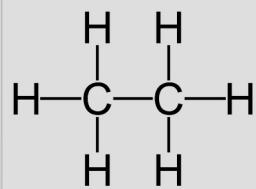




# CRACKING THE ETHANE CRACKER



ROSE M. BAKER

DAVID L. PASSMORE

# About these slides...



Rose M. Baker



David L. Passmore

The slides in this collection are the talking points that guided our discussion at the 2012 PA WIB Symposium with approximately 40 Symposium participants. The content and flow of the slides provides an outline of our remarks, but not their detail. Nor do these slides represent the rich, useful comments made by Symposium participants.

The possibility of ethane cracker holds much promise for western PA. The decision to plan, build, and operate the cracker involves substantial risk and uncertainty by Royal Dutch Shell. PA residents are highly invested in the deliberations about and outcomes from this decision.

We welcome any comments or questions you might have about this presentation.

Rose, [rmr194@psu.edu](mailto:rmr194@psu.edu), 814.865.9919

David, [dip@psu.edu](mailto:dip@psu.edu), 814.863.2583

WEB SITE AVAILABLE AT PAWIB2012.TUMBLR.COM ....

# cracking the ethane cracker

• précis • presenters • workshop • links • media • penn state irtd •

Presentation by Rose M. Baker & David L. Passmore at 2012 WIB Symposium  
hosted by the Pennsylvania Association of Workforce Investment Boards  
at the Penn Stater Hotel & Conference Center in State College, Pennsylvania  
on August 16, 2012

## | INSTITUTE FOR RESEARCH IN TRAINING & DEVELOPMENT |

The IRTD produces research and analysis about the workforce and economy of Pennsylvania and beyond.

The IRTD conducts research that is policy-relevant, but is not policy-prescriptive. The IRTD often conducts research and analysis about topics and issues that, at times, are the focus of vigorous debate and public attention and that frequently are associated with diverse stakeholders who represent divergent opinions. The Institute adds value, attention, and discussion to this debate by conducting and reporting research and analysis for decisions affecting workforce and economic development.

Baker and Passmore are principal members of the Institute for Research in Training & Development (IRTD).

The **Institute for Research in Training & Development** (IRTD) produces research and analysis about the workforce and economy of Pennsylvania and beyond.

The IRTD conducts research that is policy-relevant, but is not policy-prescriptive. The IRTD often

# 2012 WIB SYMPOSIUM

PENNSYLVANIA ASSOCIATION OF WORKFORCE INVESTMENT BOARDS

## Related literature at:

<http://www.diigo.com/user/davidpassmore/psu-ethane>



agencies, including federal agencies, local governments, contracts, and purchase orders with public, private, and government organizations as well as other Penn State units through Intercollegiate Research and Development Contracts (despite developing research contracts).

The IRTD has been involved in research and analysis that has spanned a wide range of topics (cf., funded projects, presentations, publications, and news events of the IRTD).

How is Research Conducted?  
The IRTD employs a wide variety of tools and techniques in its research work (Read two-page overview).

To conduct its analytical work, the IRTD leases, purchases, and creates a variety of analytical models and data. For instance, the

technically appropriate approaches possible.

The research and analysis of the Institute are pursued independent of the commercial or political interests of any actual or potential sponsor of the Institute's work.

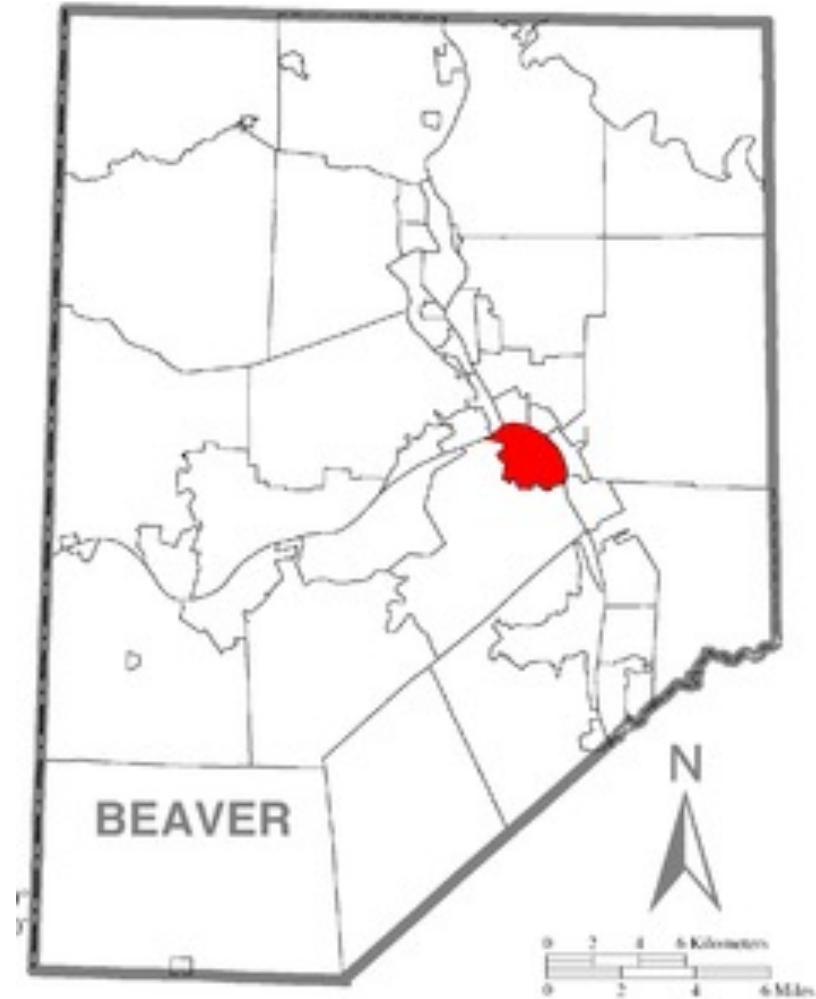
# Pennsylvania Ethane Opportunity

- Shell Chemical LP land purchase option for Horsehead Corporation near Monaca in Beaver County.
- Evaluate site for a potential petrochemical complex.



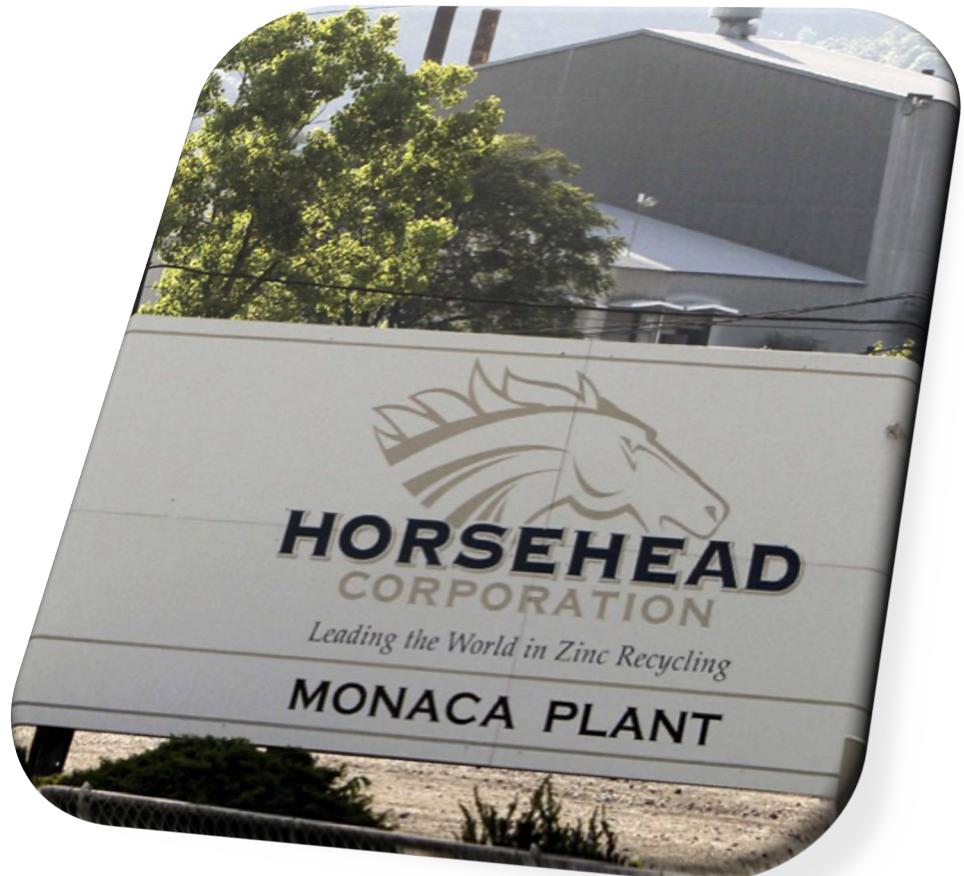
# Pennsylvania Ethane Opportunity

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- Process ethane from “wet” Marcellus Shale gas.



# Pennsylvania Ethane Opportunity

- Shell Chemical LP land purchase option for Horsehead Corporation near Monaca in Beaver County.
- Evaluate site for a potential petrochemical complex.
- Process ethane from “wet” Marcellus Shale gas.
- Supply ethylene for intermediate sales to industries & for final end use in manufactured products.



# Pennsylvania Ethane Opportunity

- A \$66 million/year tax credit for 25 years totaling \$ 1.65 billion.
- State pays costs of clean up of the Monaca zinc smelter site for ethane cracker.
- Shell free from all state & local taxes if they build at Beaver Co. site.
- RBN Energy from Houston says Shell deal at high risk of failure without incentives and subsidies.



# Shell's timeline

## GENERIC PROJECT STAGES & TIMELINE

\* Approximate 'on average' times.  
Actual time varies by opportunity.



A WORLD-SCALE PETROCHEMICAL COMPLEX IS INTRICATE AND TYPICALLY TAKES FIVE YEARS OR MORE TO BUILD, FROM PLANNING TO START-UP.

# Shell's timeline

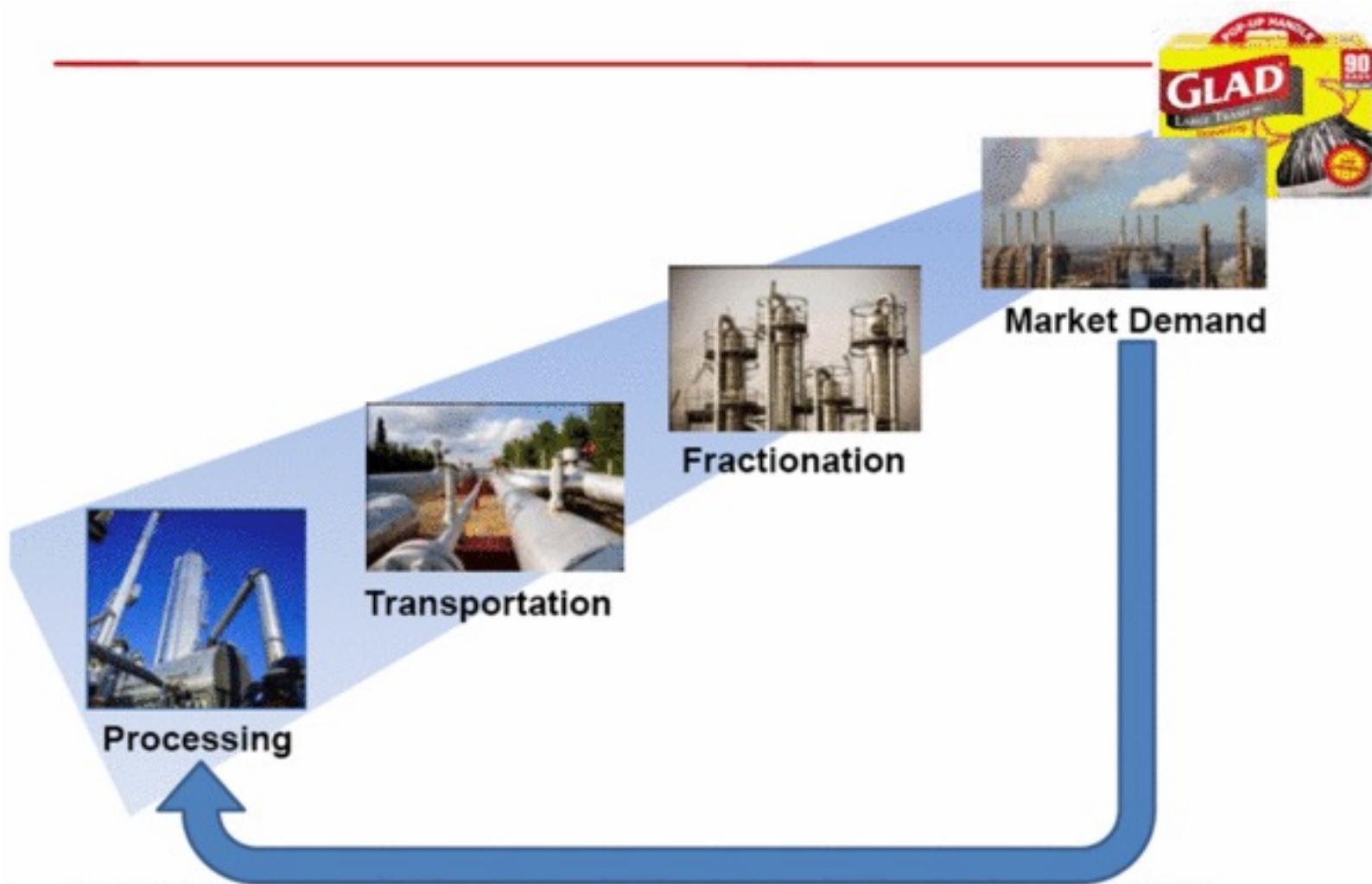
## GENERIC PROJECT STAGES & TIMELINE

\* Approximate 'on average' times.  
Actual time varies by opportunity.



**SHELL MUST CLEAR MANY HURDLES BEFORE IT CAN EVEN MAKE AN INVESTMENT DECISION.**

# Natural gas liquids “value chain gauntlet”



# Shell's timeline

## GENERIC PROJECT STAGES & TIMELINE

\* Approximate 'on average' times.  
Actual time varies by opportunity.



**NEED TO CONFIRM THE SUITABILITY OF THE SITE, SECURE ETHANE SUPPLY, COMPLETE ENGINEERING AND DESIGN WORK, CONFIRM THE SUPPORT OF CUSTOMERS FOR PRODUCTS, RECEIVE ALL NECESSARY PERMITS AND DETERMINE WHETHER THE PROJECT IS ECONOMICALLY SOUND AND COMPETITIVE WITH ALTERNATIVE INVESTMENT OPPORTUNITIES.**

# Shell's timeline

## GENERIC PROJECT STAGES & TIMELINE



2017?



## WHAT'S THE BUZZ?

**What have you read? What have you heard? What plans are under consideration? What is expected of you? What actions have you taken? What do you believe will happen to the workforce and economy?**

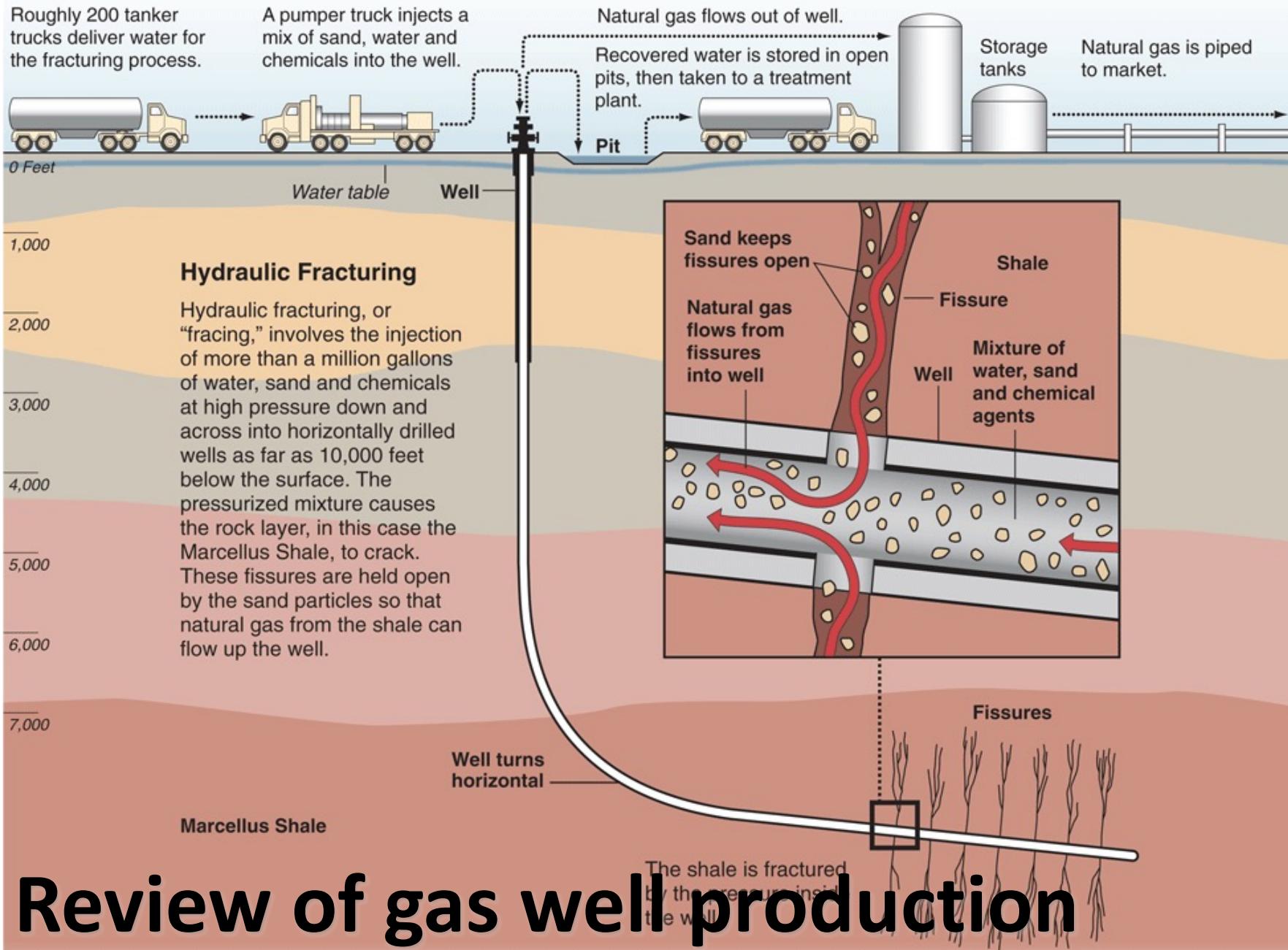
# Discuss 4 topics today....

- Natural gas liquids.
- Ethane → ethylene:  
cracking.
- American Chemistry  
Council (ACC) economic  
forecasts.
- Several quick, back-of-  
the-envelope forensic  
analyses.





## NATURAL GAS LIQUIDS



# What comes out of a gas well?

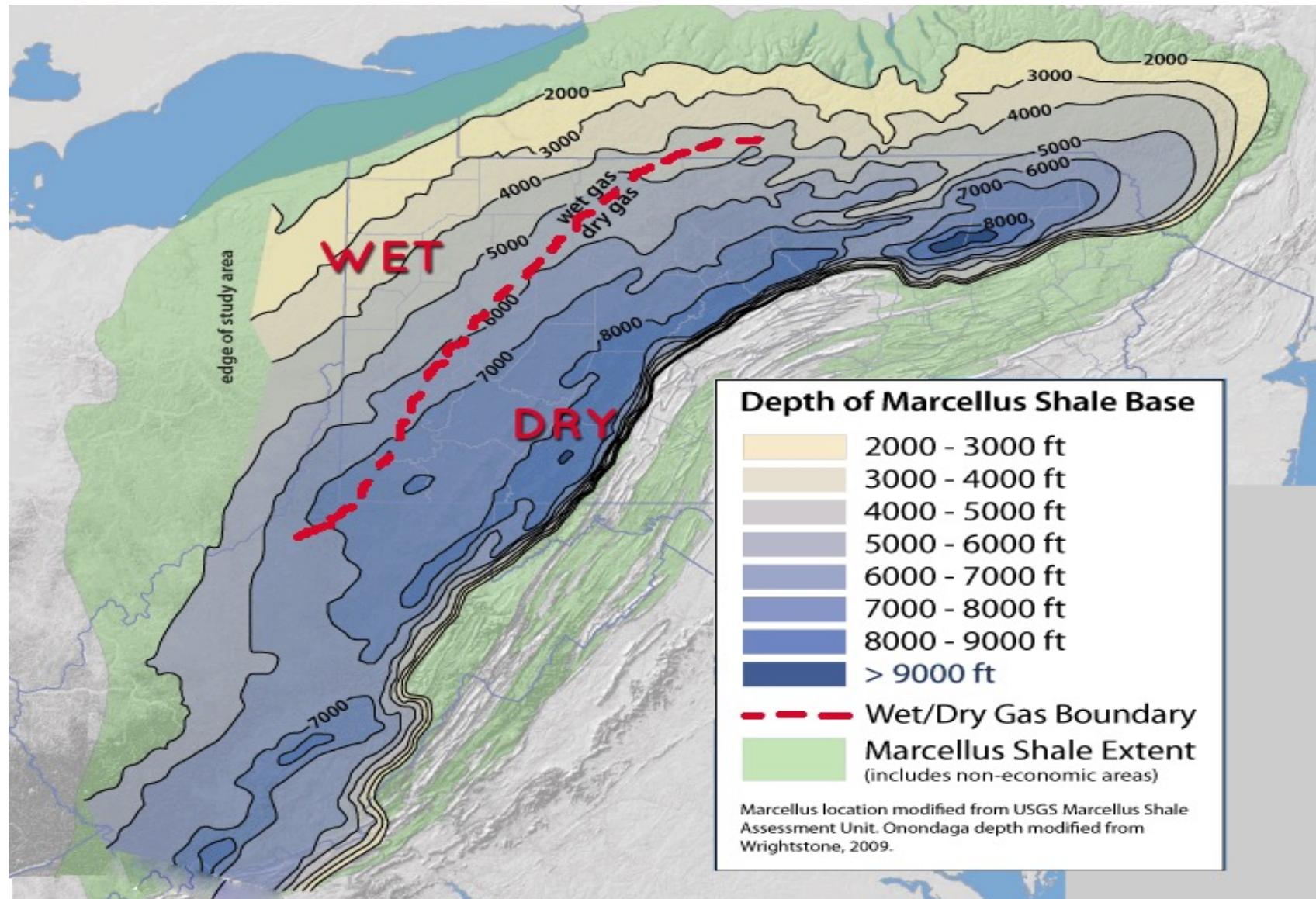
- Methane (primarily)
- Water
- Gases (nitrogen, helium, and some acidic gases such as hydrogen sulfide)
- Small amounts of mercury and radon
- Heavy gaseous hydrocarbons

- Ethane
- Propane
- Butane

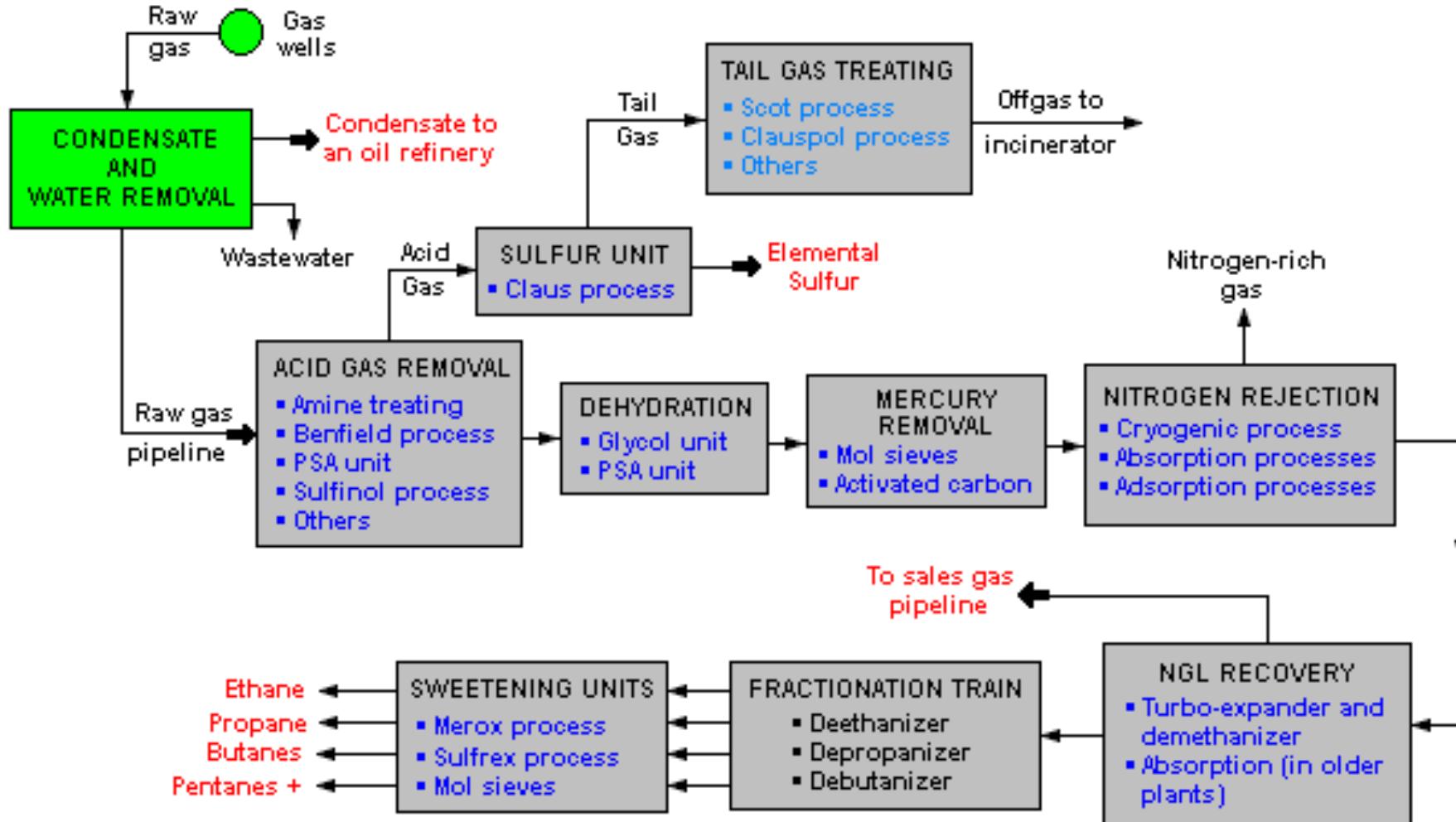


Natural  
Gas  
Liquids

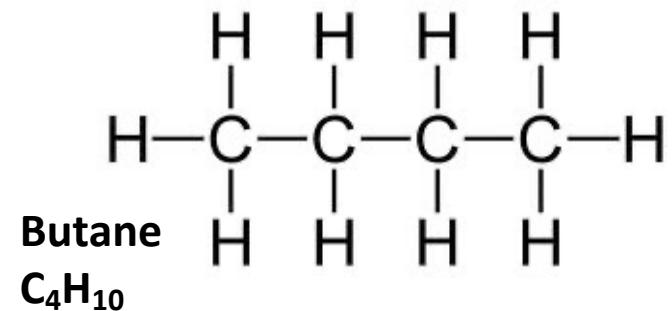
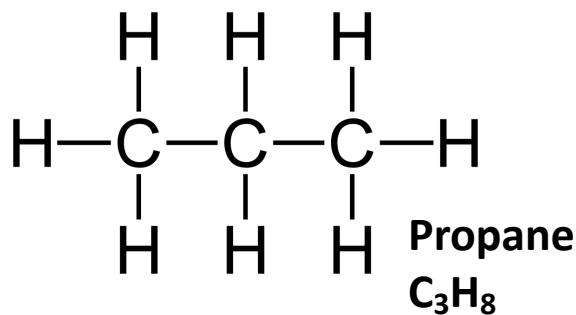
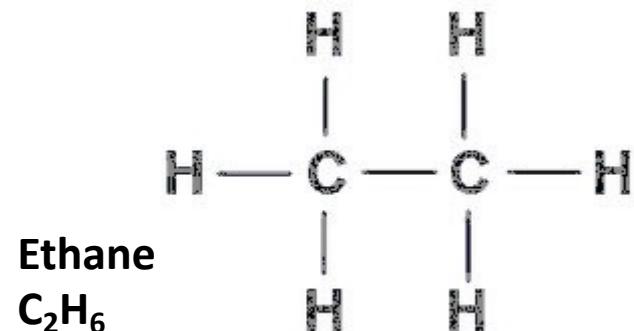
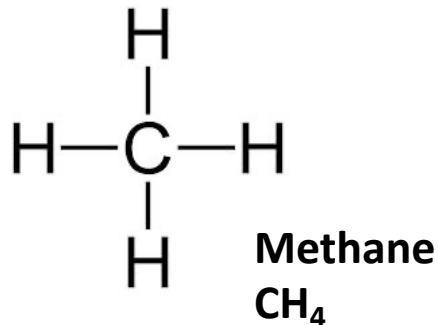
# Where's the “wet” gas?



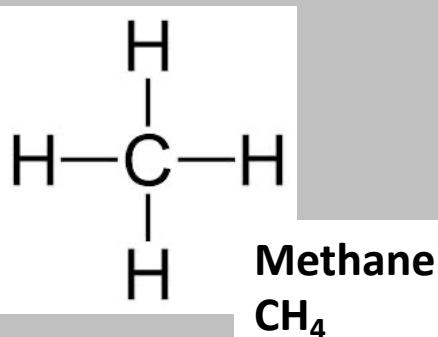
# Raw natural gas is processed



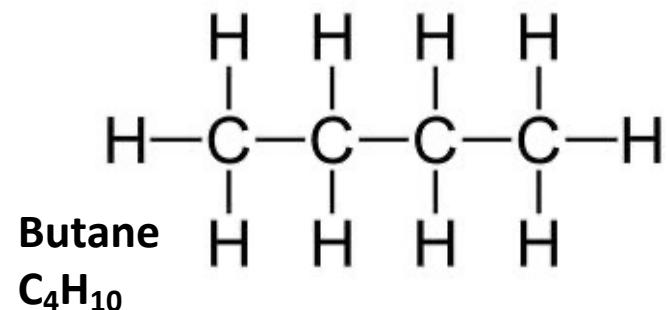
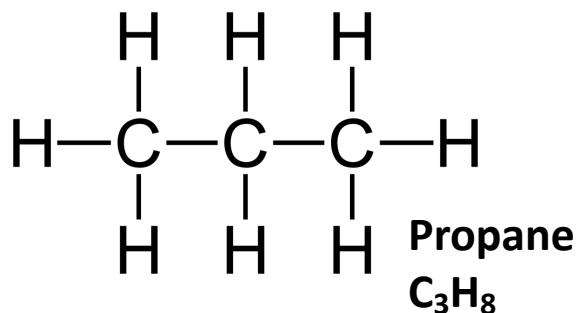
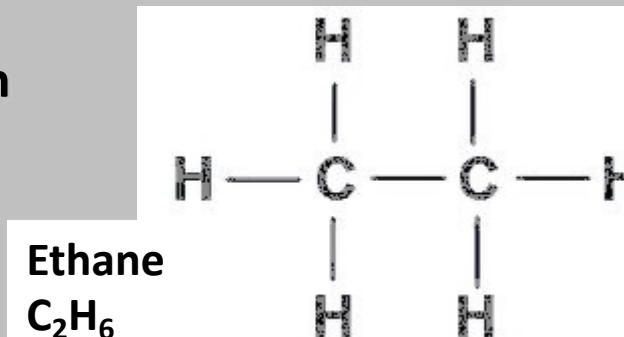
# Methane gas & some gas liquids



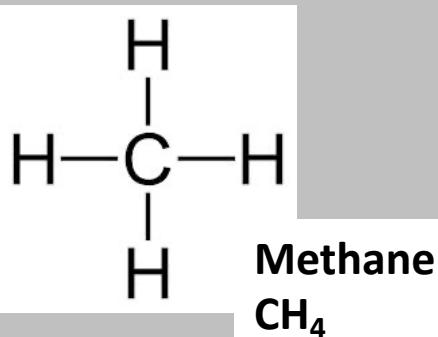
# Methane gas & some gas liquids



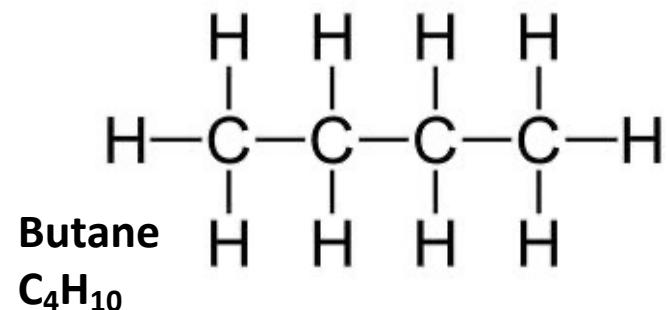
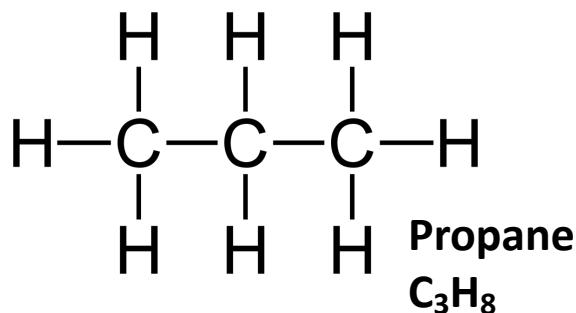
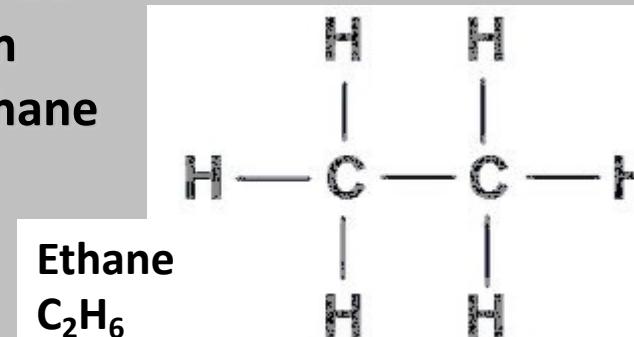
Deliver roughly  
same BTUs & can  
be mixed



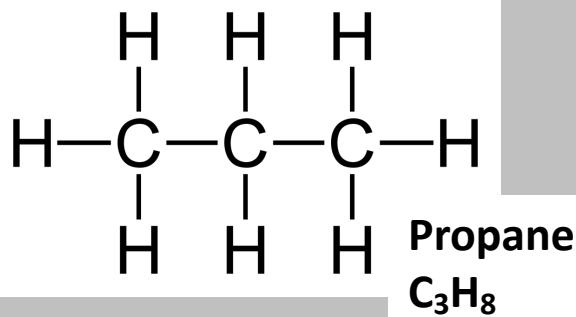
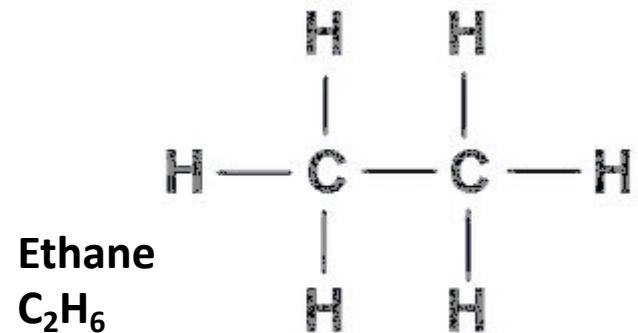
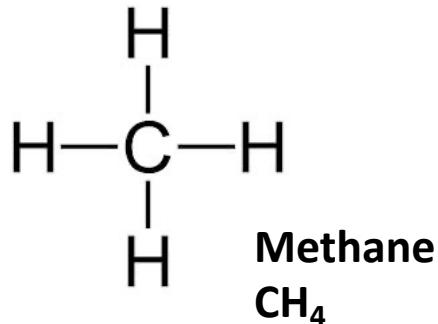
# Methane gas & some gas liquids



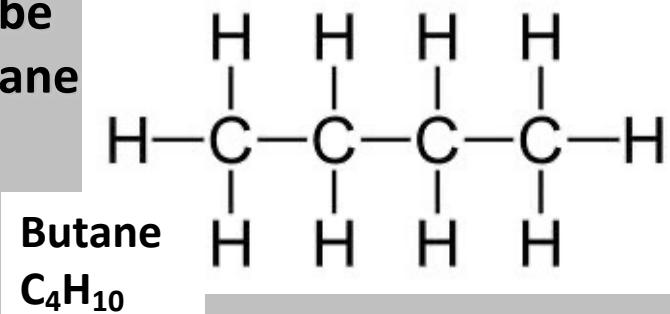
Ethane is said to be  
“rejected” when  
mixed with methane



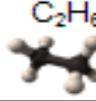
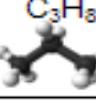
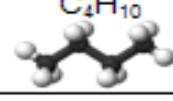
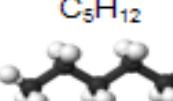
# Methane gas & some gas liquids



Deliver much higher  
BTUs but cannot be  
mixed with methane



# Attributes of natural gas liquids (Energy Information Administration)

NGL Attribute Summary				eia
Natural Gas Liquid	Chemical Formula	Applications	End Use Products	Primary Sectors
Ethane	$C_2H_6$ 	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	$C_3H_8$ 	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, Residential, Commercial
Butane	$C_4H_{10}$ 	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tires; LPG; lighter fuel	Industrial, Transportation
Isobutane	$C_4H_{10}$ 	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	$C_5H_{12}$ 	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentanes Plus*	Mix of $C_5H_{12}$ and heavier	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oil sands production	Transportation

C indicates carbon, H indicates hydrogen; Ethane contains two carbon atoms and six hydrogen atoms

\*Pentanes plus is also known as "natural gasoline." Contains pentane and heavier hydrocarbons.



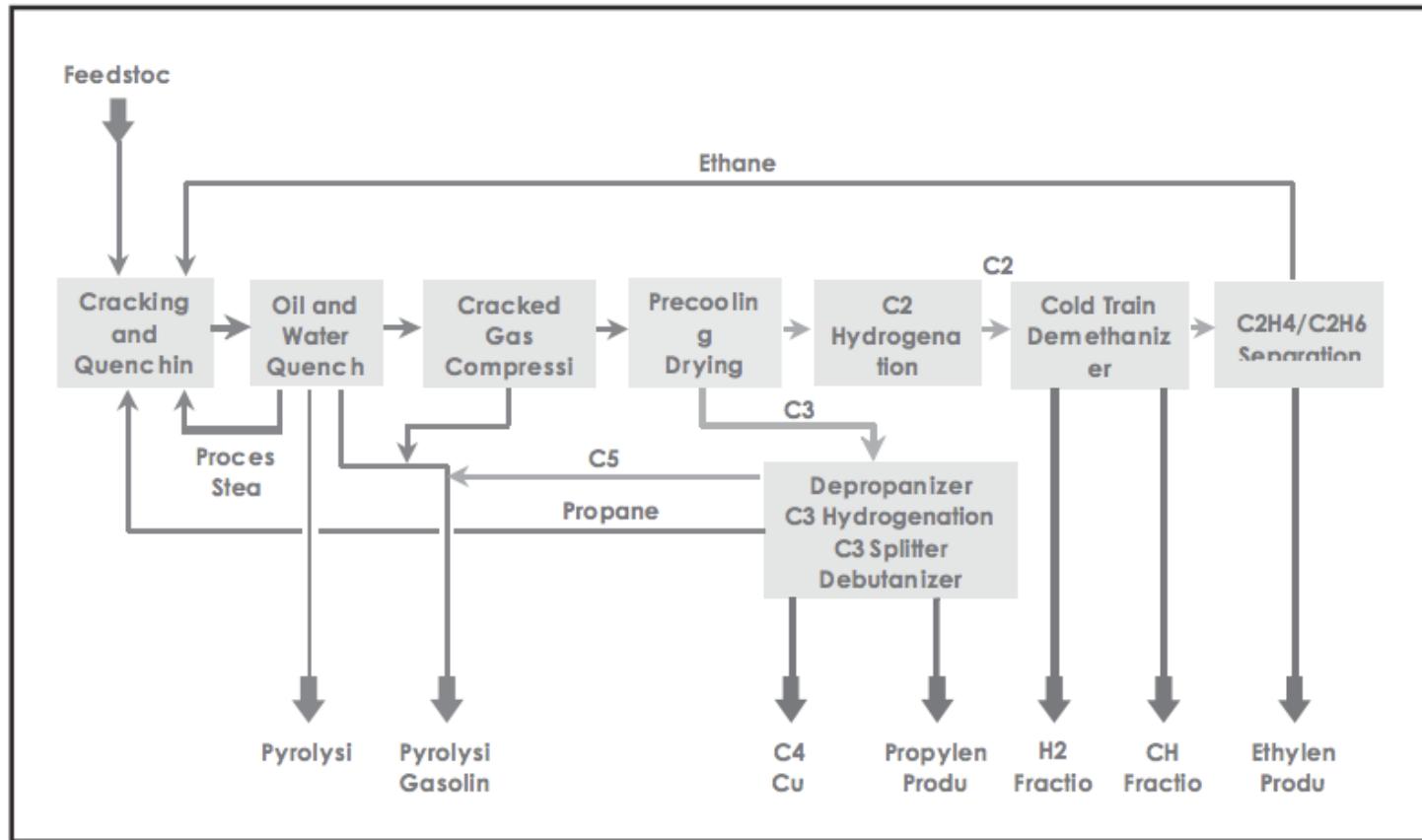
**QUESTIONS? DISCUSSION?**



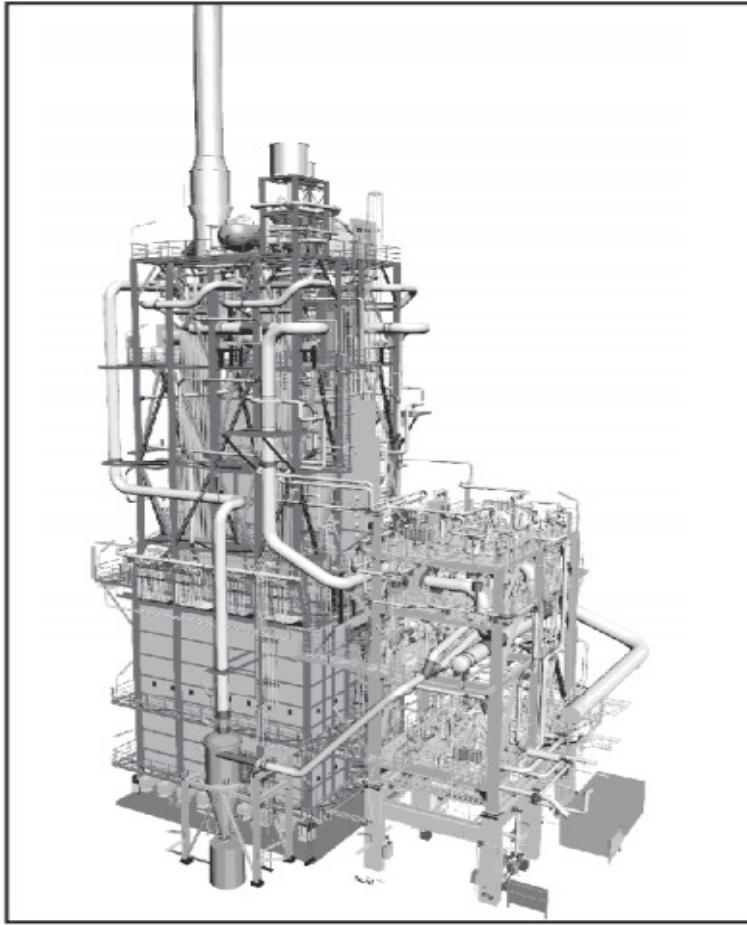
**ETHANE → ETHYLENE: CRACKING**



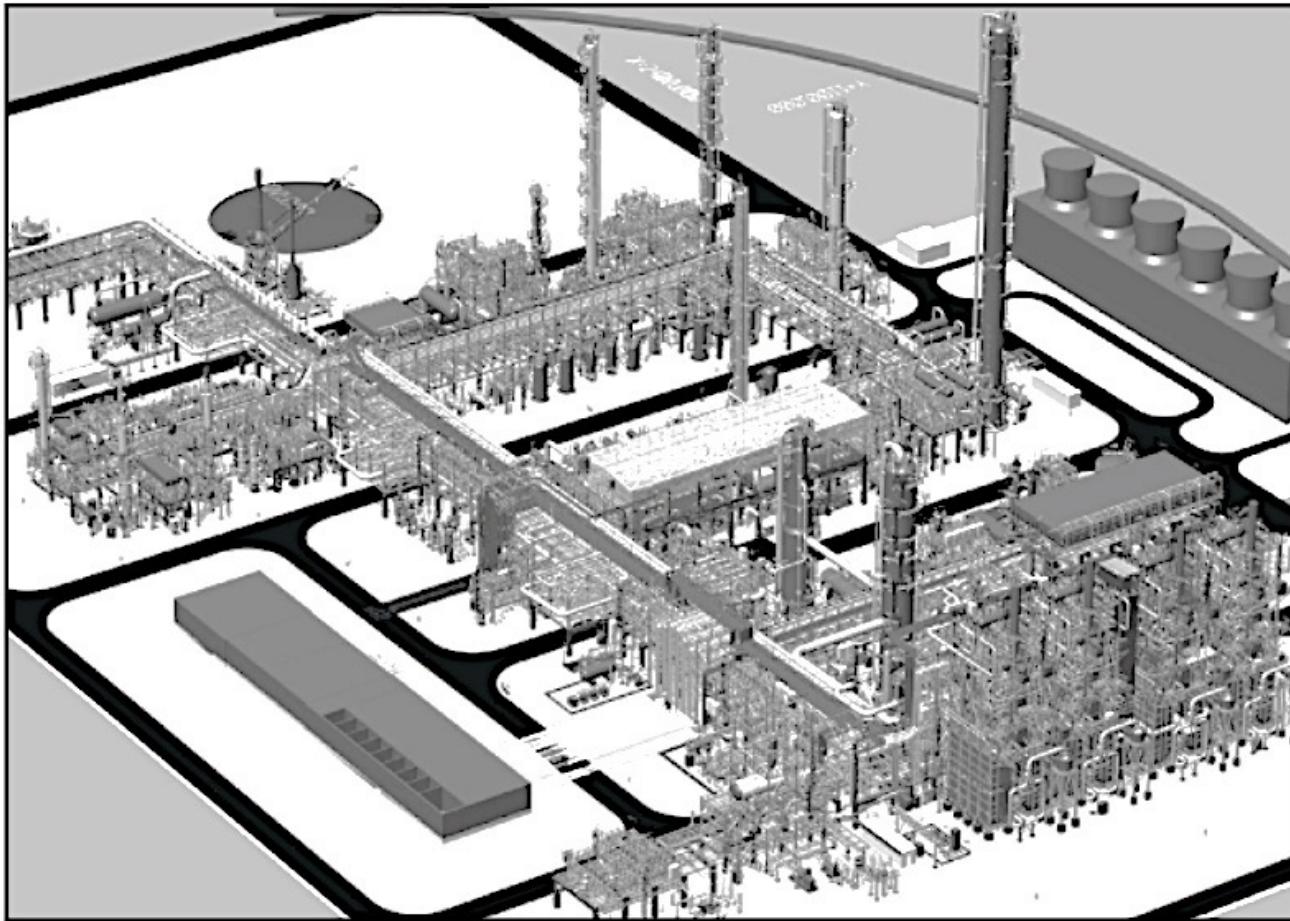
**ETHANE MUST BE “CRACKED”  
TO MAKE ETHYLENE**



**THE CRACKING PROCESS INVOLVES BREAKING UP THE CARBON AND HYDROGEN MOLECULES AND REARRANGING THEM.**



**CRACKING IS ACCOMPLISHED BY HEATING ETHANE TO GREATER  
THAN 800°C (1500°F) IN THE CRACKER FURNACE.**



**CRACKING CAN BE ENERGY-INTENSIVE AND A SIGNIFICANT  
SOURCE OF GREENHOUSE GASES.**

# **Ethylene processed in two ways**

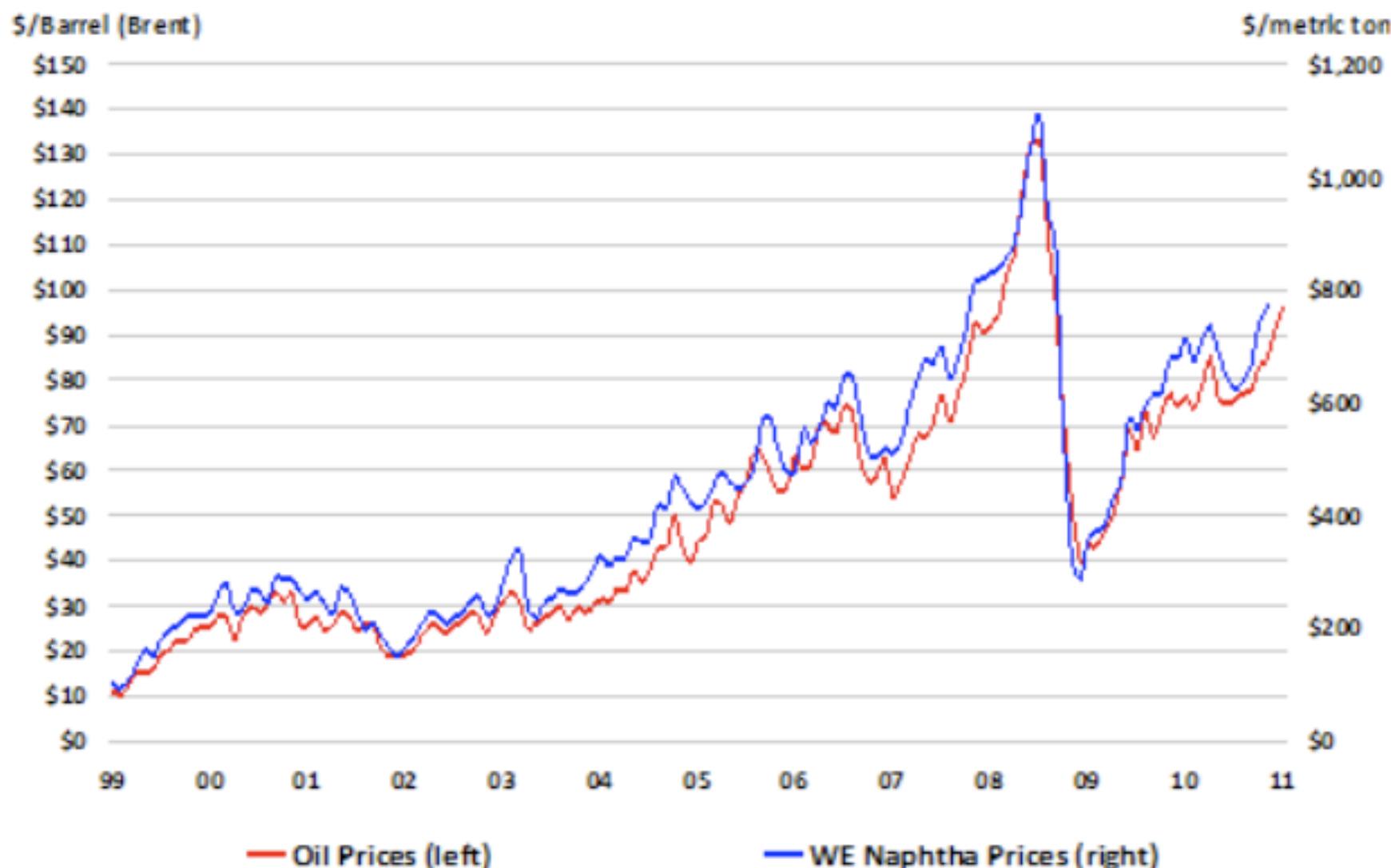
## **In Western Europe & Middle East**

- Ethylene is cracked from naphtha, a byproduct of distillation of crude oil.**
- Ethylene prices are tied to oil prices.**

## **In North America**

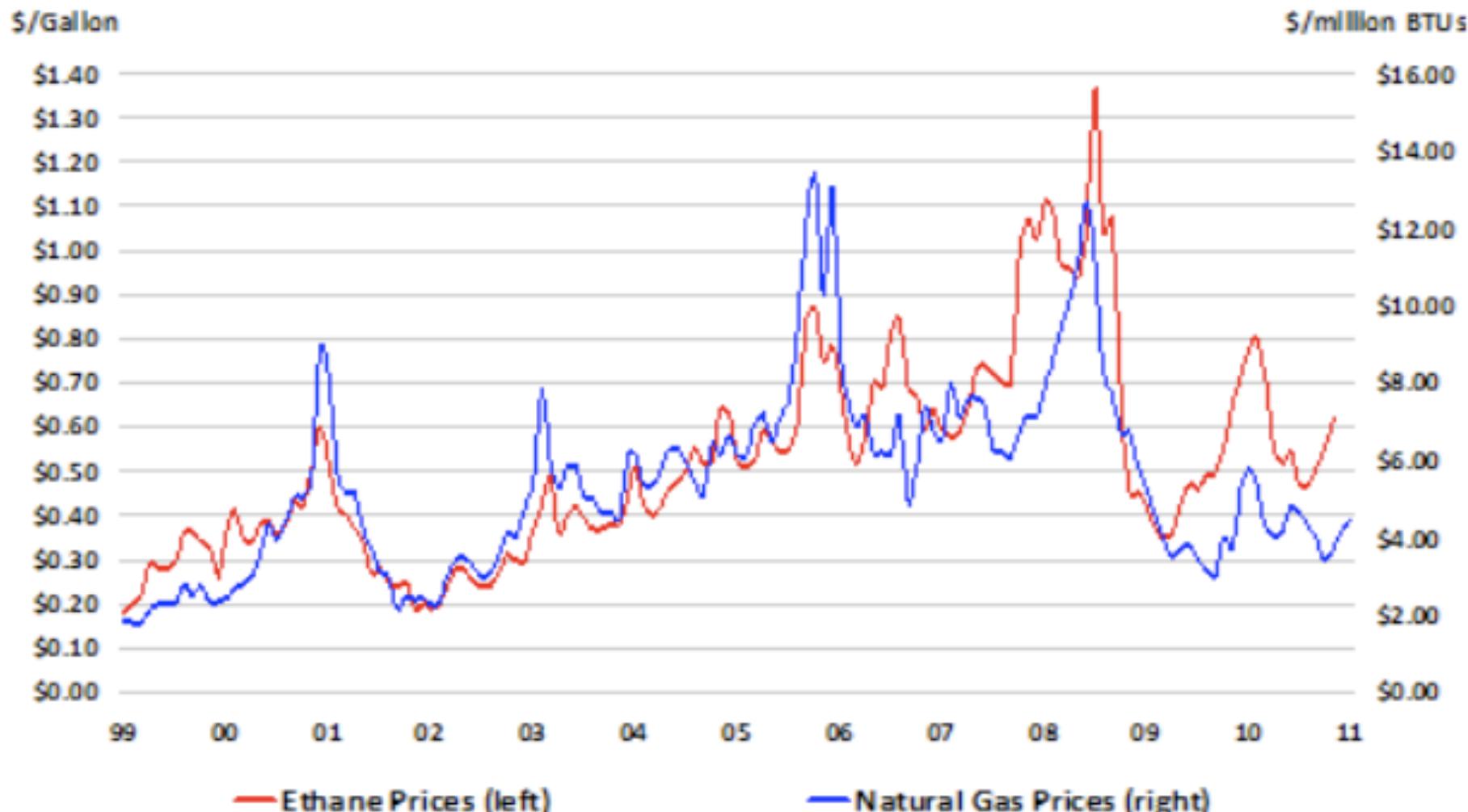
- Ethylene is cracked from ethane.**
- Ethylene prices are tied to natural gas prices.**
- Oil to gas price ratio was 30 in late July 2012 and favors gas → ethane → ethylene.**

# Naphtha & oil prices



Source: EIA, Chemical Week Associates, Haver Analytics

# Ethane & natural gas prices



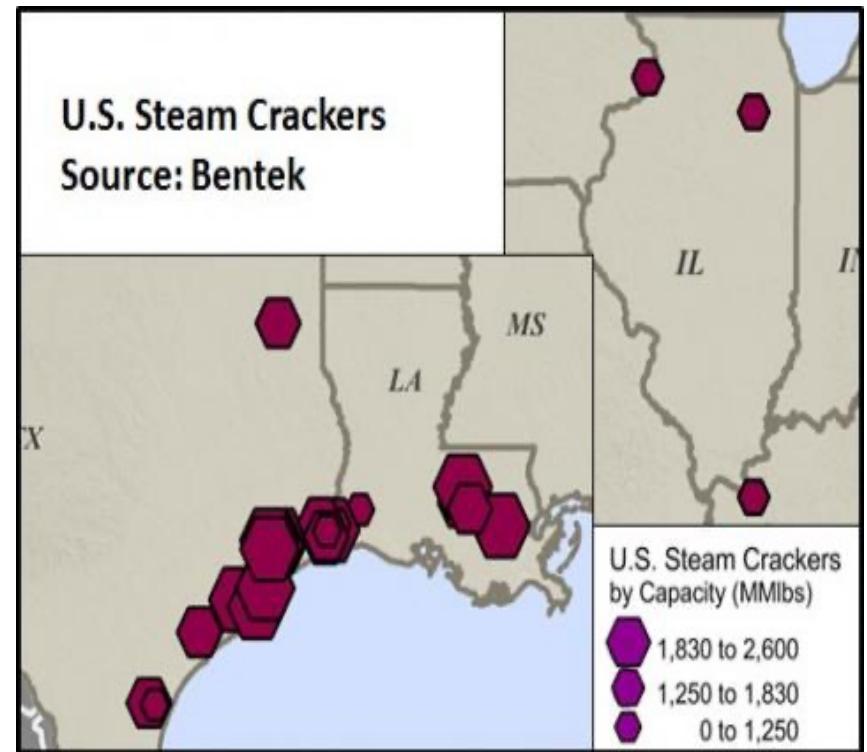
# A few ethane processing facts

- Transporting ethane requires extreme pressure or cold.
- No truck, barges, or trains. Ships are not economical.
- Pipeline is possible, but transportation costs are high.



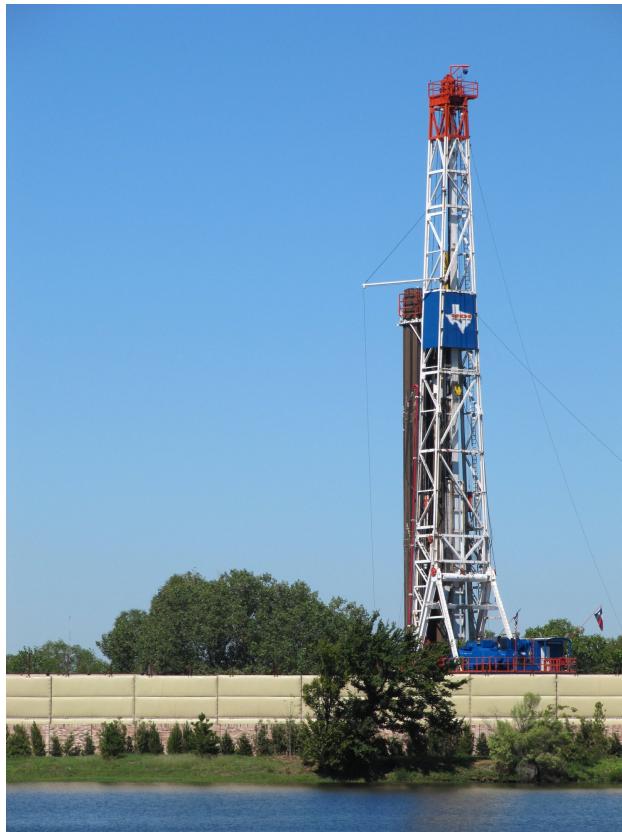
# A few ethane processing facts

- **93% of all ethane cracked on Gulf Coast (mostly Louisiana).**
- **No ethane cracked west of Rockies. All ethane is rejected.**
- **Except for  $\approx 1$  Mb/day, all East Coast ethane is rejected.**

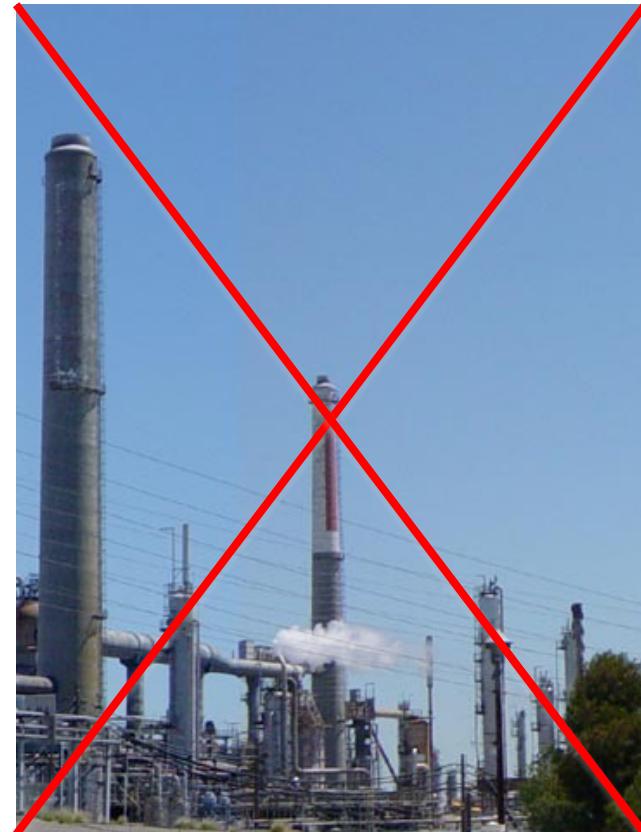


# The gap

Pennsylvania has  
natural gas...



but no ethane processing





**QUESTIONS? DISCUSSION?**



## **AMERICAN CHEMISTRY COUNCIL ECONOMIC FORECASTS**

# American Chemical Council March 2011 national report



<http://www.americanchemistry.com/ACC-Shale-Report>

**Shale Gas and New Petrochemicals  
Investment: Benefits for the Economy,  
Jobs, and US Manufacturing**

# August 2011 Addendum for PA



## Shale Gas & New Petrochemicals Investment in Pennsylvania

American Chemistry Council  
August 2011

This analysis is an addendum to the previous ACC analysis completed in March 2011, titled *Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs, and US Manufacturing*. That report presented the results of an analysis conducted to quantify the economic impact of the additional production stimulated by an increase in ethane availability. This present analysis should a new petrochemicals complex be constructed in that state. It tax revenues generated from a private sector investment in petrochemicals.

<http://goo.gl/1I76J>

That Pennsylvania could be the site of a new petrochemicals complex to take advantage of the lower feedstock costs arising from shale gas is obvious. Pennsylvania features the ninth largest state chemical industry in the United States, with revenues of over \$25 billion and employing nearly 43,000 people in chemical manufacturing operations. The western part of the state sits on top of the Marcellus shale formation which is estimated to contain 84 trillion cubic feet of natural gas. Logistical and other significant infrastructure is present as well. The state features access to the Great Lakes and the Ohio River Valley (and beyond), and major rail lines, as well as excellent universities (University of Pennsylvania, Penn State University, University of Pittsburgh, Lehigh University, Carnegie Mellon University, etc.) with strong chemistry, materials science, polymer science, and chemicals engineering departments. Furthermore, Pennsylvania is within 500 miles of most of the US industrial base.

# ACC national report examined...

- Direct, indirect, & induced effects of
  - 25% increase in “chemical Industry” output
  - Capital investment of \$16.2 billion
- On employment, payroll, total economic output, and tax revenues.



# ACC national report found...

From 25% increase in chemical industry output:

---

<b>Impact Type</b>	<b>Employment</b>	<b>Payroll (\$ Billion)</b>	<b>Output (\$ Billion)</b>
Direct Effect	17,017	\$2.4	\$32.8
Indirect Effect	79,870	6.6	36.9
Induced Effect	85,563	4.1	13.7
<b>Total Effect</b>	<b>182,450</b>	<b>\$13.1</b>	<b>\$83.4</b>

---

# ACC national report found...

From 25% increase in chemical industry output:

---

	Payroll	Households and Proprietors	Corporations and Indirect Business Taxes	Total	Over 10 Years
Federal	\$1.0	\$0.9	\$0.6	\$2.5	\$24.9
State and Local	\$0.02	\$0.30	\$1.57	\$1.9	\$19.0

---

(billions)

# ACC national report found...

From \$16.2 billion capital investment in plant & equipment:

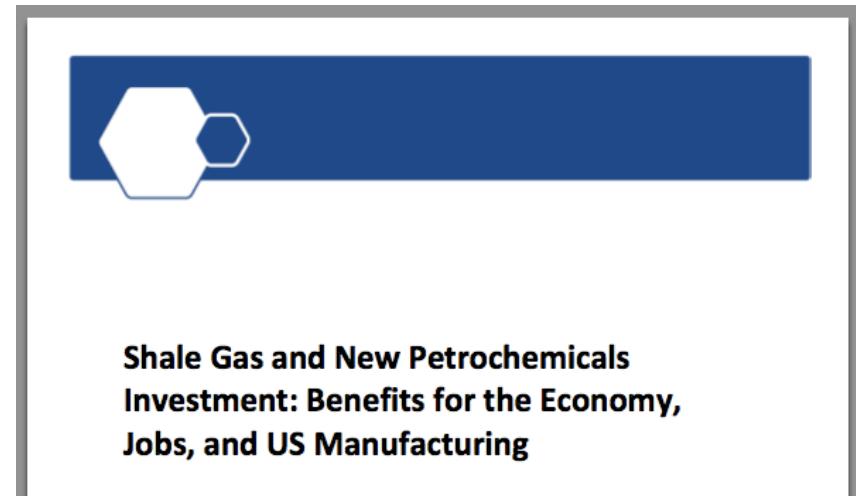
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<b>Impact Type</b>	<b>Employment</b>	<b>Payroll (\$ Billion)</b>	<b>Output (\$ Billion)</b>
Direct Effect	54,094	\$4.3	\$16.2
Indirect Effect	74,479	5.1	16.8
Induced Effect	100,549	4.8	16.1
<b>Total Effect</b>	<b>229,122</b>	<b>\$14.2</b>	<b>\$49.0</b>

---

# We note, however...

- Added chemical industry output in 2006 or 2008 dollars (report does not say), but nearest start is 2017.
- Capital investment occurs over 3 years, but ACC compressed this into 1 year.



# ACC national report...

- Found 25% increase in chemistry industry output would generate “17,000 new knowledge-intensive, high-paying jobs in the U.S. chemical industry” (p. 1).
- *However*, did not analyze the industry’s current or anticipated occupational staffing or educational attainment and knowledge/skills/abilities requirements in the industry.

# ACC forecast for Pennsylvania

## Shale Gas & New Petrochemicals Investment in Pennsylvania

American Chemistry Council  
August 2011



This analysis is an addendum to the previous ACC analysis completed in March 2011, titled *Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs, and US Manufacturing*. That report presented the results of an analysis conducted to quantify the economic impact of the additional production of petrochemicals and downstream chemical products stimulated by an increase in ethane availability. This present analysis focuses on the benefits to the state of Pennsylvania should a new petrochemicals complex be constructed in that state. It specifically examines the additional output, jobs and tax revenues generated from a private sector investment in petrochemicals.

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# ACC report for PA found...

From \$4.8 billion increase in PA chemical industry output:

---

<b>Impact Type</b>	<b>Employment</b>	<b>Payroll (\$ Million)</b>	<b>Output (\$ Billion)</b>
Direct Effect	2,396	\$347	\$4.8
Indirect Effect	8,194	\$571	\$2.2
Induced Effect	6,951	\$303	\$0.9
<b>Total Effect</b>	<b>17,541</b>	<b>\$1,221</b>	<b>\$7.9</b>

---

# ACC report for PA found...

From \$4.8 billion increase in PA chemical industry output:

Impact Type	Payroll	Households and Proprietors	Corporations and Indirect Business Taxes	Total
Federal	\$111.3	\$66.0	\$63.6	\$240.8
State and Local	\$1.0	\$7.3	\$132.3	\$140.6

(millions)

# We note, however...

- ***Direct* employment effect estimated by ACC is 2,396 jobs.**
- **The Beaver plant is expected to be staffed with 400 workers.**
- **Is it possible that the ACC report overestimates direct employment impact by 600%?**



This analysis is an addendum to the previous ACC analysis completed in March 2011, titled *Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs, and US Manufacturing*. That report presented the results of an analysis conducted to quantify the economic impact of the additional production of petrochemicals and downstream chemical products stimulated by an increase in ethane availability. This present analysis focuses on the benefits to the state of Pennsylvania should a new petrochemicals complex be constructed in that state. It specifically examines the additional output, jobs and tax revenues generated from a private sector investment in petrochemicals.

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# We note that, in June...

- A member of Governor's cabinet reduced impact estimate to 6000-8000 jobs.
- A cabinet member said that the ACC numbers are used because "because they're the best available."
- A cabinet member cautioned, "it's almost an impossible number to nail down."

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Pennsylvania Brad Bumsted Marcellus Shale

Larger text Smaller text

Cracker plant jobs claim may be way off

Tweet

By Timothy Puko

Published: Friday, June 15, 2012, 10:10 p.m.

Updated: Saturday, June 16, 2012

The jobs created by a proposed petrochemical plant in the region could be less than half of what Gov. Tom Corbett and state leaders have been touting, according to new numbers from a member of Corbett's cabinet.

There are likely to be 6,000 to 8,000 new permanent jobs if and when Royal Dutch Shell plc opens a plant in Beaver County, according to data from the Department of Labor & Industry. That includes about 400 workers at the plant and thousands of others grown across several sectors from manufacturing to retail.

State leaders consistently have claimed there will be 10,000 to 20,000 new permanent jobs as part of a pitch for a \$1.65 billion tax credit for Shell and related industry.

As recently as Thursday, Corbett posted on his Twitter feed, "A crackerplant would create up to 20,000 permanent jobs in Southwest PA."



VIDEO

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About Timothy Puko

Tribune-Review Staff reporter  
Timothy Puko can be reached via e-mail or at 412-320-7991.

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- Trump Planning 'Amazing' Convention Surprise
- New Dangers Found in Artificial Popcorn Butter

# We note that, in June,...

- A member of Governor's cabinet reduced impact estimate to 6000-8000 jobs.
- A cabinet member said that the ACC numbers are used because "because they're the best available."
- A cabinet member cautioned, "it's almost an impossible number to nail down."

The screenshot shows a news article from TribLive.com. At the top, there's a navigation bar with links for Home, News, Investigative, Neighborhoods, State, Politics, U.S./World, Sports, Opinion, Business, A&E, Lifestyles, and Obituaries. Below the navigation bar, a sub-navigation bar includes Pennsylvania, Brad Bumsted, and Marcellus Shale. The main headline reads "Cracker plant jobs claim may be way off". Below the headline, there are social sharing icons for email, Facebook, and Twitter, along with a "Larger text" and "Smaller text" link. The author is listed as Timothy Puko. A large, semi-transparent black box with white text overlays the bottom half of the article. The text in the box reads: "A PA Department of Labor & Industry study is anticipated to clear this up." There are also "VIDEO" and "More Videos" links at the bottom right of the box.



**QUESTIONS? DISCUSSION?**



**SEVERAL QUICK, BACK-OF-THE-ENVELOPE  
FORENSIC ANALYSES**

# Three analyses

- If the direct job effect is 400 jobs, not 2,400 jobs.
- PA economy when chemistry output is 25% > than baseline, 2017–2021.
- Chemistry industry employment if output is 25% > than baseline, 2017–2021

**If the direct job effect is 400 jobs, not 2,400 jobs....**

- **2,924 total jobs**
  - ≈ 400 direct, 1,369 indirect, 1,160 induced
- **\$204 million in payroll**
  - ≈ \$58M direct, \$95M indirect, \$51M induced
- **\$1.32 billion in output**
  - ≈ \$0.80B direct, \$0.37B indirect, \$0.15B induced

# A word about the next two analyses...

The two findings from analyses shown on the next two slides display our estimates the value in 2017–2021 of a 25% increase in what the ACC report described as the “chemistry industry.” The estimates are calculated from the Pennsylvania *REMI Policy Insight*, economic and demographic modeling and forecasting tool (<http://remi.com>).

A 25% increase in an industry the size of the chemistry industry in Pennsylvania is, in a word, huge. Unprecedented. However, the ACC report “considers a 25% increase in

ethane is not merely a thought exercise. New investments in petrochemical capacity to utilize this resource advantage are already being made by chemical companies. The assumptions are reasonable and are consistent with public announcements by companies such as Dow Chemical, Shell Chemical, LyondellBasell and Bayer MaterialScience among others.” The report describes the increase as “hypothetical, but realistic.” More consideration of the economic modeling of this change is needed.

# PA economy when chemistry output is 25% > than baseline, 2017–2021

Category	2017	2018	2019	2020	2021
Total Employment (Thousands (Jobs))	34.8467	35.8135	36.1592	36.5156	36.6699
Private Non-Farm Employment	29.8242	30.623	30.8613	31.0845	31.1284
Gross Domestic Product (Billions of 2005 Dollars)	5.25378	5.37891	5.50403	5.64081	5.771
Output (Billions of 2005 Dollars)	11.4534	11.6563	11.891	12.212	12.5231
Value Added (Billions of 2005 Dollars)	5.25378	5.37909	5.50391	5.64087	5.77106
Personal Income (Billions of Nominal Dollars)	2.88477	3.23785	3.49841	3.73846	3.95758
Disposable Personal Income(Billions of Nominal Dollars)	2.38971	2.68176	2.90466	3.11017	3.29816
Real Disposable Personal Income (Billions of 2005 Dollars)	1.9079	2.02765	2.11957	2.20239	2.26953
Population	7.47363	13.5625	18.835	23.4502	27.4814

# Chemistry industry employment if output is 25% > than baseline, 2017–2021

Category	2017	2018	2019	2020	2021
Private Non-Farm Employment	8.43975	8.26822	8.25063	8.35038	8.45899
Intermediate Demand Employment	1.07365	1.03363	1.02305	1.03485	1.04583
Local Consumption Demand Employment	0.39403	0.38837	0.38671	0.39298	0.39878
Government Demand Employment	0.00087	0.00087	0.00086	0.00085	0.00085
Investment Activity Demand Employment	0.02005	0.01918	0.01941	0.01972	0.01993
Total Export Employment	6.95116	6.82618	6.82059	6.90199	6.99361
Exports to Rest of Nation Employment	4.91154	4.83105	4.81254	4.89139	4.95683
Exports to Rest of World Employment	2.03961	1.99513	2.00805	2.01059	2.03677

# Ours are analyses, not forecasts

- Our quick, back-of-the-envelope analyses are not forecasts.
  - We leave the forecasting of PA chemistry industry futures to those paid to do it.
  - Our analysis is more like an fact-seeking autopsy of the Pennsylvania chemistry economy. → We just want to understand the numbers already published.
- Royal Dutch Shell is taking on substantial risk and facing many uncertainties in this project, as PA residents are, too.



**DISCUSSION?**

WEB SITE AVAILABLE AT PAWIB2012.TUMBLR.COM ....

# cracking the ethane cracker

• précis • • presenters • • workshop • • links • • media • • penn state irtd •

Presentation by Rose M. Baker & David L. Passmore at 2012 WIB Symposium  
hosted by the Pennsylvania Association of Workforce Investment Boards  
at the Penn Stater Hotel & Conference Center in State College, Pennsylvania  
on August 16, 2012

## | INSTITUTE FOR RESEARCH IN TRAINING & DEVELOPMENT |

The screenshot shows the IRTD website. At the top left is the Penn State logo. To its right is the IRTD logo, which consists of the letters 'IRD' in a stylized font above the text 'INSTITUTE FOR RESEARCH IN TRAINING & DEVELOPMENT'. Below the logo is a black and white photograph of a person in a lab coat working at a computer. To the left of the photo is the text 'RESEARCH ON THE WORKFORCE & ECONOMY OF PENNSYLVANIA & BEYOND'. On the right side of the photo, there is descriptive text about the IRTD's focus and purpose.

**Focus**  
The Institute for Research in Training & Development (IRTD) produces research and analysis about the workforce and economy of Pennsylvania and beyond.

**Purpose**  
The IRTD produces research and analysis about the workforce and economy of Pennsylvania and beyond.

**Value**  
The IRTD conducts research that is policy-relevant, but is not policy-prescriptive. The IRTD often conducts research and analysis about topics and issues that, at times, are the focus of vigorous debate and public attention and that frequently are associated with diverse stakeholders who represent divergent opinions. The Institute adds value, attention, and discussion to this debate by conducting and reporting research and analysis for decisions affecting workforce and economic development.

Baker and Passmore are principal members of the Institute for Research in Training & Development (IRTD).

The **Institute for Research in Training & Development** (IRTD) produces research and analysis about the workforce and economy of Pennsylvania and beyond.

The IRTD conducts research that is policy-relevant, but is not policy-prescriptive. The IRTD often

# 2012 WIB SYMPOSIUM

PENNSYLVANIA ASSOCIATION OF WORKFORCE INVESTMENT BOARDS

## Related literature at:

<http://www.diigo.com/user/davidpassmore/psu-ethane>

The screenshot shows a section of the Penn State Knowledge Commons website. It features a photograph of people working at laptops, followed by a block of text about research contracts, a section titled 'How is Research Conducted?', and a footer with links to other pages.

agencies, including federal agencies, foreign governments, foundations, and private foundations, to conduct research and analysis, to negotiate contracts, and purchase services with public, private, and government organizations as well as other Penn State units through interdepartmental research contracts (despite developing research contracts).

How is Research Conducted?  
The IRTD employs a wide variety of tools and techniques in its research work (Read two-page overview).

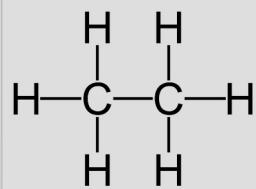
To conduct its analytical work, the IRTD leases, purchases, and creates a variety of analytical models and data. For instance, the

technically appropriate approaches possible.

The research and analysis of the Institute are pursued independent of the commercial or political interests of any actual or potential sponsor of the Institute's work.



# CRACKING THE ETHANE CRACKER



ROSE M. BAKER

DAVID L. PASSMORE