Comments by PennFuture on the NESCAUM "Economic Analysis of a Program to Promote Clean Transportation Fuels in the Northeast/Mid-Atlantic Region"

October 31, 2011

Introduction

Reducing U.S. consumption of petroleum should be one of the most important economic, national security and environmental priorities being tackled by our state and nation. However, reducing petroleum use has been difficult, especially in the transportation sector, where its use dominates fueling infrastructure investments, commercialized technologies, and consumer purchase patterns. The regional clean fuels standard (CFS) is an innovative policy approach aimed at diversifying transportation fuels through a fuel purchase mandate that prioritizes low carbon fuels over traditional transportation fuels. The goals of the CFS are admirable and completely supported by PennFuture.

Addressing climate change, the definitive environmental challenge of our time, will require innovative public sector policies, political will and private sector support. Presently in Pennsylvania, the required political will and private sector support needed to design, pass and implement the regional CFS may hinge on a number of factors. These include a need to prioritize oil independence, a need to move beyond a preoccupation with Marcellus Shale-based natural gas development and a need to recognize the myriad benefits of clean energy and climate change policy.

PennFuture believes that Pennsylvania's participation in the regional CFS is largely influenced by how beneficial the natural gas and electric utility industries perceive the policy. PennFuture understands and supports NESCAUM's efforts to showcase the potential benefits of the CFS to all stakeholders, including those in industries that will be impacted by the program, through optimistic projections and assumptions. We also recognize that what may seem optimistic today can perhaps be proven to be conservative or even an underestimate in the future. Uncertainty related to assumptions is inherent in any forward-looking analysis. We believe it is critical that the CFS process move forward to the program design phase in order to continue to provide more information to stakeholders and bring us closer to implementing oil reduction policies.

Overview of Clean Fuel Standard Requirements

The framework for the CFS anticipates a 5 to 15% reduction in life cycle carbon intensity of transportation fuels over a period of 10 to 15 years. The NESCAUM analysis focuses on a 10% reduction in carbon intensity achieved over a 10 year period. The requirement would apply only to land-based transportation fuels and intra-national marine fuels. The framework document suggests that heating oil might be added later to the standard.

General Observations

LT: I recommend a different approach to laying out the concerns. Something like:

We recommend that the CFS proceed to the detailed policy design phase to validate pathways for compliance. Further we recommend that NESCAUM and the states consider complementary policies that can help accelerate carbon intensity reductions under a CFS umbrella policy for the region.

The NESCAUM analysis demonstrates very large economic benefits from various scenarios to meet CFS targets. The scenarios rely on aggressive and optimistic assumptions to reach the higher end targets for carbon intensity reduction of the fuel pool. We realize that the final targets have not been set. To properly design the policy, a more fine-tuned set of fuel pathways needs to be considered within the bounds outlined by the economic analysis. Below we outline some areas where the fuel pathways need more exploration during the process of setting the final targets.

Policies complementary to the CFS can accelerate alternative fuel development and deployment. The CFS will create a system that spurs innovation and deployment of alternative fuels but our current oil dependence and need to reduce carbon pollution requires that we act on transportation fuels as fast as possible. We recommend that the CFS policy be adopted and, in parallel, the region deploys complementary policies that will also help address the uncertainties discussed in these comments.

Although long-term economic impacts of the CFS are positive, there are some concerns about the potential for negative economic impacts in the early years of the program. PennFuture is interested in understanding if there is a way to design, adjust or phase in the program in a manner that would avoid or minimize these negative economic impacts. We believe this is an important issue to address, especially considering the economic situation in Pennsylvania and the nation.

When developing the design of the CFS program, NESCAUM should consider re-examining some of the assumptions made about technology and cost breakthroughs. For example, the NESCAUM scenarios assume that one technology (biomass, natural gas or electricity) will achieve a technical and cost breakthrough and therefore be used to achieve 60% of the required reduction of CO_2, while it assumes that the other two technologies will remain high in cost and carbon emissions and yet each achieve 20% of the reduction. Such a scenario is highly unlikely, and if it did occur, it seems unlikely that 20% of the reductions would be achieved by losing technologies. For example, in the biofuels scenario with low oil costs, 50% more natural gas vehicles would be in use when a car costs $7,000 more than a gasoline vehicle compared to the natural gas scenario when a natural gas vehicle price is the same as a gasoline vehicle.

Technology deployment rates and future prices are extremely hard to determine. At the time of the conclusion of the economic analysis, there were few battery electric or plug in hybrid electric vehicles on the market, virtually no advanced biofuels and natural gas technology experience that is basically limited to some light duty vehicles, buses and large municipal trucks. NESCAUM did a solid job of projecting vehicle technology and cost development, accurately asserting that technology improvements and increased volume manufacturing will reduce costs for these technologies. As part of the program design phase, to assist in the difficult process of developing cost projections and production paths for biofuels, NESCAUM could consider future scenarios using data from previous adoptions of commodity technologies. PennFuture believes that electric vehicle production and costs are likely to follow the history of hybrid vehicles over the past 10 years and it is less likely that advanced vehicle technology development will adhere to Moore's law.

Consumer behavior is another unknown that makes the economics of the CFS very hard to predict. Payback periods are important to consumers purchasing relatively higher priced advanced vehicles, as compared to traditional vehicles. The length of the payback period for the incremental cost differential may change as oil prices, advanced vehicle premiums, CFS credit prices, alternative fuel prices and other factors fluctuate. It would be interesting to better understand how these factors could affect consumer purchasing behaviors and the ability to meet or exceed the CFS.

CFS credit values are instrumental in creating a regulatory scheme that incentivizes low carbon fuels. The delicate balance of finding a credit price that affects the alternative vehicle and fuel markets while not adversely impacting the consumer may be difficult to achieve. NESCAUM may therefore want to develop sensitivity analyses in the program design process that look at technology development and costs, consumer behavior and macroeconomic impacts at different CFS credit prices.

Biomass Section

The first renewable fuels standard (RFS1) passed in 2005, required 7.5 billion gallons of renewable fuel by 2012. In 2007, a second standard was passed (RFS2) which requires 16 billion gallons of cellulosic ethanol, at least 1 billion gallons of biomass-based diesel, and total advanced biofuels of 21 billion gallons, all by 2022. It also requires total renewable fuel volume of 36 billion gallons in 2022. EPA is empowered to set biomass-based diesel targets as long as the minimum requirement is reached by 2022. Interim targets are established for cellulosic ethanol, total advanced biofuels, and total renewable fuels, but EPA is authorized to modify these totals based on available manufacturing capacity.

A portion of the CFS would be met by the national RFS. If the RFS is met, then about one third of the CFS goal would be accomplished. However, the RFS goals are subject to administrative decisions dependent on biofuel production capacity; therefore, the goals can be lowered or otherwise relaxed. A recent NRC report shed serious doubt on the likelihood that the RFS will be achieved.[1] The "Billion Ton Update" published by EERE has an estimate of potentially available biomass estimates that 420 million tons of total biomass might be available in the US in 2022 at a price of $40 per dry ton for forest residue biomass and $50 per dry ton for agricultural biomass.[2] If the price level was raised to $80 per dry ton for forest residues and $60 per dry ton for agricultural biomass then about 650 million tons might be available. The lower price would average $3.20 per million Btu based on higher heating value while the higher price would average $4.35 per million BTU. The anticipated wholesale price of natural gas in 2022 is $4.00 per million BTU, as referenced by NESCAUM through EIA projections. Therefore, unless the low price biomass prevails, it may be difficult for biomass to compete with natural gas as a fuel, all other factors held equal. The value of the CFS credit price could impact the cost competitiveness of biomass compared to other low carbon fuels that have comparatively higher lifecycle emissions, as well as compared to traditional fuels.

Average yield of cellulosic biomass is 80 gallons per ton of dry biomass and therefore 200 million tons of dry biomass would be required to produce the cellulosic ethanol required by the RFS2. Williams *et al*.[3] report that gasification of biomass would produce about 80 gallons of diesel and gasoline using the Fischer-Tropsch synthesis technology. Other reports using different gasification/pyrolysis approaches report somewhat higher yields but they have yet to be proven in practice. It is worthwhile to note that first of its kind commercial plants handling solids are generally more costly and more difficult to achieve efficient operation than plants handling liquids or gases. Therefore, biofuel plants that handle solid dry biomass may take longer than projected to reach full capacity and cost reductions.

If 5 billion gallons of advanced biofuels were required by the RFS, then around 50 million tons of dry biomass would be needed to produce the fuel required by the RFS. The total RFS2 requirement of 21 billion gallons of advanced biofuels would require almost 250 million tons, excluding any biomass based diesel. Thus merely meeting the RFS2 would utilize 59.5% of the biomass resource available in the US at an average cost of $3.20 per million BTU of biomass. Thus it would appear that there may be adequate biomass theoretically available to meet the RFS2 target. However, if the RFS2 target is met by 2022, there will be serious constraints on the supply of biomass which would be required to meet the CFS. Similarly, the use of biomass for local heat (which is often more economical than oil where natural gas is unavailable) will further constrain biomass supplies. If the RFS2 target is not met, indicating perhaps the inability to produce cost competitive advanced biofuels, then the CFS will require greater volumes of other, non-biomass, low carbon fuels.

Both cost and availability of advanced biofuels, as defined by the RFS, are highly uncertain. No commercial plants are currently producing cellulosic ethanol or advanced biofuels based on plant matter in the US. For example, the low end estimate of cellulosic ethanol is $0.62 per gallon based on waste

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[1] National Research Council, "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy, 2011

[2] US DOE, Billion Ton Update, August 2011, http://www1.eere.energy.gov/biomass/pdfs/billion_ton_update.pdf

[3] Williams et al, "Comparing climate-change mitigating potential of alternative synthetic liquid fuel technologies using biomass and coal", Princeton Environmental Institute of Princeton University, 2006, http://www.netl.doe.gov/publications/proceedings/06/carbon-seq/Tech%20Session%20178.pdf

biomass. If we look at the Billion Ton report we find that 80% of the projected biomass in 2022 will be waste at a price of $3.20 -$4.35 per million BTU. Agricultural biomass in the Billion Ton study is defined to include crop residue, agricultural processing residue, and energy crops. The forest biomass definition includes pulpwood, urban wood waste, mill residues, and forest residues. The costs shown above are weighted average costs for both agricultural biomass and forest biomass. The price of feedstock in the Billion Ton study corresponds to feedstock costs of $0.65 - $0.88 per gallon of cellulosic ethanol. Biomass comes from many sources, some of which are waste streams that must be disposed of. The cost of such material is normally low and can even be negative. Crop residues must be collected and processed which makes them more costly than waste streams. Primary forest wastes require a parallel infrastructure to recover during the logging operations and may well be more costly yet. Urban wood wastes have no inherent cost but must be separated from other urban waste and processed to remove materials that might be detrimental in manufacturing biofuel and the cost of this can be low or high. The NRC study on RFS2[4] presents a detailed analysis of the cost of harvesting, transporting and storing each of the waste fuels. In the case of corn stover, the NRC estimate of feedstock cost at the point of use is significantly higher than the cost of ethanol from waste assumed in the NESCAUM study.

All of these sources with varying costs can be depicted on a supply curve which determines the amount available at a particular price. Today, a corporation with waste biomass might be willing to give it away rather than have to pay for its disposal. If a market is developed that uses these types of material, even the waste producer will want to make money, since it makes no sense to give away a product that someone is willing to pay for. In a perfect market, all of the biomass would sell for the price at which the highest cost biomass producer in the market can accept. This is referred to as the marginal price point since it is the cheapest possible price for the next available ton of biomass. As a market develops the cost for currently unused biomass will rise to this marginal price. Since not all biomass has the same utility in producing fuel or other bio products the actual cost paid per ton will be adjusted to compensate for this fact, but in general almost all of the biomass will be sold at a price near the marginal point. Since the RFS will consume about 60% of the potentially available biomass at a moderate cost in the US, and the cost of biomass will be equivalent to $0.65 per gallon, the low cost scenario in the NESCAUM report that projects biomass waste ethanol at $0.62 per gallon seems overly optimistic. The recent National Research Council Report suggests that biomass will be considerably more expensive than projected in the Billion Ton study and suggests that the RFS2 may not be met.

As a result of the information above, NESCAUM may, as part of the program design, want to provide additional information about the production of biofuels in the northeast. The economic analysis relies on PA and NY as the main producers of biofuels, since forest products in the rest of the northeast are already being used. There is not much crop waste in PA and the PA DCNR report indicates that utilizing significant amounts of biomass from PA forests will not be easy. PennFuture believes that the CFS program design phase should incorporate a better understanding of the availability and cost of biomass over the northeast region, combined with an examination of the effects of potential competing demand for biomass from heating, electrical generation and biofuels.

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[4] National Research Council, “Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy, 2011

Electricity Section

Electric vehicles should continue to be encouraged in the marketplace. They can reduce conventional automotive emissions, reduce US dependency on foreign sources of energy and, as our electricity generation systems becomes less carbon intense, can increasingly help reduce net carbon emissions.

Optimistic Assumptions about Advanced Vehicle Technology Penetration

NESCAUM should, as part of the program design process, further explain its assumption that both plug in hybrid (PHEVs) and battery electric vehicles (BEVs) will be cost competitive with internal combustion engine (ICE) vehicles within the period of the CFS implementation. In the 2012 model year both PHEVs and BEVs will have a base price almost $20,000 higher than the base prices of other mid-size sedans. While they may have optional equipment not included in base models of ICE vehicles, the incremental cost for an equivalently equipped vehicle is somewhere in the vicinity of $15,000. It is highly unlikely that the price of a PHEV can reach equity with an ICE because of the higher inherent complexity of the system which requires most components of both BEV and ICE vehicles. Similarly the BEV needs much larger batteries and a major breakthrough will be needed to achieve parity with the cost of ICE vehicles.

While developing the design of the CFS program, NESCAUM could look at the differential cost of hybrids, which have related ICE-only models, over time to determine the rate of improvement in battery technology. The Honda Civic hybrid has been in production over 10 years, the Ford Escape over seven years and the Camry hybrid for six years. In spite of this, the hybrid models are still priced far higher than the equivalent ICE-only models. Once this real data analysis is completed, an optimistic case where future progress is 25% faster than historical and a pessimistic case with progress 25% slower could be selected to provide a probable range of price and performance of PHEV and BEV vehicles during the CFS implementation. An example of comparative PHEV and BEV costs is especially relevant to battery life and replacement. For example, the Prius has only a 1.3 KWH battery with a replacement cost around $2,200, while the Volt has a 16 KWH battery and the Leaf has a 24 KWH battery. While it is certain that battery prices will come down, it is uncertain as to whether or not they will fall enough to have PHEVs or BEVs with no differential purchase cost, as compared to ICEs.

Existing and proposed increases to the Corporate Average Fuel Economy (CAFE) standards are pivotal policies required to reduce oil consumption, decrease transportation sector pollution and develop advanced vehicle technologies. The exact outcome on vehicle technology development, automaker model offerings and consumer purchasing behavior resulting from the CAFE standards is unknown. Furthermore, it is unknown how CAFE will impact advanced vehicle cost differentials. PennFuture is interested to understand NESCAUM’s perspective on how changes to the CAFE standard may impact advanced vehicle market penetration, cost reduction and pollution reduction.

Carbon Emissions Profiles Are Dependent on Dispatch

Average greenhouse gas emissions from electricity production in the northeast (NERC regions – examples: NEWE, NYUP, RFCE)[5] are lower than emissions from oil-fired generation (1672 lbs CO2/MWH). Emissions reductions are also realized when comparing electric powered vehicles powered from the grid to oil-powered ICE vehicles. However, the emissions profile of an electric grid will change depending on the fuel mix of generation sources operating at any moment of the day. Electric vehicles will likely recharge during the night when wind, base load nuclear and coal are predominantly powering the grid. The time of day/night when a vehicle is charged will impact its emissions reduction potential, making it difficult for determining compliance and credit value, unless general averages are used.

Natural Gas Section

Natural gas is a critical component to reducing pollution and U.S. oil dependence and should continue to be promoted through the regional CFS. However, PennFuture believes the NESCAUM economic analysis overestimates the cost effectiveness of emissions reductions from natural gas vehicles. This is due to assumptions made about natural gas production, infrastructure, vehicle efficiency and technology use that effect emissions reduction potential. When developing program design, NESCAUM should take a closer look at the natural gas assumptions to confirm that natural gas will be competitive in the CFS. If reanalysis indicates natural gas may not be competitive based on carbon reductions alone, perhaps NESCAUM could recognize some of the criteria pollutants (in addition to greenhouse gas) reduction benefits that result from natural gas and other alternative fuel use.

The NESCAUM analysis' assumptions about biogas penetration are based on rather optimistic assumptions about the fuel's ability to compete on costs with natural gas. This assumption leads to a likely underestimate of natural gas infrastructure costs.

Unconventional Natural Gas Emissions

There are uncertainties related to NESCAUM assumptions made about life cycle emissions of CO2 from using alternative fuels, especially emissions from natural gas vehicles. Unconventional (shale) natural gas requires additional energy inputs compared to conventional natural gas, in order to extract natural gas from shale rock trapped deep underground. These energy inputs result in pollution emissions, including greenhouse gases. NESCAUM's lifecycle analysis factors in only conventional sources for natural gas alternative fuel, therefore the emissions factors are artificially low.

Since Marcellus shale gas will be predominately used for NG vehicles in the northeast region it is desirable to know the effective greenhouse gas emissions from this source. Unfortunately, at this time there is no clear answer to that question. Most studies examining lifecycle greenhouse gas profiles compare natural gas to coal in electric power applications. Using combined data and assumptions from

[5] EPA eGrid Data on NERC Region CO2e output, http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf , NEWE 863.4 lb/MWH; NYUP 686.7 lb/MWH; RFCE 1065.2 lb/MWH.

several studies[6] may assist in estimating comparative emissions from natural gas and gasoline in transportation application and account for distribution loss, GWP of 25 and CNG vehicle efficiency, and other factors. Using this approach, a range of greenhouse gas emissions reductions can be established for natural gas vehicles ranging from only a few percentage points reduction to up to a 13 percent reduction in emissions, as compared to gasoline vehicles.

However, unconventional shale gas provides another complicating factor that cannot be easily resolved. Most of the emissions from shale gas production result from fracking or reworking the well. These events emit very large amounts of methane, and they reoccur periodically during the life span of a typical well as it is reworked. Thus the calculation of lifetime average emissions is based on an assumption concerning the volume of gas recoverable from an average well. If the EIA estimates[7] of 1.42 billion cubic feet per well are correct, then emissions from shale gas used for CNG would be 20 percent or so higher than for gasoline.

Recent draft EPA regulations propose to require the use of reduced emission completions for both initial completion and reworking the unconventional wells, as well as reduced emissions from pneumatic controllers and centrifugal compressor seals. These regulations would reduce completion and rework emissions of methane by 90%. This change alone would reduce the CO2 equivalent emissions of CNG by about 32 pounds per million BTU and give CNG a 15% reduction in GHG emissions below that of gasoline. The effect of EPA regulations relating to pneumatic devices and centrifugal compressor seals are less clear but may provide a further 1-3% advantage for CNG over gasoline. It must be stated however that all of the available data sources are of mixed credibility, and its applicability to Marcellus shale is unknown.

Infrastructure, Efficiency and Technology

The NESCAUM economic analysis only factors in emissions and infrastructure cost for CNG vehicles. Natural gas has less energy per unit volume than conventional gasoline or diesel fuel, therefore compression to reduce fuel volume is required to provide a similar amount of energy. Many heavy duty vehicles may require liquid natural gas (LNG), which requires more energy to liquefy than the compression energy required for CNG, to provide enough energy for long distance travel. LNG will have greater lifecycle emissions than CNG, which should be considered by NESCAUM.

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[6] Paulina Jaramillio, "A Lifecycle Comparison of Coal and Natural Gas for Electricity Generation and the Production of Transportation Fuels", Carnegie Mellon University, December 2007, located at: http://wpweb2.tepper.cmu.edu/ceic/theses/Paulina_Jaramillo_PhD_Thesis.pdf
Skone, T.J., "Lifecycle Greenhouse Gas Analysis of Natural Gas Extraction & Delivery in the United States", National Energy Technology Laboratory, summary presentation located at http://cce.cornell.edu/EnergyClimateChange/NaturalGasDev/Documents/PDFs/SKONE_NG_LC_GHG_Profile_Cornell_12MAY11_Final.PDF
David Hughes, "Lifecycle Greenhouse Gas Emissions from Shale Gas Compared to Coal: An Analysis of Two Conflicting Studies", Post Carbon Institute, July 2011, located at http://www.postcarbon.org/report/390308-life-cycle-greenhouse-gas-emissions-from

[7] U.S. Energy Information Administration "Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays", U.S. Department of Energy, Washington, D.C., July, 2011, page viii, http://www.eia.gov/analysis/studies/usshalegas/pdf/usshaleplays.pdf

Relative efficiencies of different technologies are also important to consider when estimating costs effectiveness and emissions. Diesel engines modified to use CNG are less efficient using natural gas than unmodified engines using conventional diesel fuel. Venkatesh *et al.* have recently concluded that on average current transit buses using CNG fuel emit about 7% more CO2 than conventional diesel vehicles but that a new generation of engines may lead to buses using CNG emitting 3% less CO2 per mile traveled.[8] A study shows a 19.5% reduction of carbon dioxide equivalent emissions using CNG in place of gasoline in light vehicles. On the other hand use of CNG in light diesel vehicles results in an 11% increase in carbon dioxide equivalent emissions.[9] Argonne National Labs analysis indicates a 3-12% increase in CO2 by switching from diesel to LNG.[10]

Criteria Pollutant Reduction

Criteria pollutant emissions are far lower for natural gas vehicles compared to traditional gasoline vehicles. Compared to similar gasoline vehicles carbon monoxide is reduced at least 90%, NOX by 35-60%, non-methane hydrocarbons by 50-75%, with zero evaporative loss and near zero particulate. However, the data for diesel powered vehicles is more complex. Several studies on CNG emissions with conventional diesel engines (no particulate filter and not ultra low sulfur diesel fuel) indicate that CNG significantly reduces criteria pollutants.[11] A study in New York city using ultra low sulfur diesel and particulate filters showed that clean diesel buses emitted less particulate, less CO, and much less non-methane hydrocarbon than CNG fueled buses but somewhat higher NOX .[12]

Studies in California show that toxic air emissions including aldehydes and ketones are much higher with CNG buses.[13] It is clear that natural gas spark ignition engines would result in pollution reductions that could improve health in metropolitan areas. Diesel conversions to CNG would reduce NOX but possibly have mixed results on other pollutants as studies provide conflicting results. Comparatively, electric vehicles would have zero emissions of criteria pollutants. However, the effective emissions would depend on the mix of electric generation sources powering the grid and the health effects would depend on the spatial distribution of the various energy sources.

There are uncertainties about the lifecycle greenhouse gas emissions of unconventional natural gas and how changes in the LCA assumptions could affect relative competitiveness of natural gas with other low carbon fuels. When thinking about program design, NESCAUM may want to also consider the role that

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[8] Venkatesh et al, "Uncertainty in Life Cycle Greenhouse Gas Emissions from United State Natural Gas End-Uses and its Effects on Policy", Environmental Science and Technology, August, 2011

[9] Jaramillo

[10] Gaines, L; Stodolsky, F; Cuenca, R; Eberhardt, J, "Life-Cycle Analysis for Heavy Vehicles", Argonne National Laboratory's Transportation Technology R&D Center and the U.S. Department of Energy's Office of Heavy Vehicle Technology, June 1998, located at http://www.transportation.anl.gov/pdfs/TA/102.pdf

[11] Kevin Chandler (Battelle), Kevin Walkowicz (NREL) AND Nigel Clark (West Virginia University)" United Parcel Service (UPS) CNG Truck Fleet: Final Results TSDOE/NREL Truck Evaluation Project"

[12] Dana M Lowell, William Parsley, Christopher Bush, Douglas Zupo, "Comparison of clean diesel buses to CNG buses", Metropolitan Transit Authority, http://www.osti.gov/bridge/servlets/purl/829622-k8LC2V/native/829622.pdf

[13] California Air Resource Board, "Physiochemical and Toxicological Properties of Emissions from CNG and Diesel Buses", April 2011, http://www.arb.ca.gov/research/veh-emissions/cng-diesel/cng-diesel.htm

natural gas and other alternative transportation fuels can play in reducing criteria pollutants and how these pollutant reductions could be incorporated into the CFS.

Biogas and Natural Gas Infrastructure

If the price of natural gas remains around $4.00 per million BTU, which then translates to a price of CNG at the pump of $1.79 per equivalent gallon of CNG, and the Billion Ton study[14] projects prices of feedstock to manufacture biogas between $3.20 and $4.35 per million BTU, there will be relatively little biogas available because it will not be cost competitive. Biogas production today comes from manure digestion, landfill gas, and anaerobic digestion in sewage plants. However, to be available in large volume from commercial sized plants, a wide variety of biomass will have to be utilized and it is hard to envision competitive biogas when the feedstock is more costly than the commercial product, which will incorporate additional costs such as transportation of feedstock, fuel manufacturing, delivery, profits, etc. The recently completed National Research Council study on biofuels to meet the RFS standard concludes that biomass costs may be significantly higher than projected in the million ton study.[15]

A 2009 study in the Netherlands projects a production cost of $12.50 per million BTU for biogas (produced thermally from biomass) at zero biomass cost in a plant with capacity consistent with US expectations for biomass.[16] Work is underway to convert woody biomass to methane utilizing enzymes and bioprocessing. While no specific cost data are yet available it is enlightening to compare the cost per BTU produced as projected for cellulosic ethanol. If the costs for conversion are equivalent; the $0.62 ethanol is equivalent to $7.20/MMBTU bio gas, $1.32 ethanol to $15.52 biogas, and at $2.50 cellulosic ethanol (most probable early production cost) to $29.41 biogas.

Given the same costs to bring biogas or natural gas to market, the resulting equivalent pump price for CNG would be $1.80 for natural gas, and respectively, $2.23, $3.31, or $5.13 for biogas. On a cost basis, it would be difficult for biogas to compete with natural gas, unless the CFS credit price was high enough to make the biogas more attractive. It is not certain at what price the CFS credit would be needed to change these market dynamics and what the macroeconomic effects of this credit value would be.

Natural gas infrastructure needs in the natural gas future scenario range from $1.3 billion to $2.9 billion and overall infrastructure costs are generally lower than in other fuel scenarios. These low infrastructure costs are due to assumptions made that biogas will be the primary source of natural gas used. Because biogas has very low carbon intensity, less gas will be needed to meet the carbon reduction target. Less gas means less gas infrastructure. Due to optimistic assumptions about biogas penetration, it is likely that infrastructure costs have been underestimated.

Conclusion

[14] U.S DOE, U.S. Billion Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry, 2011, https://bioenergykdf.net/content/billiontonupdate

[15] National Research Council, "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy, 2011

[16] Van Der Meijden et al, "Production of bio-methane from Woody Biomass", Energy Research Centre of the Netherlands, June 2009, http://www.ecn.nl/docs/library/report/2009/m09086.pdf

PennFuture is encouraged by the strong work performed by NESCAUM that helps stakeholders better understand the economic possibilities of the northeast regional CFS. PennFuture strongly supports the goals of the CFS: to reduce greenhouse gas pollution, diversify transportation fuel sources, spur advanced vehicle technologies and fuels, reduce oil dependence and lessen our economy's vulnerability to fossil fuel price shocks.

However, PennFuture recognizes that current economic and political constraints affecting Pennsylvania and the nation complicate the path towards successfully designing and implementing a regional CFS. This is unfortunate because data indicates that global economic recessions usually follow oil price shocks.[17] If a quick move to the design and implementation phases of the CFS does not occur, then the Northeast and Mid-Atlantic states will have missed an opportunity to establish new growth markets, hedge against rising oil prices, enhance national security and reduce pollution.

Engendering industry support for the CFS will be key to maintaining forward momentum on the CFS in Pennsylvania. NESCAUM and the participating states should continue to solicit industry input as they move to the policy design phase. Industrial stakeholders will likely want more information, such as state-based data on the CFS and details about the design of the program. In addition, NESCAUM should anticipate that sophisticated industries that are experts in their respective fields may question the assumptions in NESCAUM's economic analysis. PennFuture has highlighted some of the assumptions that may be challenged, as well as recommended other areas where additional information should be provided in the program design phase. These additional data could provide beneficial insights that would be valuable to alternative fuel and vehicle industries. Providing these types of data may allow NESCAUM to develop important relationships with, and support from industry, which will be important to ensuring Pennsylvania's continued commitment to the CFS.

[17] James D. Hamilton, "Causes and Consequences of the Oil Shock of 2007-2008" UC San Diego, April 27, 2009, http://dss.ucsd.edu/~jhamilto/Hamilton_oil_shock_08.pdf