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Barriers to the adoption of fuel-saving technologies in the trucking sector

1. INTRODUCTION

Freight trucks are the backbone of most economies, because they are responsible for a significant portion of goods movement. Although freight trucks make up a relatively small percentage of the on-road vehicle fleet, they are responsible for a disproportionately large share of fuel consumption and greenhouse gas (GHG) emissions. Because the trucking sector is growing rapidly, there is increasing focus on technologies that can improve the efficiency of these vehicles.

Although many technologies provide real-world fuel-savings benefits for heavy-duty trucks, they often have slow or limited uptake in the market. Ideally, technologies with an attractive return on investment would be rapidly adopted by all applicable commercial fleets. However, adoption rates of most efficiency technologies from major heavy-duty vehicle (HDV) markets, such as the European Union (EU), United States (U.S.), and China, show that this is generally not the case (Rodríguez, Muncrief, Delgado, & Baldino, 2017). Trends indicate there are barriers that prevent these technologies from reaching full adoption levels within a short timeframe after commercial introduction. In general, these barriers fall into four main categories: uncertainties about technology performance and return on investment, capital cost constraints, split incentives, and lack of technology availability.

Prepared by Ben Sharpe

The primary objectives of this paper are to briefly summarize the key barriers that impede the adoption of fuel-saving technologies in the trucking sector and to discuss some of the ways policymakers can combat them. After this introductory section, this briefing paper is organized as follows:

» Section 2 discusses the importance of fuel savings in the trucking sector and some of the key technology areas where advancements are being made to improve vehicle efficiency.

» Section 3 describes each of the four barriers and provides some examples of how each of these barriers can manifest in real-world situations.

» Section 4 summarizes two previous studies that have investigated fuel-saving technology adoption barriers in the EU and the U.S.

» Section 5 outlines the three principal types of policy measures that can combat these barriers and accelerate the adoption of technologies that provide environmental and economic benefits to both fleets and society at large.

2. IMPROVING THE FUEL EFFICIENCY OF TRACTOR-TRAILERS

For most trucking fleets around the world, fuel costs represent a considerable percentage of overall operating expenses. For example, as shown in Figure 1, fuel accounts for the largest or second largest operational cost for fleets in Germany and the U.S. (Bundesverband Güterkraftverkehr Logistik, 2013; Torrey and Murray, 2015). Germany is the largest trucking market in Europe in terms of sales and truck activity (Muncrief & Sharpe, 2015).

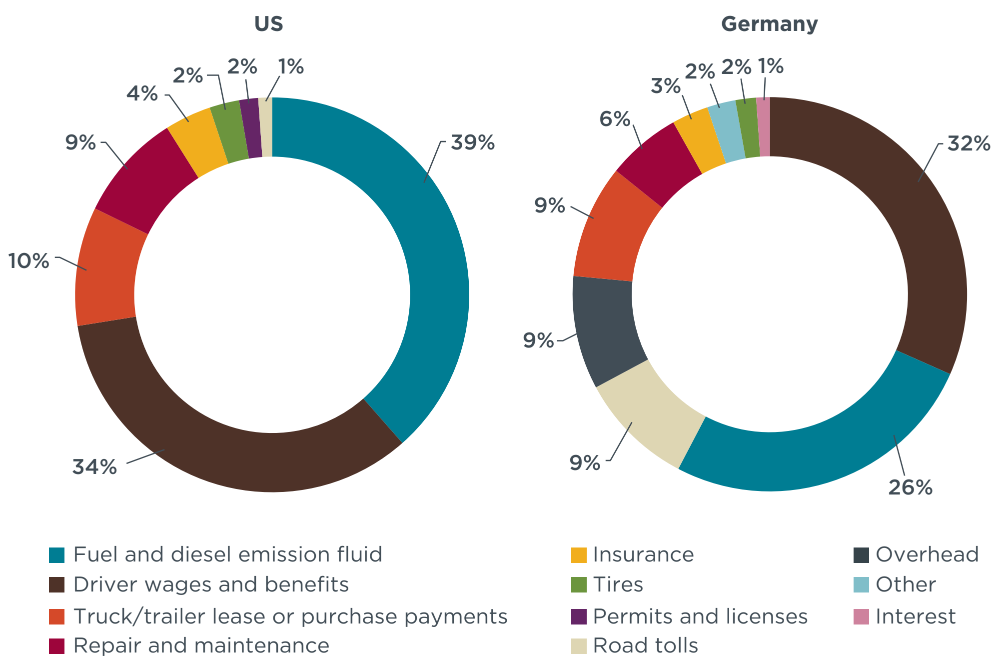

Figure 1: Breakdown of the operational costs of trucking in the U.S. and Germany

With fuel representing such a large part of the operating costs, fleets have a significant motivation for improving the fuel efficiency of their tractor-trailers. With this inherent demand for more efficient equipment, fuel-saving technologies are continually emerging from established manufacturers and third-party equipment suppliers. As shown in Figure 2, there are technologies aimed at boosting efficiency in virtually every system on the tractor-trailer, including the engine, transmission, driveline, tires, aerodynamics, and structural components.

One key reason certain fuel-saving technologies may have limited uptake is that so many variables can impact fuel consumption (e.g., wind, temperature and humidity, road conditions, traffic circumstances, driver behavior, payload, and topology). Moreover, isolating the fuel impacts of an individual technology or package of technologies can be a very challenging endeavor, both in terms of measurement procedures and because of the aforementioned variables that affect fuel performance.

Another crucial input when assessing the potential efficacy of an efficiency technology is regional considerations. Not only can tractor-trailers configurations differ from region to region (e.g., extended-nose tractor trucks in North America versus flat-faced tractor trucks in Europe and many other regions around the world), but operations can vary greatly as well. The two most important operational characteristics that affect fuel consumption are average speed and payload. The fuel-efficiency benefit of aerodynamic aids is very sensitive to truck speed; the faster a truck typically travels, the greater the reduction in fuel use from an aerodynamic technology. On the other hand, tire rolling resistance is proportional to truck weight; tires with low rolling resistance provide greater benefits on heavier trucks than on lighter trucks. In comparison to U.S. trucks, Chinese freight trucks typically travel at lower average speeds (highway cruising speeds of roughly 70 km/h compared to 105 km/h), but tend to operate at higher maximum weights (maximum vehicle weights of 49,000 kg or more compared to 36,000 kg). As such, the expected benefits of aerodynamic aids will generally be smaller for Chinese trucks than for U.S. trucks, but the expected benefits of reduced rolling resistance will typically be greater.

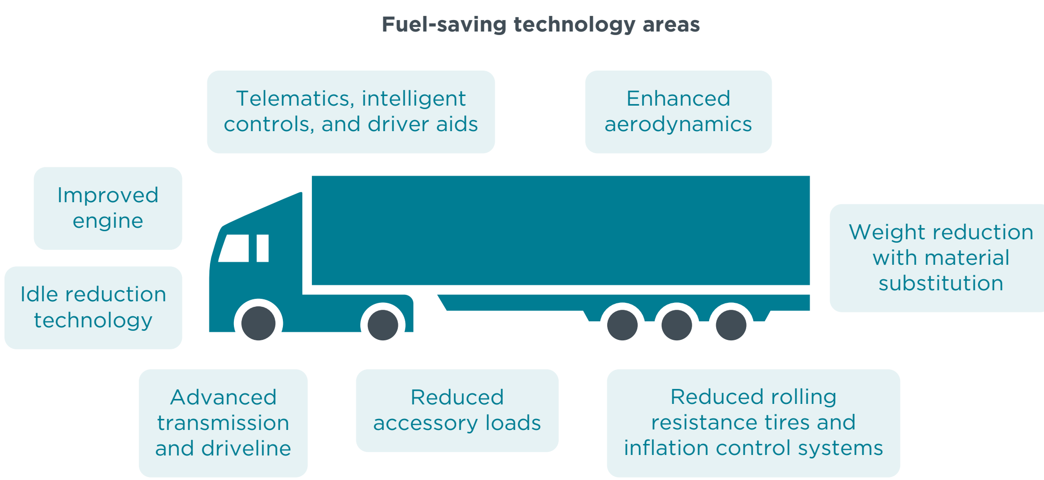

Figure 2: Tractor-trailer fuel-saving technology areas

3. BARRIERS TO FUEL-SAVING TECHNOLOGY ADOPTION IN THE TRUCKING SECTOR

As shown in Figure 3, the four types of barriers—uncertain return on investment, capital cost restraints, split incentives, and lack of technology availability—each can play a role in slowing the rates of technology adoption. Sections 3.1 through 3.4 summarize how each of these barriers manifest in the trucking sector.

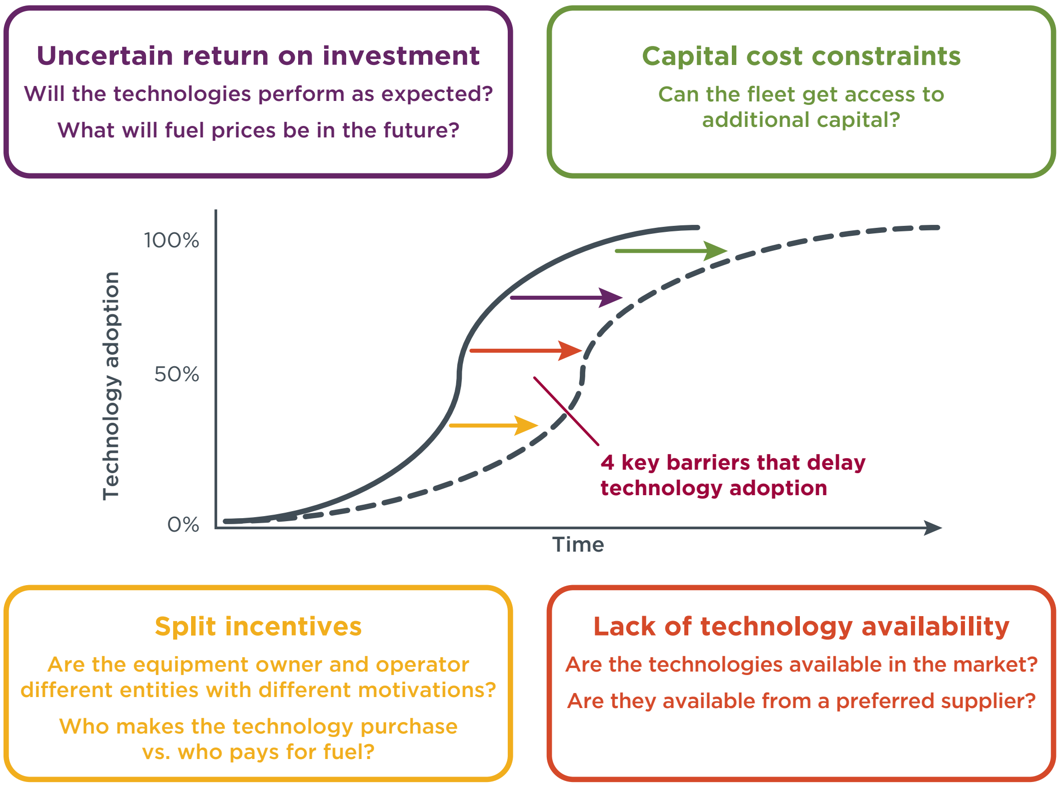

Figure 3: Four key barriers that delay the uptake of fuel-saving technologies

3.1 UNCERTAINTIES ABOUT TECHNOLOGY PERFORMANCE AND RETURN ON INVESTMENT

Fleets often are faced with uncertainty about the performance and operational impacts of a new technology. This might include uncertainty about the effectiveness, payback time, driver acceptance, or reliability and maintenance requirements of the new technology. This is further complicated by the fact that many fleets have different methodologies for payback time (or total cost of ownership) calculations, which can be influenced by fuel price volatility, first owner lifetime, and projected resale value.

Findings from ICCT studies in the EU and U.S. indicate that fleets perceive a lack of credible information about the real-world performance of technologies—particularly over a range of different operating profiles (e.g., average speed, topology, payload). A common interview response from trucking companies of all different types and sizes was that they tend to be very skeptical of manufacturer claims. As previously stated, in the U.S. project, the study team heard several times that a general rule-of-thumb is to take manufacturer claims about fuel consumption reduction and cut these numbers in half for a more realistic real-world estimate. This sentiment points to clear questions about the credibility of many forms of data that are being provided by technology providers, due to lack of standardization. Moreover, this barrier is often exacerbated by the fact that there can often be large performance variability among various product and brand offerings.

3.2 CAPITAL COST CONSTRAINTS

The upfront capital cost of the technology becomes a barrier when the fleet is not willing or is unable to invest the initial capital to purchase the technology—even in cases when the fleet has calculated that the technology has an attractive payback time.

Many fleets have expressed that the high cost of new trucks is a challenge for purchasing additional efficiency features. In particular, in many regions, regulations aimed at reducing pollutant emissions (e.g., particulate matter and nitrogen oxides [NO_X]) have increased costs to trucks over the past decade, and these emissions technologies are generally associated with fuel penalties.[1] The overall costs of new trucks—compounded by the financial constraints posed by the global recession and its aftereffects—have limited the availability of capital for many actions the fleets would like to take.

Additionally, fleet managers have limited budgets, and other non-efficiency technologies on the market can compete to make it on the specification sheet for tractors and trailers. These can include safety technologies or features that are attractive to drivers. The latter can be an especially critical decision factor, because driver turnover rates are very high in some markets, and fleets are often very focused on retaining drivers. For example, in the for-hire trucking market in the U.S., driver turnover rates are roughly 100%. This means that a fleet that employs 100 drivers will need to hire 100 drivers every year. This can create a situation where fuel-efficiency technologies are less valuable to a fleet than features that are a selling point in driver recruitment and retention.

3.3 SPLIT INCENTIVES

In one manifestation of the split-incentive barrier in the trucking industry context, the entity buying the technology is not the same entity that must pay for the fuel. Therefore, the former will tend to avoid purchasing the fuel-saving technology because they will bear the upfront cost but will not experience the associated savings. Vernon and Meier (2012) studied this issue in the U.S. and suggested that the market structure of the trucking industry contributes to split incentives because entities responsible for investments in equipment do not always pay fuel costs, and drivers are not always rewarded for fuel-efficient operation. The same study stated that approximately 23% of trailers are subject to an "efficiency problem" when owners of rented trailers do not pay fuel costs. That study suggested that principal-agent problems have the potential to significantly discourage investments in fuel-saving technologies and can also result in insufficient maintenance and inefficient practices.

In another instance of a split incentive in the trucking sector, fleets can sometimes have provisions in their contracts where the fuel costs can be passed directly to the shipper. In this situation, the fleets have a disincentive to invest in efficiency technologies,

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1 An exception is selective catalytic reduction (SCR) technology, where the engine can be tuned for improved efficiency, and the relative high levels of engine-out NO_X are controlled in the SCR aftertreatment system.

because fuel expenses are paid directly by the shipper, and the shipper would reap the savings from reduced fuel costs. Based on findings from ICCT studies in the EU and U.S. (see Section 4), these fuel provisions are not common, so the impact from this disincentive to minimize fuel consumption is thought to be relatively small.

3.4 LACK OF TECHNOLOGY AVAILABILITY

Lack of availability occurs when a technology cannot be purchased in a particular market or region or when it is not available from a preferred manufacturer. For example, if a technology is only offered from a particular third-party supplier, knowledge of the technology may not be widespread amongst fleets. Or, a technology may only be available from one OEM or a subset of OEMs. Fleets may prefer to acquire trucks from a certain OEM for several different reasons (e.g., contractual obligations, positive previous experiences, operations constraints), so if a technology is not available from all OEMs, this can present an availability barrier. Moreover, a technology may only be offered on a subset of equipment types (e.g., a technology may only be offered on certain truck models or as part of a certain specification package), which could limit a fleet's ability to acquire the technology as part of the overall truck or trailer specification that is desired.

4. KEY TAKEAWAYS FROM PREVIOUS STUDIES ON BARRIERS TO ADOPTION FOR FUEL-SAVING TECHNOLOGIES IN THE TRUCKING SECTOR

The summaries of two previous ICCT stakeholder interview projects in this section illustrate how the four barriers discussed in the previous section can work individually and feed off one another to create environments that are hostile to the diffusion of tractor-trailer efficiency technologies in the market.

EU STUDY

In 2012, the ICCT commissioned CE Delft to systematically investigate and identify the barriers to the widespread uptake of fuel-saving technologies in the European trucking sector (Faber, den Boer, & Aarnink, 2012). The objective of this project was to engage with several different stakeholder groups in the trucking industry to better understand the reasons for the limited adoption of cost-effective fuel-saving technologies and to inform the policy-making process in the EU and abroad. Over the course of the project, the study team surveyed trucking companies,[2] original equipment manufacturers (OEMs), shippers and logistics service providers, leasing companies, and financial institutions.

Key findings from the study are as follows:

» **Most fleets believe that operational improvements are far more cost-effective than efficiency technologies**. An important barrier is the lack of information on the fuel savings of individual technical measures for trucks and especially for trailers. Although many transport companies and all OEMs are aware that certain efficiency technologies exist, few respondents believed that these technologies are cost-effective.

2 The project team surveyed nearly 40 trucking fleets over the course of the study. Although seven companies that were surveyed operate 20 or less trucks, no small fleets (e.g., less than five trucks) or owner-operators were included in the study.

The consensus of interview responses implies that it is a widely held belief in the road freight sector that operational measures—particularly those measures that do not require investments—lead to savings, and that technical measures to improve efficiency are costlier and less impactful.

- » **The supply of fuel-saving technologies from OEMs is limited**. Most truck OEMs offer packages of certain efficiency technologies as options to prospective truck purchasers, but they are not typically offered with the standard package. Additionally, certain technologies are not offered on new vehicles, but instead are sold as aftermarket devices for in-use trucks. For trailers, the situation is worse, because manufacturers do not typically offer fuel-saving equipment unless their client specifically asks for it.
- » **Financial institutions do not take fuel efficiency into account when deciding on a loan**. Responses from banks and lending institutions indicate that loan decisions are primarily based on the financial health of the transport company.
- » **The split incentive appears to have less relative impact than the other barriers.** From the survey responses, the split-incentive barrier manifests in two situations: (a) truck and trailer ownership, and (b) fuel provisions in transport contracts. In the first instance, fleets described certain situations when the truck or trailer is purchased and owned by a shipping or logistics company and then leased to a fleet for operation. In this case, the shipper has very little incentive to pay additional costs for efficiency technologies, because the fleet will be operating the vehicle and paying for the fuel and thus would reap the return on investment from these technologies. The study team was unable to collect quantitative data on the distribution of ownership in trucking fleets to estimate the percent of companies affected by this manifestation of the split incentive. In the second instance of a split-incentive barrier, a fleet can pass all of its actual fuel costs to the shipping company. In such "open-book" contracts, the fleet has little incentive to reduce its fuel costs, because they are paid directly by the shipper. The study team found that these open-book fuel provisions occur in roughly 20% of transport contracts. For the fleets interviewed that operated all or part of the time under open-book contracts, 80% of the respondents cited that fuel efficiency was not an important parameter when acquiring a new truck. Given that fuel efficiency was ranked as the first or second most important criterion when purchasing a truck for over 60% of the fleets surveyed (i.e., all of the fleets surveyed in the study, not just those operating under open-book contracts), this implies that open-book contracts do indeed create a disincentive for investing in fuel-saving technologies.

U.S. STUDY

In 2013, the ICCT collaborated with the North American Council on Freight Efficiency and Cascade Sierra Solutions to interview a diverse cross-section of stakeholders from the trucking industry in the U.S. to investigate the decision-making processes for adopting new fuel-saving technology (Roeth, Swim, Kircher, & Smith, 2013). The stakeholder groups included dozens of various sized for-hire and private trucking fleets, nearly 1,900 owner-operators (who responded via an online survey), shipping and logistics companies, truck and trailer manufacturers, component suppliers, and truck dealerships.

The stakeholder responses from this study indicate that there are clear prevailing barriers to the widespread adoption of viable off-the-shelf efficiency technologies. These barriers include limited availability of technologies of interest, lack of credible information about the new technologies' benefits, and uncertainty in the fuel-savings payback period.

The following are the key findings from the study:

» **Fleets expect a return on investment within 2 to 3 years**. The results indicated that large for-hire fleets tend to purchase new tractor trucks and operate them for 5 to 6 years, on average, before reselling them in secondary markets. Generally, fleets expect an efficiency technology to pay for itself in terms of fuel savings within the first half of the ownership cycle—that is, in 2 to 3 years—so that in the second half of the ownership cycle, the fleet can see a return on investment from the technology.

» **Lack of credible information deters many fleets from adopting efficiency technology**. Typically, fleets are very risk averse and would ideally opt to test technologies in their own operations before deciding if a larger investment is warranted. In addition to trusting self-generated data, fleets tend to value information from other fleets and trucking associations. There seems to be a high degree of skepticism of marketing information from truck manufacturers and technology suppliers. As a rule-of-thumb, most fleets take manufacturer/supplier fuel reduction claims and cut them in half. For example, if a company told Fleet A that Technology X cuts fuel use by 6%, Fleet A would use 3% fuel savings in their assessment of whether to invest in Technology X.

» **Reliability, fuel economy, and maintenance impacts drive the decision-making process**. Reliability—that is, keeping trucks available for useful work—was the most important criterion fleets cited when deciding whether to invest in a technology. Following reliability, fuel economy and maintenance were the next most important factors. In order of importance from highest to lowest, the remaining criteria were: durability, resale value, driver retention, and fleet image/branding.

» **High driver turnover impacts fleets' technology choices**. Very high driver turnover means that many fleets do not make significant investments in driver training or technologies that require driver intervention. Instead, fleets that tend to experience high driver turnover rates opt for "passive" efficiency technologies that function properly regardless of whether the driver intervenes.

5. POLICY MEASURES TO ACCELERATE FUEL-SAVING TECHNOLOGY ADOPTION

This section discusses policy measures that can work directly to help break down the four barriers discussed in Section 3. Various types of policies and programs can address technology adoption barriers in several ways: providing investment certainty to technology developers to ensure market uptake, ensuring fleets have greater technology availability to choose from at the time of purchase, and providing standardized certification information about the efficiency performance of various engine and truck offerings. The three types of policies can be broadly categorized as fuel-efficiency standards, market-based approaches, and fiscal measures. As illustrated in Figure 4, these three types of policy measures can work to overcome barriers to adoption and accelerate the deployment of efficiency technologies.

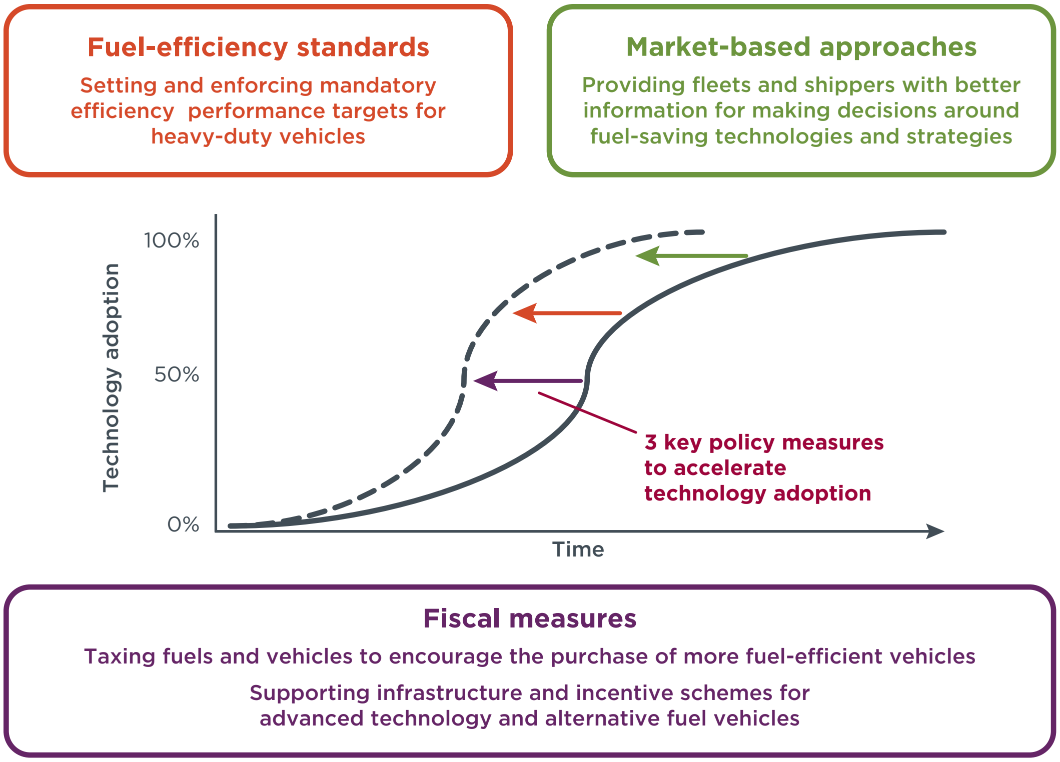

Figure 4: Three primary types of policies that accelerate the uptake of fuel-saving technologies

4.1 FUEL-EFFICIENCY STANDARDS

The first type of policy measure that can help to mitigate the barriers described in Section 3 is a mandatory regulation for new vehicle fuel efficiency and/or GHG levels.[3] To date, Canada, China, Japan, and the U.S. have enacted mandatory efficiency standards for new HDVs, and many other countries are in various stages of development for their own regulatory measures. Although most efficiency standards are technology neutral, meaning the technologies used to comply with the regulation are not prescribed, the standards mandate improvements in vehicle efficiency at certain intervals (e.g., compliance must be demonstrated by a certain year), which translates to increased market penetration of efficiency technologies. And although some of this uptake would occur without the standards in place (i.e., as a result of demand from fleets for more efficient equipment), efficiency standards can add a level of certainty to both manufacturers and fleets that is necessary for meeting climate and fuel-consumption targets. Manufacturer data from 1970 to 2010 show that heavy-duty truck fuel consumption decreased at a rate of roughly 1% per year (Schuckert and Krukenberg, 2011). This is a reasonable estimate of the rate of fuel-efficiency progress in the absence of regulation. In contrast, regulatory programs in Canada, China, Japan, and the U.S. are requiring fuel-consumption reductions between roughly 2% and 4% per year (Delgado, Miller, Sharpe, & Muncrief, 2016), which is a substantially higher rate of improvement than what the market can deliver without efficiency standards.

3 Carbon dioxide (CO_2) represents the majority of GHG emissions from vehicles. Because CO_2 emissions are directly a function of the fuel consumed, fuel-efficiency standards are a proxy for GHG standards and vice versa.

As shown in Figure 5, fuel-efficiency standards can directly help to mitigate the impacts of uncertain technology performance and lack of technology availability. In developing efficiency standards, regulatory agencies typically engage in a thorough review of available and anticipated technologies to estimate their performance, costs, and any impacts on operations. This regulatory impact analysis informs fleets and other stakeholders so they can be confident that the technologies will yield the expected benefits and an acceptable return on investment in a timeframe that is within the range of typical industry expectations. Moreover, by helping to ensure that all manufacturers are developing and deploying efficiency technologies, fuel-efficiency standards directly address the lack-of-technology-availability barrier.

In addition to addressing uncertain technology performance and lack of technology availability, efficiency regulations can also work indirectly to lower capital costs and reduce the impact of split incentives. Fuel-efficiency standards require increased technology deployment over time, and as technology production volumes increase, economies of scale generally result in per-unit manufacturing cost reductions. Regulations also indirectly impact the split-incentive barrier, because standards mean a buyer has less opportunity to purchase a truck with poor efficiency simply to minimize capital expenses.

One example in which regulatory agencies address the issue of technology barriers directly is the U.S. fuel efficiency and GHG regulation. In their Phase 2 regulatory impact analysis document, the U.S. EPA and NHTSA devote a section (Section 8.2) to discussing barriers to technology adoption in the heavy-duty vehicle sector, with a focus on trucking (U.S. Environmental Protection Agency and Department of Transportation, 2016). The agencies highlight several barriers that each play a role in delaying the uptake of fuel-saving technologies. Many of these barriers have been discussed above in Section 3, and we describe three additional barriers below:

- Adjustment and transaction costs: with certain technologies, drivers need to be properly trained so that fuel-savings benefits can be more fully realized.
- Network externalities: this situation arises when the benefits to the new user of a technology depend on how many others have already adopted it. One example of this barrier is the case of natural gas trucks. The limited availability of refueling stations may decrease potential buyers' willingness to purchase natural gas trucks, while the small number of natural gas trucks on the road does not provide sufficient economic incentive to construct more natural gas refueling stations.
- First-mover disadvantage: many fleets and manufacturers would prefer not to be early adopters (or developers), because first movers typically incur a disproportionate amount of the deployment (or development) costs associated with a technology.

U.S. EPA and NHTSA acknowledge that each of these barriers (as well as the barriers described in Section 3) creates a disincentive to early adoption but that fuel-efficiency standards "may help to overcome such barriers by ensuring that [technologies] will be widely adopted." Moreover, the agencies contend that a "significant number of fuel efficiency improving technologies will remain far less widely adopted in the absence of [fuel efficiency] standards" (ibid).

4.2 MARKET-BASED PROGRAMS

The primary objective of voluntary market-based programs, such as green freight initiatives, is to promote enhanced efficiency and environmental stewardship in the on-road freight sector (and often other modes of transport, such as marine and rail). Green freight programs around the world are in various stages of maturity, and each is unique in its functionality and objectives. However, common features include data collection and benchmarking on fuel consumption and emissions, as well as information sharing on technologies and strategies for boosting efficiency and environmental sustainability. Green freight programs typically include the following three components:

- **Data collection and benchmarking.** This is arguably the most critical enterprise of any green freight program. Amassing and organizing data on fuel consumption and activity (e.g., total miles traveled) allows the various stakeholders of the program to assess how truck fleets compare in terms of fuel-efficiency metrics.
- **Guidance for technologies and operational best practices.** Program administrators and participating companies generally use data and information collected about efficiency technologies and strategies to share best practices and lessons learned. This is an important service, because fleet operators often lack the information they need to make informed decisions in these areas.
- **Technology verification.** This refers to the independent testing of technologies using well-established test procedures, such as those of the Society of Automotive Engineers. Employing standardized protocols to assess the fuel-savings performance of individual products and making this information public gives fleets, governments, and other stakeholders access to test results that demonstrate that technologies have a minimum level of effectiveness under certain conditions. Often, verification done by green freight programs or other independent entities creates a level playing field in which technology suppliers can showcase their products' merits. By having their products vetted through the technology verification process, manufacturers can highlight third-party results that demonstrate a certain level of performance.

By providing fleets and shippers with information to assist them in decision-making around fuel efficiency, green freight programs help to address the uncertain technology performance barrier. Moreover, helping to create an environment where technologies can be verified by a third-party can give manufacturers added incentive to introduce products in the market. Thus, green freight programs also help to overcome the lack of technology availability barrier.

Green freight programs are highly complementary to fuel-efficiency standards. One example of how green freight programs and regulation have worked in concert to better maximize the uptake of a fuel-saving technology is the case of trailer side skirts in the U.S. The U.S. EPA established the SmartWay program in 2004, and one of the technologies that the program has featured prominently is trailer side skirts, which typically provide between 3% and 7% savings for tractor-trailers that spend a sizable portion of time operating at highway speeds (Sharpe, Clark, & Lowell, 2013, Sharpe & May, 2015; Sharpe & Roeth, 2014). In 2008, the California Air Resources Board (CARB) began developing an in-use regulation mandating that tractor-trailers operating in the state would need to use SmartWay-verified aerodynamic devices and tires with low rolling resistance (CARB, 2008). CARB's tractor-trailer GHG regulation went into effect in 2010, and because so many tractor-trailers from around the country operate in California, the regulation has had far-reaching impacts and has been a key reason why the adoption of technologies, such as side skirts, has increased considerably in recent years. Looking to further increase the deployment of trailer fuel-saving technologies and leverage the successes of the SmartWay program and the CARB regulation, the U.S. EPA and NHTSA introduced trailers as a newly regulated equipment category in its Phase 2 efficiency standards. As a result of the complementary nature of the SmartWay program and the CARB and U.S. EPA/NHTSA regulations, trailer skirts have gone from fairly small penetration to a technology that is now installed on over 50% of new box-type trailers in the U.S. and Canada. Going forward, it is expected that their adoption is going to continue to increase, because the Phase 2 regulation requires improved aerodynamic performance through 2027 (ICCT, 2015; Sharpe & May, 2015; Sharpe & Roeth, 2014).

4.3 FISCAL POLICIES

Fiscal policies are the final type of policy measure that can help to accelerate fuel-saving technology adoption; the policies generally work in two ways: (a) taxes or fees for less efficient equipment or technologies, or (b) financial incentives for more efficient and/or emission-reduction technologies. Fiscal policies come in a variety of different forms, including feebates, grants or vouchers for vehicle or infrastructure purchase, fuel or carbon taxes, emission trading schemes, or low- or no-interest loans (CARB & CalStart, 2017; German and Meszler, 2010, SBS News, 2016).

As shown in Figure 5, fiscal measures work directly to address both capital cost constraints as well as split incentives. Incentive funding can assist a fleet in making an investment in a technology that would have been cost prohibitive otherwise. Moreover, fiscal measures can also help to address the split-incentive barrier by offering the technology purchaser/owner financial support for the technology, because that entity will not be the party receiving the benefits of reduced fuel savings. In addition, fiscal measures indirectly target uncertain returns on investments. Incentive funding that goes to manufacturers or fleets can cover some of the incremental costs of technology development and deployment and ease the burden of introducing new technologies. Although these additional funds will not eliminate the uncertainty associated with new technologies, they can help to mitigate the financial risk to companies so that technology investment is more tenable.

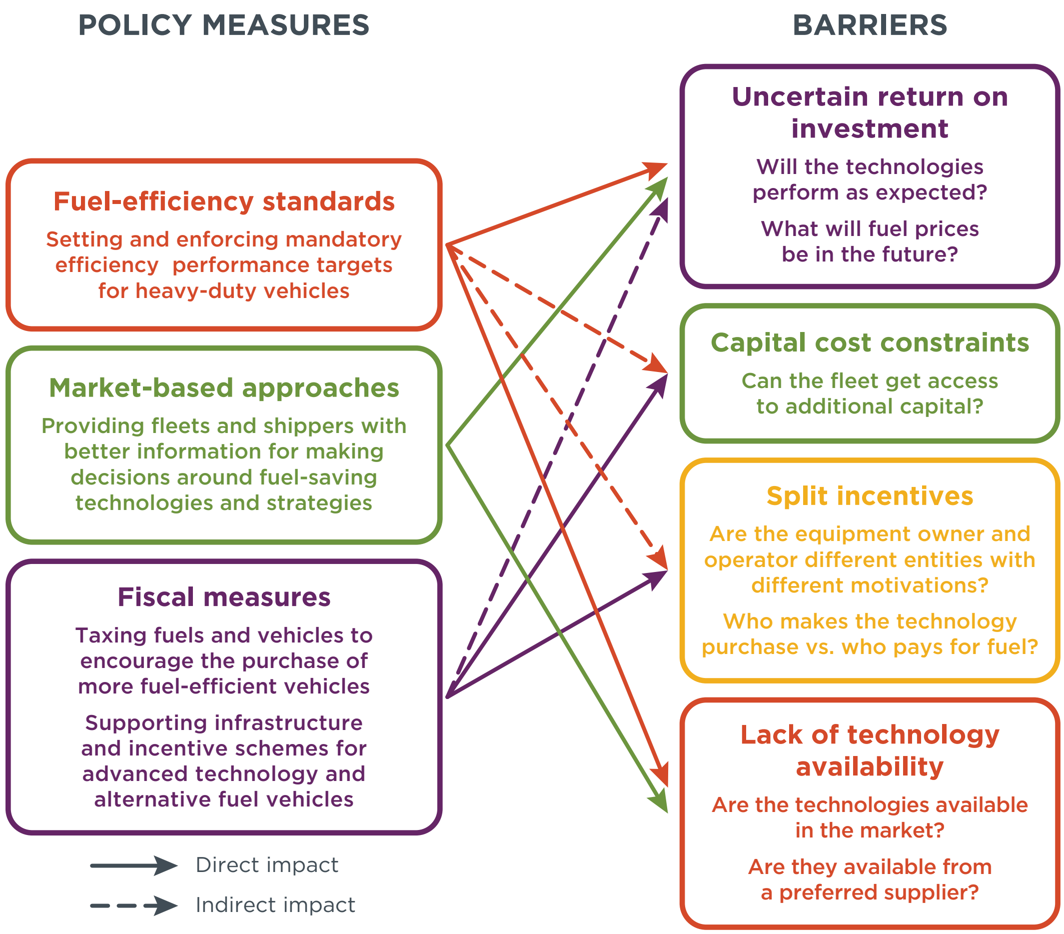

Figure 5: Each policy measure helps to mitigate barriers to fuel-saving technology adoption

5. CONCLUSIONS

Fuel costs represent a significant expense for commercial trucking fleets, and there is a strong incentive to use fuel as efficiently as possible. There are several fuel-saving technology options for both trucks and trailers, but for a myriad of reasons, some of these technologies have had slow or limited uptake in the market. Based on a review of the literature and ICCT research in various regions around the world, these barriers to technology adoption generally fall into four broad categories:

» Uncertainty about technology performance and return on investment,
» Capital cost constraints,
» Split incentives, and
» Lack of technology availability.

These barriers can manifest in several different ways, and the overall impacts on technology adoption rates are a function of numerous exogenous factors, including fleet composition, trucking operational characteristics, and climate and topography. Moreover, among the trucking industry, there is typically significant diversity in attitudes, opinions, and expectations regarding the value of a given efficiency technology. These and other factors make it challenging to quantify the impacts of each barrier on technology adoption. Nevertheless, qualitatively, it is abundantly clear that these barriers can have a critical impact in slowing the uptake of fuel-saving technologies in the trucking sector.

To counter these barriers, there are three primary types of policy measures:

» Fuel efficiency/GHG standards;

» Market-based (i.e., data collection and dissemination) programs; and

» Fiscal measures.

As shown in Figure 5, each of these policy measures targets a different combination of the four barriers. As such, these policy measures are highly complementary, and the accelerated adoption of technology can be maximized by employing these three types of policies in a coordinated approach.

Although each of the three types of policy measures can be effective in helping to speed up the penetration rates of fuel-saving technologies, ICCT analysis of several trucking markets reveals that fuel-efficiency standards are the most impactful way to spur technology development and deployment. By mandating that vehicles achieve a level of fuel-efficiency performance by a certain deadline, regulations are a direct way to ensure that fuel-saving technologies are entering the market. Fuel-efficiency standards provide certainty and a level playing field to manufacturers and fleets, and companies and individuals can make technology investments with the added confidence that several technologies and technology packages will see widespread adoption across the entire market.

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