BSR

Transitioning to Low-Carbon Fuel

A Business Guide for Sustainable Trucking in North America

A Working Paper from the Future of Fuels Working Group

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About This Working Paper

This working paper outlines a holistic approach for companies to transition to low-carbon transportation fuel, with a focus on trucking fleet operators and their partners in North America. It is a contribution from BSR's Future of Fuels Working Group and follows our first report, "The Sustainability Impacts of Fuel" (published in 2012 and projected to be updated later this year), which reviewed what was known at that time about the sustainability impacts of transportation fuel.[1] This guide builds on that report's findings by providing guidance on how companies can address those impacts.

This report was written by Eric Olson and Ryan Schuchard with contributions from Jane Church. It is based on input from Future of Fuels member companies; discussions with industry, civil society, and government representatives at three in-person forums and four webinars during 2013; and a review of literature that is referenced in each section. (See the acknowledgments for more information.)

We welcome comments and questions at futureoffuels@bsr.org.

DISCLAIMER

ABOUT BSR

BSR works with its global network of more than 250 member companies to build a just and sustainable world. From its offices in Asia, Europe, and North and South America, BSR develops sustainable business strategies and solutions through consulting, research, and cross-sector collaboration. Visit www.bsr.org for more information about BSR's more than 20 years of leadership in sustainability.

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1 Eric Olson and Ryan Schuchard, "The Sustainability Impacts of Fuel: Understanding the Total Sustainability Impacts of Commercial Transportation Fuels," BSR, 2012, www.bsr.org/reports/BSR_Future_of_Fuels_Sustainability_Impacts_of_Fuel.pdf. Note that a revision is planned for 2014.

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Executive Summary

Truck fleets create significant climate and other sustainability impacts through the production and use of the fuels that they consume, as we described in our first paper, "The Sustainability Impacts of Fuel." Based on that research, this paper acts as a guide for companies to proactively and intelligently transition to low-carbon transportation fuel. The primary audience is trucking fleet operators in North America; this guide will support them as they develop fuel sustainability strategies in the face of cost pressures and concerns about fuel and vehicle reliability.

The guide is also written for their value chain partners, such as fuel providers, manufacturers of vehicle equipment, "shippers" (companies who order the freight that trucks carry), and investors. These companies have various stakes in fuel sustainability and stand to gain from working with trucking companies to transition fleets to low-carbon fuel.

Many truckers are committed to sustainability, and some have adopted measures that improve the sustainability of their fleets. However, even relative leaders have the opportunity to be more proactive about transitioning to low-carbon fuels in light of the whole range of lifecycle impacts of fuels.

Yet, they do so in spite of several challenges: The marketplace is undergoing profound changes, sustainable fuels are not yet scalable, the issues involved are complex, sustainability standards are underdeveloped, and key stakeholders have different ideas about the way forward.

In response to these challenges, this guide outlines a holistic strategy for transitioning to low-carbon fuel. This strategy involves using a portfolio approach with technology investment, playing an active part in accelerating the development of scalable solutions, focusing on decarbonizing fuels while addressing sustainability issues more widely, developing standards that improve truckers' ability to manage fuel sustainability, and incorporating diverse stakeholder perspectives into fuel strategies.

Organized around those design principles, this guide outlines four steps for transitioning to low-carbon fuel:

» Step 1: Understand your total fuel footprint
» Step 2: Optimize your use of available fuel and vehicles
» Step 3: Collaborate to enable new low-carbon solutions
» Step 4: Advocate for a better policy environment

Getting fuel sustainability right is good for business. In addition to addressing climate change, it can reduce costs by lowering lifecycle fuel prices, shape public policy and marketplace choices, prepare companies to respond to rapid changes to markets and technologies, and generate goodwill from customers and stakeholders.

This guide does not explore the actual sustainability impacts of fuels in depth. Our first paper, which we published in 2012 and will update later this year, delves into that subject.

This guide expresses certain viewpoints at the level of overall suggested steps and activities, while leaving it to the reader to make the tactical decisions appropriate for their organization. In that regard, it provides background on public policies, but does not endorse any specific policies.

Introduction

Truck fleets create significant sustainability impacts through the production and use of the transportation fuels that they consume, as catalogued in BSR's recent report "The Sustainability Impacts of Fuel."[2]

Among those impacts are greenhouse gas (GHG) emissions from the combustion of transportation fuels. Transportation fuel combustion is the second-largest source of emissions in the United States, where it constitutes 28 percent of total emissions.[3] Globally, the combustion of transportation fuel is projected to be the source of the fastest-growing GHG emissions through 2050.[4]

In addition to these tailpipe emissions, fuels create significant emissions during their production phase (often referred to as the "well-to-tank" phase). When taking into account the full lifecycle contribution of such mobile sources, GHG emissions make up more than 40 percent of total emissions.[5] Additionally, fuels create a number of wider environmental and social impacts throughout their production and consumption lifecycle.[6]

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[2] Ibid.

[3] U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011," 2013, www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf.

[4] Intergovernmental Panel on Climate Change. "Climate Change 2014: Mitigation of Climate Change," 2014, http://www.ipcc.ch/publications_and_data/publications_and_data.shtml

[5] William Cowart, Veronika Pesinova, and Sharon Saile, "An Assessment of GHG Emissions from the Transportation Sector," U.S. Environmental Protection Agency, 2003, www.epa.gov/ttnchie1/conference/ei12/green/pesinova.pdf. See also Ryan Schuchard, "Transportation Fuel and Climate: Five Key Issues for Business Leaders and Policy Makers," BSR, 2014, www.bsr.org/en/our-insights/blog-view/transportation-fuel-and-climate-five-key-issues.

[6] Eric Olson and Ryan Schuchard, "The Sustainability Impacts of Fuel," BSR, 2012, www.bsr.org/en/our-insights/report-view/the-sustainability-impacts-of-fuel.

Many fleet operators are committed to sustainability; they understand that climate change poses critical risks and that business as usual threatens the long-term survival of their company.[7] In response, many have adopted measures that improve the sustainability associated with fuel use, such as by encouraging eco-efficient driving practices, leveraging telematics, using modern trucks with maximum fuel economy, and piloting the use of electric and alternative fuel vehicles (EVs and AFVs).[8] These activities represent solid progress and provide important lessons to draw from.

Still, there are significant opportunities to improve and accelerate the transition to low-carbon fuels.[9] The fleet operations and fuel pilot activities mentioned above are integral to fuel sustainability. However, trucking operators need to more directly address the challenges that are holding back a timely, profitable transition to low-carbon fuels.

This process is not straightforward. Trucking operators are considering fuel sustainability in the face of difficult operating environments, which includes fragmentation, intense competition, commodification of services, relatively low levels of capital investment, and slow rates of innovation diffusion.

Getting fuel sustainability right is good for business. Many truckers and their partners already think of transitioning to low-carbon fuels as good corporate citizenship, and many appreciate that playing an active role to accelerate this transition can improve the company's reputation and support long-term risk management. Some more direct business benefits include the following:

» **Reduced costs from lower lifecycle fuel prices:** Some new sources already make better sense economically. Some companies are already using natural gas and electric vehicles, which as of October 2013 were 40 percent and 65 percent cheaper per unit than diesel, respectively, on a gasoline-gallon-equivalents basis, and may equate to payback periods with new vehicles of three years.[10]

» **Shaping of public policy and marketplace choices:** As this guide details, the future of fuels has yet to be written. Policy makers have not yet addressed many key fuel sustainability issues, but they will in the near future. And as the fuel marketplace transitions, companies that are managing fuel sustainability can actively shape the technologies, institutions, and perspectives that will define the fuel economy of tomorrow.

» **Readiness to respond to rapid changes in markets and technologies:** By managing fuel sustainability appropriately, companies will develop a base of understanding about fuel options and will have piloted technologies that position them to roll out fuels and vehicles at scale when opportunities arise.

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[7] BSR and Globescan, "State of Sustainable Business Survey 2013," 2013, www.bsr.org/reports/BSR_GlobeScan_Survey_2013.pdf. See also Carbon Disclosure Project, "Global 500 Climate Chante Report 2013," 2013, www.cdp.net/CDPResults/CDP-Global-500-Climate-Change-Report-2013.pdf.

[8] Automotive Fleet, "Top 50 Green Fleets," *Automotive Fleet 500,* 2013, www.fleet-central.com/TopFleets/pdf/AUTOF_top50green.pdf. See also Union of Concerned Scientists, "Truck Electrification: Cutting Oil Consumption and Reducing Pollution," 2012, www.ucsusa.org/assets/documents/clean_vehicles/Truck-Electrification-Cutting-Oil-Consumption-and-Reducing-Pollution.pdf.

[9] In this guide, "carbon" is used as shorthand for "carbon equivalents," which includes carbon dioxide as well as so-called short-lived climate pollutants, such as black carbon and methane.

[10] Based on diesel at US$3.51, compressed natural gas at US$2.09, and electricity at US$1.22. *Source:* U.S. Environmental Protection Agency, "Alternative Fuel Price Report: October 2013," 2013, www.afdc.energy.gov/fuels/prices.html. See also U.S. EPA, "Business Case for Battery-Electric Trucks in Los Angeles, California," 2011, http://westcoastcollaborative.org/files/sector-fleets/WCC-LA-BEVBusinessCase2011-08-15.pdf.

Figure 1: Trucking Fleet Operators and Their Value Chain Partners

Fleet operators or carriers: Companies that own and operate trucking fleets. These are typically referred to as "carriers" (as they physically carry goods) in contrast to the "shippers" who place shipments that the carriers deliver.

Shippers: Companies that rely on third parties to deliver their shipments. Although shippers contract or subcontract freight to others, they still may be exposed to regulatory, market, and stakeholder risks. Large companies that both own their own fleets and use third parties for deliveries may work with both a carrier and a shipper.

Fuel providers: Companies that produce, refine, and/or distribute fuel (e.g., oil, gas, biofuel, etc.). Fuel buyers and technical organizations are becoming increasingly interested in the production impacts of all fuels.

Manufacturers: Makers of vehicles or components used in the production and use of liquid fuel, electric vehicles, and infrastructure. Fleet operators increasingly look to collaborate to make more sustainable vehicle options available.

Investors: Financial services firms that invest in any of the above sectors. Companies involved in the fuel value chain may be exposed to regulatory, market, and stakeholder risk.

By managing fuel sustainability more comprehensively, companies can identify key emerging policy issues and avoid stranded assets.

» **Goodwill from customers and stakeholders:** Because of the substantial sustainability impacts associated with it, fuel is a source of numerous stakeholder concerns that can negatively impact a company's reputation. As civil society groups and government policy makers seek to pressure companies to abandon unsustainable practices and as business customers ask suppliers to be more creative about finding solutions, customers will be more likely to reward companies who take fuel sustainability seriously. These companies will be seen as leaders.

These opportunities apply to trucking fleets, as well as their many value chain partners, specifically fuel producers, vehicle manufacturers, shippers, and investors (see Figure 1), who can work with truck fleet operators to be more ambitious in their efforts.

Key Management Issues for Fuels

As this guide details, companies can realize the benefits above through a proactive approach for transitioning to low-carbon fuels. However, interdependent issues complicate the fuel landscape—and create opportunities for leaders.

ISSUE 1: THE MARKETPLACE IS UNDERGOING PROFOUND CHANGE

Low-carbon fuels are becoming more readily available. For example, in 2013, the U.S. biodiesel industry produced at a peak rate equivalent to displacing 5 percent of on-road diesel demand and an annual rate of 1.7 billion gallons, and natural gas is expected to grow to cover 10 percent of incremental transportation energy needs by 2018.[11] As of 2011, there are around 11 million alternative fuel vehicles (AFVs) used in the United States.[12] One of the companies doing the most is UPS (United Parcel Service); they consider their fleet a "rolling laboratory," which included more than 3,100 vehicles in operation at the end of 2013.

In its midsized "package truck" fleet, UPS operates more than 900 compressed natural gas (CNG) vehicles, more than 800 liquefied petroleum gas (LPG) vehicles (with another 1,000 ordered and projected to be in operation by the end of 2014), 50 vehicles on ethanol in South America, and 158 EVs (100 of which are zero-tailpipe emissions EVs) in California. Its heavy-duty fleet is currently operating 249 liquefied natural gas (LNG) tractors in the United States (with another 800 ordered and projected to be in operation by the end of 2014) and 19 biomethane tractors in the U.K.

These examples show that the fuel marketplace is undergoing profound changes, which is represented by two different trends. First, fuel markets are beginning to transition away from oil as the dominant fuel used in vehicles. As global demand for fuel increases in the coming decades, perhaps by 50 percent by 2040, the relative share of oil is expected to drop. This is a monumental change, but it is also a long-term process, and at the current pace, it will take several decades before oil supplies less than half of the overall mix.[13]

[11] Sarah Kent, "Natural Gas Seen as Major New Transport Fuel," *Wall Street Journal*, 2013, http://online.wsj.com/news/articles/SB10001424127887323393804578556650833190508.
[12] U.S. Energy Information Administration, "How Many Alternative Fuel and Hybrid Vehicles Are There in the U.S.?," 2013, www.eia.gov/tools/faqs/faq.cfm?id=93&t=4.
[13] Eric Olson and Ryan Schuchard, "The Sustainability Impacts of Fuel: Understanding the Total Sustainability Impacts of Commercial Transportation Fuels," BSR, 2012, www.bsr.org/reports/BSR_Future_of_Fuels_Sustainability_Impacts_of_Fuel.pdf.

Second, this transition is giving rise to a "polyfuel" economy marked by a more diverse mix of fuels that are used in the locations and applications where they are most appropriate. These fuels include natural gas, biofuel, and electricity, among other categories.

This diversification supports sustainability. As Anup Bandivadekar et al. remarked in a paper published by the Massachusetts Institute of Technology (MIT), "No single technology development or alternative fuel can solve the problems of growing transportation fuel use and GHG emissions. Progress must come from a comprehensive, coordinated effort to develop and market more fuel-efficient vehicles and benign fuels, and to have more sustainable ways to satisfy transportation demands."[14] The transition to a polyfuel economy is desirable because the result will allow emissions to be reduced more efficiently and will be more resilient. However, the transition period creates challenges for companies.

The future mix of available fuels and vehicles is uncertain. Natural gas, biodiesel, and electricity are growing as fuels and already making an impact. However, different fuels are developing at different rates, and their availability varies. As a result, it is difficult for trucking operators to know what the future mix of available fuels will look like and which options will be most cost effective for different applications. Therefore, the future fuel marketplace brings not only relative opportunities and risks associated with multiple fuels, but we simply do not know for certain which fuels and vehicles will be available and cost effective in the future.

The most cost-effective sources of emissions reductions are diverse and changing. Not only is the mix of fuels a moving target, but the sources companies can tap to reduce emissions from fuel are as well. These potential sources include: electrifying vehicles when possible; switching to biofuels, advanced "drop-in" fuels, or other liquids or natural gas; reducing the upstream emissions from incumbent diesel and gasoline sources; improving the efficiency of fuels and vehicles during use; and using trains or ships instead of trucks.

However, when we look at these options from the standpoint of lowest cost of emissions abatement, the opportunities depend on such factors as the source of energy used for fuel processing and types of production practices in place. The understanding and availability of reductions, therefore, are also in a state of flux as the scientific research around the most cost-effective opportunities for GHG abatement emerges and the technology landscape changes.

Implication: **Companies should manage fuel sustainability as a diverse portfolio that evolves based on a regular review.** Transitioning to low-carbon fuels requires investing substantial long-term capital under conditions of constantly changing policy and technology. With the landscape changing unpredictably, fuel sustainability should not be seen as an exercise in simply "picking the right fuel now"; it calls for a portfolio approach (with respect to both fuels and carbon-reduction strategies) that makes use of an ongoing review of scientific research and technology. A company's portfolio of actions must address multiple types of fuel, different strategies for emissions reduction, attention to both the use and production phases of fuels, the change desired at various time scales (e.g., the near, medium, and longer term), and direct company as well as policy advocacy.

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[14] Anup Bandivadekar et al., "On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions," MIT, 2008.

ISSUE 2: SUSTAINABLE FUELS ARE NOT YET SCALABLE

Achieving fuel sustainability requires the transition to low- or zero-carbon fuels to have minimal other sustainability impacts. In order to make this transition to low-carbon fuels within business constraints, such fuels must be available, reliable, and cost effective at a sufficiently large scale, and the same must be true for the vehicles that use them, which additionally need infrastructure and equipment for maintenance.

As described above, the supply of low-carbon fuels is growing and making an impact. But modern renewables still comprise less than 10 percent of all energy consumed in the United States, and the technical requirements for road fuels keep the share of low-carbon sources limited in transportation to around 3.5 percent from biofuels and less than 0.01 percent from electricity.[15] Advanced low-carbon biofuels have been slow to commercialize, and significant volumes are unlikely to be available before 2020. While electric trucks exist, penetration is slow, and the cost of new vehicles is high. Thus while there are changes under way, they are not scalable solutions for most trucking companies.

The marketplace lacks alternatives to conventional, high-carbon, petroleum-based diesel that are cost effective at a large scale. Prices for biodiesel are high; pure biodiesel (B99 or B100) currently costs about 17 percent more than diesel on average on an energy-content basis.[16] More importantly, availability is limited: Only 325 stations in the United States provide biodiesel in ratios of 20 percent (B20) or greater.[17] Other fuels that are being developed, including dimethyl ether (DME), methanol, and hydrogen, are not yet widely available, tested, or known to be cost effective for fleets. Opportunities for electrification are restricted to specialized applications and are more appropriate for light-duty purposes and short distances than heavy-duty long hauling.

There is a lack of vehicle equipment and infrastructure. In addition to fuels, companies need vehicles to run on them reliably with a total cost of ownership that is attractive when compared with diesel. The price of EVs remains high; for example, a business case assessment done by the U.S. Environmental Protection Agency (EPA) in 2011 found that the premium for an all-electric version of a US$65,000 Class 3–4 diesel truck was US$86,000, while the premium for an all-electric version of a US$97,000 Class 5–6 diesel truck was US$69,000.[18] An additional challenge is maintenance and operators: For example, natural gas and biodiesel engines may require specialized bays, ventilation systems, and parts that are different than those of their diesel engine counterparts.

Even as new fuels become more attractive, opportunity costs must be overcome. Trucks are large, long-lived assets, and operators amortize investments over the many years of a truck's useful life, which can be more than 19 years.[19] Companies seek to get as much useful life out of their investments as possible. And when one company replaces outdated equipment, others may

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[15] REN21 (Renewable Energy Policy Network for the 21st Century), "Renewables Global Status Report," 2013.

[16] Based on diesel at US$3.51 and B99/100 biodiesel at US$4.12. *Source:* U.S. Environmental Protection Agency, "Alternative Fuel Price Report: October 2013," 2013, www.afdc.energy.gov/fuels/prices.html.

[17] Ibid.

[18] U.S. Environmental Protection Agency, "Business Case for Battery-Electric Trucks in Los Angeles, California," 2011, http://westcoastcollaborative.org/files/sector-fleets/WCC-LA-BEVBusinessCase2011-08-15.pdf.

[19] Raymond Schubert, "Heavy-Duty Truck Retrofit Technology: Assessment and Regulatory Approach," Tiax, 2008, www.ucsusa.org/assets/documents/clean_vehicles/heavy-duty-truck-retrofit-tech.pdf.

purchase it on a secondary market and give it a new life. This need to utilize assets explains why even though the per-unit cost of natural gas is lower than that of diesel, it still takes significant time to turn over a fleet.

Implication: **Companies have an important role to play in accelerating the development of large-scale, low-carbon fuel solutions.** While companies have some options, sustainable fuel solutions are not becoming scalable on their own and significant policy interventions, and creative business collaborations are needed. Trucking operators and their partners have a key role to play in accelerating change by making larger and more creative commitments to purchasing advanced fuels and collaborating with peers in other sectors on research, development, and deployment of new fuels and infrastructure. They can also advocate for public policy that will recognize and price the climate impacts that fuels are currently externalizing at no or low cost.

ISSUE 3: THE ISSUES INVOLVED ARE COMPLEX

The production and use of fuels contribute to climate change and a host of other environmental and social impacts. Because these issues are multifaceted, fuel sustainability is often taken to mean different things. In the simplest case, the driving force is decarbonization (e.g., see the GHG Protocol). More comprehensively, it is thought to include the breadth of negative and positive environmental, social, and economic issues (e.g., as covered in our 2012 report on fuel's sustainability impacts). And some tools take an in-between approach that captures a select number of quantifiable parameters, such as climate and health (e.g., the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation [GREET] lifecycle assessment [LCA] tool).

The multifaceted nature of sustainability presents challenges. There are many issues at stake, and there are often tradeoffs (e.g., switching to a new technology causes positive impacts in one area and negative impacts in another) as well as co-benefits (e.g., switching to a new technology causes positive impacts in more than one area). However, companies and partners must resist the temptation to let this complexity paralyze action.

Accelerating low-carbon development is paramount. With fuel sustainability, decarbonization is typically singled out as the driving agenda because of the sweeping planetary changes that it is causing and the fact that it affects all other issues. From a practical perspective, the most work has been done to create frameworks and databases that allow climate impacts to be managed. For example, companies can readily view published GHG intensity figures, and most companies use the GHG Protocol to account and report on climate emissions. These frameworks allow companies to immediately compare and manage their climate impacts.

Wider sustainability is also necessary. In addition to reducing climate impacts, we must address a broader set of sustainability issues. These issues—health, water, land use, and indigenous peoples' rights—are important in their own right. They are also critical to the success of low-carbon solutions as the rise of perceived or potential unintended consequences could undermine future development pathways. Conversely, improvements around other issues, such as by reduced tailpipe emissions and positive impacts on health when vehicles are electrified, can strengthen the case for climate solutions in some instances. Therefore, while companies must focus on low-carbon fuels, they cannot be single-minded and must tune in to the broader sustainability agenda around fuels.

Implication: **Companies should focus on decarbonizing fuels while also addressing sustainability broadly.** With transportation fuels, the breadth of sustainability issues is wide, and the interactions are complex, but companies must not use this nor the specter of unintended consequences as a reason for inaction. While any transition is associated with uncertainty, the need to transition away from high-carbon, unsustainable fuels is particularly urgent.

Getting this transition right means striking a balance between basing investments on sound science and accurate data and understanding the uncertainties and trade-offs—while simultaneously taking steps in the timely way that is needed to minimize the climate crisis.

ISSUE 4: SUSTAINABILITY STANDARDS ARE UNDERDEVELOPED

Over the past decade, corporate sustainability has matured, with most large companies managing sustainability in their sourcing and working with stakeholders on key issues.[20] However, despite making progress overall, many companies find it difficult to manage fuels sustainably for several reasons.

There is a lack of accepted protocols for associating fuels with their full range of lifecycle impacts. As we described in "The Sustainability Impacts of Fuel," these extensive impacts include dozens of social, environmental, and economic factors that vary by feedstock, location, geology, climate, and the technology used. Furthermore, technologies are changing rapidly and are often treated as proprietary, making impacts difficult to examine. Some tools have been developed, but they are not yet widely used by companies and stakeholders to compare fuels and fleets.[21] The main standard for corporate accounting and reporting of climate impacts, the GHG Protocol, outlines but does not provide detailed guidance on accounting for the total lifecycle impacts of transportation fuels.

There is also a lack of transparency systems for the fuel supply chain itself. The supply of crude oil is distributed around the world, meaning that information quality and availability varies widely. Refineries are complex; they process mixtures of crude oils, purchase intermediate streams and blend components from other refiners or traders, sell intermediate streams and blend components to other refiners or traders, and produce multiple products. And fuel supply chains are treated as fungible, being mixed into shipping vessels, pipelines and storage tanks, and product exchanges where they meet universal demand.

This blending of feedstocks during processing and distribution obscures chains of custody. It has led fuel users to be indifferent historically to the source of fuels, provided that the fuel meets basic performance standards, favoring instead the economic advantages that come from the ability to swap one for another.

As a result, there are no established systems and infrastructure allowing interested parties to trace purchased fuel back to specific points of origin and, thereby, favor sources or production practices. Some organizations have proposed traceability initiatives to address this complexity, though they are in the early stages of development.[22]

Fuel users are unable to fully understand and manage system impacts. Actions taken to restrict the flow of oil from one source or type to a specific location may result in it being diverted ("leaking") to another one. Increased exports of U.S. coal to the European Union in the face of decreasing demand in the United States is one example of this phenomenon. Some people have

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[20] BSR and Globescan, "State of Sustainable Business Survey 2013," 2013, www.bsr.org/reports/BSR_GlobeScan_Survey_2013.pdf.

[21] Eric Olson and Ryan Schuchard, "The Sustainability Impacts of Fuel," BSR, 2012, www.bsr.org/en/our-insights/report-view/the-sustainability-impacts-of-fuel.

[22] See, for example, the Sierra Club and ForestEthics initiative: www.sierraclub.org/pressroom/downloads/Tar%20Sands_letter-0701.pdf.

suggested that curtailing oil imports from the Canadian oil sands to the United States will similarly boost shipments to China, where refineries may have fewer pollution controls and overall climate impacts could actually be greater. Without relevant protocols and the transparency resources mentioned above, it is difficult to translate individual company actions into net impact on the system.

Implication: **Companies must develop mechanisms that improve their ability to manage fuel sustainability.** The sustainability impacts of fuel are complex, variable, and dynamic; and the commodity nature of fuel markets has led to a system that allows for the most economically efficient trading. Progress on sustainability has been limited due to a lack of standardized, transparent information. As information technology improves, attention to fuel sustainability grows, and more creative collaborations are developed, companies should look for opportunities to develop new institutions that create standards to help manage fuel sustainability.

ISSUE 5: KEY STAKEHOLDERS HAVE DIFFERENT IDEAS ABOUT THE WAY FORWARD

At the core of fuel sustainability is science and technology: reductions in grams of CO2 per megajoule (abbreviated as "g CO2 e/MJ") of fuel lifecycles, emissions per distance of travel, and the wider impacts that occur throughout the value chain. Much of the future rests on engineering new technical solutions.

However, the emergent nature of new fuels and associated uncertainties with sustainability research create questions that are more qualitative and subjective in nature. For example, companies should consider the following:

» What is your role in addressing GHG emissions from oil sands, which can be 25 percent (or more) higher than many conventional sources—in the context of other unconventional oil sources, such as oil shale, that could be even higher?[23]

» What are the sustainability advantages and risks for natural gas in light of a recent study that shows that it is 25 to 75 percent higher than EPA estimates, and what should you do about it?[24]

» How concerned should you be about indirect land use change (ILUC) and interactions with food markets from biofuels, and what should you do to ensure its practices are sustainable?

» How should you think about the climate benefits of EVs when electricity sources may be very different and unknown?

These questions have core technical components, but for individual companies to answer them, they must do more than perform an independent, objective analysis—they must bring together stakeholders with a variety of perspectives to address this diverse set of problems. This process requires us to share information and build consensus.

There are varied perspectives about what matters. The fuel value chain comprises a network of business, government, and civil society actors (see Figure 2). These actors have varying priorities that may bear on their ability to

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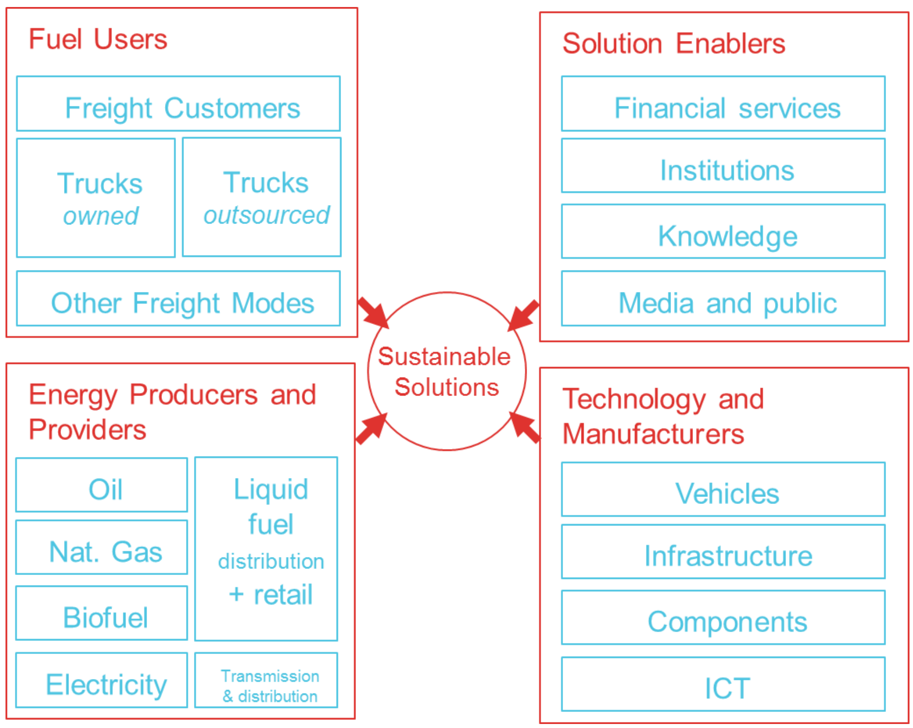
[23] Eric Olson and Ryan Schuchard, "The Sustainability Impacts of Fuel," BSR, 2012, www.bsr.org/en/our-insights/report-view/the-sustainability-impacts-of-fuel.

[24] Coral Davenport, "Study Finds Methane Leaks Negate Benefits of Natural Gas as a Fuel for Vehicles," *New York Times,* 2014, www.nytimes.com/2014/02/14/us/study-finds-methane-leaks-negate-climate-benefits-of-natural-gas.html.

promote fuel sustainability. Fuel users are concerned with the cost efficiency of fuels, total cost of ownership of vehicles, and reliability of fuels and vehicles. Energy producers and providers are concerned with air and water environmental regulations in addition to fuel quality. Technology providers and manufacturers are concerned about fuel efficiency and safety features, and solution enablers may have existing product mixes or research agendas.

Perspectives among sustainability advocates are also heterogeneous. For example, while some organizations advocate that climate change is a critical and pressing challenge, others raise questions about environmental issues that may be harmed by development of low-carbon infrastructure, a proposed solution to climate change. In other cases, climate change matters, but it is not a particular group's key concern; for example, unconventional oil production may lead to issues that concern biodiversity and relations with indigenous communities. There is, therefore, not a single, clear sustainability perspective.

Figure 2: Select Stakeholders Involved with Fuel Sustainability



Furthermore, as discussed previously, even the most sophisticated current scientific assessments of fuel paint an incomplete picture of impact. Improving understanding requires the development of new systems that will depend on companies to accept and use them. Among the challenges companies must address with stakeholders: The problems and benefits of different fuels are split among different parties, and different groups have different risk tolerances and approaches to uncertainty. Human rights, among some other social impacts, are not easily quantified and may, therefore, be overlooked in policy discussions. Local issues that affect communities, such as production practices for natural gas, are as much about managing an effective stakeholder engagement process as they are about the science of impacts.

The key stakeholders have different beliefs about what is possible for the necessary transformation. Even assuming a single objective, such as GHG emissions reduction, there are numerous visions of a future fuel system that is realistically achievable and what it would take to create it. In this case, some envision a portfolio of fuels that represents about the same mix of fuels as today but with far greater efficiency, while others believe we can and should significantly ramp up a certain basket of fuels. Others call for simply moving beyond petroleum, while others are "technology-agnostic," maintaining that what is needed is demand-side policies that encourage the adoption of whatever low-carbon fuels the market decides are most efficient.[25] These differences are attributable to different theories of change and underlying assumptions about human and market behavior.

Different actors often work in isolation. These varied priorities and perspectives cause the different actors to work in isolation, which prevents them from developing a clear, shared understanding of sustainability and economic issues and how they are intertwined. Discourse about fuels tends to be dominated by one-sided views from proponents of specific industries or issues. Companies, in turn, hear many different calls to action without a single lens they can use to focus on fuel sustainability.

Implication: **Leading companies incorporate diverse stakeholder perspectives into their fuel strategies.** While fuel sustainability involves technical considerations at its core, company performance and opportunities are shaped by diverse perspectives, competing interests, and human impacts that mean subjective concerns need to be managed. Furthermore, the rise of the polyfuel economy complicates issues even more, making stakeholder engagement an even more critical skill. In response, companies should encourage and host dialogue about difficult issues as the fuel marketplace becomes more varied. Companies should also support the development of coalitions. Future of Fuels is one such coalition, but it is not the only one. This guide highlights other areas for collaboration, and there are many opportunities to collaborate in ways that have not yet been addressed.

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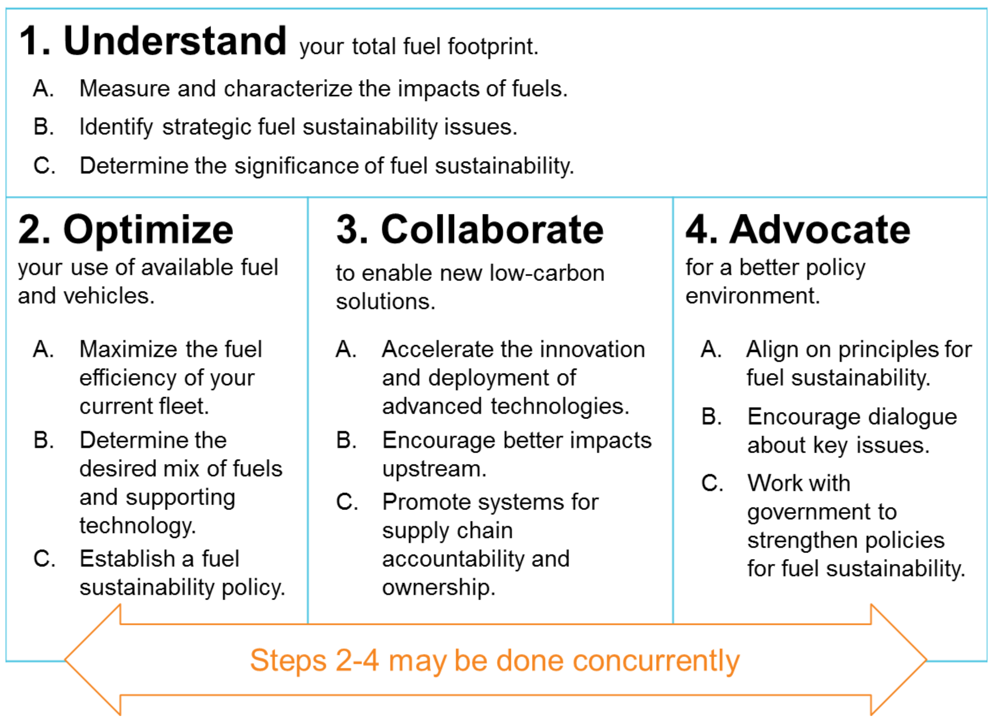
This introduction highlights numerous challenges. Critically, these challenges are not reasons for companies not to act, but instead, they imply a set of design principles that leaders should incorporate into their strategies for transitioning to low-carbon fuel. Those design principles include taking a portfolio approach, accelerating the development of scalable solutions, focusing on decarbonizing fuels while addressing sustainability issues more widely, developing institutions that improve the ability to manage fuel sustainability, and incorporating diverse stakeholder perspectives into fuel strategies. The next section explores how companies can incorporate these principles into their actions.

[25] For example, see perspectives from Shell, Greenpeace, International Energy Agency, World Bank, and Resources for the Future.

Guide for Making the Transition

As we have outlined, the current major transportation fuels are high carbon and unsustainable; trucking fleet operators, therefore, need to find ways to more rapidly and effectively transition to low-carbon fuels. However, several issues complicate their options. But these issues also create opportunities for leaders. With those opportunities in mind, the following roadmap presents a practical, systematic approach for trucking fleet operators to work together with business partners and stakeholders to promote and use more low-carbon, sustainable fuel (see Figure 3).

Figure 3: Guide for Fuel Sustainability



This Roadmap for Fuel Sustainability contains four steps, each based on a set of discrete activities. It is meant to serve as a guide, not a prescription, to help companies as they develop their own fuel strategies: Step 1, “Understand your total fuel footprint,” is a natural place to start, but companies may not follow the steps linearly and may emphasize the activities that they find most helpful.

Trucking operators making use of these recommendations should generally designate a person and a cross-departmental fuel champion team to steward the process.

This guide is written for trucking operators, but it also addresses their key value chain partners: shippers, fuel providers, manufacturers of vehicles or components, and investors. Their roles are outlined in each section.

The concept of a cross-fuel, lifecycle roadmap for fuels is new, but there is a wide variety of tools and approaches to draw from, including fleet efficiency management, policy engagement, LCA, supplier engagement, and policy advocacy. The framework provided here draws connections among the many good case studies and resources that already exist.

Step 1: Understand Your Total Fuel Footprint

If you want to improve the sustainability of a trucking fleet's overall transportation fuel portfolio, the logical starting point is to understand the company's current fuel footprint. There are essentially two components: First, objectively measure the company's fuel use and associated GHG emissions using standardized tools. Second, conduct an assessment of strategic fuel issues for the company, which is more relative and qualitative in nature.

These activities will help the company characterize the size of its fuel-related impact and the relative significance of fuel sustainability. This information, in turn, informs the approach a company should take to transition to low-carbon fuels as outlined in subsequent sections of this guide.

Activity 1A: Measure and Characterize the Impacts of Fuels

BACKGROUND
Standard accounting and reporting of GHG emissions is prescribed by the Greenhouse Gas Protocol's Corporate Standard, which organizes emissions into three concentric scopes. For trucking fleet operators, fuel impacts can be thought of as follows:

» **Scope 1 emissions:** Direct emissions from onboard fuel combustion of vehicles that the company owns or controls. For trucking operators, this "mobile source" category will generally comprise the vast majority of its footprint.

» **Scope 2 emissions:** Indirect emissions from electricity used in operations. For fleets, this category corresponds to power for EVs that the company owns, controls, or operates. For most companies, this is currently a very small area of impact.

» **Scope 3 emissions:** Emissions associated with the wider value chain of fuels and vehicles; includes 15 categories in all. For the fleet operator, Scope 3 emissions linked to fuel are those in the "Fuel- and Energy-Related Activities" category and concern upstream production (e.g., well-to-tank) impacts from fuel.

A key question for fleet operators is whether they really need to spend the time and expense measuring the fuel- and energy-related activities as part of their Scope 3 emissions. Indeed, in 2011, only 72 of the largest 500 companies reporting to the Carbon Disclosure Project (CDP) disclosed on this category.[26]

However, if fleet operators do not conduct this additional assessment, they will find it difficult to make meaningful decisions about alternative and innovative fuels. Without an assessment using this category, fuels are measured only by their direct combustion, and thus the emissions of CNG from shale versus CNG from biogas will look the same, despite the fact that they are quite different on a total lifecycle basis. As attention grows around the upstream impacts of sources, such as oil sands, natural gas, and biofuels, this category is likely to become more relevant and to develop more sophisticated measurement tools.

Application of these scopes of emissions depends on company assets and operations. Trucking fleet operators' value chain partners account for emissions from fuel that they are associated with in the following categories:

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[26] Carbon Disclosure Project, "Global 500 Report," 2012, www.cdproject.net.

» **Shippers:** Upstream transportation and logistics; downstream transportation and distribution[27]
» **Fuel providers:** Processing of sold products; use of sold products; purchased goods and services[28]
» **Manufacturers:** Use of sold products[29]
» **Investors:** Investments[30]

ISSUES TO CONSIDER

Trucking fleets that seek to measure and characterize the impacts of the fuel they use typically follow these steps as advised by the GHG Protocol:

1. **Identify sources:** Identify sources of emissions. Mobile combustion is one of the major categories of emissions within a company's boundaries; others that should be accounted for alongside it include stationary combustion, process emissions, and fugitive emissions.
2. **Select a calculation approach:** Decide on a calculation approach, which for fuels from trucking fleets will generally mean applying a documented emission factor to data on fuel use. Other emissions may be calculated based on a mass balance or stoichiometric basis specific to a facility or process.
3. **Collect data and choose emissions factors:** Collect data, typically on the purchased quantities of commercial fuels using published emission factors.
4. **Apply the calculation approach:** Calculate direct and indirect CO2 emissions from fuel combustion in mobile sources and provide calculations and emission factors.
5. **Roll up data to the corporate level:** Incorporate data on fuels into the wider inventory of global GHG emissions, including data from multiple facilities, possibly in different countries and business divisions.

RECOMMENDATIONS FOR FLEET OPERATORS

Measure the GHG emissions of fuels in fleets that the company owns and operates (Scope 1 and 2 emissions) using guidance from the GHG Protocol as described above. Fleet operators should then account for the wider lifecycle impacts of the fuels consumed in their operations using the GHG Protocol's guidance for measuring within the value chain (Scope 3). The resources at the end of this section provide the full Corporate Accounting and Reporting Standard, guidance for fleets, and a worksheet tool.

RECOMMENDATIONS FOR PARTNERS

Shippers, fuel providers, manufacturers, and investors should all consider accounting for and reporting their Scope 3 emissions associated with fuels as described above.

[27] Greenhouse Gas Protocol, Scope 3, Calculation Guidance, 2012, www.ghgprotocol.org/feature/scope-3-calculation-guidance.
[28] Ibid.
[29] Ibid.
[30] Ibid.

OUTCOME
The outcome is an inventory of GHG emissions and fuel use that informs the company's wider corporate GHG inventory. Additionally, the process will result in an itemization of the types of vehicles and the makeup of their associated fuel use managed by the company, which will be useful in later steps.

RESOURCES

- Carbon Footprint of Freight Transport (COFRET), "Harmonization of CO2 Calculation for Freight Transport—A Progress Report," 2014, www.cofret-project.eu/Latest-Info/News/Harmonization-of-CO2-Calculation-for-Freight-Transport-A-Progress-Report_40.htm.
- Environmental Defense Fund. Fleet Calculator. http://business.edf.org/projects/fleet-vehicles/fleet-calculator.
- Greenhouse Gas Protocol, "Calculating CO2 Emissions from Mobile Sources," 2013, www.ghgprotocol.org/files/ghgp/tools/co2-mobile.pdf.
- Greenhouse Gas Protocol, "Corporate Accounting and Reporting Standard," 2002, www.ghgprotocol.org/files/ghgp/public/ghg-protocol-revised.pdf.
- Greenhouse Gas Protocol, "Scope 3 Calculation Guidance: Category 3—Fuel- and Energy-Related Activities Not Included in Scope 3 (2012)," 2011, www.ghgprotocol.org/files/ghgp/Chapter3.pdf.
- Greenhouse Gas Protocol, Transport Tool, 2013, ww.ghgprotocol.org/files/ghgp/tools/WRI_Transport_Tool.xls.
- National Biodiesel Board, Emissions Calculator, www.biodiesel.org/using-biodiesel/handling-use/emissions-calculator.
- U.S. Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program, www.eia.gov/oiaf/1605/gdlins.html.

Activity 1B: Identify Strategic Fuel Sustainability Issues

BACKGROUND
Whereas the previous activity focused on the impacts of fuels for companies with fleets that they directly own and operate, a wider set of companies have stakes in fuels indirectly, which companies need to understand. For example, fuel may be a source of significant impact and risk in the value chain, as it is a major part of some suppliers' and buyers' budgets that are exposed to changing fuel markets. Figure 1 in the first section outlines different situations in which a company may have significant exposure to fuel-related issues.

Additionally, the problem of fuel sustainability presents many opportunities to improve value chain impacts (described in detail in during Step 3), which can translate into potential for companies to create value with new investments.

ISSUES TO CONSIDER
Factors that may contribute to fuel sustainability being a strategic concern for companies include:

- **Supply chain:** Does a valuable share of sourced goods need to travel long distances to make it to your company?
- **Product markets:** Do you make products that use or relate to fuels where regulation is uncertain and could have a significant impact on product development and marketability (e.g., engines and technology)?
- **Strategy:** Does your core business depend on the success of particular fuels, feedstocks, or vehicle technologies?

- **Biomaterials and food:** Does your company significantly use or require biomaterials that could interchangeably be used for fuel, food, or other materials? Or does your company depend on agriculture livelihoods?
- **Stakeholder attention:** Have you received questions or requests from stakeholders that concern fuel sustainability?
- **Natural resources:** Does your company have any captive sources of energy, such as methane emissions or biowaste?
- **Performance:** Do you have fuel sources whose GHG content is particularly higher or lower than average? Or fleets with particularly high or low efficiency?
- **Technology:** Does your company have a business model for EVs and/or electricity transmission and distribution?
- **Incentives:** Can your company benefit from subsidies, grants, or other incentives for fuel sustainability?
- **Local availability:** Are there reputable biofuel producers or marketers near your business or fueling location? This could include distant suppliers that have efficient freight or the logistical capacity to serve the local market.
- **Infrastructure:** What is the source of electricity in the regional grid? Is it dependent on coal, other fossil fuels, or nuclear power? Is there a significant increasing percentage of low-carbon electricity sources entering the regional grid? What will be the marginal source of electricity with added demand for vehicles? Are plug-in facilities available or obtainable?

RECOMMENDATIONS FOR FLEET OPERATORS

Consider the questions above, which can help to identify risks and opportunities that relate to regulation, customers, markets, and stakeholder attention. Companies may perform Activity 1B after or in conjunction with Activity 1A, in which they measure and characterize the impacts of fuels.

RECOMMENDATIONS FOR PARTNERS

All partners (shippers, manufacturers, fuel providers, and investors) should make similar considerations for fuels issues and consider how making changes to their portfolio and engaging with trucking operators may present opportunities.

OUTCOME

The outcome is a list of issues that relate to the company's business functions and an understanding of which fuel sustainability issues are strategic for the company. This information, in turn, can be used for reporting in companies' CDP and financial filings that concern climate risks and opportunities.

RESOURCES

- Carbon Disclosure Project, "Investor CDP 2013 Information Request," 2013, www.cdproject.net/CDP%20Questionaire%20Documents/Investor-CDP-2013-Information-Request.pdf.
- Commission for Environmental Cooperation, "Destination Sustainability: Reducing Greenhouse Gas Emissions from Freight Transportation in North America," 2011, www3.cec.org/islandora/en/item/4237-destination-sustainability-reducing-greenhouse-gas-emissions-from-freight-en.pdf.
- Ecofys, "Summary of Approaches to Accounting for Indirect Impacts of Biofuel Production, 2009, http://rsb.org/pdfs/documents_and_resources/09-10-09_Ecofys-SummaryApproachesAccounting_indirect_impacts_biofuel_production.pdf.
- Eggert, Anthony, and Art Guzzetti, "Transportation, Land Use, and Accessibility," Alliance to Save Energy, 2013, www.ase.org/policy/energy2030/transportation-land-use-accessibility.

» Fouquet, Roger, “The Slow Search for Solutions: Lessons from Historical Energy Transitions by Sector and Service,” Basque Centre for Climate Change, 2010, http://8020vision.com/wp-content/uploads/2010/07/BC3WP201005.pdf.

» International Energy Agency, *Energy Technology Perspectives 2012—How to Secure a Clean Energy Future,* 2012, www.iea.org/w/bookshop/add.aspx?id=425.

» National Academy of Sciences, *America’s Energy Future,* 2009, http://books.nap.edu/openbook.php?record_id=12091.

» Securities and Exchange Commission, “Commission Guidance Regarding Disclosure Related to Climate Change,” 2011, www.sec.gov/rules/interp/2010/33-9106.pdf.

Activity 1C: Determine the Significance of Fuel Sustainability

BACKGROUND

Once the issues in Activities 1A and 1B have been evaluated on their own, they need to be synthesized and considered in the context of stakeholders. A thorough stakeholder evaluation is important because companies have different key stakeholders, and such stakeholders have different perspectives about the issues where uncertainty persists (e.g., fracking impacts, economic and lifecycle GHG impacts of biofuels, and nuclear safety, etc.) as a result of different interests, theories of change, and risk tolerances.

ISSUES TO CONSIDER

Factors that may help to determine the company’s fuel sustainability priorities include:

» How does fuel fit into your company’s overall sustainability profile and commitments?

» How are changes in the marketplace likely to affect your company’s performance and options over time?

» Are there any sustainability issues that are particularly important given your company’s region or product portfolio?

» What is the balance of concerns between immediate issues and emerging issues?

» In which cases does your company have key stakeholders who hold different or competing positions?

» How can diverse and potentially competing perspectives affect your company? And how can they be reconciled?

RECOMMENDATIONS FOR FLEET OPERATORS

Determine the priority level of transportation fuel sustainability as a concern for the company. Such a determination is typically done through a process of materiality assessment that considers objective sustainability impacts and opportunities, stakeholder perspectives, and the relevance of those issues to the business.

RECOMMENDATIONS FOR PARTNERS

Determine how much of a priority transportation fuel sustainability is to the company.

OUTCOME

The outcome is a determination of the significance of fuel sustainability and the identification of key areas for follow up. This activity’s results may also suggest what teams need to be involved for future discussions and/or further investments in personnel and team coordination.

This final activity in the “Understanding your total fuel footprint” step enables the company to decide how best to move forward by providing an analytical basis for subsequent steps.

RESOURCES

- BSR, “Materiality Analysis,” 2013, www.bsr.org/consulting/services/BSR_Services_Materiality.pdf.
- BSR, “Navigating the Materiality Muddle,” 2013, www.bsr.org/en/our-insights/bsr-insight-article/navigating-the-materiality-muddle.
- Tuppen, Chris, “Materiality Determination,” Fronesys, 2011, http://advancingsustainability.com/documents/DeterminingMaterialitywhitepaperfromFronesys.pdf.

Step 2: Optimize Your Use of Available Fuel and Vehicles

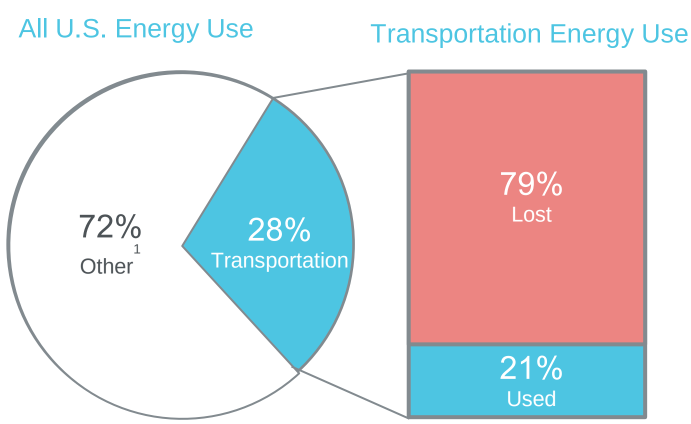
The next step for most companies will be to optimize their use of existing fuels and vehicles. In this step, companies focus on making practical, near-term decisions that concern available assets and choices. Companies that own and manage fleets will take these steps themselves, and those whose fuel impacts are found outside of owned operations can use the following as a guide to help their partners take action.

Activity 2A: Maximize the Fuel Efficiency of Your Current Fleet

BACKGROUND

Efficiency is widely considered to be the best "first fuel" because so much energy is wasted—approximately 80 percent used in transportation is lost (see Figure 4)—and it provides an effective alternative to new fuel supplies with virtually no net negative impacts.[31] For that reason, this activity, which is the first to focus on action, is to maximize the fuel efficiency of existing fleets.

Figure 4: Energy Lost in U.S. Transportation



Note: This figure includes thermodynamic limits but excludes miles not traveled. "Other" is defined as "residential, commercial, and industrial."

Source: Lawrence Livermore National Laboratory, "Estimated Energy Use in 2012: 95.1 Quads," 2013.

ISSUES TO CONSIDER

Fuel efficiency within existing fleets is impacted by a combination of driving practices and the management of the fleet system. Some changes in both areas are relatively quick and practical, while others take more time and investment. Figure 5 outlines select measures that tend to be available in the near term.

[31] Lawrence Livermore National Laboratory, "Estimated Energy Use in 2012: 95.1 Quads," 2013, https://flowcharts.llnl.gov/.

Figure 5: Tactical Measures to Maximize Fuel Efficiency in the Near Term

Driver Behavior	Loads, Modes, and Routes	Vehicle Technology
1. Minimize speed (avoid speeding altogether), accelerate slowly, upshift at low RPMs, and maximize time in top gear. 2. Keep a steady foot on the accelerator, and avoid the overuse of engine braking or unnecessary starts and stops. 3. Keep vehicle maintained by keeping engine tuned, fluid levels within target levels, and tires properly inflated; "be skeptical about gizmos." 4. Be fastidious about minimizing auxiliary air conditioning, heat, and electricity use.	1. Drive fewer miles and with fuller loads when possible. 2. Maximize cargo density. Reduce unnecessary volume while avoiding unnecessary distances; maximize backloading and minimize packaging. 3. Use trains or ships (or trucks instead of planes) when possible. 4. Choose the least congested routes, and deliver during off-peak periods. 5. Leverage ICT to optimize the logistics network and route planning. 6. Incorporate telematics.	1. Retrofit vehicles with a low rolling resistance and single-wide tires, aerodynamic fairings, and trailer or boat skirts and tails. 2. When upgrading to new vehicles, upgrade to the best-in-class efficiency, which includes lightweight options.

Note: These measures tend to be most available in the near term and require relatively low levels of investment. The next step in the guide, "Collaborate to Enable New Low-Carbon Solutions," addresses long-term structural efficiency measures.

RECOMMENDATIONS FOR FLEET OPERATORS

To maximize fleet efficiency, fleet operators should make sure they understand the practices and performance of leading fleets. Second, they should conduct a baseline assessment in order to understand the current state of their own fleet. Third, they should set goals and strategies for performance improvement. Many companies have found the EPA SmartWay program to be a valuable resource.

RECOMMENDATIONS FOR PARTNERS

Shippers and investors should ask carriers how they are managing the recommendations above and look for ways to help promote best practices and performance. Manufacturers and fuel producers may provide information that will help companies use fuels and vehicles most efficiently.

OUTCOME

Through these and other measures, currently available technologies and practices could reduce the fuel use of freight by 40 to 50 percent within 10 years.[32] For individual companies, the result of maximizing efficiency is an improved sustainability profile through activities that increase control and generally have positive financial returns and virtually no net negative impacts.

[32] National Research Council, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,* 2010, National Academies Press, www.nap.edu/catalog.php?record_id=12845.

RESOURCES

- American Council for an Energy Efficiency Economy, "Further Fuel-Efficiency Gains for Heavy-Duty Vehicles," 2013, http://aceee.org/fact-sheet/heavy-duty-fuel-efficiency.
- International Energy Agency, "Technology Roadmap: Fuel Economy of Road Vehicles," 2012, www.iea.org/publications/freepublications/publication/name,31269,en.html.
- Rocky Mountain Institute, "Reinventing Fire: Transportation," 2012, www.rmi.org/transportation%E2%80%AC.
- Sierra Club, "Fuel Saving Tools and Programs for Companies," 2013, https://content.sierraclub.org/beyondoil/fuel-saving-tools-and-programs-companies.
- U.S. Department of Energy, Petroleum Reduction Planning Tool, 2013, www.afdc.energy.gov/prep.
- U.S. Department of Energy, "Strategies to Conserve Fuel: DOE Alternative Fuels Data Center," 2013, www.afdc.energy.gov/conserve.
- U.S. Environmental Protection Agency, "SmartWay Trends, Indicators, and Partner Statistics," 2013, www.epa.gov/smartway/tips/index.htm.
- U.S. National Highway Traffic Safety Administration, "Factors and Considerations for Establishing a Fuel Efficiency Regulatory Program for Commercial Medium- and Heavy-Duty Vehicles," 2010, www.nhtsa.gov/.
- Union of Concerned Scientists, "Reducing Oil Use through Fuel-Efficient Trucks: Half the Oil Plan," 2013, www.ucsusa.org/clean_vehicles/smart-transportation-solutions/better-fuel-efficiency/trucks-fuel-efficiency.html\.

Activity 2B: Determine Your Desired Mix of Fuels and Supporting Technology

BACKGROUND

The many fuels available today have varying levels of sustainability, availability, reliability, and cost effectiveness. The ideal mix of fuels depends on several factors that are subjective to the company. This activity helps an individual company identify the mix of fuels that is desirable for its operations.

ISSUES TO CONSIDER

Whenever possible, companies should use low-carbon fuels, including biofuels, natural gas, and electricity—though they vary. (A new edition of our guide, "The Sustainability Impacts of Fuel," will provide a set of expanded definitions of fuel later this year.) However, these fuels are not suitable for all purposes. Companies must consider the following additional criteria:

GHG and other sustainability impacts: In order to make credible reduction claims, fuel users need to understand the lifecycle GHG emissions of the specific biofuel supply chain they are using. Companies should seek fuels that have lower carbon footprints than conventional fuel and that do not involve other major sustainability trade-offs.

Vehicle application: As companies evaluate alternatives to petroleum-based diesel, each fuel will have certain technical trade-offs. Key considerations include route type (EVs, CNG, and LPG are less amenable to long-distance hauling), climate (cold temperatures inhibit biofuels due to cold flow properties—although winter blends are available), topography and payload (EVs are less suited to significant climbing with heavy loads), and duty cycle (EVs require downtime for charging.) Figure 6 provides a summary of key electrification opportunities for trucks.

Figure 6: Key Electrification Opportunities for Trucks

Truck Type		Opportunity
Class 7–8 Tractors	Over the road	Electrification of auxiliaries. Over the long term, hybrid electric. Prospects for use of LNG.
	Short haul and regional	Engine electrification, hybrid electric, electrification of auxiliaries, plug-in electric, and electrified corridor. Long term: hydraulic hybrid.
Class 3–8 Vocational Work Trucks	Urban	Engine electrification, hybrid, and electrification of auxiliaries. Hydraulic hybrid.
	Rural and intracity	Hybrid electric and plug-in hybrid. Long term: engine and auxiliary electrification. Hydraulic hybrid.
	Worksite support	Hybrid electric, electrification of auxiliaries, and plug-in hybrid.
Class 2B–3	Pickups and vans	Hybrid electric, auxiliary electrification and plug-in hybrid. Long term: engine electrification. Hydraulic hybrid.

Source: California Hybrid, Efficient, and Advanced Truck Research Center (CalHEAT), 2013, www.calstart.org/Libraries/CalHEAT_2013_Documents_Presentations/CalHEAT_Roadmap_Final_Draft_Publication_Rev_6.sflb.ashx.

The majority of medium- and heavy-duty diesel manufacturers approve blends of at least 20 percent biodiesel (B20) in their equipment. When purchasing equipment, fleet managers should ensure that it is approved for use with B20. If diesel equipment is going to be used in cold weather, managers should pay attention to the cold-weather operability of the fuel blend, both for conventional diesel fuel and biomass-based diesel.

Proximity to cost-effective sources: Biofuels and natural gas are more abundant and less expensive when the supply is nearby. Supplies vary—some locations will have plenty of commercial distribution. In other cases, the company may have captive sources of waste methane or biomass that could be converted into fuel, or they could contract with a private dealer. Also, EVs and other advanced vehicles are cheaper where there are regulatory incentives like rebates. Key considerations, therefore, are the presence of captive fuel sources and the location of routes, hubs, and offices where the vehicles are purchased.

Risk considerations: Given the changing marketplace landscape, the fuel-vehicle portfolio can represent different kinds of objectives from an investment standpoint. Key considerations that bear on fuel selection are the ability and willingness to experiment with vehicle modifications, concern for activist pressure or key issues, and objectives around being at the forefront of vehicle technologies.

Investment criteria: Finally, companies must make financial considerations that are unique to their situation. Key considerations are the replacement schedule of vehicles, financial investment criteria (e.g., Net Present Value, hurdle rate, or payback period), and whether they have the capital available to invest.

RECOMMENDATIONS FOR FLEET OPERATORS

Conduct an evaluation of each option's strengths, weaknesses, opportunities, and risks to make near-term technology investments to reduce the carbon intensity of their fuel mix and make recommendations for the following:

Using low-carbon fuels in vehicles the company already owns: In some instances, companies can simply increase the ratio of low-carbon fuel being used in vehicles they already own; there is growing evidence that in many cases, even when 85-percent ethanol fuel (E85) is available at the same station, drivers of flex-fuel vehicles (FFVs) don't use it. Therefore, the low-hanging fruit is when companies own FFVs, which can use up to 85 percent ethanol, and aren't optimizing their use. FFVs often aren't marketed as such, so this may require some investigation.[33] However, opportunities are mostly relevant for engines that run on gasoline, not diesel.

They can also use higher levels of biodiesel blends in diesel trucks. While the retail pump may contain up to 5 percent biodiesel (B5) and still be considered D975 diesel, trucks can theoretically run on higher blends, in most cases up to 20 percent (B20) without engine modifications, and up to 100 percent (B100) in appropriate applications. Increasing biodiesel content beyond the blend level recommended by the original equipment manufacturers (OEMs) may have operational and maintenance effects that should be balanced against the benefit of low-carbon fuel content, and OEM engine warranties are typically not honored for blends beyond B5. Also, first-generation biodiesel can plug filters at low temperatures (i.e., 35º F).

Companies can have their in-house mechanics or a third party assess their options and consult with vehicle manufacturers. The National Institute for Automotive Service Excellence (ASE) has accredited a biodiesel training course for diesel technicians. Companies should hire mechanics who have completed this course or contact the National Biodiesel Board to inquire about future training opportunities.

Level of quality is the main characteristic that ensures the performance of alternative and conventional fuels. Fuels should meet quality and performance criteria, such as the consensus standards set by ASTM International (formerly the American Society for Testing and Materials).

Companies may also consider creating off-take agreements for low-carbon biofuels, such as cellulosic or algal that minimize negative indirect impacts. These options can help advance these industries in the early stages of commercialization.

Modifying existing engines to accept greater levels of low-carbon fuels: Another opportunity is to modify current engines to run on low-carbon fuel, such as CNG, LPG, alcohols, or electricity. Modification can be more cost effective than purchasing new vehicles and can give companies an opportunity to experiment and customize.

Purchasing vehicles that use low-carbon fuels and substitutes: An additional option is to acquire vehicles that use low-carbon fuels and substitutes, and then to actually use those fuels. New vehicles—which can be purchased as-is or built to order—could include EVs, natural gas vehicles, and vehicles using more emergent fuel sources, such as hydrogen fuel cell vehicles.

RECOMMENDATIONS FOR PARTNERS

Vehicle manufacturers and fuel producers should collaborate with fleet operators on research and development (R&D) to make low-carbon fuels perform better in a wider range of fleet operations. Shippers and investors should seek to understand carriers' choices for fueling and in turn encourage and share best practices.

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[33] U.S. Department of Energy, "Flex-Fuel Vehicles," 2013, www.fueleconomy.gov/feg/flextech.shtml.

OUTCOME

The outcome of Step 2, “Determining the desired mix of fuels and supporting technologies,” is a strategy for fuel purchasing along with recommended modifications to engines and investments in new vehicles to support the desired fuel use. This step includes judging the future residual value of vehicles and the future development of refueling infrastructure for alternative fuels.

RESOURCES

» American Council for an Energy Efficiency Economy, “ACEEE’s Green Book,” 2013, www.greenercars.org/.

» Calstart, “CalHEAT Research and Market Transformation Roadmap,” 2013, www.calstart.org/Projects/CalHEAT/Research-and-Market-Transformation-Roadmap.aspx.

» The Climate Group, “Plugged-In Fleets: A Guide to Deploying Electric Vehicles in Fleets,” 2012, www.theclimategroup.org/_assets/files/EV_report_final_hi-res.pdf.

» National Biodiesel Board, “Background Sheet (on Diesel and Biodiesel Cold Flow),” www.biodiesel.org/docs/default-source/ffs-performace_usage/cold-flow-backgrounder.pdf.

» National Biodiesel Board, “Biodiesel Beats the Cold: Hot Tips for Using Biodiesel in Cold Weather,” 2008, www.biodiesel.org/docs/default-source/ffs-performace_usage/hot-tips-for-using-biodiesel-in-cold-weather-%28general%29.pdf?sfvrsn=6.

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» National Biodiesel Board, “Changes in Diesel Fuel: The Service Technician’s Guide to Compression Ignition Fuel Quality,” www.biodiesel.org/docs/ffs-performace_usage/service-technician's-guide-to-diesel-fuel.pdf.

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- U.S. Environmental Protection Agency, SmartWay Finance Program, 2013, www.epa.gov/smartway/financing/index.htm.

Activity 2C: Establish a Fuel Sustainability Policy

BACKGROUND
After completing Activities 2A and 2B, companies will have developed a recommended strategy for managing fuel efficiency, purchasing fuel, making modifications to powertrains, and investing in new vehicle assets. Companies should next transform that vision into action by establishing a fuel sustainability policy that drives implementation.

ISSUES TO CONSIDER
A fuel sustainability plan may include the following elements:

1. **GHG emissions and energy reduction from fuels:** Overall goal(s) for improving the performance of the fleet and the role of fuels and vehicles to enhance corporate impacts overall.
2. **Fueling and charging practices:** Guidance about fuel purchasing and use (e.g., depending on when there is a choice, that is, when higher biofuels blends are available and suitable for FFVs) and how, when, and where EVs should be charged in consideration of the electricity source’s carbon intensity.
3. **Fuel procurement:** Guidance about whether and how sustainability concerns should be integrated into contracts in order to encourage lower carbon intensity, and whether and how fuel sustainability certification should be used.
4. **Acquisitions and investment:** Guidance for making capital investments in new vehicles, which should generally encourage high-efficiency vehicles and vehicles that use advanced, low-carbon fuels, with consideration of the breadth of regulatory, stakeholder, and other risks and opportunities.
5. **Operations and maintenance:** Specificity around practices for ongoing maintenance and operations to ensure that vehicles are running efficiently and productively.
6. **Planning and review:** Clarification of the overall plan and measures to ensure that reviews are timely and that the company responds to new developments. This part of the plan should include a review of the sustainability of fuel options that considers:
    - GHG intensity
    - Other high-level sustainability issues
    - Climate and sustainability uncertainties
    - Research to watch
    - Perspectives and controversies
    - Benefits and opportunities for sustainability certification
7. **Coordination and communication:** Direction about which teams are involved in governance and implementation and measures to promote open communication with various stakeholders.

While some corporate fuel policies exist (see the appendix that discusses sample corporate policies), in general, governments and universities have led the way.

Corporate activities in this arena have been limited and do not comprehensively address lifecycle issues and supplier engagement. Since so much work remains in this area, leading companies can show the way.

RECOMMENDATIONS FOR FLEET OPERATORS

Establish a fuel sustainability policy that gives fleet and capital budgeting teams the guidance they need to make decisions that support business and sustainability objectives.

RECOMMENDATIONS FOR PARTNERS

Shippers and investors should ask fleet operators to identify their fuel sustainability policies, and encourage dialogue among peers and stakeholders about sharing best practices.

OUTCOME

The outcome of this activity is a fuel and vehicle purchasing policy that aligns with sustainability and reflects current availability and research. It will ensure that company opportunities for fuel efficiency, fuel purchasing, and related technology investments for vehicles are fully understood and utilized.

RESOURCES

» Appendix: Select Corporate Policies

» Environmental Defense Fund, “Five-Step Green Fleet Framework,” 2010, http://business.edf.org/projects/fleet-vehicles/five-step-green-fleet-framework.

» U.S. Department of Energy, “Comprehensive Federal Fleet Management Handbook,” 2011, www1.eere.energy.gov/femp/pdfs/eo13514_fleethandbook.pdf.

Step 3: Collaborate to Enable New Low-Carbon Solutions

The third step is to play a constructive role in driving long-term, systemic improvements in the sustainability of the total fuel value chain. In order to do this, companies should make strategic investments to improve the impacts of all fuels—to new low-carbon sources and incumbent fuels alike—while accelerating the adoption of more advanced technology.

The purpose of the second step was to make sure that current business and operational conditions support practical technology upgrades. This step, in contrast, aims to enable companies to participate in more of those activities by solving the larger problems that stand in the way. Companies may find that Step 3 naturally follows Step 2; for others, the two steps may work better in tandem.

In this step, companies can achieve some of their greatest impacts by building the market and creating new standards and systems; it is instrumental to advancing a more sustainable fuel system. It is also an area where it can be difficult to find traction individually and measure progress, and therefore, a place where collaboration and a support network is essential.

Activity 3A: Accelerate the Innovation and Deployment of Advanced Technologies

BACKGROUND

As discussed earlier in this guide, the fuel marketplace lacks alternatives to conventional, high-carbon, petroleum-based diesel that can be deployed cost effectively on a large scale. Furthermore, even as new fuels become more attractive, opportunity costs must be overcome. Trucking operators and their partners have a key role to play in collaborating to accelerate change by making larger and more creative commitments to advanced fuel purchases and by collaborating with peers in other sectors on research, development, and deployment of new fuels and infrastructure.

This activity addresses that problem directly and involves actors at various points along the spectrum of technology development, from basic R&D to deployment. It also applies to different fuels (and hence greater efficiency as a “source” of fuel), as well as vehicles, infrastructure, and production equipment.

ISSUES TO CONSIDER

There are several areas where trucking operators and their value chain partners could work together to accelerate the innovation and deployment of advanced technologies. Ideas raised at forums held by BSR during 2013 include the following:

Investigate and support R&D. As outlined in “The Sustainability Impacts of Fuel,” basic R&D is needed to overcome many physical and technical challenges to low-carbon fuels. Trucking operators can lend their time, resources, and facilities to help drive R&D for critical technologies. This includes supporting areas where advances could create breakthroughs, such as significantly increased life and storage capacity of batteries, making cellulosic and advanced biofuels (e.g., through genetic engineering, microbial fuel cells, and biosynthesis), autotrophic algae (fuel from sunlight rather than sugar), and large-scale deployment of Carbon Capture and Storage (CCS) technology cost effective. Companies can also provide support for technologies that are farther along in development (see Figure 7) by leading pilots to prove concepts and share lessons.

Demonstrate and motivate markets. Trucking operators play a key role in bringing advanced vehicle fleets to new markets, which will help technology move along the cost curve by expanding its scale. Generally, the advanced low-carbon fuel technologies that are being used, including EVs and biodiesel, are limited to company pilots or are being tested in trials in limited markets where they are promoted by regulators.

Companies that have experience with these technologies can play a positive role in a few ways: Encourage markets to embrace technologies by sharing experience and best practices, publicize studies on how to use and manage new fuel systems, promote awareness about obstacles and the need for investment, and form buyers groups to lower costs and make long-term commitments to fuel producers and vehicle manufacturers.

Figure 7: Most Promising Vehicle Technologies for Reducing GHG Emissions

Pathway	Technology	Class 7-8 Urban	Class 8 OTR	Class 3-8 Work site	Class 3-8 Urban	Class 3-8 Rural	Class 2B-3*
Electrification	Hybrid electric	Solid	Light	Solid	Solid	Solid	Solid
	Electric auxiliaries	Solid	Solid	Solid	Solid	Light	Solid
	E-trucks	Solid		Light	Solid	Light	Light
	Electric power take-off			Solid			
	Plug-in hybrids	Solid		Solid	Solid	Solid	Solid
	Electrified corridor	Solid			Light		
	AF hybrid	Solid	Light	Light	Solid	Solid	Solid
Engine and driveline	Hydraulic hybrid	Light			Solid	Solid	Solid
	Optimized AF engine	Solid	Solid	Solid	Solid	Solid	Solid
	Waste heat recovery	Solid	Solid		Solid	Light	Light
	Engine optimization	Solid	Solid	Solid	Solid	Solid	Solid
	Alternative power plans and combustion cycles	Solid	Solid	Light	Light	Light	Light
	Transmission and driveline	Solid	Solid	Solid	Solid	Solid	Solid

*Vans/trucks

The 13 technology strategies deemed most feasible by the CalHEAT research. Solid paint represents the technologies in the roadmap that are expected to contribute to noticeable GHG emissions reductions by 2020. Light paint represent technologies expected to be implementable after 2020 with noticeable results. Empty boxes indicate technologies not expected to offer significant results in that truck category

Source: Calstart, 2013

Collaborate on deployment. Finally, fleet operators can work with peers and partners to create shared solutions to network problems. These include jointly developing fueling and charging infrastructure, pooling funding to make more advance vehicle purchases, and communicating effectively about sustainability benchmarks and performance on fuel sustainability.

In this category, companies should also consider how they can improve the structural efficiency of fuel for transportation, such as by siting their operations near suppliers and markets, which helps curtail travel. (See the International Energy Agency's "A Tale of Renewed Cities" at the end of this section for more on a strategic "avoid, shift, and improve" approach to improved structural efficiency.) Figure 8 provides a selection of consortiums companies may consider.

RECOMMENDATIONS FOR FLEET OPERATORS

Determine targeted areas where the company can accelerate the innovation and deployment of advanced technologies in the areas described above: investigating and supporting R&D, demonstrating and motivating markets, and collaborating on deployment. Trucking operators should seek opportunities to work both one-on-one with partners and in coalitions that can pool resources.

RECOMMENDATIONS FOR PARTNERS

Shippers can convene peers and partners in order to share best practices and find opportunities to pool resources. Manufacturers and fuel producers have a key role to play in making information available. Investors should consider ways to provide trucking operators access to low-cost capital and incentives.

OUTCOME

By accelerating the innovation and deployment of advanced technologies, companies make strategic investments that aim to speed up the process of low-carbon fuel development. These investments can increase the viability of the key technologies that will be the most advantageous in the future.

RESOURCES

» American Council for an Energy Efficiency Economy, "Plug-In Electric Vehicles: Challenges and Opportunities," 2013, http://aceee.org/research-report/t133.

» California Energy Commission, Alternative and Renewable Fuel and Vehicle Technology Program, 2013, www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-LCD.pdf.

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» Ogden, Joan, and Lorraine Anderson, "Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers," University of California, Davis, 2011, http://steps.ucdavis.edu/research/steps-book/.

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Figure 8: Fuel Sustainability Consortiums

California Hybrid, Efficient, and Advanced Truck (CalHEAT) Research Center
www.calstart.org/Projects/CalHEAT.aspx
Promotes research, development, demonstration, and commercialization of advanced, efficient truck technologies and systems (based in California).

Future of Fuels
www.bsr.org/futureoffuels
Identifies and promotes the use of pathways that enhance the sustainability of available and emerging transportation fuel choices.

GeoEVSE Forum
www.afdc.energy.gov/vehicles/geoevse.php
Establishes a repository of public electric vehicle supply equipment (EVSE) location data for use by consumers and industry.

Natural Gas Vehicle Technology Forum
www1.eere.energy.gov/cleancities/natural_gas_forum.html
Supports development and deployment of commercially competitive natural gas engines, vehicles, and infrastructure.

The North American Council for Freight Efficiency (NACFE)
http://nacfe.org/
Advances efficiency for goods movement in North America.

U.S. Environmental Protection Agency: SmartWay EPA Program
www.epa.gov/smartway
Helps freight shippers, carriers, and logistics companies improve their fuel efficiency and save money.

- U.S. Department of Energy, "Alternative Fuel Infrastructure Expansion: Costs, Resources, Production Capacity, and Retail Availability for Low-Carbon Scenarios," 2013, www.nrel.gov/docs/fy13osti/55640.pdf.
- U.S. Department of Energy, "Potential for Energy Efficiency Improvement Beyond the Light-Duty-Vehicle Sector," 2013, www.nrel.gov/docs/fy13osti/55637.pdf.
- U.S. Department of Energy, Transatlas Interactive Mapping Tool, 2013, http://maps.nrel.gov/.
- Western Governors' Association, "Transportation Fuels for the Future," 2008, www.westgov.org.

Activity 3B: Encourage Better Impacts Upstream

BACKGROUND
As detailed in our 2012 report, "The Sustainability Impacts of Fuel," the lifecycle impacts of fuel are significant and diverse, and all fuels have important real and potential issues that need to be managed. A significant portion of these climate and other impacts are found upstream (the well-to-tank phase) hidden from the immediate view of fuel users, and they persist despite historical local regulation and new efforts with low-carbon fuel standard (LCFS) policy frameworks.

For many fuel producers, the issues described here concern their direct operations, and many producers have already committed to ensuring that they are using best practices and complying with regulations. Yet, it is difficult to generalize even within specific fuel sectors, as performance varies widely.

While most companies have historically selected fuels based on their technical attributes and ignored lifecycle sustainability issues, those issues could significantly disrupt fuel markets by leading to new regulations.

ISSUES TO CONSIDER
Companies can promote improved production practices in many areas. Figure 9 outlines key opportunities, arranged by the major fuel groups: conventional fossil fuels, unconventional fossil fuels, biofuels, and electric vehicles. In addition, some areas can be thought of as game-changing breakthroughs, or categories where advances will be more difficult, but the impact would have effects of a greater order of magnitude. Those include:

- Making large-scale deployment carbon capture and storage technology cost effective;
- Creating fracking processes that use waterless, nontoxic fluids; and
- Transforming the so-called resource curse into a "blessing" through national content and transparency and anti-corruption efforts.

Companies can support investment in these areas by partnering with fuel providers and supporting open-source collaboration that addresses these issues. They can also share research and insights about them with peers, civil society organizations, and government agencies.

RECOMMENDATIONS FOR FLEET OPERATORS
Using Figure 9 as a guide, determine upstream hot spots for the company and where the company is in a position to make an impact. Communicate to fuel suppliers that making improvements is important, and look for ways to support new solutions.

RECOMMENDATIONS FOR PARTNERS

For fuel producers, top performers should promote actions that encourage peers to do more and share information in order to demystify impacts that are taking place upstream. Investors should look carefully into the performance of investees and encourage their best performance.

OUTCOME

The outcome of this activity is a set of targeted partnerships that encourage better impacts upstream and provide a view into the production impacts and risks of the company's fuel use. It provides a more informed vantage point for purchasing fuel, as well as communicating with stakeholders more effectively.

RESOURCES

» Association for Canadian Studies in the United States, "Greening Freight Trucks: What to Do and How to Do It," 2012, www.acsus.org/public/pdfs/Blank%20OP_v4n3v2.pdf.

» The Conference Board of Canada, "Getting the Balance Right: The Oil Sands, Exporting and Sustainability," 2010, www.secureourfuels.org/wp-content/uploads/2009/06/CBC_oil-sands.pdf.

» Global Reporting Initiative, "GRI Oil and Gas Sector Supplement," 2012, www.globalreporting.org/resourcelibrary/OGSS-G3.1-Complete.pdf.

» International Energy Agency, "Golden Rules for Natural Gas," 2012, www.worldenergyoutlook.org/goldenrules/.

» IPIECA, "Improving Social and Environmental Performance Good Practice Guidance for the Oil and Gas Industry," 2013, www.ipieca.org/publication/improving-social-and-environmental-performance-good-practice-guidance-oil-and-gas-indus-0.

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» U.S. Department of Energy, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET)," 2012, http://greet.es.anl.gov/.

Figure 9: Select Opportunities to Improve Upstream Sustainability Impacts

Conventional Fossil Fuels (Oil and Gas)

- Encourage production and distribution practices that reduce methane emissions leaks from natural gas.
- Improve production impacts, which includes reducing venting and flaring (Equitable Origin, World Bank Global Gas Flaring Reduction Partnership, and UN Environment Programme).
- Improve production impacts of oil sands and heavy oil, which includes increasing energy efficiency and using renewable electric power.
- Scale up CO2-enhanced oil recovery (C2ES).
- Improve production footprint management, which includes managing human rights and indigenous communities more effectively (BSR, Bureau of Land Management, IPIECA, Institute for Human Rights and Business, and Equitable Origin).
- Improve environmental health and safety in operations, which includes increasing safety of sour oil and gas production and oil and gas refining and reducing toxic releases and pipeline and shipping spills (IPIECA).
- Improve local benefits through community engagement and investment (BSR, Equitable Origin, and Natural Resources Charter).
- Minimize emissions of SO2, SO3, NOX, and CO2, especially outside OECD (Organisation for Economic Co-operation and Development) countries.
- Improve general environmental and social management systems—both for day-to-day impacts and to avoid emergencies (IPIECA, International Oil and Gas Producers Association [OGP], and Equitable Origin).

Unconventional Fossil Fuels (Oil and Gas)*

- Improve environmental standards for "tight oil and gas," especially around water and chemical management and transparency (Environmental Defense Fund).
- Improve production impacts of oil sands and heavy oil, which includes (1) water reduction and the use of dry tailings (for mining) and (2) greater energy and water efficiency, DG for in-situ production (Ceres, Canadian Oil Sands Innovation Alliance, and Suncor).
- Improve oil sands footprint management by making seismic lines and road access more benign (CAPP) and reducing the impact of road access, e.g., by flying (Cenovus).
- Improve emergency preparation and response for production in extreme environments, such as (1) the Arctic and other far north (IPIECA, OGP, and International Standards Organization [ISO]) and (2) deepwater, including emergency preparation and response, subsea response, and capping/containment (OGP and ISO).
- Integrate lessons learned around an enabling corporate culture to prevent accidents, and apply the lessons to the context of the Arctic and deepwater (Earthjustice).

Biofuels

- Encourage ILUC reduction, holding all biomass to the same sustainability and land use standards as biofuels (UN Food and Agriculture Organization [FAO], UNEP, and California Air Resources Board).
- Select appropriate feedstock for geography in the context of water, food, and biodiversity (RSB and FAO).
- Minimize the displacement of existing food production—locally and globally (RSB, FAO, and Global Bioenergy Partnership).
- Improve water footprint, and use land and water management guidelines for production (RSB and The Nature Conservancy).
- Ensure effective environmental health and safety measures are taken, including management of pesticides, toxins, and health impacts of production (IPIECA, World Bank, Rainforest Action Network, RSB, and ISO).
- Improve local benefits, including farm job creation, working conditions, and rural development, and energy security—most relevant for emerging biofuels production in Africa (RSB) and Southeast Asia.
- Improve production footprint management, including local community engagement and relations—most relevant in Africa, Asia, and in some countries in Latin America (BSR and Rainforest Alliance).

Electric Vehicles

- Decrease the carbon intensity of grids and power EVs in low-carbon grids (EPRI, Climate Central, and MIT).
- Improve production footprint management of all production sources that will grow with more power plants to meet increased demand, including (1) power generation for coal, gas, wind, and solar, and (2) battery lifecycle issues (UNEP).
- Address the costs of infrastructure required for wider-scale EVs, including larger transformers, new charging equipment, and greater generating capacity—in a way that is equitable for rate-payers and the community, especially for the poor.
- Manage the risk of power surges and outages from an increasingly complex set of demands and sources for the grid.

Activity 3C: Promote Systems for Supply Chain Accountability and Ownership

BACKGROUND
As explained previously, there is a lack of accepted protocols for associating fuels with their full range of lifecycle impacts. There is also a lack of transparency systems for the fuel supply chain itself. Fuel users are, therefore, unable to fully understand and manage the impacts on the system. Leading companies must play a role to develop institutions that improve all involved companies' ability to manage fuel sustainability.

ISSUES TO CONSIDER
Initiatives are under way to improve the accountability of impacts in the fuel supply chain through sustainability certifications. Those initiatives include:

- **Biofuels: Roundtable on Sustainable Biomaterials (RSB):** Sustainability standards that cover lifecycle sustainability issues for a diverse array of biofuels. Other certifications systems include International Sustainability and Carbon Certification (ISCC), Roundtable on Sustainable Palm Oil (RSPO), and Roundtable on Responsible Soy Association (RTRS).
- **Natural gas: Shale Center for Sustainable Development:** Certification performance framework for shale production with 15 standards. This certification is under development.
- **Petroleum: Equitable Origin:** The EO100 Standard addresses social and environmental impacts for onshore oil and gas exploration and production operations. This standard uses a trading system and currently focuses on Latin America.

Lifecycle accounting of fuels is gaining traction with the LCFS policy framework being implemented in California and other regions, but beyond that, there are few meaningful shared frameworks that connect the decisions and investments of fuel producers to the buying power of fuel purchasers. (For example, the Renewable Fuel Standard specifies fuel types but does not address performance within those types, which vary widely.) The result is that trucking companies and other users of fuel have very little visibility into the impacts of their fuel supply chain.

This situation creates two challenges for trucking operators in practice. First, there is a general lack of systems for measuring and passing information about fuel sustainability impacts through different points along a batch of a fuel's production pathway that would, in turn, give buyers information that could allow them to encourage good performance. The reasons are largely economic; fuel buyers generally look for the most inexpensive option and are unaccustomed to paying a premium for sustainability attributes.

The second is the state of measurement. While some aspects of fuel production are well tracked, there are many questions about what the impacts are and how they can be monitored. Even within the implementation of the LCFS policy frameworks, critical questions remain, and research is continually under way.

RECOMMENDATIONS FOR FLEET OPERATORS
Fleet operators should test certification and transparency programs, such as those described above, and look for ways to make them scalable. In doing so, consider ways to give preference to fuel providers who are serious about transparency and to extend the length of fuel purchasing contracts in order to encourage collaboration.

RECOMMENDATIONS FOR PARTNERS

Fuel providers and investors should support the development of institutions that allow greater transparency in the fuel system in order to incentivize good performance.

OUTCOME

The outcome of this activity is supplier engagement with fuel providers and participation in certification programs that lead to lessons learned from pilot initiatives. This final activity within the step of "Building a better fuel value chain" leads companies to develop a strategic plan for influencing long term change in the system. It also prepares companies for the final step, which addresses policy advocacy.

RESOURCES

» Equitable Origin, "EO100 Standard," 2013, www.equitableorigin.com/eo100-standard/download/register/.

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» IPIECA, "Improving Social and Environmental Performance: Good Practice Guidance for the Oil and Gas Industry, 2013, www.ipieca.org/publication/improving-social-and-environmental-performance-good-practice-guidance-oil-and-gas-indus-0.

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» Roundtable on Sustainable Biomaterials, "RSB Sustainability Standards," 2013, http://rsb.org/sustainability/rsb-sustainability-standards/.

» Stewart Carter, Assheton, "It's Time Certification Came to the Oil and Gas Industry," *The Guardian*, 2013, www.theguardian.com/sustainable-business/certification-oil-gas-industry.

Step 4: Advocate for a Better Policy Environment

Public policies establish the guidance, markets, and incentives that promote or inhibit fuel sustainability (see Figure 10). Therefore, one of the most positive, lasting things that companies can do to promote fuel sustainability is to work with governments and other stakeholders to create and promote policies that enable more ambitious, effective deployment of low-carbon, sustainable fuel pathways.

Figure 10: Sample Fuels and Vehicle Sustainability Policies

Policies that Promote Carbon Reduction	Policies that Promote Sustainability Broadly
• Price on carbon for fuel through cap and trade or tax • Fuel production mandates (Renewable Fuel Standard)[34] • Fuel efficiency standards for vehicles and GHG regulation[35] • Pollution controls for vehicles (address local emissions but not GHG)[36] • Fuel lifecycle content performance standards • Standards and allowances that increase productivity via larger loads per vehicle	• Rules and regulations for the production of oil, gas, agriculture, and power plants[37] • Environmental and safety standards for refining and distribution of liquid and gaseous fuels • Land use requirements for highways, energy production, and power plants

Trucking operators have a significant role to play toward enabling commercialization of fuels, vehicles, and infrastructure. However, without supporting policies in place, early movers are at a disadvantage. Policy advocacy, therefore, is critical to developing a complete approach for managing fuel sustainability.

Activity 4A: Align on Principles for Fuel Sustainability

BACKGROUND

An important first step in advocating for sustainable fuel policies is to develop a core set of principles that can guide and sustain a company's efforts over time. Companies should create principles that balance the need for urgency, comprehensiveness, and practicality in making the changes that are required to make the fuel system sustainable.

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[34] Randy Schnepf and Brent D. Yacobucci, "Renewable Fuel Standard (RFS): Overview and Issues," Congressional Research Service, 2013, www.fas.org/sgp/crs/misc/R40155.pdf.

[35] Center for Climate and Energy Solutions, "Federal Vehicle Standards," Center for Climate and Energy Solutions, 2013, www.c2es.org/federal/executive/vehicle-standards.

[36] U.S. Environmental Protection Agency, "Laws and Regulations for Heavy Trucks, Buses, and Engines," 2013, www.epa.gov/otaq/hd-hwy.htm.

[37] U.S. Environmental Protection Agency, "Regulatory Actions," 2013, www.epa.gov/airquality/oilandgas/actions.html.

ISSUES TO CONSIDER

In order to focus policy efforts and communicate effectively with peers and other stakeholders, it is generally helpful to develop design principles to guide a company's efforts. Key design principles that were raised during our workshops in 2013 include the following:

1. **Avoid dangerous climate change by averting 2° C of warming.** Achieve the emissions cuts needed to minimize harm to future generations.[38]
2. **Enhance sustainability broadly.** Minimize negative impacts and maximize positive impacts across the spectrum of environmental, social, and economic issues throughout the lifecycles of all fuels.
3. **Promote urgent action and intelligent action in tandem.** Provide direction and impetus to act now while encouraging further research in key areas as needed and the flexibility to respond to new findings.
4. **Minimize market distortions and emphasize performance.** Incentivize performance above all. Use the market to find solutions, and encourage continuous improvement. However, this approach only works if market distortions, which include externalities, are eliminated.
5. **Harmonize policies.** Untangle the web of state and federal renewable fuel standards. Policies, such as RFS, fuel efficiency standards, cap and trade, carbon taxes, urban growth, public transportation, etc., should be coordinated in an overall framework. Finally, policies should be strategic in nature and forward looking (40 to 50 years).
6. **Distribute costs and benefits fairly.** The cost of policies should be fairly spread across the economy and limit the consequences of differing national policies on competitiveness while recognizing the priorities of the developing world.
7. **Promote long-term investment.** Policies should be long-term oriented in order to create investor confidence.
8. **Empower buyers and users.** Enhance the transparency of fuel impacts in the supply chain in ways that allow fuel buyers to make more informed choices and reward the best fuel performance.

Such design principles will also help to promote alignment within the company. Stakeholders increasingly scrutinize companies that they see as "saying one thing" in their sustainability team while its government affairs team "says another." The issue of misalignment between lobbying efforts and sustainability commitments is an area of increasing activism that creates risk for companies that have an inconsistent approach.[39]

RECOMMENDATIONS FOR FLEET OPERATORS

Develop design principles, such as those mentioned above, for directing all policy advocacy efforts related to fuels, from direct lobbying to more indirect initiatives, such as public education. Companies should also ensure that the policy agenda is aligned throughout the company and that the positions of trade associations

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[38] Edward Cameron, "Two Degrees of Responsibility: Business in a Climate-Constrained World," BSR, www.bsr.org/en/our-insights/bsr-insight-article/business-in-a-climate-constrained-world.

[39] Ryan Schuchard, "Communicating on Climate Policy Engagement: A Guide to Sustainability Reporting," BSR, 2010, www.bsr.org/reports/BSR_Communicating_on_Climate_Policy_Engagement.pdf.

and other coalitions reflect their principles. At the same time, companies should consider how coalitions can support their policy agenda and build new ones that support their objectives.

RECOMMENDATIONS FOR PARTNERS

As value chain partners conduct Step 1 ("Understand your total fuel footprint"), they—investors and shippers specifically—may determine that fuel sustainability is a strategic consideration. In this case, they should develop design principles and strengthen alignment in a way similar to that recommended for trucking operators above.

OUTCOME

The outcome of this activity is a constructive agenda for public policy advocacy based on principles that take into account the broad range of issues and interests involved. This approach should lead to a compelling, coherent message for policy makers that demonstrates to them and the public that the company is serious about its desire for improving fuel sustainability.

RESOURCES

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» Pembina Institute, "Solving the Puzzle: Environmental Responsibility in Oil Sands Development," 2012, www.pembina.org/oil-sands/solutions.

» Sperling, Dan, and Sonia Yeh, "National Low-Carbon Fuel Standard: Policy Design Recommendations," National LCFS Project, 2012, http://nationallcfsproject.ucdavis.edu/files/pdf/2012-07-nlcfs-policy-design-recommendations.pdf.

» Yeh, Sonia, and Daniel Sperling, "Low-Carbon Fuel Standards: Implementation Scenarios and Challenges," Energy Policy, 2010, www.sciencedirect.com/science/article/pii/S0301421510005410.

Activity 4B: Encourage Dialogue about Key Issues

BACKGROUND
The opportunity to improve fuel sustainability is multifaceted, involving numerous industries, issues, and communities. Furthermore, since there are significant uncertainties and trade-offs among different issues, there are no silver bullet technologies (see the appendix for details).

ISSUES TO CONSIDER
As previously discussed, significant gaps remain in our knowledge of the sustainability impacts of fuel, and these gaps stand in the way of a company's ability to make effective investments in fuel sustainability. Key areas where uncertainties persist, and in turn, research and dialogue are needed, include:[40]

All fuels:

1. Increase harmonization and granularity for lifecycle, value chain, and system (including spatial) assessments.
2. Develop appropriate guidance for users to navigate and appraise different methodologies.
3. Integrate social parameters (e.g., human rights, labor, etc.) more fully into assessments.
4. Quantify economic impacts with full consideration of security issues.
5. Identify comparable local impacts on communities and ecosystems (BSR).

Conventional fossil fuels:

1. Identify general information about the impacts for production outside of OECD countries.
2. Create and implement guidance on whether and how engagement in locations with different levels of political stability and types of governance are positive or negative (BSR, IPIECA, International Council on Mining and Metals [ICMM], and International Finance Corporation [IFC]).

Unconventional fossil fuels:

1. Identify oil sands production impacts and best practices more granularly and with common assumptions.
2. Clarify which assumptions and beliefs around the divergent models for oil sands and tight oil and gas impacts persist, why they do, and what can be done to improve shared understanding.
3. Measure production impacts from specific tight oil and gas sites.
4. Clarify the impacts and opportunities associated with fugitive methane emissions from natural gas distribution and fueling.
5. Clarify impacts of production in the Arctic and other sensitive regions.
6. Enhance transparency around fracking fluids (FracFocus, a chemical disclosure registry).
7. Clarify the promise and problems of nuclear-enabled oil sands production (Institute for Research on Public Policy, MIT).

[40] For information about priorities for research and development to improve the technical viability of fuel, see our 2012 report, "The Sustainability Impacts of Fuel."

Biofuels:

1. Increase the legitimacy of data sources, and improve communication about biofuel impacts (University of California, Berkeley Energy Biosciences Institute).
2. Improve the understanding of the impact of biofuels on vehicle systems (National Renewable Energy Laboratory [NREL]).
3. Improve the understanding of the impact of biofuels on overall vehicle emissions (NREL).
4. Create greater transparency about lifecycle biofuel impacts (NREL, UNEP, UN Food and Agriculture Organization [UNFAO], California Air Resources Board [CARB], UC Berkeley Energy Biosciences Institute, and Roundtable on Sustainable Biomaterials [RSB]).
5. Identify the potential unintended consequences and trade-offs of biofuels at a large scale (NREL, UNEP, UNFAO, CARB, UC Berkeley Energy Biosciences Institute, and RSB).
6. Identify the risks and potential unintended consequences of advanced biofuels (NREL, UNEP, UNFAO, CARB, UC Berkeley Energy Biosciences Institute, and RSB).
7. Improve the understanding of water use and stress impacts across different biofuel types (NREL, UNEP, UNFAO, CARB, UC Berkeley Energy Biosciences Institute, RSB, and World Resources Institute [WRI]).
8. Improve the understanding of whether and how impacts that are inherently local (e.g., watershed or landscape) can be understood in an objective, universal framework (LCFS and Low Indirect Impact Biofuels [LIIB]).

Electric vehicles:

1. Improve the understanding of the potential market and sustainability challenges that may come with renewables at a large scale, especially around mining, manufacturing, and production of wind and solar power (UNEP, NREL, Intergovernmental Panel on Climate Change [IPCC], Joint Institute for Strategic Energy Analysis [JISEA], Silicon Valley Toxics Coalition [SVTC], and UC Davis Institute of Transportation Studies [ITS]).
2. Improve the shared understanding of the potential unintended consequences of battery lifecycle issues with EVs at a large scale, including around mining, manufacturing, use, and end-of-life considerations (UNEP, NREL, IPCC, JISEA, and SVTC).

RECOMMENDATIONS FOR FLEET OPERATORS

Proactively take part in discussions with stakeholders and the public about their interests and experiences with fuels. Some productive things they can do include:

» Work to get the public interested in this discussion, and help them understand what is most important for measurement, speaking out on the importance of policy action.

» Communicate that failure has a role to play in technology innovation in order to counter the fear of failure and encourage useful risk taking.

» Keep predicted impacts of technology innovation realistic.

Also, those companies that have gone through the steps outlined up to this point should have a sense of the critical assumptions, uncertainties, potential unintended consequences, and trade-offs that underpin their perspective on fuels. They can use stakeholder engagement as an opportunity to answer questions and clarify thinking.

For example, a company considering investments in natural gas vehicles and EVs can ensure that they have a comprehensive understanding about the whole ranges of benefits, costs, and risks—over both the short and long term—and involve diverse stakeholders in making key decisions.

RECOMMENDATIONS FOR PARTNERS

As for trucking operators, other companies should seek out available information and participate in dialogue.

OUTCOME

The outcome of this activity is a more thorough understanding of the key policy issues at stake, clarity on where stakeholders have differences of opinion, and identification of where the company has support and where coalitions exist. Knowing this information can, in turn, support more productive dialogue with stakeholders about sharing ideas, developing a greater shared understanding of the issues, and achieving a greater sense of a common cause in addressing climate change and related sustainability issues with fuels.

RESOURCES

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» International Energy Agency, "The Contribution of Natural Gas Vehicles to Sustainable Transport," International Energy Agency, 2010, www.iea.org/publications/freepublications/publication/name,3929,en.html.

» Krupnik, Alan, *Managing the Risks of Shale Gas: Identifying a Path toward Responsible Development,* Resources for the Future, www.rff.org/shalegasrisks.

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Activity 4C: Work with Governments to Strengthen Policies for Fuel Sustainability

BACKGROUND

Once the company has established an aligned, sustainable fuel policy agenda, the next step is to select specific areas where it will focus its efforts. Productive engagement on fuel sustainability policy involves a range of activities, including supporting new legislation, strengthening current rules and regulations, and working with governments to implement sound programs.

ISSUES TO CONSIDER
There are many potential theaters of action for fuel policy. A few examples include the following:

» California Low-Carbon Fuel Standard: Attend workshops.
» EPA Carbon Pollution Standard for Power Plants: Provide comments.
» Local governments: Advocate for infrastructure development.
» National Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (Phase 2): Provide comments.
» National legislation on carbon pricing: Raise awareness about need.
» National Low-Carbon Fuel Standard Project (UC Davis): Provide comments.
» Shaheen-Portman energy efficiency legislation: Raise awareness.
» State energy commissions and governors: Provide comments.
» State renewable portfolio standard: Provide comments.
» UN Framework Convention on Climate Change (UNFCCC): Attend meetings and raise awareness, including in the run-up to COP20 (Conference of the Parties, scheduled for Lima, Peru, in December 2014) and COP21 (Paris, France, in December 2015).

Other potential mechanisms for action include calls to action, responses to solicitations for comment, and participation in trade associations.

RECOMMENDATIONS FOR FLEET OPERATORS
Companies should develop a plan to work with governments to strengthen policies for fuel sustainability. Priorities for action may include one or all of the following:

» Enabling more ambitious efficiency and GHG reduction standards and other initiatives (e.g., creating a price on carbon that applies more broadly than the ones that exist within single states and sectors);
» Addressing wider sustainability issues (e.g., addressing issues beyond carbon, such as water consumption);
» Extending policy frameworks that work into new markets; and
» Engaging communities and other key stakeholders by working with them and communities to develop focused agreements, standards, and rules.

The choice of forums should involve a mix of general and key local and sector-specific policies.

RECOMMENDATIONS FOR PARTNERS
Value chain partners should seek opportunities to collaborate with trucking operators to engage jointly with government. Fuel producers, manufacturers, investors, and shippers all provide critical perspectives that can usefully inform and provide credibility to business on policy advocacy.

OUTCOME
The outcome of this activity is participation in policy development that stands the best chance of creating positive impact, makes the best use of resources, and creates synergy among business and sustainability endeavors. These developments, in turn, support better relationships with civil society groups that are asking companies to be more proactively and visibly involved in policy action.

RESOURCES
» Ceres, “Climate Declaration,” 2013, www.ceres.org/bicep/climate-declaration.

» Metzger, Eliot, et al., "Guide for Responsible Corporate Engagement in Climate Policy," World Resources Institute, 2013, www.wri.org/sites/default/files/guide_for_responsible_corporate_engagement_in_climate_policy.pdf.

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Ways Forward

Fuel sustainability involves issues that are complex, variable, and uncertain. Yet, trucking fleet operators and their partners can promote and use low-carbon, sustainable fuels in an organized way. We summarize this approach as having four steps:

» Step 1: Understand your total fuel footprint
» Step 2: Optimize your use of available fuel and vehicles
» Step 3: Collaborate to enable new low-carbon solutions
» Step 4: Advocate for a better policy environment

To simplify, the steps are shown as a linear process, but the fuel sustainability landscape is changing quickly and requires an ongoing review. Since the first step, “Understand your total fuel footprint,” involves assessment activities that companies naturally undertake annually, the whole process can be refreshed and reviewed each year or at other relevant increments. In subsequent rounds, the company is likely to have developed a more sophisticated view of the uncertainties, risks, and issues that it can address.

This roadmap highlights the fact that reducing demand—and in doing so, treating investment in efficiency as a source of fuel itself—is a key lever for improving fuel impacts. Efficiency has many advantages: It is cost effective compared to other measures and produces tangible near-term financial benefits. Also, technologies and practices that improve efficiency are widely available, meaning that many gains can be made without significant policy changes. Finally, since some of the best actions are found in reducing end-use fuel consumption, in the form of both low-hanging fruit and making structural changes over time, efficiency is a key tool for improving impacts throughout the value chain.

But while efficiency is critical for transportation fuel, it doesn’t end there. Companies need to think about the whole system of production and use, which includes preparing for the range of fuels, and short and long-term approaches to acting. This system-wide approach includes testing and maturing supplier engagement approaches, being active on policy, and considering other methods that serve to create an overall, integrated approach to fuel sustainability.

This brief has highlighted numerous challenges. They are not reasons for inaction, but rather an agenda for development by leaders. Core to the approach is involving others. Inside the company, teams, such as fleets, government affairs, procurement, and senior leadership, should be represented. Outside the company, coalitions, scientists, and civil society groups are laying important groundwork that companies are advised to consider and collaborate on.

Companies pursuing these steps will strike some important balances. They will make operational improvements while investing in a better future. They will encourage productive dialogue with multiple departments and stakeholders that can best support investment. They will increase flexibility and openness in a time of significant change to fuel markets. And they will draw from the many existing resources, examples, and expertise. The result is a strategic approach to doing the most that the company can to address climate change and improve the sustainability of its fuel consumption, one of the strongest levers that many trucking companies possess.

Appendix: Select Public Policies

This section outlines the major types of public policies that are currently being used around the world to manage the climate impacts of fuel.

Carbon Tax

A carbon tax is a tax levied on the carbon content of fuels. Carbon taxes have been around for more than 20 years, and dozens of countries now use some form of a carbon tax, which can apply to various sectors, including stationary power, industrial processes, and transportation. For transportation fuels, carbon taxes are generally based on an average amount of CO2 associated with the combustion of those fuels, with the tax assessed either at the retail pump or farther upstream with the producer.

The most influential form of carbon tax for transportation fuels in North America is the system in British Columbia, which has cut fuel consumption 4.5 percent per capita since it was launched in 2008 without a negative effect on the economy.[41] British Columbia's carbon tax is revenue neutral (representing a tax shift, rather than a new tax), its implementation is phased in, it reduces the tax burden for citizens with the lowest incomes, and it covers a broad range of sectors.

The following are carbon tax schemes around the world as they relate to transportation fuels:

» **British Columbia (2008):** Carbon tax covers diesel, gasoline, and natural gas, assessed at the retail pump (approximately US$22 per ton of CO2, or around US$0.25 per gallon of diesel and gasoline).

» **Denmark (1991):** Carbon tax covers natural gas (approximately US$18 per ton).

» **Finland (1990):** Carbon tax covers diesel, gasoline, and natural gas (US$30 per ton or US$3.02 per megawatt hour of natural gas and US$0.26–0.34 per gallon of diesel and gasoline).

» **France (2013):** Carbon tax covers diesel, gasoline, and natural gas (starts at around US$10 per ton).

» **Ireland (2010):** Carbon tax covers kerosene, certain ("marked") gas oil, LPG fuel oil, and natural gas (US$20 per ton).

» **Netherlands (1990):** Carbon tax covers diesel, gasoline, and natural gas (US$20 per ton).

» **Norway (1991):** Carbon tax covers diesel, gasoline, and natural gas (ranges from US$16 to 62 per ton).

» **Quebec (2007):** Carbon tax covers petroleum and natural gas assessed to around 50 fuel providers (approximately US$25 per ton, or US$0.03 to 0.04 per gallon of diesel and gasoline).

» **South Africa (2010):** The tax charged for new motor vehicles is based on the amount of CO2 emitted by the vehicle.

» **Sweden (1991, 1997, and 2007):** Carbon tax covers diesel and gasoline (US$150 per ton).

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[41] *The Economist,* "We Have a Winner: British Columbia's Carbon Tax Woos Skeptics," 2011, www.economist.com/node/18989175.

Some advantages of carbon taxes are that they can be administratively simple and work as a tax shift as opposed to a new tax, as has been done in British Columbia. Some drawbacks compared to other measures are that it may not motivate new behavior if the price is not high enough and that it does not directly control for the amount of emissions reduction.

Low-Carbon Fuel Standard

A more recent development is the low-carbon fuel standard (LCFS), a framework that integrates the full lifecycle impacts of fuel into an emissions cap and trading scheme. LCFS frameworks have been adopted in several North American regions (e.g., California, Oregon, and British Columbia) and throughout Europe, and more than 20 additional U.S. states are considering adoption.[42]

LCFS assigns a "well-to-wheels" carbon intensity score for fuels that accounts for different production methods ("pathways") and then requires fuel providers to reduce carbon intensity over time. It uses a market platform that allows producers to either make their own reductions or buy credits from high performers. It also allows producers to submit new methodologies to the registry of approved pathways. LCFS focuses on carbon reduction but includes sustainability provisions.

These standards are meant to make up for the shortcomings found in other fuel regulations, such as mandates. It applies to all fuels and is performance based, which means that it avoids picking winners—indeed, producers with the highest carbon-intensity fuels can be included, so long as they sufficiently improve their efficiency—and it continually incentivizes improvement.

Benefits of an LCFS include stronger control over the emissions levels, coverage of impacts throughout the value chain, and precision that encourages performance within different fuel pathways. The framework is more complex than a tax and does have some drawbacks that need to be addressed.

One drawback is that scientific studies have not yet agreed on the magnitude of indirect effects of land use production for biofuels, which are at the heart of the lifecycle content calculations the market is based on. Regulators are addressing this uncertainty by using the values from the best available scientific research and then adjusting them as the data improves. California's LCFS uses the best available research to account for ILUC, which helps them ensure that they are achieving real GHG savings. Other LCFS frameworks (e.g., Europe's Fuel Quality Directive) do not yet account for ILUC.

Another drawback is "shuffling," where producers direct their best-performing fuels to the regulated market and higher-carbon fuels elsewhere with no net improvement across their portfolio. The antidote for this tendency is to expand the number of jurisdictions that have LCFS frameworks in place.[43]

A third drawback is the potential difficulties companies face if technologies do not develop at a rate that matches standard requirements. Movement to low-carbon technologies requires coordination among vehicle manufacturers, fuel suppliers, refueling infrastructure, and the vehicle purchaser and operator. All these need to happen at a sufficient rate in order for LCFS compliance to be possible. In

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[42] National Low-Carbon Fuel Standard Project, "World Map of Regional Policies," 2013, http://nationallcfsproject.ucdavis.edu/map.

[43] Dan Sperling and Sonia Yeh, "Toward a Global Low-Carbon Fuel Standard. Transport Policy," 2010, www.sciencedirect.com/science/article/pii/S0967070X09000997.

response, alternative compliance mechanisms and cost-containment mechanisms are being considered.[44]

The LCFS is an important new development. At the same time, it needs further testing and development, and it will be most effective when it is coupled with other policies. Also, the scope of fuel issues is broad, and while the LCFS contains provisions for sustainability beyond GHG emissions, there are wider parameters that both policy and voluntary company actions need to address.

Renewable Fuel Standard

The Renewable Fuel Standard (RFS) is a U.S. federal law that specifies a mandatory minimum volume of biofuels must be used in the national transportation fuel supply. The RFS was established by Congress in the Energy Policy Act of 2005 (RFS1) and updated and expanded in the Energy Independence and Security Act of 2007 (RFS 2).

The current phase of the RFS (e.g., RFS2) specifies that the total supply of qualified (e.g., reduce emissions 20 percent compared to conventional oil) biofuels must expand to 36 billion gallons by 2022. Furthermore, within that framework, supplies must grow as follows:

» Advanced biofuels: 21 billion gallons
» Cellulosic and agricultural waste-based biofuel: 16 billion gallons
» Biomass-based biodiesel: 1 billion gallons

The RFS is implemented by the U.S. EPA, which administers detailed compliance standards for fuel suppliers, a tracking system based on Renewable Identification Numbers (RINs) with credit verification and trading, special treatment of small refineries, and general waiver provisions.

A key advantage of the RFS is that it reduces the risk of investing in biofuels by guaranteeing demand over a set period, and it, therefore, leads to development of a crucial low-carbon fuel source. Potential drawbacks are that it chooses biofuel types (rather than focusing on performance) and that it provides subsidies to major agricultural producers that are no longer in their economic infancy.

The RFS also faces the challenge of a competing policy objective with the so-called blend wall, the maximum blending (10 percent or E10) of ethanol into gasoline allowed by U.S. federal law. Recent projections of U.S. fuel demand are lower than when RFS volume targets were set, which means that RFS could lead to the creation of more biofuels than are marketable under current policies. Policy makers have recognized this problem and are considering potential solutions.

Heavy-Duty National Program

In August 2011, the U.S. EPA and National Highway Traffic Safety Administration (NHTSA) established a national program to reduce GHG emissions and establish new fuel efficiency standards for commercial trucks and buses beginning in 2014 and extending through 2018. These are the first GHG emission and fuel

[44] A report by the University of California, Davis, examines the economics of LCFS and cost-containment mechanisms. Available at www.its.ucdavis.edu/research/research-findings/uc-davis-report-examines-economics-of-lcfs-cost-containment-mechanisms. See also California Air Resources Board, "Proposed First Update to the Climate Change Scoping Plan," 2014, www.arb.ca.gov/cc/scopingplan/2013_update/draft_proposed_first_update.pdf.

consumption standards for heavy- and medium-duty vehicles in the United States.[45]

The program manages two key metrics: 1) grams of CO_2 per ton-mile (and gallon of fuel per 1,000 ton-mile) for vocational vehicles and combination tractors and 2) payload-dependent grams of CO_2 per mile (and gallon of fuel per 100 miles) for pickups and vans.[46]

In this year's State of the Union Address, President Barack Obama committed to redoubling efforts for truck efficiency. As part of this commitment, he has directed the EPA to extend the Heavy-Duty National Program beyond 2018. This directive is combined with additional initiatives for truck efficiency and GHG emissions reduction.[47]

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[45] U.S. Environmental Protection Agency, "EPA and NHTSA Adopt First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium-and Heavy-Duty Vehicles," 2011, www.epa.gov/oms/climate/documents/420f11031.pdf.

[46] Dieselnet, "Heavy-Duty Vehicles: GHG Emissions and Fuel Economy," 2011, www.dieselnet.com/standards/us/fe_hd.php.

[47] Office of the Press Secretary, "Opportunity for All: Improving the Fuel Efficiency of American Trucks—Bolstering Energy Security, Cutting Carbon Pollution, Saving Money, and Supporting Manufacturing Innovation," The White House, fact sheet, 2014, www.whitehouse.gov/the-press-office/2014/02/18/fact-sheet-opportunity-all-improving-fuel-efficiency-american-trucks-bol

Appendix: Select Corporate Policies

Figure 11: Key Elements of Guidance for U.S. Federal Government Fleet Management

1. Develop a fleet management plan.
2. Reduce fleet GHG emissions.
3. Reduce petroleum consumption 2 percent per year.
4. Increase alternative fuel consumption 10 percent per year.
5. Right-size fleets.
6. Reduce vehicle miles traveled.
7. Increase the fuel economy of your fleet.
8. Acquire AFVs, and use alternative fuels.
9. Use biodiesel blends in diesel vehicles.
10. Acquire EVs.
11. Ensure that 75 percent of light-duty vehicles (LDV) acquired in metropolitan areas are AFVs.
12. Use plug-in hybrid electric vehicles (PHEV) when they are commercially available at a cost comparable to non-PHEVs.
13. Refrain from acquiring non-low-GHG-emitting vehicles.
14. Monitor fleet performance.
15. Review strategies.

Source: U.S. Department of Energy, "Comprehensive Federal Fleet Management Handbook," 2011.

The following are excerpts from fuel and fleet purchasing policies, which are found mostly in university and government programs:

» Develop an organization-wide fleet sustainability plan, choose the right size fleet for department objectives, select petroleum reduction strategies, acquire and locate vehicles appropriately, and develop infrastructure (such as the Comprehensive Guidance for U.S. Federal Government Fleet Management; see Figure 11).[48]

» Refrain from entering into a contract for procurement of an alternative or synthetic fuel, including a fuel produced from nonconventional petroleum sources, for any mobility-related use, unless the contract specifies that the lifecycle GHG emissions associated with the production and combustion of the fuel supplied under the contract must, on an ongoing basis, be less than or equal to such emissions from the equivalent conventional fuel produced from a conventional petroleum source (Section 526 of Energy Independence and Security Act of 2007).[49]

» Seventy-five percent of light-duty vehicle purchases should be AFVs or ultra-efficient vehicles (with a mileage of 35.5 miles per gallon to match Corporate Average Fuel Economy [CAFE] standards) by 2016.[50]

» Departments planning to purchase or lease vehicles should consider and balance need, vehicle duty, fuel type, availability, the CO2 impact of the vehicle, the alternative fuel or ultra-efficient standards, and cost. The vehicle selected for purchase or lease should have the lowest CO2 impact (preferably all electric), while meeting performance and budgetary constraints.[51]

» Routinely assess the need for EV-charging stations on campus, and develop strategic plans for their location, including incorporating them into new parking lot construction projects or major parking lot renovations as justified.[52]

» Conduct annual updates to ensure that the recommended fuel types are consistent with current technology, establish a replacement schedule for all fleet vehicles, and require (where feasible) that vehicles be replaced with ones that operate on reduced-emission fuels.[53]

» Require motor vehicle fleets to acquire AFVs, including hybrid EVs, and develop numerical goals (with a timeline) for acquiring these vehicles..[54]

» The Department of Administrative Services is directed to consult with the Energy Advisor to include transportation fuels in the energy consumption measurement tool and to develop and implement a goal-driven plan to

[48] U.S. Department of Energy, "Comprehensive Federal Fleet Management Handbook," 2011, www1.eere.energy.gov/femp/pdfs/eo13514_fleethandbook.pdf.
[49] Public Law, Energy Independence and Security Act of 2007, www.govtrack.us/congress/bills/110/hr6.
[50] UC Santa Barbara, Sustainable Procurement and Use Practices, 2012, www.policy.ucsb.edu/policies/policy-docs/sustainable-procurement.pdf.
[51] Ibid.
[52] Ibid.
[53] City of Santa Monica, Guiding Principles of the Santa Monica Sustainable City Program, 1994, www.smgov.net/uploadedFiles/Departments/OSE/Categories/Buying_Green/Sustainable_Procurement_policies.pdf.
[54] State of Ohio Office of the Governor, "Coordinating Ohio Energy Policy and State Energy Utilization," 2007, www.greenenergyohio.org/page.cfm?pageID=1137.

reduce petroleum consumption by state vehicle fleets through revision of policies, adoption of technologies, and utilization of alternative fuels.[55]

» Favor the purchase of new light-duty vehicles (a gross vehicle weight of less than 8,500 pounds) that score 8.0 or higher on the U.S. EPA's emissions and air pollution index, provided that such vehicles are available and capable of carrying out the operational needs of the agencies using them.[56]
» Continue the rigorous existing review process wherein all vehicles are evaluated on the basis of the composite EPA emissions and air pollution score and an average motor pool miles-per-gallon score for all 2003 and later models, so that those vehicles that chronically pollute can be removed from the vehicle pool.[57]
» Purchases of conventional or alternative fuel should require that all fuel meets consensus standards for performance and quality, such as those established by ASTM International. When possible, fuel should be purchased from producers or marketers who are certified in a voluntary fuel quality assurance program.

These policies are illustrative examples but do not necessarily address the full range of subjects. Suggestions outlined in Step 2 of the roadmap will inform considerations about the range of issues involved.

[55] Ibid.
[56] Northern Arizona University, "Campus Sustainability Strategy Plan," 2003, www.responsiblepurchasing.org/UserFiles/File/General/NAU_CampusSustainabilityStrategyPlan_2003.pdf.
[57] Ibid.

Glossary

advanced biofuel	Also called second-generation (or third- or fourth-generation) biofuel. Generally biofuel other than that made from sugars and vegetable oils found in arable crops. May come from plant dry matter (lignocellulose biomass), woody crops, agricultural residues or waste, and algae. The RFS uses a more specialized definition that refers to biofuel other than cornstarch where lifecycle GHG emissions are at least 50 percent lower than conventional fuel. Feedstocks like sorghum, wheat, and imported Brazilian sugarcane that meet this threshold are included as advanced biofuels.
alternative fuel	Fuels other than diesel and gasoline, such as CNG, LNG, biofuel, DME, hydrogen, and EVs.
alternative fuel vehicle (AFV)	Vehicles, including EVs, that run on alternative fuel.
B5, B20, and B100	B5 refers to fuel that is 5 percent biodiesel and 95 percent petrodiesel. Other "B" formulations follow this convention, with B2, B20, and B100 as the most common. Key characteristics: B0–B5: Complies with ASTM D975. Blenders may provide up to B5 without designating it as biofuel. B6–20: Complies with ASTM D7467: No or minor modifications are needed, but some OEMs will restrict warranties. B100: Complies with ASTM D6751. May require engine modifications; purchase from BQ-9000-certified provider recommended.
biomethane	Methane derived from biogas, also called renewable natural gas. Used in the form of CNG or LNG.
blend wall	The maximum blending (10 percent or E10) of ethanol into gasoline allowed by U.S. federal law times the total volume of gasoline in the marketplace.
carbon intensity	Lifecycle carbon emissions associated with fuel, typically measured in grams of CO2 per megajoule of energy content (e.g., g CO2 e/MJ). The California low-carbon fuel standard program provides tables that list carbon intensity by fuel pathway.
carrier	Companies that own and operate trucking fleets. These are typically referred to as "carriers"—as they physically carry goods—in contrast to the "shippers" who place shipments that the carriers deliver.
compressed natural gas (CNG)	Natural gas, composed mainly of methane (CH_4) compressed to less than 1 percent of the volume it occupies at standard atmospheric pressure.
dimethyl ether (DME)	An alternative fuel that runs in diesel engines with only moderate engine modifications required. DME may be produced from various feedstocks, including natural gas

	and methanol, and is being developed as a synthetic second-generation biofuel (BioDME).
drop-in fuel	Fuel blendstock that does not require substantial changes in refining or distribution infrastructure.
electric vehicle (EV)	Vehicle that uses an electric motor for propulsion, powered by an external source in the case of a plug-in electric vehicle (PEV) or onboard electrical power generator, such as a hydrogen fuel cell. PEVs include all battery-powered electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
flex-fuel vehicle (FFV)	Vehicles that can interchangeably run on gasoline or a blend of up to 85 percent ethanol (E85). FFVs may be indicated by a yellow gas tank cap, label on the fuel door, badge on the body, notation in the owner's manual, or reference to the Vehicle Identification Number.
fuel	Refers to transportation fuel. Include alternatives to onboard fuel, including electrification and fuel efficiency.
fuel pathway	Description of the lifecycle of a fuel. For example, "Production of Biomethane from High Solids Anaerobic Digestion (HSAD) of Organic (Food and Green) Wastes" Is on type of pathway for CNG.
fuel provider	Companies that produce, refine, and/or distribute fuel (e.g., oil, gas, biofuel, etc.). Fuel buyers and technical organizations are becoming increasingly interested in the production impacts of all fuels.
hybrid electric vehicle (HEV)	Vehicle that combines conventional internal combustion engine (ICE) propulsion with an electric propulsion system that produces power through regenerative braking.
hybrid hydraulic vehicle (HHV)	Vehicle that combines conventional internal combustion engine (ICE) propulsion with additional power through pressurized fluid from kinetic energy recovered during braking and decelerating.
indirect land use change (ILUC)	Expansion of croplands induced from increased global demand for biofuels.
liquefied natural gas (LNG)	Natural gas, composed mainly of methane (CH_4) converted to liquid and condensed to 1/600 of its volume in a gaseous state. The energy density is 2.4 times greater than that of CNG and 60 percent greater than petroleum diesel fuel.
low-carbon fuel	Fuels with a lower carbon intensity than conventional gasoline or diesel. These include biomethane and electricity, as well as many biofuel and natural gas pathways.
natural gas	Fossil fuel comprised mostly of methane that is used as compressed natural gas (CNG), liquefied natural gas (LNG), or liquefied petroleum gas (LPG or propane).
natural gas vehicle (NGVs)	Vehicles that use natural gas.

offtake agreement	Agreement between a fuel producer and buyer to purchase or sell a specified amount of the producer's future fuel.
original equipment manufacturer (OEM)	Makers of vehicles or components used in the production and use of liquid fuel, EVs, and infrastructure. Fleet operators increasingly look to collaborate to make more sustainable vehicle options available.
renewable diesel	Diesel that meets the ASTM petroleum diesel specification but is produced from fats or vegetable oils through a hydrotreating process. Also called hydrogenation-derived renewable diesel (HDRD).
renewable fuel	Fuels produced from renewable resources, such as biofuels, hydrogen, and electricity, derived from renewable power sources.
Renewable Identification Number (RIN)	Serial number assigned to a batch of biofuel for the purpose of tracking its production, use, and trading as required by the U.S. EPA Renewable Fuel Standard.
shipper	Companies that rely on third parties to deliver their shipments. Although shippers contract or subcontract freight to others, they still may be exposed to regulatory, market, and stakeholder risks.

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Future of Fuels Member Organizations

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- Nike
- Shell
- Suncor
- UPS
- U.S. Department of Defense
- Volvo Group
- Walmart
- Westport Innovations

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Acknowledgments: Discussion Forums

The perspectives presented in this guide have been shaped by discussion forums that we hosted or cohosted in 2013, including the following:

STAKEHOLDER FORUM ON FUEL SUSTAINABILITY OPPORTUNITIES
May 2, 2013
San Francisco (cohosted by Ceres)
In-person meeting to discuss the key lifecycle improvement opportunities for the major fuel groups: oil, gas, biofuels, and EVs. Approximately 65 attendees.

FUTURE OF FUELS PRACTITIONER DISCUSSIONS
June–July 2013
Virtual
Four-part webinar series that undertook technical "deep dives" into the four fuel groups mentioned above. Approximately 185 attendees in all.

FORUM ON FUEL SYSTEM TRANSFORMATION
September 26, 2013
Washington, D.C. (hosted by WRI)
In-person forum to discuss opportunities in these areas for the fuels mentioned above: efficiency, policy, technology, and supply chain. Approximately 45 attendees.

SUSTAINABLE FUEL POLICY FORUM
November 5, 2013
San Francisco
In-person forum to examine fuel policy issues specifically, with discussion of current developments around the LCFS and the need for policy action by companies. Approximately 40 attendees.