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Michael S. Waugh
Chief, Transportation Fuels Branch
California Air Resources Board
Via email

Subject: **Comments on ARB Technology Assessment: Transportation Fuels – as presented at the September 3, 2014 workshop**

Dear Michael,

We appreciate the opportunity to comment on ARB's Technology Assessment for Transportation Fuels presented September 3rd. VNG builds compressed natural gas (CNG) refueling stations to serve light-duty natural gas vehicles (NGVs) – including cars, vans, and pickups operated by fleets as well as everyday drivers. While we are developing our initial station networks in Pennsylvania, Massachusetts, and Texas, VNG is strongly interested in bringing consumer-friendly NGV fueling to the California market as well, and is a member of the California Natural Gas Vehicle Coalition (CNGVC).

A Unique Role for NGVs

NGVs can play an important, unique role in achieving GHG emission reductions as a component of ARB's transportation strategy for both the heavy-duty *and* light-duty sectors. As the lowest-carbon fossil fuel, natural gas provides inherent reductions in GHGs of about 25% compared to gasoline while using the same established internal combustion engine technology. Natural gas has particular importance as a solution for larger vehicles that are unlikely to be electrified in the near term due to weight and power requirements, including not only heavy-duty trucks but **important light truck fleet segments like pickups and cargo vans as well**.

Moreover, the higher octane of natural gas gives it potential to achieve higher engine efficiencies than gasoline if ICEs are fully optimized to take advantage of the properties of this fuel. While current NGVs face an efficient penalty of about 5% for light-duty vehicles (and more for heavy-duty vehicles), this is due to the fact that at today's low production volumes automakers simply convert existing gasoline engines to operate on natural gas. With sufficient market adoption, automakers would have justification to make the investments needed to design production-line NGVs with very high engine efficiencies – in fact, an in-depth technology assessment report by the National Petroleum Council indicated that NGV efficiencies could reach 69 mpg for small cars and 48 mpg for pickup trucks.[1]

Beyond their specific importance in meeting the needs of heavy-duty and light truck fleets, NGVs are also important as a hedge against slow or postponed deployment of ZEVs across all vehicle segments, which remains a significant risk despite efforts underway at both ARB and CEC to support their development. While ZEVs are obviously a critical component of ARB's 2050 vision, they face significant near-to-medium term market adoption challenges in terms of costs for batteries or fuel cells – and, for EVs, additional consumer acceptance challenges in terms of range and refueling time. These challenges

[1] National Petroleum Council. Advancing Technology for America's Transportation Future. August 2012. http://www.npc.org/reports/FTF-report-080112/Chapter_14-Natural_Gas.pdf

are clearly surmountable in the long term, but putting all of the state's emission reduction eggs in the ZEV basket is a risky strategy in the near-to-medium term.

By contrast, NGVs face significantly lower barriers to adoption than ZEVs, with potential to achieve low costs in the near term with no sacrifices in range or refueling. NGVs use the same ICE platform as conventional vehicles, and require only the addition of tanks made of relatively low-cost (steel or carbon composite) materials. While incremental costs for these vehicles are currently high, this stems only from the small-volume conversion process and is *not* inherent to the technology. The NPC projects that incremental costs could fall by two thirds or more immediately with high-volume production – a precedent which has already been demonstrated in Europe, where mass-produced NGVs have incremental costs of $3,000 or less in markets like Italy and Germany. Indeed, GM has already reduced the price of its bi-fuel natural gas pickup trucks by 10% this year compared to last year.

Due to this lack of technology risk as well as low natural gas costs, the NPC estimates that NGVs could have "larger, earlier, and faster" impacts than ZEV alternatives. **Allowing a significant role for NGVs in ARB's transportation planning would reduce overall program technology risks while achieving immediate emission reductions in parallel with ZEV market development.**

Methane Emissions Are an Issue for All Alternative Fuels

The shale gas boom and growing interest in NGVs in California and nationwide has led to greater scrutiny over methane leakage throughout the natural gas system, including the concerns highlighted by ARB in its Technology Assessment. While there is a considerable amount of uncertainty surrounding both the degree of existing leakage as well as the appropriate methodology to use in evaluating the greenhouse impact of these emissions (since methane has a much shorter lifespan in the atmosphere compared to carbon dioxide), the issue clearly merits ARB's attention given the prominence of natural gas in the state's overall energy mix.

Indeed, methane leakage is potentially a significant problem for ALL alternative fuel technologies – not only NGVs, but electric vehicles (EVs), hydrogen fuel cell vehicles (FCVs), and ethanol-fueled cars as well. Natural gas-fired power plants are the single largest source of electricity generation in the state, accounting for almost twice the generation of non-hydro renewables. While the share of renewables will undoubtedly grow, natural gas will likely remain an important source of baseload power for decades to come. Natural gas is also the feedstock for the vast majority of current production of hydrogen in the U.S., as well as a key input for ethanol production. It is unclear whether methane leakage concerns were also included in the evaluations of EVs, FCVs, and biofuels, but ARB should apply these findings across the board to get a clear picture of transport GHG emissions from all technologies.

Fortunately, a comparison between electricity grid and the natural gas grid is instructive. Just as the state's electricity mix will get gradually cleaner over time and reduce the lifecycle GHGs of EVs, the natural gas grid will also get gradually cleaner thanks to improvements to both the grid itself and the fuel transported through it, reducing the lifecycle GHGs of *all* fuels that depend on this feedstock.

Multiple Efforts Underway to Measure and Reduce Leaks

The first step towards evaluating the methane issue is to obtain better data on how much methane is escaping and where the leaks are located. As noted by ARB in its presentation, there are a wide range of studies underway at the national level by institutions including EPA, Environmental Defense Fund (in

collaboration with a wide range of industry stakeholders), and the Gas Technology Institute, among others, which will provide unprecedentedly detailed data on methane leakage at every step of the natural gas supply chain.

There are also several similar efforts underway by ARB, the Energy Commission, UC-Irvine, and others to collect data specific to California's natural gas distribution networks, which as ARB acknowledges is critical given the heterogeneity among pipeline systems in different parts of the country. There is good reason to expect that methane leakage rates in California are less than the national average, since western pipeline systems are generally newer and less leak-prone than older systems in the eastern part of the country.

Regardless of what these studies reveal in terms of the GHG impact of the state's natural gas use, there will certainly be opportunities for improvement. The "Mitigation Ongoing and Potential" section of the Technology Assessment presentation notes that there are a range of cost-effective means available to reduce methane leakage, and ARB is developing a multi-pronged strategy to encourage the deployment of such means. Many such efforts are underway and achieving results at the state and federal level:

- **Significant Reductions Already Happening Upstream:** According to the most recent report from EPA's Greenhouse Gas Reporting Program, methane emissions from petroleum and natural gas systems have decreased by 12% since 2011, and methane emissions from hydraulic fracturing operations have fallen 73%.[2] These gains have been largely due to voluntary actions; deeper reductions will come with the implementation of EPA regulations (which mandate the use of "green completions" that capture emissions at the drilling site) in the next year.

- **Benefits from Accelerating Pipeline Maintenance:** As noted above, it is likely that California's natural gas system leakage is significantly lower than the national average. Still, accelerated replacement and repair schedules for natural gas pipelines can yield significant benefits in terms of both reduced methane emissions as well as job creation, as discussed in a recent report from the Blue-Green Alliance (a coalition of labor unions and environmental groups) entitled "Interconnected."[3] Such an initiatives in California represent an opportunity to seize "low-hanging fruit" in the effort to reduce methane leaks.

- **New Technologies to Improve Leak Detection and Repair:** New technologies will further facilitate the detection and reduction of methane leaks. For instance, the Environmental Defense Fund is collaborating with seven oil and natural gas companies to hold a "Methane Detectors Challenge" that will fund designs for innovative new low-cost devices to monitor natural gas distribution systems for methane leaks and enable their rapid repair.[4] Technology demonstrations of these devices are currently underway, with industry purchase and deployment to follow in late 2015.

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[2] Environmental Protection Agency. "EPA Releases Greenhouse Gas Emissions Data from Large Facilities." Sept 30, 2014. http://yosemite.epa.gov/opa/admpress.nsf/0/58d0225b6c4023ea85257d63005ca960?OpenDocument

[3] Blue-Green Alliance. "Interconnected: The Economic and Climate Change Benefits of Accelerating Repair and Replacement of America's Natural Gas Distribution Pipelines." http://www.bluegreenalliance.org/interconnected

[4] Environmental Defense Fund. "Methane Detectors Challenge." http://www.edf.org/energy/natural-gas-policy/methane-detectors-challenge

For all these reasons and many more, there is good reason to believe that the methane leakage issue will become better understood and more effectively mitigated in the years ahead, which will improve the lifecycle GHG emissions of NGVs in the state – as well as the EVs, FCVs, and ethanol-fueled vehicles that also depend on this feedstock. Continued attention to this issue by regulators, the industry, and environmental groups is crucial to achieving these methane emission reductions, but these efforts can proceed in tandem with ARB's continued support for this inherently clean, low-emission fuel.

Reducing the Carbon Intensity of the Natural Gas Mix

In addition to reducing the overall methane leakage rates of the natural gas system, further climate change benefits can be achieved by improving the lifecycle GHG profile of the gas being transported through the system. Gas pipelines can accommodate blends of fossil natural gas with biomethane as well as hydrogen derived from renewable energy generation, enabling them to serve as a low-cost, widespread distribution system for an increasingly low-GHG fuel mix – much like the electricity grid.

- **Biomethane**: Biomethane generated from sources like landfills, wastewater treatment plants, and livestock operations can be captured and processed to pipeline gas standards, allowing it to be used interchangeably as a "drop-in" biofuel capable of reducing GHG emissions of NGVs by 90% or more compared to gasoline – including potentially carbon-*negative* pathways. Because these lifecycle GHG reductions are achieved by capturing methane that would otherwise escape into the atmosphere, **the use of biomethane not only reduces overall GHG impacts but directly offsets methane leakage in the natural gas system.**

  The potential for biomethane in the transportation sector is drawing increased attention from both natural gas fueling providers and policymakers. CNGVC members including Clean Energy and Waste Management are making a push to increase the use of biomethane in their fueling stations in the state, and AB 1900, passed last year, has tasked the state Public Utilities Commission to develop standards to allow and encourage the injection of processed biomethane from landfills – the largest and lowest-cost source of biomethane – into the natural gas grid. Moreover, the state's Low Carbon Fuel Standard provides a long-term policy framework to incentivize biomethane use in the transportation sector, giving transportation potentially the greatest market 'pull' for this ultra-low carbon fuel.

- **Hydrogen Blends (aka "Power to Gas")**: The injection of low-level (10-20%) blends of hydrogen into the natural gas pipeline system offers the potential to further improve the emissions profile of natural gas in the state while also meeting the goals of increasing the use of California's abundant renewable energy resources. Connecting utility-scale solar and wind farms to the electric grid can pose significant cost and permitting hurdles in many cases, particularly for large but remote renewable resources located in the desert and other areas far from population centers. Moreover, the intermittency of solar and wind generation can pose an additional challenge to grid operators – particularly as these resources increase their share of generation.

  "Power-to-gas" applications, a type of hydrogen energy storage, is an alternative to the transmission of renewable energy through the electricity grid that involves an intermediate step: the on-site conversion of renewable generation to hydrogen via electrolysis of water. This hydrogen gas can then be injected into the natural gas pipeline system, where it can either

reduce the GHG profile of natural gas used in existing applications (including NGVs as well as natural gas power plants) or extracted as pure hydrogen for use in fuel cells. A number of power-to-gas demonstration projects are currently operating in Germany and the UK.[5]

In addition to reducing the lifecycle GHG emissions of the gas transported through the pipeline system, the National Renewable Energy Laboratory has found that **hydrogen blends would likely reduce natural gas leakage due to the higher mobility of hydrogen molecules, resulting in a further reduction in system-wide GHG emissions.**[6]

While efforts to integrate biomethane and hydrogen into California's gas grid are at their early stages, these approaches hold significant long-term promise. And, thanks to policies and regulations that encourage clean energy and low carbon fuels, California is positioned to be a leader in the deployment of these solutions on a large scale.

Conclusion

Natural gas is an inherently clean fuel, capable of reducing both GHGs and smog-forming pollutants from vehicles powered by internal combustion engines. It has particular value as an alternative for heavy-duty as well as light trucks that are unlikely to have commercially-available ZEV alternatives in the foreseeable future. And, with significantly lower cost and performance barriers to consumer adoption than ZEVs, NGVs ought to have a significant role in a risk-managed portfolio of transportation technology pathways supported by the state, especially in the near-to-medium term.

Methane leakage is a serious issue, and one that *all* alternative fuel technologies must account for, not only NGVs. Fortunately, there are a number of efforts underway to reduce leakage from natural gas transmission and distribution as well as improve the GHG profile of gas transported through the pipeline system. ARB has a major role to play in both of these areas, and it should continue to vigorously pursue such efforts to improve natural gas GHG emissions in tandem with continued support for NGVs as a platform for increasingly low-carbon fuels. Much like EVs, NGVs are a lower-carbon alternative today – and will deliver steadily-increasing air quality and greenhouse gas benefits over time.

Sincerely,

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[5] ITM Power. "Power-to-gas Energy Storage." http://www.itm-power.com/energy-storage/power-to-gas-energy-storage-solution/

[6] National Renewable Energy Laboratory. "Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues." http://energy.gov/sites/prod/files/2014/03/f11/blending_h2_nat_gas_pipeline.pdf