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Editor: Jean-François Larivé, CONCAWE
Design and production: Words and Publications • words@words.co.uk

Foreword

Alain Heilbrunn, Secretary General, CONCAWE

Environmental issues are, in many ways, at the heart of public concerns today. Quite naturally CONCAWE gets involved in these issues and brings its contribution in a variety of ways, as illustrated by the articles in this *Review*.

The climate change debate produces many words, incantations and a few long-term commitments. When it comes to concrete measures though, only industry is targeted. Since 1990, energy-intensive industry is the only sector that has reduced its GHG emissions. Pressure is now mounting on transport, not so much on airplanes, ships and trucks which have the highest rate of growth, but on passenger cars whose emissions represent a diminishing proportion of the total. The car industry is about to achieve impressive improvements to fuel economy and is asked to do still more. The ambitious biofuel targets that are being proposed imply biofuel volumes that may widely exceed availability. As the first article in this *Review* shows, just stabilizing the annual mileage driven by cars in Europe would have more or less the same effect on CO_2 emissions as the combination of complex and costly measures that are being imposed on industry. Industry is proud to be part of the solution, but achieving the radical emission reductions that are being targeted will require efforts by all actors in society.

The quality and accuracy of industrial emissions reporting is essential to establish and maintain trust between industry, regulators and the public. When this *Review* is published in November 2007, the deadline for compliance with the IPPC Directive will have passed and all industrial sites concerned will be expected to be in compliance with this legislation. One of the objectives of this Directive is to encourage public participation in environmental decision making, and this is one of the functions of the European Pollutant Release and Transfer Register which improves on its predecessor (EPER) in terms of scope and quality of reporting. CONCAWE has produced a compendium of air emission estimation methodologies and a software toolkit to help quality reporting by its members. We are proud that this work has been accepted by the EU Commission as an example of a sector-specific methodology. CONCAWE is also contributing to ongoing efforts to improve refinery energy efficiency and CO_2 emissions reporting.

Air quality remains a major field of expertise and investigation for CONCAWE. Our article on the measurement of particulate matter (as required by the first Air Quality Daughter Directive) illustrates the challenges often associated with complying with legislation. The new draft legislation under discussion at European Parliament and EU Council level proposes limits on finer particles ($PM_{2.5}$). This promises new challenges for compliance and will require appropriate measurement techniques.

The last article in this *Review* presents an analysis of environmental sensitivity of petrol filling stations in Europe. CONCAWE has been working on water and soil contamination for many years. In past issues of the *Review* we reported on issues related to the Water Framework Directive, and particularly on effluent assessment. As our work on the risk assessments of petroleum products progresses in the context of the REACH legislation, we observe that a number of effluent-related issues emerge and need to be resolved. Water and soil protection is becoming an area of strong focus and it is essential that the technical expertise available in the refining industry remains at an appropriate level to address these specific issues.

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The transport sector in general, and particularly road transport, is the focus of much attention at the moment. Demand for mobility keeps increasing, driving up demand for both vehicles and fuels, while road transport relies almost exclusively on oil-based fuels. An upward trend of CO_2 emissions is the inevitable result, while questions are raised as to short-term security of oil supply and long-term sustainability of road transport.

Driven by these issues of climate, security of supply and sustainability, the EU Commission is preparing a package of energy-related legislation designed to address both vehicle efficiency and composition of the pool of transport fuels. Under the voluntary agreement entered into by auto manufacturers, average CO_2 emissions of cars sold in Europe have been decreasing over time but are likely to fail to meet the 140-g/km target foreseen for 2008. A mandatory target of 120 to 130 g/km by 2012 has now been proposed, with the aspiration to reach 95 g/km by 2020. On the fuels side, the Renewables Directive will supersede the current Biofuels Directive and mandate the introduction of 10% biofuels (by energy) in the road fuel pool by 2020. In addition the proposed revised Fuels Quality Directive includes a provision for progressive decrease of the 'life cycle GHG emissions' of road fuels to achieve a reduction of 10% by 2020 compared to 2010.

These proposals could potentially have a momentous effect on the EU road fuel market and on the oil refining sector. In order to better understand the issues at stake, CONCAWE has developed a simple 'fleet and fuels' model and used this to generate a number of scenarios described and discussed in this article.

The fleet and fuels model

Developed as a simple Excel spreadsheet, the model starts from historical data from the past 15 years and realistic assumptions on light-duty (LD) vehicle life time, to describe the average fuel efficiency of gasoline and diesel vehicles for new vehicles and for the total fleet in each past year. An empirical factor of 10% is added to 'official' fuel efficiency figures to represent the difference between the standard driving cycle (New European Driving Cycle, NEDC) and the 'real world'. Relating this data to observed fuel consumption in the 2005 base year gives the distance driven in that year.

Looking into the future, the distance driven is increased at a certain rate to represent the desired increase in mobility demand, whilst efficiency figures for new vehicles can be introduced over time according to the desired scenario. The model can then derive the fleet average efficiency and the demand for both gasoline and diesel fuel. The rate of penetration of diesel vehicles in the new fleet can be varied over time. It is also assumed that new cars are driven 50% more than those near their end of life.

Much less is known about the heavy-duty (HD) fleet, so the model only accounts for a HD diesel consumption increase over time according to the desired growth rate. The latter therefore represents the aggregation of transport demand and HD vehicle efficiency evolution.

Biofuels can be gradually introduced, ethanol into gasoline and either FAME or advanced bio-components (referred to as Biomass To Liquid or BTL) into diesel. Each biofuels component is given a certain 'Well-to-Wheels' GHG emissions footprint, expressed as percentage CO_2 equivalent saving compared to the fossil fuel it replaces. Based on the JRC/EUCAR/CONCAWE Well-to-Wheels (WTW) study[1], values of 40 and 80% for conventional and advanced ethanol respectively, 50 and 90% for FAME and BTL respectively, have been used.

[1] *Well-to-Wheels analysis of future automotive fuels and powertrains in the European context.*

The future composition of the EU road fuel pool

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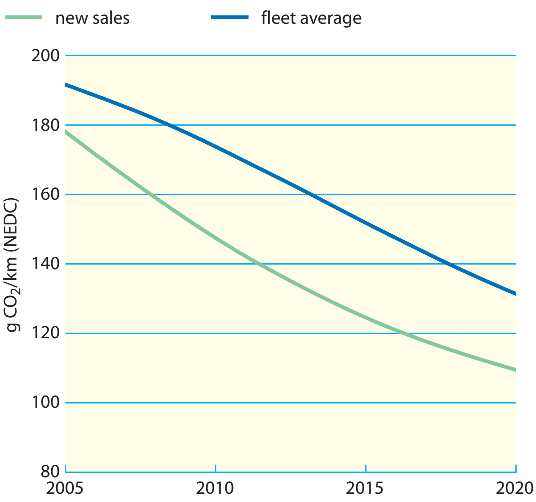
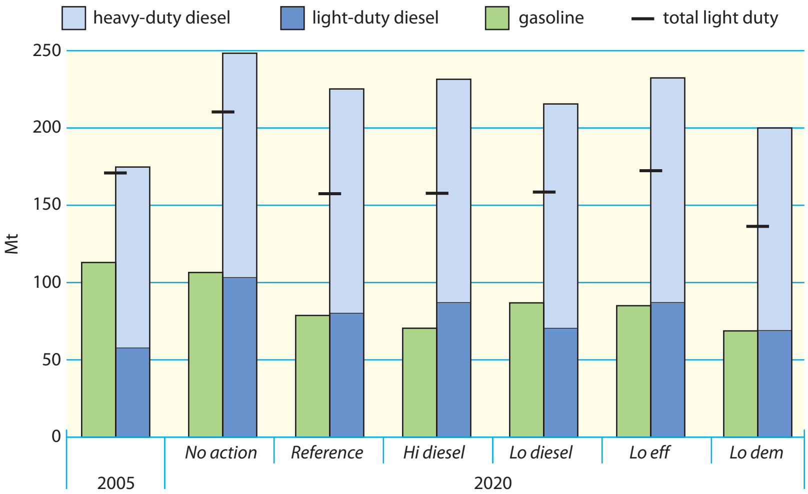
There is a 5-year gap between new vehicles and fleet average performance.

Figure 1 Vehicle emission trends for new sales v. fleet average, 2005–2020



Below: Gasoline demand decreases and diesel demand increases in all scenarios. Large car efficiency improvements are required for the total LD demand to decrease.

Figure 2 Demand for diesel (light-duty and heavy-duty) and gasoline in 2020 in the various scenarios



The model then calculates the gasoline and diesel pool composition and the resulting 'Well-to-Wheels' CO_2 emissions from the whole road transport sector. Forecasts are made year by year up to 2020.

Demand scenarios: impact of vehicle efficiency and mobility demand

In a first series of scenarios we explored the sensitivity of projected fuel demand to vehicle efficiency and mobility demand assumptions. Table 1 summarises the scenarios considered.

With vehicle life in the order of 15 years, the car population evolves only slowly, resulting in a lag of approximately 5 years between new cars and fleet average in CO_2 emissions terms (Figure 1).

Figure 2 shows the 2020 demand for gasoline and diesel (LD and HD) in the various scenarios. All scenarios show a decrease in gasoline demand and a large increase in diesel demand driven by the combination of diesel penetration in LD vehicles and increasing road haulage activities. The car efficiency improvements in the *Lo eff* case broadly compensate the increase in mobility to keep the total LD demand more or less constant. Higher efficiency improvements are required to reduce the demand (*Reference* case).

The rate of 'dieselisation' of the car fleet has a significant impact on the ratio between diesel and gasoline demand

Table 1 Demand scenarios

Case	Description
No action	No further changes to LD vehicle efficiency after 2005, LD vehicles distance driven increase of 2% per annum and HD diesel demand increase of 1.5% per annum. Share of diesel amongst new cars starts at 50% in 2005 to reach 55% in 2012 and gradually decreases back to 50% by 2020.
Reference	New LD vehicle efficiency improvement to 125 g CO_2/km by 2012 and 100 by 2020[1].
Hi diesel	As per *Reference* with share of diesel amongst new cars increasing linearly to 70% by 2020.
Lo diesel	As per *Reference* with share of diesel amongst new cars stabilizing to 50% up to 2012 then decreasing linearly to 30% by 2020.
Lo eff	As per *No action* with new LD vehicle efficiency improvement to 135 g CO_2/km by 2012 and 110 by 2020.
Lo dem	As per *No action* LD vehicles distance driven increase of 1% per annum and HD diesel demand increase of 0.7% per annum.
NA, lo dem	A combination of the *No action* and *Lo dem* scenarios.

[1] This corresponds to stated Commission's ambitions of 120 and 95 g CO_2/km for vehicles by 2012/2020 respectively taking into account a 5-g contribution from fuels. The figures are for the official driving cycle NEDC.

for LD vehicles, but here again the already existing fleet creates a long response time to changes. Even in the *Lo diesel* case where the diesel share of new cars falls dramatically after 2012, diesel demand keeps increasing relative to gasoline until well after 2015 (Figure 3). In all cases the diesel to gasoline ratio is much higher in 2020 than in 2005. This is an important observation in a context where the growing imbalance between diesel and gasoline is one of the main challenges for EU refiners.

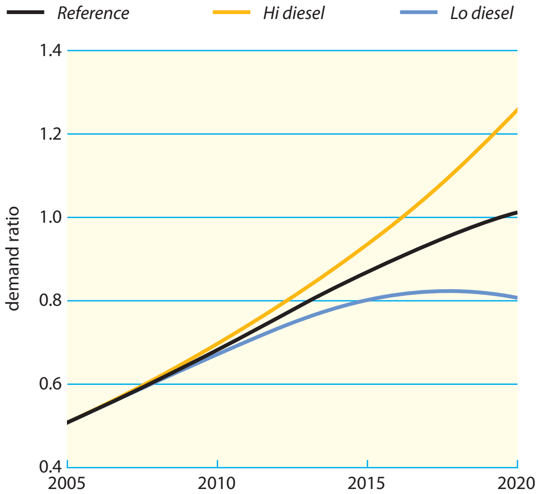
The resulting WTW CO_2 emissions from road transport are shown in Figure 4, which illustrates the relative impact of mobility demand and vehicle efficiency. The efficiency gains considered in the reference case (corresponding to the EU Commission's ambitions) can nearly stabilise emissions. The same result can be obtained through halving the mobility demand growth.

Meeting EU ambitions with biofuels

Having established the base line with fossil fuels we considered biofuels introduction scenarios with a view to meeting either the Renewables Directive target of 10% on an energy basis by 2020 or the ambition of the Fuels Directive to reduce the GHG footprint of road fuels by 10% by 2020 compared to 2010 (10% 'life cycle' (LC) reduction). Starting from the *Reference* case defined above we explored four cases as per Table 2.

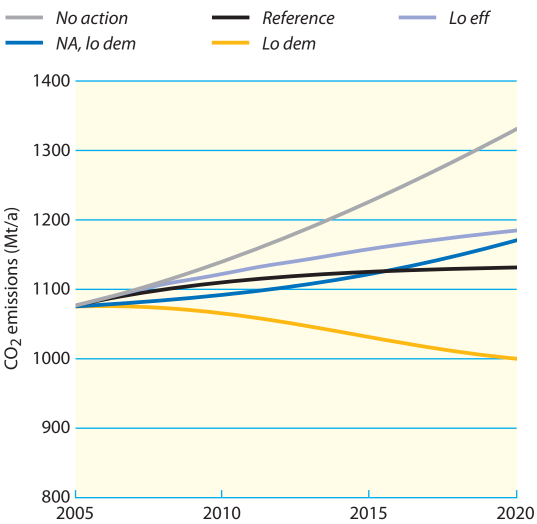
In the proposed revision of the Fuels Directive, the 10% LC ambition does not *per se* assume that only biofuels can be used. It is also implicitly envisaged that conven-

Figure 3 Light-duty diesel/gasoline demand ratio, 2005–2020



Only a steep decrease of the diesel share of new cars can stabilise the diesel demand relative to gasoline albeit at a much higher level than today.

Figure 4 Total EU road transport WTW CO_2 emissions



Vehicle efficiency gains ambitioned in the EU have the same impact as halving the mobility demand growth.

Table 2 Biofuels introduction scenarios

Case	Description
Max domestic	Introduction of biofuels at a rate and to a level consistent with forecast for in-EU production (based on the JEC study). This includes ethanol and FAME from crops as well as ethanol from straw and BTL from woody residues.
10% biofuels	Biofuels quantities to meet the 10% by energy target in 2020. Domestic supplies as above but with 50% of FAME crop area now dedicated to woody biomass for BTL, supplemented by FAME imports (7.6 Mtoe/a required).
10% LC	Biofuels quantities to meet the 10% life cycle (LC) reduction by 2020. Supplies as above now with 10 Mtoe/a FAME import and balance by cane ethanol import.
10% LC <E30	As above but with enough FAME import to limit gasoline ethanol content to 30% v/v (25 Mtoe/a FAME).

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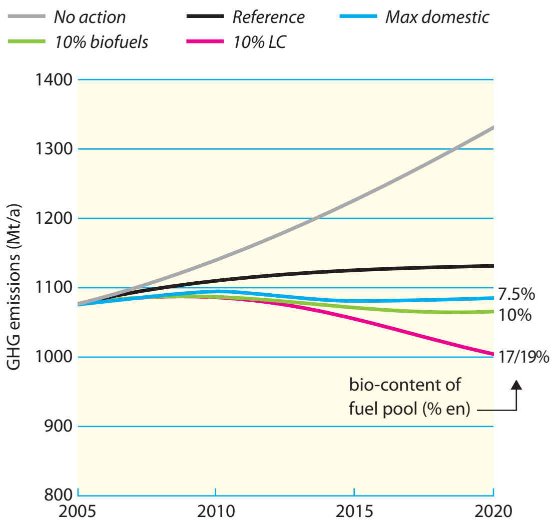
tional fossil fuels could play their part through GHG emission reductions in refining and upstream. Refineries have been continually improving their energy efficiency for many years and are set to continue to do so, although marginal gains are becoming increasingly costly and difficult to achieve. Whereas there may be a certain scope for such schemes as CO_2 capture and storage or use of biomass as fuel in refineries, the many constraints attached to these will confine them to a limited number of cases. On the other hand refineries are faced with increasing product quality and own emissions constraints as well as changes in crude oil supply and product demand pattern that all point towards higher complexity therefore higher energy intensity and higher CO_2 emissions. On balance, we believe that the best EU refiners can hope for is to cancel out the inevitable increases through efficiency improvements and other measures. In practice therefore, biofuels would have to supply essentially all of the required reduction.

The WTW GHG emissions from road transport in the various scenarios are shown in Figure 5. Because it relies mostly on biofuels that have a relatively high GHG footprint, the *10% biofuels* scenario delivers only modest GHG gains, about 1/3 of what the LD vehicles deliver through improved efficiency. The *10% LC* reduction obviously delivers more, but requires much more resources. The bio-content of the total road transport fuel pool increases from 7.5% in the *Max domestic* case to 17 or 19% in the *10% LC* case depending on the amount of ethanol allowed.

The corresponding gasoline and diesel pool mass composition are shown in Figure 6. The proportion of ethanol in gasoline is much higher than that of bio-components in diesel and reaches nearly 50% in the *10% LC* case unless massive FAME imports are allowed. This is because there is potentially enough domestic ethanol to cover more than 10% of the dwindling gaso-

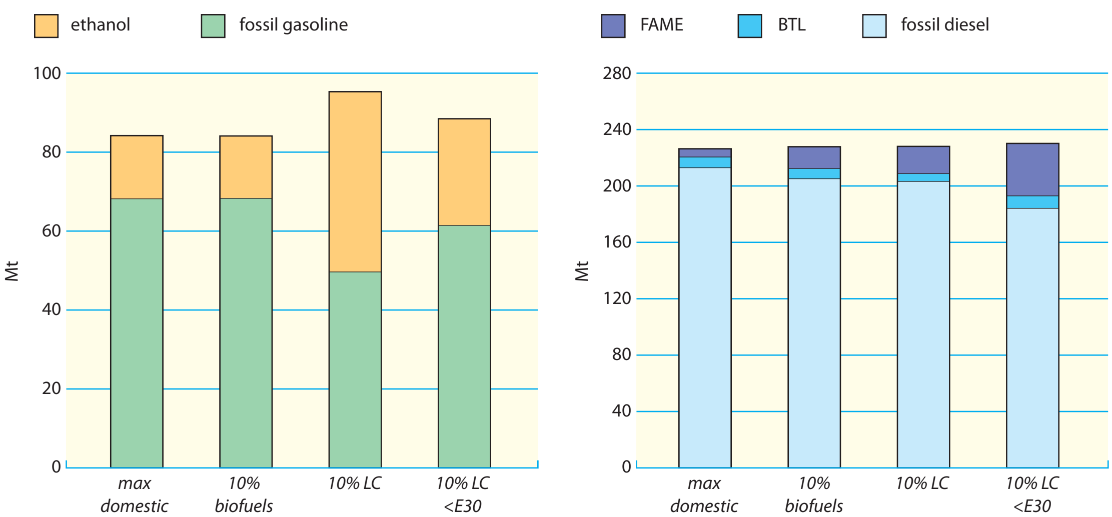
10% biofuels introduction delivers only modest GHG gains. Much larger bio-component volumes are required to reach 10% LC.

Figure 5 Total EU road transport GHG emissions



The proportion of ethanol in gasoline is much higher than FAME in diesel.

Figure 6 Gasoline and diesel pool mass composition

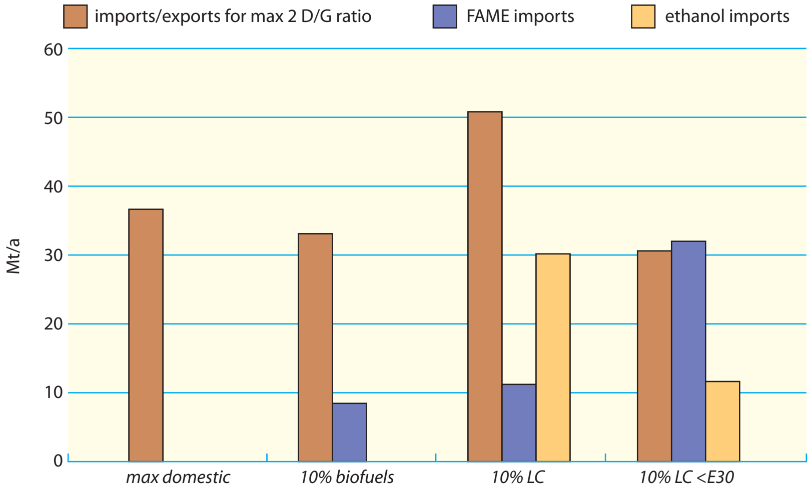


line demand, and also because ethanol has a lower energy content than FAME or BTL. More than 40 Mt/a biofuels imports are necessary to meet the *10% LC* ambition, increasing to 47 Mt/a when cane ethanol imports are limited and replaced by FAME (which is less efficient from a GHG point of view). Note that these scenarios include the fairly optimistic assumption that advanced biofuels supplies, including up to 8 Mt/a of BTL, would be available within the time frame. Without these advanced components, meeting the *10% LC* ambition would require much larger tonnage.

We have mentioned above the critical nature of the diesel to gasoline ratio for EU refineries. In a previous study where we considered the impact of that ratio on refinery investment and energy requirements, we determined that it would be highly desirable to keep the refinery production ratio below 2 (CONCAWE report 1/07). The way to achieve this is to export gasoline and/or import diesel or similar components. The minimum amounts of gasoline exports and diesel imports that would be required to keep the refinery production ratio under 2 are shown in Figure 7 together with the required ethanol and FAME imports. The most striking observation from this figure is the relationship between ethanol imports and gasoline exports, illustrating the increased reliance on international trade that would result from over-reliance on ethanol to meet the EU biofuels ambitions.

It must be noted that the arbitrary limit of 2 for the diesel/gasoline production ratio already represents a marked increase from today's value of about 1.6, and would require significant refinery adaptation. If the current value was to be retained, imports and exports would each have to be in excess of 50 Mt/a.

Figure 7 Gasoline exports and diesel imports required to keep the refinery production ratio below 2



Ethanol imports would trigger gasoline exports.

This simple analysis sheds some light on the relative impact of mobility demand, vehicle efficiency improvements and biofuels introduction on the evolution of road transport GHG emissions in Europe in the next 12 years. For biofuels to play a significant part they have to be introduced in quantities that would far exceed EU production capabilities. In this respect, over reliance on ethanol would result in an increased dependence of the EU on international trade to rebalance the domestic refineries' diesel and gasoline productions.

The European Pollutant Release and Transfer Register

A publicly available display of industrial emissions

The European Pollutant Release and Transfer Register Regulation[1] (E-PRTR) came into force on 24 February 2006, replacing the European Pollutant Emission Register[2] (EPER) Decision.

Starting with 2007 data, and every year after that, operators of certain industrial facilities, mainly those that are subject to IPPC[3], are required to report to their Member State (MS) authorities:

- specific data on their annual emissions to the environment;
- transfers to offsite wastewater treatment facilities; and
- amounts of wastes produced.

The MSs then send these data to the European Commission who in turn make the data publicly available in the form of a single, integrated and fully searchable electronic database accessed from the Internet.

The current EPER database (www.eper.cec.eu.int) holds emission data for the years 2001 and 2004. E-PRTR data for 2007 should appear on the Internet on or before September 2009. Data for all following years will appear on the internet no later than 16 months after the end of the reporting year.

Quality data is essential

The aims of the E-PRTR are to facilitate public participation in environmental decision making and to contribute to the prevention and reduction of pollution of the environment.

Since the industrial facilities covered by the E-PRTR are basically those subject to IPPC, the data provided effectively become a publicly stated measure of how successful IPPC is in preventing and reducing emissions. In the public eye emissions may be considered synonymous with pollution irrespective of their actual environmental impacts which, for a given emission level, vary widely according to local conditions. Analysis of the E-PRTR data may also be used by some to make claims about the relative effectiveness of existing control measures.

Clearly, the **quality** of the data provided is of key importance as it will, in part, drive future environmental legislation applicable to industry. For example, if releases of a particular substance are overestimated, additional unnecessary regulatory controls may be implemented. Underestimation carries with it the risk of future BAT requirements that are unnecessarily stringent.

Also, the on-line database provides a single, easily accessible and user-friendly shop window, updated annually, through which the public can view industry's performance individually or comparatively at site or industrial sector level, nationally and internationally on an ongoing basis.

Main differences between E-PRTR and EPER

The E-PRTR requires annual reporting of data as opposed to once every three years under EPER.

E-PRTR covers more substances than EPER (91 in total compared to 50). Reporting thresholds for releases to water have been added for more substances and reporting thresholds for releases to land introduced.

Some clarifications and changes have been made for substances that make up group entries (e.g. polycyclic aromatic hydrocarbons) and the threshold for reporting releases of dioxins and furans has been reduced by a factor of 10.

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[1] *EC Regulation 166/2006* [2] *Decision 2000/479/EC.*
[3] *IPPC Directive 96/61/EC*

Operators must also report the quantity of any 'accidental releases' separately and in addition to the total releases of any substance that exceeds the relevant reporting threshold.

The quantities of E-PRTR substances in wastewater transfers to **offsite** wastewater treatment must be reported. Although this is in fact similar to the 'indirect releases to water' under EPER, it is worth emphasising since the E-PRTR Regulation defines 'facility' as '*one or more installations on the same site that are operated by the same natural or legal person*' and the Commission E-PRTR guidance[4] interprets offsite as '*beyond the boundaries of a facility*'. The term 'offsite' therefore includes onsite wastewater treatment plants where they are operated by a separate legal entity.

Some additional activities not listed under IPPC are also captured by the E-PRTR Regulation. Amongst these, and of possible interest to our industry sector, is the inclusion of '*independently operated industrial wastewater treatment plants which serve one or more PRTR activities with capacity >10 000 m^3/day*'.

The E-PRTR Regulation [Art 5(4)] also requires that operators should prepare their data collection in accordance with '… *internationally approved methodologies* ***where available*** …', a seemingly small nuance, but one that may have consequences upon how data are collected by industry in the future. The intent here appears to be to move away from locally or nationally agreed methodologies towards a more internationally (EU-wide) harmonised approach.

During development of its guidance document, the Commission indicated that if an internationally approved method is 'available' it should be used but eventually agreed to accept that operators may use '**equivalent**' methodologies other than internationally approved ones, even when available, if certain conditions are met. The Commission has however indicated that it will re-examine this issue following their analysis of PRTR data submitted for 2007.

Among these conditions the ones of most immediate relevance to industry are:

- whether the methodology is already prescribed by the National authority in a facility's permit / licence or national or regional legal act; and
- whether the methodology is a European-wide sector specific calculation method, developed by industry experts, which has been delivered to the European Commission and relevant international organisations. Such methods may be used unless they have been rejected by the international organisation.

Because of these rules, use of in-house methods, even when authorised by the local authorities, may need to be reconsidered. This presents both a challenge and an opportunity for our industry.

CONCAWE activities

CONCAWE have produced reports on air pollutant emission estimation methods for EPER and for E-PRTR reporting by refineries, the latest version of which has just been released (CONCAWE Report 3/07). The report is accompanied by a software toolkit, available to CONCAWE Member Companies only, to assist their facilities to calculate their emissions to air of E-PRTR substances.

This work has been recognised by the European Commission as an example of a sector specific methodology. The emission factors in the CONCAWE report have also been provided to the UNECE/EMEP for inclusion in the EMEP/CORINAIR Emission Inventory Guidebook which is recognised by the Commission as an internationally approved calculation methodology.

[4] *Commission E-PRTR guidance*

The European Pollutant Release and Transfer Register

A publicly available display of industrial emissions

Through this work CONCAWE has established a conduit through which our industry can further develop and improve a sector-wide approach to calculating emissions for E-PRTR that will be part of an internationally approved method.

Key points and recommendations to operators

It is clearly in the interest of industry to pay ever more attention to compiling complete and accurate data on releases and transfers from refinery facilities. The data will be subject to more public scrutiny and may ultimately have a direct impact on the development of future environmental regulation of our industry.

It is recommended that operators consider the following points:

1. Ensure that the data collection methodologies at each facility identify the E-PRTR substances that could be released and identify all potential release sources for these substances.

2. Become familiar with the requirements of the E-PRTR regulation and the guidance issued by the Commission in order to be ready to evaluate and respond to national requirements for implementation of the regulation.

3. Where in-house emission estimating methodologies or emission factors could be a useful addition to the current set of CONCAWE's air pollutant emission estimation guidance reports, it should be considered to publish details of such method as candidate for recognition as a 'Sector Specific' or 'Internationally Approved' methodology via inclusion in future revisions of CONCAWE Report 3/07 and the EMEP/CORINAIR Guidebook.

The future importance of E-PRTR should not be underestimated.

The compliance challenge from measuring PM_{10} concentrations

Correction factors can make all the difference

The First Air Quality Daughter Directive (1999/30/EC) establishes limit values for ambient concentrations of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM_{10}) and lead. This includes a 24-hour PM_{10} compliance limit that entered into force in January 2005. This provision limits to 35 the number of exceedance days above a daily average concentration of 50 µg/m^3. It was not long into that year before a number of Member States were expressing great concerns over their ability to meet this requirement at many of their measuring sites. At some locations the whole of January 2005 were exceedance days. The reaction to this was felt in a number of arenas, not least in the ongoing debate in the Council and Parliament over the finalisation of the Ambient Air Quality Directive which will ultimately replace the First Daughter Directive[1]. There has been much discussion over the implications of these compliance problems for the new Directive. In this article we explore the key issue of the measurement protocol that has undoubtedly contributed to these problems in a number of Member States.

With regard to the measurement methods required to demonstrate compliance, the Directive sets forth a 'Reference Method' for each of the four main pollutants covered. However, other measurement methods are permitted provided they are demonstrated to give results equivalent to the reference method. In recognition of the difficulties in measuring particulate concentrations in ambient air (especially continuous measurement), the requirements for demonstrating equivalence to the reference method for PM_{10} are more extensively covered in the Directive viz:

'A Member State may use any other method which it can demonstrate gives results equivalent to the reference method or any other method which the Member State concerned can demonstrate displays a consistent relationship to the reference method. In that event, the results achieved by that method must be corrected by a relevant factor to produce results equivalent to those that would have been achieved by using the reference method.' [2]

Since the finalisation of the Directive, the most common alternative measurement method to the reference method, installed by Member States in establishing their measurement networks, is the TEOM (Tapered Element Oscillating Microbalance). This device provides essentially continuous measurement (at least down to hourly values) of PM_{10} concentrations. Due to its design, some particulate matter is lost prior to measurement (due to vibration and the heating) resulting in 'under-measurement' of actual concentrations. However, through the use of suitable correction factors, equivalence to the reference method can apparently be achieved. These correction factors are affected by the nature of the PM that is being measured and have therefore to be determined locally.

It is on this very question of 'what constitutes an appropriate correction factor?' that significant debate has taken place over the past several years. Some Member States have applied correction factors of unity, while others have used factors of 1.4 or higher.

The European Environment Agency, through the European Topic Centre on Air and Climate Change (ETC/ACC), have studied the variability in the use and magnitude of correction factors across the Union and reported their findings in a technical Paper, *PM_{10} measurement methods and correction factors in AIRBASE: 2004 Status Report*[3].

[1] *This Directive, COM(2005) 447 final, will in fact replace the first three Daughter Directives.*

[2] *Council Directive 1999/30/EC, 22 April 1999 Relating to Limit Values for Sulphur Dioxide, Nitrogen Dioxide and Oxides of Nitrogen, Particulate Matter and Lead in Ambient Air: Annex IX, Section IV.*

[3] *ETC/ACC Technical paper 2005/6, Frank de Leeuw, December 2005.*

The compliance challenge from measuring PM_{10} concentrations

Correction factors can make all the difference

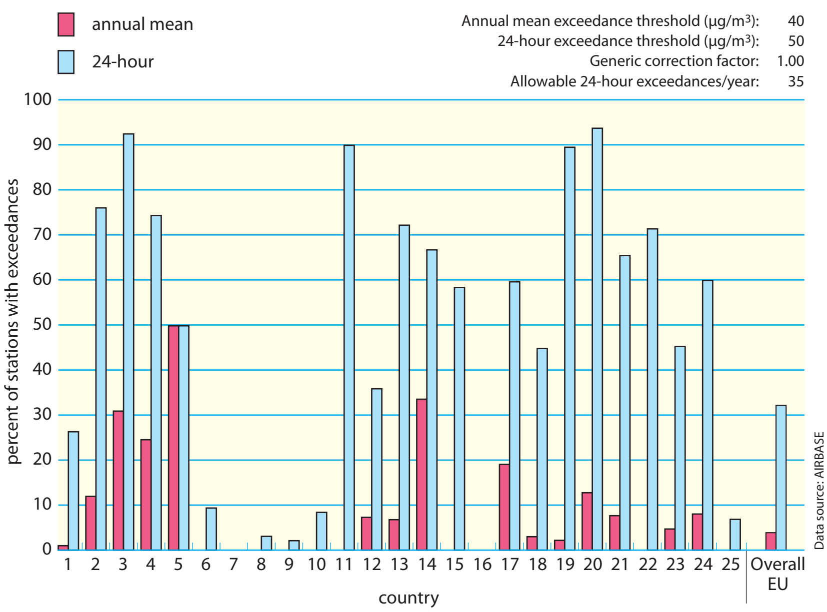
In this brief Article we explore the implications of this divergence in approach to the application of correction factors. In doing so we have drawn on the information provided in the ETC/ACC technical paper and on the comprehensive measurement data available in AIRBASE[4]. For the reporting year of 2004 (the latest data available in AIRBASE at the time of the study), AIRBASE included data on more than 1800 PM_{10} measuring stations in the European Union. All these data were utilised in this study.

The available information on the correction factors (including whether the data reported to AIRBASE includes such a correction or not) allowed the 'as reported' concentration data in AIRBASE to be adjusted to assess the implications of various common 'correction factor scenarios' on the level of compliance with PM_{10} limit values.

For example, if the reported 24-hour average PM_{10} concentration was 40 µg/m^3 and the 'correction factor' used for that station was unity, when exploring the implications of a common correction factor of 1.3, the 'corrected' concentration was calculated as 52 µg/m^3. Against the 24-hour limit value of 50µg/m^3 this would result in a 'non-exceedance" day becoming an exceedance day. Conversely, in exploring the 'no correction factor' case, at a site where a correction factor of 1.2 was used with a reported 24-hour average concentration of 60 µg/m^3, the adjusted concentration would be 50 µg/m^3, moving the exceedance day to a non-exceedance day.

[4] *AIRBASE is a comprehensive data base on measurement stations and measured concentrations in ambient air in Europe provide under the Exchange of Information Directive (97/101/EC). AIRBASE is maintained by the European Topic Centre on Air and Climate Change (ETC/ACC).*

Figure 1 Exceedances of PM_{10} limit values implied by the 'as reported' data in AIRBASE 2004



Base Case (as reported in AIRBASE)

The first case explored used the '*as reported to AIRBASE*' data for 2004. The results are given in Figure 1 which shows the percentage of measuring stations in each Member State with exceedances above the limit values. The annual mean limit value being 40 µg/m^3, the number of exceedances above the threshold of 50 µg/m^3 daily mean is limited to 35 per year.

Figure 1 shows that in this 'Base Case', in many Member States, this 35-day maximum above the 50 µg/m^3 threshold for the 24-hour average concentration is widely exceeded. Although the 24-hour limit did not enter into force until 2005, this '2004 Picture' anticipates the widespread reporting of exceedances by individual Member States that occurred the following year. In the overall EU some 32% of measuring stations show exceedances of the 24-hour limit. In some individual Member States this increases to more than 75%. Figure 1 also indicates the 24-hour limit is substantially more difficult to comply with than the annual mean limit value of 40 µg/m^3 with less than 5% of stations in the EU exceeding this latter limit.

The 'No Correction' to measurements case

Figure 2 shows how this picture changes if all the 'as reported' measured data are adjusted back to a correction factor of unity. Of course in Member States where a correction factor was not applied in the 'as reported' data to AIRBASE, or in situations where the measurement stations utilise the reference method (correction factor of unity by definition), the situation is unchanged from that shown in Figure 1.

This said, with this adjustment to a common correction of 'unity', the 24-hour limit exceedance in the whole EU is reduced from 32% to some 27%. The situation in some Member States changes much more significantly. For example in 'Country 2' exceedances reduce from some 75% of stations to less than 10% and for the annual mean limit from some 12% to zero. This situation reflects the use of a relatively high correction factor in reported measurements from this country.

The 'Common Correction Factor of 1.3' case

Figure 3 depicts the compliance situation if a common 1.3 correction factor were to be used on non-reference method measurements and such corrected data reported into AIRBASE. Compared to the 'Base Case' (Figure 1), the compliance situation for both the 24-hour and annual mean limits significantly worsen. In the whole EU exceedances of the 24-hour limit rise from 32% to 50% of measuring stations; for the annual mean limit exceedances rise from 5% to 15% of measuring stations.

These 'compliance cases', derived from the processing of AIRBASE data, were designed to demonstrate the very significant impact of the present diversity of PM_{10} measurement correction factors on the PM_{10} compliance situation. It is not the purpose of this study to make any value judgement on what correction factors are appropriate in a given situation, this is a complex area since the 'particulate cocktail' varies both spatially and temporally. However, the results surely serve to highlight the urgent need to make further progress on the harmonisation of approaches across Member States to establish a level playing field for assessing compliance with current and future limit values (including those for $PM_{2.5}$ in the new Ambient Air Quality Directive). On the one hand, the use of inappropriately high correction factors will continue to mask the very real progress expected from significant policy steps already taken and those currently under development as a follow up to the Commission's Thematic Strategy on Air Pollution. On the other hand, use of an inappropriate correction factor will fail to provide the information necessary to inform future policy responses.

Figure 2 Exceedances of PM_{10} limit values if reported data into AIRBASE were adjusted back to a common 'correction factor' of unity

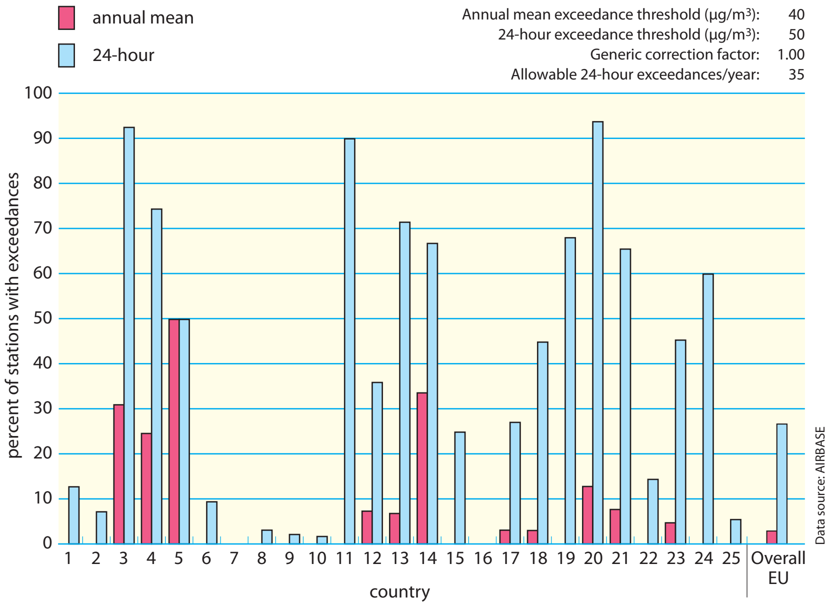
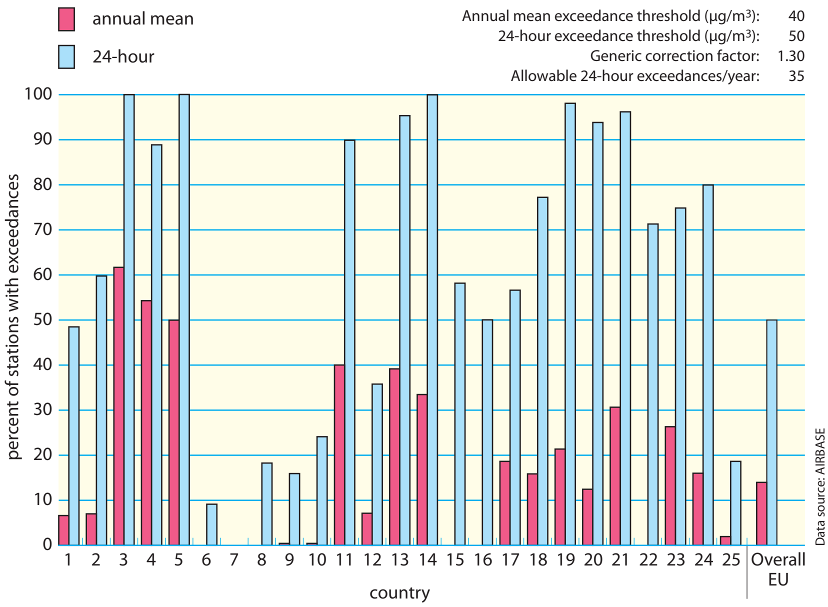


Figure 3 Exceedances of PM_{10} limit values if reported data into AIRBASE were adjusted with a common correction factor of 1.3



Assessing the environmental sensitivity of petrol filling station locations across Europe

The need for a risk-based approach to implementing the Groundwater Directive

In the context of the Groundwater Directive (2006/118/EC), the CONCAWE Soil & Groundwater Task Force commissioned the consultants, Arcadis Geraghty & Miller (Newmarket, UK) to assist in a study of petroleum facilities across Europe. The first phase of the project specifically assesses the environmental sensitivity of petrol filling station locations with regard to their proximity to groundwater, surface water and ecological receptors. The principal aim is to promote a risk-based approach, as opposed to a prescriptive engineering-based approach, to implementing the Groundwater Directive. Additionally, the methodology developed through this study provides a tool for the oil industry to identify areas of higher environmental sensitivity and thus encourage rational investment in preventative measures where it is most needed. The countries included in this study are listed in Table 1, while an outline of the overall project structure is illustrated in Figure 1. This article illustrates the results to date at a European, National, Regional and Site level.

Background

Across Europe, the consistency of digital data in terms of definitions, scale and quality varies greatly from country to country. So, to try to obtain a meaningful comparison across countries, petrol filling station locations have been classified in this study into five categories of envi-

Table 1 Countries covered by this study

- Austria
- Belgium
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Italy (Emilia Romagna, Lazio, Lombardi, Piedmont and Veneto only)
- The Netherlands
- Norway
- Poland
- Spain
- United Kingdom

Figure 1 Project structure

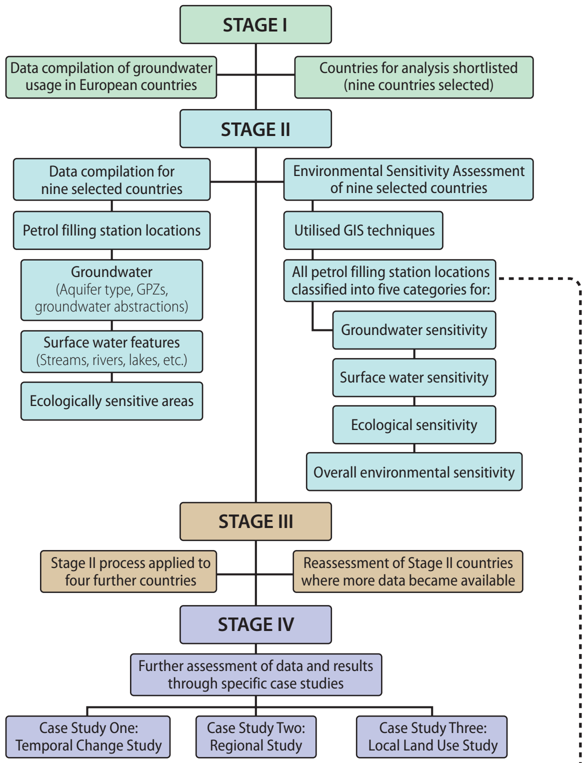


Table 2 Classification criteria

	Sensitivity Category						
	Category 1	*Category 2*	*Category 3*			*Category 4*	*Category 5*
Groundwater	Within a GPZ1 Class	Within 100 m of a GPZ1 Class GPZ2 **AND** Major Aquifer Class	Other GPZ2 Class	GPZ3 Class	Not in a GPZ but on, or within 100 m of a Major Aquifer Class	Minor Aquifer Class **AND** not in a GPZ	Non-Aquifer Class **AND** not in a GPZ
Surface water	< 25 m	25–50 m **OR** < 250 m from the coast	50–100 m			100–250 m	> 250 m
Ecological	Within	< 50 m	50–100 m			100–250 m	> 250 m
Overall environmental sensitivity	Defined by whichever of the groundwater, surface water and ecological categories are most sensitive						

ronmental sensitivity in relation to groundwater, surface water and ecological receptors.

The classification criteria are provided in Table 2, where Category 1 represents the most sensitive conditions and Category 5 represents the least sensitive conditions.

Aquifer class and Groundwater Protection Zone (GPZ) definitions for each country exhibit the greatest variation. Therefore, wherever possible, the data for each country has been sub-divided to define three classes of aquifer type (Major, Minor and Non-Aquifer) and GPZ (GPZ1, 2 and 3). Generally the GPZ1 class represents the area of highest protection or most stringent legislation, with the GPZ3 class representing the total catchment area for public drinking water supplies.

Methodology

The environmental sensitivity of each petrol filling station location was determined using a Geographical Information System (GIS). Digital data in a GIS format was collected for each country to represent:

- Petrol filling station locations
- Aquifer types/groundwater vulnerability
- Groundwater Protection Zones (GPZs)
- Groundwater abstraction locations
- Surface water features
- Ecologically sensitive areas (e.g. Natura2000 sites).

The petrol filling station locations were overlaid onto the various environmental receptor datasets within the GIS. The proximity of the sites to the environmental receptors were then calculated and recorded as attributes of each petrol filling station. Lastly, each petrol filling station was classified into an environmental sensitivity category according to the criteria in Table 2.

The case studies in Stage IV (see Figure 1) were developed utilising the CORINE land cover data produced by the European Environment Agency.

Study findings—European level

To date, more than 85,000 petrol filling station locations across Europe have been analysed for their environmental sensitivity. Approximately 14% of these sites were found to be located in areas of higher environmental sensitivity (Categories 1 and 2 in Table 2). This average figure conceals a wide variation between countries, ranging from approximately 32% of sites in Poland to 7% of sites in Germany.

Approximately 14% of sites are located in areas of lowest environmental sensitivity (Category 5 in Table 2).

A further breakdown of the higher sensitivity sites across Europe shows that the majority (approximately 8% of sites) are thus categorised because of their proximity to

Table 3 Groundwater protection zone classification in Europe

Country	GPZs defined	Regulation basis	Digital format	Number of GPZ Classifications	Notes
Austria	✓	Regional	✓	5	Two types of GPZ; one protects aquifers (2 Classes) and another abstractions (3 Classes).
Belgium	✓	Regional	✓	3	GPZs in Wallonia are not as established as in Flanders. No data for Brussels.
Czech Republic	✓	National	✓	3	Water protection zones — not GPZs. Additional data on areas of General GW Accumulation (Natural Spring areas).
Denmark	✗	–	✗	–	Groundwater Vulnerability is focused on quality of groundwater for public supply.
Finland	✓	National	✓	4	Not all GPZs have been digitally mapped to date.
France	✓	Local	✗	3	Many GPZs are yet to be designated, very few are digitally mapped. The third class of GPZ is not always defined.
Germany	✓	Regional	✓	3	Water protection zones — not GPZs. Some definitions of classes vary between regions.
Italy (5 regions)	✓✗	Regional	✓✗	2–4	Where designated, definitions of GPZ class vary widely between regions.
The Netherlands	✓	National	✓	3	
Norway	✗	National	✗	–	
Poland	✓	National	✓	2	Spatially, GPZs are wide-ranging throughout Poland.
Spain	✗	–	✗	–	
United Kingdom	✓	Regional	✓	3	GPZs only defined for England and Wales.
	✓=yes, ✗=no		✓=yes, ✗=no		

Assessing the environmental sensitivity of petrol filling station locations across Europe

The need for a risk-based approach to implementing the Groundwater Directive

surface water, with groundwater sensitivity accounting for about 4% of sites, and ecological sensitivity for some 3% of sites.

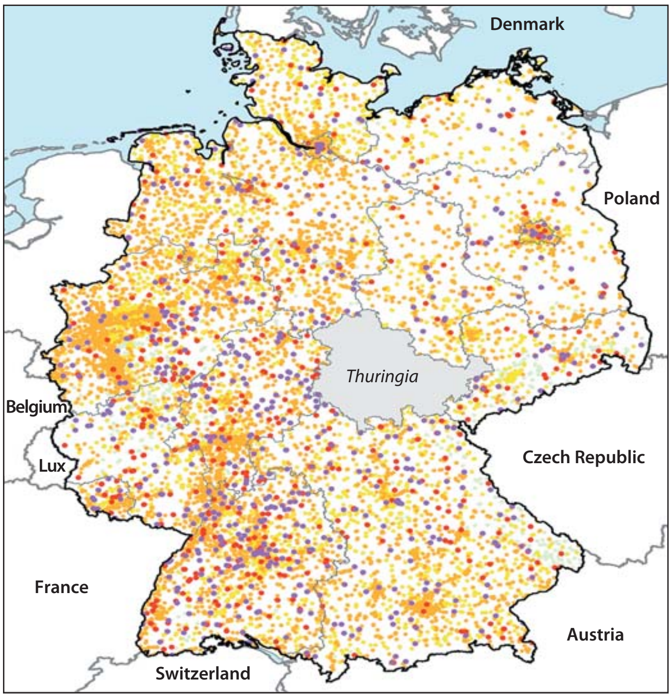
The study has also identified major inconsistencies in data across, and in some cases within, countries—limiting the potential to accurately compare data and results from the different sources. Groundwater Protection Zones, which are an important concept in protecting public water supplies in any country, have also proved to be by far the most inconsistent data type, as illustrated in Table 3.

Study findings—national level

Germany example

The distribution of environmental sensitivity at petrol filling stations on a national level, as illustrated for Germany in Figure 2, enables the identification of areas where clusters of sites with higher sensitivities occur. For example, the majority of Category 3 and 4 sites are driven by groundwater sensitivity, whereas the proximity to surface water features is the main driver for Category 1 and 2 sites—a higher proportion of which tend to occur to the west and south-west of the country. Likewise, areas of lower sensitivity (Category 5 sites) can be identified, such as the area along the Germany/Czech Republic border.

Figure 2 Overall environmental sensitivity of petrol filling stations in Germany



Thuringia omitted from analysis due to insufficient data availability

- Category 1 – 624 (4%)
- Category 2 – 477 (3%)
- Category 3 – 8510 (84%)
- Category 4 – 5241 (33%)
- Category 5 – 906 (6%)

Study findings—regional level

Berlin and Stuttgart case study

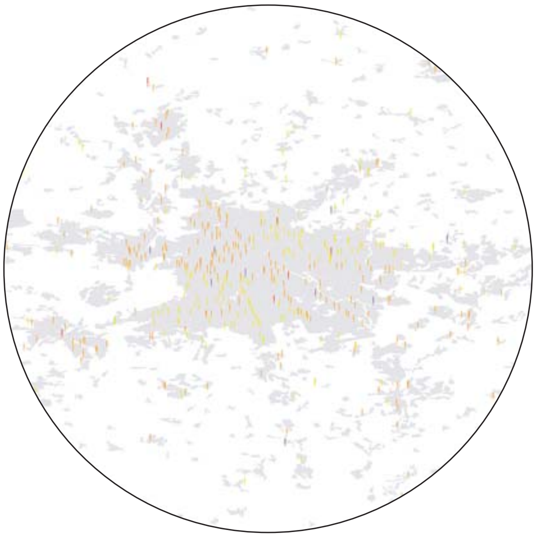
The regions around Berlin and Stuttgart were found to have similar environmental characteristics, however the distribution of environmental sensitivity at petrol filling station locations in these regions differs as seen in Figure 3. In both regions, between 85–90% of sites lie within an urban category of land cover, as defined by the CORINE land cover dataset, however the spatial distribution of these urban areas is very different. As a result, the increased proportion of higher sensitivity sites (Category 1 and 2) that occur in the Stuttgart region, in comparison to the Berlin region, is largely due to the dispersed nature of urban areas around Stuttgart. When combined with the spatial distribution of the environmental factors, urban areas and therefore petrol filling stations in the Stuttgart region are in proximity to more environmental receptors.

In terms of potable water supply it is interesting to note that in the Stuttgart region the public water supply is generally sourced from Lake Constance, whilst in the Berlin region public water supply is sourced from artificially recharged aquifers around the city. However the Stuttgart region contains a larger coverage of GPZs, many of which are designated to protect natural groundwater springs and spa waters, and as a result groundwater sensitivity there is higher in comparison to Berlin.

Figure 3: Urban areas and overall environmental sensitivity of petrol filling stations in Berlin and Stuttgart

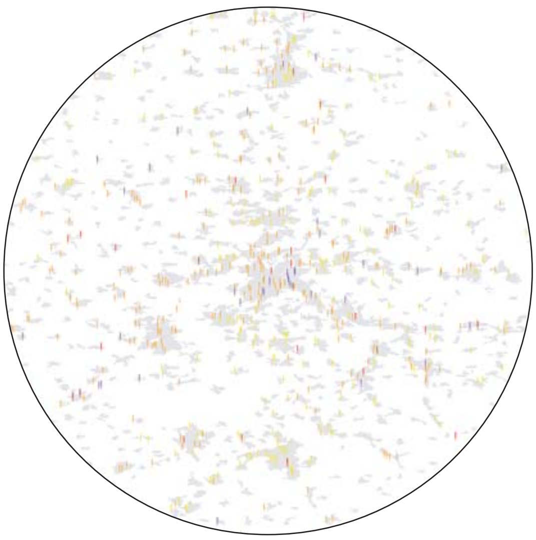
Urban areas as represented by the CORINE Land Cover database produced by the European Environment Agency

Berlin



- Category 1 – 9 (2%)
- Category 2 – 7 (1.6%)
- Category 3 – 231 (52%)
- Category 4 – 196 (44%)
- Category 5 – 3 (0.7%)

Stuttgart



- Category 1 – 43 (7.2%)
- Category 2 – 22 (3.7%)
- Category 3 – 278 (46%)
- Category 4 – 246 (41%)
- Category 5 – 11 (1.8%)

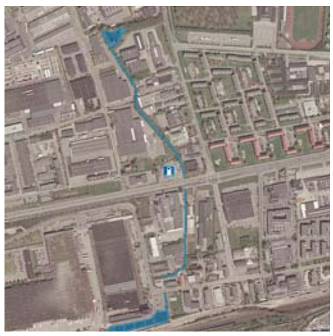
Site level

The principal aim of this study is to provide indications of patterns and trends in environmental sensitivity at a regional and national level. To identify individual sites where the environmental sensitivity is highest, additional data would be required. The 'footprint' of a petrol filling station varies widely from site to site, in terms of the potential for adverse environmental impact, when compared to surrounding land covers and the proximity of environmental receptors. Figure 4 provides an example of the conditions surrounding a site in an urban setting. This highlights the need to consider each site in relation to other potential point sources and to the nature of the environmental receptors at risk. Ultimately this study has demonstrated how each site is subject to different surroundings and environmental circumstances, and thus promotes a risk-based approach on a site-specific basis for dealing with potential environmental impacts.

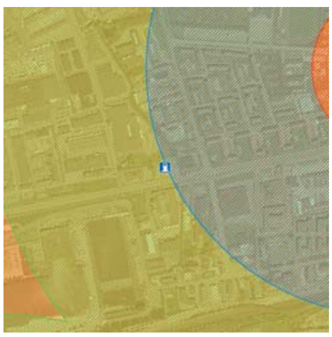
Figure 4: Assessment of environmental sensitivity at a site-specific level

Surrounding land use

Surface water receptors



Groundwater receptors



Minor aquifer class

Proximity to groundwater abstraction:

- <250 m
- <750 m
- <1250 m

Assessing the environmental sensitivity of petrol filling station locations across Europe

The need for a risk-based approach to implementing the Groundwater Directive

Conclusions

This project defined and assessed the environmental sensitivity of more than 85,000 petrol filling stations across Europe and has identified variations in the distribution of environmental sensitivity for sites.

The outcome of the research shows that:

- Patterns in environmental sensitivity at petrol filling station locations can vary at a national, regional and local level.
- The availability, data definitions, quality and scale of environmental data across Europe is not consistent, limiting the potential to compare data and results accurately across national borders.
- Environmental sensitivity of petrol filling station locations is not only a result of the distribution of environmental receptors, but is also influenced by external factors such as land cover patterns, and in the case of groundwater sensitivity, differences in the regulation of groundwater for drinking water supply at both a national and regional scale.
- At a practical level the study has also provided a potential screening tool for identifying sites of higher sensitivity for further investigation at a site specific level, enabling resources and investment to be applied rationally.

This study has shown that each site is subject to different surroundings and environmental circumstances, which clearly justifies adopting a risk-based approach on a site-specific basis when implementing the requirements of the EU Groundwater Daughter Directive.

Abbreviations and terms used in this CONCAWE *Review*

AIRBASE	The European air quality database system
BTL	Biomass To Liquid
CORINAIR	CORe INventory of AIR emissions
CORINE	EU programme 'COoRdination of INformation on the Environment'
EMEP	UN-ECE's cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
ETC/ACC	European Topic Centre on Air and Climate Change
EUCAR	European Council for Automotive Research and development
FAME	Fatty-Acid Methyl Ester—known as Biodiesel
GHG	Greenhouse Gas
GIS	Geographical Information System
GPZ	Groundwater Protection Zone
HD	Heavy Duty
IPPC	Integrated Pollution Prevention and Control (EU Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control)
JRC	European Commission's Joint Research Centre
LC	Life Cycle
LD	Light Duty
NEDC	New European Driving Cycle
$PM_{2.5}/PM_{10}$	Particulate with an aerodynamic diameter less than or equal to 2.5 / 10 µm
REACH	Registration, Evaluation and Authorisation of Chemicals
TEOM	Tapered Element Oscillating Microbalance
UN ECE	The United Nations Economic Commission for Europe
WTW	Well-To-Wheels

CONCAWE contacts

Secretary General

Alain Heilbrunn
Tel: +32-2 566 91 66 Mobile: +32-475 90 40 31
E-mail: alain.heilbrunn@concawe.org

Technical coordinators

Air quality
Lourens Post
Tel: +32-2 566 91 71 Mobile: +32-494 52 04 49
E-mail: lourens.post@concawe.org

Fuels quality and emissions
Ken Rose
Tel: +32-2 566 91 69 Mobile: +32-499 97 53 25
E-mail: ken.rose@concawe.org

Petroleum products • Risk assessment
Bo Dmytrasz
Tel: +32-2 566 91 65 Mobile: +32-485 54 41 12
E-mail: bo.dmytrasz@concawe.org

REACH implementation
Alexander Merck
Tel: +32-2 566 91 85 Mobile: +32-495 57 17 50
E-mail: alexander.merck@concawe.org

Refinery technology • Oil pipelines
Jean-François Larivé
Tel: +32-2 566 91 67 Mobile: +32-485 75 73 73
E-mail: jeanfrancois.larive@concawe.org

Water, waste and soil • Safety
George Stalter
Tel: +32-2 566 91 83 Mobile: +32-495 26 14 34
E-mail: george.stalter@concawe.org

Office management and support

Office manager
Sophie Bornstein
Tel: +32-2 566 91 18
E-mail: sophie.bornstein@concawe.org

Documentation/library
Office administration
Annemie Hermans
Tel: +32-2 566 91 80
E-mail: annemie.hermans@concawe.org

Virginie Baumard
Tel: +32-2 566 91 78
E-mail: virginie.baumard@concawe.org

Marleen Eggerickx
Tel: +32-2 566 91 76
E-mail: marleen.eggerickx@concawe.org

Sandrine Faucq
Tel: +32-2 566 91 75
E-mail: sandrine.faucq@concawe.org

Anja Mannaerts
Tel: +32-2 566 91 73
E-mail: anja.mannaerts@concawe.org

Barbara Salter
Tel: +32-2 566 91 74
E-mail: barbara.salter@concawe.org

We are pleased to welcome Alexander Merck to the CONCAWE team. Alexander joined the Secretariat on 1 October and replaces Lothar Kistenbruegger as Technical Coordinator for REACH Implementation.

Jan Urbanus, Technical Coordinator for Health, returned to his parent company, Chevron, at the end of September. No replacement has yet been appointed.

CONCAWE publications

Reports published by CONCAWE from 2006 to date

2006	
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2/06	Techno-economic analysis of the impact of the reduction of sulphur content of residual marine fuels in Europe
3/06	Performance of European cross-country oil pipelines—statistical summary of reported spillages—2004
4/06	Analysis of the CAFE cost benefit analysis
5/06	Motor vehicle emission regulations and fuel specifications—Part 1—2004/2005 update
6/06°	Motor vehicle emission regulations and fuel specifications—Part 2—historic review (1996–2005) *(included on CD with Report 5/06)*
7/06°	European downstream oil industry safety performance—statistical summary of reported incidents—2005
2007	
1/07	Oil refining in the EU in 2015
2/07	Sulphur dioxide emissions from oil refineries and combustion of oil products in Western Europe and Hungary (2002)
3/07	Air pollutant emission estimation methods for E-PRTR reporting by refineries
4/07	Performance of European cross-country oil pipelines—Statistical summary of reported spillages in 2005 and since 1971
5/07	Report of a Workshop on Environment and Health: Air Quality Research Needs in the EU 7th Framework Programme of Research, 15–16 January 2007
6/07	Human exposure information for EU substance risk assessment of kerosine

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New reports are generally also published on the website.

° Not published on the CONCAWE website; copies may be purchased from the Secretariat.

Correction

The Article 'Water Environmental Quality Standards' in CONCAWE *Review* Volume 16 Number 1 published this table on Priority and Priority Hazardous Substances in which Brominated Diphenylether was shown as a PHS. Please note that while Brominated Diphenylethers are on the priority substance list in the field of water policy, only Pentabromodiphenylether (CAS-number 32534-81-9) is identified as a priority hazardous substance, as indicated in the amended table on the right.

Where groups of substances have been selected, typical individual representatives are listed as indicative parameters.

Table 1 Priority Substances (PS) and Priority Hazardous Substances (PHS)

Alachlor	Mercury and its compounds
Anthracene	Naphthalene
Atrazine	Nickel and its compounds
Benzene	Nonylphenol
Brominated diphenylether	*(4-(para)nonylphenol)*
(Pentabromodiphenylether)	Octylphenol
Cadmium and its compounds	*(Para-tert-octylphenol)*
Chloroalkanes, C10-13	Pentachlorobenzene
Chlorfenvinphos	Pentachlorophenol
Chlorpyrifos	Polyaromatic hydrocarbons
1,2-Dichloroethane	*(Benzo(a)pyrene)*
Dichloromethane	*(Benzo(b)fluoranthene)*
Di(2-ethylhexyl)phthalate (DEHP)	*(Benzo(g,h,i)perylene)*
Diuron	*(Benzo(k)fluoranthene)*
Endosulfan	*(Indeno(1,2,3-cd)pyrene)*
(Alpha-endosulfan)	Simazine
Fluoranthene	Tributyltin compounds
Hexachlorobenzene	*Tributyltin-cation*
Hexachlorobutadiene	Trichlorobenzenes
Hexachlorocyclohexane	*(1,2,4-trichlorobenzene)*
(Gamma-isomer, Lindane)	Trichloromethane
Isoproturon	*(Chloroform)*
Lead and its compounds	Trifluralin

CONCAWE
Boulevard du Souverain 165, B–1160 Brussels, Belgium
Telephone: +32-2 566 91 60 • Telefax: +32-2 566 91 81
info@concawe.org • www.concawe.org

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