

Fuel-Marking Programs: Helping Governments Raise Revenue, Combat Smuggling, and Improve the Environment

Introduction

Many countries face national fuel supply chain problems, which include smuggling, adulteration and dilution of fuels, and outright theft, all of which deprive governments of much needed tax revenue. An example is the Philippines which, due to fuel smuggling, has adulterated fuel products in its supply chain.¹ According to experts, this costs the country as much as \$750 million annually in tax revenue. Meanwhile, other Asian countries that subsidize fuel, such as Bangladesh, Indonesia, and Malaysia, are vulnerable to losses when their low-priced fuels are smuggled to countries that charge international market prices, depriving governments of the intended benefits of providing subsidized fuel.

Governments worldwide have developed various fuel taxation programs to help fund essential services that benefit their citizens. In many cases, these taxes represent a significant portion of a country's total tax receipts, especially in the case of lower-income countries. However, when taxes and/or subsidies result in major fuel price discrepancies, they offer the temptation to take advantage of price arbitrage by perpetrating fuel fraud. Typically, such schemes fall into two categories: tax evasion and subsidy abuse. For example, higher-priced, nonsubsidized, and taxed fuels are diluted with smuggled lower-priced

or subsidized fuels. This affects governments irrespective of their fuel policies, with tax evasion on higher-priced fuels, and subsidized fuels being diverted from their intended beneficiaries. Overall, the result of fuel smuggling and fraud is significant global financial losses, probably totaling tens of billions of dollars annually.

To prevent fuel fraud, governments have developed comprehensive fuel-marking programs, using advanced technology molecular markers and sophisticated management systems that result in timely, actionable intelligence, allowing governments to mitigate tax evasion and subsidy abuse, minimize financial losses, and raise revenues.

Fuel Fraud: A Pervasive Global Problem

All countries are susceptible to fuel fraud. But for developing economies in which every dollar counts, fuel fraud can substantially reduce a government's total revenues. Countries that subsidize their fuels are susceptible to losses due to their low-priced fuels exiting to other countries with fuel prices aligned with international market prices. In Asia, countries with fuel subsidies such as Bangladesh, Indonesia, and Malaysia are particularly vulnerable to financial losses due to their relatively low diesel prices.

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¹ *Philippine Daily Inquirer*. 2014. With Oil Smuggled in, Government Waves Tax Revenues Goodbye. 6 March.

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A good example of this problem at work is in the Kingdom of Saudi Arabia, where diesel sells for approximately \$0.06 per liter, compared to more than 15 times that price in the neighboring United Arab Emirates (UAE). Smugglers cross the Saudi border into the UAE with documents showing they are carrying legal loads of hydraulics and used oil. However, their fuel tankers are often loaded with a mixture of legal oil products and illicit diesel, frequently in proportions of up to 26 tons of illicit diesel mixed with up to 4 tons of legal oil products.² Over the UAE border, specialized factories then separate the used oil from the diesel. It is estimated that Saudi Arabia loses billions of barrels of diesel annually due to smuggling.

In Venezuela, diesel retails for approximately \$0.05 per liter—significantly below the average South American price of \$0.85 per liter. As a result, Venezuela also loses significant amounts of fuel that is smuggled into neighboring countries such as Columbia, Ecuador, Guyana, and Honduras.

While fuel smuggling is a significant cross-border problem, local fuel fraud—in the form of adulteration—is also a common problem in countries that offer significant arbitrage opportunities due to varying tax rates and/or subsidies for one type of fuel or solvent compared to other oil products. A common subsidy is the provision of lower taxes—or no taxes—for kerosene so that poor families have access to affordable cooking and heating without using less environmentally friendly biomass fuels. Unfortunately, this subsidization provides the opportunity to use the lower-priced kerosene as an adulterant in more costly, nonsubsidized diesel and gasoline products, creating two fiscal problems. First, governments are deprived of a percentage of tax revenue on the higher-priced fuels in proportion to the adulteration rate. Second, the diversion of the subsidized fuel benefits criminals, rather than the targeted beneficiaries, resulting in wasted government spending. Furthermore, fuel fraud has a more severe financial impact on developing countries because fuel costs often represent a greater portion of their gross domestic product compared to developed nations.

Fuel fraud also causes harm to the environment by replacing quality fuel with adulterants or waste byproducts, resulting in increased fuel consumption and increased greenhouse gas emissions that worsen air pollution. Illegal fuel-laundering plants

often indiscriminately dump waste products in the countryside,³ causing additional environmental damage. Meanwhile, for both diesel and gasoline engines, adulterants also diminish engine performance and lifespan, leading to increased spending on vehicle maintenance.

Nationwide Fuel-Marking Programs Make a Difference

A comprehensive solution needs to first reveal the quality and condition of the downstream fuel supply chain by examining its every stage, beginning with the country’s refineries or fuel depots, following products through wholesale depots and the transport network (including trucking firms and pipelines), and eventually verifying how petroleum products are sold at the retail level. To ensure the integrity of the entire fuel supply chain, safeguards need to be implemented into every phase of the process. This requires marker and analyzer technologies that integrate security measures directly into the different types of fuel. Marker technologies that blend an invisible marker with the fuel at very low concentrations—often measured in parts per billion—provide the highest level of security for the entire supply chain. Even at very low concentrations, their presence or absence in fuel can be detected at retail outlets with sophisticated but easy-to-use analyzers.

Fuel markers can range from simple colored dyes to unique covert markers and their respective detection methodologies. As noted above, fuel-marking programs are typically instituted to address a wide range of objectives. Since a particular program’s operational requirements are designed to meet unique objectives, every fuel-marking program is different. For programs that require a more sophisticated solution using current advanced technology, it is possible to embed a second layer of security by adding an additional molecular marker using gas chromatography–mass spectrometry (GC–MS) technology. In the event of a failed field screening, this allows for a subsequent sample to be taken to a laboratory for further forensic analysis, which can definitively identify the existence of the fuel marker. This assures full compliance with the higher standards of admissible evidence required by most legal systems.

² *Saudi Gazette*. 2012. Smugglers Selling Cheap Fuel in the UAE. 11 April.

³ BBC News. 2006. *Customs Raid Illegal Fuel Plants*. 6 February. http://news.bbc.co.uk/2/hi/uk_news/northern_ireland/4683680.stm

The Right Solution for the Right Outcome

Every fuel-marking program has unique objectives. For example, a country may choose to deploy a “national marker” program, indicating that all taxes have been fully paid on fuels. In essence, the marker serves as a “chemical tax stamp” for all taxed fuels. In this type of deployment, inspectors look for the dilution of the fully taxed fuel caused by the addition of a lower-taxed petroleum product that does not contain a marker. To maintain program integrity, it is essential to maintain the absolute confidentiality and security of the marker. Regular audits are critical for program integrity. In such a program, marker laundering is not an issue since it would result in making the higher-taxed fuel “illegal.”

However, a country may want to expand the scope of its fuel-marker program by complementing the “national marker” program with marking the highest-volume, lower-taxed petroleum products. By doing so, the government would then be able to pinpoint the sources of fuel fraud. In this case, the potential adulterants would need to be treated with laundering resistant markers to prevent criminals from potentially removing the markers to avoid detection.

Fuel-Marking Program Operations

Fuel-marking programs are comprised of a number of facets, including fuel-marking methods, supply chain security, field sampling and testing, laboratory testing, and data analytics. Efficiently and effectively linking these elements into a comprehensive operational program guarantees overall program integrity. Providing objective evidence to enforcement personnel that proves the existence of fraudulent activity relies on full traceability and creation of a legal case file.

The success of a fuel-marking program requires long-term commitment by multiple government agencies, including key executives from the departments of energy, finance, customs, transportation, and law enforcement. Additionally, support from both state-owned and independent oil companies is critical to successful implementation. Best practices dictate that a program should be administered as a management

system by an independent organization. The management system should direct all aspects of the storage and secure transport of the markers, addition of unique markers into the supply chain, and the subsequent sampling and analysis of suspect materials to ensure the policies are implemented and their objectives achieved.

In most instances, operations should be certified to international process integrity standards such as those of the International Organization for Standardization. The program’s various operations must be regularly audited for process compliance to ensure the program is being managed transparently. When this is the case, a fuel-marking program will provide objective results that are independent of questionable influences. Moreover, the program’s operations will be completely visible to government agencies that are accountable for tax collection and subsidy programs.

The team managing the program should put in place a national operating infrastructure for a full chain of custody, complete traceability, and quality assurance of the marker from storage in a bonded warehouse, to secure distribution, and on-site storage at each distribution terminal.

Another critical component of a legally enforceable fuel-marking program is the proper management of fuel samples to assure the integrity of the chain of custody for all samples taken. The effective deployment of a laboratory information management system assures that all samples are properly and uniquely labeled, tracked, and processed in a consistent and repeatable controlled environment, providing greater confidence in the integrity of the program.

Case Studies of Successful Fuel-Marking Programs

The following case studies describe successful programs that have helped the governments of Ghana and Serbia address serious problems with adulteration of the national fuel supply.

Ghana Case Study

Prior to 2005, Ghana carried a significant debt burden from the refining and distribution of fuel from its Tema Oil Refinery at below cost. To distance itself from petroleum pricing and in turn depoliticize petroleum fuel pricing decisions, in

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2005, the Government of Ghana established the National Petroleum Authority (NPA), which was given the legal authority to monitor and implement a fair market pricing mechanism for domestic fuel products. Since 2003, as part of a deliberate effort to move away from subsidization of fuel products, Ghana saw the retail price of gasoline and diesel fuel products increase from about \$0.25 per liter in 2002 to \$0.95 in 2012. Meanwhile, in response to public resistance to these price increases, the government has continued to subsidize kerosene, which represents, for the bottom quintile of society, an expenditure equal to almost 6% of their annual income. Subsidies are also provided for off-road diesel and marine premix fuel.

Because there are no neighboring countries with significant subsidy programs, cross-border smuggling into Ghana is not a concern. Consequently, Ghana’s fuel-marking program is primarily focused on adequate supply chain management, high-tax fuel adulteration, and fuel quality concerns associated with adulteration.⁴

Program Design and Implementation

In order to more effectively monitor the quality deterioration of petroleum products due to adulteration, and to assure the appropriate recovery of tax revenues from the sale of these products, the Ghana NPA initiated a fuel-marking program known as the Petroleum Product Marking Scheme. Approaching the program as a “national tax stamp” for higher-priced, taxed fuels, a multilayered marker system was deployed. Markers are injected into both high-tax diesel as well as lower-grade gasoline. The first layer entails using a near-infrared fluorescent (NIRF) machine-readable marker in combination with a portable field analyzer. This gives NPA field inspectors the ability to quickly and comprehensively screen all retail fuel stations and immediately determine whether further sale of the alleged illegal fuel should be halted. The second marking layer is a forensic-level molecular marker. When a NIRF screening reveals a suspected illegal fuel sample, an additional sample is taken, and following the appropriate chain of custody protocols, is transported to a regional laboratory, which is staffed and operated by NPA personnel.

A comprehensive analysis is conducted using GC–MS equipment to definitively determine the absence or presence of the molecular marker. Should this test fail to detect the molecular marker, an additional GC–MS test of the fuel sample is conducted, this time by an independent testing laboratory staffed with personnel from a recognized independent testing authority. As a result, the prosecution of suspected criminals is supported by two definitive test results, using the most advanced molecular testing protocols that provide independent results.

Furthermore, all subsidized fuels (i.e., kerosene, low-taxed diesel, and marine premix) are marked using a different molecular marker. As a result, for each suspected diluted sample, the laboratory can run a separate test to determine whether, in fact, a subsidized petroleum product was used as the adulterant. This information is then used in the investigation of potential suspects. Interestingly, in some cases, it has been determined that, where dilution of higher-taxed fuels is occurring, the actual adulterants are comprised of nonpetroleum related products such as pumpkin seed oil, which—because it does not fully combust—contributes to air pollution.

Because the NPA does not mark high-grade octane gasoline, it also uses the marker program to look for lower-grade products that may have been mixed into the higher-octane fuel. The presence of a marker indicates a case of fuel-grade degradation, facilitating grade-quality control.

The Ghana program incorporates a separation of duties between the marking organization and the testing organization. All fuel-marking is done by hand as the fuel is loaded directly into fuel distribution trucks at 10 depot sites around the country. Automated records and controls are established to maintain integrity of the fuel-marking process. This is undertaken by a recognized international testing and inspection company with extensive experience in the oil and gas industry. NPA personnel carry out the actual collection of field samples, field screening, and first-level regional laboratory testing. Altogether, about 125 personnel are involved in fuel-marking, while an additional 30 personnel are engaged in sampling, screening, and testing.

⁴ C. Larbi. 2014. NPA Introduces Fuel Marking Scheme to Check Adulteration. *Modern Ghana*. 11 March. <http://www.modernghana.com/news/528618/1/npa-introduces-fuel-marking-scheme-to-check-adulte.html>

Program Results and Returns

Early sample test results indicated that mere awareness of the Ghana Petroleum Product Marking Scheme served as an effective deterrent against fuel fraud within the country. The use of an aggressive public awareness campaign and the enrollment of the major oil companies helped reduce the percentage of retail sites with significant fuel product dilution from 34% to 7% in the first 6 months of the program. This translated into significantly increased tax revenues and a more than 100% return on investment.

Serbia Case Study

The Republic of Serbia, located at the crossroads of Central and Southern Europe, is a transit point for many commodities traveling through Europe to a wide variety of destinations—creating a perfect environment for fraud in the absence of strict governance. It came to the Government of Serbia's attention that even though the number of fuel stations in Serbia was growing—as were the number of vehicle registrations—the taxable sale of fuels used in cars was declining. According to the government, fuel adulteration was resulting in an annual loss of €40 million, and industry experts estimated the actual loss to be as high as €100 million. Losses incurred by the major oil companies active in the country were considered to be of a similar scale.

Recognizing the evidence of illicit fuel trade in Serbia and its impact on government revenues, and—equally important—the secondary negative effects of poor fuel quality, the Ministry of Energy, Development and Environmental Protection issued a decree in late 2013 that stated that, as of 2014, all road fuel would be required to be marked with advanced chemical markers prior to being released to the market for consumption. Under the decree, the ministry mandated that oil companies would be responsible for procuring and paying for the marking services from government-designated providers. Retail outlets were to be sampled, and those found with unmarked fuel or evidence of diluted fuel would be subject to fines of RSD1.5 million–RSD3 million (\$14,220–\$28,440),⁵ and would be prohibited from doing business from 6 months to 3 years.

On 1 February 2014, fuel-marking began in Serbia. All legally produced and imported domestic road fuels (petrol and diesel) were marked with a

marker package containing a NIRF marking, allowing the use of simple handheld field test analyzers to accurately measure legal fuel concentrations, as well as a molecular marker to facilitate forensic-level testing using GC–MS technology. Marking is conducted at each individual oil marketing company depot facility at the truck or barge level, based on the measured and reported fuel volume.

In conjunction with the launch of the program, the ministry embarked on an extensive media and public relations campaign to inform the public about the fuel-marking program, how it worked, and the expected benefits of the program. The original plan for the program was to set a period of 6 months to allow the concentration of fuel markers to reach the correct levels at all points in the supply chain (i.e., unmarked fuel needs to be purged through the system and retail storage tanks through the normal sales process as it is replaced with marked fuel), as well as to allow for adequate training of marker inspectors and government staff. However, the head of Technical Supervision for the Department of Market Inspection did not want to lose momentum from the publicity garnered by the public launch of the program, and began marker inspections immediately by stopping fuel trucks to conduct sampling and testing, combined with inspections of retail stations. The presence and activity of inspectors reinforced the Ministry of Energy, Development and Environmental Protection's own public relations campaign, and created the perception that enforcement was underway despite the fact that the official launch of enforcement was not scheduled until 1 August 2014.

From February to June 2014, more than 930 million liters of fuel were marked, and the government seeing significant evidence of the efficacy of the program even before enforcement began. The oil companies welcomed the introduction of the marking system, after seeing sales volume increase by 18% for diesel and 14% for gasoline—this during a time when the government expected sales to decline due to poor economic growth and catastrophic flooding throughout most of Serbia. Based on its excise tax collections from when the program started, the government expects a €60 million increase in excise tax collection as a result of fuel-marking. In summary, the Serbian program provided annual return on investment of 6–7 times.⁶

⁵ 1 Serbian Dinar (RSD) = \$.00948

⁶ Swiss-Serbian Chamber of Commerce. 2014. *The Government's Priority: Fight Against Gray Economy*. <http://sscc.rs/chamber-commerce/wp-content/uploads/2014/08/THE-FIGHT-AGAINST-THE-GRAY-ECONOMY.docx>

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Conclusion

National fuel tax and subsidy programs that are implemented in countries such as Venezuela, Kingdom of Saudi Arabia, and the Philippines create significant arbitrage opportunities that are exploited illegally, robbing nations of much needed fiscal revenue. In addition, fuel fraud perpetuates extensive secondary effects such as harmful auto emissions, increased fuel consumption, disrupted supply chains, and loss of confidence in national governance systems. While fuel-marking systems have been in use since the 1950s, recent developments in marker technologies, coupled with advances in analytical capacity, now provide the technical foundation for extremely accurate and effective fuel-marking programs.

A robust fuel-marking program provides a government with a comprehensive approach that analyzes each stage of the supply chain, beginning with the country’s refineries or fuel depots, and extending to the eventual sale of fuel products at the retail level. The ultimate effectiveness of a fuel-marking program is realized when it mitigates fuel fraud, resulting in the return of stolen revenues to state coffers.

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