

CEE Midstream/Downstream Review

Do we WANT it?

Industrial Demand Inventory

107 projects, $75 billion, mainly in the Gulf Coast region

Segment	$ million
Fractionation (28)	6,208
Ethylene (15; 5 polyethylene)	25,230
Propylene (7)	3,822
Methanol & ammonia (11)	8,733
Chlor-alkali (6)	3,957
GTL (3, large scale)	18,130
Plastics (5)	919
Metals (14)	4,586
Other (consumer goods, 9)	3,780
Other chemicals (4)	114

Downstream investment timing for modeling ($million)

	2011	2012	2013	2014	2015	2016	2017	2018	Total
TX	$90	$555	$2,676	$5,689	$6,530	$5,110	$2,220	$280	**$23,150**
TX restarts		$365	$150						**$515**
Other US	$1,484	$5,419	$4,706	$7,952	$7,234	$4,305	$1,870	$0	**$32,970**
US restarts			$166	$550					**$716**
GTL (LA)		$39	$52	$1,839	$3,600	$7,200	$3,600	$1,800	**$18,130**
Total	**$1,574**	**$6,378**	**$7,750**	**$16,030**	**$17,364**	**$16,615**	**$7,690**	**$2,080**	**$75,481**

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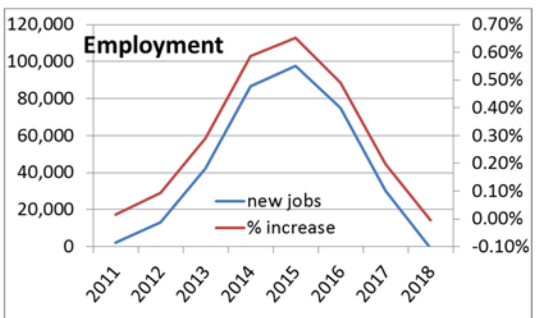
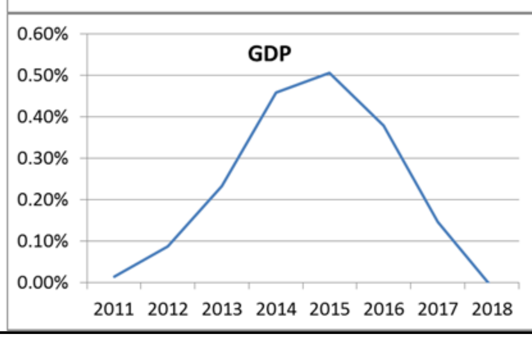
Economic Impacts in TX (preliminary)

Changes relative to the standard baseline





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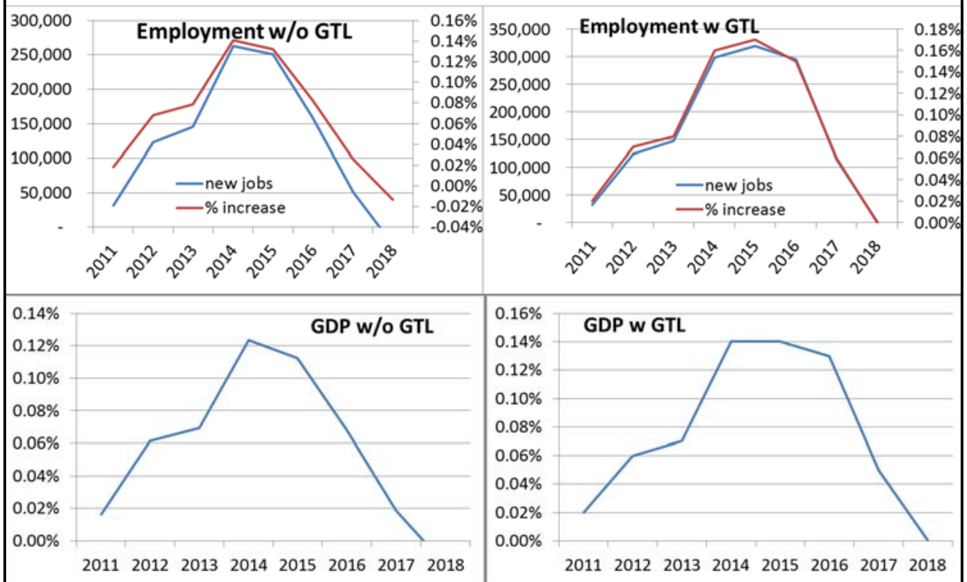
Economic Impacts in US (preliminary)



Changes relative to the standard baseline

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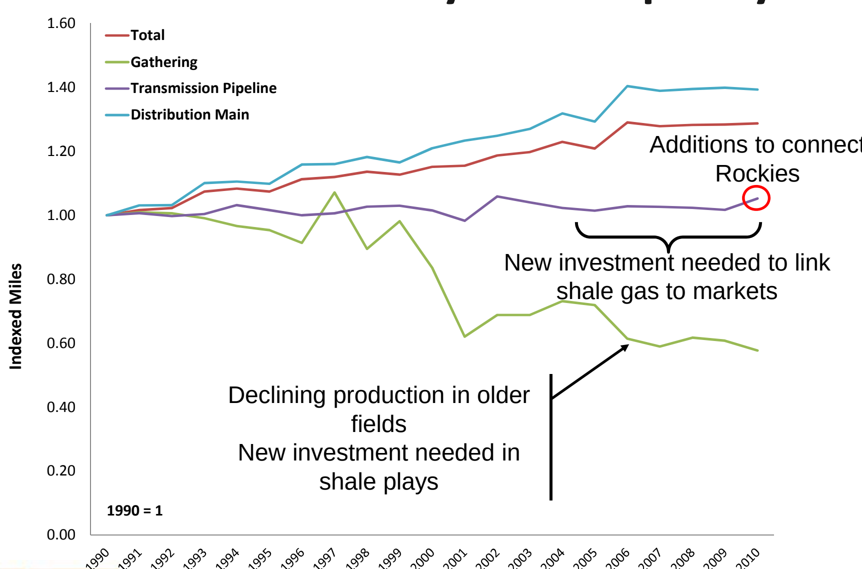
U.S. Natural Gas System Capacity



AA, CEE analysis

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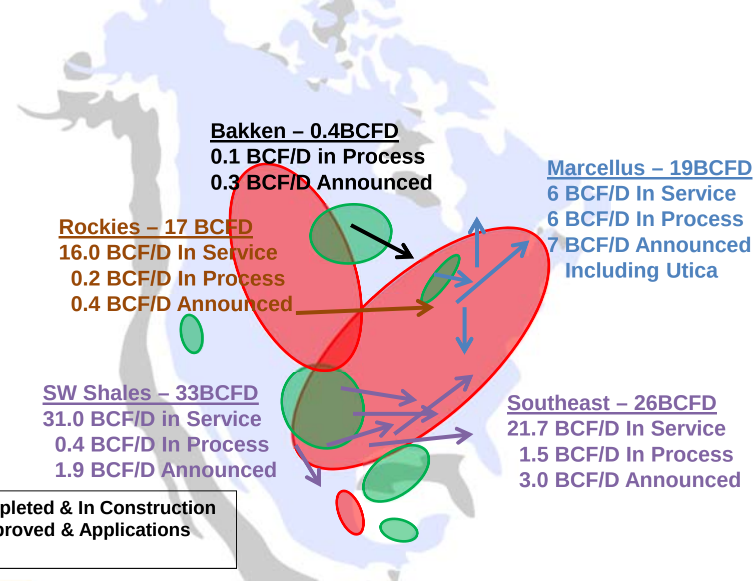
Major Natural Gas Pipeline Capacity Additions 2008-2015 BCF/D

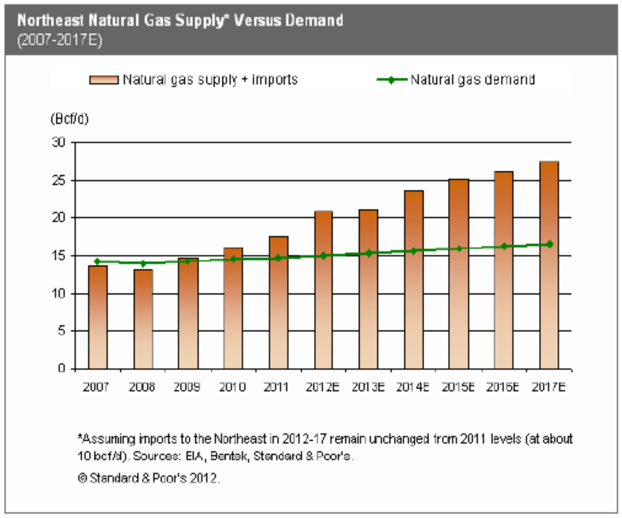


In Service: Completed & In Construction
In Process: Approved & Applications Filed/Pre-Filed

Source: EIA Natural Gas Pipeline Projects. Includes intrastate data.

OBSERVATIONS
Natural Gas Pipeline Additions - Northeast

- Including announcements, gas pipeline capacity should be sufficient to meet projected Marcellus/Utica deliverability of about 16 BCF/D in 2017
- Projects tend to be shorter-haul, debottlenecking with some bi-directional flows targeted to eastern Canada
- Projects are “supply-push” with producers contracting for firm transportation
- Pipelines appear to be avoiding throughput risk – shippers paying demand charges plus fuel, no commodity charge
- Northeast basis vs. Henry Hub is disappearing at several delivery points – discourages long haul pipeline construction
- Decontracting on US long haul pipelines from the Gulf Coast and Rockies will not be immediate: most are at least 75-80% firm contracts with 4-5 years remaining
- TransCanada is facing declining throughput west to east and escalating tariffs-a major rate case is pending



•Northeast could be over-supplied by 2017

•Additional takeaway capacity out of the region needed

•Proposals to move gas to eastern Canada; bi-directional flows

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OBSERVATIONS
Natural Gas Pipeline Additions

- Most of the pipeline additions relating to the southwestern shale gas plays have been completed or are in construction
- There is little activity on the horizon reflecting the impact of low natural gas prices on these southwestern shale gas plays
- To date there has been limited gas pipeline construction in the central shale gas plays like the Bakken
- There is one Bakken project - Alliance Pipeline's Tioga 106 MMCFD project to reduce gas flaring

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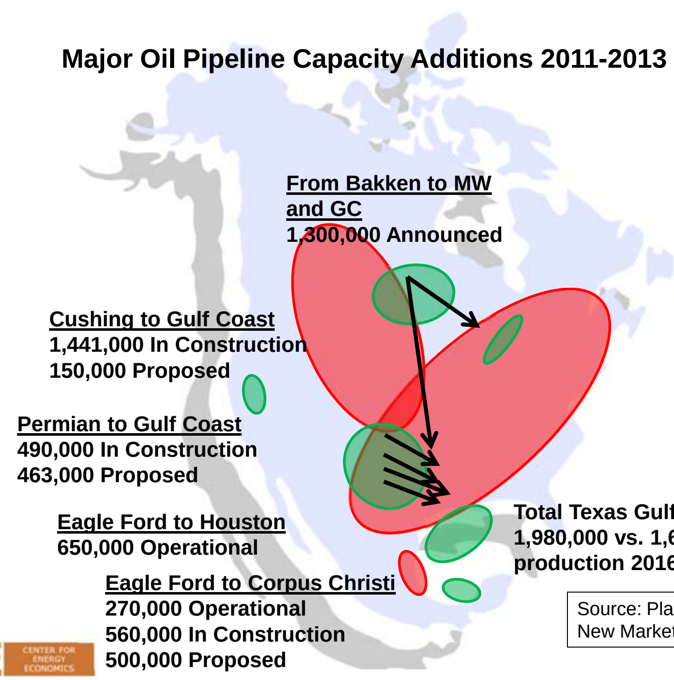
NATURAL GAS FLARING IN NORTH DAKOTA

- 25-30% of total natural gas production in the Bakken Shale is being flared compared to 1% nationwide
- Although associated natural gas and NGL production accounts for less than 10% of a producer's economics, it ***still equals*** a substantial amount of lost revenues to producers
- Current regulatory exemptions are being evaluated
- Infrastructure is needed for natural gas gathering and processing, and NGL takeaway to eliminate flaring
- **Keeping up with the pace of expanding oil, natural gas and NGL development is the #1 challenge for midstream companies-North Dakota Pipeline Authority**
- *Source: ONEOK Partners*

Major Oil Pipeline Capacity Additions 2011-2013 BPD



Source: Platts, "New Crudes, New Markets," October 2012

Bakken Oil Takeaway Capacity

- Current oil production is 500-700,000 bpd and may reach 1.3 million bpd by 2015
- Rail takeaway capacity is currently about 730,000 bpd and is projected to hit 1,000,000 bpd by year end 2013
- Rail will continue to play a key transporation role for the Bakken

Source: Platts, New Crudes, New Markets, October, 2012

Marcellus Shale Proposed Ethane Takeaway Pipelines

Proposed Ethane Projects

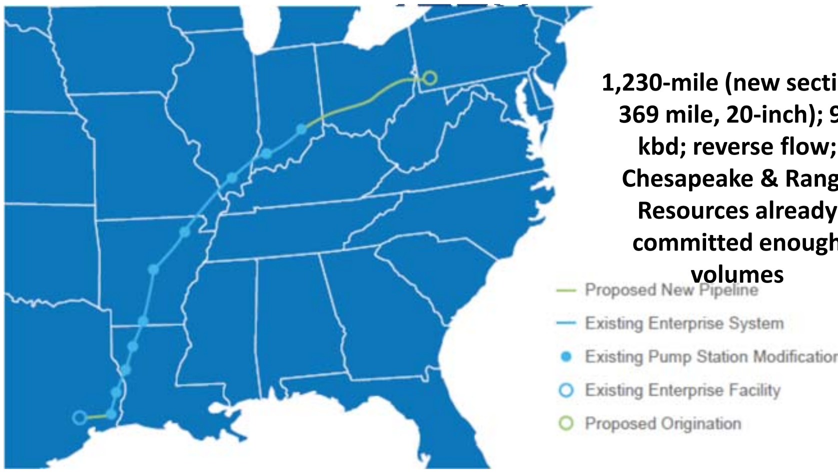
Project	Company	Capacity (mbbls/d)	Proposed in-service date
Mariner West	Markwest Energy Partners L.P./Sunoco Logistics Partners L.P.	50-65	Jul-13
Mariner East	Markwest Energy Partners L.P./Sunoco Logistics Partners L.P.	70	Mid-2013
Appalachia to Texas (ATEX)	Enterprise Products Partners L.P.	190	1Q2014

•Royal Dutch Shell is proposing a new ethane cracker in Pennsylvania for 2017

•Currently most producers in the Marcellus are rejecting ethane due to lack of processing capacity

•Gulf Coast is the big pull – existing infrastructure, market access, export points

Marcellus Ethane Solutions -



1,230-mile (new section: 369 mile, 20-inch); 90 kbd; reverse flow; Chesapeake & Range Resources already committed enough volumes

http://www.atexexpresspipeline.com/map/

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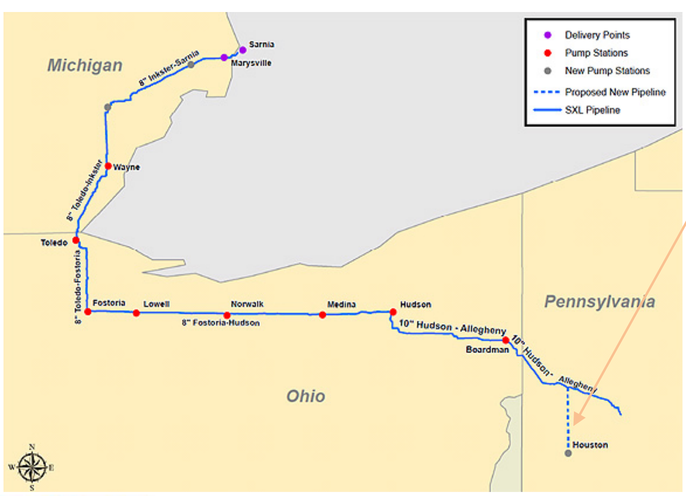
Marcellus Ethane Solutions – Mariner West & Mariner East



45-mile, 50 kbd; another same size new pipe will send ethane to NJ

http://www.sunocologistics.com/Mariner-West/169/

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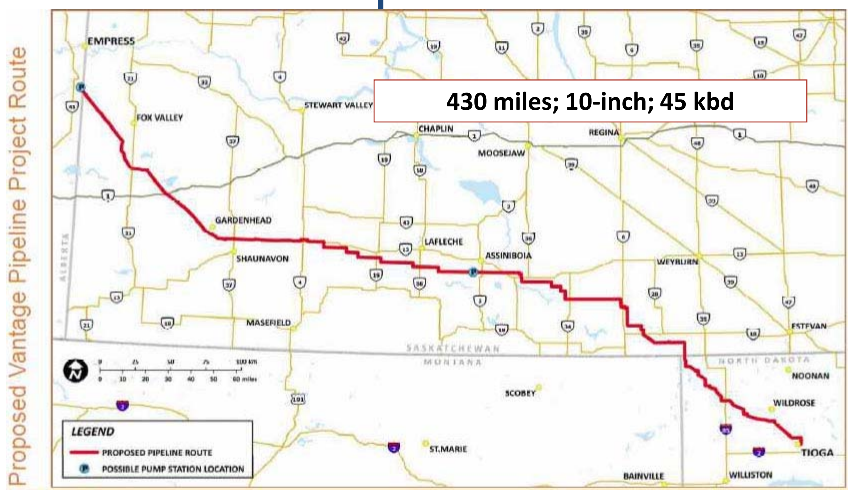
Bakken Ethane – Vantage Pipeline



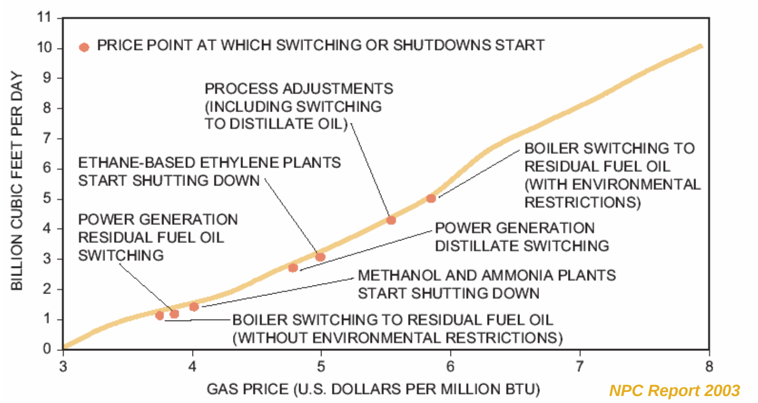
http://www.vantagepipeline.com/

NGL Margins as a Driver

- Frac spread (ethane-natural gas) rose to record highs in 2011 ($11/MMBtu) ➔ expansions and new construction of processing facilities
- U.S. is now a net exporter of some liquids (propane); 20-25% of ethylene & PE exported
- But, infrastructure bottlenecks ➔ increased ethane rejections, especially in Marcellus
- Falling NGL prices could curtail or delay investment in liquids infrastructure

Methanol

- Lost most methanol capacity in the 2000s due to high gas prices
- Some mothballed plants may return
- *How resilient to NG prices, NG:Oil price spread for export competitiveness?*



NPC Report 2003

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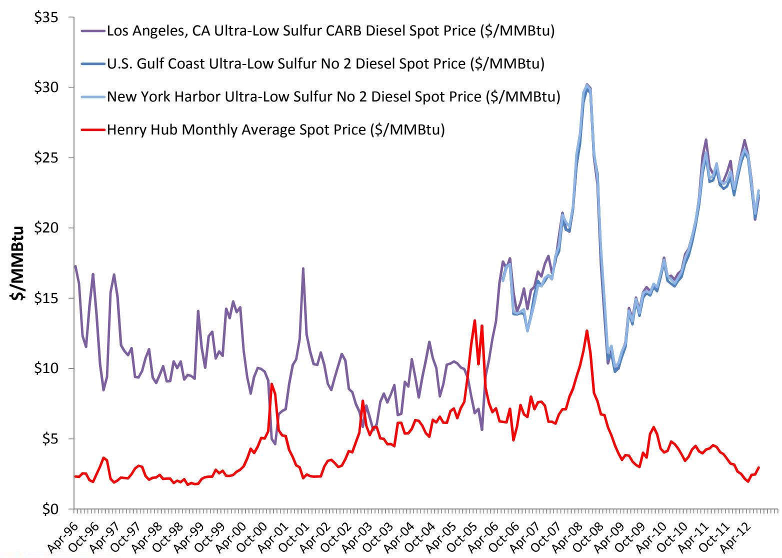
On a Btu basis, NG price seems attractive



EIA, CME, CEE analysis

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Conversion factors capture tradeoffs

Less energy/gallon for NG; more NG must be used

Property	Diesel	LNG	CNG
Energy Content (Btu/ gal)	128,700	74,700	20,300
Diesel Gallon Equivalent "DGE" (gal)	1 gal	1.72 gal	3.7 gal
Diesel Gallon Equivalent "DGE" (gal)	1 gal	0.23 cu ft	0.49 cu ft
Density (lbs./ gal)	6.8	3	1
Energy Density (Btu/lb)	18,250	28,266	28,266

NG is lighter weight than diesel, but heavier fuel tanks eliminate advantage

NEPI, http://www.tagnaturalgasinfo.com/uploads/1/2/2/3/12232668/natural_gas_for_heavy_trucks.pdf

Typical truck fuel systems

Fuel	Tank Configuration and Nominal Size	Effective Size[1] "Usable Fuel"	Range[2]	Fuel System Weight (full fuel)	Additional Cost of Fuel System Installed[4]
Diesel	75 gallon	75 DGE	450 miles	1,200 lbs[3]	--
CNG	(5) 15 DGE tanks behind cab	68 DGE	367 miles	2,050 lbs	$27,000
CNG	(2) 41 DGE side mounted	74 DGE	400 miles	1,650 lbs	$35,000
LNG	(1) 119 gallon side mounted	60 DGE	324 miles	1,200 lbs	$22,000
LNG	(1) 150 gallon side mounted	75 DGE	405 miles	1,400 lbs	$26,000
LNG	(2) 150 gallon side mounted	150 DGE	810 miles	2,800 lbs	$45,000
LNG Westport HD 15L	(1) 119 gallon side mounted	58 DGE	365 miles	1,600 lbs[5]	$70,000[6]

NEPI

NEPI economic modeling results

Very Profitable
- Annual miles per truck >90,000 miles (spark) or 140,000 (HDPI)
- Fuel is available OR > 250,000 (LNG) to 500,000 (CNG) DGE used per year on site
- Range is <450 miles (spark) or 350 miles (HDPI)

Marginally Profitable
- Annual miles per truck is 60,000 to 90,000 (spark) or 95,000-140,000 (HDPI)
- Range between fuelings is 450-750 miles

Not Profitable or Not Practical
- Annual miles per truck is <60,000 miles (spark) or 95,000 miles (HDPI)
- Fuel is not available
- Required range between fuelings is > 750-800 miles (spark) or > 350 miles (HDPI)

Assumes a $1.50/ DGE fuel price differential between diesel and natural gas

CEE Center for Energy Economics, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin

NEPI

LNG heavy-duty truck well to wheel GHG emissions (BC)

	Extraction	Processing	Fueling, transportation and storage	Emissions at end use	Total life cycle
Natural gas (LNG)	78 g/km	36 g/km	150 g/km	824 g/km	**1088 g/km**
Diesel	227 g/km	130 g/km	12 g/km	1114 g/km	**1483 g/km**

Source: NRCAN GHGenius Model and Terasen (March 2008)

26.6% reduction

CEE Center for Energy Economics, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin

Westport

Argonne GREET

For one heavy duty truck: Fueling with LNG reduces GHG emissions by 4.425% as compared to diesel, while fueling a truck with CNG reduces GHG emissions by 5.323%.

Fuel:	Avg Annual Miles Traveled	Avg Fuel Economy (miles/gasoline gal equivalent)	Annual Total Fuel Use (gasoline gal equivalent)	Petroleum Usage (barrels)	GHG Emissions (short tons)
LNG	80,000	5.0	10,410	4.3	159.8
CNG	80,000	5.0	13,700	2.0	158.3
Diesel	80,000	6.0	15,033	304.3	167.2

Argonne National Lab

Some interest in NG for other transport applications…

- Marine transport, port operations
  - State of Washington (WSF), Staten Island
  - Long Beach, Georgia Ports Authority

LNG 16-Year Price Forecast Outside the Pacific NW Delivered for WSF Use

Year	2015	2020	2025	2027
WSF ULSD Sept. 2011 Forecast	$3.57	$3.78	$3.90	$4.03
Henry Hub Natural Gas Price per 1 million MMBTU	$5.04	$5.49	$6.09	$6.45
Conversion Factors for Henry Hub Natural Gas Commodity to LNG Price				
Gas Gallon	$0.50	$0.55	$0.61	$0.64
Liquefaction	$0.44	$0.47	$0.51	$0.53
Trucking	$0.31	$0.33	$0.34	$0.35
Price per LNG Gallon	**$1.25**	**$1.35**	**$1.46**	**$1.52**
ULSD Equivalent Price with 1.7 G LNG=1 G ULSD Adjustment	$2.13	$2.30	$2.48	$2.58
Savings Per Gallon	$1.44	$1.48	$1.42	$1.44
Percent Savings	40%	39%	36%	36%

http://www.leg.wa.gov/JTC/Documents/Studies/LNG/LNG_FINALReport_Jan2012.pdf

…but uncertain applications for rail?

Mode	THC	NMHC	CO	NOx	PM
ECI Natural Gas Conversion	7.55	1.17	10.0	5.2	0.38
Diesel Tier 2 compliant EMD	0.22	0.22	1.0	5.1	0.07
Diesel Tier 2 compliant GE	0.16	0.16	0.4	5.3	0.10

There is no NOx benefit from using this natural gas-fueled locomotive, and all other criteria pollutant emissions are higher—including particulates, which are four to five times greater. Compared to the operation of the same locomotive on diesel fuel, natural gas is less energy efficient[12] and produces more greenhouse gas emissions (CO_2 equivalent). Also, a locomotive using this natural gas conversion kit will likely have higher emissions of some toxic air containments, especially formaldehyde.

Claims that natural gas-fueled locomotives will be less expensive to operate than diesel equipment are unfounded. In recent years, prices in the North American natural gas market have been high and unstable. Moreover, support of natural gas-fueled locomotives will require significant investments in new fueling infrastructure that are duplicative to established diesel based infrastructure. These infrastructure investments and their associated operating costs must be accounted for in any evaluation of cost effectiveness.

BNSF Railway Company, Union Pacific Railroad Company, The Association of American Railroads, California Environmental Associates

APPENDIX

Source: EIA Natural Gas Pipeline Projects. Includes intrastate data.

Natural Gas Pipeline Capacity Additions 2008-2015 (MMCF/D)

REGION	NE	SE	SW	MW	CENTRAL
Completed & In Construction	10,688	21,741	52,014	6,170	15,674
Approved	1,105	1,346	2,800	101	189
Sub-Total	11,793	23,087	54,814	6,271	15,863
Application Filed or Pre-Filed	4,562	250	630	0	106
Sub-Total	16,355	23,337	55,444	6,271	15,969
Announced	7,172	3,054	2,917	2,100	255
TOTAL	23,527	26,391	58,361	8,371	16,224

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Northeast Gas Pipeline Additions 2008-2015

REGION	STATUS	COST ($MM)	MILES	CAPACITY MMCF/D
Total Northeast	Completed; In Service	3,706	749	7,023
NE Marcellus Shale	Completed; In Service	1,207	230	2,340
Total Northeast	In Construction	1,242	203	3,665
NE Marcellus Shale	In Construction	1,227	203	3,638
Total Northeast	Approved	555	53	1,105
NE Marcellus Shale	Approved	549	48	1,101
Total Northeast	Application Filed	341	44	862
NE Marcellus Shale	Application Filed	341	44	862
Total Northeast	Pre-Filed Application	1,900	258	3,700
NE Marcellus Shale	Pre-Filed Application	1,900	258	3,700
Total Northeast	Announced	3,174	1,182	7,172
NE Marcellus/Utica Shale	Announced	2,662	1,116	6,972

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Southeast Gas Pipeline Additions 2008-2015

REGION	STATUS	COST ($ MM)	MILES	CAPACITY MMCF/D
Total Southeast	Completed and in construction	8,695	1,965	21,741
Total Southeast	Approved	74	43	1,346
Total Southeast	Application Filed & Pre-Filed	-	100	250
Total Southeast	Announced	1,689	747	3,054

Projects demand pull with customers contracting for FT

Southwest Gas Pipeline Additions 2008-2015

REGION	STATUS	COST ($ MM)	MILES	CAPACITY MMCF/D
Total Southwest	Completed and In Construction	16,187	4,222	52,014
SW Shales	Completed and In Construction	12,222	3,575	30,835
Total Southwest	Approved	78	56	2,800
SW Shales	Approved	-	-	-
Total Southwest	Application Filed & Pre-Filed	60	10	630
SW Shales	Application Filed & Pre-Filed	-	10	420
Total Southwest	Announced	466	567	2,917
SW Shales	Announced	120	442	1,900

Central Gas Pipeline Additions 2008-2015

REGION	STATUS	COST ($MM)	MILES	CAPACITY MMCF/D
Total Central	Completed and In Construction	11,135	3,339	15,674
Central Shales	Completed and In Construction	80	221	81
Total Central	Approved	-	34	189
Central Shales	Approved	-	-	-
Total Central	Application Filed & Pre-Filed	-	79	106
Central Shales	Application Filed & Pre-Filed	-	79	106
Total Central	Announced	-	645	655
Central Shales	Announced	-	500	255

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