Should Pennsylvania Incentivize Natural Gas?
House Democratic Policy Committee Hearing

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Good morning. Thank you Chairman Sturla and Representative Vitali and distinguished members of the House Democratic Policy Committee for the gracious invitation to discuss the idea of incentives for natural gas use. I will concentrate on incentivizing transportation use of natural gas. But let's establish two points for a common understanding. First, natural gas is NOT a bridge fuel to a renewable energy system, it is a simply bridge to nowhere.

There has been a series scenarios of natural gas use developed to seed climate models and these efforts suggest that, the availability of low priced abundant natural gas displaces more than just coal fired electricity production and substantially increases economic activity in general. The combined effect is that there is no discernible reduction in fossil fuel GHG emissions out to 2050. If a high fugitive emissions rate for natural gas production is assumed, climate forcing increases by 5%. To meet the IPCC AR5 goal of limiting warming to 2°C we need to immediately transition to low-carbon renewables (wind, solar and nuclear) and move transportation to the grid. Some see the natural gas transition as an impediment to these climate goals.

Second, natural gas IS a cleaner burning fuel compared to its other fossil counterparts. Less criteria pollutants are emitted on combustion. Compared to coal plants, natural gas plants emit less sulfur dioxide (SO_2) and nitrogen oxides (NO_x), both of which are precursors of particulate matter. Natural gas also has lower primary emissions of particulate matter up to 2.5 microns in size ($PM_{2.5}$) compared to coal combustion. Exposure to $PM_{2.5}$ has been conclusively been linked to human mortality and morbidity.

My colleagues and I have recently had a paper accepted in the journal *Energy* that shows a complete switch to natural gas from coal can result in a reduction of monetized health and environmental damages of between $20 and 50 billion annually. The majority of this reduction is in the PJM ISO region – PA!

Do we need subsidies/ Incentives to make this transition? I can't imagine the Commonwealth can do much at re-work the entire electricity system as this is a massive change but the adoption of the Clean Power Plan will be a step towards this transition. We should expect similar health benefits (but not as large) can be expected for natural gas replacement of diesel fuel because of the particulate emissions associated with diesel combustion.

The use of natural gas in transportation can take the form of compressed natural gas (CNG) or liquefied natural gas (LNG). It is commonly thought that natural gas life cycle greenhouse gas emissions are less than its fossil counterparts for transportation, gasoline or diesel. The often quoted GREET modeling system developed at Argonne National Laboratories shows that there is between a 6 to 11% reduction in these emissions.

However, two recent peer-reviewed publications by two of my colleagues at CMU and graduate student Fan Tong (the lead author) documented an extensive study of natural gas use in the light duty fleet (the cars and trucks we normally drive) and commercial vehicles (delivery vans, trucks, buses, garbage trucks and tractor trailers). They showed that the vehicles using natural gas fuels have slightly higher greenhouse gas emissions based on a delivery of the intended service, a distance traveled (per km) or "freight" movement (per tonne-km). The authors conclude that within the limits of the uncertainty of the life cycle model, natural gas emits the same level of GHG emissions as gasoline or diesel. As I said before there is really no GHG emissions advantage for natural gas use.

Any alternative fuel must compete against the incumbent in the marketplace. Like in politics, the incumbent has some built in advantages. For diesel and gasoline these include vehicles that use the fuel, an extensive infrastructure designed to deliver the fuel, produce and maintain the vehicles, and the entire system is well known and "comfortable" for the general public.

Natural gas starts with an extensive delivery infrastructure of hundreds of thousands of miles of pipelines, some 150,000 natural gas vehicles nationwide, but the end use fueling infrastructure is very limited. I have seen estimates 7 to 61 CNG refueling stations in PA. To put the vehicle numbers into perspective, there are about 600,000 Flexible Fuel Vehicles (FFV) capable of using the alternative fuel E85 in PA. There is four times more PA FFV than natural gas vehicles in the national fleet. So one can assume the number of vehicles to support early use of natural gas in PA is likely very small.

Any alternative fuel has a difficult marketplace entry because of the chicken and egg perspective. The fuel needs to be available to run the vehicles and the vehicles need to be available to use the fuel. There is an infrastructure threshold where fuel availability no longer enters into the buying decision. This is generally thought to be around 10% of the stations offering the fuel. We estimate that there are between 2,000 to 3,000 refueling stations in PA and thus one can envision the need for 200 to 300 stations offering the fuel to reach this milestone. This would be a transition that would be difficult to incentivize with any degree of success, mainly due to costs.

I will point out that after years of federal incentives dating back to the 70's, E85 use in PA is less than a tenth of 1% of fuel sales and there are only 37 refueling stations in the State. The impediment is simply fuel costs. E85 costs more on a gallon of gasoline equivalent basis than gasoline (now E10).

Natural gas has been shown at times to provide transportation services at less cost than its petroleum competitors. This is good. Comparing the price of diesel and gasoline from 2012 to 2014 about ¾ of the time the petroleum fuels were cheaper. Without the cost difference the luster of natural gas as a fuel is lost.

New fuel vehicles having not yet achieved economies of scale, generally have a premium price. Because cost benefits are usually small between the alternative and incumbent proponents look early on to fleet use. The high mileage use allows the initial capital outlay to be rapidly recovered.

Natural gas has been adopted by many fleets, return to base delivery vans are a prime example. The advantage of this strategy is multifold: the fueling infrastructure can be right sized to the use, vehicles can be refueled overnight, and return to base vehicles do not need to be bi-fueled or dual fueled vehicles reducing costs. We should note that within the last year UPS has announced the addition of 15 CNG fueling stations and 1,400 new CNG vehicles. One of those stations is intended for New Stanton.

Although I have been discussing the problems/issues to adopting the alternative fuel there is a sweet spot for a targeted incentive. When I think of public policy issues, I try to imagine policies that can hedge the bets. So if one adopts incentives in hopes of helping the PA economy, creating general prosperity, and potentials jobs, why not target the incentive where we know there are additional benefits that can accrue so that no matter the ultimate economic outcomes there will be a positive benefit-cost balance sheet.

Remember natural gas is a clean burning fuel, we should take advantage of this. The literature is clear that CNG compared to diesel use results in less hydrocarbon, VOC, SOx, NOx and particulate emissions, even with after treatment. These pollutants result in health impacts such as cardiovascular disease and infant mortality. The exact health impacts need to determined based on a specific program but currently, diesel transit buses, return to base delivery trucks, garbage trucks, and school buses all operate in densely populated areas of the Commonwealth. Health impacts are the highest where exposure is the highest. These are the streets of our heavily populated cities and suburbs. A program targeted at these vehicles to aid in switching from diesel to natural gas will likely have monetized health impacts larger than the associated economic benefits. Thus, if one must incentivize do so where it can do the most good.