Shale Development: Its impact on Infrastructure and LNG Exports

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OFFICE OF ENERGY PROJECTS

FEDERAL ENERGY REGULATORY COMMISSION

Why Shale Gas? Why Now?

- **Project drivers**
  - Market
  - Supply
- **Impacts on Existing Infrastructure**
- **Shale Gas and LNG Exports**

Market Drivers

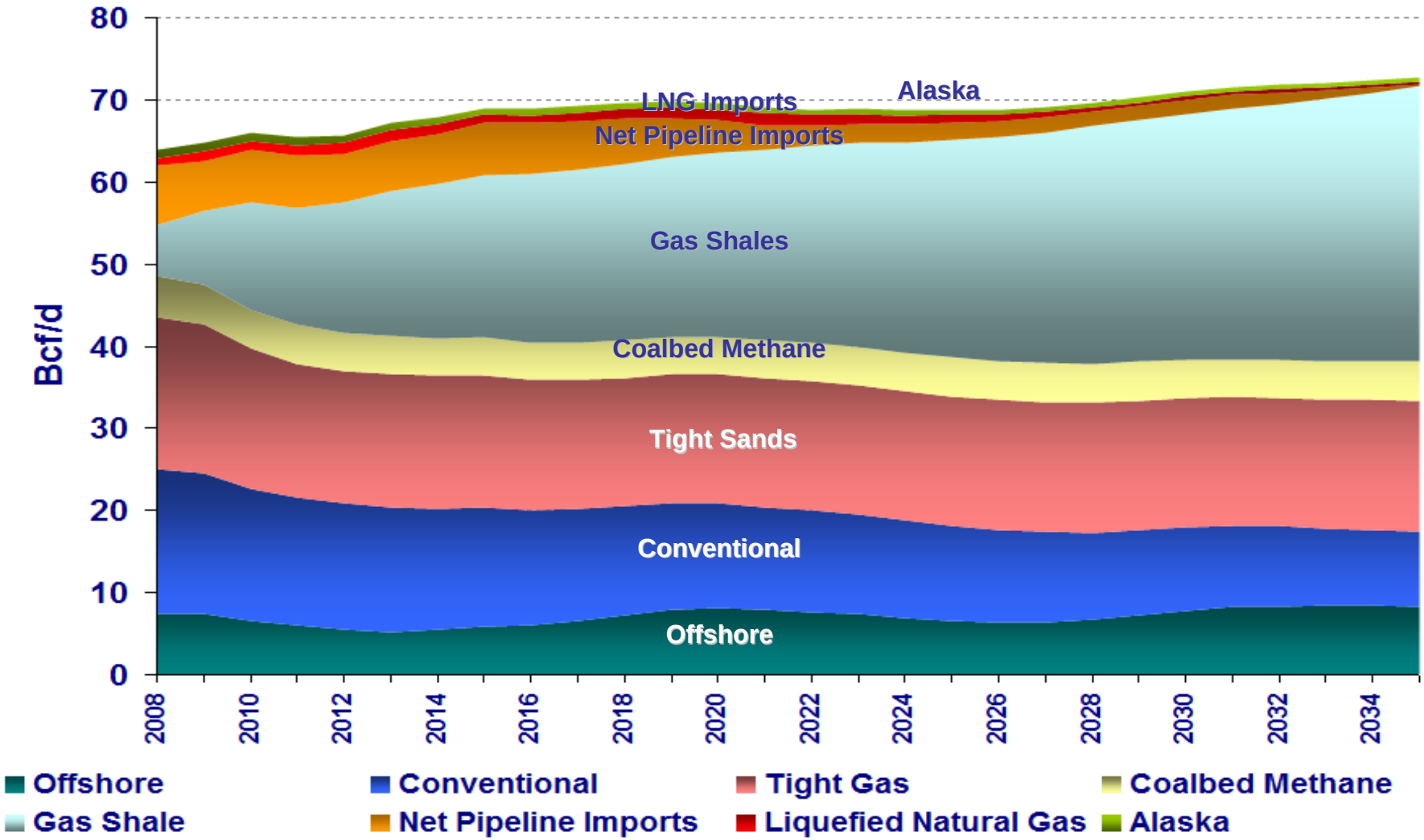
Natural gas is in demand…now more than ever!

- **Firming-up Variable Power Generation (RPSs)**
- **New Baseload Power Generation**
- **Replacing / Converting Retiring Coal-Fired Plants**
- **Natural Gas Vehicles**

Supply Drivers

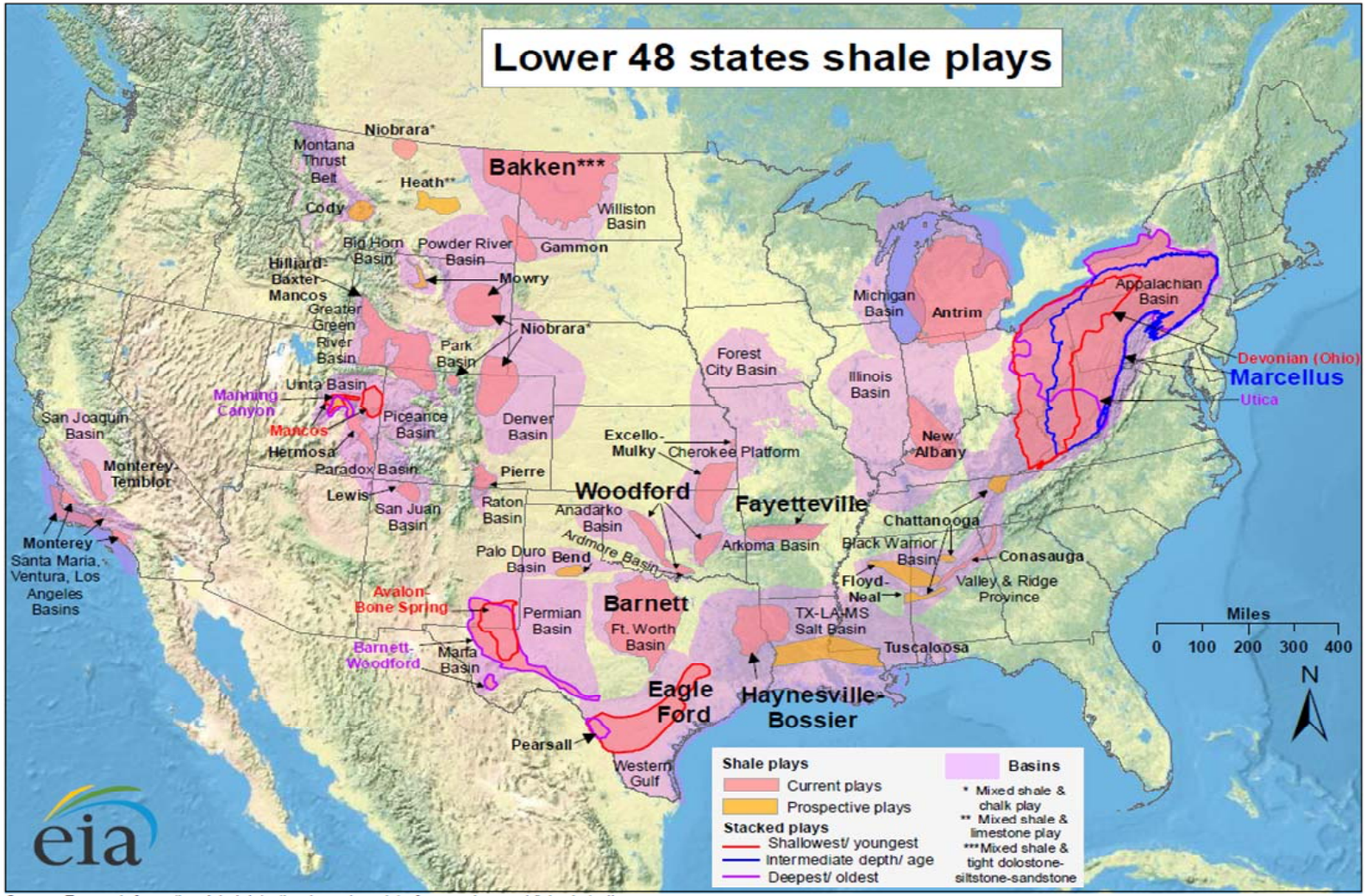
- Shale gas is abundant and is becoming increasingly cheaper to produce
- Rockies gas can now easily reach markets in the Northeast, and with Ruby, the Pacific Coast
- Deeper shale formations (e.g., Utica) are now being considered as emerging supply sources

Future U.S. Gas Supply



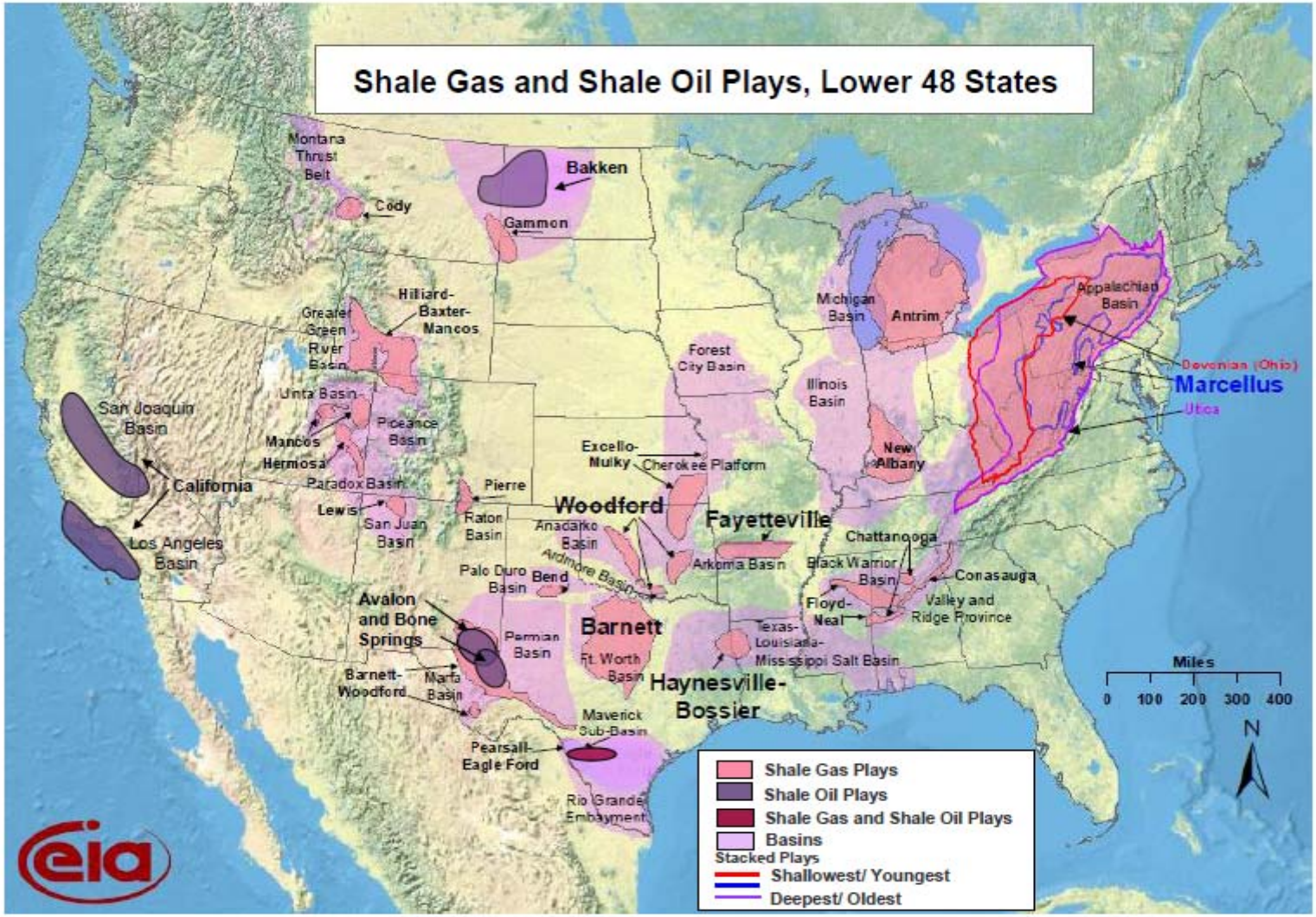
Source: EIA Annual Energy Outlook 2011 (April 2011) and EIA spreadsheets.

Shale Gas Plays in the United States



Source: EIA's Shale Gas Plays, Lower 48 States

Shale Gas and Shale Oil Plays, Lower 48 States



Source: EIA's Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays July 2011

Technically Recoverable Gas in the U.S.

Natural Gas Resource Assessment of the Potential Gas Committee, 2010 (mean values)

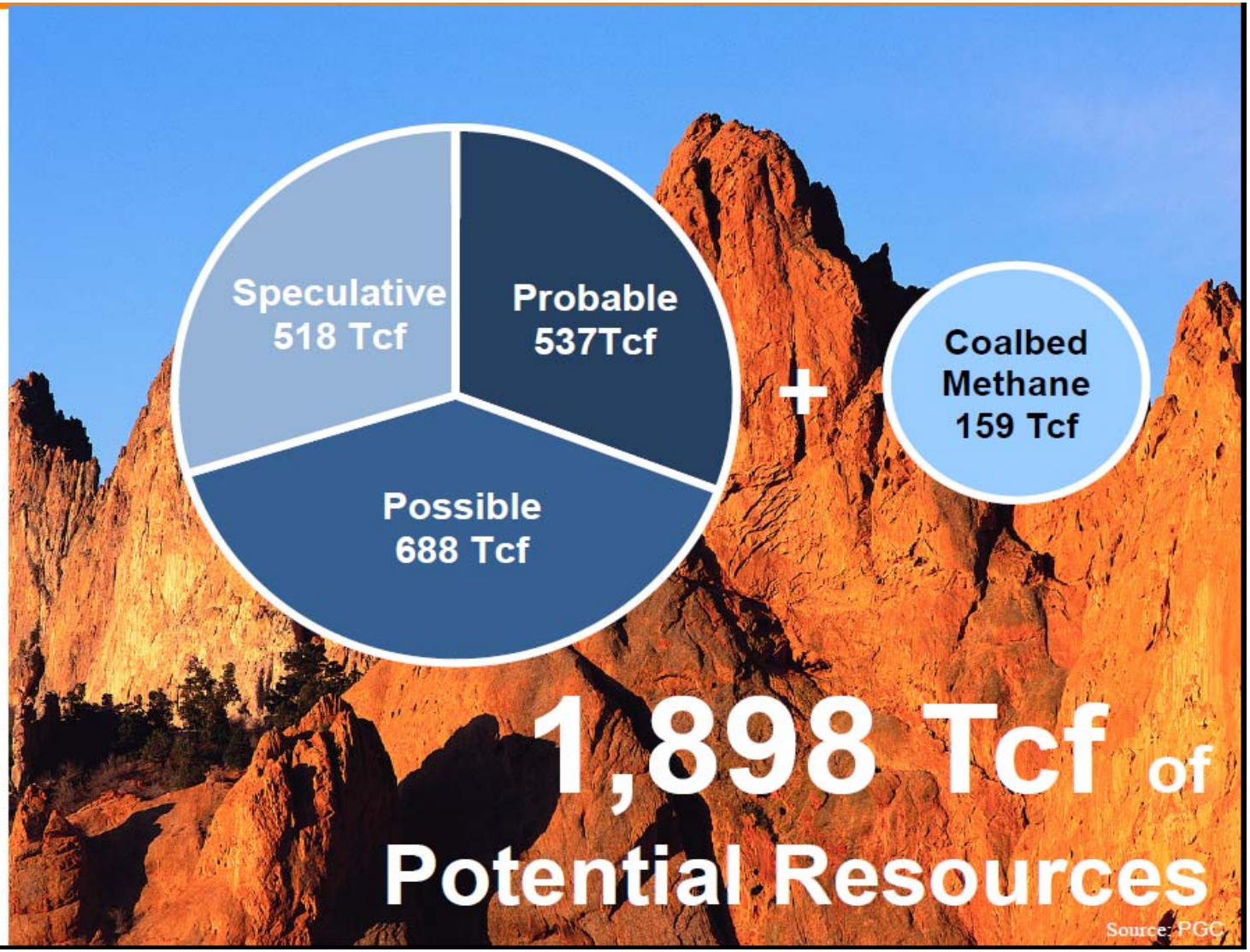
Traditional Gas Resources	1,739.2 Tcf
Coalbed Gas Resources	158.6 Tcf
Total U.S. Gas Resources	1,897.8 Tcf
Proved Reserves (EIA)*	272.5 Tcf
Future Gas Supply	2,170.3 Tcf

* Latest available value (dry gas), year-end 2009

Source: Report of the Potential Gas Committee (December 31, 2010) "Potential Supply of Natural Gas in the United States" April 27, 2011

PGC's Assessment Highest in 46-Year History

Potential Gas Committee

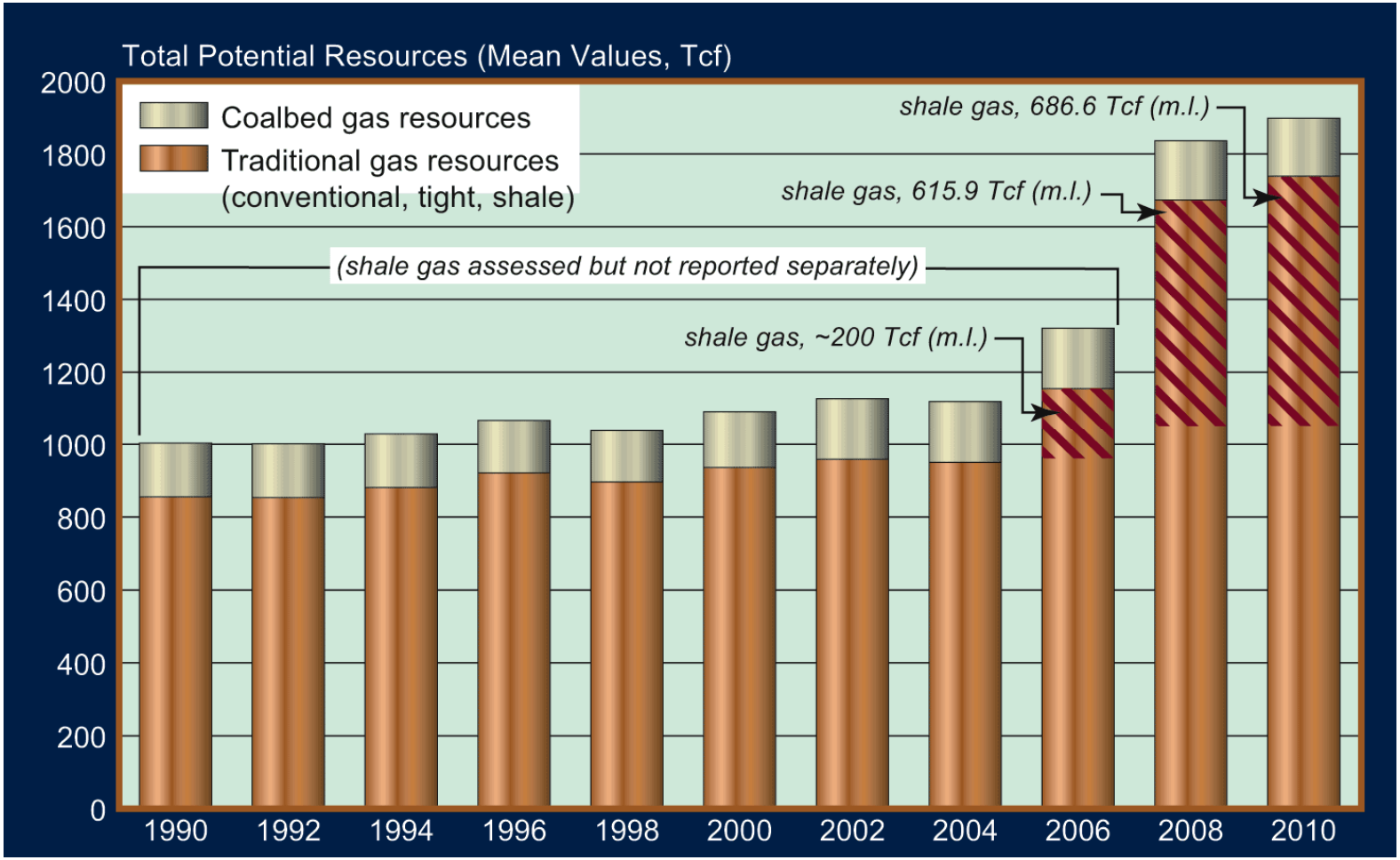


Source: GasMart 2011 CenterPoint Energy

The growing importance of shale gas is substantiated by the fact that, of the 1,898 Tcf of total potential resources, shale gas accounts for 687 Tcf (36%).

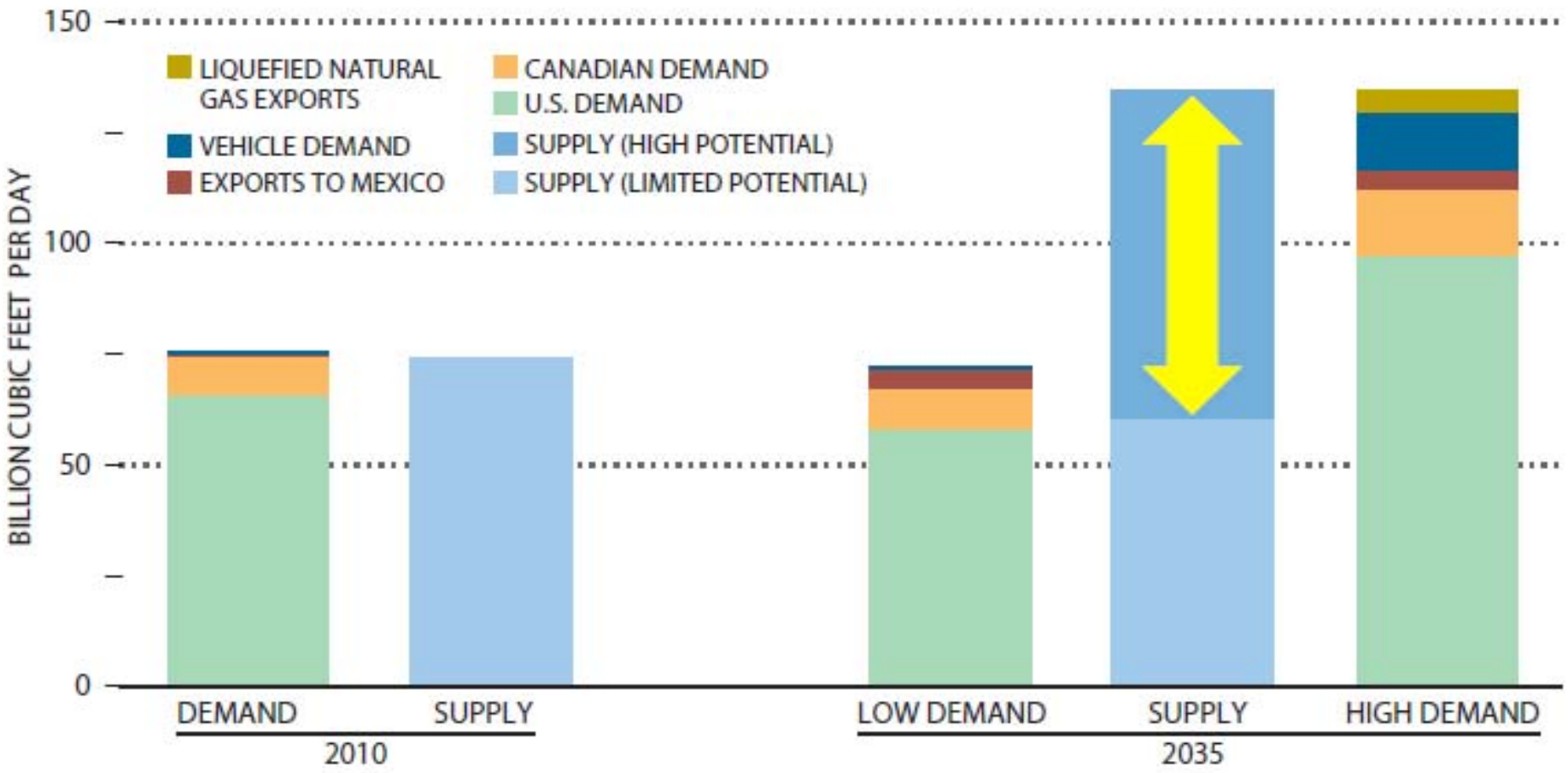
PGC Resource Assessments, 1990-2010

Total Potential Gas Resources (mean values)



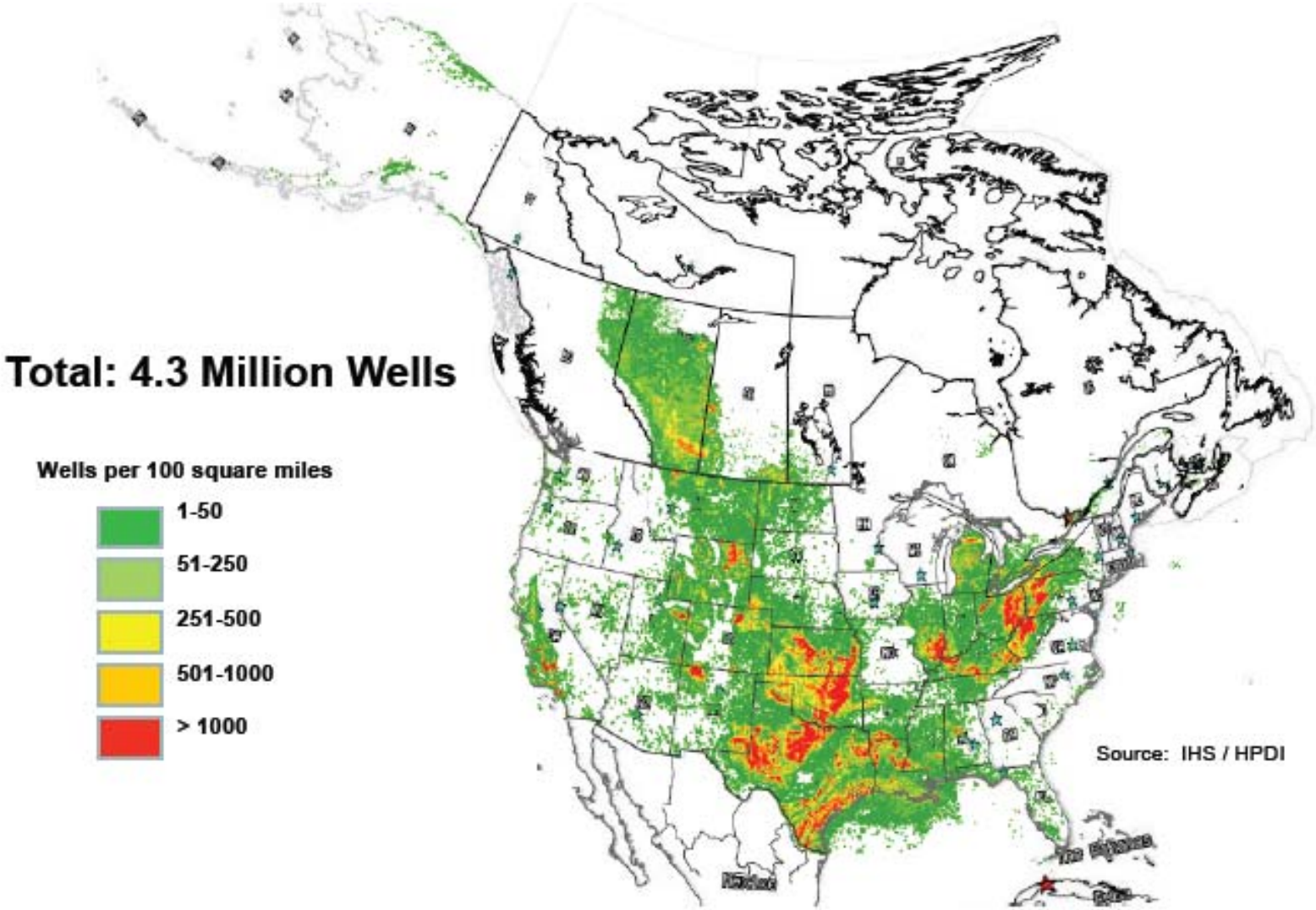
Source: Report of the Potential Gas Committee (December 31, 2010) "Potential Supply of Natural Gas in the United States" April 27, 2011

North American Natural Gas Can Meet Even the Highest Potential Demand



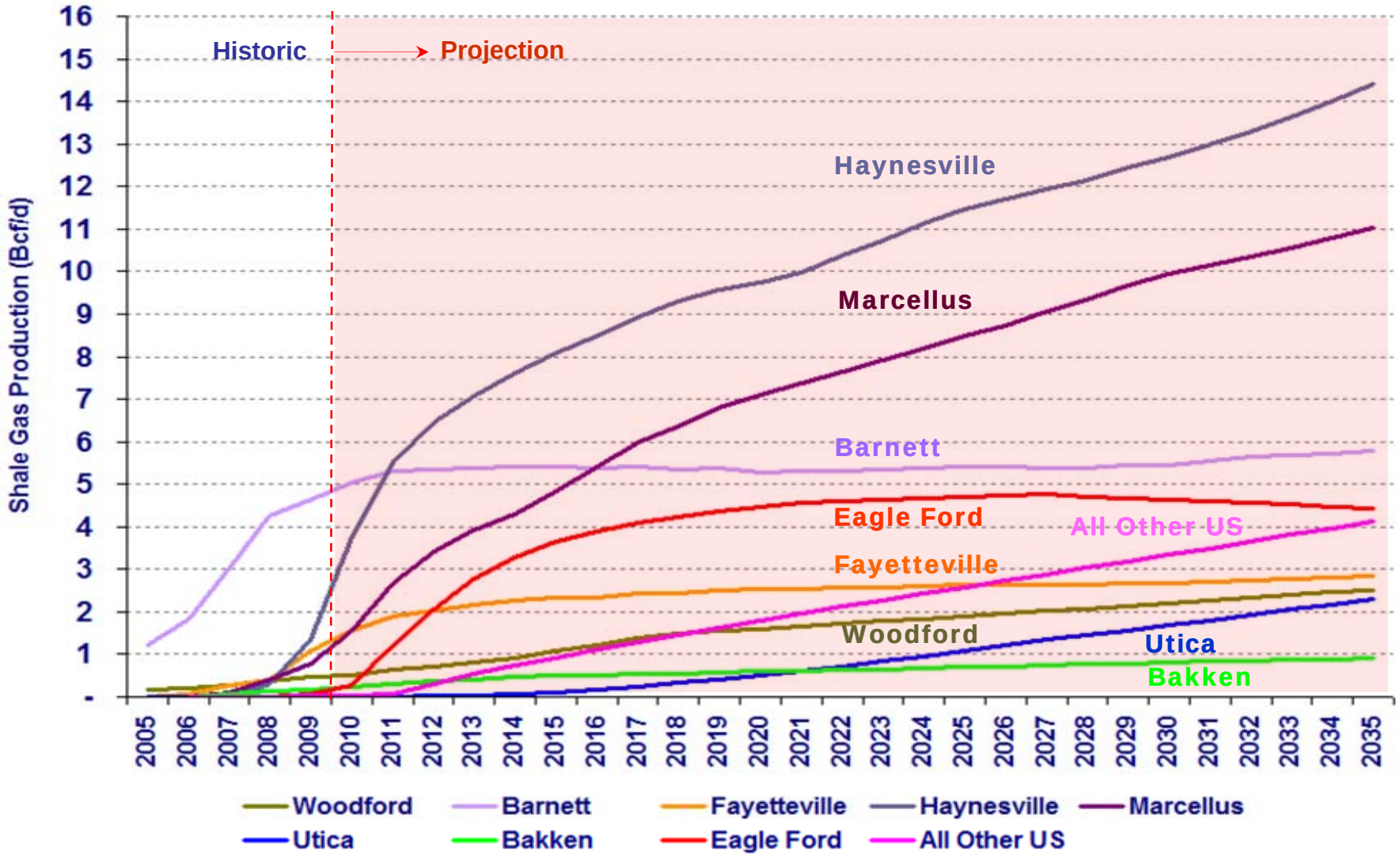
Source: North American Resource Development Study – Prudent Development – September 15, 2011

The Geographic Reach of Oil and Gas Development in North American Wells is Large



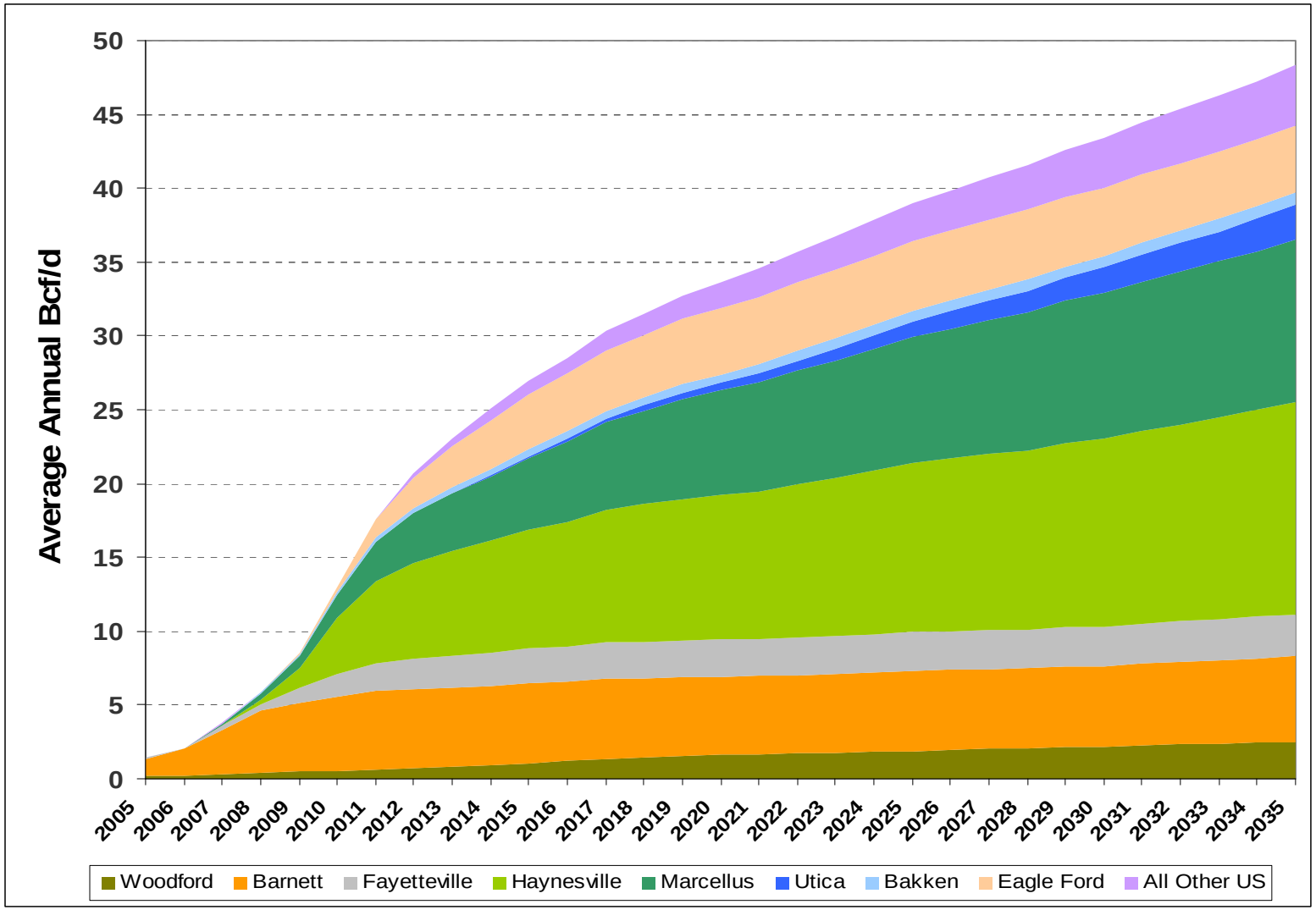
Source: North American Resource Development Study – Prudent Development – September 15, 2011

Shale Gas Estimates



Source: Based on data from ICF International and Compass Reports January and July 2011

Shale Gas Estimates



Source: Based on data from ICF International and Compass Reports January and July 2011

Projects Impacting the Shale Basins

FERC Related Projects

Natural Gas Basin	Capacity (MMcf/d)	Miles of Pipe	Compression (HP)	Cost (Millions)
Total Barnett	2,027	230	91,940	$602
Total Barnett, Woodford & Fayetteville	3,532	877	290,070	$3,517
Total Fayetteville	6,032	448	122,107	$2,240
Total Woodford	638	50	19,500	$134
Total Haynesville	3,230	196	229,716	$1,618
Total Marcellus	6,776	640	426,657	$3,535
Total Bakken	120	77	4,500	0
Total Various Supplies	3,910	638	283,334	$2,168
Grand Total	26,265	3,156	1,467,824	$13,814

Potential Projects

Natural Gas Basin	Capacity (MMcf/d)	Miles of Pipe	Compression (HP)
Total Barnett	2,139	40	9,500
Total Barnett & Woodford	1,800	175	70,000
Total Fayetteville	1,100	346	100,000
Total Bakken	130	100	0
Total Haynesville	1,100	0	20,260
Total Marcellus	5,228	970	0
Grand Total	11,497	1,631	199,760

Source: FERC

Changing Supply Dynamics

Emerging shale gas plays and Rockies gas (via REX) have resulted in a change in the traditional flows on pipelines that historically have brought gas from the gulf to markets in the northeast.

The impact??

- **a glut of gas in the Market Area**
- **underutilized pipeline facilities**
- **loss of traditional transportation revenue**

Impacts on Existing Infrastructure

So…what's a pipeline to do…

- ➲ **File a rate proceeding?**
- ➲ **File to modify existing infrastructure?**
- ➲ **File to abandon certificated facilities?**
- ➲ **File to construct new facilities?**
- ➲ **All of the above?**

Rate Proceedings

- **Columbia Gulf Transmission Company – Docket No. RP11-1435-000**
- **Tennessee Gas Transmission – Docket No. RP11-1566-000**

Both seek to make their recourse rates less "distance sensitive"…Columbia Gulf is proposing a postage stamp rate, while Tennessee proposes to shift costs from mileage to non-mileage.

Columbia Gulf Transmission Company
Docket No. RP11-1435-000

From Testimony Filed in the Proceeding:

- The flattened basis differential between the price of gas near the Gulf of Mexico and the price of gas in the Midwest and Northeast due to the increase in new gas supplies means there is less economic incentive to transport Gulf of Mexico gas to northern points.
- CGT's customers are now increasingly sourcing gas from the shale production areas to the west of CGT's system. This means that CGT's customers are now using receipt points near Delhi, Louisiana instead of traditional points on CGT's Onshore and Offshore laterals resulting in decreased throughput on the Onshore zone.
- In general, the new pipelines that provide takeaway capacity from the Texas, Oklahoma, Louisiana, and Arkansas shale plays have helped integrate the pipeline system in the Eastern U.S. These pipelines allow significant volumes to flow west-to-east, which has decreased the differential that once existed between the price of gas in Texas and Louisiana and the price of gas in eastern markets. The market is therefore no longer as reliant on CGT to bring supplies to the market. As a result, demand for transportation capacity on CGT's system has decreased as the pipeline system has grown more integrated. The declining production costs associated with developing shale gas supplies along with the increased production from the Marcellus Shale will likely cause a further flattening of the price differential between Gulf of Mexico supply and northern markets.

Tennessee Gas Transmission
Docket No. RP11-1566

From Testimony Filed in the Proceeding:

- CGT may lose some of its northern LDC customers who can access the Marcellus Shale or gas supplies from the Rockies without using CGT's system.
- Tennessee is now receiving approximately 30% of its supply from the middle of its system (Zone 4), up from 5% in 2009. (TPG-132, page 20, lines 1-3).
- In the past, supply shortages often resulted from damage to offshore facilities due to hurricanes. Today, such shortages would not have the same operational impact because Tennessee has more supply being delivered directly into its market are from REX and Marcellus. (TGP-132, page 29, lines 5 -10).
- Natural gas from REX and Marcellus has displaced receipts from traditional sources in south Texas and the Gulf of Mexico. For example, physical receipts of Marcellus gas into Tennessee's 300 Line located in Pennsylvania have increased from zero in 2008 to nearly 1 Bcf/d by November 2010. (TGP-141, page 10 line 17 – page 11, line 2).
- In recognition of the increased Marcellus shale gas and other supplies entering into the Tennessee system in Zone 4, Tennessee proposes to modify the location of existing pooling points. By moving the pools there will be a reduced likelihood of a restriction into the pool due to constrained segments of pipe. (TGP-141, page 46, line 13 – page 47, line 18).

Modifications to Existing Infrastructure / Change in Flow Patterns

The following pipeline companies have sought FERC approval to make facility changes to existing infrastructure, and amend Presidential Permits to allow transportation and exportation of shale gas into Canada:

- **Empire**
- **Iroquois**
- **Maritimes and Northeast**
- **National Fuel**
- **Tennessee**
- **Vector**

Existing Pipelines are Eyeing Backhauls in Response to Marcellus Growth

According to Gas Daily (August 5, 2010), existing pipelines are mulling the option to backhaul gas as the rapid growth of shale gas production redraws the map for pipeline flows across North America:

- The growing market chatter regarding offering backhaul capacity on Rockies Express Pipeline has been increasing, with the pipeline company even mentioning it as an area of growth for next year in an investor presentation in January 2010.
- Tennessee Gas Pipeline announced recently that it has contracted for some 400,000 Mcf/d of backhaul capacity from the Marcellus Shale to Southeastern markets this year and projects to have about 936,000 Mcf/d in 2012.
- Transcontinental Gas Pipe Line officials announced that the pipe has the ability to move gas west to Leidy, Pennsylvania, and even back down to Transco zone 5 in the Mid-Atlantic.

Abandoning Existing Infrastructure

The following pipelines have sought FERC authority to abandon certificated facilities, typically in historic production areas (including offshore) and on parts of their systems with low throughput:

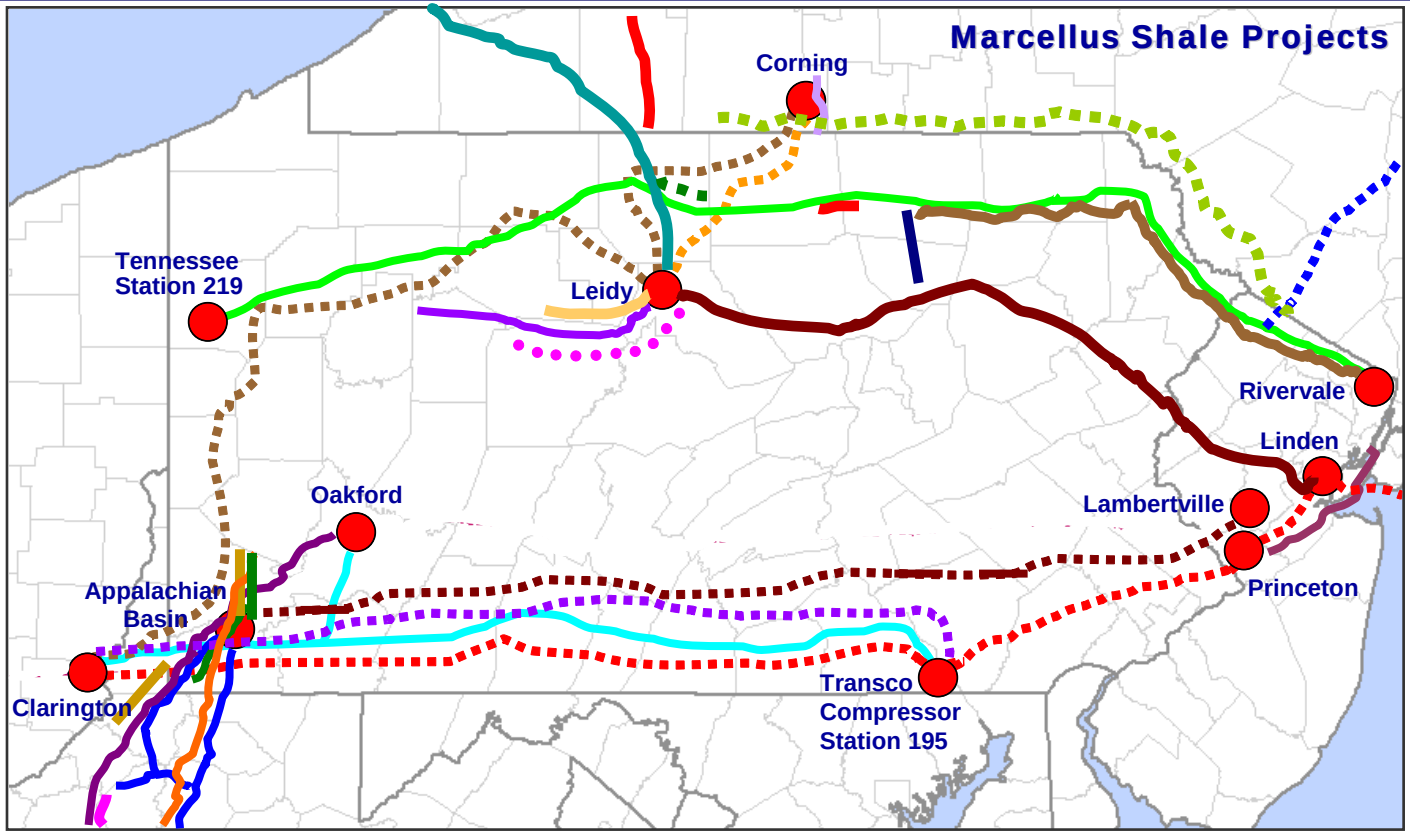
- **ANR**
- **Columbia Gulf**
- **Florida Gas Transmission**
- **Northern Natural**
- **Southern Star**
- **Tennessee**
- **Texas Eastern**
- **Transco**

Construction of New Facilities

The following pipelines have sought to construct new facilities to transport Marcellus shale gas:

- **Equitrans**
- **National Fuel**
- **Tennessee**
- **Texas Eastern**
- **Transco**
- **Dominion**
- **Central NY Oil and Gas**

Marcellus Shale Projects



Approved or Pending Projects

- Appalachian Expansion (NiSource)
- Line 300 Exp (Tennessee)
- NiSource/MarkWest & NiSource
- N Bridge, TIME 3, TEMAX (TETCO)
- Appalachian Gateway (Dominion)
- Line N & N, R & I Projects (NFG)
- Tioga County Extension (Empire)
- NSD Project (Tennessee) & Ellisburg to Craigs (Dominion)
- Northern Access & Station 230C (NFG & Tennessee)
- Sunrise Project (Equitrans)
- TEAM 2012 Project (TETCO)
- Northeast Upgrade (Tennessee)
- Marc I (Central NY)
- Low Pressure East-West (Equitrans)
- East-West - Overbeck to Leidy (NFG)
- NJ-NY Project (TETCO & Algonquin)
- Northeast Expansion (Dominion)
- Northeast Supply Link (Transco)

Potential Projects

- NYMarc (Iroquois)
- New Penn (NiSource)
- Marcellus to Manhattan (Millennium)
- Appalachia to Market Expansion & TEAM 2013 (TETCO)
- MPP Project (Tennessee)
- Keystone (Dominion/Williams)
- West to East Connector (NFG)
- NiSource & UGI
- Northeast Supply (Williams)*

* Combined Transco's Rockaway Lateral and Northeast Connector Projects

Source: FERC

Summary of Natural Gas Facilities Impacting the Marcellus Shale Basin

Natural Gas Basin	Status	Company/ Project	Capacity (MMcf/d)	Miles of Pipe	Compression (HP)
Marcellus	In-Service 11/10	Texas Eastern Trans., LP (TEMAX & TIME III projects)	455	62	84,433
Marcellus	In-Service 10/09	Texas Eastern Trans., LP (Northern Bridge Project)	150	0	10,666
Marcellus	In-Service	Columbia Gas Trans., LLC (Appalachian Exp. Proj.)	100	0	9,470
Marcellus	Under Construction	Tenn. Gas Pipeline Co. (Line 300 Expansion)	350	129	59,158
Marcellus	Prior-Notice In-Service	Columbia Gas Trans., LLC (Majorsville Compressor/ MarkWest Upgrade)	250	4	0
Marcellus	Prior-Notice In-Service	Columbia Gas Trans., LLC	150	6	0
Marcellus	Prior-Notice In-Service	Equitrans, LP (Low Pressure East and West Upgrade Project)	92	0	0
Marcellus	Under Construction	Dominion Trans., Inc. (Appalachian Gateway Project)	484	107	17,965
Marcellus	Pending	Central NY Oil and Gas Co. (MARC I Project)	550	39	31,660
Marcellus	In-Service 10/11	National Fuel Gas Supply Corporation (Line N R & I Project)	150	20	4,740
Marcellus	Pre-Filing	National Fuel Gas Supply Corporation (E-W / Overbeck to Leidy)	425	82	25,000
Marcellus	Pending	Texas Eastern Trans. & Algonquin Gas Trans. (NJ-NY Project)	800	20	0
Marcellus	Under Construction	Equitrans, LP (Sunrise Project)	314	47	14,205
Marcellus	Pending	Texas Eastern Trans., LLC (TEAM 2012 Project)	200	16	20,720
Marcellus	Pending	Tenn. Gas Pipeline Co. (Northeast Upgrade Proj.)	636	40	22,310
Marcellus	Approved	Tenn. Gas Pipeline Co. (Northeast Supply Diversification Project)	250	7	0
Marcellus	Approved	Dominion Trans., Inc. (Ellisburg to Craig Project)	150	0	10,800
Marcellus	Approved	Dominion Trans., Inc. (Northeast Expansion Project)	200	0	32,440
Marcellus	Pre-Filing	Transco (Northeast Supply Link)	250	39	36,000
Marcellus	Pending	National Fuel Gas Supply Corporation (Northern Access Project)	320	0	14,210
Marcellus	Pending	Tennessee Gas Pipeline Company (Station 230C Project)	0	0	12,260
Marcellus	Pending	National Fuel Gas Supply Corporation (Line N 2012 Expansion Project)	150	5	20,620
Marcellus	Under Construction	Empire Pipeline, Inc (Tioga County Extension)	350	16	0
Total			6,776	640	426,657

Natural Gas Basin	Status	Company/ Project	Capacity (MMcf/d)	Miles of Pipe	Compression (HP)
Marcellus	Potential	Nisource (New Penn)	500	82	
Marcellus	Potential	TETCO (Appalachia to Market Expansion- TEAM)	500		
Marcellus	Potential	Dominion/Williams (Keystone Connector)	1,000	240	
Marcellus	Potential	Williams (Northeast Supply)	688	250	
Marcellus	Potential	NFG (West to East Connector)	625	324	
Marcellus	Potential	Iroquois Gas Transmission System LP (NYMarc System Project)	500	66	
Marcellus	Potential	Millennium Pipeline (Marcellus to Manhattan)	675	0	
Marcellus	Potential	Tennessee Gas Pipeline Co. (MPP Project)	240	8	
Marcellus	Potential	NiSource Gas Transmission and Storage & UGI Corporation	500	0	
Total			5,228	970	

Source: FERC

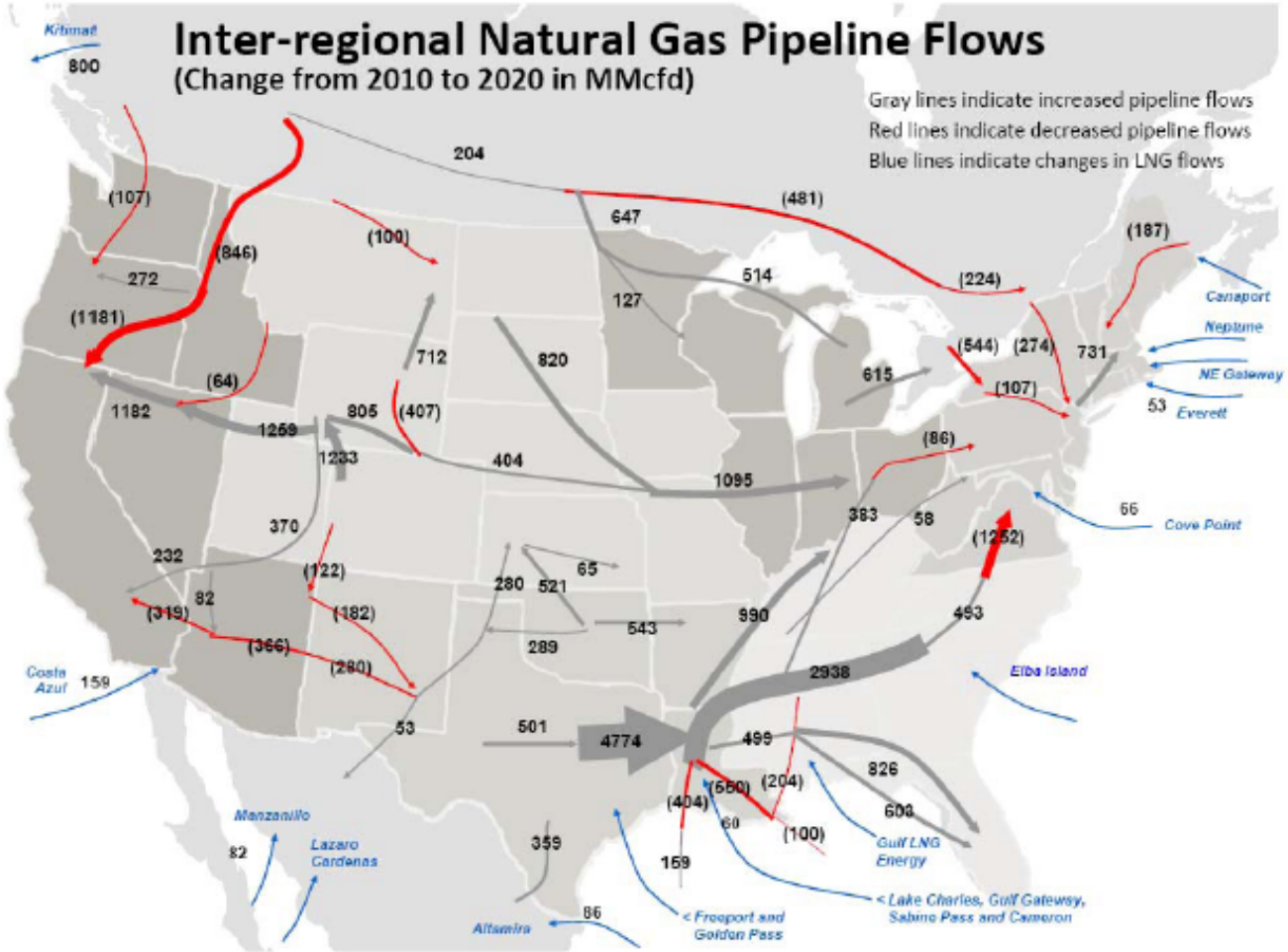
All of the Above? Sorta!!

El Paso Midstream Group's big plan:

- Transport 60,000 barrels/d of ethane from SW Pennsylvania to Louisiana
- Purchase over 800 miles of apparently ***no-longer-needed*** pipeline owned by Tennessee (via abandonment by sale)
- Modify existing compression on Tennessee to handle pumping liquids (most likely through abandonment by sale and amendment)

Projected Change in Gas Flows 2010 – 2020

- Increases in flows from the Gulf Coast to the Southeast are due to increases in Mid-continent shale gas production.
- REX Pipeline enables increasing flow from the Rocky Mountains eastward.
- Marcellus gas production growth displaces gas flows into the Northeast U.S. (Shifts within the Northeast are not depicted on this interregional flow map).
- Declining conventional production in Alberta and increasing gas consumption for oil sands development causes flows from Western Canada to decline.

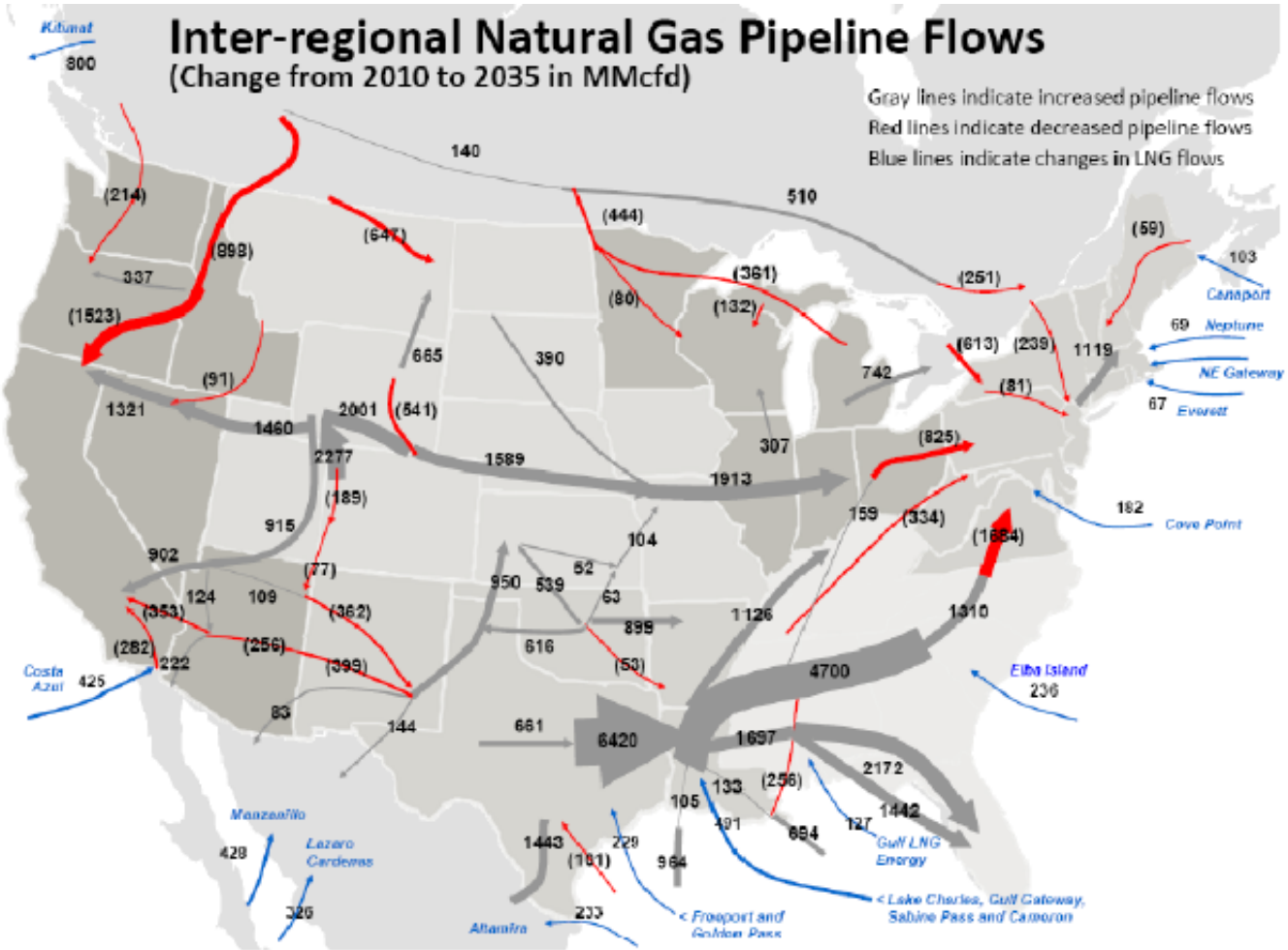


Note that this map does not generally show intra-regional pipeline expansions such as those that occur in the Marcellus shale production area.

Source: North America Midstream Infrastructure Through 2035 – A Secured Energy Future. Prepared for the INGAA Foundation June 28, 2011

Projected Change in Gas Flows 2010 – 2035

- Substantial increases in flows continue to occur out of the Mid-continent shales and the Rocky Mountain producing basins.
- Marcellus gas productior growth continues to displace gas flows into the Northeast U.S. (Shifts within the Northeast are not depicted on this interregional flow map).
- Flows on TCPL to eastern markets recover slightly, but remain down in the longer term.



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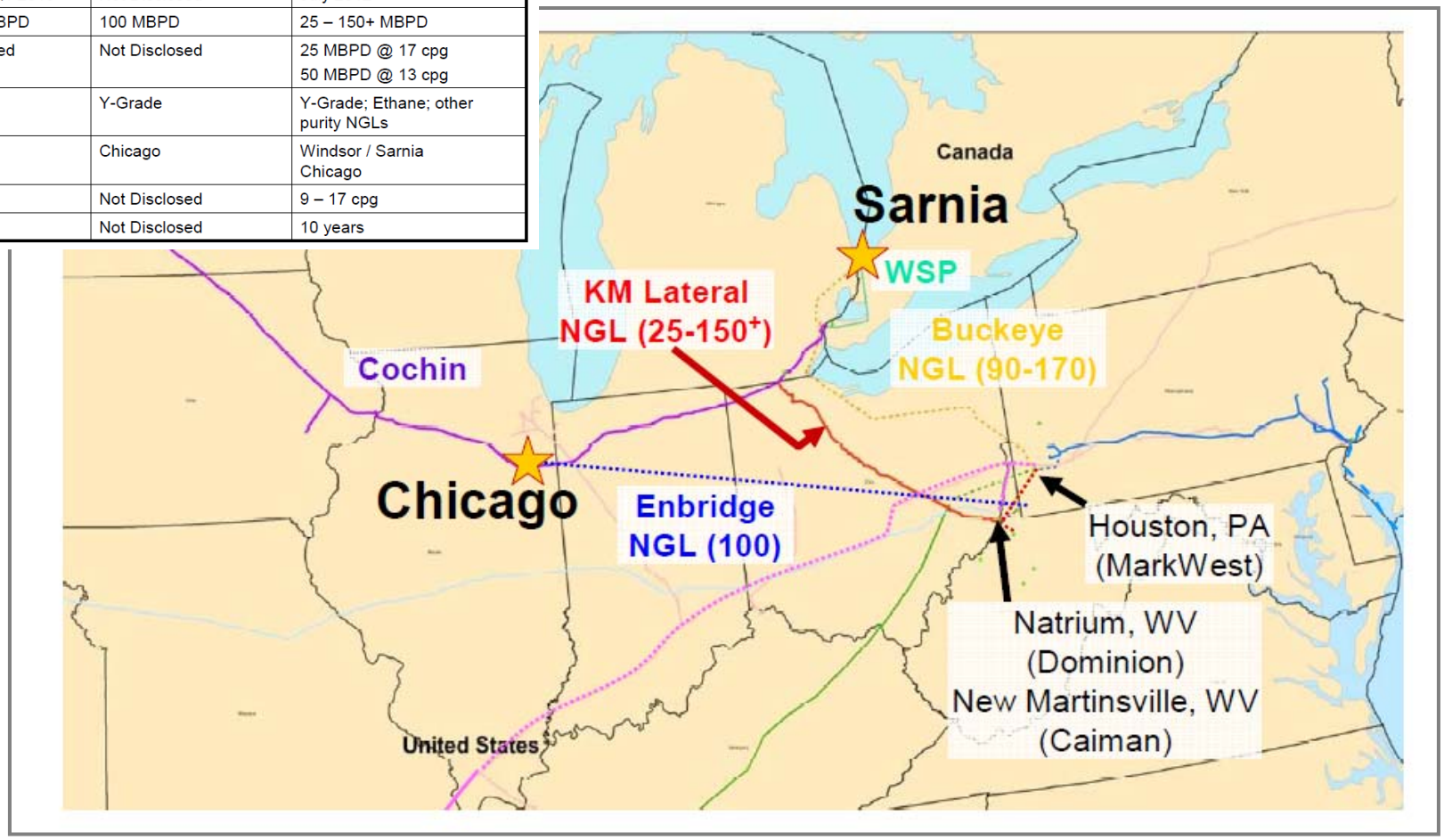
Natural Gas Liquid Projects for the Marcellus Shale

The following pipelines have expressed interest in constructing new facilities to transport natural gas liquids out of the Marcellus shale:

- **Williams – Confluence project which will tie in to Williams proposed Atlantic Access pipeline**
- **MarkWest – Mariner West and East Projects**
- **El Paso and Spectra Energy – Marcellus Ethane Pipeline System**
- **Kinder Morgan Energy – Cochin Marcellus Lateral Pipeline**
- **Enbridge Energy – Marcellus NPL Pipeline to Chicago**
- **Buckeye Partners – Union Pipeline Project**

Proposed Marcellus Mixed NGL Projects

	Buckeye Union Pipeline	Enbridge (NGL to Chicago)	Kinder Morgan Cochin Marcellus Lateral Project
Project Description	~400 mile new 14-16" Y-Grade line to Sarnia	~450 miles new pipe; Y-Grade line to Chicago	250 miles new 12" - 16"; 150 miles existing 12"
Start-up	Q4 2012 - Q1 2013	Not Disclosed	July 2012
Capacity	90 – 170 MBPD	100 MBPD	25 – 150+ MBPD
Aggregate Min Commit	Not Disclosed	Not Disclosed	25 MBPD @ 17 cpg 50 MBPD @ 13 cpg
Products	Y-Grade	Y-Grade	Y-Grade; Ethane; other purity NGLs
Destinations	Sarnia	Chicago	Windsor / Sarnia Chicago
Rate	14 – 17 cpg	Not Disclosed	9 – 17 cpg
Term	15 years	Not Disclosed	10 years

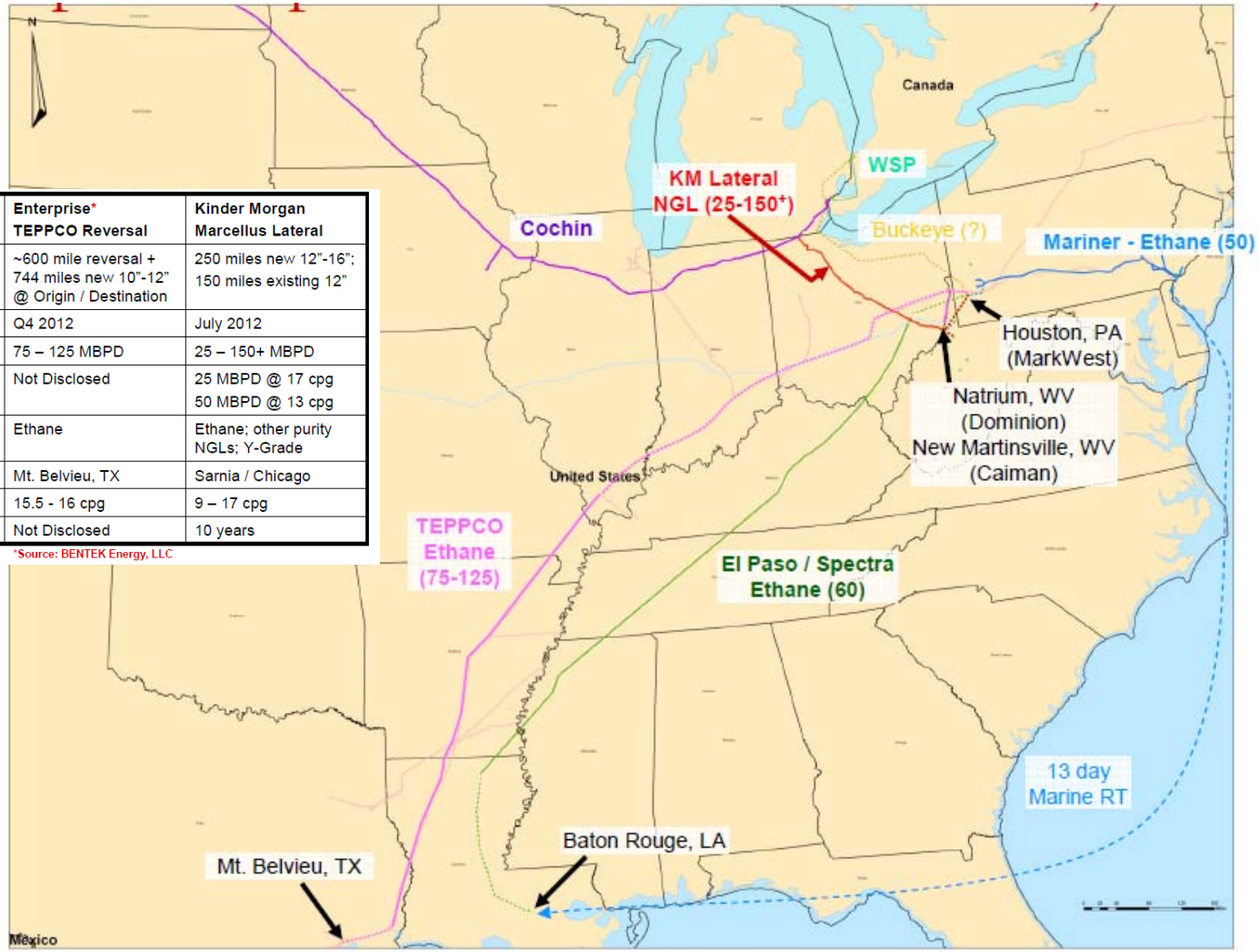


Source: Kinder Morgan's Presentation at the Platt's 3rd Appalachian Gas Conference October 29, 2010

Proposed Marcellus Ethane Projects

	MarkWest / Sunoco Mariner Project	El Paso / Spectra TN Gas Reversal	Enterprise* TEPPCO Reversal	Kinder Morgan Marcellus Lateral
Project Description	45 mile new (MW) + 250 mile 8" SXL pipe + storage + marine	830 mile reversal + 200 miles new @ Origin / Destination	~600 mile reversal + 744 miles new 10"-12" @ Origin / Destination	250 miles new 12"-16"; 150 miles existing 12"
Start-up	Mid-2012 / Q2 2012	April 1, 2013	Q4 2012	July 2012
Capacity	50 MBPD	60 MBPD	75 – 125 MBPD	25 – 150+ MBPD
Aggregate Min Commit	Not Disclosed	50 MBPD	Not Disclosed	25 MBPD @ 17 cpg 50 MBPD @ 13 cpg
Products	Ethane	Ethane	Ethane	Ethane; other purity NGLs; Y-Grade
Destinations	Louisiana markets	Baton Rouge, LA	Mt. Belvieu, TX	Sarnia / Chicago
Rate	Not Disclosed	18+ cpg	15.5 - 16 cpg	9 – 17 cpg
Term	Not Disclosed	10 years	Not Disclosed	10 years

*Source: BENTEK Energy, LLC



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Shale Gas and LNG Exports

Current Proposals at FERC to Export LNG:

- **Sabine Pass LNG Terminal**
- **Freeport LNG Terminal**

Sabine Pass LNG Terminal

- **Application to export domestically produced natural gas in Docket No. CP11-72**
- **Proposes to liquefy, store, and export approximately 16 million metric tonnes of LNG per annum (mpta) or the equivalent of 803 Bcf/yr or 2.6 Bcf/d**
- **Proposes to use the five existing LNG storage tanks and a sixth LNG storage tank authorized in Docket No. CP05-396**
- **Liquefaction to be constructed in two stages**
  - Stage 1 – Two ConocoPhillips Optimized Cascade LNG Process Trains (LNG Trains 1 and 2) each capable of a liquefaction capacity of approximately 4.0 mtpa
  - Stage 2 - LNG Trains 3 and 4 are identical to LNG Trains 1 and 2
- **Creole Trail will file for authorization to modify its system for bi-directional flow**
- **400 feet of new 42-inch diameter pipeline to connect with Creole Trail**

Freeport LNG Terminal

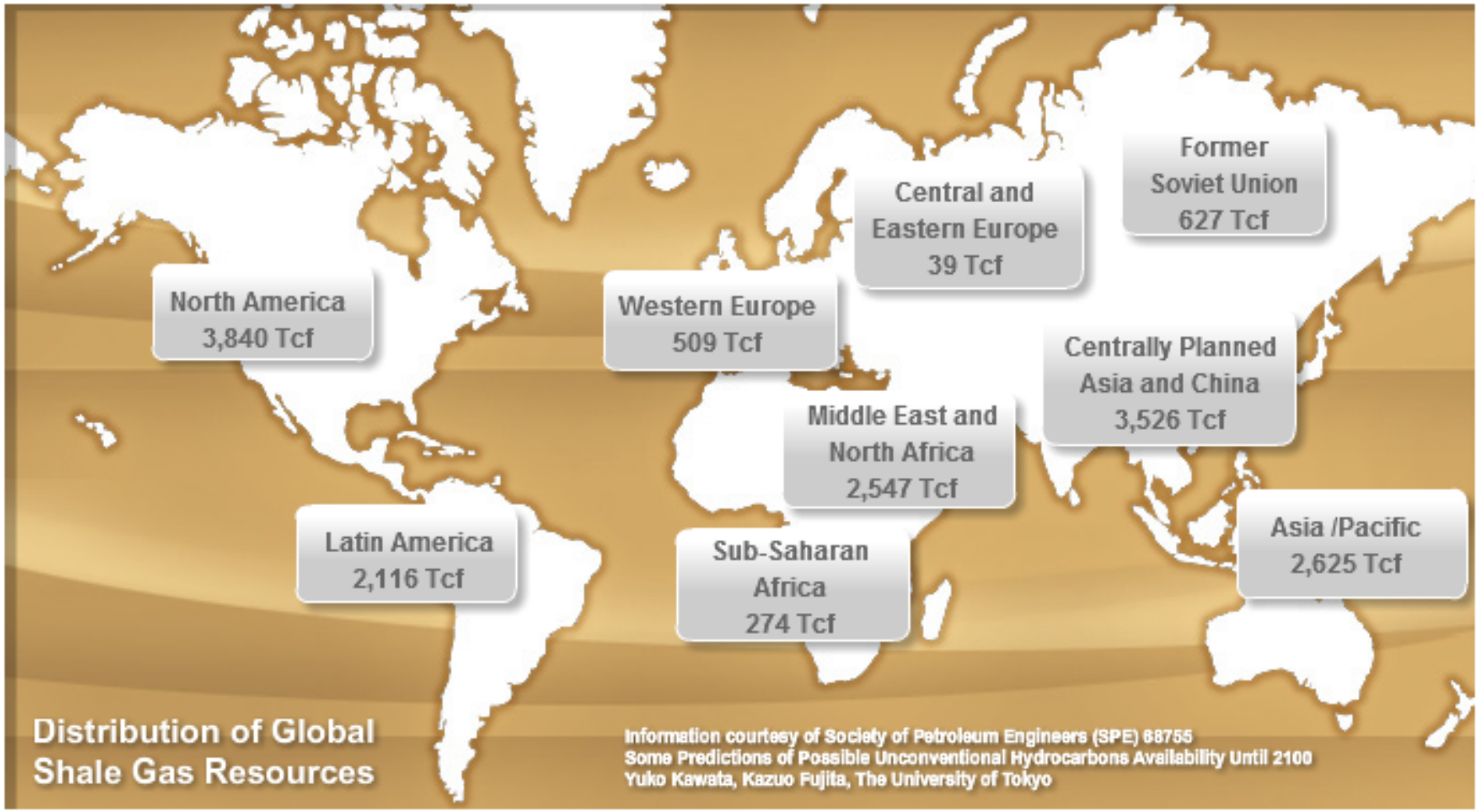
- Pre-Filing application to export domestically produced natural gas in Docket No. PF11-2
- Proposes to liquefy, store, and export approximately 12 million metric tonnes of LNG per annum (mpta) which equates to processing 1.8 Bcf/d of pipeline quality natural gas
- Proposes to use the two existing LNG storage tanks and a third LNG storage tank authorized in Docket No. CP05-361
- Three liquefaction trains (Trains 1, Train 2, and Train 3) each capable of producing 4 mpta of LNG
- Pipeline quality natural gas will be derived from interconnecting intrastate pipeline systems through Freeport LNG's existing Stratton Ridge meter station

Shale Gas and LNG Exports

LNG Export Projects on the Horizon:

- **Elba Island LNG Terminal**
- **Lake Charles LNG Terminal**
- **Cove Point LNG Terminal**
- **Jordan Cove LNG Terminal**

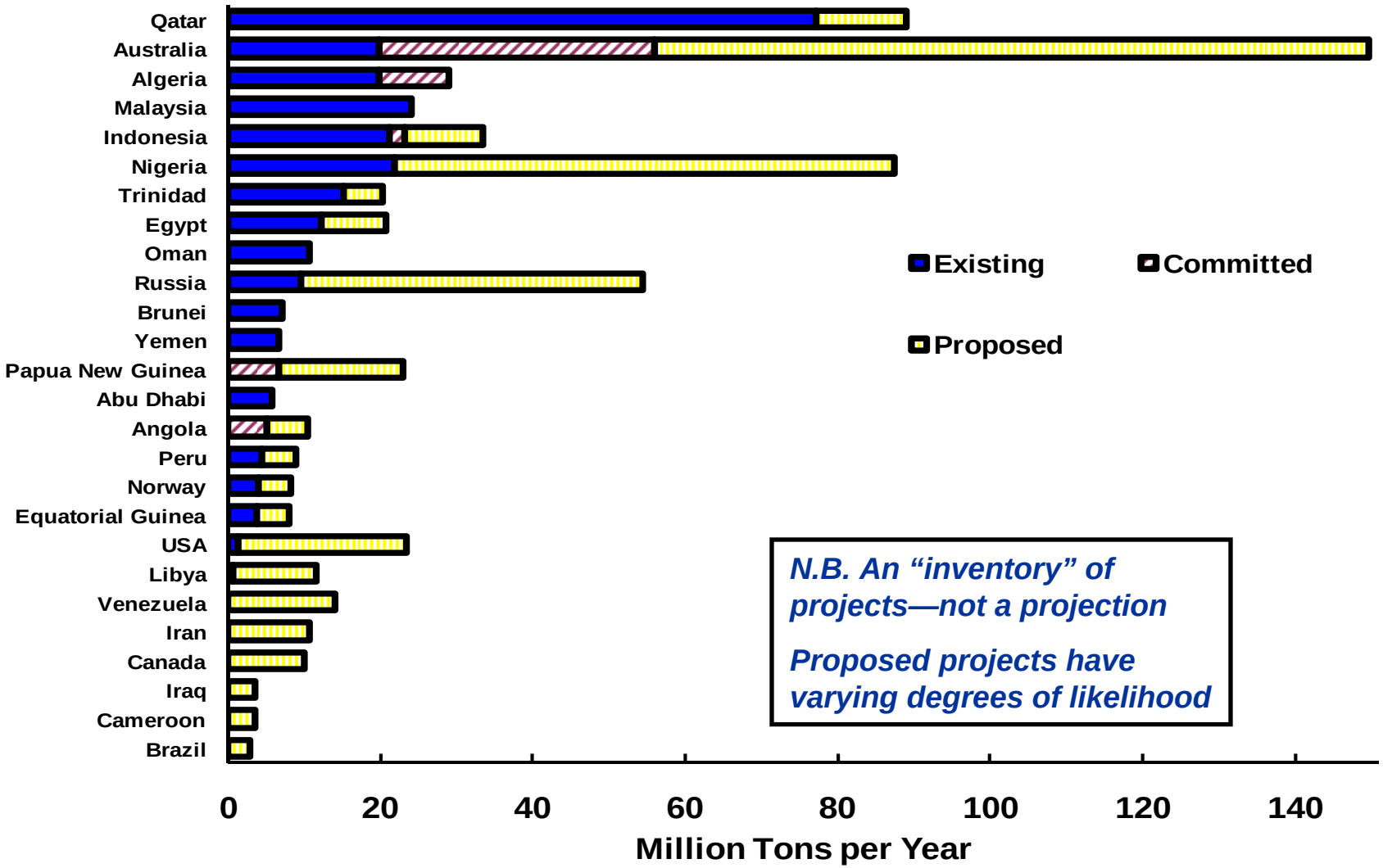
Global Shale Gas



Source: Halliburton.Com

Where Will the LNG Come From?

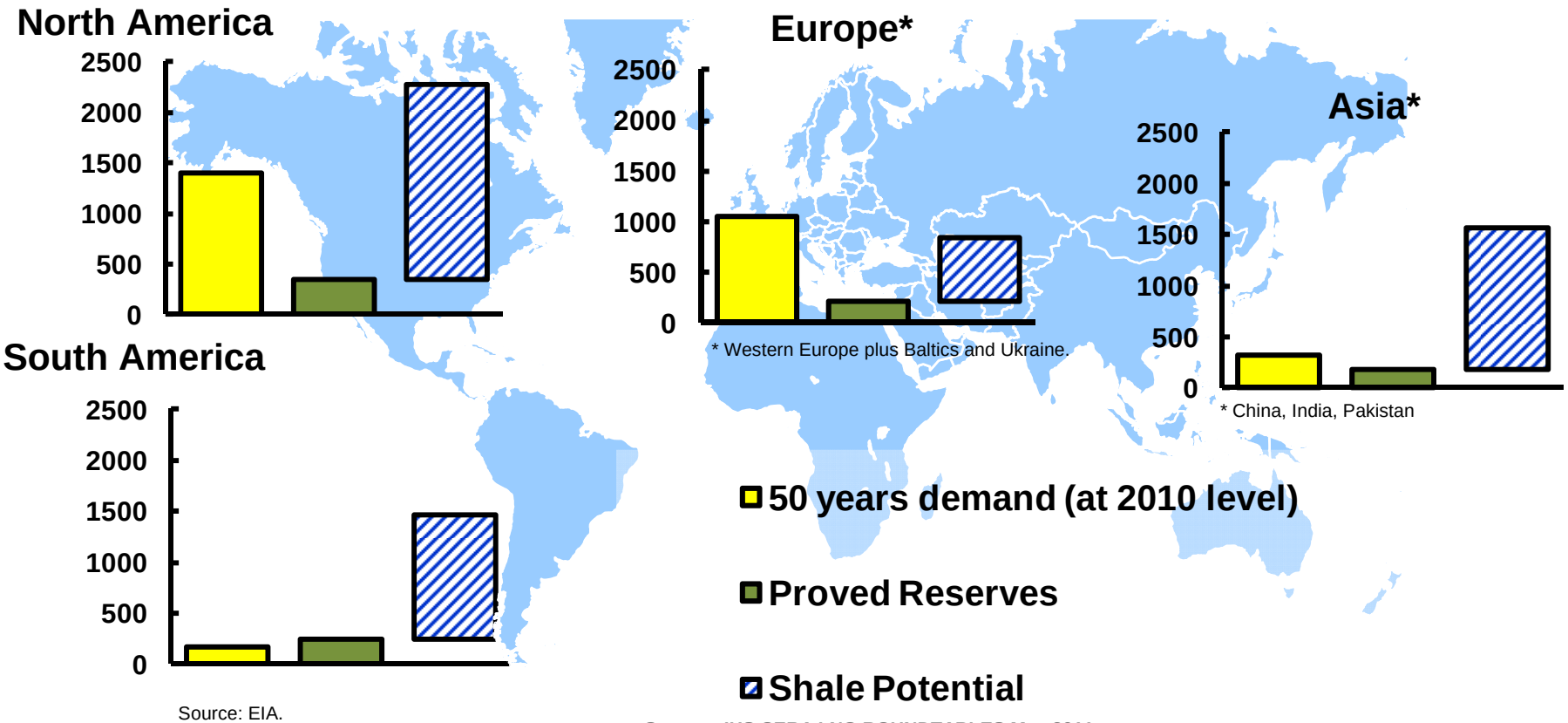
LNG Capacity by Status and Country



Source: IHS CERA LNG ROUNDTABLES May 2011

Shale Gas Potential: A Threat to LNG Demand?
(trillion cubic feet)

- **All major natural gas markets have substantial shale potential.**
  - North American production benefits from geographic and regulatory advantages.
  - Large potential in Asia, specifically China.
  - Europe's potential is lower and above ground risks are substantial.



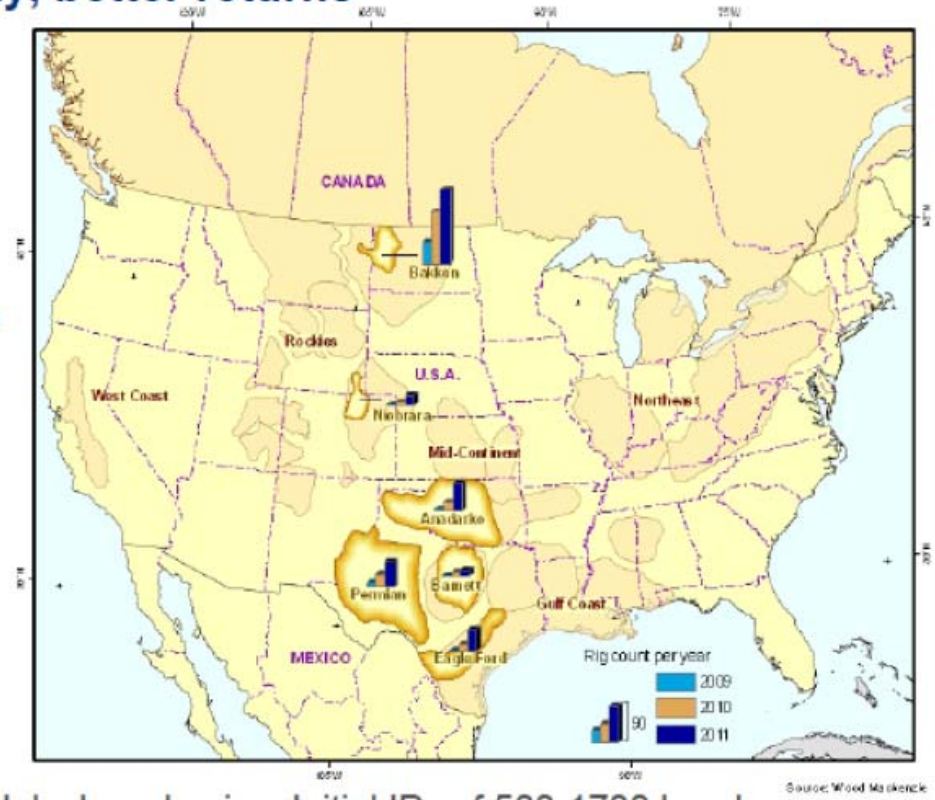
Source: EIA.

Source: IHS CERA LNG ROUNDTABLES May 2011

U.S Oil Shales Plays Provide Greater Returns at Current High Liquid Prices and Low Gas Prices

Move to oil plays—new prospectivity, better returns

- **Bakken – The Barnett for tight/shale oil**
  - Six billion barrels of resource potential
  - Williston Basin oil production to reach 450,000 b/d by 2015
  - Activity increasing in Canadian Bakken with current production at 60,000 b/d
- **Eagle Ford Oil Play**
  - Approximately 45 rigs active today
  - Chesapeake's JV to increase to 40 rigs by 2012 from 16 currently
  - Proposed Anadarko JV adds further upside to oil rig expectations
- **Niobrara Oil Play**
  - Play spans Powder river and Denver-Julesburg basins. Initial IPs of 500-1700 boed.
- **Major tight oil players are gas focused independents - Chesapeake, EOG, Newfield, Pioneer, Anadarko etc**
- **More Shale/Tight Oil JVs expected**

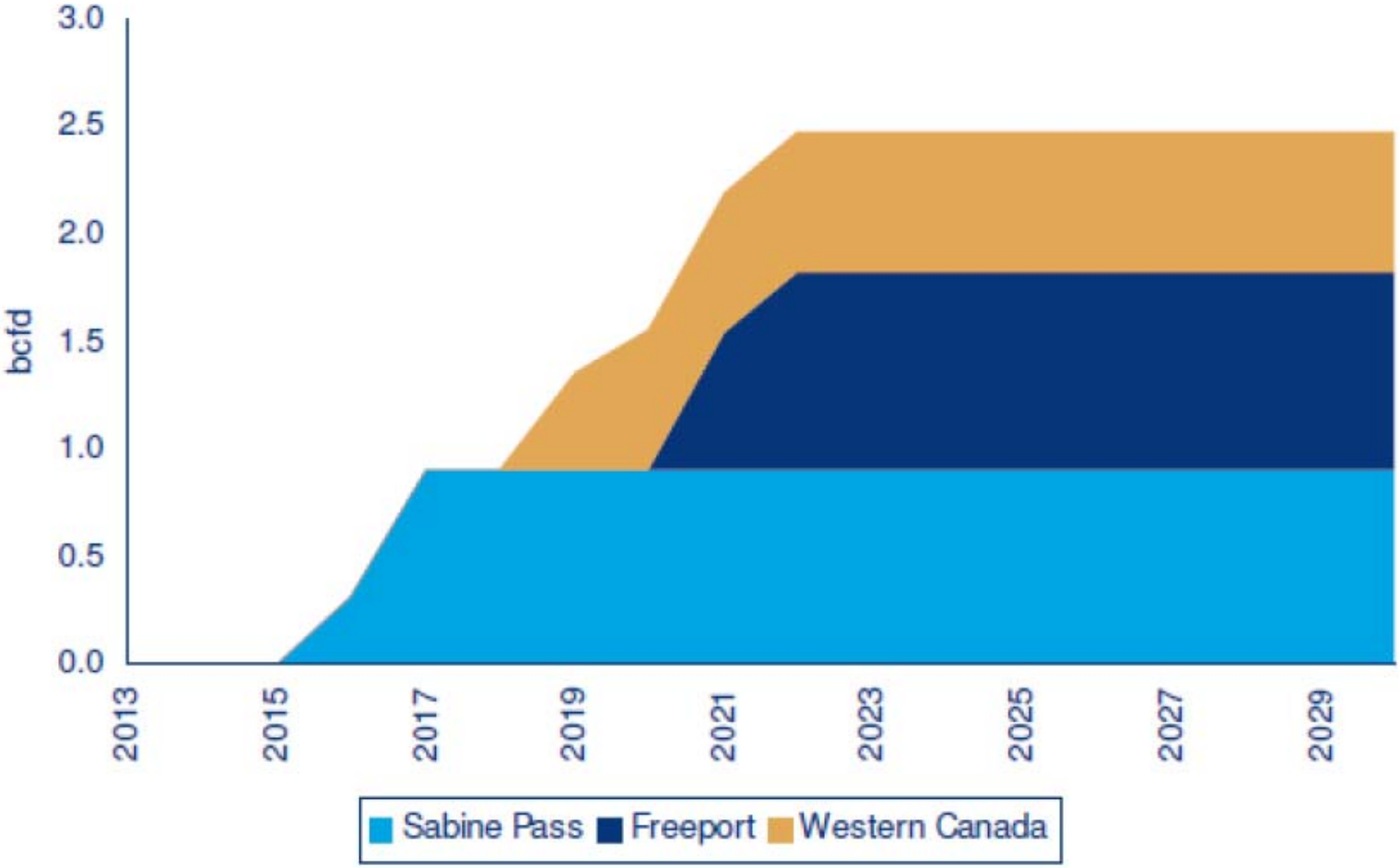


Source: Wood Mackenzie

Source: Wood Mackenzie

Source: DTE Energy Shale Gas Update Michigan Energy Providers Conference Mackinaw Island July 27-29, 2011

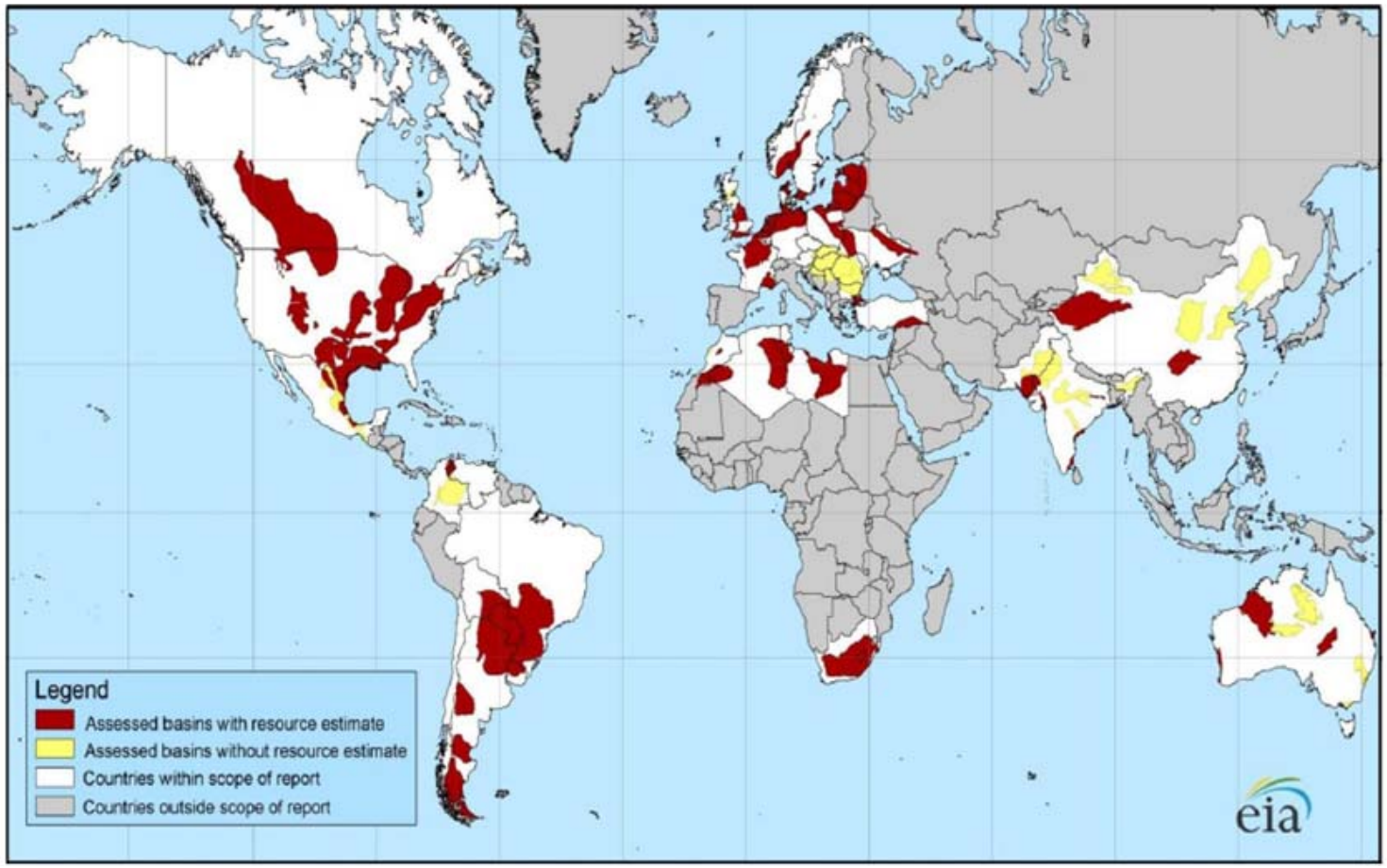
Abundant Supply of Shale Gas in North America Drives Economic Advantage to Export LNG



Sources: Wood Mackenzie (Global Gas Model, North America Gas Service)

Source: DTE Energy Shale Gas Update Michigan Energy Providers Conference Mackinaw Island July 27-29, 2011

Worldwide Potential Shale Gas Reserves of 6,622 Tcf Will Raise the Global Resource Base by More Than 40%



(Tcf)

China – 1,275
USA – 862
Argentina – 774
Mexico – 681
S. Africa – 485
Australia – 396
Canada – 388
Libya – 290
Algeria – 231
Brazil – 226
Poland – 187
France - 180

Source: DTE Energy Shale Gas Update Michigan Energy Providers Conference Mackinaw Island July 27-29, 2011