Diesel remains an important fuel for the off-road sector including construction, agricultural, mining, heating, power generation, maritime, locomotives etc., especially in the developing regions. Similarly with on-road fuels, harmonization of off-road diesel specifications and vehicle emission standards has yet to be achieved. This is because countries are at different stages of economic and socio-political development, especially in Asia Pacific which is currently the highest user of off-road diesel. There are a number of countries that already use a single diesel grade for both their on-road and off-road sectors, while others aim to eventually harmonize specifications of off-road diesel with on-road diesel to avoid possible adulteration and distribution issues.

However, before harmonization can be achieved, countries are currently using various methods to avoid supply of illegal and off-spec products:

- Use of dyes, markers and tax incentives to differentiate multiple diesel grades by color;
- Encourage supply of better off-road diesel quality; or
- Simply put into place a fuel quality monitoring legislation and system.

The full report examines key developments in off-road diesel quality and vehicle emissions, and primarily focuses on issues regarding sulfur and FAME because of the legislative and regulatory developments occurring globally for these two parameters. Of the two, sulfur reduction is the more dominant issue being considered by governments and stakeholders globally. Notably, other properties such as lubricity and cold flow are important in determining off-road diesel quality and influencing the composition of emissions, but there is no legislative or regulatory activity for these at this time.

**Conclusion**

Although countries and regions are moving toward alignment of some parameters for off-road diesel, particularly sulfur, it
will take time to achieve. Since countries have different configurations in place for their refining industries, diverse off-road vehicles and NRMM, and varying political and market conditions, it will not likely take place in the short to medium term.

Sulfur and FAME have been examined in this report because of the legislative and regulatory developments occurring globally for these two parameters, especially in the top off-road diesel markets. Current maximum off-road diesel sulfur limits worldwide vary widely, from 10 ppm to 30,000 ppm. Only two countries of Kazakhstan and Tajikistan will further reduce sulfur limits, or phase out off-road diesel specifications containing higher sulfur limits and eventually align with on-road diesel specifications.

Stratas Advisors expects continued usage of biodiesel in on-road diesel markets with established mandates such as the EU, U.S., Canada and Brazil. However, biodiesel usage is currently not mandatory in the off-road sectors of these regions and countries, except for Brazil at B8 in its Non-road diesel B grade (S1800). Biodiesel is voluntarily used by the off-road sector in the U.S., and in diesel by NRMM in the EU because GHG emissions reduction from this sector also counts towards the 6% target under the Fuel Quality Directive (FQD). In Canada, heating oil is exempt from the 2% renewable fuel content mandate. Mandatory biodiesel usage in the remaining Top 10 markets such as China, India, Japan and Russia is currently challenged either by quality issues, a lack of non-edible feedstocks or a political will to mandate usage. However, biodiesel is used voluntarily by the off-road sectors in China and India (e.g. railways, generator sets, agricultural machinery etc.).

Looking at the outlook for emission standards, the EU will move from its current Stage IV requirement to Stage V starting from 2018. Only Brazil will continue to implement PROCONVE MAR-I in 2019 depending on engine output, while there are no expected changes for other top 10 markets which continue to stay at Stage III or Tier 4 requirements.

As countries move toward stricter off-road vehicle and NRMM engine requirements, the role of fuel quality in safeguarding the functionality of vehicles and engines continues to develop. Sulfur-free diesel remains a critical prerequisite for cleaner and durable emission-control systems.