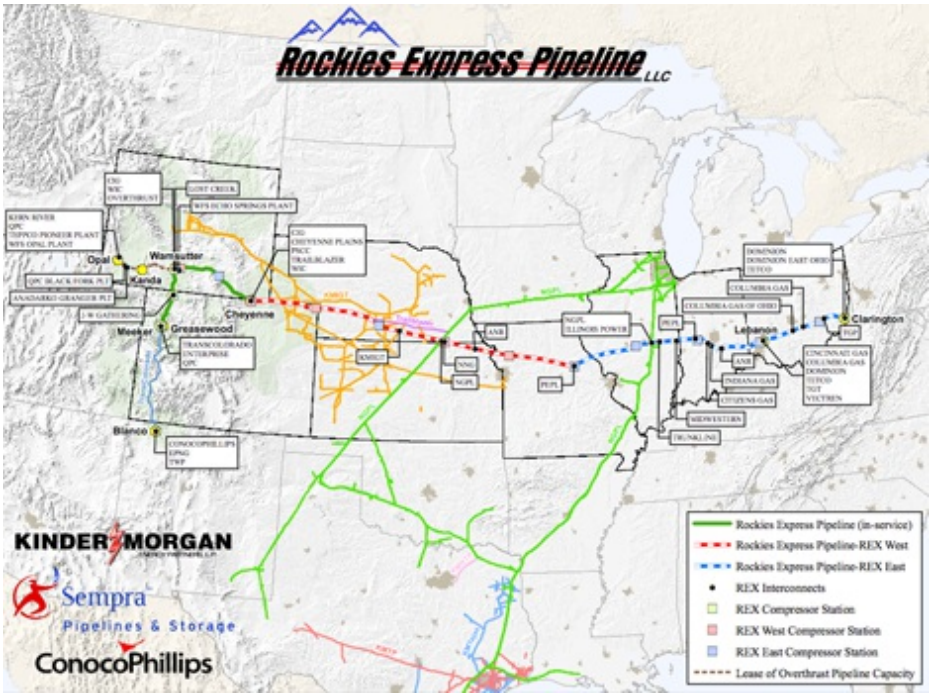
The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Tech Talk - natural gas pipelines and regulation

Posted by Heading Out on July 18, 2011 - 10:10am

In the last post on this topic, I covered some of the earlier developments in the use of natural gas (NG) as a lighting source and began to discuss its evolution into a widely used fuel. That use, and the international marketing of NG, has largely come about as the increasing use of pipelines has made it easier to move NG from places where it is overly abundant to those where it is not. A recent example of this is the Rockies Express Pipeline (REX), which carries NG from Colorado to Ohio, and thence to points East. Out in the West NG is still abundant and so well head prices are low – in 2009, for example, it averaged $3.21 per kcf in Colorado. That same year in Maine, the residential price was $16.43 per kcf (against $8.80 in Colorado). The well head price in Ohio fell from $7.88 per kcf in 2008, the year before the pipeline was completed, to $4.36 in 2009.

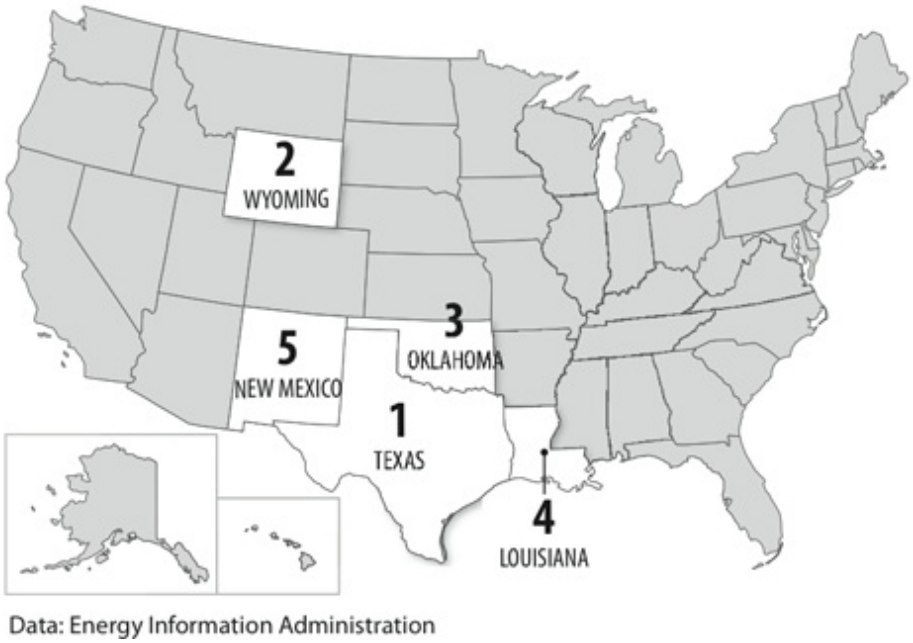


The Rockies Express pipeline (Kinder Morgan)

As new fields such as those in the various shale layers that are now becoming popular are opened, they only become significant as the gas that is produced from the well is connected into a distribution network. Pipeline costs have been estimated as around $1 to $1.5 million per mile. After the pipe is in place it is often hard to see where it runs, in the USA at least.

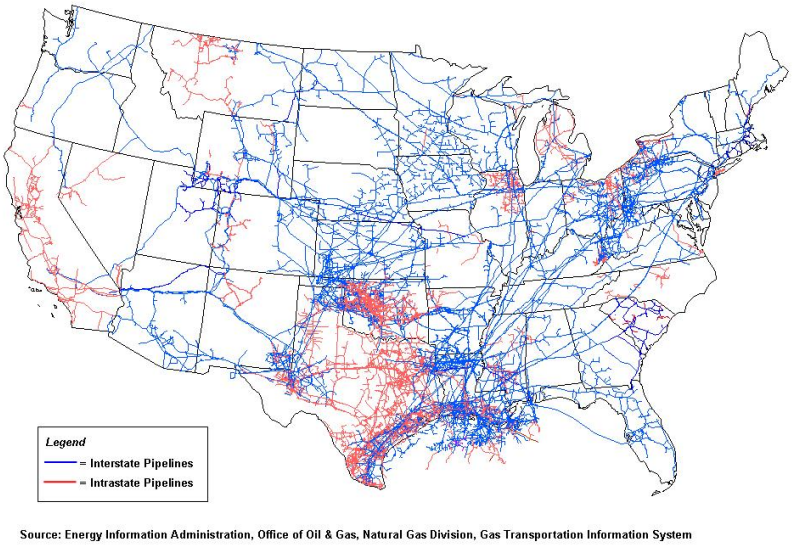
Pipeline route over the Marcellus Shale, after installation

In 2009, the US used some 22 trillion cubic feet of NG (Tcf), moving ahead of Russia to again become the world's largest producer and consumer. In that year the greatest production came from five Southern and Western states.



Top Gas Producing States in 2009 (NEED)

The need for a network to supply other states less fortunate in this resource has largely been met, with new pipelines being installed as needed. However, it should be noted that just having the production does not in itself create nirvana, since earlier this year New Mexico and the Southwest suffered from shortages when demand exceeded available supply due to an unexpected cold spell.

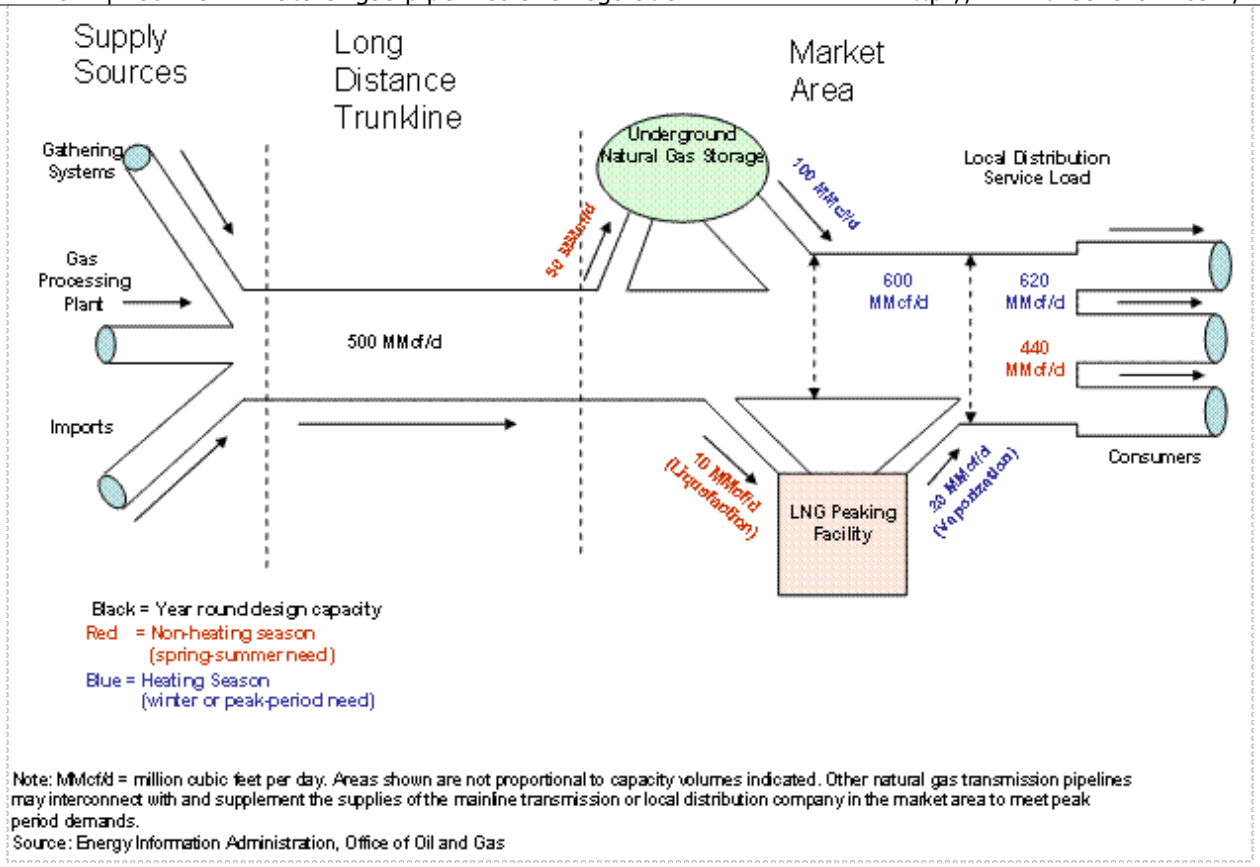


Natural gas pipeline network around the United States (EIA)

This network has made it much easier to ensure that gas is available to customers when they need it. And while this has recently become more of an issue as natural gas turbines are installed to provide back-up power to more intermittent power generators such as wind and solar farms, NG-fueled electric power stations have been the most - in fact, almost the only - conventional new power construction in the United States for several years.

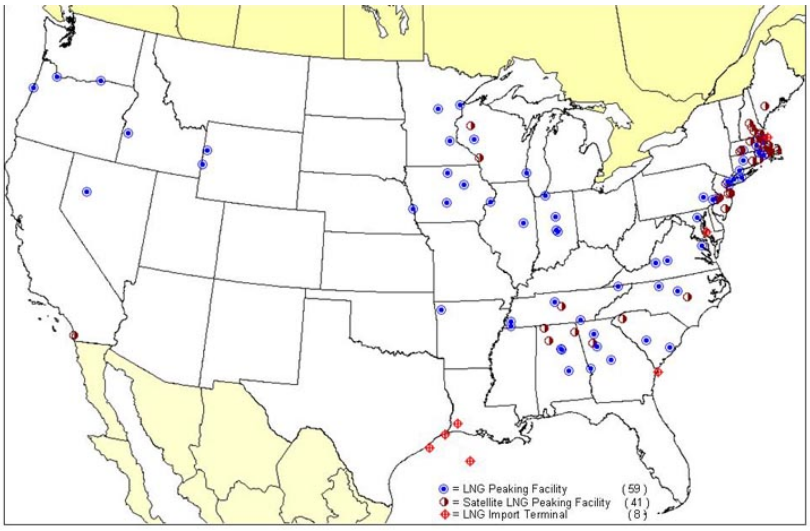
As the experience in New Mexico showed, just having a network of pipes in place is not in itself enough. The first need is that the gas must travel down the pipes to the customers at a given volume, and this requires that it be pumped under pressure. Rather than creating the driving pressure purely at the input end, the pipe travels through a series of compressor stations that raise the pressure along the pipeline length, as friction would otherwise reduce it to below viable levels. For safety reasons gas pressure is reduced as the pipes travel through urban areas, and the normal operating pressure can thus vary between 200 and 1,500 psi. For those that forget Boyle's Law from high school science, at constant temperature, raising the pressure by a factor of 6 will cause an equivalent reduction in the volume of the gas that is being pumped.

However, if you consider the network as a schematic, you will note a couple of additional features.



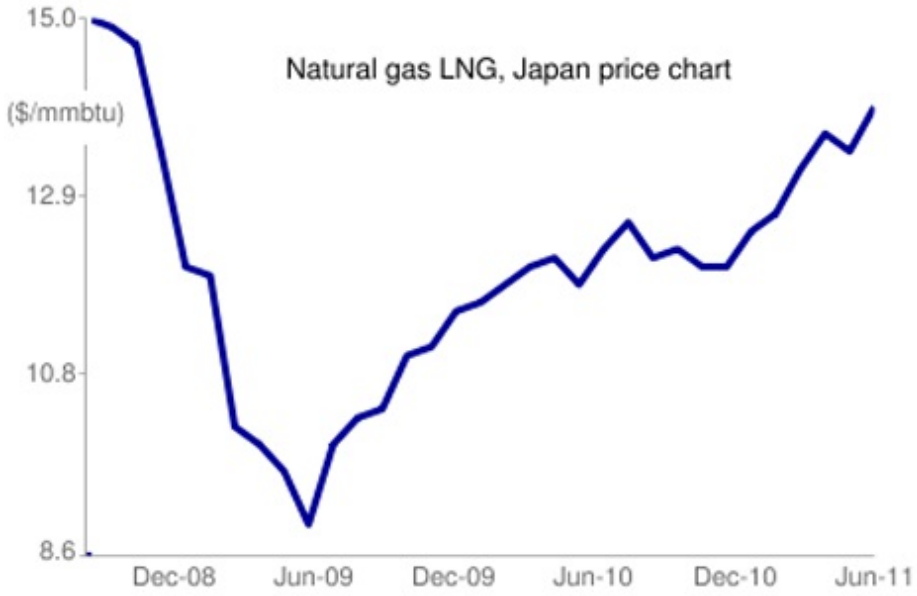
Flow Diagram of the US Gas Distribution Network (EIA)

The two additions are for temporary storage of gas for use at times when demand is high (Note that there are none in the Southwest !). The gas can be stored either as a gas, or it can be cooled to a liquid (which reduces the volume by a factor of 600 and stored in that form. The LNG facilities need a re-gasifier, and if they are taking the gas from a pipeline, also a liquefaction unit to do the initial conversion. By using these facilities that are dotted around the country, pipelines don't have to be as large to ensure that there is enough gas for the consumer at the high demand locations around the network.



Locations of storage facilities for natural gas including LNG import terminals (EIA)

I have used a map that shows the location of LNG import terminals, since this is an additional source of NG for the United States. Again, the volume that is involved is a function of price, though often, to justify the cost of the parts of the supply train, there is a concurrent long-term commitment to a given price schedule, so that spot prices are not necessarily that valid and what is paid in Japan, for example, is not indicative of prices elsewhere. That is particularly true at present since the loss in power from the nuclear reactors in Japan is expected to result in a long-term increase in LNG demand to replace the lost power.



Variation in the price of LNG in Japan (Mongabay)

As I write this the current quoted import price for LNG into the United States is $6.78 per kcf, some $1.71 over the quoted Henry Hub price for NG.

One of the most powerful drivers in the growth of demand for natural gas has been as a result of its increased use in generating electricity. This is particularly evident as it takes market share from coal-fired power stations due to concerns over the emission of greenhouse gases.

> Nationwide, coal-fired electric power generation declined 11.6 percent from 2008 to 2009, bringing coal's share of the electricity power output to 44.5 percent, the lowest level since 1978. Coal consumption at U.S. power plants paralleled the decline in generation, dropping 10.3 percent from 2008.
>
> In sharp contrast, natural gas-fired generation increased 4.3 percent in 2009, despite the 4.1-percent decline in overall electric generation. The natural gas share of generation increased to 23.3 percent—,the highest level since 1970. Electricity's share of the total U.S. natural gas consumption has also risen rapidly, growing from 17 percent in 1996 to over 30 percent in 2009

There is a greater capacity for gas-generated power than these numbers reflect, since the utilities still tend to use coal over NG for longer-term operation as the costs are lower.

The growth of this market developed after the Second World War, and the development of a distribution network. However, in the years immediately after the war the industry was heavily regulated, both in terms of price and volume, in much the same way as the Texas Railroad

Commission had regulated oil. But because the gas entered and left inter-state pipelines it was regulated under the Natural Gas Act of 1938, which among other things forbade the construction of a new interstate pipeline into a state that already had one. In 1954, the Supreme Court voted that the FPC should set wellhead prices for NG. This removed some of the incentive to develop new wells and from then until 1968 production and prices remained relatively steady. In 1968 however, reserve additions* fell from 20 Tcf to 12 Tcf, and in 1969 they were down to 8 Tcf. With the industry still controlled, reserve additions failed to keep up with demand for the next 12 years. However, the Arabian oil (and gas) embargo imposed in 1973 led the price of NG to multiply 750% between 1972 and 1976. Consumption fell at these higher prices, and the market re-equilibrated until 1980. But the over-regulation of the industry led to serious problems.(*Ed. note the word "additions" was originally missed out of the narrative, I am grateful to those who commented on this error).

> The interstate pipeline experience during this period was an unmitigated disaster. To deal with the shortages in the interstate market, interstate pipelines submitted curtailment plans to the FPC describing how they would determine who got gas and who did not. The plans gave top priority to residential consumers. Boiler fuel users, such as electric utilities, were given lowest priority. Users who experienced curtailed deliveries could either shut down their operations or switch to alternate fuels. During the winter heating season of 1977-1978, gas deliveries in New York and New Jersey were curtailed for everyone except residential consumers. Commercial users received only 94.3 percent of requirements, industrial users only 79.2 percent of requirements and electric utilities only 13.5 percent of requirements.

Just as the regulations were being changed to help resolve these problems and de-regulate wellhead pricing, the Shah of Iran was overthrown, and prices took off again. This encouraged new drilling and in 1981 for the first time since 1968, more gas was discovered than was consumed that year. Unfortunately, this happened just as the rise in prices was moving consumers out of the product. The result was a drop in demand, which bottomed out in 1986. With the increase in supply this generated a "gas bubble." In 1986, the Texas Railroad Commission changed the rules to ease sales of the gas to end users rather than just the pipeline companies; at the same time the Federal Energy Regulatory Commission began the series of changes that, by 1992, meant you no longer had to own a pipeline to be able to buy natural gas.

I'll write about where that took us, and the evolution of the gas producers and market as I continue with this short topic next time.