The INGAA Foundation, Inc.

ICF INTERNATIONAL

North American Midstream Infrastructure Through 2035 – A Secure Energy Future

Press Briefing

June 28, 2011

The INGAA Foundation, Inc.

Disclaimer

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Study Objectives

- This study was initiated to investigate more fully the impacts of recent trends in natural gas supply (particularly robust shale gas development) and consumption on future infrastructure requirements.
- The objective is to estimate future U.S. and Canada midstream infrastructure requirements for natural gas, oil, and natural gas liquids through 2035.
  - Study is based on a detailed supply/demand outlook for North American energy markets
  - For purposes of this analysis, “midstream” includes gathering, processing, pipeline transportation and storage, and LNG import and export facilities.
  - Bracketing results around a reference case are considered.
  - Updates INGAA Foundation 2009 infrastructure study.
  - NGL and oil infrastructure associated with natural gas development needed consideration.

Scope of Work

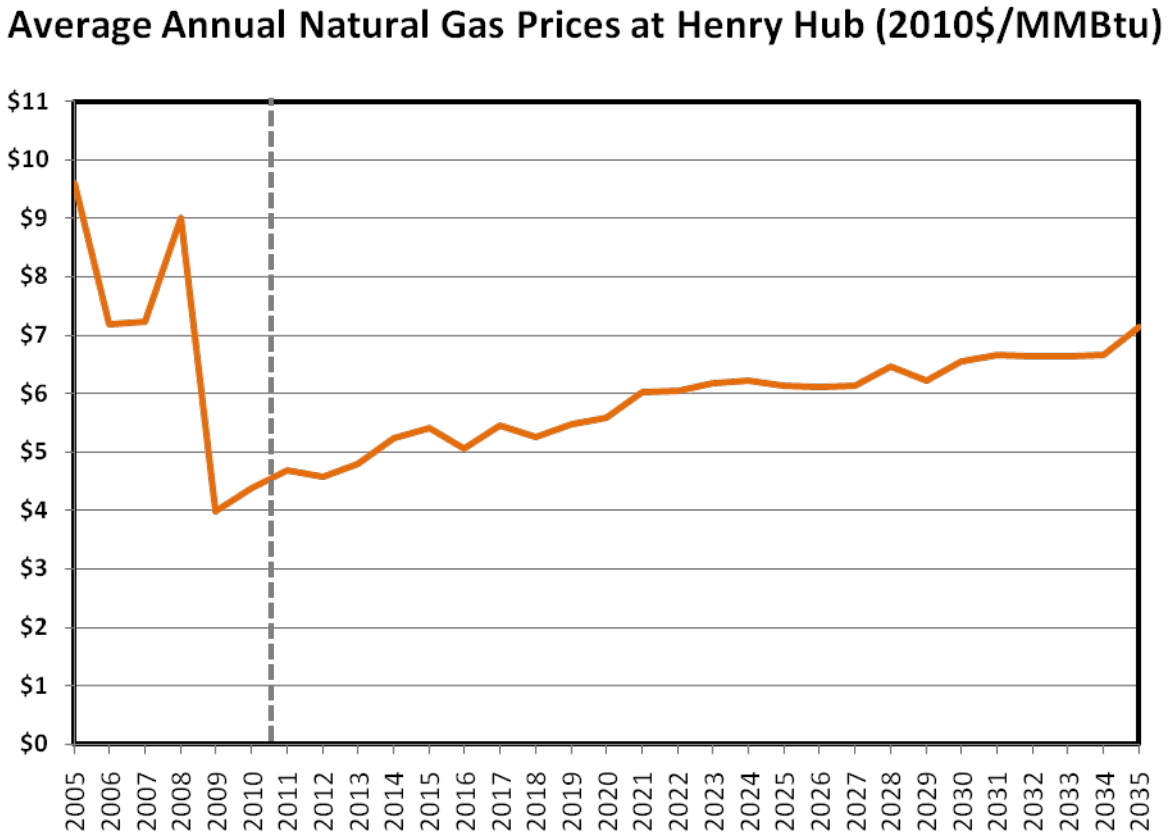
- This study provides natural gas and liquids infrastructure requirements
  - Regional supply/demand projections considering most current trends in gas markets
  - Well completion and production information for major natural gas supply areas
  - Capital requirements for new gas power plants and associated pipeline connection requirements by region
  - Gas-fired generation, gas use, and estimates for number of gas power plants and associated pipeline connection requirements by region
  - Reviews Underground Natural Gas Storage Requirements and Associated Pipeline Connection Requirements by Region
  - Bracketing case impacts on natural gas infrastructure needs
  - NGL and oil infrastructure pipeline and processing requirements using production and well information by major supply area

Reference Case Overview

- The starting point for this study is the ICF April 2011 Reference Case:
  - U.S. economic growth continues at a rate consistent with the average observed during the past 20 years.
    - U.S. electric load grows, but slower than in past.
  - Significant growth in gas use occurs, particularly in the power sector where incremental gas-fired generation is required to satisfy electric load growth.
  - Some other gas uses also increase. For example, in Canada incremental gas is needed for oil sands development and for coal-to-gas plant conversions.
  - Continued robust growth in shale gas development makes it possible to satisfy growing market needs.

Projected Natural Gas Price in Reference Case

- The Reference Case projects real gas prices that rise from $4 to between $6 and $7 per MMBtu.
- This price level is sufficiently high to encourage significant gas supply development, but not so high as to limit market growth significantly.
- The gas price is not low enough to motivate significant gas for coal substitution in the power sector beyond what is motivated by environmental policies assumed in the projection.



Reference Case Assumptions

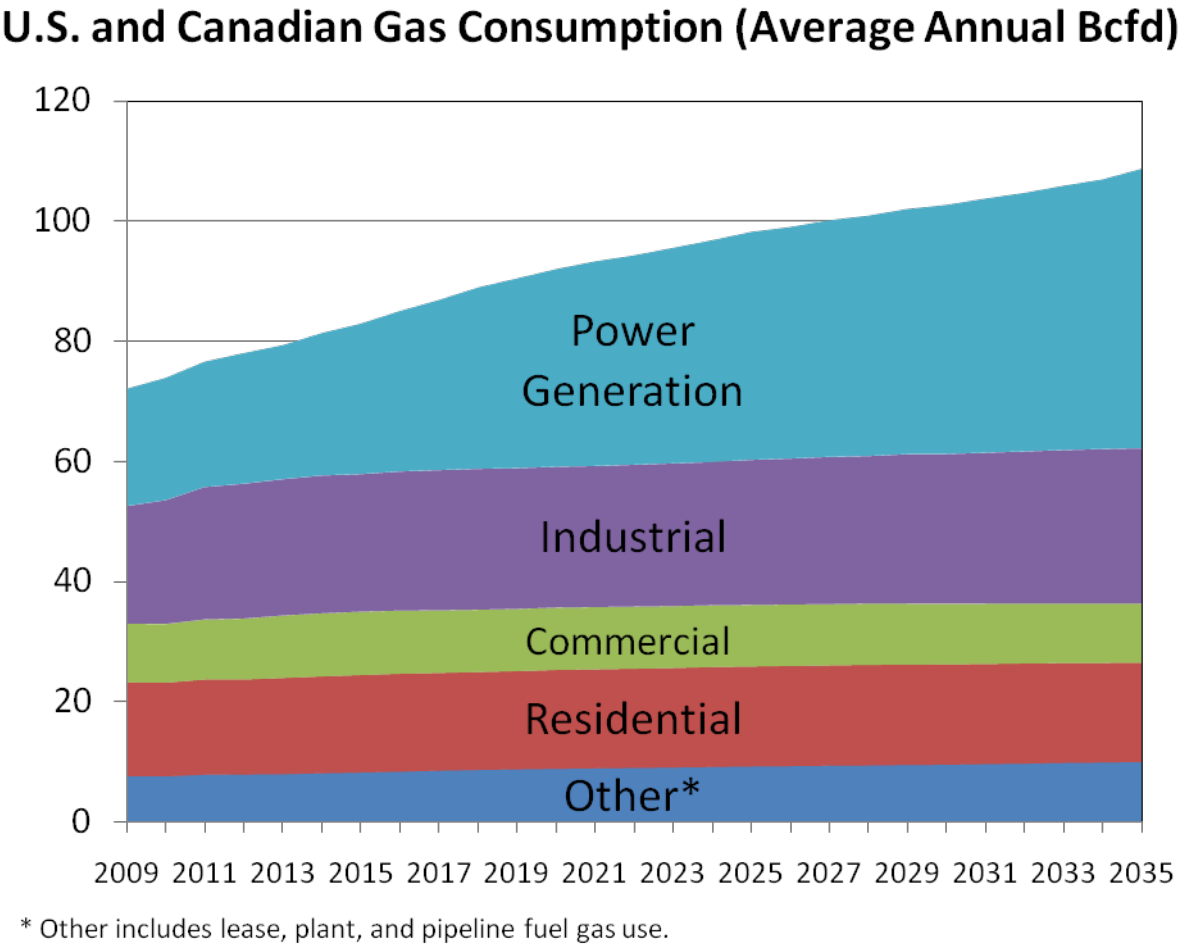
- U.S. economy grows at 2.8% per year.
- Oil prices average about $80 per barrel in real terms.
- Demographic trends consistent with past 20 years. U.S. population growth averages about 1% per year.
- Electric load growth averages 1.3% per year.
- ICF's Base Case reflects one plausible outcome of EPA's proposals for major rules – these include the Clean Air Transport Rule (for SO_2 and NO_x), air toxics (including mercury), water intake structures and coal combustion residuals (CCR, or ash). It also includes a CO_2 price beginning in 2018, reflecting the current lack of consensus in Congress and the time it may take to implement direct regulation of CO_2 The base case generally leads to retirement and replacement of some coal generating capacity with gas generating capacity.
- Power plant mix: renewables up to meet state RPS's, coal generation down, and other forms of non-gas generation slightly down. Gas generation grows to fill the gap between electric load and the total generation from other technologies.
- DSM, conservation and efficiency trends continue, consistent with recent history.
- CNG vehicles assumed to be limited to fleet growth.

Reference Case Assumptions (continued)

- Weather assumed consistent with past 30 year averages.
- Current U.S. and Canada gas production from over 300 trillion cubic feet of proven gas reserves.
- Gas supply development is permitted to continue at recently observed activity levels – no significant restrictions on permitting and fracturing beyond current restrictions.
- No significant hurricane disruptions to natural gas supply (20-year average).
- No Arctic projects (specifically no Alaska and Mackenzie Valley gas pipelines).
- Net LNG exports occur only at Kitimat (no net LNG exports from elsewhere in U.S. and Canada).
- ***Near-term midstream infrastructure development assumed per project announcements. Unplanned projects included when market signals need of capacity, and assumed there will be no significant delays in permitting and construction.***

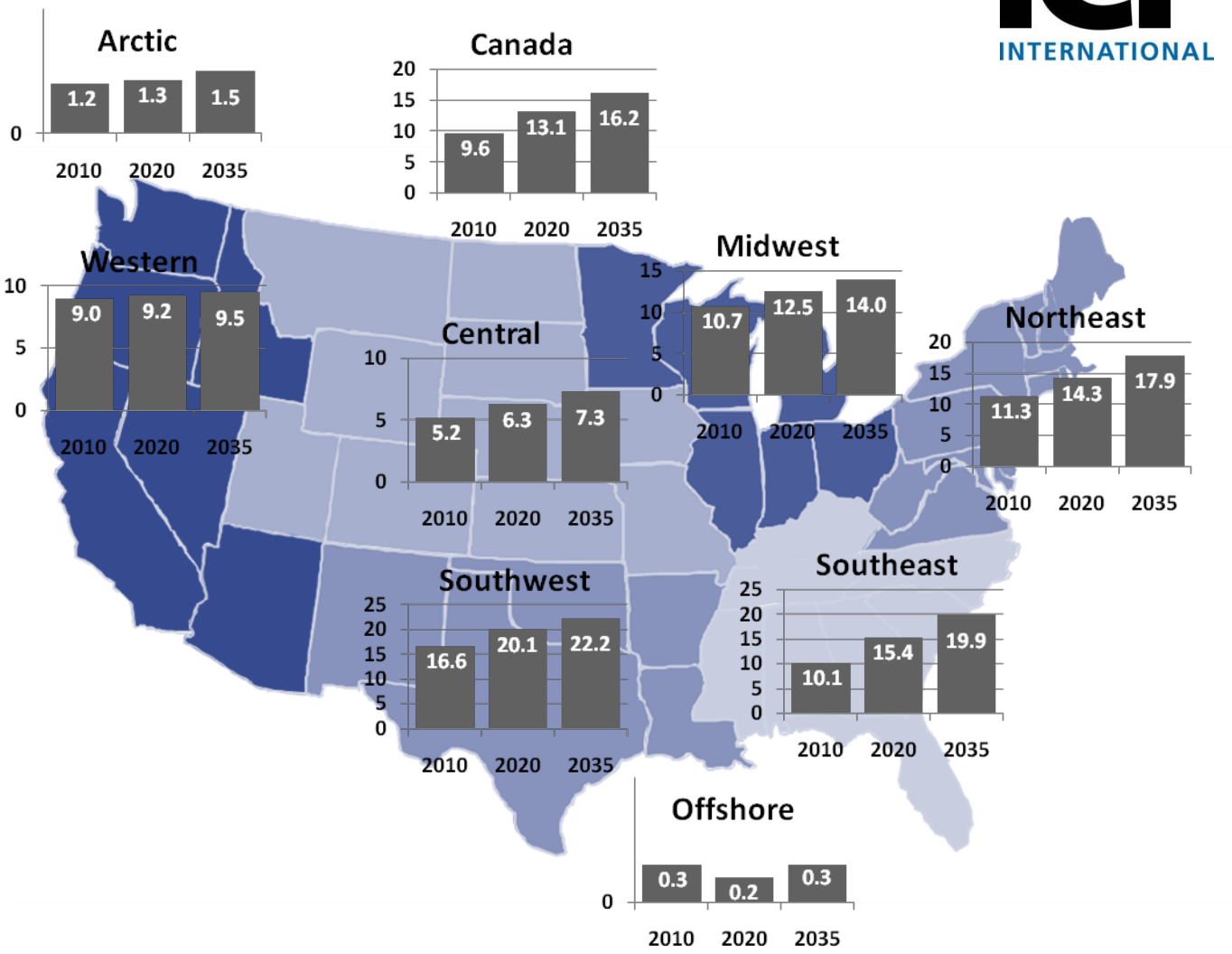
Natural Gas Consumption

- Total gas consumption is projected to increase at a rate of 1.6% per year
  - By 2035, total gas consumption in U.S. and Canada projected to approach an average of 110 Bcf per day.
- About 75% of incremental demand growth is in power sector.
  - Power sector gas consumption projected to more than double by 2035.
- In aggregate, very little demand growth in the other sectors.



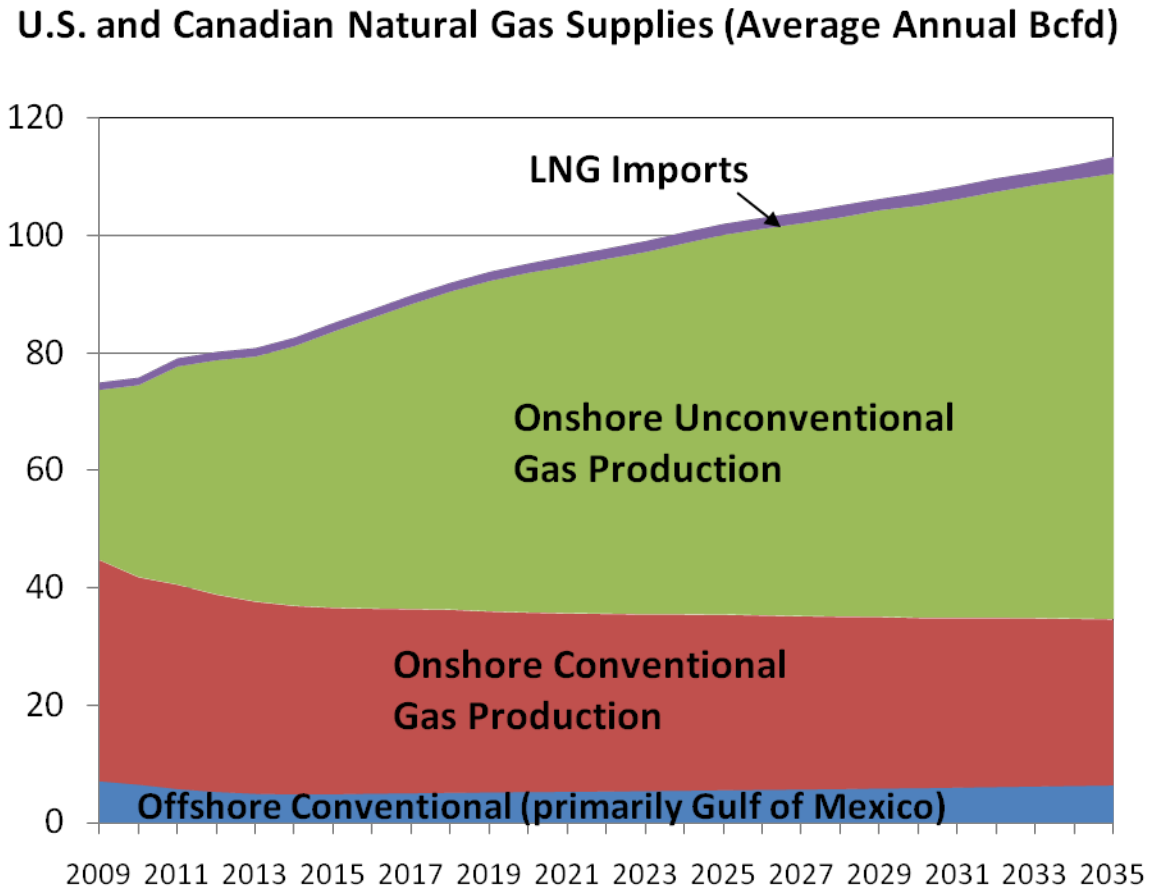
Regional Natural Gas Demand (Bcfd)

- U.S. demand increases are primarily due to power generation growth.
- Canada's gas demand growth includes gas used in extracting oil from oil sands.



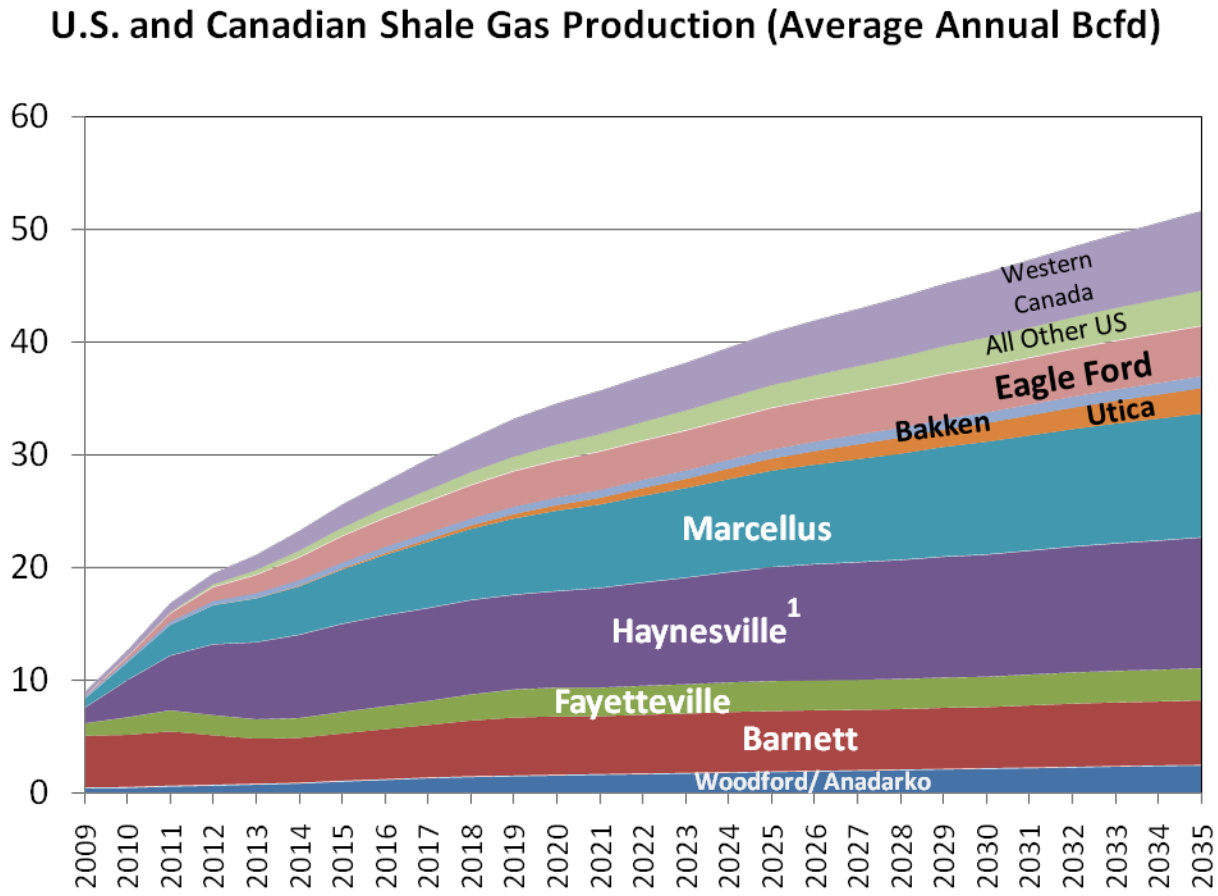
Natural Gas Supply

- Onshore conventional and offshore gas production continues to decline, while unconventional production grows robustly.
- Unconventional production comprises two-thirds of the total supply by 2035.
- Shale gas is >50% of the remaining resource.



Shale Gas Production

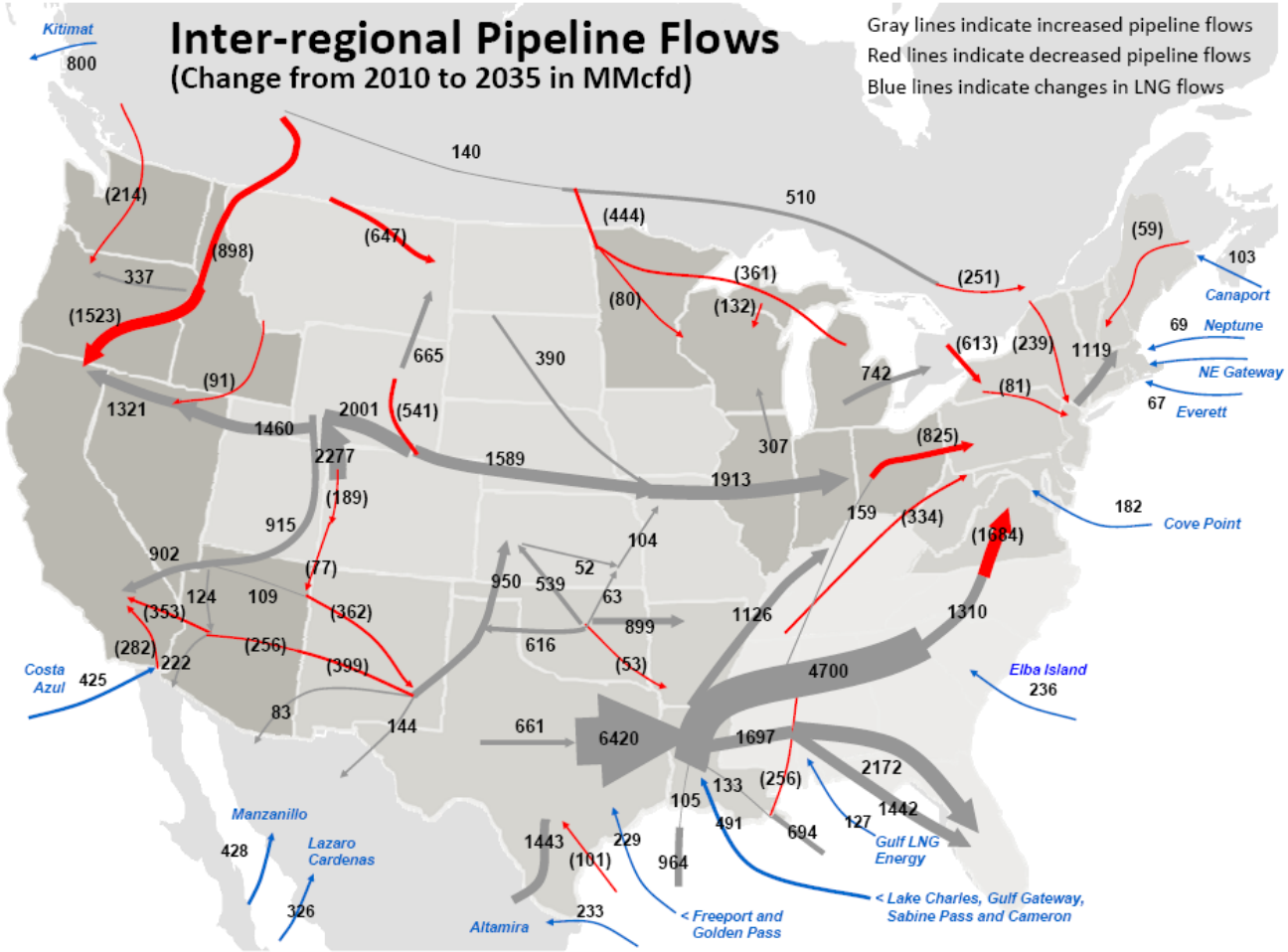
- The shale gas plays are among the fastest growing production areas worldwide.
- Total U.S. and Canada shale gas production is expected to increase from about 13 Bcfd in 2010 to 52 Bcfd by 2035.
- Barnett has been under development for 10 years, while development of Eagle Ford began in 2009.
- The strength of the shale plays was evident during the recession, when development continued despite relatively low natural gas prices.



[1] Haynesville values shown here include production from other shales in the vicinity, e.g., the Bossier Shale.

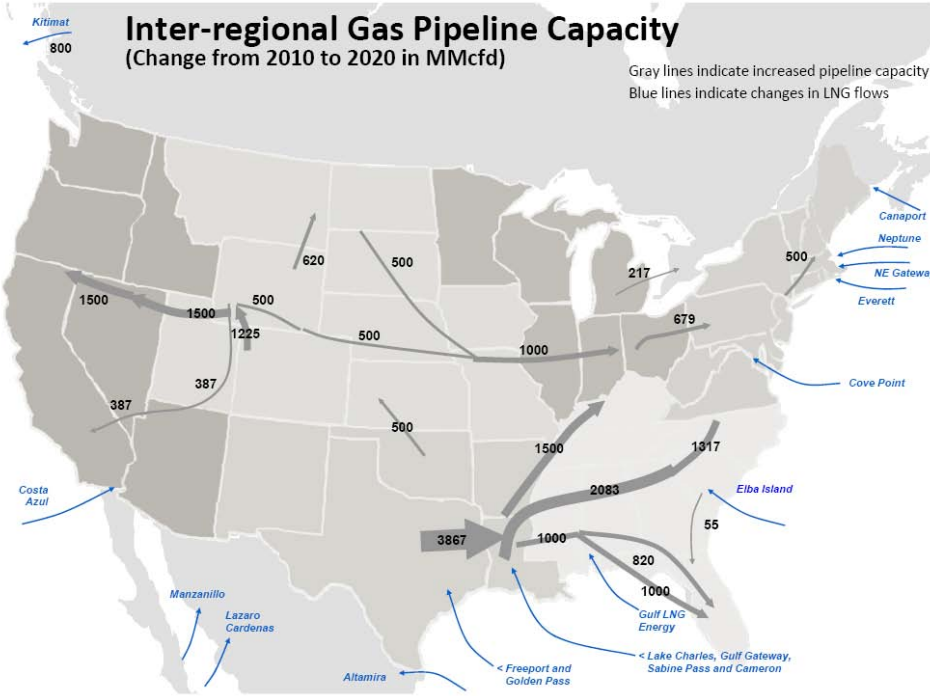
Projected Changes in Gas Flows (2010 – 2035)

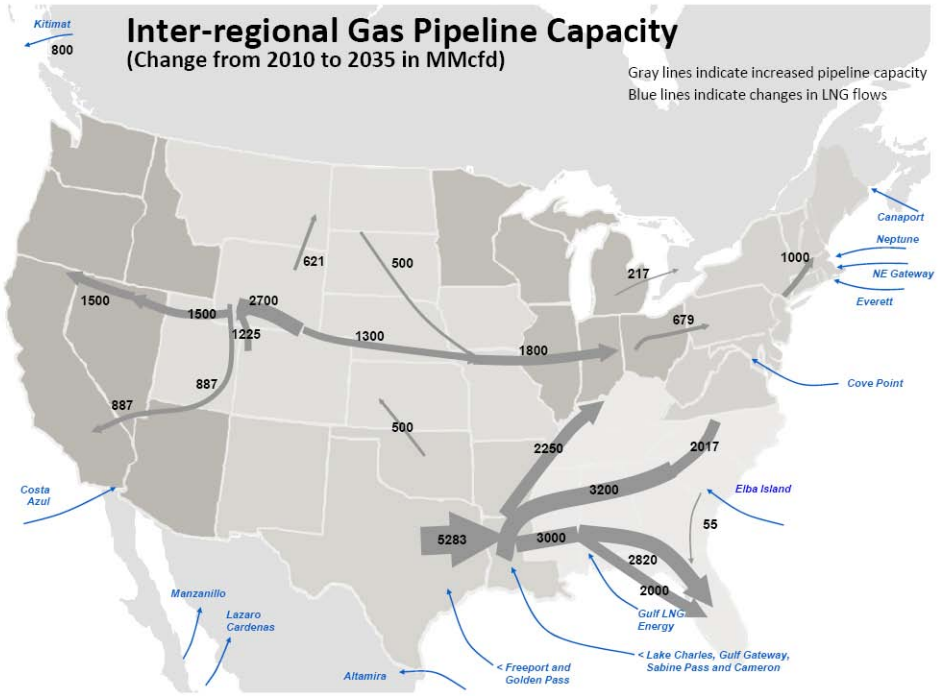
- Substantial increases in flows continue to occur out of the Mid-continent shales and the Rocky Mountain producing basins.
- Marcellus gas production growth continues to displace gas flows into the Northeast U.S.
- Flows from Canada to lower 48 markets recover slightly, but remain down in the longer term.



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

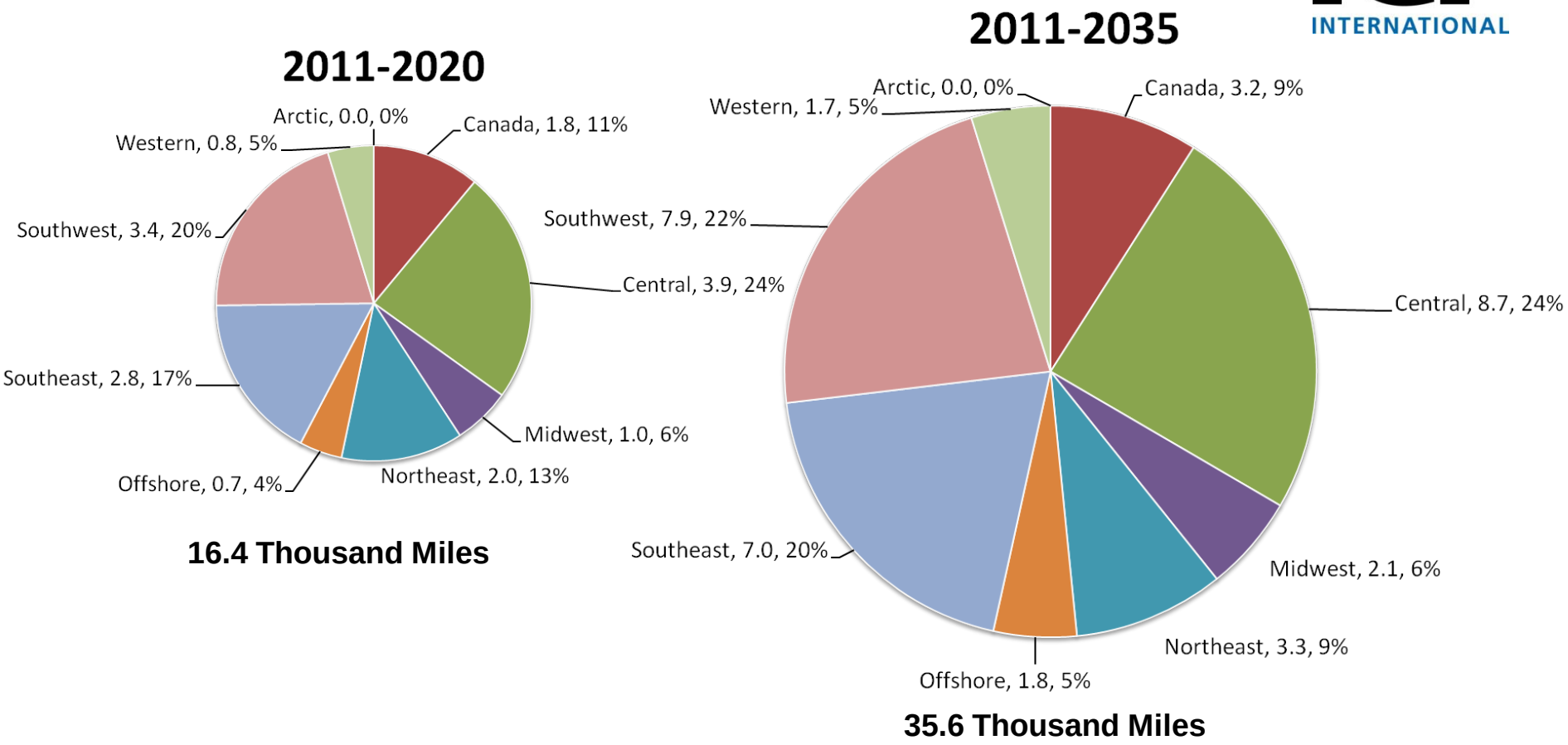
Interregional Gas Pipeline Expansions





- Roughly 29 Bcfd of incremental pipeline capacity is built from 2011 to 2020 and from 2021 to 2035 an additional 14 Bcfd is built. A total of 43 Bcfd of incremental pipeline is needed to accommodate increasing gas supply that is necessary to satisfy market needs over time. Note that these maps do not generally show intra-regional pipeline expansions such as those that occur within the Marcellus shale production area.

Miles of Gas Transmission Mainline (Excluding Laterals) by Region (1000 Miles)



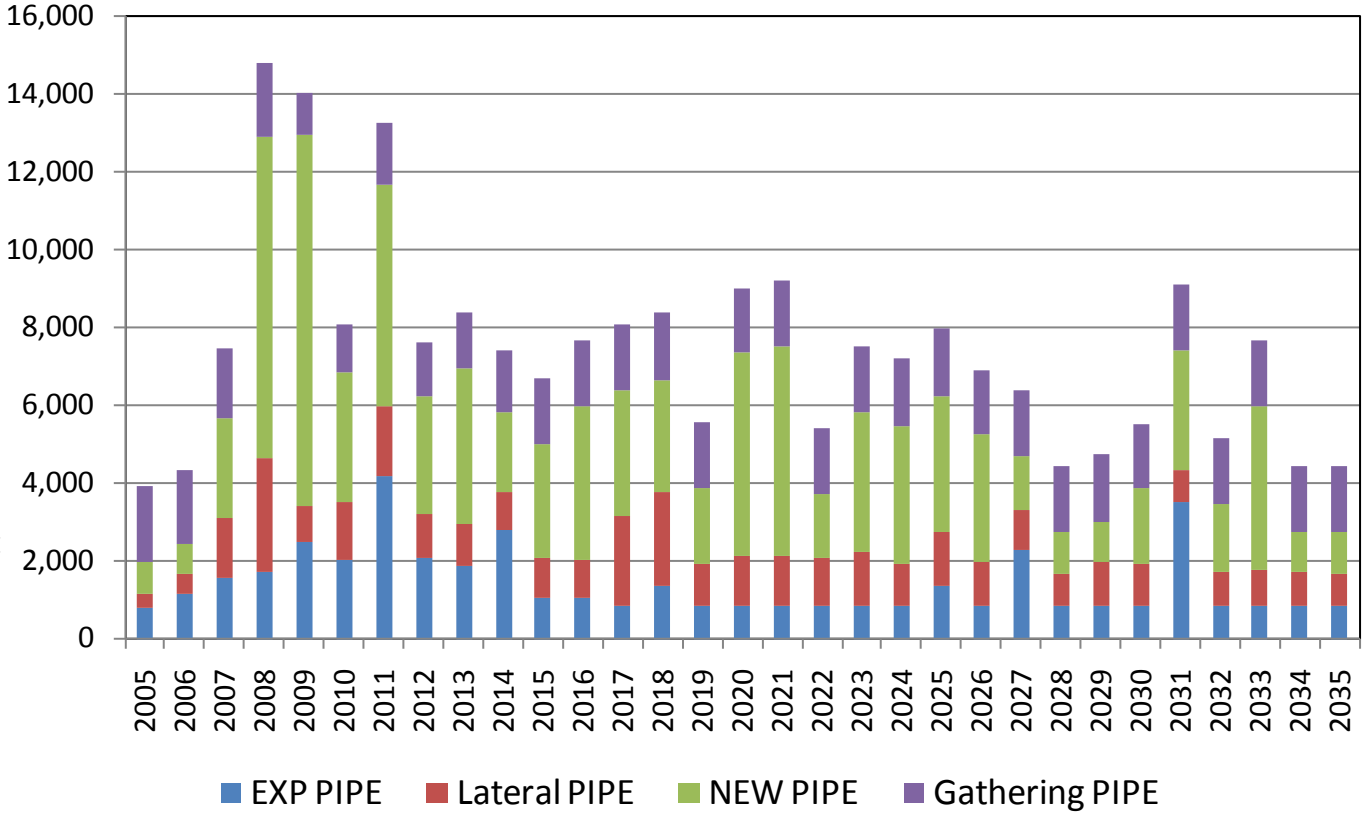
- The Central region (which includes the Rocky Mountains) will have the largest share of new transmission pipe, followed closely by the Southwest and Southeast regions. Much of the new mainline capacity is required to transport growing shale gas production.

Capital Expenditures for New Gas Pipeline

Million dollars (Real 2010$) spent annually, including cost of compression

- Between 2005 and 2010, pipeline expenditures averaged $8.8 Billion per year in real 2010 dollars.
- Annual pipeline expenditures are projected to be between $4 and $13 billion per year between 2011 and 2035.
- Of the $178 billion of projected investment between 2011 and 2035, roughly 50 percent is for new transmission lines.
- Capital expenditures for projected new pipeline infrastructure average about $7 billion per year in real 2010 dollars.
- If upstream gathering lines are excluded, average annual capital expenditures for new pipeline are $5.5 billion per year in real 2010 dollars.

Total Pipeline Expenditures By Year (Million Real 2010$) [1]



1. Pipeline project costs are represented in the year a project enters service. Actually, investments are generally spread over one or more years leading up to a pipeline entering service.

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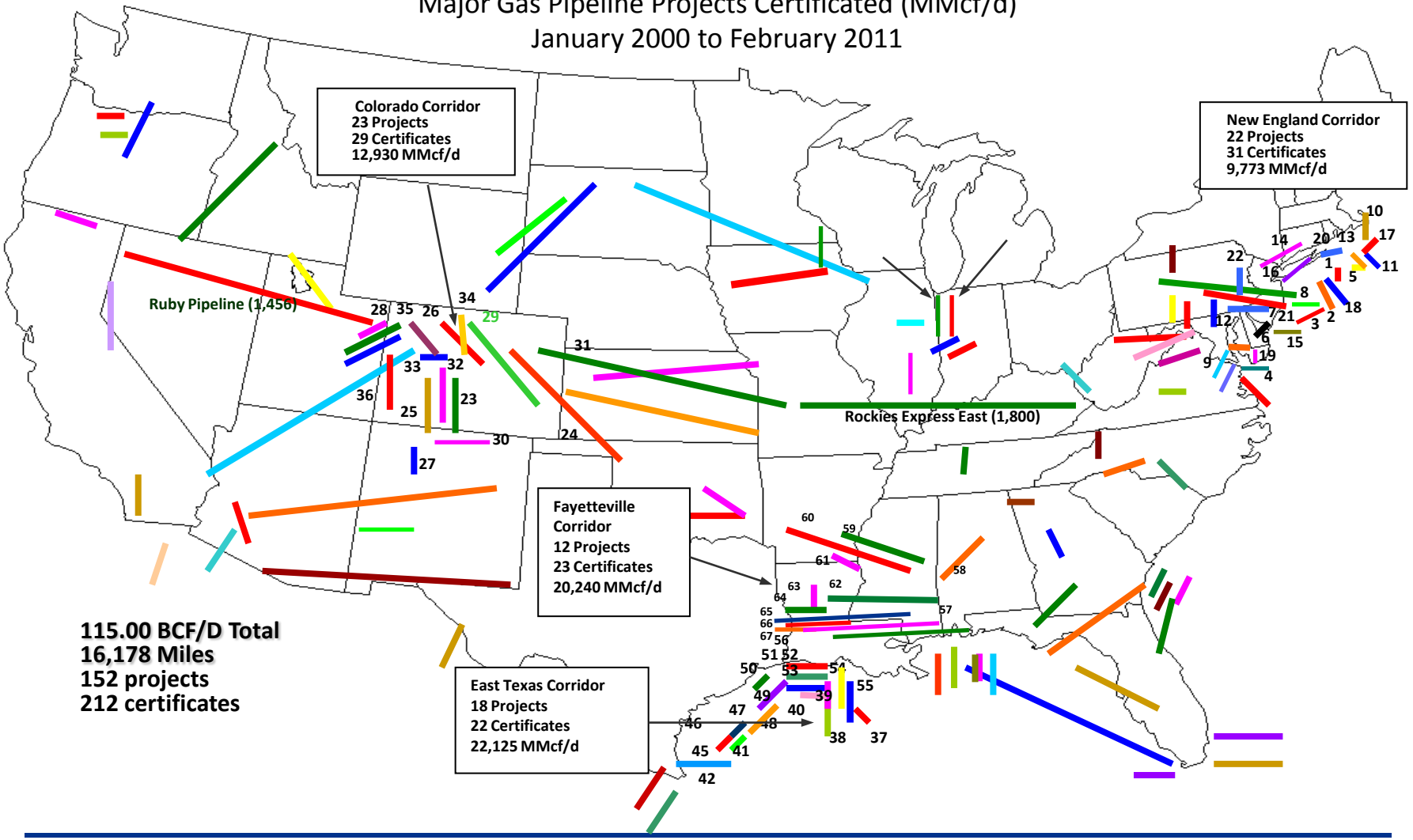
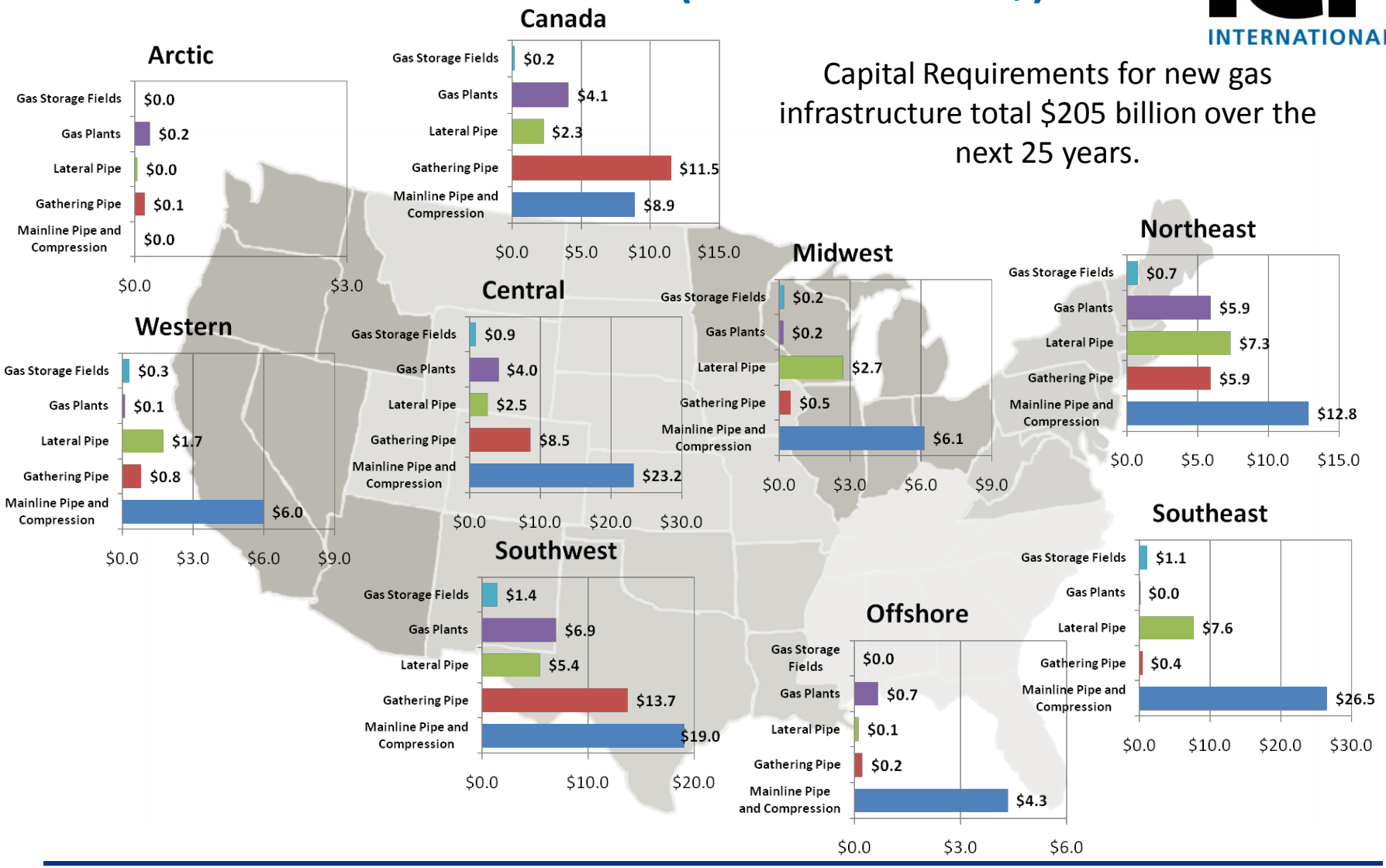
Market Responsive Infrastructure Additions

Major Gas Pipeline Projects Certificated (MMcf/d)
January 2000 to February 2011



Source: FERC, 2010

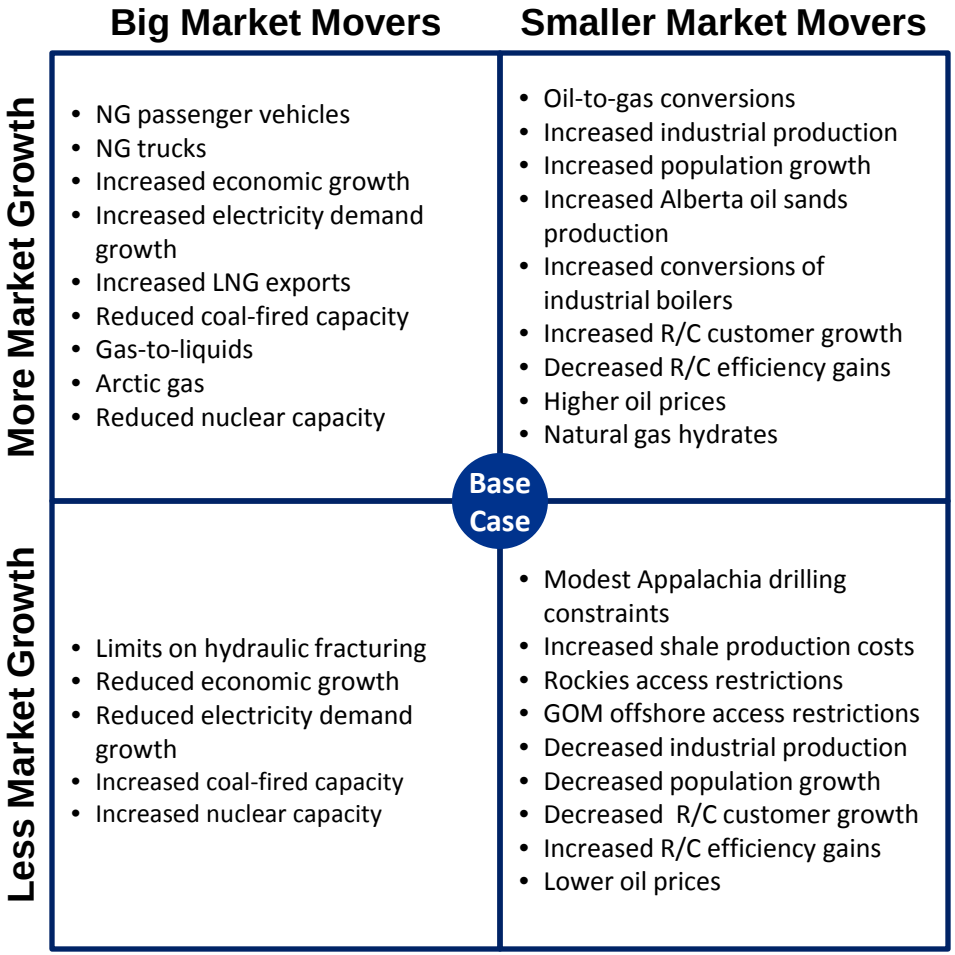
Regional Gas Infrastructure Capital Requirements for 2011 to 2035 (Billions of 2010$)



Capital Requirements for new gas infrastructure total $205 billion over the next 25 years.

Variables that Impact Projected Market Growth

- While the reference case makes reasonable "middle-of-the-road" assumptions for each variable, alternate assumptions could affect the projection for market growth.
- Some variables are potential "Big Market Movers", for which a change in assumption would create significantly more or less incremental market growth.
- Other variables are "Smaller Market Movers", which would have less (but still significant) impacts on incremental growth.



Basis for NGL Infrastructure Analysis

- Refinery production of ethane, propane, and butane is unchanged over time.
- Natural gas plant liquids are produced as a function of natural gas production trends and gas composition. The natural gas-oil price ratio is assumed to remain low enough to make ethane extraction economic for all new gas supplies.
- Demand for propane and butane grows by 1 percent per year in US and Canada. Any excess propane and butane is exported. Since exports occur mostly from the Gulf Coast, pipeline infrastructure needs would be the same as if Gulf Coast refineries/petrochemical demand increased to consume propane/butane supplies (and exports are zero).
- All incremental ethane production is used for ethylene cracking. Regional demand patterns remain same as in 2010. An alternative premise would assume that ethylene crackers are built in or near the Appalachian Basin (and less NGL pipeline would be needed).
- All pentanes+ increases are used in US and Canadian refineries.
- Seasonal variability is not considered in the flows. To extent that US East supplies own propane/butane, local underground LPG storage may be needed. Otherwise Midcon/Gulf storage may be utilized (with increased pipeline flows back and forth).

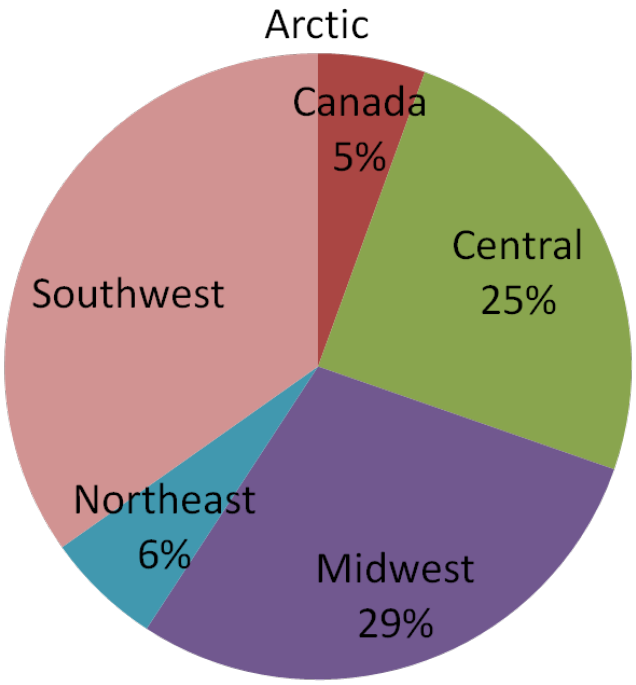
Basis for Crude Oil Infrastructure Analysis

- Demand for crude oil at US refineries would follow slowly declining trajectory in EIA's AEO. Canadian crude runs would stay constant at 2010 levels.
- Runs within each PADD or Canadian province would not change dramatically from 2010 levels. Therefore, regional products trade would not shift. This premise avoids having to build new or expand existing refinery capacity. Refinery upgrades due to changing crude slates still may be needed.
- Another premise is that North America would use its own crude first, so all increases in North American crude oil production will back out imports.
- These assumptions mean that due to decline in AK crude production, West Coast refineries need to get more crude supplies from Canada or the Rockies. The case results presented here assume that crude comes from WCSB via pipeline to western British Columbia and ships to California from there.
- Alternative configurations are possible in which California imports more oil and WCSB oil is exported. This would likely reduce infrastructure changes.
- Transport of oil from wellhead to pipeline/rail terminals is assumed to be predominantly by truck, so there is no estimate for capital cost of new oil gathering line.

Regional NGL Pipeline Expenditures

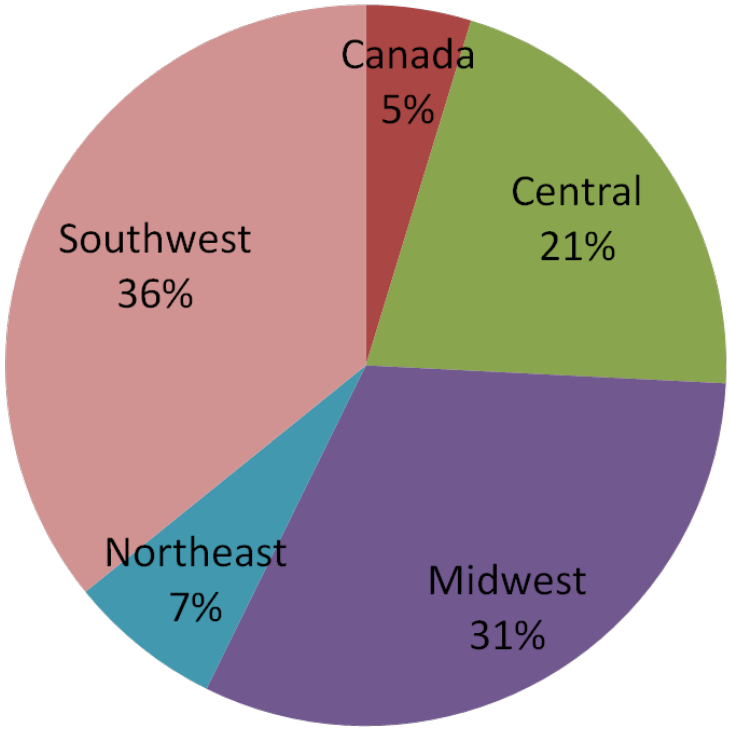
Total Expenditures, 2011-20 (Billions of 2010$):

$12.3



NGL Pipeline Expenditures, 2011-35 (Billions of 2010$):

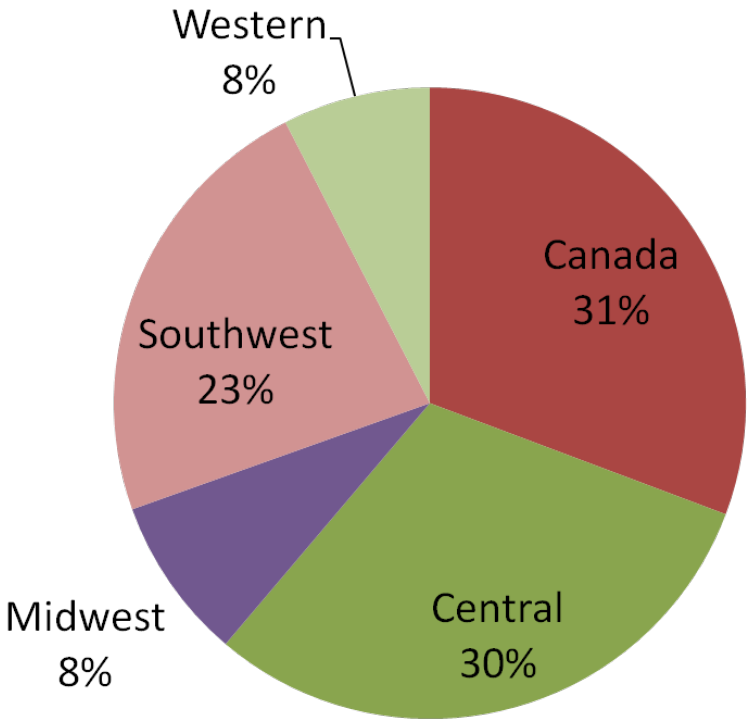
$14.5



Regional Oil Pipeline Expenditures

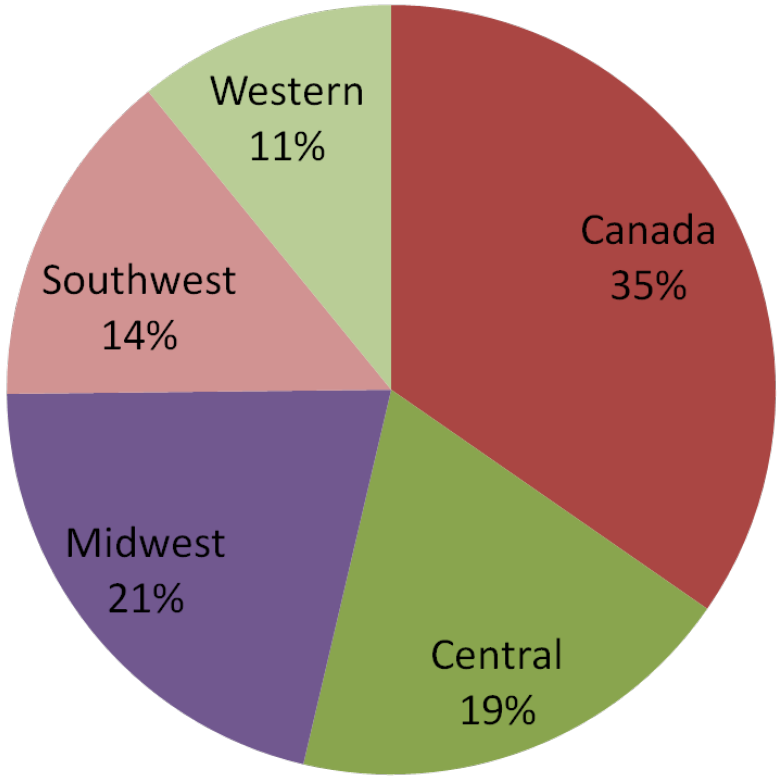
Total Expenditures, 2011-20 (Billions of 2010$):

$19.6



Oil Pipeline Expenditures, 2011-35 (Billions of 2010$):

$31.4



Summary and Conclusions

Conclusions

- The ICF Reference Case projects significant gas market growth, particularly in the power sector where gas use doubles over the next 25 years.
- Significant infrastructure will be needed to support growing long run demand in many regions, including the Southeast, Northeast, Southwest and Canada.
- The case also projects significant supply development and growth in gas production, primarily from shale resources. Producers are also likely to develop shale plays with large quantities of oil and natural gas liquids, which need new pipeline infrastructure in addition to what is required for natural gas.
- Key to this projection are gas prices that rise from $4 per MMBtu in real terms to between $6 and $7 per MMBtu in the longer-term. This gas price level is sufficiently high to foster the development of incremental gas supplies while not so high as to limit market growth significantly.
- The ICF Reference Case represents a “middle of the road” case; a variety of variables could result in more or less gas market growth.

Summary of Incremental Gas Infrastructure Added in the Reference Case (cumulative)

Summary of Incremental Gas Infrastructure Added in the Reference Case (cumulative)	2011 to 2020	2011 to 2035	Average Annual
Inter-regional Pipeline Capacity (Bcfd)	29	43	1.7
Miles of Transmission Mainline (1000s)	16.4	35.6	1.4
Miles of Laterals to/from Power Plants, Storage Fields and Processing Plants (1000s)	6.6	13.9	0.6
Miles of Gathering Line (1000s)	165	414	16.5
Inch-Miles of Transmission Mainline (1000s)	491	1,043	42
Inch-Miles of Laterals to/from Power Plants, Storage Fields and Processing Plants (1000s)	142	304	12
Inch-Miles of Gathering Line (1000s)	592	1,518	61
Compression for Pipelines (1000 HP)	3,039	4,946	197
Gas Storage (Bcf Working Gas)	NA	589	24
Processing Capacity (Bcfd)	18.1	32.5	1.3

Natural Gas Infrastructure Capital Requirements (Billions of 2010$)

Natural Gas Infrastructure Capital Requirements (Billions of 2010$)	2011 to 2020	2011 to 2035	Average Annual Expenditures
Gas Transmission Mainline	$46.2	$97.7	$3.9
Laterals to/from Power Plants, Gas Storage and Processing Plants	$14.0	$29.8	$1.2
Gathering Line	$16.3	$41.7	$1.7
Gas Pipeline Compression	$5.6	$9.1	$0.3
Gas Storage Fields	$3.6	$4.8	$0.2
Gas Processing Capacity	$12.4	$22.1	$0.9
Total Gas Capital Requirements	$98.1	$205.2	$8.2

- Recent historical trends have matched or surpassed the average annual expenditures shown here.

NGL and Oil Infrastructure & Capital Requirements

NGL Pipeline Infrastructure	2011-20	2011-35	Average Annual
Miles of Transmission Mainline (1000s)	10.6	12.5	0.5
Cost of Transmission Mainline (Billions 2010$)	$12.3	$14.5	$0.6
Oil Pipeline Infrastructure	**2011-20**	**2011-35**	**Average Annual**
Miles of Transmission Mainline (1000s)	13.0	19.3	0.8
Cost of Transmission Mainline (Billions 2010$)	$19.6	$31.4	$1.3
NGL and Oil Pipeline Infrastructure	**2011-20**	**2010-35**	**Average Annual**
Miles of Transmission Mainline (1000s)	23.6	31.8	1.3
Cost of Transmission Mainline (Billions 2010$)	$31.9	$45.9	$1.8

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Key Messages

- **Natural gas market – Dynamic and changing rapidly**
- **Pipeline infrastructure – Essential for natural gas to achieve its potential**
- **Natural gas pipeline industry – Proven track record**
- **Robust pipeline infrastructure – Supports competitive natural gas market**