

Consider Natural Gas Pipeline Constraints in Electricity Market Operations

Xing Wang, Alstom Grid
Tongxin Zheng, ISO-NE

FERC Technical Conference: INCREASING REAL-TIME AND DAY-AHEAD MARKET EFFICIENCY THROUGH IMPROVED SOFTWARE

June 22, 2015



Gas and Electric Coordination

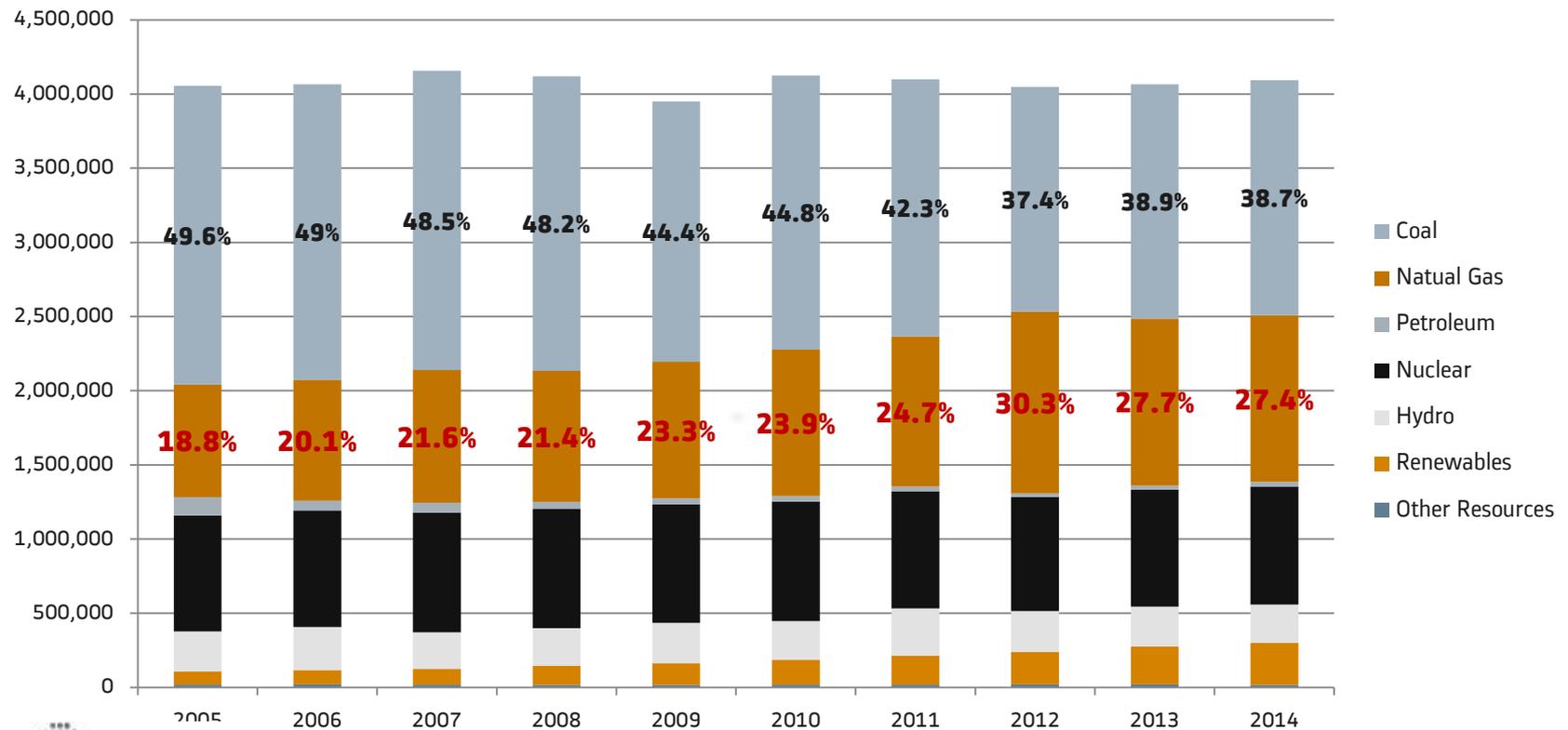
- Hot Topic in power industry due to increasing power generation dependency on natural gas
- ISO-NE and PJM have been particularly concerned with their exposure to natural gas related risks
- FERC calls for closer coordination between gas and electric operation
- Electricity wholesale markets operation needs better model of natural gas supply risks

Outline

- Overview of Natural Gas Pipeline System and Gas Wholesale Market
- ISO-NE's Challenges and Experiences on Gas and Electric Coordination
- What Can We Do
- Consider Gas Pipeline Risks in Electricity Market Operations

Natural Gas Dependency

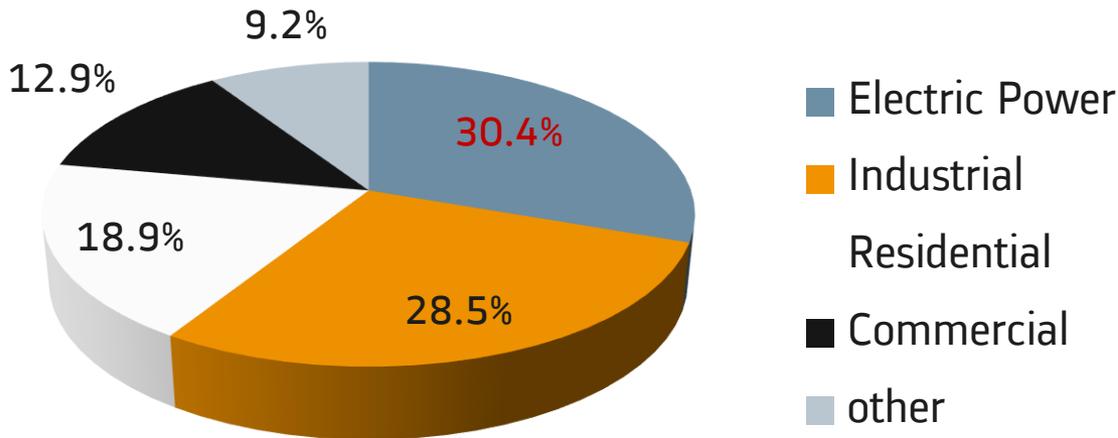
- Growing Dependency on Natural Gas
 - Annual Electricity Production by Fuel Type (data source EIA)



Natural Gas Demand in US

- Natural gas used for electricity generation constitutes 1/3 of the natural gas demand.

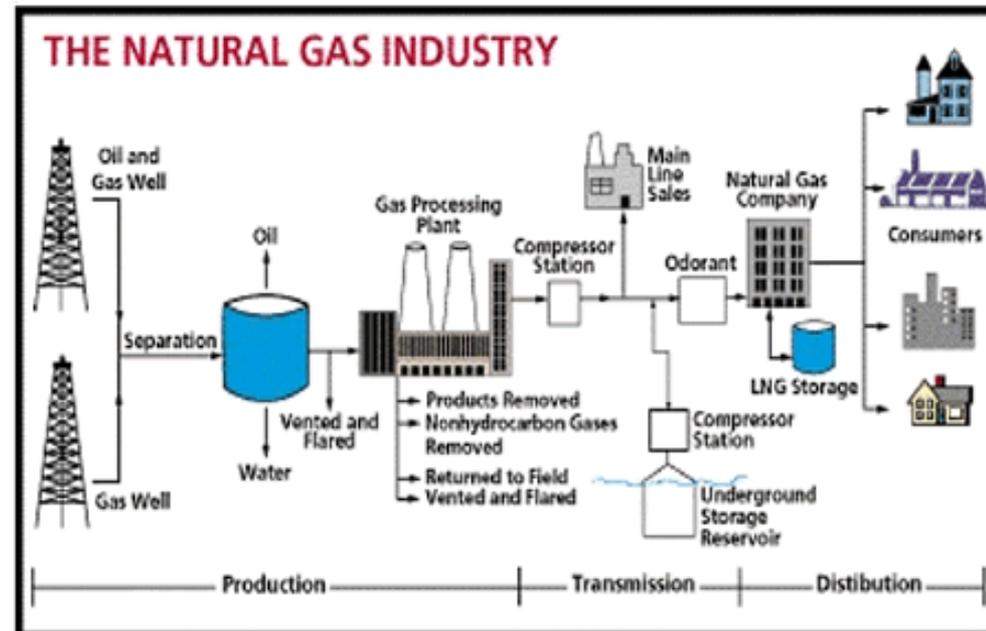
2014 Natural Gas Consumption



Data Source: EIA

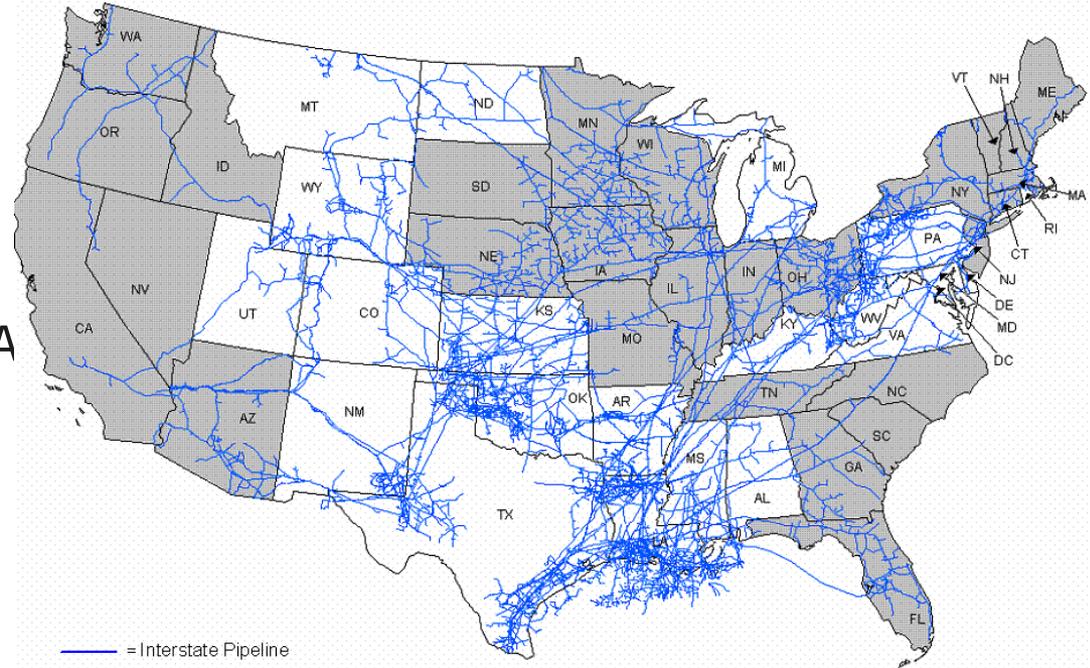
Structure of Natural Gas Industry

- Natural Gas Production
 - Exploration
 - Gas Processing
- Gas Transmission and distribution
 - Midstream
 - Pipeline
 - Local distributor
- Customer
 - Large industry customer
 - Power Generator
 - Local distribution Company



Natural Gas Transportation

- Gas Pipeline
 - Intrastate 29%
 - Interstate 71%
- Major Elements
 - Transmission Pipe
 - Compressor Station
 - Metering Station
 - Valves
 - Storage
 - Control Station and SCADA
 - flow rate through the pipeline
 - operational status
 - pressure
 - temperature readings



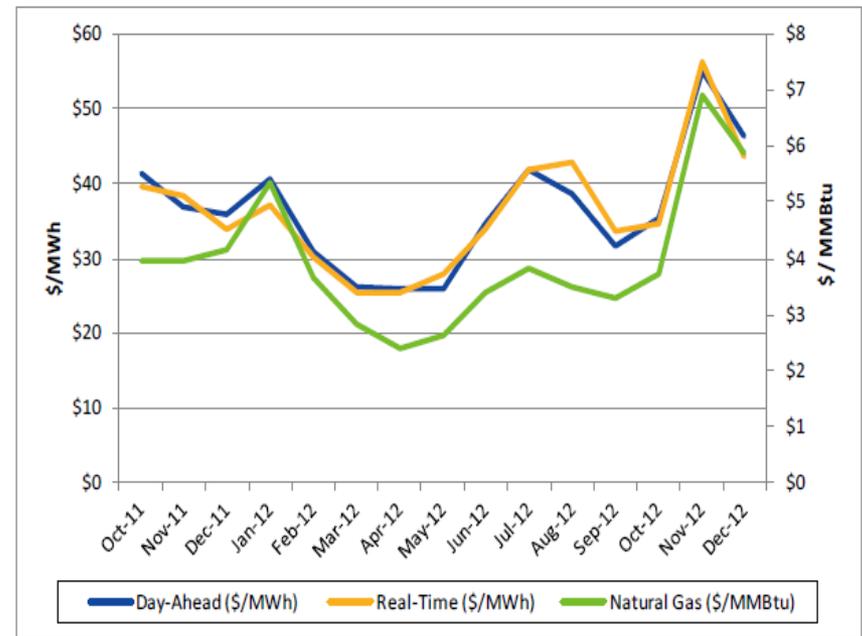
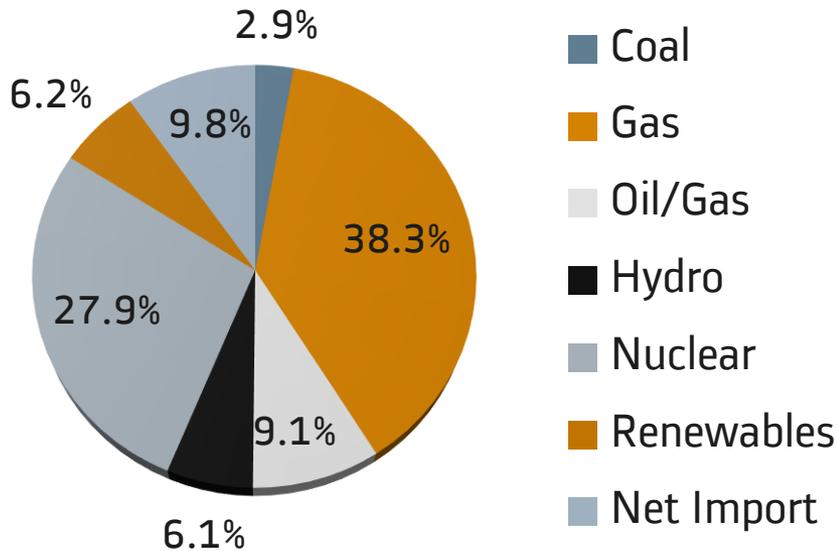
Gas Market and Pipeline Operation

- Natural Gas Physical Market
 - Buy and sell natural gas
 - Producers, Consumers and Marketers
 - Financial Market
 - OTC
 - Derivatives
 - Physical Contracts
 - Phone or electronic bulletin
 - Swing, baseload, and firm
- Pipeline Operation
 - Physical Gas delivery
 - Day-ahead Gas Nomination
 - Intra day Gas Nomination

Natural Gas Dependency in ISO NE

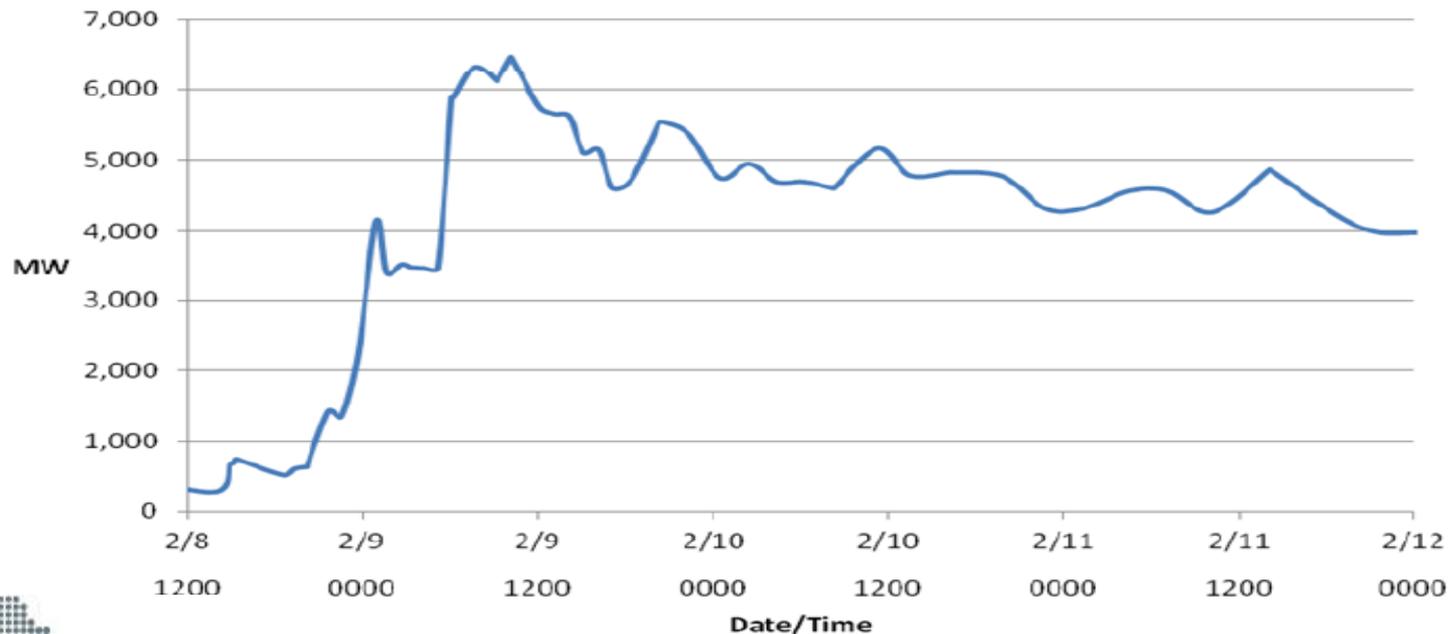
- New England region is heavily depend on the natural gas generation.

ISO NE Energy Source 2012



Power System Operation Challenges

- The natural gas supply disruption or pipeline operation can create significant power system reliability issue.
- Capacity reduction of ISO NE system during Feb 8-9 2013, winter storm.



System Operational Challenges

- Natural Gas Pipeline Capacity Limitation
 - Natural Gas The regional gas delivery system is in very tight balance on a winter peak day even before any gas sector demand growth is assumed.
- Curtailment of Non-firm Natural Gas Contract
 - Curtailment of non-firm gas contract under Pipeline Maintenance
- Pipeline Operations can affect power system reliability
 - Pipeline Outage
 - Flow Balance
- Misalignment of Gas and Electricity Markets Timing

What Have Been and Are Being Done

- Electricity Day-Ahead Market and Natural Gas Day-Ahead Market timeline alignment
- Information sharing with Pipeline Operations
- Intra-day and Hourly reoffering capability
- Pay-for-Performance Rules in Forward Capacity Market provide gas generators financial incentive to secure fuel arrangements and ensure reliable performance

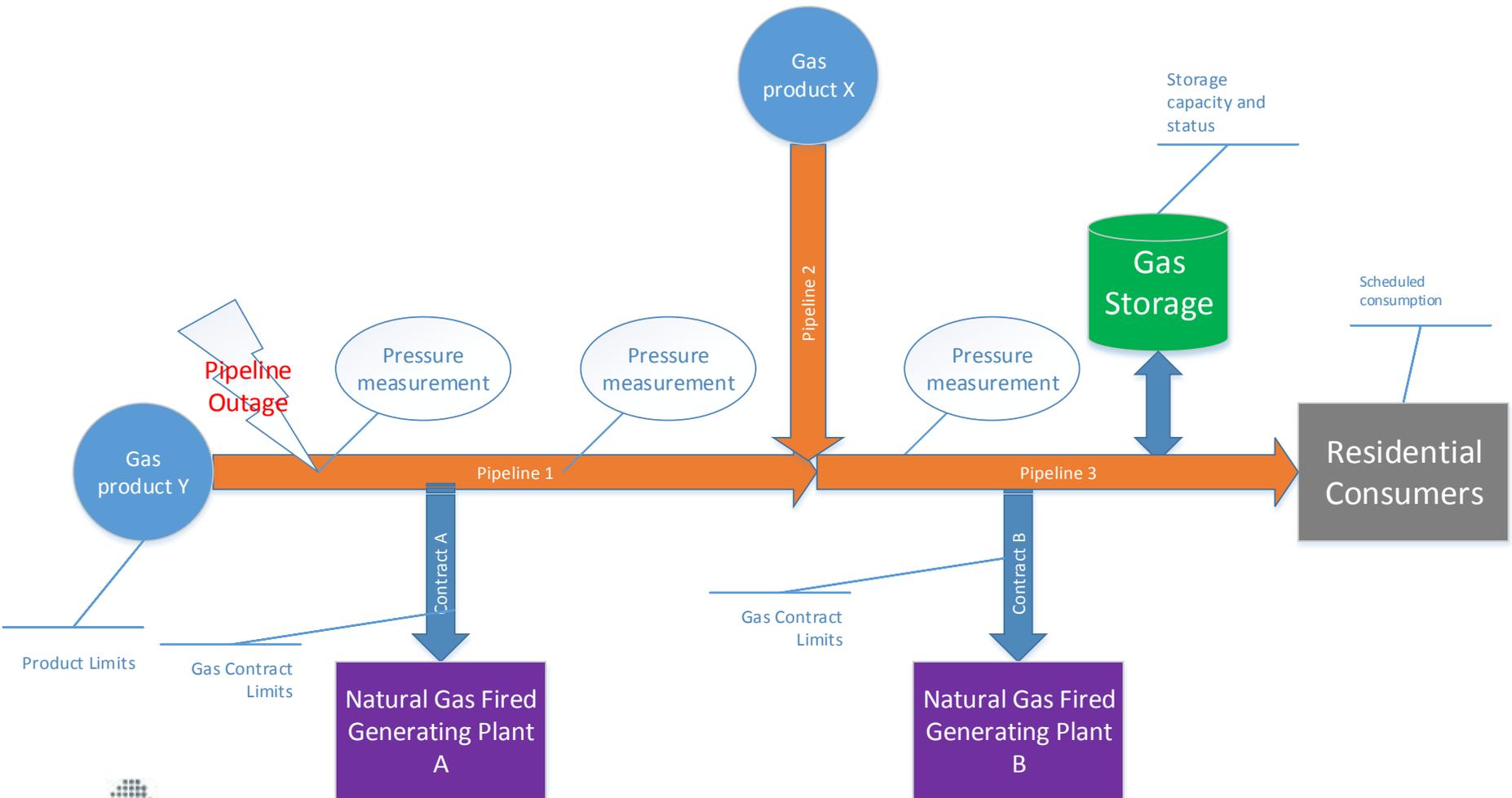
What Else Can We Do

- Information exchange between pipeline operators and market operators
 - Establish required pipeline data model and messages
 - Leverage experiences from Common Information Model
 - Potential RT gas situation awareness in grid control room
- Enhance gas model in market operations
 - Model natural gas pipeline topology
 - Model natural gas storage, contracts, and other constraints
 - Model the correlation between gas pipeline pressure and gas fired generators' ramping capability
 - Model gas pipeline contingencies

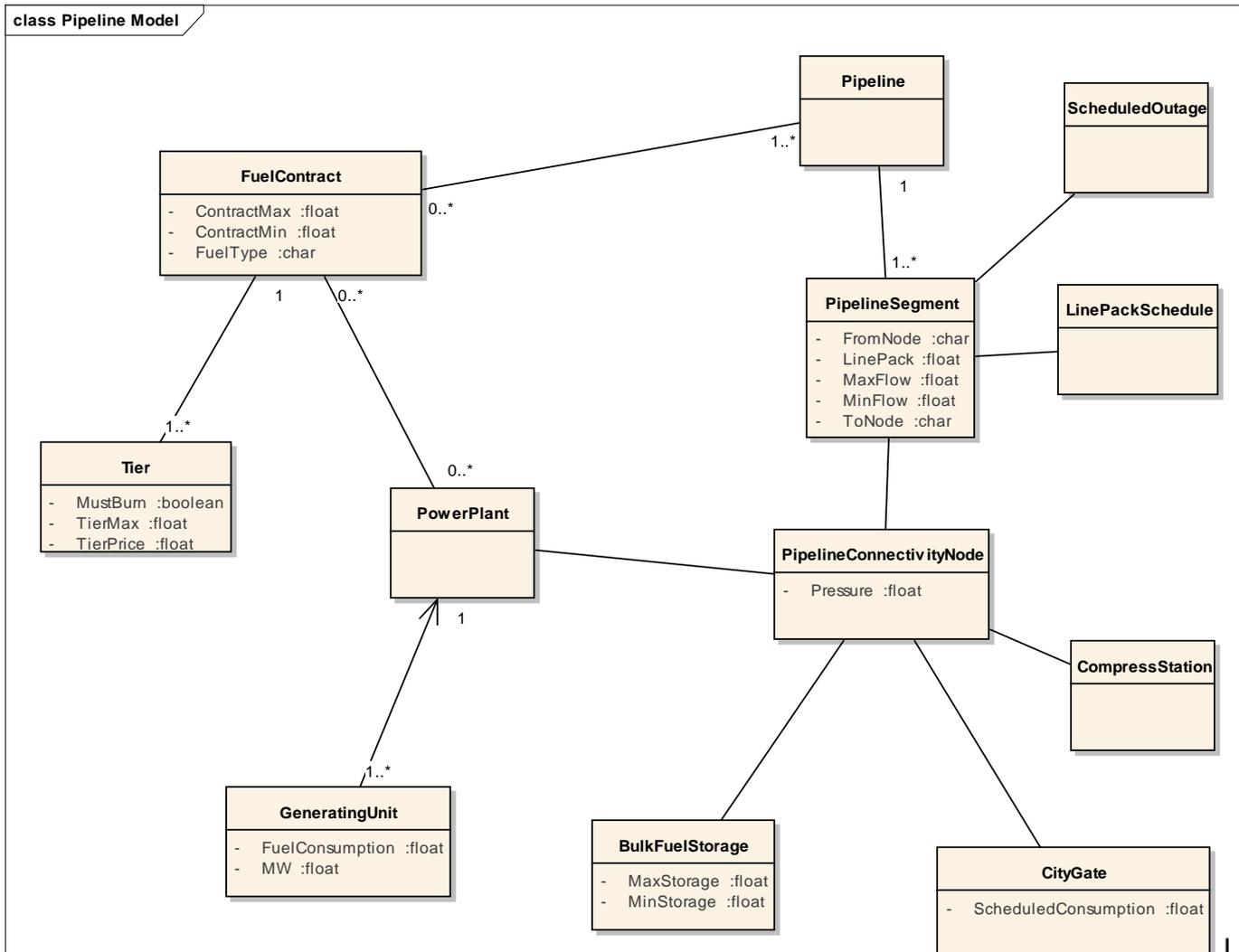
Price-based and Fuel-based Hybrid Unit Commitment and Dispatch Model

- UC/ED objective functions are still based on offer prices;
- Plug the fuel model and fuel contract model into SCUC and SCED formulation;
 - Require unit heat-rate curves if we want to calculate its fuel usage (derived from unit startup/shutdown and dispatch MW with unit HRC based fuel model);
- Allow more accurate fuel and pipeline constraints than generic energy constraints
- Allow modeling pipeline topology, gas storage, pipeline pressure etc.
 - Depending on what pipeline data can be available
 - Start with simplified linear model
- More accurate modeling of unit availability based on real-time/scheduled pipeline outage information.

Proposed Gas Pipeline Model for UC/ED



UML Class Model for Gas-Electric Coordination



Conclusion

- The natural gas market and pipeline operation may create power system reliability issues.
 - Thousands of MW of generating capacity can be lost due to gas supply disruption, pipeline emergency, and limited pipeline capacity.
 - As gas units become baseloaded, the system is losing its ramping capability.
- Gas and electricity markets should work together to improve the overall market efficiency.
- Gas supply and transportation risks should be modeled in electricity market clearing and reliability processes.