

# Natural Gas/Power Interconnection and Coordination Landscape

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# ROADMAP

- Part I – Background and Landscape
  - Domestic natural gas production
  - Power's increased reliance on natural gas
  - Regional supply and flow shifts
- Part II – Challenges
  - Infrastructure Distinctions
  - Flow changes from regulatory perspective
- Part III- Interdependency Issues and Efforts
- Part IV- Conclusions and Recommendations

# Overview

- Development in markets and technology
- Infrastructure issues
- Operational Considerations
- Contracts and Fuel Planning Issues
- Communications for scheduling & dispatch
- Market challenges and regional issues

# Historical Event – Hydraulic Fracturing and Horizontal Drilling

- Hydraulic Fracturing and Horizontal Drilling
  - Paradigm shift of domestic natural gas supply
- Regional gas supply resulting in shifting of gas flows
- Lower and more stable pricing leads to migration of power generation fleets to natural gas
- LNG
  - Increased certificating of LNG Export Facilities
  - Prospect of LNG Exports and potential impact on natural gas prices

# Policy Factors

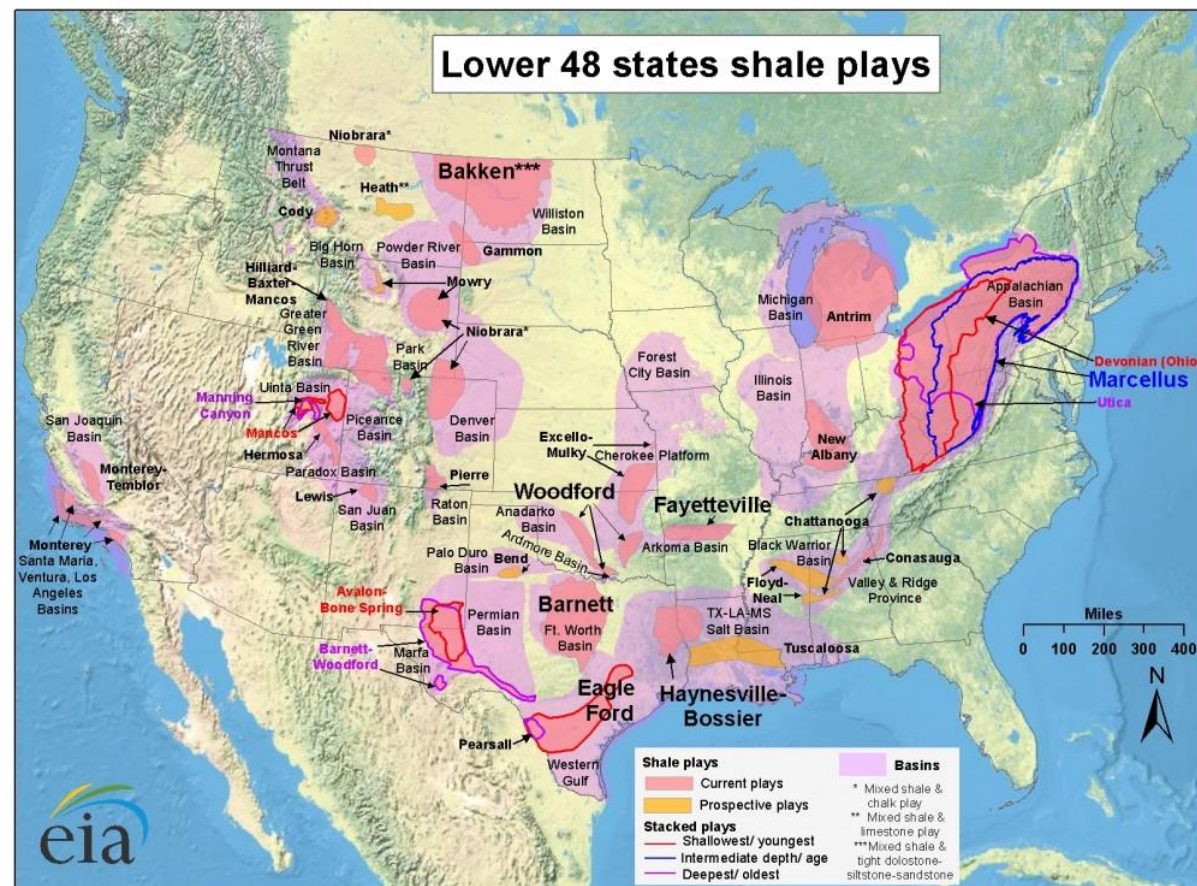
- Natural Gas perceived as cleaner fossil fuel
  - Growing social awareness of air pollution associated with fossil fuel use has contributed to advances in gas and combined cycle turbines.
- The U.S. passage of the Clean Air Act in 1970 demonstrated the first major federal commitment to restrictions on power plant emissions.
  - Further regulation that impacts coal facilities
- The availability of natural gas at competitive prices and repeal of the Fuel Use Act of 1978 has served as a major boost for gas turbine development.
- Regulatory compliance is major driver of shift to natural gas.

# Natural Gas as a Bridge Fuel

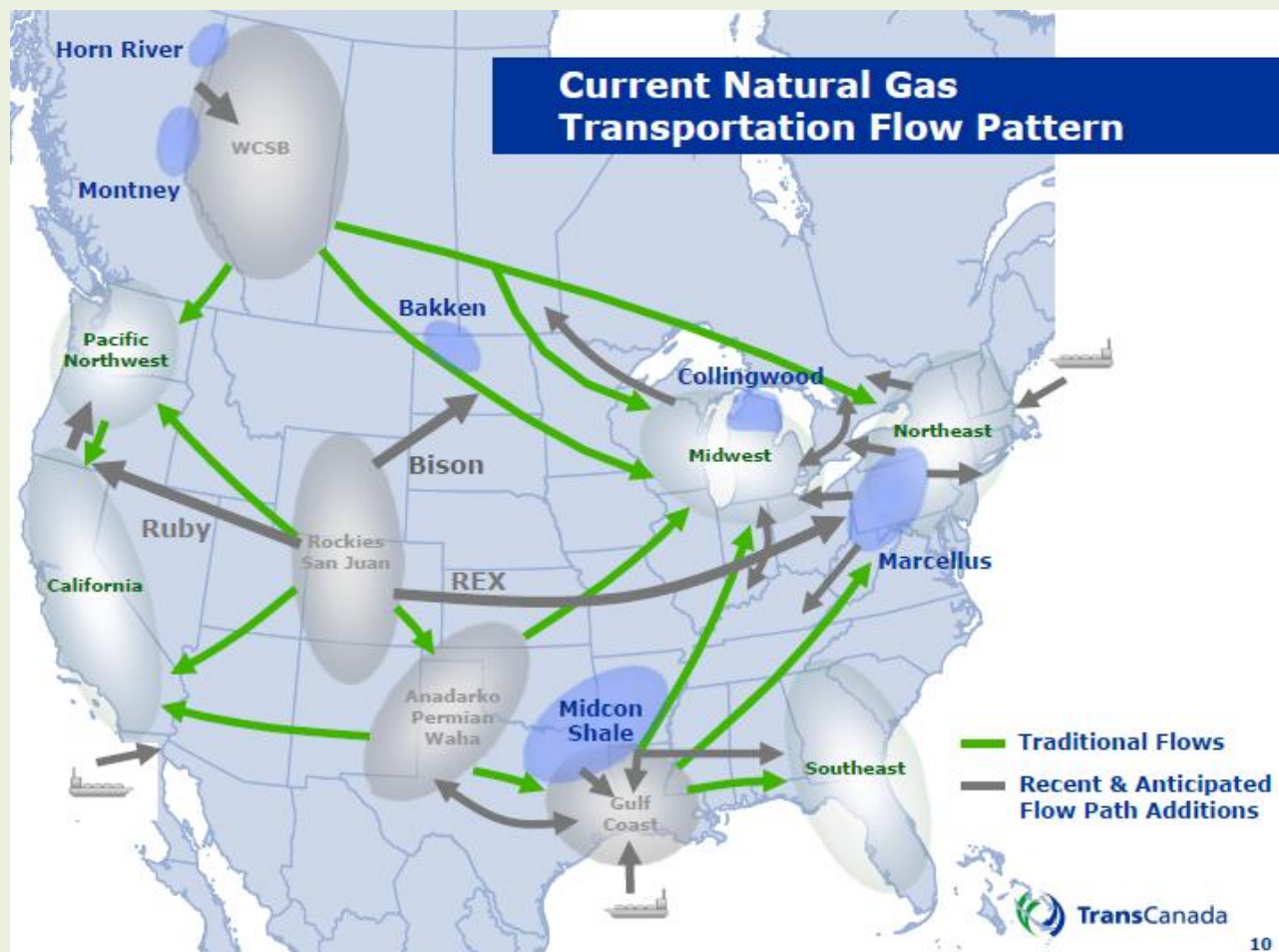
- Current administration views natural gas as bridge fuel to renewables and clean energy technology
- Power generation industry touts retiring of coal plants and replacing with natural gas CC
  - Duke Energy December 11, 2013 press release
  - Public and policy-maker perspectives on coal v. natural gas; nuclear v. natural gas
- Coal use for power generation has and will diminish but coal is not dead
  - Flexibility always will be a significant factor in power production



# Today's Developing "Grid" Flow Patterns – Shale Plays

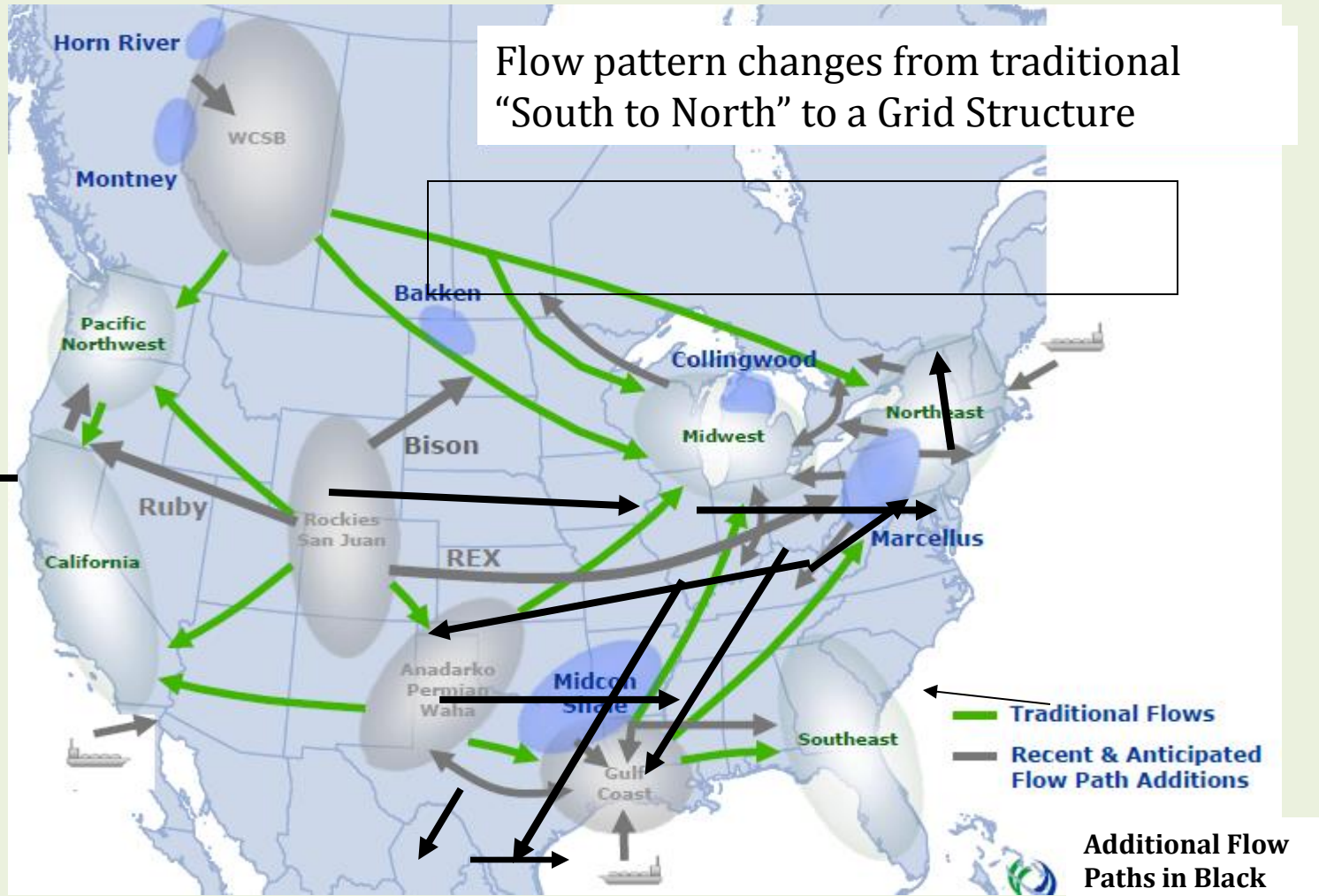


# Today's Developing "Grid" Flow Patterns



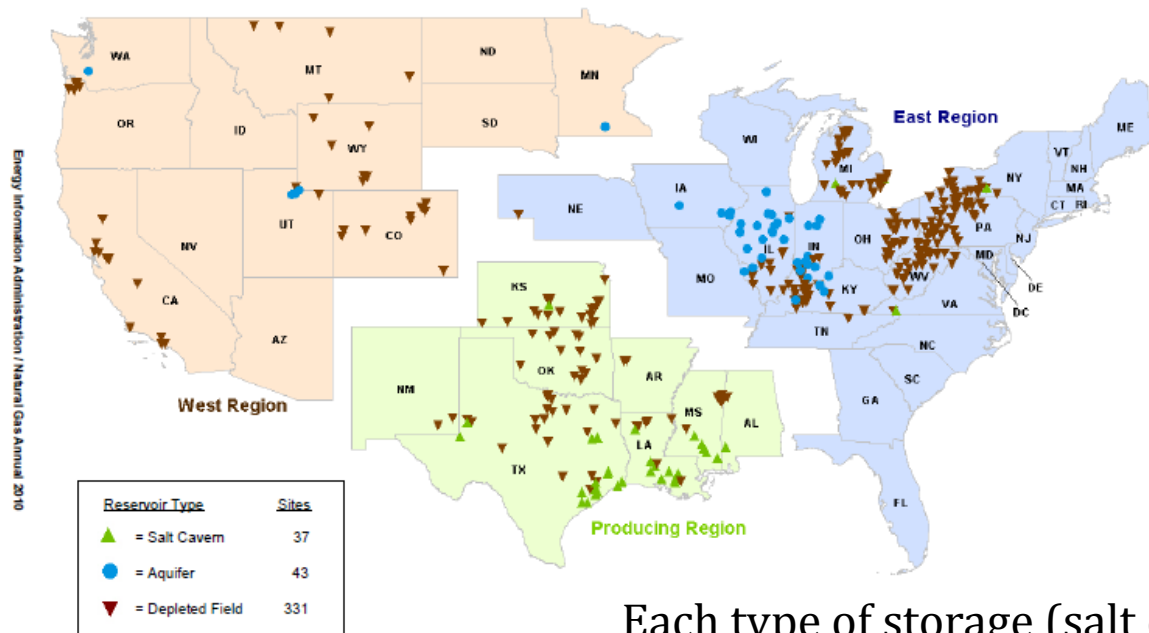


# Today's Developing "Grid" Flow Patterns



# Underground Storage in U.S.

Figure 15. Locations of Existing Natural Gas Underground Storage Fields in the United States, 2010

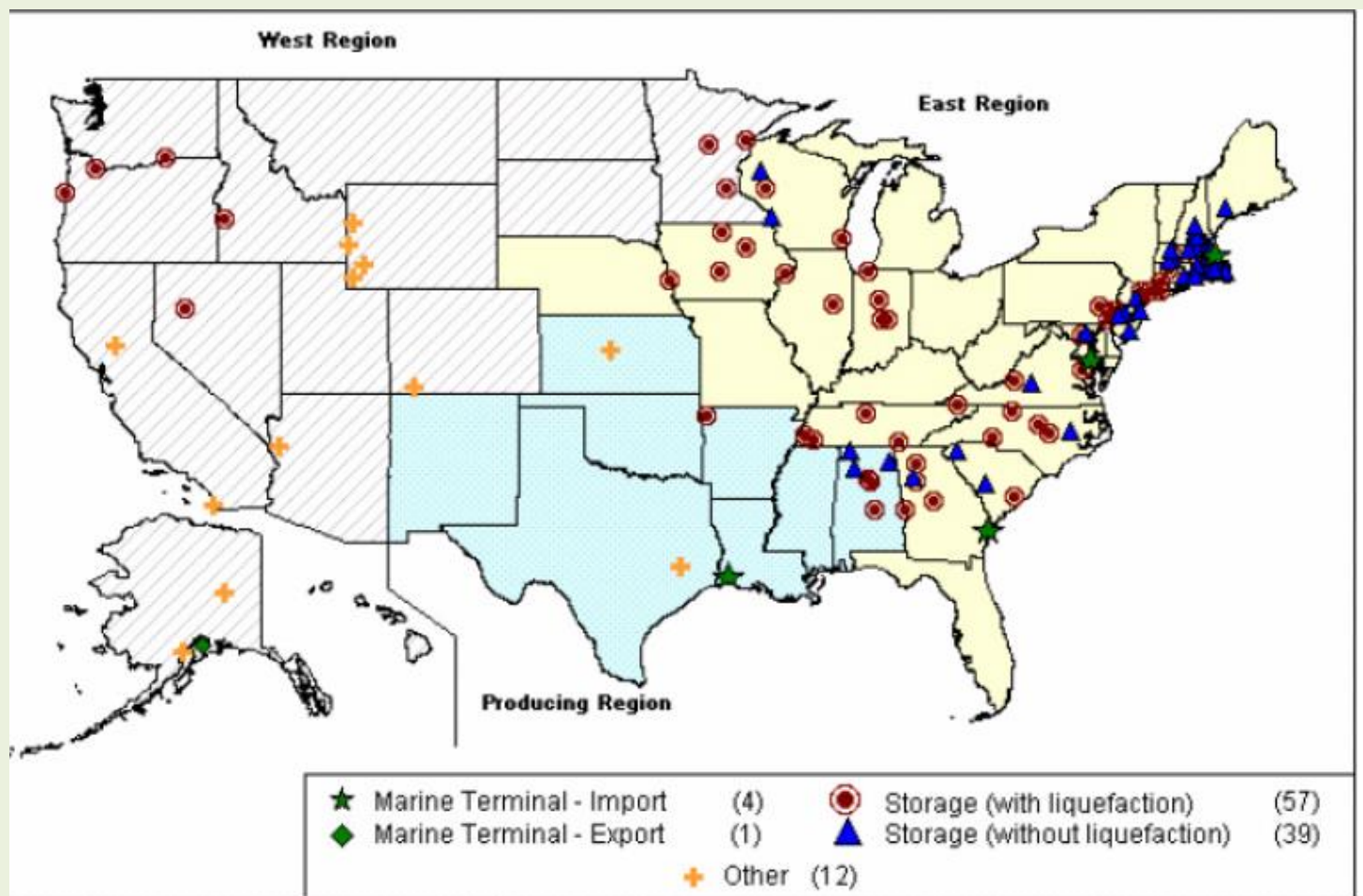


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Source: Energy Information Administration (EIA), Form EIA-191A, "Annual Underground Gas Storage Report."

Each type of storage (salt dome, depleted fields, aquifers, LNG and propane) all have different deliverability and operating characteristics.

# U.S. LNG Facilities



# Increased Reliance of Power Generation on Natural Gas Supply

- Energy Infrastructure Report (2014)
  - Additional Incremental Facilities
- Flow patterns to power generation
- Incremental Facilities
  - Who pays?
- Local Example of new facilities: Duke/Piedmont Line
  - Example of additional facilities being built to accommodate increased reliance of natural gas

# Shift to Natural Gas as Fuel

- Fleet transformations
  - Duke Energy
    - Retirement of three coal-fired plants since 2012
    - New CC plants
    - Will probably maintain 30% coal plants for flexibility
    - Polar event demonstrates potential need for flexibility



# Example: Polar Vortex Event

- January 2014
  - Extreme Cold Conditions – in NC, coldest average temperature since 1988
  - Increased demands for natural gas to serve direct heating requirements and fuel for power-generation
  - Caused spikes in Natural Gas and Power Prices
  - Increase in gas prices led to spike in power prices (except ERCOT – gas prices were stable; power prices spiked)
  - Impact of increased reliance on natural gas

# Example: Recent Polar Vortex Event

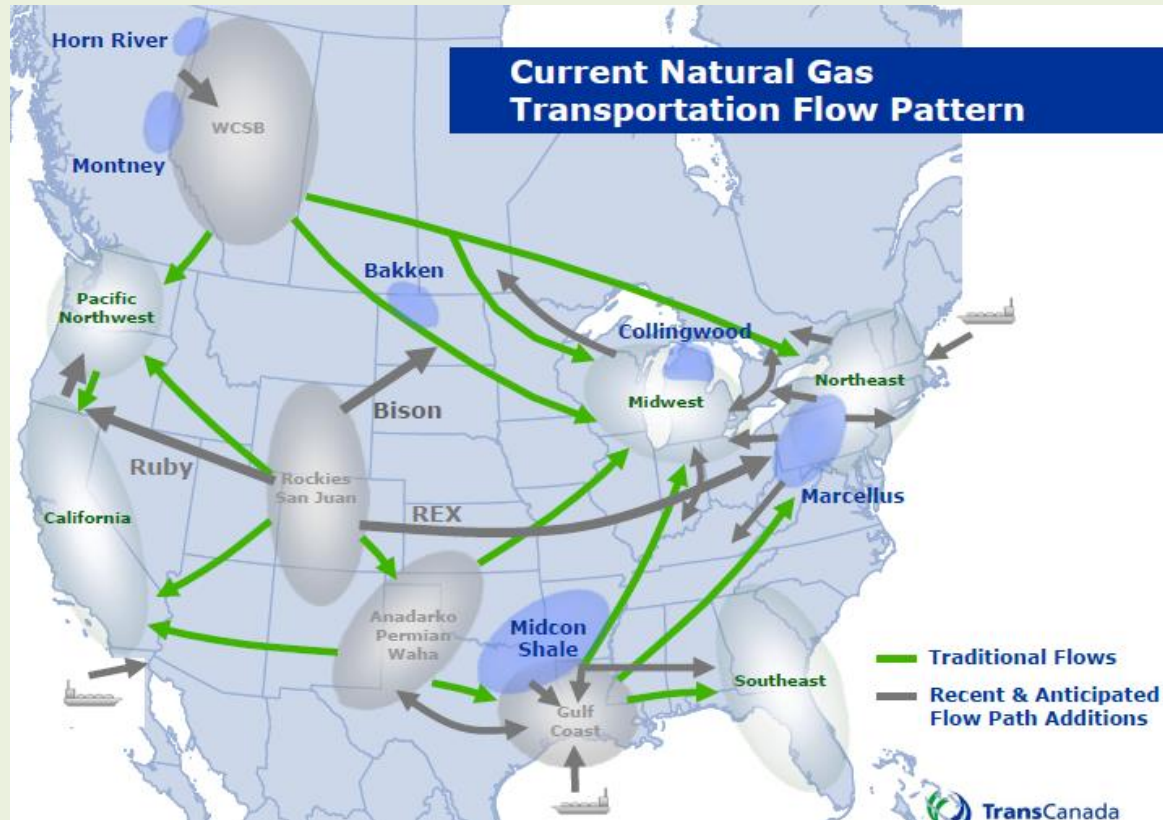
- ISO NE – insufficient gas delivery capacity, results in price spikes
- Pipelines declared Operational Flow Orders (OFOs)
  - Shippers leveraging Operational Balancing Agreements (“OBA’s) to take advantage of seller’s market
- Saw increased prices in Transco Zones 5 and 6
  - Up to \$80 to \$100/MMBtu
- FERC ordered technical conference to explore the impacts on the RTOs and ISOs

# Examples of flow pattern changes in regulatory environment

- Potential Gas Quality Challenges as a result of flow changes and regional supply
  - TETCO – Additional Control Zone requested
  - Hotter gas – (high C2+ gases – ethane, propane, butane)
  - Tariffs delineate acceptable levels/pipelines will blend streams
  - Control Zone – traditional eastern flow – now western flow – out of the Appalachian Basin
  - Appalachian gas can be non-conforming (too hot)
  - Created a western flowing control zone

# Overview of Natural Gas Flow changes

- Bi-directional Gas Flow



# Regulatory Impact of Flow Changes

- Backhaul/displacement of natural gas
- Bi-directional flow of gas on TETCO
  - Gas supply from Marcellus Shale
- TETCO removed the exemption of fuel charges for all reverse flow transportation in its Access Area
  - No longer backhaul; actual transportation
- FERC accepted TETCO's information and allowed the charging of fuel on historically backhaul transactions



# Regulatory Impact of Flow Changes




# Open Seasons – Example - Iroquois

OPEN  
SEASON

SoNo


SERVING EASTERN CANADIAN AND NORTHERN NEW ENGLAND MARKETS


South-to-North Project



**Project Highlights**

- Reverse flow on Iroquois offering physical transportation to U.S.-Canada border
- Open Season Date – December 3, 2013 through January 24, 2014
- Receipt Points
  - Dominion at Canajoharie
  - Constitution at Wright
  - Algonquin at Brookfield
- Delivery Points
  - Waddington
  - Zone 1 Points
- Capacity – up to 300,000 Dth/day
- Term – 15 years minimum
- Proposed in-service date of November 2016





# Additional Incremental Projects and Open Seasons

- Constitution Pipeline
  - June 13, 2013 filed its FERC certificate application to construct a 650,000 Dt/day pipeline from Susquehanna County, PA to Iroquois at Wright, NY with an in-service date of March 2015. Constitution has requested certificate authorization that will allow it to begin construction in June of 2014.
- Dominion Transmission
  - Last year, open season for up to 250,000 Dt/day of capacity from Leidy to Iroquois at Canajoharie, NY with a proposed in-service date of November 2016.
- Algonquin Gas Transmission
  - currently supplies up to 345,000 Dt/day to Iroquois shippers at Brookfield, CT. Algonquin submitted its FERC pre-filing application for the AIM Project to expand its capacity into New England by up to an additional 450,000 Dt/day with an in-service date of November 2016.
- TCPL
  - Held an open season to enable receipt of natural gas from Iroquois and other eastern Canadian supply points beginning in 2016.

# Non-strategic Changes – specific to pipelines

- TETCO
  - Ohio Pipeline Energy Network Project
    - 550 MMcf/D of capacity and reverse flow capabilities from the Utica and Marcellus production areas
- WBI Energy
  - Garden Creek II Pipeline Project
  - From Bakken region to Northern Border Pipeline
- Incremental Facilities
  - Who Pays; e.g., compressors
- Should the infrastructure builds be gas or electric

# Part II. Challenges – Infrastructure/Reliability Distinctions; Interdependency Issues



# Gas v. Electric Business Models

- The commercial and regulatory model for the electric industry is one of central planning, of rolled-in or subsidized costs.
- The natural gas industry model only builds pipelines when shippers are willing to step up and pay the incremental cost of pipeline capacity.
- Basic model differences make longer term planning coordination difficulties the BIG issue.
- Timing for development of new pipeline infrastructure is the main issue:
  - Planning, siting, regulatory and construction of new main line gas pipelines will be on the order of 3-5 years, if started now
  - Compliance with Mercury and Air Toxics Standards is 1-2 years.

# Electric Grid v. Gas Pipeline Network

- Interstate pipelines:
  - Funded directly from the contracts signed by shippers (customers) for service on the pipeline;
  - Shippers are willing to sign contracts for several reasons:
    - need firm natural gas to support firm load at the delivery point;
    - price spreads between a receipt and delivery point are large enough to justify the cost of the firm contract.
- Unbundling of gas industry did not slow infrastructure development because pipelines continued to earn a return on investment through shipper contracts.
- Pipeline infrastructure remains efficient and reliable, which provides for a competitive gas market.

# Electric Grid v. Gas Pipeline Network

- Electric line failure cascades across region affecting millions
- A pipeline outage unlikely to significantly impact other pipelines in region
- Electric system operates regionally requiring regional planning and construction
- Need for single operator to monitor & control regional electric grid
  - Power industry requires central planning and the gas industry does not.
  - Gas is pipeline/project-specifically controlled with minimal pipe-to-pipe planning
- Unbundling of electric industry resulted in disincentive to build needed transmission infrastructure causing reliability concerns.

# Power and Natural Gas Infrastructure Distinctions

- Two different Market Models often in conflict:
  - Power: Centralized planning and cost socialization
  - Gas: Free market development with cost born by individual beneficiary.
- The lack of secure fuel arrangements by generators, limited on-site storage, and increasing constraints on the pipeline system have hindered the performance of natural gas generators.
- Over-reliance on one type of fuel source creates serious risks to grid reliability.
- The potential for substantial unit retirements before the planned long-term changes can influence resource development decisions and is a significant risk in resource (generation) planning.

# Power and Natural Gas Infrastructure Distinctions

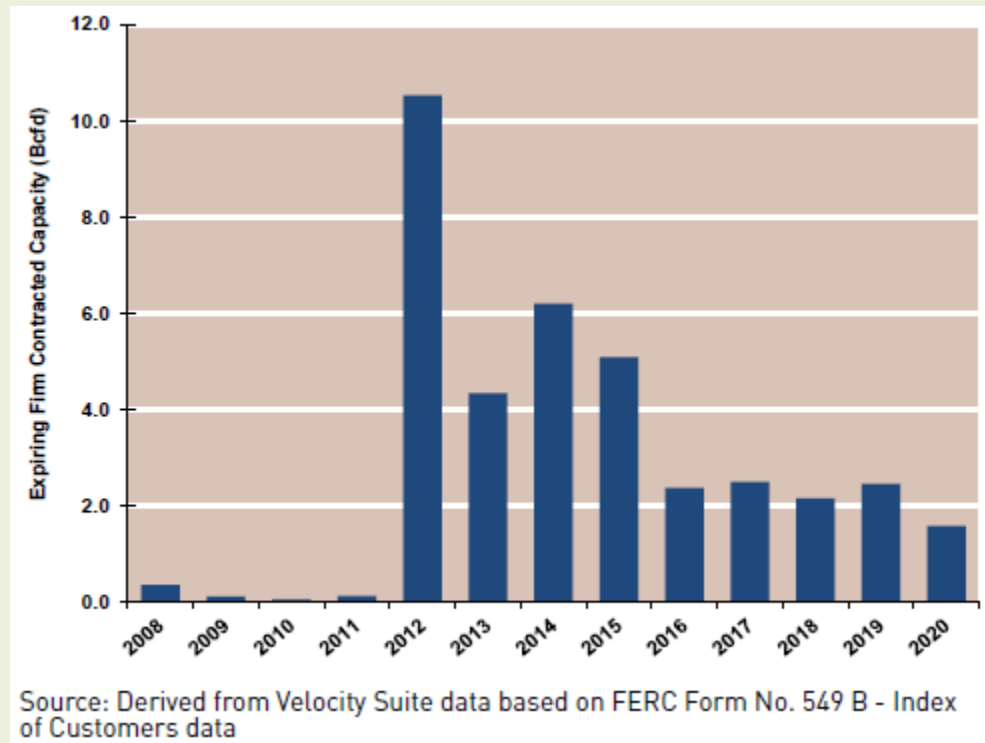
- Generation and natural gas infrastructure realities – build lines or wires?
- Role of storage – natural gas and electric power – potential or kinetic?
  - Battery and Fuel Cell technology
  - Gas above and below ground
- Permanent or mobile?
- Carbon capture and storage (CCS), a suite of technologies designed to capture and store carbon dioxide (CO<sub>2</sub>) from power plants and industrial sources.
- Gas turbine efficiencies and condition monitoring and performance research.



# Gas Transportation Contract Issues

- IOU (gas and electric) concerns about “prudent” contracting;
- LDCs enter into short-term (one year or less) and up to 3 year gas supply contracts; and, have 3 – 5 or so year firm (FT) transportation agreements;
- The general majority of pipeline contracts with current LDC shippers are set to expire in the 2014 – 2015 time frame, but Right of First Refusal (ROFR) terms dictate capacity availability;
- Producers/Marketers generally have been “anchor shippers” for new projects and are faced with languishing margins and low gas prices; Anchor contracts are long term up to 10+ years, and;
- Demand-pull shippers must “step-up” to build new capacity.

# Gas Transportation Contract Issues



# Electric Market and Gas Turbine Relationships

- Major changes in the electricity market have led to management decisions to pursue gas turbine development.
- There are four main reasons why electrical restructuring has driven the gas turbine market:
  - The changing and new market conditions favor power plants with lower capital costs and shorter payback periods.
  - Restructuring benefits projects with short construction lead times.
  - High efficiency plants are likely to thrive in a competitive market.
  - Generation competition leads to more dynamic and fast-changing power markets which are well suited by combustion turbines.

# Electric Market and Gas Turbine Relationships

- Technologies advance, but policies and procedures evolve at a slower pace.
- Other major factors contributing to gas-fired generation growth:
  - Market developments
  - Environmental developments
- Economic and technical developments, government policy, and resource discoveries all affected natural gas prices and availability.
- These price and availability factors help drive gas turbine sales, but the convergence of causes would also include environmental policy.

# Electric Market and Gas Turbine Relationships

- Coal Retirements mean more gas turbines, renewables and DSM.
- Growth of a more decentralized system through distributed generation (micro-turbines and renewables) and DSM/LAARs.
- R&D is one of the major keys to gas turbine success. Technical improvements such as material advancements and cooling innovations help to increase gas and combined cycle turbine efficiency and make them more competitive in the power generation market.
- No single technology but a convergence of technologies will lower costs and increased efficiencies.



# Electric Markets and Gas Turbine Relationships

- Simple Cycle
  - Operate When Demand is High – Peak Demand
  - Operate for Short / Variable Times
  - Designed for Quick Start-Up
  - Not designed to be Efficient but Reliable
    - Not Cost Effective to Build for Efficiency
- Combined Cycle
  - Operate for Peak and Economic Dispatch
  - Designed for Quick Start-Up
  - Designed to Efficient, Cost-Effective Operation
  - Typically Has Ability to Operate in Standby Mode
- Needed for Grid Var/Frequency support for Intermittent generation.

# Electric Market and Gas Turbine Relationships

- Typical overall thermal efficiencies of a combustion turbine (CT) are in the 20% - 40% efficiency range: ie. The GE LMS100 as a heat rate of 8000, and a % efficiency of about 45% and the GE MS501 has a heat rate of about 12,680 and a % efficiency of about 28%.
- Combined Cycle Plant Efficiency are generally about 58-60%.
  - Biggest losses are mechanical input to the compressor and heat in the exhaust.
- Steam Turbine output
  - Typically 50% of the gas turbine output
  - More with duct-firing
- Simple cycle (CT) efficiency (max ~ 44%)
- Combined cycle (CC) efficiency (max ~58-60%)

# Electric Market and Gas Turbine Relationships

- A competitive market demands high efficiency plants. When generators are forced to compete against other generators, only those who can provide electricity at low cost will survive. This is why reliability requirements or “best-value: concepts need attention.
- To reduce costs, they must achieve high levels of production operation for as little fuel as possible.
- A good analog of simple efficiency is heat rate, which is the number of Btu’s necessary for each kWh of plant operation.
- The lower the heat rate is, the more efficient the plant will be.
- Increased efficiencies may require increased pressures and pipeline reconfigurations.

# Part III – Electric – Natural Gas Coordination Issues

# Background

- The gas industry does not want regional coordination (or socialization of costs) similar to electric industry.
- Electric tariff changes are the best vehicle for establishing penalties and incentives and “socializing” gas infrastructure-related costs.
- State regulators have a role to play in changing environment to encourage more firm contracts for increased reliability in promoting “best value.” Assignment of a “reliability cost-factor” is one way.
- Each facility (plant) should figure out what works best for itself, contractually, etc., i.e., – let the gas industry arrange customized solutions.
- Each ISO has unique market “regional” regulatory and issues that must be carefully addressed to a uniquely different long-line pipelines that transverse many regions and ISOs, each with different protocols.



# Electric – Natural Gas Interdependency Issues

- Pipeline expansion or any other type of additional no-notice flexibility needs to pay for itself (read: firm contracts), or it won't get built. Not only are firm contracts needed for new pipe, but also to keep pipelines in service.
- Each pipeline is operationally uniquely configured, unlike the power industry which operates on parallel paths.
- Regulators must revisit the concepts of fuel procurement prudence related to “least-cost”, “lowest cost”, and “best-value as they relate to reliability requirements of power generators and the ISOs.
- Education (of the electric industry on the gas industry and vice versa) is going to be key to arriving at solutions to gas-electric interdependency issues. **Currently, there is a lack of understanding, from basic operations to complex tariff and contractual issues, on both sides.**

# Electric – Natural Gas Interdependency Issues

- More flexibility (with regard to pipeline usage and capacity) generally equals greater risk, and this risk demands higher costs.
- **“Firm” contracts/service and other reliability and operational terms have different meanings in the gas and electric industries.**
- ISOs determine which plants are firm for reliability
  - Plants then contract for firm fuels, back-up options, et al.
  - Engage producers, pipelines, marketers and LDC’s for firm gas transportation, storage & supply solutions.
- It is up to the ISO and power producers to contract for or build the capacity required even though the ultimate responsibility for fuel planning lies with the Power Producers.
- The ISOs may institute protocols and incentives to assure reliability.

# Multi-hour Timing Gap Between Gas and Electric days

- A multi-hour gap in the timing between the two days increases the difficulty of providing the needed services to gas-fired generation.
- For example, the electric day completes its planning for the next day by 6:00 p.m. of the current day. While the completed electric COP identifies which electric units will run the next day (which in turn provides the basic information to project the next day's fuel consumption), the pipeline deadlines for timely nominations historically have been at 11:30 a.m. of the current day. Trading further complicates timing issues. See FERC NOPR.
- Thus, there is a six-or-more hour gap of incompatibility between the two power and gas scheduling approaches to DAM and RTM planning and operations.
- Pipelines are willing and are adding nomination cycles flexibility. But it is not that simple across time zones and physical operations of the pipeline and the power industry.

# FERC Regulatory – Order 698 and NOPR

- FERC sought to improve coordination between gas and electric industries to improve communications about scheduling of gas-fired generators
- Established communication protocols between interstate pipelines and power plant operators; transmission owners and operators
- Incorporated NAESB WEQ and WGQ definitions and standards
- NOPR re voluntary sharing of non-public, operational information to promote reliability of service
  - Affiliate limitations
  - No conduit Rule

# Dodd-Frank Implementation – the Question of Trade Options

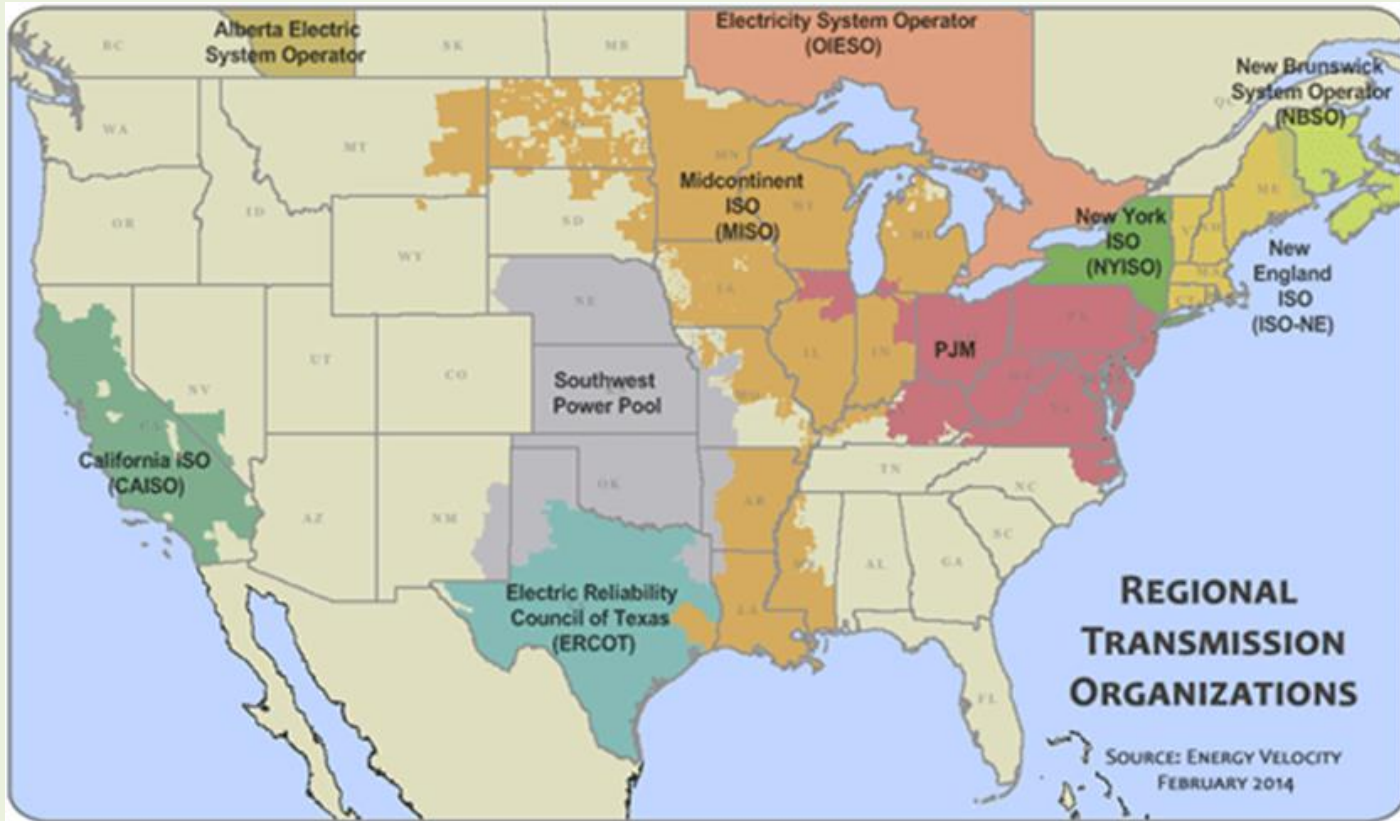
- Dodd-Frank remains a significant regulatory event for the energy industry
  - Unclear as to application and requirements to entire energy industry
- Compliance issues
- Business entry issues



# FERC Coordination

- Since 2011
  - Natural Gas-Electric Coordination
- Quarterly Updates
- References regional efforts and task forces
- Infrastructure updates
- NOPR

# ISO/RT0 Organizations' Coordination



Consider how each potential ISO rules for pipeline interaction would play in pipeline tariffs spanning numerous ISOs, Federal Power Agencies and NERC regions.

# Regional

- Noted regional – NESCOE Gas-electric Focus Group (See Blog dated October 15, 2013)
- MISO – Electric Natural Gas Coordination Task Force
- PJM Gas Electric Senior Task Force
- Desert Southwest Task Force
- EISPC – Eastern Interconnection States' Planning Council
- EIPC – Eastern Interconnection Planning Collaborative
- ERCOT

# Part IV

- Conclusions and Recommendations

# Challenges to Moving Forward

- Cost allocation, who pays and how are the costs recovered;
- Changing regulatory policy creates cost recovery uncertainty;
- Cost to power customers will be determined based on the level of retirements as well as the location of the new gas-fired power plants;
- Costs are allocated to mainline pipeline development with complex cost recovery mechanisms and to lateral pipelines which are generally the responsibility of the power plant owner;
- Gas infrastructure and contractual timing to meet power EPA resource adequacy requirements – the responsibility is with power.



# Power Industry Action Plans

- An Action Plan is needed on a state-by state basis to address the issues identified in the numerous ISO and Federal forums.
- Actions should be taken to analyze total gas and electric demand, at both the ISOs' market footprint and at the state level.
- ISO stakeholders should support State regulatory bodies in developing a better understanding of all future energy demands, in both the electric and natural gas industries, and take action to develop a "Total Energy Solution."
- Natural gas supply and pipeline flow developments, combined with power compliance deadlines for Environmental Protection (EPA) regulations, demand immediate action as total energy landscape changes accelerate.

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