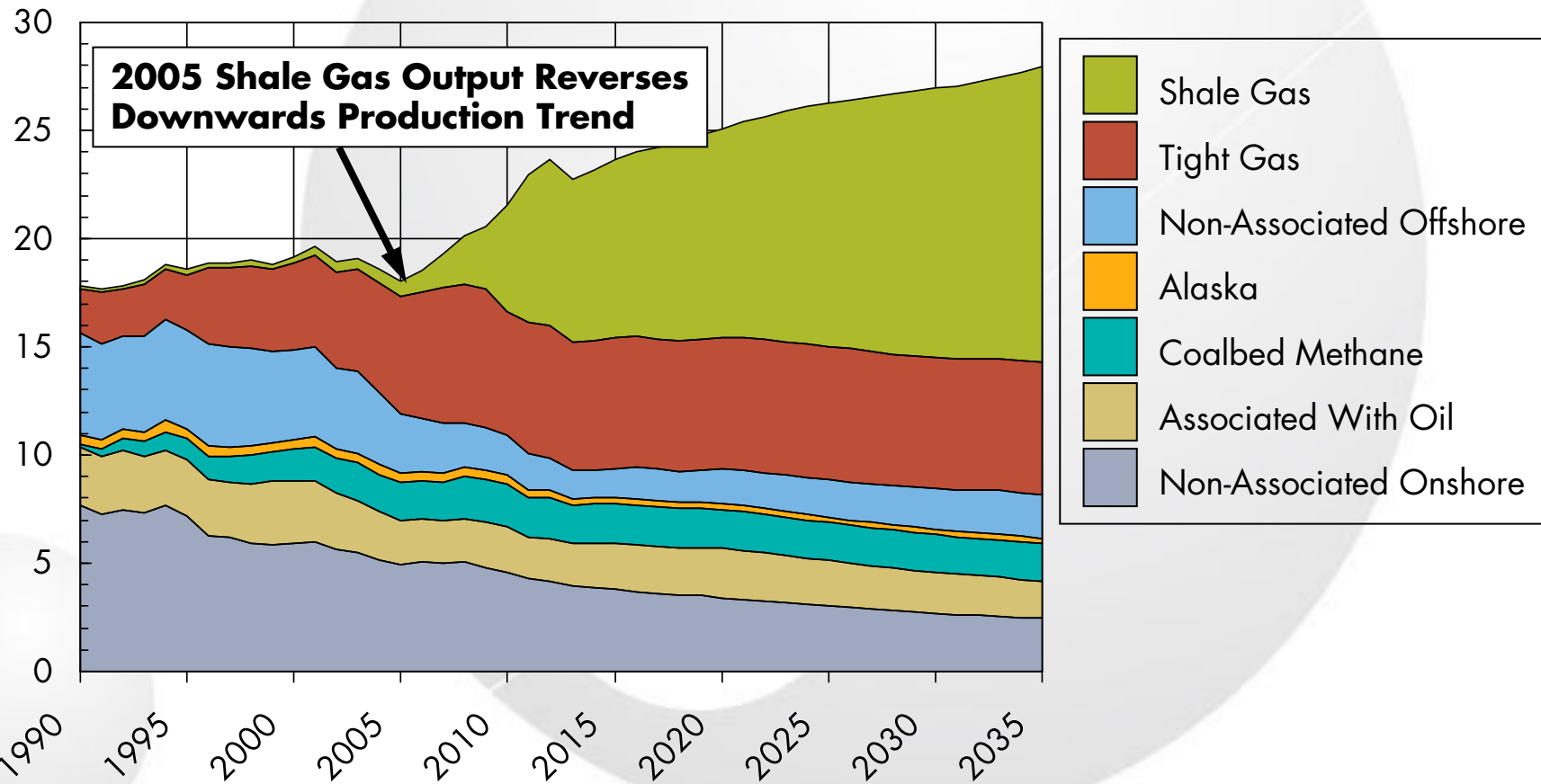


Source: Tecnon OrbiChem

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US NATURAL GAS PRODUCTION BY SOURCE

Trillion Cubic Feet (TCF)



Source: EIA

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SHALE GAS ECONOMICS

Shale Gas Economics Dependant Upon:

- Cost of extraction
- Ease of distribution
- Gas composition

Shale Gas a Victim of Its Own Success?

- Most shale gas fields yield acceptable return at \$5-6/mmBtu
- 'NGL Uplift' adds \$2.50-5.00/mmBtu
- Oversupply and low prices are slowing dry gas development
- Focus is turning to wet gas and shale oil
- US oil rig count now exceeds gas rig count
- Focus on wet gas improves ethane availability

Source: Tecnon OrbiChem

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SHALE GAS – WHAT'S IN IT?

Natural Gas (Methane)

- 'Dry' Gas
- Heating Fuel
- Power Generation
- Liquefied for Export (LNG)

Natural Gas Liquids (Ethane & Propane)

- 'Wet' Gas
- Petrochemical Feedstock
- NGLs

Source: Tecnon OrbiChem

APIC 2013 SHALE GAS COMPOSITION

<i>Component (Volume %)</i>	<i>Marcellus Shale (New York, Pennsylvania, Ohio, West Virginia)</i>					<i>Barnett Shale (Texas)</i>			
	<i>Well 1</i>	<i>Well 2</i>	<i>Well 3</i>	<i>Well 4</i>	<i>Well 5</i>	<i>Well 1</i>	<i>Well 2</i>	<i>Well 3</i>	<i>Well 4</i>
Methane	79.4	82.1	83.8	95.5	95.0	80.3	81.2	91.8	93.7
Ethane	16.1	14.0	12.0	3.0	0.1	8.1	11.8	4.4	2.6
Propane	4.0	3.5	3.0	1.0	0.0	2.3	5.2	0.4	0.0
Carbon Dioxide	0.1	0.1	0.9	0.3	4.8	1.4	0.3	2.3	2.7
Nitrogen	0.4	0.3	0.3	0.2	0.1	7.9	1.5	1.1	1.0

Source: Oil & Gas Journal

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SHALE GAS – WHAT'S IN IT FOR PETROCHEMICALS?

Increased Supply of 'Dry' Gas (Methane):

- Lower energy prices (heating and power generation).
- Benefit energy or power intensive industries such as Chlor-Alkali
- Feedstock availability for C₁ products e.g. Methanol etc.
- In 2006 there were 60 plans for US LNG *import* terminals
- Now terminals applying and being approved to *export*

Increased Supply of 'Wet' Gas (Ethane & Propane):

- Lower ethylene feedstock costs and increased competitiveness
- Investment in E/P vs naphtha crackers or closures
- 10 million tpa US ethylene expansions announced
- US ethane surplus and exports

Source: Tecnon OrbiChem

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US OLEFINS – BACK TO THE FUTURE?

Pre 2000

- US ethylene crackers mainly ethane and E/P feedstock
- Competitively priced ethylene and derivatives
- Ethylene derivatives enjoy 'export support' prices
- Major importer of propylene and butadiene

2000-2010

- US ethylene crackers switch to naphtha feedstock or close
- US ethylene derivatives less competitive – plant closures

Post 2010

- US crackers switching to ethane feedstock
- New ethane crackers planned
- Competitively priced ethylene and derivatives
- More US ethylene, polyethylene and MEG?
- Reduced availability and higher prices for C₃, C₄ etc.

Source: Tecnon OrbiChem

APIC 2013 FRACKING - OBJECTIONS



Source: Tecnon OrbiChem

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SHALE GAS - CONCLUSIONS

Certainties

- There's a lot of Shale Gas around
- Technology allows for economic exploitation
- High oil price environment helps
- Higher natural gas availability & lower prices boost NGL markets
- Higher ethane availability & lower prices boost C₃ and C₄ markets

Uncertainties

- Recoverable reserves
- Extraction rates
- Pricing
- Government regulatory policy
- Environmental concerns

Source: Tecnon OrbiChem



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