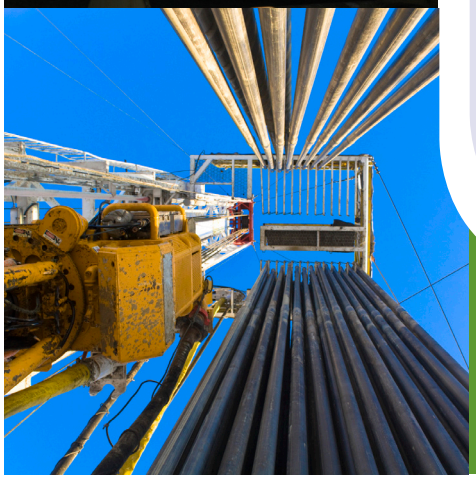

Shale Gas INNOVATION & COMMERCIALIZATION CENTER

Ben Franklin Technology PArtners

Tapping Pennsylvania's Potential

Mining the collective knowledge of stakeholders from the public and private sector, the goal of the Ben Franklin Shale Gas Innovation and Commercialization Center (SGICC) is to identify and commercialize emerging technologies that support responsible exploration, extraction, and use of the natural gas located in Pennsylvania's Marcellus and Utica shale formations.

The Center offers access to the latest research along with financial and business support services to entrepreneurs, emerging start-ups, and high-growth companies engaged in developing new applications in this industry.

The Center's Strategies

- Identifying emerging technologies, markets, and applications for natural gas
- Providing capital to accelerate commercial enterprises and encouraging investment in gas-related enterprises
- Supporting research related to the safe and efficient extraction/transportation of natural gas
- Encouraging collaborative industry-university efforts by linking researchers, industry partners, investors, end-users and government agencies

Fueling our Economy

Supporting research that creates new business opportunities surrounding the shale gas industry will further increase the availability of sustainable, high-paying jobs, generate billions in tax revenue, and supply Pennsylvania with clean, affordable energy for years to come.

Areas of New Research

- Determining the feasibility of converting heavy trucks to a "dual fuel" model
- Using industrial waste materials to develop proppants for the drilling process
- Connecting operators of shallow natural gas wells with local end-users
- Understanding the remediation of acid mine drainage water for use in hydro-fracturing operations

Partnering Organizations

The Shale Gas Innovation and Commercialization Center is an initiative of Ben Franklin Technology Partners (http://www.cnp.benfranklin.org). For a listing of SGICC partners and advisors, visit www.sgicc.org

For more information contact:
Bill Hall, Director - Shale Gas Innovation & Commercialization Center, billhall@rtto.psu.edu

814-863-4881 • www.sgicc.org

Opportunity Knocking

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Examples of Current Research Projects in the Shale Gas Industry

Opportunity/Identification of Shallow-Well Gas Operations Much of the natural gas produced thus far from the Marcellus has been exported to demand centers in the northeast United States which has had significant consequences. First, the gas transmission availability through Pennsylvania has become scarce, and smaller producers (producing from the Marcellus or from shallower gas-producing zones) have had difficulties securing takeaway capacity. Shallow-well gas operators are unable to sell their gas most of the year because of the lack of interstate pipeline capacity and the increasing cost to access an interstate pipeline. In addition to being economically disadvantageous for these companies and the natural gas market, companies without firm pipeline access may choose to abandon their wells for economic reasons (rather than end-of-life abandonment). Historically, this type of economic abandonment can create environmental problems since such wells are not always properly plugged. The well creates escape vectors for oil and natural gas, posing risks to public health through potential groundwater contamination. In some cases where operators cannot be held liable, the public must pay for abandoned wells to be capped. Keeping wells from being prematurely abandoned in this way generates a public benefit.

Opportunity/Converting Waste Materials into Proppants Proppants are required to extract hydrocarbon resources from unconventional geological formations. These formations are said to be "tight," which means the hydrocarbons are trapped in the rock. Hydraulic stimulation is a technology through which small explosives followed by hydraulic pressure are used to create pathways to allow the hydrocarbon to flow from tight formations. Proppants are pumped into the well to hold the pathways open. Nittany Extraction Technologies, LLC (Netco) was formed to organize a product-development project around IP created at Penn State which ultimately converts various, abundant waste minerals into high-quality proppants. The company has obtained patent rights to the technology, optimized processing at the lab scale at PSU, and proven the technical feasibility at the multi-ton scale in collaboration with a Pittsburgh-based refractory company.

Opportunity/Using Natural Gas as Dual Fuel This project is attempting to utilize natural gas resources, developed in Pennsylvania for heavy duty vehicle fleet operations through low cost "add-on" systems. There is also a need for technology assessment and development to obtain a natural gas add-on system that displaces diesel fuel (or often referred to as "substitution") rather than giving a boost in horsepower. Frequently, because of a lack of communication between the engine ECU and the control system for the add-on natural gas supply system, the gas adds to the energy delivery to the engine, observed as a boost in engine output, rather than reducing the amount of diesel fuel required to maintain engine output. As a result, there may be increased energy and cost savings if, with minor modifications, an add-on fuel supply system could communicate directly or indirectly with the ECU to enable diesel fuel substitution with natural gas, while maintaining power and performance.

Opportunity/Treatment of Abandoned Mine Drainage Penn State University is currently looking at three very early stage technologies related to the treatment of Abandoned Mine Drainage (AMD) as a water source for hydrofracking shale gas wells. The use of such technologies would provide water quality improvement to watersheds degraded by AMD, while providing a local source of water for the shale gas industry. Two of the three technologies are novel passive treatment approaches to address acidity and to remove metals such as iron and aluminum from the AMD. The third technology is an active treatment approach to remove sulfate which is frequently a concern when considering the use of AMD for fracking. At this point all three technologies are pre-commercial and not ready for development, but they are being monitored for future support when the technology has been advanced.

For more information contatct: Bill Hall, Director – Shale Gas Innovation & Commercialization Center 814-863-4881, billhall@rtto.psu.edu