



**TARGET INDUSTRY RECOMMENDATIONS
FOR DEVELOPMENT OF
SHALE GAS SUPPLY CHAIN COMPANIES
for the
PITTSBURGH REGIONAL ALLIANCE**

from



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EXECUTIVE SUMMARY

Growth in the oil and gas supply chain is extremely cyclical. Companies in the supply chain therefore are extremely cautious when adding capacity and building new facilities. Moreover, manufacturing and production expertise in the supply chain is extremely concentrated in a few oil centers. This has steered most new facility investment into existing oil centers like Houston and Oklahoma City.

But shale gas is a revolutionary technology that is transforming the energy industry and it will have an impact on where companies locate facilities. This report condenses Tamerica's recommendations on oil and gas supply chain industries that the Pittsburgh Regional Alliance (PRA) should pursue and the reasons for our recommendations.

Because of the cyclicity of new facilities, timing is critical in developing the supply chain. We discuss industry trends so that the PRA leadership understands the timing of opportunities. Unexpected events, such as moratoriums on hydraulic fracturing or an extreme drop in liquids and gas prices, could have sudden and profound effects on the industry. Among the trends that suggest that the industry will expand facilities is a high capacity utilization rate on horizontal drilling rigs, a growing number of rigs that are actively drilling and increasing lease rates for rigs. High crude prices are also a critical driver of investments in production and equipment facilities. Despite low natural gas prices, investment continues in shale gas exploration and production because the lower risk in these properties offsets the lower product prices.

Long term the oil and gas equipment markets are expected to grow significantly because of increasing drilling activity in shale gas formations and an increase in pipeline construction. Falling dollar exchange rates and countervailing duties against Oil Country Tubular Goods (OCTG) from China will also stimulate domestic production of drilling pipe, casing and tubing. The big price spread in the US market between hydrocarbons from natural gas and those from crude petroleum also provides a platform for transforming natural gas into transportation fuels and petrochemical feedstocks using a technology called Gas-to-Liquids (GTL).

The Pittsburgh region has locational assets that match the needs of many of the supply chain industries. Tamerica identified 6 target industries that are best matched to the locational assets of the region. They are, from upstream to downstream:

- Regional offices for operators and production companies without a physical presence in the region
- Regional Facilities for Service Companies active in the region
- Drilling Equipment Fabricators
- Oil Country Tubular Goods
- R&D centers for frac water treatment and shale geomechanics
- Gas to Liquids (GTL) plants

We discuss the trends and target industry recommendations fully in the report.

INTRODUCTION

Growth in the oil and gas supply chain is extremely cyclical. Employment levels in the industry dropped by 15 percent between 2008 and 2009 but recovered to levels exceeding 2008 this year. Companies in the oil and gas supply chain therefore are extremely cautious when adding capacity and building new facilities. Moreover, manufacturing and production expertise in the supply chain is extremely concentrated in a few oil centers. This has steered most new facility investment into the existing oil centers. But shale gas is a revolutionary technology that is transforming the energy industry and it will have an impact on where companies locate facilities. This report condenses Tamerica's recommendations on oil and gas supply chain industries that the PRA should pursue and the reasons for our recommendations.

Because of the cyclical nature of new facilities, timing is critical in developing the supply chain. It is therefore important that we discuss industry trends so that the PRA leadership understands the timing of opportunities. Unexpected events, such as moratoriums on hydraulic fracturing or an extreme drop in liquids and gas prices, could have sudden and profound effects on the industry.

EQUIPMENT UTILIZATION RATES

While most of the equipment industry is concentrated in Houston or in Oklahoma and Louisiana, vendors often locate facilities in other world regions with significant activity because of the logistics cost of shipping equipment to the production regions. National Oilwell/Varco, the world's largest manufacturer of drilling rigs, for example, has its major manufacturing plant in Pampa, TX but also has manufacturing plants in China, Scotland, Norway, Canada, Dubai and Singapore. The need for new manufacturing facilities in the supply chain is driven by the day rates for equipment rentals plus the rig utilization rates. The need for drilling rigs precedes the needs for the rest of the completion equipment.

Utilization rates fell dramatically in the US during 2009 but have since recovered. Even with moderate prices for natural gas, the rig count continues to climb. News published by publicly traded companies in this industry provide a better source of information on industry trends than government employment reports, which lag by six to nine months at the industry level.

Recent news reports suggest that the equipment industries in the oil and gas supply chain are operating near peak production. Here are three recent stories that illustrate the trend:

-April 27, 2011 Dow Jones Newswires National Oilwell Varco "said it added \$2.28 billion of new equipment orders during the quarter, boosting to \$6.16 billion its backlog of contracts to outfit the flurry of new land and offshore rigs under construction. ...Judging by the number of rig orders that have been



announced by drilling contractors in recent months, ‘you can extrapolate that we’re going to do quite well.’”

-April 28, 2011 Dow Jones Newswires Helmerich & Payne “the dominant supplier of high-performance drilling rigs used in shale drilling remains poised to benefit from the continuing rush into alternative shale gas fields. ... The rig utilization rate increased to 85% from 70% a year earlier, and climbed from 84% in the first quarter.”

-May 6, 2011 Dow Jones New Service Baker Hughes reports that “there were 890 rigs drilling for natural gas in the U.S. during the week ended Friday, up eight from the previous week and the second consecutive increase. ...The number of horizontal rigs, the type typically used to access the gas and oil held in shales, increased by 15 to 1,038 from a week earlier, the third consecutive record high. “

The backlog of contracts reported by National Oilwell Varco represents 11 months of production for its rig technology operation. The delivery time for rig delivery has grown enormously in the last year. As a result, operators are shifting some rigs from the Marcellus region to the shale oil play in the Bakken formation in North Dakota. The returns from drilling for oil are so much higher than for gas because of the differential in prices. This situation will likely continue until manufacturing capacity in rig fabrication expands.

All of the current news suggests that the equipment side of the supply chain is poised to expand production to meet the demand from drillers and contractors working in the shale plays. This will provide future opportunities to the Pittsburgh region.

MARCELLUS DRILLING AS A SHARE OF OVERALL ACTIVITY

The need for new and expanded facilities is driven by the amount of drilling in the industry. Employment levels in drilling, production and equipment manufacturing all depend on the amount of drilling activity. The location of facilities to support this activity depends on the location of formations that are being drilled. Since most of the nation’s past production has been in Oklahoma, Texas and Louisiana, the industry is concentrated in those states. But shale gas formations can shift this pattern because much of the current drilling is occurring in formations that are geographically removed from the traditional oil centers (see Figure 1 at the end of the document). The biggest growth in rigs since 2005 has been in Pennsylvania and North Dakota.

While the number of drilling rigs working in the Marcellus formation has grown dramatically since 2008, nationwide activity levels have grown at a comparable rate (see Figure 2). The moratoriums on hydraulic fracturing in New York and Maryland have reduced the number of active rigs in the Marcellus formation below what would have been expected based on past



activity (see Figure 3). Activity levels in the Marcellus will have to grow significantly before the region begins to attract well completion equipment manufacturers. The exceptions are perhaps in drilling rigs and in oil country tubular groups (drilling pipe and tube).

PIPELINE EQUIPMENT

The market for pipeline services is growing with the shale gas explosion. Since shale gas is located in new formations, pipeline companies have to invest in equipment for gas gathering, compression, gas treatment and storage facilities as well as for new transmission pipelines to move the product to customers. The office of Energy Projects at FERC has identified nearly 3,800 miles of announced transmission pipelines as of February 2011 with 5 major storage projects including one in New York by National Fuel Gas Supply Corporation to serve the Marcellus formation.

Many of the nation's crude and gas pipelines are between 50-100 years in age. As pipelines corrode they can rupture, as the recent gas fire in San Mateo, California illustrates. Many of the aging pipelines in the nation's infrastructure will have to be replaced.

A recent analysis of pipeline, storage and gathering infrastructure conducted by the INGAA estimated that the nation would invest between \$110-\$163 billion in new transmission infrastructure and an additional \$10-18 billion in gathering infrastructure between 2009-2030¹. These investment levels are double the national spending levels on transmission and gathering infrastructure over the last decade. These additional facilities will require significant amounts of new pipe and compression equipment.

OCTG PRODUCTS

Pipe and tube used in the oil and gas supply chain is called OCTG in the steel industry (OCTG is the abbreviation for Oil Country Tubular Goods). OCTG consists of the drilling pipe, well casing and well tubing used in well completion plus the pipe used in gathering and transmission pipelines.

OCTG is different in its locational orientation than other types of completion equipment. OCTG is manufactured using a steel process which requires significant electrical energy and has less engineered content than drilling rigs or the other supply chain items. In 2008 over half of the 7 million tons of OCTG were imported, with China contributing the majority of those imports². Chinese imports will drop significantly with the International Trade Commission's decision to levy countervailing duties on Chinese imports. This, together with the dropping value of the dollar

¹ INGAA Foundation "Natural Gas Pipeline and Storage Infrastructure Projections through 2030" Oct. 2009

² US ITC "Certain Oil Country Tubular Goods from China" Publication 4081, June 2009



and moderate electricity prices in the US, suggest that more domestic capacity will be required in the future (see Figure 4 for a graph of dollar exchange rates since 1999). All of these factors have combined to reduce the costs of domestic production relative to imports.

DOWNSTREAM OPERATIONS AND GAS-TO-LIQUIDS PLANTS

In the past, natural gas and crude petroleum uses diverged at the downstream end of the supply chain. Crude petroleum was transported to refineries where it was distilled into transportation fuels and petrochemical feedstocks. Natural gas was transported by pipeline to industrial customers, electric generators and commercial & residential customers for heating uses.

Future uses of natural gas are certain to include petrochemical feedstocks. A number of facilities are now emerging in the world to transform natural gas into liquid petrochemicals and fuels using either Fischer Tropsch chemistry or the Mobil process.

Five companies worldwide have technologies for converting natural gas to liquids. Sasol of South Africa is one of the world's leaders in GTL. Sasol has operated a 25,000 barrel per day plant in Mossel Bay, South Africa since 1993. Shell has operated a 12,000 barrel per day plant in Bintulu, Malaysia since 1993. Shell is now constructing the world's largest GTL project in joint venture with the Government of Qatar. The Pearl project in Qatar will produce 340,000 barrels per day of product. Exxon has developed a commercial Fischer-Tropsch system for natural gas feedstocks but has not announced any commercial ventures using their technology. Chevron, on the other hand, has teamed with Sasol to build a 45,000 barrel per day plant in Western Australia. Chevron has also operated a 33,000 bpd GTL plant in Nigeria since the early 1990s.

The final IP owner is Syntroleum, which has a major R&D center in Tulsa, OK. Syntroleum claims that the capital cost of its technology is about \$25,000 per daily barrel with an operating cost between \$3.50 and \$5.00 per barrel.

A number of GTL projects are purportedly looking for sites along the Gulf Coast. These plants are rumored to be close to announcement, some before late 2011.

GTL plants require a moderate volume of natural gas to operate. A 30,000 barrel per day facility would require 330,000 mcf of gas for fuel and feedstock. The projects need massive amounts of water for cooling and process uses. A ratio of about 1.1 barrels of water per barrel of product has been reported by Shell for its Pearl facility in Qatar.

The driver for these projects is the significant US disconnect between hydrocarbon prices for natural gas and natural gas liquids, which are increasingly produced from shale gas formations, and crude petroleum, largely imported from Canada, Venezuela and the Arabian Peninsula. Hydrocarbon prices for natural gas today are about 25 percent of their cost when extracted from crude oil (see Figure 5). The cost spread is significant enough to justify the additional processing



costs of converting natural gas into liquid feedstocks. Since shale gas has created a long-term surplus of natural gas, prices are expected to remain stable in the next decade but are forecast to jump for crude because of economic growth in India and China.

We believe that GTL plants are a longer-term prospect for the Pittsburgh region especially at large sites along the Ohio River. As the technology can be adapted for natural gas liquids, it could prove of great interest in the Marcellus region, where wells are producing a high volume of natural gas liquids in addition to dry gas.

The petrochemical and polymer end of the downstream is likely to grow significantly in the US in the next decade. Feed-in tariffs on alternative energy and the curtailment of nuclear energy are leading to rising energy costs in Europe. Feedstock costs, which account for about 60 percent of production costs in the plastic industry, today in the U.S. are about \$400 per ton less than in Europe and \$300 less than in Southeast or Northeast Asia. The US has a major cost advantage again in the petrochemical and polymer industries because of our domestic energy costs and feedstock costs. Petrochemical and polymer production would be logical additions to a GTL production capacity in Southwest Pennsylvania.

SHALE GAS SUPPLY CHAIN TARGET RECOMMENDATIONS

Considering the region's cost advantages and access to the hydrocarbon market, we make the following recommendations to the PRA for its marketing and promotion efforts.

1). Regional offices for operators and production companies without a physical presence in the region

Wiki-Marcellus lists approximately 100 operators that are actively drilling in the region or leasing properties. We could only find 41 of these operators with offices in the region. This suggests that the number of operators with regional offices in the region could double over the next five years. Most of the other operators will expand and grow during the next 5 years. This category excludes the large number of small field offices that operators are opening near the drilling sites.

2). Regional oil field services headquarters for service companies active in the region

Wiki-Marcellus lists 111 service companies operating in the Marcellus region but 33 don't have a regional location. Those service companies that are active in the region are also growing. One of the major service companies we interviewed informed us that they grew by 80+ percent in 2010 and expected to double their size in the region during 2011. This suggests that the service end of the supply chain will grow significantly during the next 5 years in terms of expansion and opening of new offices.



3). Drilling equipment fabricators

The rapid global growth in horizontal drilling is increasing the backlog of companies that fabricate drilling rigs. While the Marcellus drilling levels are not yet robust enough to warrant new manufacturing in the drilling equipment sector, this could change abruptly if the moratoriums in neighboring states are lifted. While this is not an immediate target for PRA, it should be included in the shale gas marketing initiative.

4). Oil Country Tubular Goods

Countervailing duties on Chinese imports plus the dramatic drop in the US dollar suggests that domestic production of drill pipe, casing and oil tubing could grow by 25 percent or more in the next 5 years. The region has the energy prices and locational assets needed to become—perhaps better termed rebecome - a major center for production of OCTG. Large footprint (200+ acre) river sites with barge and rail access for bulk transportation of steel slabs and coils (raw materials) are the types of properties that this target will require.

5). R&D centers for IT and frac water treatment

The talent pool in the Pittsburgh region is strong in organic chemistry, metallurgy and computer science. Each of these disciplines is critical to the growth and development of the energy industry. Many of the technical issues involved with shale gas involve the treatment of fluids used in hydraulic fracturing and the types of proppants that are needed to optimize wells in different shale basins. These are issues that require significant chemical engineering expertise.

The region also has significant expertise in rock mechanics and civil engineering. These are disciplines that have important roles in investigating the geo-mechanics of shale formations, which is an important field of investigation for improving the efficiency of shale gas fracking.

The major oil service companies like Schlumberger and Halliburton are expanding their R&D footprints. Halliburton is relocating its chemistry and chemical engineering center from Duncan, OK to Houston. Schlumberger has consistently added R&D labs around the world as a strategy for attracting more technical talent. The Pittsburgh region has a lot of talent to offer the R&D leaders in the energy industry. A concerted effort by PRA, regional business leaders, NETL and the region's fine higher education institutions to provide a package of benefits to the R&D leaders in energy could generate significant interest and should be a long-term target for the PRA.

6). Gas to Liquids (GTL) plants

GTL technology offers the region the long-term potential to add value to its natural gas resources, especially its high value liquids, in the form of petrochemicals, transportation fuels and polymers. While the GTL industry is just now emerging domestically, it could become a significant industry in the next 5 years in the Pittsburgh region. The IEA's World Energy Outlook in 2006 estimated that the GTL industry could grow from .77 bcf/day to 19.25 bcf/day by 2030.

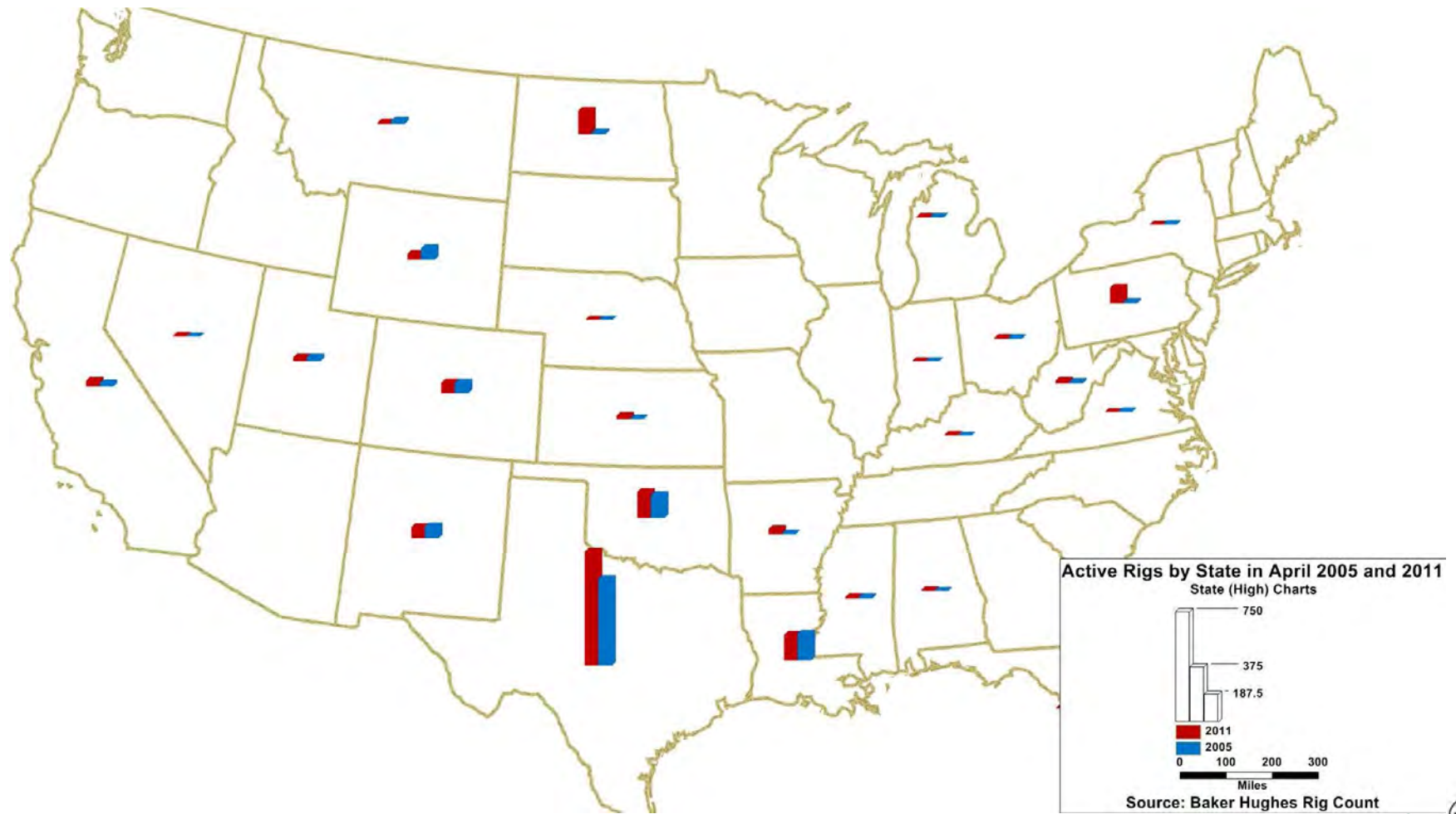
While this forecast was considered optimistic when it was made in 2006, it could prove to be an accurate reflection of reality if oil prices continue above \$100/barrel. The Pittsburgh region should insure that it has the sites available to meet the needs of this industry (100+ acres with ample water resources, ideally on a major river). This target could generate significant economic growth for the region. If the multiplier effects are similar to those in refining and petrochemicals, this sector could have jobs multipliers in the range of 6-10 indirect and induced jobs for every direct job.

SUMMARY OF TARGETS

The target list we have prepared for this project lists the best candidates in each of these target industries. The marketing recommendations we are making in a later report will further describe the sales techniques and strategies that the PRA should use to reach these target companies.



Figure 1. Active Rigs by State in April 2005 and 2011

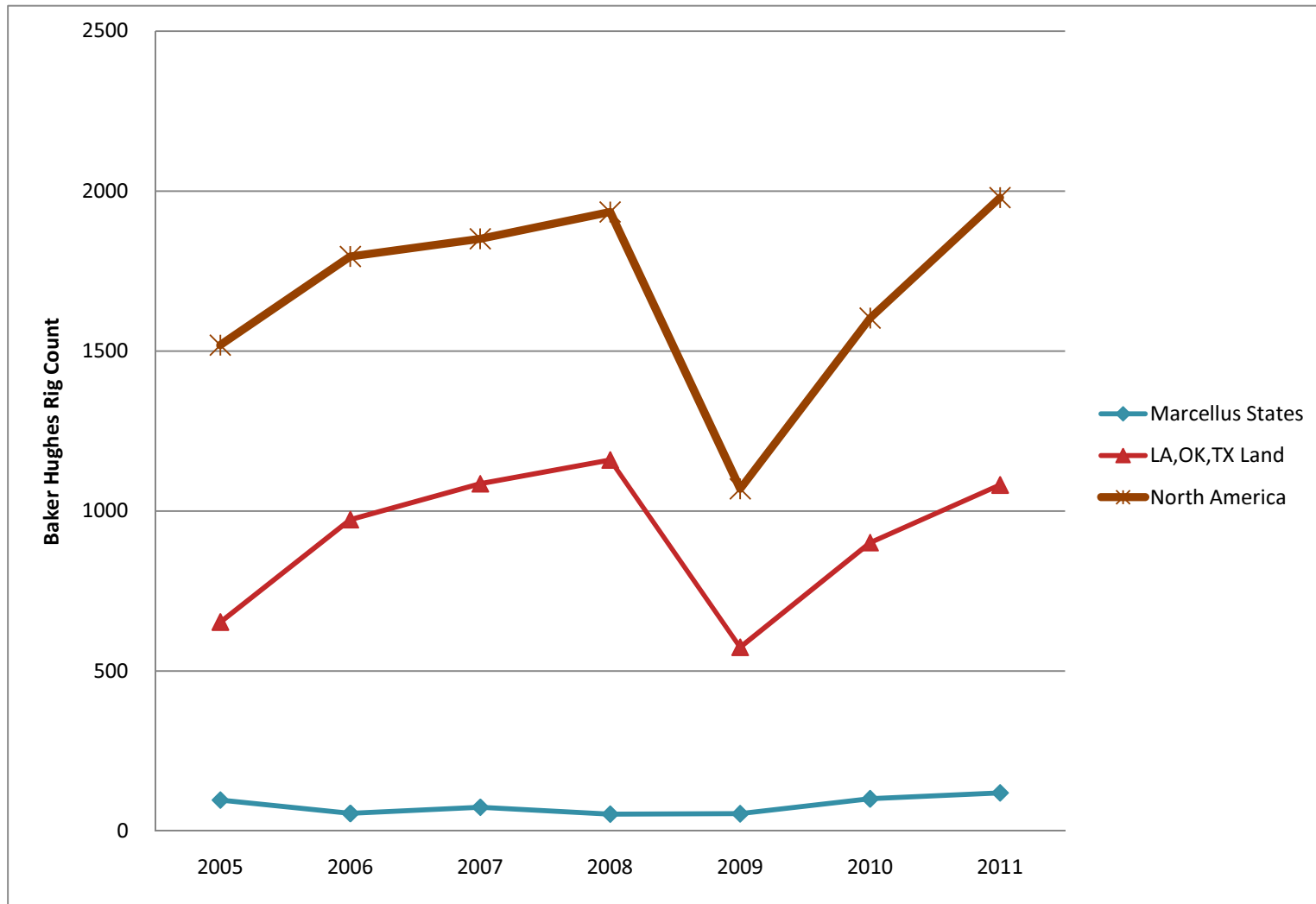


Source: Baker Hughes Rig Count



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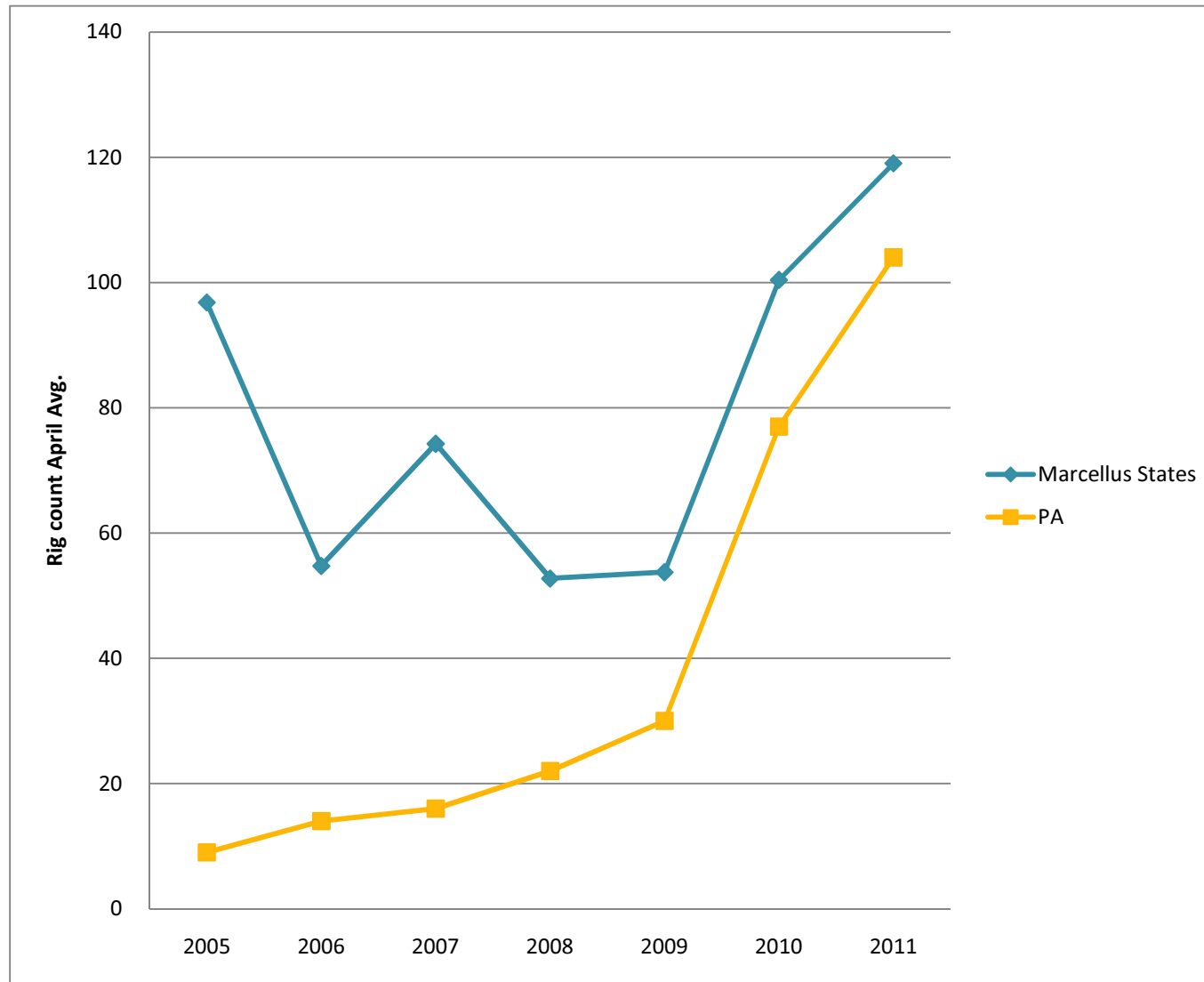
Figure 2. Active Drilling Rigs by Year (April Avg. for Each Year)



Source: Baker Hughes Rig Count

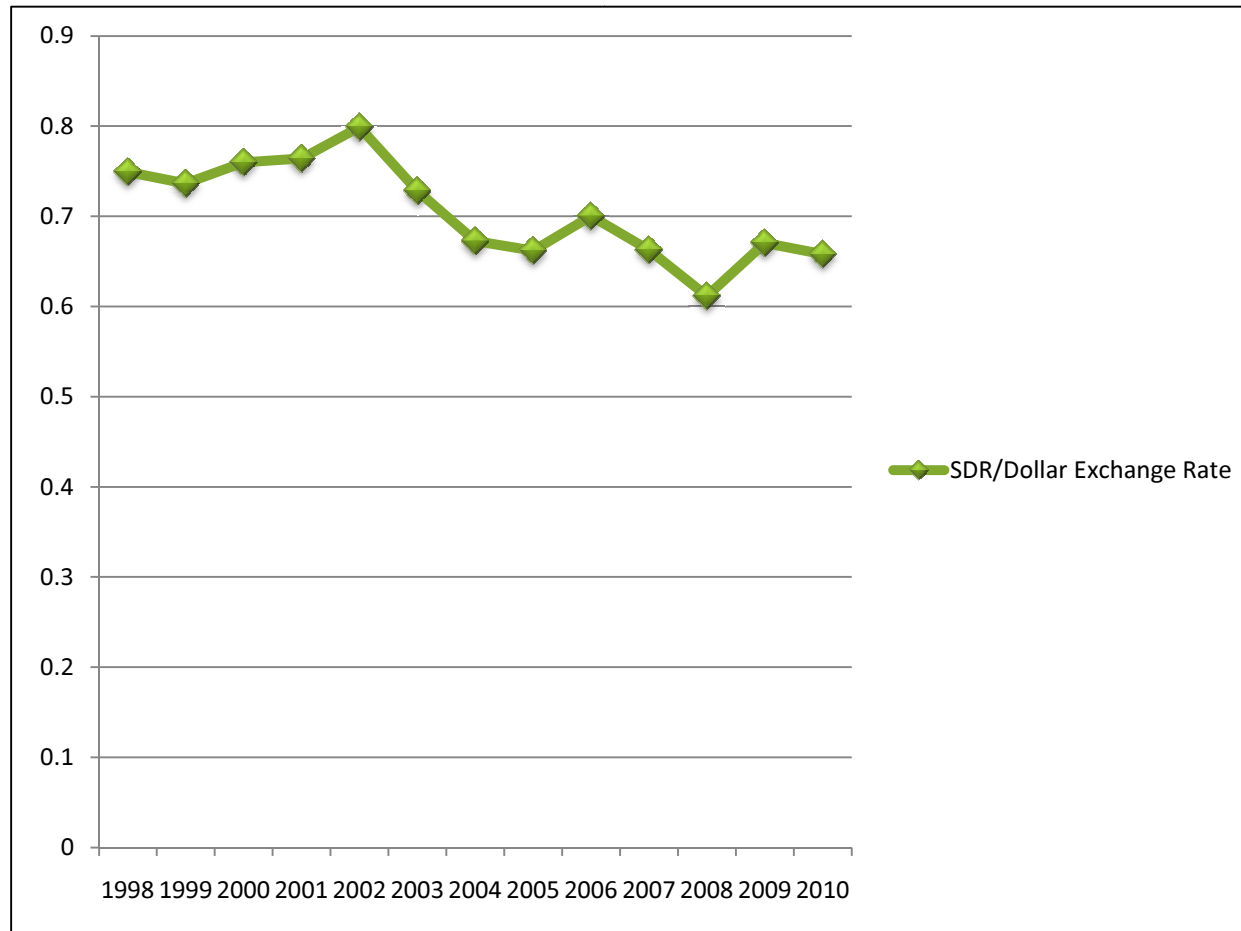


Figure 3. Active Rigs in Marcellus States



Source: Baker Hughes Rig Count

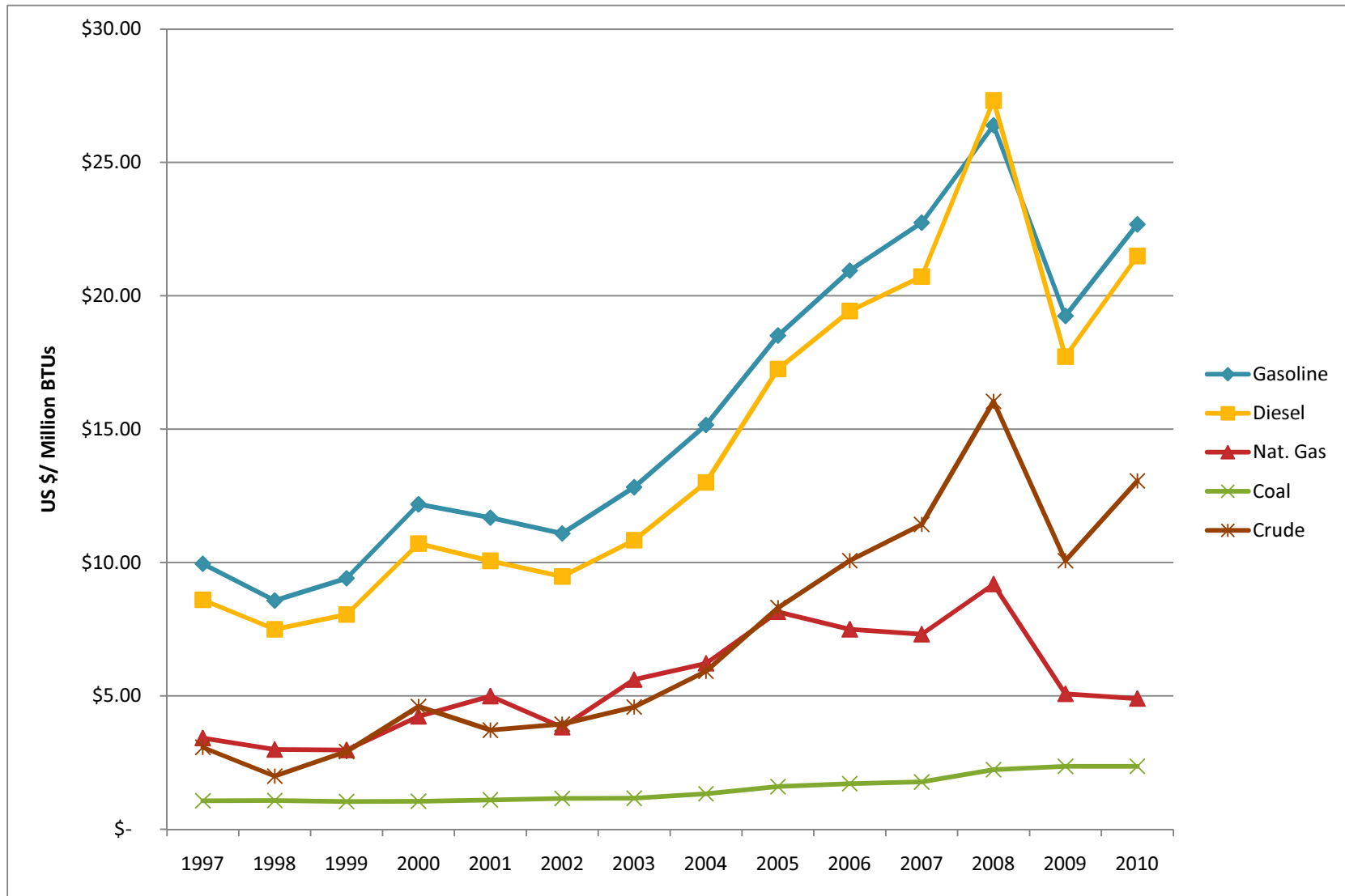
Figure 4. SDR/Dollar Exchange Rate



Source: International Monetary Fund exchange rate database



Figure 5. Average Annual Cost of Hydrocarbons since 1997



Source: DOE

