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The Future of Motor Fuels

By Sander Cohan

For nearly a century, the dominance of gasoline and diesel fuel has remained relatively unchallenged. As motor transportation has spread and evolved with economic development, these two products of the petroleum refining industry have driven global demand for oil.

In the study, "Scatter Shot Reform: Fuel Engine Pathways for Automotive Transportation, 2009-2025," Energy Security Analysis Inc. (ESAI) explores how global fuel markets will develop in the coming decades, identifying new technologies and markets that will rise to prominence.

Changes in gasoline and diesel specifications, along with the emergence of alternative fuels and new automotive technologies, signal the beginnings of a shift in motor fuels markets. The competing and sometimes conflicting reform will result in a vastly different motor fuels landscape than the comparatively simple market seen today.

This transformational process will result in the expansion of the potential number of fuel pathways from two — gasoline and diesel — to more than 12, covering the gamut of technologies and environmental strategies. Biofuels will remain prominent, but natural gas, coal and electric resources will all play a major role.

Price: Not the Only Driver of Change

In this future landscape, the price of the technology, relative to oil, will not be the only driver. The process of market transformation will be lengthy and motivated by a variety of different sources:

- **Climate Change:** Concerns surrounding conventional transportation fuels' contribution to global climate change have led to policies to encourage the use of fuels with lower greenhouse gas emissions. Concerns over air quality have led to tighter and cleaner fuel specifications. But despite the best attempts of policy makers, the preferred approach and definition of these emissions varies substantially from country to country and by level of economic development.
- **Diversity of Supply:** As more of the world's crude oil production comes from a decreasing number of countries, a growing concern builds among consuming nations that supplies of crude oil — and therefore petroleum products — will become more vulnerable to political and economic instability in these increasingly important oil-producing countries.
- **Agriculture Market Support:** The production of some alternative fuels requires certain agricultural commodities. Many markets for non-petroleum fuels were developed as a way to use surplus crops and sustain sagging agricultural markets. Other markets emerged to support the agricultural sector by finding uses for marginal and low-yield cropland.
- **New Domestic Markets:** Alternative fuel markets also promote economic development. The expansion of new motor fuels pathways opens new opportunities for the scientific community, the energy industry and entrepreneurs to develop new production processes and previously unheard of transportation methods. Efforts in market development can translate into greater economic growth and job creation.

Scatter Shot Reform

ESAI's preliminary analysis of North America anticipates that approximately 18 percent of the future conventional transport fuel mix will be substituted or avoided by 2025, approaching 2.8 million barrels per day (b/d). The composition of this mix will not come from a singular source, but rather from a variety of sources. It will also vary greatly according to region.

A series of current issues will lay the groundwork for the upcoming market framework:

Tighter Automotive Efficiency Standards: One of the most profound effects on motor fuels demand will be the tightening of Corporate Average Fuel Economy (CAFE) standards. The increase and acceleration of fleet fuel standards to 35.5 MPG in 2016 will nearly double the decline in demand over the schedule set forth in the 2007 Energy Security and Independence Act. The savings will multiply dramatically if the rules are extended to mirror the California Low Carbon Fuels standard, resulting in a goal of 42 MPG by 2020.

New Renewable Fuels Standard (RFS) Legislation: The recent RFS will play a large role in shaping these motor fuels pathways. The mandate to blend more than 2.3 million b/d of renewable and alternative fuels by 2022 will require profound

changes, not only in the way drivers consume fuels, but also the entire supply chain, from production through transport to fuel blending. The Obama administration's focus differs from the Bush administration goals with an even greater emphasis on climate sustainability and non-agricultural and non-food sources of fuel.

Regional Rules: Individual state policies will affect the regional outlook for motor fuels. While an E20 blending standard might encourage the development of higher ethanol blends in the Midwest, the emphasis on lower lifecycle greenhouse gas emissions in California and the tighter land-use regulations of the Low Carbon Fuels Standard will generate a push toward hybrids, plug-in vehicles and compressed natural gas there.

The Changing Fortunes of Automakers: The future configurations of the major automakers will play an essential role in the future landscape. The ultimate effect is uncertain: technological innovation might stagnate as corporate assets are re-evaluated, but it's equally likely that the development of more efficient vehicles that rely on non-petroleum power sources such as electricity or compressed natural gas will accelerate. These local-market influencers will lead to the development and expansion of both new and existing alternative fuels.

The Expansion of Ethanol: Through 2025, ethanol will continue to make up a major portion of the expected growth in alternative fuels. With vocal advocates, these fuels have found support in the agricultural sector with the benefit of an established industrial base that can produce fuels in enough quantity to challenge gasoline.

Ethanol markets are in transition, however, and won't develop as initially anticipated. First generation fuels have fallen out of favor because of their potential negative effects on climate and food markets. Although second generation ethanol promises to solve many of these problems, roadblocks in both commercializing the technology and developing nationwide supply chain and blending infrastructure still remain, and will slow the fuel's entrance into broader gasoline and diesel markets.

The Promise of Biodiesel: Biodiesel is a second promising alternative fuel with broad policy and market support. In many ways, biodiesel produces a product with greater advantages than ethanol. Most notably, it can blend with conventional fuels without compromising as much engine performance.

High break-even prices and concerns over sustainability have slowed the introduction of biofuels into North American markets. Second generation variants are emerging in the pipeline, but face similar roadblocks to ethanol: infrastructure, facility location and feedstock supply.

Plug-in Hybrids and the Smart Grid: The plug-in hybrid electric vehicle (PHEV) has emerged as the major new alternative to biofuels. PHEVs offer a broad range of advantages, such as lower transport emissions and substantially higher fuel efficiency, all while utilizing the existing electric grid and combustion engine technology. The development of economic plug-ins has featured prominently in both the Obama administration's plan to stimulate the economy and in automakers' plans to build vehicles that will deliver on the promise of climate change mitigation and fuel efficiency.

Although PHEVs have substantial support and will begin appearing in markets in 2011, they will not gain full traction until later. PHEVs rely on pending breakthroughs in battery technology and manufacturing infrastructure. Additionally, to capture the full benefits of the climate change possibilities, cleaner power generation and transmission technologies must be expanded as well.

The Return of Compressed Natural Gas: Compressed natural gas (CNG) has existed on the sidelines of the alternative fuel world for some time. With support from T. Boone Pickens and the discovery of substantial new domestic natural gas reserves locked in shale, this technology merits reconsideration. CNG can be less expensive than petroleum fuels and offers substantial improvement in certain transport emissions.

While CNG is a common technology in industrial and commercial fleets, it has a long way to go before it can be widely used as a motor fuel on par with gasoline and diesel. The lack of vehicles and refueling infrastructure currently limit CNG technology to specific geographic areas that have built terminals to accommodate it. Initiatives to develop the requisite infrastructure come into competition with biofuels.

No Hydrogen in the Near Term: Hydrogen fuel cell technology offers the promise of a zero emissions car from an extremely rich energy source. Although hydrogen fuel cell technology is visible on the streets today, the technology is far away from commercial introduction.

In addition to the roadblocks in developing an affordable fuel cell power train that can be used in automotive applications, other hindrances will keep these cars from substantially entering the market until after 2020. Along with lack of refueling infrastructure, there is still no large-scale method to produce hydrogen economically for retail consumption.

Opportunities and Challenges

The primary challenge for fuel retailers and marketers in the coming 20 years lies in understanding the increasing complexity of the motor fuels market. There is not going to be one, singular replacement for the current transportation fuel mix. Over the coming years, retailers will have to understand a few key issues:

- **Gasoline and Diesel Will Dominate the Market.** With the exception of first generation biofuels, many new fuel pathways are still in their very early stages. In the meantime, customers will still be looking for the best priced gasoline and diesel.
- **The Future Is Not Just Ethanol and Biodiesel.** Although these fuels will play a large role, they will not be the only options. Alternative fuel policy will embrace a broad variety of new fuels and technologies. Some will work in the convenience market, others will not. ESAI expects an expansion of technologies, and a varying mix of technologies according to existing infrastructure and local regulations. E85 might gain prominence near agricultural resources, while CNG will work near a lot of natural gas.
- **Develop an Infrastructure to Bring New Fuels to Consumers.** It is one thing to be able to produce fuel in quantity, but it's another thing to bring the fuel, or fuel technology, to market. Successful alternative fuels will rely not only on the benefits of their technology, but also on the ability of retailers to deliver supply.
- **Regulation Will Change — Often.** As technology develops, the regulatory structure around these fuel pathways will continuously change. Retailers must be able to evolve and adapt their delivery infrastructure and business model to keep ahead of changing specifications, regulations and blending rules.

When it comes down to it, the process of transformation is already underway, and the market will ultimately benefit from these new technologies and motor fuels. But it's important to remember that the process of market transformation will not likely be smooth.

Sander Cohan is a transport fuels analyst at ESAI. His forthcoming study, "Scatter Shot Reform: Fuel Engine Pathways for Automotive Transportation, 2009-2025" is available at www.esai.com.