# The Rare Gases Market Report

## Restraint in Supply Makes for a Better Managed Business

### By Richard Betzendahl

**Today there are about 85 plants worldwide designed to extract a crude mixture of Kr and Xe. In this market update, we focus on the supply and demand for krypton and xenon.**

Williams Ramsay and Travers Morris discovered the three gases — krypton (Kr), xenon (Xe), and neon (Ne) — more than 120 years ago. These gases are part of a family of gases most commonly referred to as rare or noble. Completely inert and chemically stable, rare gases are produced from specially designed large air separation plants (ASU). Today there are about 85 plants worldwide designed to extract a crude mixture of Kr and Xe. In this market update, we focus on the supply and demand for krypton and xenon.

The current world production of crude gas mixture (approximately 90 percent Kr, eight percent Xe, and two percent impurities) is around 111,000,000 liters. Of this, krypton is approximately 100,000,000 liters and xenon is about 11,000,000 liters. Note that Xe is 11 percent of the total, not the eight percent you would expect given the ratio of xenon in the crude mixture. This is because some xenon production is attached to the hydrocarbon waste streams of some oxygen plants, instead of having these $O_2$ plants be equipped with internal trays. Some of the krypton is not recovered in this process, but most of the xenon is, causing a higher percentage of Xe to be produced than you would expect.

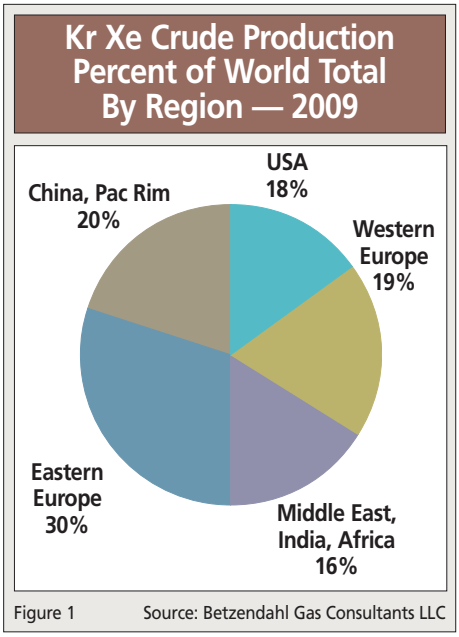


Figure 1 Source: Betzendahl Gas Consultants LLC

The world's production of crude mixture is still controlled by the three largest industrial gas companies — Air Liquide, Praxair, and Linde — plus Iceblick. Together, these four companies control more than 80 percent of all Kr and Xe produced. Iceblick, founded in 1992 with the collaboration of companies from Russia, Ukraine, and Kazakhstan, is the major purifier of crude in Eastern Europe. Iceblick controls most of the former Soviet Union's supply of Kr and Xe, which is almost a third of the world total.

Figure 1 shows the sourcing of crude gas mixture by geographic region. Over the last few years most of the new production has been attached to the large oxygen plants built in China for the steel and chemical industries. Unlike other industrial gases, rare gas supplies are not based on local production. Rare gases are, in fact, global commodities where the balance of demand, supply, and speculation determines price, which makes tracking these markets very interesting.

As the world economy turned positive in early 2010, demand for rare gases began to grow but supply remained fairly flat. As reported last July *(see "Rare Gases Market Update," CGI, July 2009, p. 36)*, xenon demand was down almost 40 percent and krypton was down almost 30 percent from the previous year (2008). As it turns out, demand for both Xe and Kr were near the bottom of a downward trend at that time. During the last 12 months demand for xenon has regained some strength, increasing by about 5–10 percent, but demand remains well below the peak seen in summer of 2008. Krypton is doing better with demand up 10–20 percent, driven by increased demand from insulated window manufacturers.

The most interesting part of the current rare gas supply-and-demand scenario is that anticipated new plant capacity has come on much slower than expected. Some projects have put their crude gas columns, from which Xe and Kr are derived, on hold but equipped their ASUs with trays and taps for future rare gas production. Also of interest is the fact that some major players shut off their older, less efficient crude columns when declining prices for rare gases moved Kr and Xe to low-profit margin levels. These factors, coupled with the slow recovery in the steel industry, have brought supply and demand closer to balance. This new restraint in supply indicates the industry has gotten smarter about managing the rare gas businesses. As readers of past rare gases reports will recall, this market has been typified by wild swings in supply and demand, with the two rarely in balance. In this recession, it appears gas companies have been able to manage supply and prevent prices from crashing back to the unprofitable levels of 2006. Due to this balancing, pricing for Kr and Xe have stabilized. We could begin to see prices rise in late 2010 into 2011 if the world economy continues to grow.

The world krypton market declined almost 30 percent in 2009, hitting the bottom in 2Q of 2009. As pricing lags demand in this market, prices did not stabilize until 1Q of 2010.

Of the two gases discussed in this report, krypton demand seems to be the most in balance with supply. Pricing for Kr dropped just over 50 percent from its peak in 2008, moving from $1.60–$2.25 per liter in 2008 to $0.75– $1.10 per liter in 2010, for large users. The decline in price was directly related to the world economic recession, and specifically to the collapse of the construction industry. Krypton used for insulation in glass windows had accounted for between 40–50 percent of all Kr produced. *(See*

*"Rare Gases," CGI, June 2007, p. 22.)* In Europe, environmental regulations require energy efficient windows, and Kr is widely used in the manufacture of insulated windows. With construction being one of the industries hardest hit by the recession, rapidly decreasing demand for windows drove down demand for Kr. This drop in demand was felt to a lesser extent in the US where the market for insulated windows is smaller. Exacerbating the drop in demand was the effect of the large inventories of Kr that European insulated window manufacturers had built up prior to the recession in late 2008. These manufacturers were able to draw on their inventories for three to nine months.

Other applications for krypton also declined during the economic downturn. The exception to this was in medical markets, which are relatively recession resistant. Demand for krypton used in medical laser applications actually grew slightly during this period.

In the first quarter of 2010 demand for Kr began to pick up as European window manufacturers ran out of Kr inventory and orders for window products resumed. In the US, the strengthening green movement and new government tax credits for energy efficient replacement windows have boosted demand for Kr. The US Department of Energy's (DOE) Building Technologies Program is now coordinating a volume purchase of R-5 windows and low-e storm windows, to expand the market of these high efficiency products(*www1.eere.energy.gov/buildings/windowsvolumepurchase/*). As price is the principal barrier to more widespread market commercialization, the aim of this volume purchase initiative is to work with industry and potential buyers to make highly insulated windows more affordable. The R-value measures a product's resistance to heat loss — the higher the R-value the more energy efficient. The new DOE program qualifies window suppliers for R-5 insulating factor or better and also requires them to offer volume discount prices. The program's goal is to allow government bodies and individuals to buy energy efficient windows for new construction or replacement at attractive prices. Many of the windows that meet this insulating factor are argon-filled triple pane, and some are double pane Kr-filled. The new DOE program will impact both the argon and krypton markets. If construction picks up and the program is successful, supply of Kr could tighten and prices could rise.

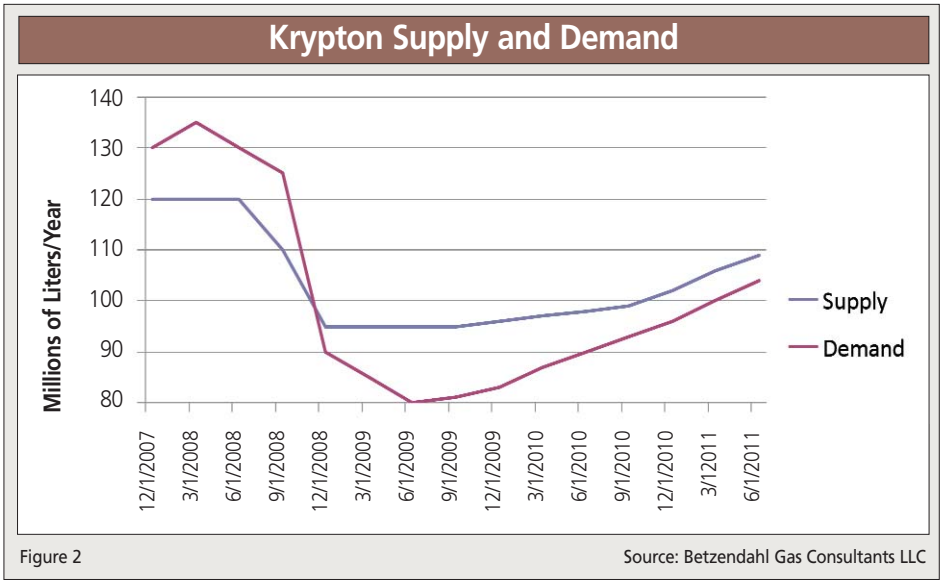


Figure 2 Source: Betzendahl Gas Consultants LLC

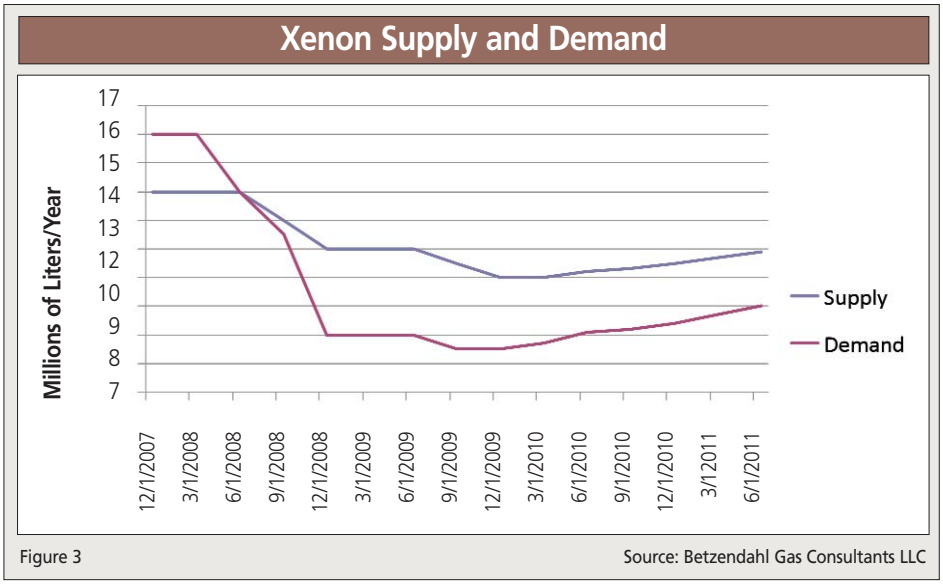


Figure 3 Source: Betzendahl Gas Consultants LLC

World demand for xenon fell by about 40 percent in 2009 and, like krypton, xenon demand bottomed out in 2Q'09. Pricing for Xe dropped nearly 75 percent from its peak of $20.00–$30.00 per liter in 2008 to $6.00–$8.00 per liter in 2010, for large users. As in the krypton market, this decline was driven by the global recession, most significantly by losses in demand in electronics, satellite, and plasma display panel (PDP) markets.

Between 2008 and the end of 2009, xenon consumption in electronics went from about three million liters down to one million liters annually, due to the recession. Demand was also constrained by conservation efforts. *(See "Recovering Xenon and Costs," CGI, July 2009.)*

PDP manufacturers went from an annual consumption of about three million liters of Xe in 2008 to about one million in 2009. This decline is attributed primarily to the cost-cutting initiatives within the PDP industry. While the percent of Xe in a PDP panel has increased, manufacturers have dramatically decreased the annular space in the screen. This space reduction has reduced the consumption of Xe in the PDP market by over 50 percent.

Another blow to Xe demand was Russia's delay of its low level GPS satellite program, the Glonass system. The Russians planned on using almost one million liters of Xe per year for Glonass. This system was scheduled to be operational by mid-2009 but was delayed due to the world recession.

Xenon is also used in the lighting industry, another sector that was hit hard by the recession. The faltering US auto industry, where xenon is used in headlights, caused the largest drop in demand. As with krypton, xenon

applications for medical lasers continued to grow despite the recession.

Xenon pricing stabilized during 2Q'10 and demand picked up slightly. We see this growth accelerating in the second half of 2010 and continuing into 2011 as lighting and satellite markets improve. Going forward, xenon demand in the lighting market will be driven by European Union (EU) and US regulations, which are phasing out incandescent light bulbs. In September of 2009, the first in a series of incandescent bulb bans went into effect in the EU. By 2012 all frosted incandescent bulbs will be banned. The US phase-out of 100 watt incandescent bulbs is set to begin January 1, 2012, with all incandescent bulbs banned by January 1, 2014. Many other countries plan similar actions.

Replacements for incandescent bulbs include compact florescent light (CFL), Light Emitting Diodes (LED) or halogen incandescent.

Compact fluorescent bulbs use 75 percent less energy than incandescent bulbs and include the rather odd looking bulbs available in our markets today. Fluorescent lighting involves lots of industrial and rare gases including Kr and Xe.

LEDs are compound semiconductor devices whose benefits include up to 90 percent energy cost savings over incandescent bulbs. The production of LEDs involves lots of gases but not Kr and Xe. However, LEDs are very expensive and probably five years away from being a realistic alternative for most lighting applications.

Halogen bulbs use a xenon mixture with a halogen gas (hydrogen bromide, methylene bromide etc.). They offer energy savings with better light qualities than compact fluorescent bulbs and at a cost only slightly higher. Two key advantages of the halogen bulb are that it looks like the familiar incandescent bulb and the light is similar — factors that could drive the growth of halogen bulbs over other options.

The future demand picture for xenon is encouraging. As the world moves from incandescent to more energy efficient forms of lighting, it is expected that the use of xenon will increase significantly. The amount of growth will depend on the consumer preference and cost. Over the next 12 months this could add from one million to two million liters of Xe demand. The satellite programs in Russia, the EU, and China are also beginning to start again. Russia has already discussed

needing almost one-half million liters of Xe over the next six to nine months. Satellites could add an additional one million liters of demand for Xe over the next 12 months.

## Helium-3

The rarest gas today is helium-3 (He-3), with product demand being about five times that of supply. The demand for He-3 is driven by its rapidly increasing use in bomb detectors. *(See full story on page 52.)* Unlike helium, which is most economically sourced from natural gas wells, He-3 is sourced as a byproduct of decaying radioactive tritium, a substance used to enhance the yield of nuclear weapons. The US stopped tritium production in 1988. Today there are only a few sources of helium-3 worldwide and prices are approaching $3,000 per gaseous liter. New capacity is very difficult to develop. While helium occurs in the atmosphere, it represents only 0.0002 percent of the air we breathe. Only one company I know of extracts He-3 from the air and this small supply is not commercially viable. In *CryoGas International*'s upcoming November Helium Issue, we will focus on this rare gas in more detail.

## Rare Gases Outlook

Last year's rare gases report correctly projected the stabilization of Kr demand in the summer of 2009 and Xe demand in early 2010. I kept my xenon pricing range broad, projecting declines of between 20–50 percent. Unfortunately, pricing did make it to that outside number, declining by nearly 50 percent in the last 12 months. For krypton pricing, the drop was more than anticipated, with prices falling by 30 percent rather than the projected 10–20 percent.

The next 12 months are difficult to predict as economic outlooks for 2011 are mixed at this time. Some economists believe the world economy will grow two to three percent as we come out of the "great recession" and experience a period of moderate growth. Others warn that we may be headed for a "double dip recession." Obviously, each scenario will yield a different outcome in the rare gases market. I like the moderate growth scenario (having a personal bias toward the optimistic). Under the moderate growth scenario, I expect the demand for Kr to increase and supply to tighten. I believe prices for Kr will increase slightly, in the 5–10 percent range over the next 12 months. This growth will push new supply schemes, making some start ups likely over the course of the upcoming year. With xenon I am less confident. I see prices continuing to be about the same as they are today. Demand will increase but not enough to tighten supply. The major producers still have some inventory, which must be consumed before supply and demand can be in balance. If significant new rare gas capacity were to be brought on to meet the increase in Kr demand, this would add supply to Xe as well and put pressure on Xe prices. This is a tough balancing act for suppliers. If you make Kr, you make Xe: profits are based on selling both products, not selling one and inventorying the other.

If we experience a "double dip recession" then all bets are off. Demand for rare gases will slow and prices will decline further.

Perhaps the most important thing to keep in mind when analyzing the rare gases market is that just four short years ago (2006) krypton was more than 60 percent lower in cost than it is at today's "great recession" prices. And xenon prices were about 50 percent lower in 2006 that they are today. As I stated in last year's article, I do not believe that we will ever see prices

as low as we did then. Why? Suppliers have found ways to bring stability to a roller coaster market by carefully controlling capacity when demand is down and not dumping inventory at a loss. While current prices are still below acceptable returns on new plant capacity, I remain bullish on Kr and Xe in the coming year. ■

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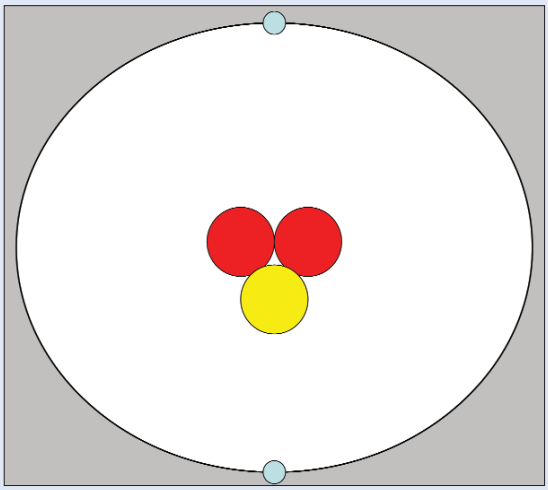
## Key Helium Isotope Supply Crisis

**By Rebecca Renner**



A severe and growing global shortage of helium-3 is threatening scientific research and nuclear security, members of the US Congress heard on 22 April [2010].

Helium-3 fulfils a critical role in cryogenics, neutron scattering facilities, medical imaging research, and radiation detection devices as well as a host of other applications. For decades the gas has been in adequate supply, but now stocks have dwindled while demand has risen dramatically.

The shortage, driven by increased demand for radioactivity detectors following the terrorist attacks of 11 September 2001, and decreasing production, was foreseeable, according to Congressman Brad Miller. As the key supplier and user of helium-3 for both security and scientific applications, the US Department of Energy (DOE) was in a key position to anticipate the impending shortage. However, the DOE failed to see it coming, Miller said at April's hearing, held by the House Committee on Science and Technology's subcommittee on investigations and oversight.

Helium-3 is the stable, inert byproduct of the radioactive decay of tritium, the radioactive heavy-hydrogen used in nuclear weapons. After the cold war, the US had tens of thousands of nuclear weapons and throughout the 1990s the supply of helium-3 exceeded demand. US tritium production ended in 1988, but the stockpile continued to grow. By 2000 the US had accumulated over 200,000 liters of helium-3.

Currently 80 per cent of helium-3 is used for radiation detectors, and while there are alternatives for this application, there are no substitutes that can be used in low-temperature research, William Halperin, a physicist at Northwestern University, Illinois, told Congress.

The supply situation is desperately uncertain, Halperin says: "The DOE is planning to release about 11,700 liters in 2010 but it is not clear where it is going and it is not well established how or when you might get delivery, even if helium-3 is allocated to you."

"Our customers are desperate," says Zuyu Zhao, principle scientist at Janis Research Company, a manufacturer of cryogenic research equipment. Despite submitting applications for helium-3 four months ago, he has not received any gas and has not been informed about the status of some applications. "This problem affects everyone on a global scale," says Zhao.

In February 2009, a governmental interagency team composed of the DOE, the Department of Homeland Security, the Department of Defense, and other government agencies was formed to address the decreasing helium-3 supply. Halperin hopes that the recent Congressional hearing will improve communications between the governmental team and the scientific community.

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