The Federal Helium Program: Problems with Government Policy and the Future of a Non-renewable Resource.

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Abstract

For nearly the last century, the market for helium has been remarkably influenced by legislation from the United States government. This influence has shaped the current climate for helium use, and the future of helium conservation for good and ill. The conservation of this unique element has unique challenges associated with it. It is the intent of this paper to investigate the actions of the federal government; specifically the Helium Privatization act of 1996, and the Helium Stewardship Act of 2013, in regards to the future of the helium market and the social benefit obtained from its variety of uses. This paper will explore legislation with concepts from environmental economics, and, using these concepts, will show where and how the government went wrong in dealing with helium.

Introduction

Despite the fact that helium is the second most abundant element in the known universe, it is a scarce necessity here on planet Earth. Since the 1920's the U.S. government has been aware of helium's strategic value, and has been engaging in legislation and committees devoted to the issue of helium conservation and stewardship. The result of the government's involvement in the helium industry has been a series of acts and amendments that have shaped and directed the helium market worldwide for nearly a century (Cai 2009). Since the first Helium Act of 1925, the uses for helium, and the agents demanding it, have changed drastically. With those changes have come new amendments and acts that are characterized by the helium market of the time. The most impactful piece of legislation was the Helium Privatization act of 1996, which directed and required the government's withdrawal from the helium industry, and the subsequent entry into the market by private enterprises (Garcia-Diaz 2013). This act had a specific time table that was to end on January 1st, 2015 (PL 104, 273), until it was voided by the Helium Stewardship Act of 2013 (PL 113-40), which extended the timetable for the federal helium reserve's privatization. With the extension of the 1996 Helium Privatization Act, the federal government validated its role in helium conservation, and made specific directions for monitoring the helium market in the future. Whether or not these actions align with economic theory of conservation is the emphasis of this research.

In this paper we will detail the specific uses for helium in an attempt to legitimize its pertinence in today's world. The historic actions and responsibilities of the Federal Helium Program will then be explored in order to contextualize its purpose and intentions for the future. We will then investigate several models and valuation methods for the helium industry so that we can build a basis for the economic value of helium in its present, and possible future states.

The involvement of the government as a market power, and as a regulating authority will be addressed as well, because the history of the helium market, and characteristics of exhaustible resource theory necessitate it. By the end of the paper we hope to have built a holistic understanding of the issues facing the Federal Helium Program in the upcoming decades, and to have begun developing a system of regulations or pricing models that best reflect the socially optimal conservation of helium.

Uses for Helium

Helium is an inert, noble gas. It is the second lightest element in the universe and has a number of unique chemical, and physical characteristics that make it essential for a variety of uses. Examples of these characteristics are that helium has the lowest boiling point of any element, and is seven times lighter than air (Garcia-Diaz 2013). Originally, the U.S. government began stockpiling helium for its use as a "lifting gas" for the Department of Defense. The physical property of helium's relatively low density, as well as its non-combustibility made it perfect for use in dirigibles and airships (Nuttall 2012). This particular use was quickly made obsolete by the advancement of aeronautic technology, however helium's overall usefulness has only grown. Today the largest use of helium is in cryogenics where it was estimated in 2010, to comprise 26% of helium consumption (Garcia-Diaz 2013). Liquid helium is currently the coldest known substance, and is used to cool conducting material down past its, "critical temperature", when it becomes what is known as a superconductor. Superconductors are mainly used in magnetic resonance imaging (MRI's) for the medical industries, and technological research. Other prominent uses include optical fiber and semiconductor manufacturing (22%), rocket and missile purging and pressurizing (17%), and metal welding (17%) (Garcia-Diaz 2013).

History of the Federal Helium Program

The U.S. government's involvement in the helium market began when it started to stockpile helium as a resource for national defense. In 1925 the first helium conservation act was passed that, "prohibited the sale of helium to non-governmental users," (Cai 2009). This act stood un-amended for 13 years, as the private sector demand for helium was only just coming into fruition. Then in 1937 the Helium Act Amendment allowed for the government's commercial sale of helium as the demand for helium in the private sector was increasing. Between 1937 and 1960, the Bureau of mines was the sole producer of helium (Mittal 2010).

Private demand for helium escalated drastically throughout the 1950's and led to the Helium Act Amendment of 1960 (Cai 2009). It was around this time that new uses for helium arose, "including applications in space technology, large scale power generation systems, and nuclear power," (Braeutigam 1979). Those uses spurred concern about the future supply of helium, and the conservation program under the 1960 amendment authorized the Bureau of Mines to enter into long-term commercial contracts for the purchase of helium from four private companies called Helex companies. The Helex companies were required to sell crude helium to the Bureau of Mines, where it was subsequently stored in a natural gas field in Amarillo, Texas. By 1973, the Interior had purchased, "about 34 billion cubic feet of helium from private crude helium producers," (Mittal 2010). The intent behind this practice was to prepare for significantly increased demand for helium, but, "By 1967 it was apparent that the actual demand for helium was falling well short of the amounts predicted at the time the conservation program was established." This led to the termination of Helex contracts in 1973, and the cessation of helium purchases from the Helex companies (Braeutigam 1979).

The helium market share for the U.S. government had been declining since the early 1960's with the introduction of the Helex companies, and in the mid 1970's, the private market

share had overtaken that of the government. Increased privatization of the helium market resulted in more competition and further eroded the market power of the U.S. government. The trend of privatization was further encouraged, and completed with the 1996 Helium Privatization Act (Cai 2009).

By 1992 the Helium Fund debt, which consisted of all costs associated with helium production and storage by the Bureau of Mines was estimated at 1.3 billion dollars, of which about 1 billion consisted of interest. The deadline for that debt was September 13, 1995, and the price of helium necessary for its timely resolution was 54 times that of the market price for helium in 1992 (Mittal 2010). Realizing the impossibility of their predicament, Congress froze the Helium Fund debt at $1.3 billion, and passed the Helium Privatization act of 1996. The 1996 act drastically changed the direction and incentives for the Federal Helium program. The two key changes was that, ”Interior was required to offer for sale all but 600 million cubic feet of the crude helium in storage on a straight-line basis,” and, “Interior was required to set sale prices to cover the crude helium reserve’s operating costs and to produce an amount sufficient to repay the program’s debt,” (Garcia-Diaz 2013). The 1996 Helium Privatization Act stipulated the deadline for the aforementioned conditions as January 1st, 2015.

However, in 2012 it became apparent to the federal government that the federal helium supply wasn't going to be sold off in time, and under the 1996 act, helium sales were to abruptly end in 2015. With the recent, massive increases in helium demand since 1996, this kind of a large scale supply shock would have had serious impacts on the technology sector, and the economy at large. In an effort to avoid this shock, congress passed the Helium Stewardship Act of 2013, which extended the sale of helium from the federal helium reserve up to a fixed retainer of 3 billion cubic feet (PL 113-40). This piece of legislation also requires the Bureau of Land

Management to, “in coordination with appropriate international agencies and the global geology community, complete a global helium gas assessment” (PL 113-40). The law further states that information must be provided via the internet on consumption, and pricing trends in the helium market.

The Privatization of The Federal Helium Reserve

In 1996 the Department of the Interior decided that the Bureau of Land Management needed to end its involvement in the extraction and stockpiling of helium. A twenty year plan was put into action that detailed the helium industry's shift into the private sector. This move by the Clinton Administration has been widely criticized as being the most disruptive force in helium conservation efforts since the federal government’s appearance in the helium saga, nearly 100 years ago.

The result of this privatization was a shift in the supply chain of the helium industry. Prior to the 1996 act, the helium demands of federal agencies and contractors were met by BLM run refineries, but the privatization act mandated that those refineries be shut down. Since 1996, helium demands are met instead by private refiners who are required to purchase crude helium from the BLM, (National Research Council, 2010). That crude helium is sold off from the Federal Helium Reserve in Amarillo TX, according to a pricing scheme that, until 2013, was set in accordance with the stipulations of the 1996 act. Those stipulations required only that the price of helium be sufficient to cover the storage costs of operating the reserve, adjusted with inflation (PL 104-273). For 17 years, that policy essentially amounted to taking the total Helium Fund debt, and dividing it by the remaining helium in reserve.

In the early years of privatization, there was relatively small impact on the helium market

because the BLM's crude helium price far exceeded its market value. At the 2013 Committee on Natural Resources, Daniel Garcia-Diaz estimated that “the initial minimum BLM selling price for crude helium after the act was passed was almost double the price for private crude helium at that time” (Garcia-Diaz 2013). This drastic increase in crude helium prices effected only those companies whose involvement in the government required the purchase of helium from BLM supplied refineries. In the private sector, prices remained competitive despite the fact that a majority of the crude helium supplied in the world was coming from the Federal Helium reserve. The 2000 report on the future of helium supplies and prices concluded “that the helium market was in an extended period of stability,” and that, “the 1996 Act would not have a substantial impact on helium users,” (National Research Council, 2000). But helium demand was anything but stable over the following decade, and the BLM's pricing scheme was ill equipped to deal with the sudden increases in helium usage. Once the price of helium in the private market began to rise, particularly during shortages experienced in 2006 and 2007, the BLM price, because of its vast market share, became a price ceiling for the private market (National Research Council 2010). Prices were held back from raising to the economically optimal level, because of the enormous, cheap helium reserve present in the market. That reserve was increasing by a set 2.6% per year despite the much faster rise in demand from emerging technological and medical applications.

Revision of the Federal Helium Reserve

Following the increase in private demand and the 2006 shortages, it was becoming obvious that the federal helium program needed serious revision. The most serious critiques of the helium program were voiced by Anu K. Mittal in 2010, before the Subcommittee on Energy and Mineral Resources, at the House of Representatives. In short, Mittal identified 2 main issues

in the helium policies outlined by the act of 1996. The first was the obvious reality that at current rates, efforts to sell off the federal reserve would fall short by about 9 billion cubic feet, or almost 1/3 of the total reserve. What was to become of this extra helium when the Helium Fund, following the deadline set in 1996, was to be terminated? Mittal, along with the Government Accountability Office, argued that the current legislation was not prepared for this discrepancy from the 1996 act (Mittal, 2010).

The second issue raised by Mittal and the GAO, is the inadequacy with which the BLM set its crude helium prices. It is important to note that the original recommendation of the GAO in 1992, was that the Helium Debt be forgiven, and the helium reserve be allocated with conservation in mind (Mittal, 2010). The response was a debt freeze, and a mandate that all crude helium in the federal reserve be privatized by 2015, for the purpose of repaying that debt. As we have covered before, this pricing scheme encouraged the opposite of conservation focused allocation, and instead incentivised the selling of large quantities of helium at below market value. As stated by the 2013 GAO report, "Refined helium prices have more than tripled from 2000 through 2012, pursuant to demand trends," (Garcia-Diaz, 2013) and the 1996 pricing model was not prepared for that kind of market evolution.

It was appeals like those made by the Government Accountability Office that finally brought about a revaluation of the Federal Helium program. Trends favored an approach to the helium industry that focused on conservation, and uses in the scientific and medical sectors. This approach was put into legislation by the 113th congress, in the form of the Helium Stewardship Act of 2013.

The Helium Stewardship Act of 2013

The first, and most notable action of the Helium Stewardship Act of 2013 was to extend the federal helium program past the previously stipulated date. Under the new act, sales of helium are to continue "no later than September 30, 2021," (Fennell, 2014). The imposition of deadline based policy, combined with the 1996 pricing regulations, previously proved to be ineffective in dealing with shifts in the market. The new model for helium sales implements an auction system to encourage the complete sale of the reserve by the new end-date. A specific percentage of the crude helium left in the reserve is to be made available for purchase every year at a BLM helium auction. This percentage is based on the amount of crude helium made available by the BLM in that fiscal year, and increases in time blocks of 2 to 5 years until the year 2020, when 100% of the crude helium will be made available for sale at auction, (PL 113-40).

The second biggest change, and arguably the most important in the efforts for helium conservation, is a revision of the minimum amount of helium in retainer. Prior to 2013 the BLM was to sell helium until such a time that it had 600 million cubic feet remaining (PL 104-273). The new act more than tripled that value, resulting in a minimum of 3 billion cubic feet of recoverable crude helium to be maintained in the Amarillo reserve (PL 113-40). This remaining helium is only to be used for national security, and federal scientific needs.

Lastly the new act put into place, a much more stringent system for checks and balances. Aware of the lack of adaptability in the previous system, congress made requirements for every stage of development in the helium market to be observed and studied from the perspective of scientists and economists. "Not later than 2 years after the date of enactment of the Helium Stewardship Act of 2013, the Secretary (in consultation with the Secretary of Energy, the Secretary of Defense, the Director of the National Science Foundation, the Administrator of the

National Aeronautics and Space Administration, the Director of the National Institutes of Health, and other agencies as appropriate) shall submit to Congress a report," (PL 113-40). The contents of this report include a formal assessment on the the future of helium demand and consumption, a 20 year strategy for securing federal helium, and a proposal for a prioritization system "that accounts for diminished availability of helium supplies that may occur over time," (PL 113-40).

These additions to the long conversation on the federal helium program were born out of concerns for helium allocation and availability, and make efforts toward the transparency and evaluation that that type of a system requires. However it is important to remember that congress is not made up of scientists and environmental economists, and this new system, may not be optimal from a long term, conservation based perspective.

Considerations for the Future of the Helium Program

The provisions of the Helium Stewardship Act of 2013 exist to combat the negative effects experienced with the previous legislation, but there are still issues with the helium industry. For one, it is my opinion that the 2013 act is responsive in nature and doesn't do enough to address the long term issue of helium availability. Essentially, the law exists to save the privatization efforts began nearly twenty years ago, without considering the legitimacy of that strategy in the first place. There are many, like Mittal and Garcia, who believed that the governments efforts to privatize the helium industry where ill founded to begin with, and did little to address the bigger issue of conservation.

When it comes to helium, conservation is extremely important, because we are dealing with rather short timetables when compared with natural gas and oil supply. In 2008, Cai et al. Concluded in their system dynamics analysis that, "there is no imminent depletion of economical

helium resources before 2060," (Cai, 2009). Even the most conservative estimates from 2013 predict the helium plateau occurring around 2100, or 2075 with higher predicted growth in demand (Mohr, 2014). Based on these predictions, many people from my generation may live to see the end of economically viable helium, which is a daunting prospect. Given the volatile history of the helium industry, the future could hold an even sooner end to helium availability, and it is this volatility that the federal helium reserve should be preparing for.

The Novelties of Helium as a Non-Renewable Resource

Like oil and natural gas, helium is defined as a non-renewable resource because its long-term, natural production is not sufficient to meet consumption. There is nothing surprising about this statement, but there are some differences between helium and other non-renewable resources that I believe warrant further discussion.

When considering oil and natural gas, it is important to think about what economic value these substances actually have for us. It's true that oil itself is non-renewable, but energy is not- there are other, fossil fuel free ways of powering automobiles and power plants- and neither is plastics and lubricants that are derived from oil. Its true that the substance itself has a limited supply, but for all of its uses, there can be found renewable substitutes, and the same is true for natural gas.

However, for helium there exists uses where substitutes simply do not exist in our current scientific understanding, specifically in regards to cryogenics. Helium is the coldest known substance, and no other substance or method of refrigeration is currently known of that can achieve similar results. "Here [in scientific research], no other substance can be used as a refrigerant to achieve temperatures from 4.2 K above absolute zero down to millikelvins,"

(National Research Council, 2010). So in terms of our current understanding, once we are out of economically viable helium, we may never be able to reach those temperatures for useful periods of time ever again. Currently 28% of helium is estimated to be used in the field of cryogenics (Garcia-Diaz, 2013), and a substantial portion of that can be considered non-substitutable use. Helium may represent one of the only, truly non-renewable resources with a non-substitutable use.

Additionally, like fisheries, aquifers, forests and other environmental goods, there are externalities associated with the use of helium. The most notable of these externalities is overexplotation. Overexplotation is defined as the consumption of a resource at such a rate that it cannot naturally replenish itself. This behavior of overexplotation (also known as "mining") results in eventual depletion of the resource in question, (Zetland, 2014). Governments have lots of ways to control consumption of natural resources, like taxes, quota's, and licenses that ensure environmental goods are not overexploited. None of these however, offer a solution to the question of helium conservation, because there is no natural production of helium here on earth. Helium is created inside stars in a process known as nucleosynthesis, after which it is ejected into empty space. With this knowledge, there is no possible way that helium could be anything less than overexploited. In other words, every use of helium results in the "mining" externality because we have no way (short of not using helium at all) to keep our helium usage sustainable.

These novelties should be considered in efforts of conservation. I believe that these two characteristics of helium have been largely ignored by the government, and provide an interesting basis for understanding the value of helium in the future. should be a significant factor in valuing helium in the future.

Previous Models for the Helium Valuation

The market value of helium, and the helium production plateau have been long debated topics with several people proposing different solutions at different times. In 1979 Ronald Braeutigam detailed a method for valuing helium at the "wellhead" called the workback method. The workback method was introduced because of 2 large difficulties in valuing helium. The first of these difficulties is that helium is a production byproduct from natural gas wells, and as such, its value is directly tied to the value of natural gas. The second difficulty is that the involvement of the Interior in the helium market brought the competitiveness of the market into question, this is why the market price of helium couldn't be considered its value, (Braeutigam 1979).

In 1991, A.M. Hughey created a model for helium based on exhaustible resource economics, and optimal control theory. He acknowledged in this model the interdependence between helium and natural gas at the production level, however his model was more focused on helium depletion rate than natural gas production. Hughey's model introduced social and private discount rates into the helium discussion. He argued that the phenomenon of rapid helium depletion could be accounted for in the discrepancy between private and social discount rates. Private parties discount the future more heavily than society according to Hughey, which leads to a sub-optimal rate of helium usage (Hughey 1991).

These two models are important because, while no longer applicable to the discussion at hand, they specify two very important issues with the helium industry. The first is the lack of competitiveness in the helium market that Braeutigam observed. This same characteristic still exists today and creates a similar problem, we don't have a private, competitive price for helium to work off of. The Interior's involvement in the Helex firms caused this deficiency in Braeutigam's time, and the 1996 Helium Privatization Act pricing policy causes it today. The

second issue facing helium valuation is the social discount rate. The private market price of helium (which we don't have) is not necessarily its true value in terms of social benefit as Hughey observed.

From these two models I have extrapolated two key concepts that I believe are imperative for the future of helium conservation. 1) We need a system to give us a competitive, private market price for helium that is largely unaffected by policies or legislation from the government. 2) Once we have a private market value, there needs to be some method for shifting the externalities of helium mining from society, to the consumer.

The Perspective from Economics of Natural Resources and Exhaustible Resources

An important concept from the economics of natural resources is defining types of goods. The four types of goods are private, club, public, and common pool. Helium is interesting because it doesn't fit very well into any of these categories. At the consumer level, helium is a private good because it is rival (the same helium cannot be used by two parties) and excludable (it is possible to exclude non paying parties from helium use). As a private good, theory tells us that in a competitive market, there shouldn't be any market failures with helium production since the market price of helium should perfectly reflect the value of its use. As helium supply falls, prices will rise accordingly and a new equilibrium will be reached.

At the production level however, helium is not a private good. Since crude helium is extracted from natural gas wells as a production byproduct rather than a primary product, it isn't excludable. In other words we don't currently have a way of excluding natural gas refineries from “consuming” or wasting helium since it occurs naturally in their wells. Helium is still rival at this stage however, so it exhibits characteristics of a common pool good. As a common pool good,

theory dictates that the individual incentives for profit, conflict with the socially optimal rate of usage, and hence governance is needed to control the rate at which the resource is exploited.

These two ways of categorizing helium are in direct contradiction, so the question becomes how to allocate helium with the greatest social value. There is nothing we can do to prevent helium depletion, so we must instead turn to the question of maximizing the value derived from the helium we have left. But what is the best way to do this?

Possible Solutions to the Helium Problem

Initially, the GOA suggested that the government dissolve the helium debt completely, and take that value as a necessary loss (Mittal 2010). Had the government taken this advice, they would have been in a fantastic position to aid the conservation efforts. For one, the BLM could have kept its helium supply out of the private market and controlled exactly where that helium was utilized, preventing "frivolous" uses. Alternatively, the BLM could have sold its helium in the private market for profit, which would have resulted in a lower starting price for helium, but translated into a much higher price for helium today. Additionally, this would have provided the opportunity for the BLM to act as a firm with market power, due to their large share of the helium supply. With that market power, they could have sold helium helium at a price greater than their marginal revenue, and curtailed helium usage indirectly with that price mechanism. This would have been the best possible outcome for the helium reserve. However, Congress did not wipe the helium debt as suggested, and instead engaged in the privatization efforts we have previously discussed.

That brings us to the 2013 Helium Stewardship Act, and the efforts of the government to continue with the privatization of the helium reserve, while making provisions for conservation.

This act does little for the conservation effort however, it merely extends the failed privatization efforts of the BLM.

Instead of extending the deadline for the privatization act, the government should have abolished the deadline, and completely changed their strategy for privatization. This new strategy would consist of sponsoring a private company for the distribution of their remaining helium. That private company would pay a fixed cost to the government for each unit of helium that they sell. This "rent" would be sufficient to pay back the remainder of the Helium debt, which as of 2013, is lower than the private market price, allowing room for the sponsored distributor to turn a profit. The private distributor now has an incentive to sell helium for as much as they can, which is congruent with incentives in the private market. The government would recover the cost of the helium debt at whatever rate per unit of helium as they would have under the 1996 act. This system pays back the governments losses, while almost completely removing them from the helium market. It also allows the price of helium to be dictated by the private market, which is adaptable in ways the government simply cant be.

If the system I proposed above were put into place, we would finally be able to observe the helium market operating competitively, and get accurate price signals from the market. Once the market stabilizes, then the government could move forward with conservation based regulations as it saw fit. These regulations could be a helium tax, production quota's, public campaigns, etc..., but until we have a competitive market, we cant know what needs to be done.

Conclusions

Helium conservation is a very complicated topic that we may never have a holistic solution for. But one thing has become remarkably clear to me, we absolutely need to observe

the private helium market with as little governmental interference as possible. Had the government stayed out of the private market in 1996, this would have been easy to do. Alternatively, had the government actually privatized the helium reserve (e.g. sold its helium at the competitive, private market price) then this would have been equally simple. The 1996 Helium Privatization Act and the 2013 Helium Stewardship Act only detracted from the competitiveness of the helium market and made helium conservation an altogether more difficult problem to address.

Braeutigam questioned the competitiveness of the helium market in 1979, and since then things have not improved. In fact, it could be argued that there has never been a competitive market for helium, since the first uses were for national defense. If this is the case, then how can we justify such an invasive governmental presence in the market? I don't think we can, and I believe that the right course of action is to observe helium in its “natural” environment.

In short, the actions of the U.S. Government in the last 20 years have been exactly contrary to conservation efforts. They failed to privatize the helium industry, and they failed to stay out of the private industry. The result has been a severely perverted helium market that experiences unnecessary externalities due to government intervention.

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