

The Booming Natural Gas Industry: Possible New Uses for an Energy Resource



John A. Rupp
Adjunct Faculty
School of Public and Environmental Affairs
rupp@indiana.edu



John W. Clark
Adjunct Faculty
School of Public and Environmental Affairs
clarkjw@indiana.edu

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Peer Reviewers:
Sanya Carley, Assistant Professor,
School of Public and Environmental Affairs;
Kevin M. Ellett, Research Scientist,
Indiana Geological Survey and Visiting
Scholar, Purdue University; and
Kevin S. Leaby, Environmental and
Energy Policy, Duke Energy

Summary

The role of natural gas in the U.S. and globally is evolving rapidly, made possible by advances in exploration and development technologies. Dramatic upward revisions to the reserve base of gas are encouraging significant growth in both traditional and emerging gas markets and challenging the gas production, transportation, and distribution companies that serve those markets. The prospect for plentiful, low-cost, and domestically secure sources of this cleanest of fossil fuels is moving markets and changing energy policy around the world. Challenges presented by this dramatic growth include environmental issues associated with the practices of exploration and development of the resource, impacts on community and regional economic development, uncertainties as to future prices and supply, significant changes on the demand side, and policy issues over potential gas exports into the global market. With that as a backdrop, a team of IU students analyzed the performance of one key leader in the gas industry and developed a series of thoughtful recommendations that could have broader application.

What Are the New Potential Uses for Natural Gas?

In the context of a recent rapid increase in supply of natural gas, numerous entities on the demand side are investigating how this domestically produced energy resource can be used to power new systems. While historically the consumption of natural gas has been largely restricted to use in manufacturing processes and for heating in commercial and residential spaces, there is now greater usage in the electricity generation sector and even in the transportation sector.

Indiana as a state is fairly typical in its pattern of gas usage for those states that are highly dependent on this energy source. Indiana as a Midwestern state whose GDP is more than 28 percent based on manufacturing is increasingly dependent on energy supplied by natural gas to sustain its economy. The state is the ninth-largest consumer of gas in the nation and that consumption is dominated by use in the manufacturing sector. In fact, it was the development of natural gas resources within the state over one hundred years ago that stimulated the development of the many industries, including glass and automotive, who remain dependent on this energy source today. The Trenton Gas Field located in east central Indiana and the most western portion of west central Ohio produced significant amounts of natural gas beginning in 1890 through the first part of the 20th century –Indiana’s first “Gas Boom.”

Now as supplies of gas are becoming more plentiful and the long-term forecasts on gas prices continue to predict low costs for this energy source, the utilities that generate electricity and elements of the transportation sector, specifically operators

of large fleets of vehicles, are evaluating the costs and benefits of integrating natural gas into their operations (Figure 1). The value to such integration has numerous potential advantages to these large volume users of energy. These include a long-term low cost secure domestic supply, an environmentally cleaner fuel, and an efficient dependable source of power.

Natural gas as a source of energy to generate electricity is highly efficient. When used in the so-called “combined cycle” operation, gas is used first to power a combustion turbine to turn a generator followed by a heat recovery system that utilizes the heat of the turbine to generate steam to spin a steam turbine, which is used to turn an additional generator. While the overall energy efficiency of a standard thermal plant used to generate electricity, such as a coal-fired generation facility, averages approximately 30 percent, a natural gas combined cycle facility may be roughly double that amount. And the effluents, including the solid, liquid, and gaseous emissions, from gas-fired facilities are significantly lower than those associated with coal. Of particular note is a 50 percent reduction in the amount of the greenhouse gas CO₂ emitted, along with very significant reductions in SO_x, NO_x, trace metals and particulate matter. In response to these factors the gas-powered portion of the nation’s generation portfolio has rapidly increased by 40 percent in the last few years and appears to be continuing to grow at very fast pace (Figure 2).

Transportation uses for natural gas are getting a fresh look as world markets for oil remain volatile and U.S gas supplies are expanding rapidly. Natural gas now provides only about two percent of U.S. transportation demand – mostly fleet vehicles like buses and taxis. A major obstacle to quickly growing natural gas use in passenger cars is the absence of the “corner filling station” quick-fill infrastructure already in place for gasoline vehicles. Policymakers are considering how natural gas vehicles (NGVs) will relate to the deployment of electric vehicles (EVs) and hybrids. Of course, natural gas-fired electricity powering EVs is an indirect expansion of natural gas for transportation uses.

The best opportunity for direct natural gas expansion into transportation markets may be trucks and other heavy duty vehicles. They can use large strategically located refueling stations along a shared infrastructure (e.g., LNG/CNG – liquefied natural gas/compressed natural gas – pumps at truck stops along interstate highways). The current demand for fuel for trucks, buses, and other heavy-

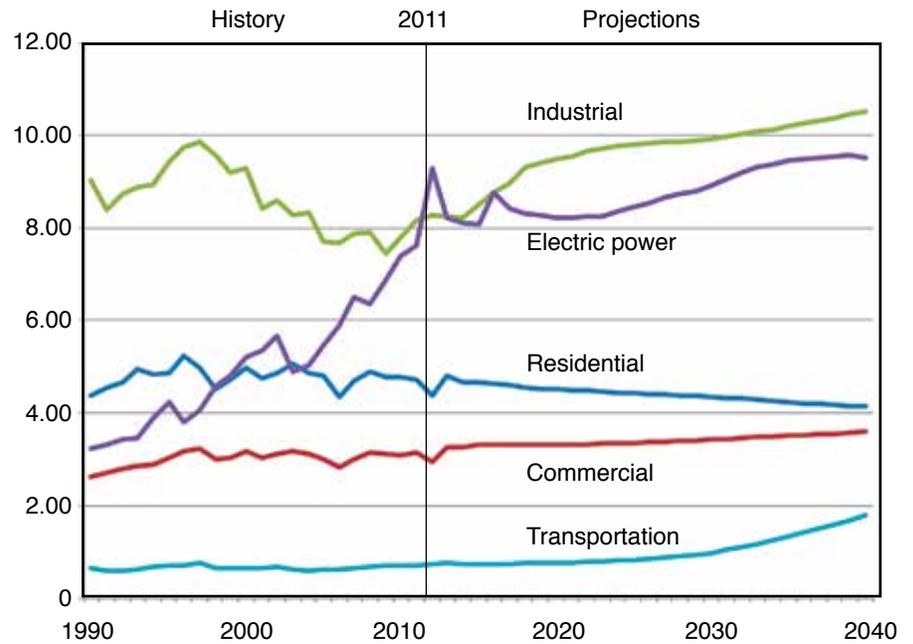


Figure 1. Natural gas consumption by sector, 1990-2040 (trillion cubic feet). *Source:* http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm

duty vehicles is about 20 percent of total U.S. consumption. By 2040, they are projected to account for about 30 percent.

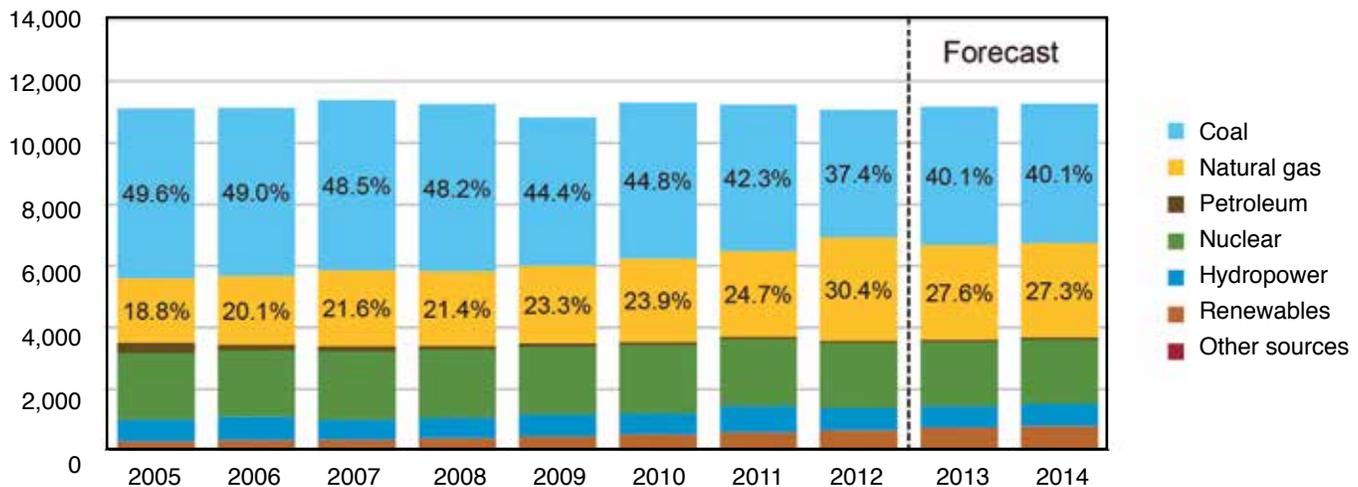
Assessment of New Opportunities for a Utility: NIPSCO

The changing market conditions associated with natural gas offer numerous opportunities for utilities that both sell gas to consumers as well as use it for generation of electricity. Northern Indiana Public Service Company (NIPSCO) is a moderate-sized utility serving a portion of northern Indiana with gas and electrical service. Its parent company, NISOURCE, is one of America’s largest integrated natural gas transmission, storage, and distribution companies, with operations in 16 states and the District of Columbia.

To better understand NIPSCO’s potential areas for growth and their pitfalls, executives with the utility worked with graduate students in the School of Public and Environmental Affairs (SPEA) at Indiana University Bloomington to conduct an analysis of the potential new uses of gas that might benefit the company.

Teams of students, all enrolled in a graduate V600 capstone course, offered a variety of conclusions to guide NIPSCO including these recommendations:

- Generate power with combined-cycle gas turbines (CCGT).
- Create new markets by supporting conversion of fleet vehicles so they consume compressed natural gas (CNG).
- Prepare for changes in the regulatory and policy framework governing the industry as the nation’s energy strategy evolves.



Note: Labels show percentage share of total generation provided by coal and natural gas.

Figure 2. U.S. Electricity generation by fuel, all sectors (thousand megawatt-hours per day). *Source:* http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm

The Capstone Experience

A capstone course at SPEA brings together graduate students from a variety of academic backgrounds within the school. Over their final semester, graduate students in the Masters of Public Affairs (MPA) and Masters of Science in Environmental Science (MSES) programs work in teams to conduct an analysis of a challenging topic. As the semester progresses, the students work with a client, who in most cases is an organization or company that faces real-world challenges, and is seeking advice on how to approach these problems. Students work closely with the client to frame the problem and carry out research and analysis to develop a set of recommendations that the client may use to address the issues around the challenge. As the semester draws to a close, the students compile a formal report and make one or more presentations of the results of their analysis to their client.

Each project is designed to emulate how graduates of SPEA will function in professional positions after leaving IU. The course is to integrate the wide variety of skills that students have obtained through previous coursework, including both the core curriculum of the MPA and MSES degrees, as well as knowledge from each student's individual concentration areas.

The NIPSCO Capstone

In this case, the students were asked to evaluate the technical, economic, regulatory and policy implications of the potentially dramatic growth in natural gas supplies and markets. They investigated the potential role and challenges associated with the enhanced use of gas in the transportation and generation sectors in the near future.

Under the guidance of SPEA adjunct faculty members John A. Rupp and John W. Clark, the students created an organizational structure to coordinate both within and

across specialization groups, to collaborate with NIPSCO, and to generate the final recommendations and summary analysis.

In order to assess how the future evolution of the natural gas market could be influenced by a series of factors, three scenarios were constructed using these factors as variables to model the potential impact of these factors. Within each scenario, key variables were evaluated to determine which would be the most influential and could significantly change the natural gas market in the U.S. Several of these factors could either positively or negatively affect the price and supply of natural gas over the next 20 years. The key variables assessed were:

1. development of natural gas resources,
2. carbon policy,
3. climate and water issues,
4. energy security,
5. coal combustion residuals and the Resource Conservation and Recovery Act,
6. renewable energy,
7. liquid natural gas exports,
8. corporate average fuel economy standards,
9. transportation policy incentives,
10. gasoline and diesel tax, and
11. nuclear energy.

Recommendations

In their final report to NIPSCO, the students made a series of recommendations.

Generation

- Establish any new generation facilities in service areas using CCGT technologies. Prepare to respond to new environmental regulations that may constrain coal-fired generation.

- Partner with new renewable energy projects in NIPSCO's service territory, especially for integration of new gas-fired generation with power from renewables.
- Remain aware of natural gas flow patterns moving through NIPSCO's service territory and use systems and practices that allow flexibility for gas purchasing and distribution.

Transportation

- Partner with companies in NIPSCO's service territory to facilitate conversion of fleet vehicles to CNG NGVs.
- Consider potential LNG infrastructure development along transportation corridors in NIPSCO's service territory.

Concerns

- Prepare for a national carbon policy or enhanced regulations of carbon under existing legal frameworks by having a flexible portfolio of energy sources for their generation portfolio.
- Study and plan for possible climate change and changing weather patterns relevant to nation-wide natural gas demand and within NIPSCO's service territory.

Conclusions

Although the recommendations made by the V600 capstone assessment were specific to the circumstances that surround NIPSCO's needs, the recommendations, and especially the conclusions, can be considered to be applicable in a general sense to any utility facing the opportunities and challenges associated with the growing natural gas market. In the analysis for NIPSCO, the key technical, economic, regulatory, and policy factors relating to changes in natural gas supplies and markets were evaluated for implications relating specifically to the generation and transportation sectors. The assessment is framed from the present through the year 2035.

The following is a set of conclusions that were offered for consideration by NIPSCO that are based on an analysis of technical, economic, regulatory, and policy factors:

Natural Gas in Electricity Generation

Natural gas will continue to meet an increasing share of generation, shifting into base load demand rather than providing service solely for peak demand. New generation capacity to meet demand growth will be from natural gas as coal-fired power plants are retired. New natural gas generation plants will be combined-cycle gas turbines (CCGT) with advanced control systems allowing for more flexible scheduling of dispatch. Inexpensive natural gas will contribute to the limited development of nuclear generation. Renewable energy will parallel the growth trajectory of natural gas for electricity generation.

Natural Gas Vehicles (NGVs)

One area for market growth in NIPSCO's service territory is the enhanced use of compressed natural gas (CNG) in fleet vehicle markets and liquefied natural gas (LNG) for long-haul freight transportation. Commercial and municipal fleet vehicles represent the best market opportunity for NGVs in NIPSCO's service territory. Several companies in Indiana have converted their fleets to NGVs and there is increasing interest in developing CNG fleets at the municipal level. Major transportation routes across NIPSCO's service territory are served by a developing national network of LNG refueling stations. The development of new LNG stations within NIPSCO's territory represents a potential market for natural gas for the company.

Environmental Policy and Natural Gas

Environmental policies are generally favorable to the growth of natural gas generation as they impose greater marginal costs on coal-fueled generation. Future individual environmental policies will probably not have significant effects on the natural gas generation sector. However, cumulatively, these policies could negatively affect the entire fossil-fuel based generation sector. A national carbon or greenhouse gas (GHG) policy, likely in the form of cap-and-trade, has the ability to change the current natural gas market by imposing higher costs on natural gas production and reducing consumption. Potential regulations concerning land, water, and air impacts associated with the development and production of natural gas could significantly affect the price of natural gas at the wellhead.

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While the supplies and use of natural gas are increasing rapidly both within the U.S. and globally, the development of this resource comes with some significant challenges. Assessments performed on the impacts of the various factors that influence this growth in usage can help to anticipate and address development challenges. And with careful consideration of the consequences of this enhanced usage, this energy resource stands to sustain and enhance modern society for a long time into the future.

Each issue of *SPEA Insight* is peer-reviewed and highlights a major public policy challenge in the USA or the world, along with analysis by SPEA faculty and other experts that will help policy makers address these challenges.

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