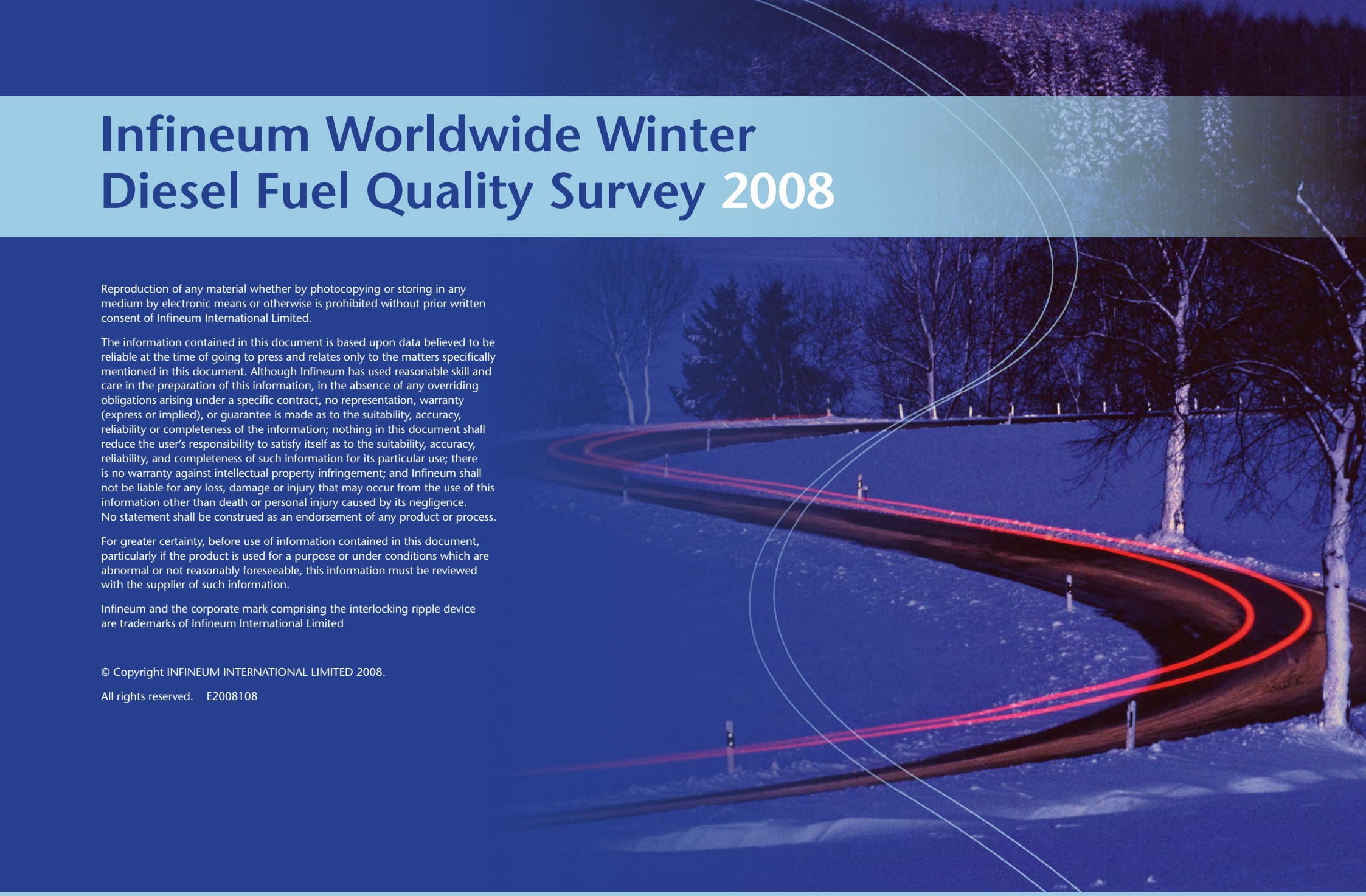
# Infineum Worldwide Winter Diesel Fuel Quality Survey 2008



# Introduction

The Infineum Worldwide Winter Diesel Fuel Quality Survey aims to provide the petroleum refining and distribution industry with an overview of the quality of automotive diesel in the marketplace, allowing tracking of international trends. To achieve this purpose, the Survey needs to cover as much of the globe as possible. For the winter 2008 survey, some 356 samples were collected in 39 countries around the world. The majority of samples were collected during January and February, deep winter months in the northern hemisphere. In southern hemisphere countries, sampling was delayed until later in the year when true winter grade samples could be obtained.

Samples need to be representative of the diesel purchased by the average consumer so they are gathered from service stations by Infineum colleagues at local area offices. As a general principle, Infineum tries to get one sample that represents the production from each refinery or region in a given country. To minimise the possibility of taking multiple samples from a single refinery, knowledge of local exchange agreements and distribution systems is used to select where each sample is collected. For the larger diesel consuming countries, this procedure results in samples that represent a reasonable average of the overall quality. However, for smaller countries or specific producers, spot sampling over a short period of time will effectively only provide a snapshot of production quality, with data derived from only one or two samples. This can make it more difficult to evaluate trends with any accuracy.

## Analysis

The analyses applied to each sample are those we consider to be of most interest to the diesel producers, marketers, distributors and consumers. They cover areas of national specification, exchange specification and performance parameters. A degree of standardisation has been applied to enable diesel from all countries to be compared and the data analysed as a single set. Standardisation, however, means that not all national specifications are reported.

Wherever possible, industry standard test methods have been applied and in-house test methods avoided. This has been done so that the data published here most accurately reflect the results which could or would be generated by organisations within the petroleum industry.

When considering our data, in particular when comparing the various test results with the national specifications, it should be noted that a number of the tests have quite wide reproducibility bands, and very little repeat testing has been conducted to determine compliance or otherwise with specifications.

## Test Methods

The majority of testing was carried out at quality accredited laboratories in the USA, Japan and the UK using the following test methods:

| | |
|---|---|
| Density | ASTM D4052 |
| Kinematic Viscosity | ASTM D445 |
| Sulphur Content | ASTM D2622 / ASTM D4294 |
| Cetane Number | ASTM D613 |
| Cetane Index | ASTM D4737 / ASTM D976 |
| Pour Point | ASTM D97 / ASTM D5950 |
| Distillation | ASTM D86 |
| Cloud Point | ASTM D2500 / ASTM D5772 / ASTM D5771 |
| CFPP | IP309 / ASTM D6371 |
| HFRR D6079 | ISO 12156-1 / ASTM |
| Wax Content | Differential Scanning Calorimetry |
| LTFT | ASTM D4539 |
| FAME Content | NF M 07-084 (modified) |

Samples collected in Mexico, Saudi Arabia and China were tested at local laboratories, using the same or similar test methods.

# The Trends

"Continuing change is inevitable and new forces unrelated to sulphur content are emerging that are driving changes in diesel production."

*Infineum Winter Diesel Fuel Survey 2006*

At the time of publication of the 2006 survey, crude oil had doubled in price in the previous two years to reach $70 per barrel, and the need to reduce global warming through reduction of $CO_2$ emissions was gaining wider public acceptance. The pace of change seemed fast, but since then it has only accelerated: The price of crude climbed steadily to a peak of $150 per barrel around midyear 2008 before falling sharply back, driving fuel prices to an all-time high in unregulated markets and putting fuel consumption firmly back on the agenda for many motorists.

The topic of global warming is debated almost daily in the media; barely a week passes without emotive news reports of retreating glaciers, shrinking icecaps and the risk of rising sea levels.

Governments have continued to implement legislation backed by tax incentives to encourage the growth of renewable energy sources.

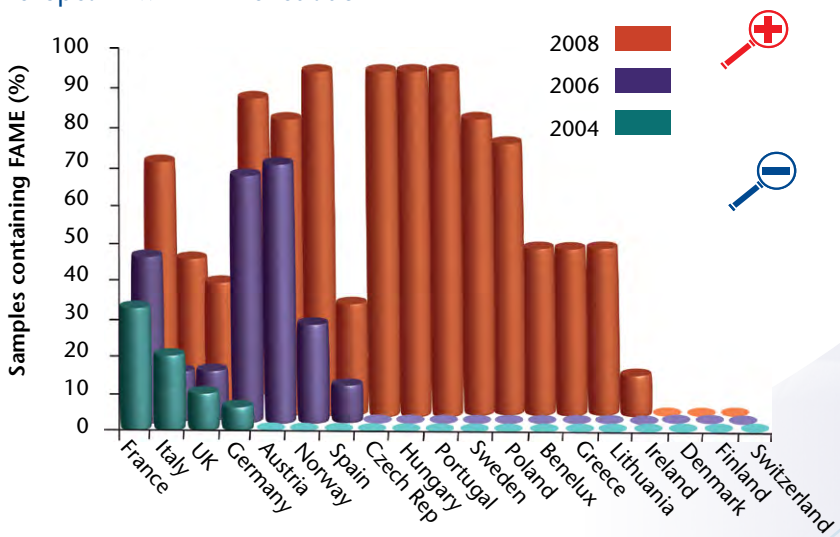
With its global coverage of the major diesel consuming nations, the 2008 Winter Diesel Fuel Survey allows an evaluation of how at least some of these headline items, and other more routine factors, are affecting this fuel segment.

## FAME

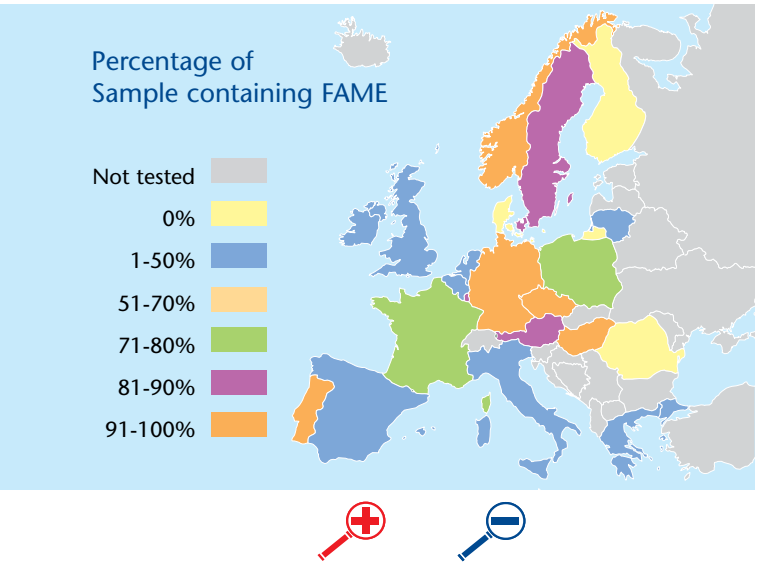
Today the main focus of fuel producers in Europe and the USA has become the need to meet the renewable energy directives; EU Directive 2003/30/EC and the US 2005 Energy Policy Act. However, debate rages on the efficacy of these initiatives making their impact uncertain. For example, there is growing acceptance that many 1st generation biofuels are not as green as some would like to claim, and a number of non-governmental organisations are expressing concern over biofuel sustainability and land usage for fuel versus food. Additionally with respect to diesel, rising vegetable oil prices have ensured that FAME still requires tax incentives to be economically viable despite the high crude oil price.

With so much uncertainty in the market a key feature of this year's survey has been an expansion of the FAME content analysis to cover almost all samples collected during 2008; up from the solely European analyses of 2004 and 2006. Results show that Europe still leads the world in the use of FAME as a diesel blend component, with more than 70% of the samples collected in nine countries seen to contain FAME However Europe is not alone in this approach; in Thailand 80% and in Brazil 100% of the samples collected also contained FAME. Additionally, FAME usage is observed in Argentina, Canada and the USA, though at lower levels.

European Bx FAME Penetration



# The Trends (continued)

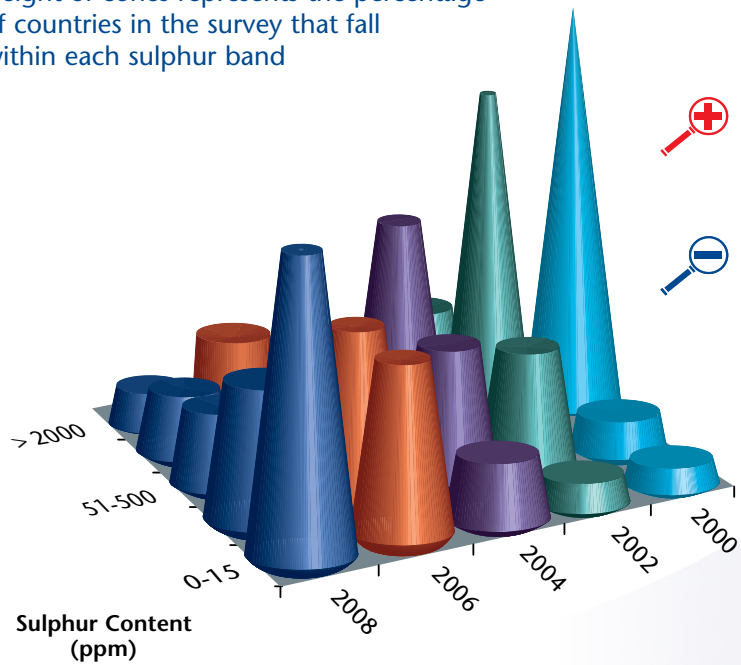



Looking more closely at the European situation, the chart above provides a breakdown of Bx FAME penetration over the five years spanning the last three surveys, whilst the associated map below illustrates the percentage of survey samples containing FAME this year. Taken together they provide a very clear indication of recent developments; slow but steady progress between 2004 and 2006 followed by rapid expansion between 2006 and 2008. It will be interesting to see how this expansion continues and if it is eventually sufficient to fulfil diesel's contribution towards the EU Biofuels Directive indicative target of 5.75% biofuel in transport fuels by 2010.

## Sulphur

It sometimes appears that sulphur reduction is yesterday's news, and to some extent it is. Specifications in the USA and Canada have been set at a maximum of 15 ppm sulphur since 2006. Austria, Denmark, Finland, Germany, Hungary, Japan, Norway, Poland, Sweden and Switzerland were all producing to 10 ppm or less at the time of our survey in 2006, and the remainder of Europe will be at <10 ppm from January 2009. However, it is noteworthy that sulphur reduction in the rest of the world continues apace. This year, over two-thirds of the countries surveyed produced diesel with an average of less than 50 ppm sulphur, and even more impressively, almost half of the countries surveyed averaged less than 15 ppm. Additions to the less than 10 ppm sulphur list this year were Benelux, Korea, Lithuania, Singapore and the UK.

Height of cones represents the percentage of countries in the survey that fall within each sulphur band



# The Trends (continued)

## Lubricity

It is impossible to discuss sulphur reduction without considering lubricity. It is now a well known fact that hydro-desulphurisation has the effect of reducing the natural lubricity of diesel and that reduced lubricity can cause premature failure of fuel injection systems. In general, fuel producers have successfully guarded against this problem over the last fifteen years by the application of lubricity additives, a feature monitored closely in previous diesel fuel surveys.

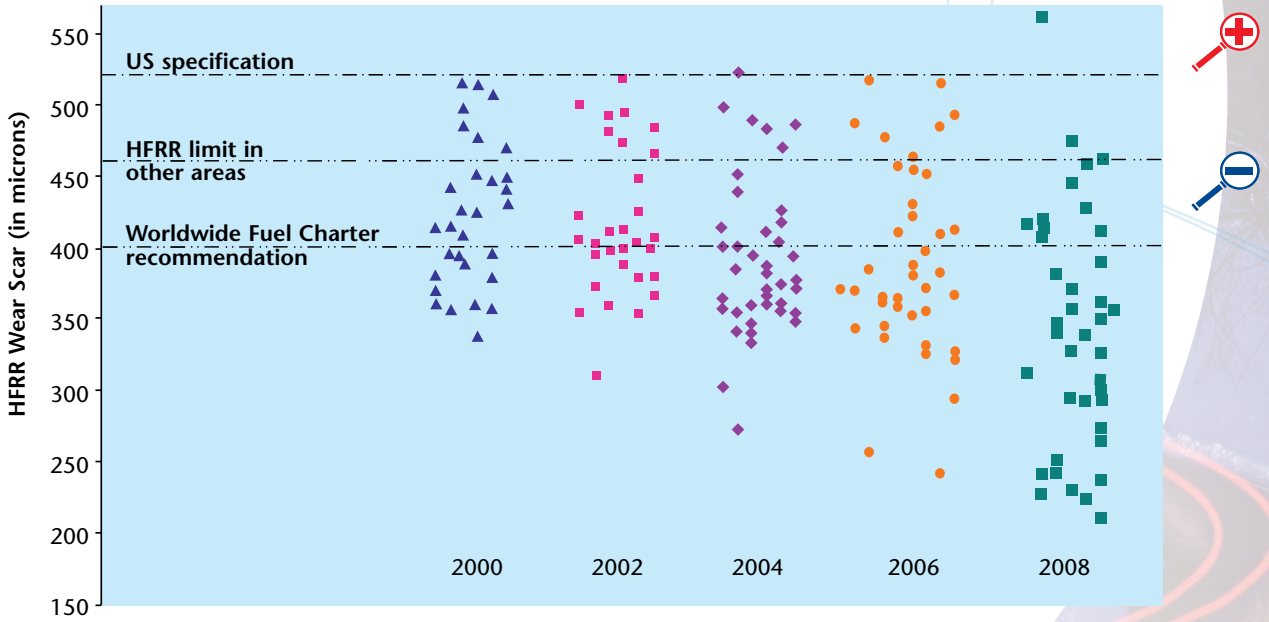
However, it is also widely known that FAME has lubricating qualities and that blends of diesel with more than 1 - 2% of FAME typically have sufficient lubricity to avoid the need to use additives. In fact, if sufficient FAME is used, lubricity performance, as measured in the High Frequency Reciprocating Rig (HFRR), can be very high. The graph below plots the average HFRR wear scar for each country over the past four diesel surveys and shows that wear scar values are falling and the number of very low wear scar measurements is increasing.

## Looking to the Future

The well established journey to lower sulphur will continue, though it is difficult to predict how long it will take before all of the samples collected for a future survey are below 10/15 ppm. When it occurs, it will surely be a landmark event.

The future for FAME is considerably more uncertain. Government directives currently ensure a short term future, but there are a number of obstacles to be overcome if FAME is to deliver the expected benefits:

### Worldwide Lubricity performance




- High production costs are driving producers to cheaper feedstocks, but these often require additional processing, make poor quality FAME or carry the highest environmental penalties.
- The need to produce renewable energy needs to be balanced with the need to produce food and retain local livelihoods.

Policies need to be refined to ensure maximum GHG (greenhouse gas) savings are obtained and trade based on volume supply of FAME irrespective of GHG credentials is avoided.

Beyond FAME there are of course 2nd generation biofuels, such as fuel from algal sources, cellulose and biomass gasification. Some 2nd generation processes are already here, others are at the pilot plant stage and others in early development. These will add to the changing face of diesel production in future years but at this stage it is too early to comment on the successes and failures of these new approaches.