EUROPEAN AIR QUALITY TRENDS FOR NO_2 AND PM

— BACKGROUND

Air quality is a complex issue as it is influenced by a variety of factors. The term air quality refers to the degree to which the air in a particular place is affected by pollutants. Air pollutants are substances which, if present in the atmosphere at high enough concentrations, can have a measurable effect on humans, animals, vegetation and the built environment.

In most European cities, air quality has improved substantially over the past decades. The visible and noticeable air pollution (smoke, dust, smog) has all but disappeared from many cities due to local, national and European initiatives. However, the measured concentrations of selected pollutants in some cities still exceed the air quality limit values and additional measures are required in order to meet them.

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Air Pollutants of Concern

Common air pollutants include: sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), volatile organic compounds (VOCs), ozone (O_3), and ammonia (NH_3). From an urban air quality compliance perspective, PM and nitrogen dioxide (NO_2) are currently considered to be the two main air pollutants of concern.

- **Particulate Matter (PM):** Particulate matter is classified by particle size. The key classifications are: total suspended particulate matter (i.e. dust), PM_{10} (less than 10 µm in aerodynamic diameter), $PM_{2.5}$ (less than 2.5 µm) and ultrafine particles (less than 0.1 µm). PM is referred to as "primary" if it is directly emitted into the air as solid particles, and is called "secondary" if it is formed by the chemical reaction of gases in the atmosphere. PM is emitted from both anthropogenic and natural sources.
- **Nitrogen dioxide (NO_2):** NO_2 is one of the components of a mixture of highly reactive gases known as nitrogen oxides (NO_x). NO_2 is primarily emitted to the air during combustion processes.

Air Quality Policy

There have been significant efforts since the 1990s to reduce emissions of air pollutants in EU through the adoption of targeted policies and the associated implementation of emission control measures. These emission reductions have resulted in improved air quality across EU. The main policies that have led to achieving these air quality improvements include:

- The Ambient Air Quality Directive (2008/50/EC) and Fourth Daughter Directive (Directive 2004/107/EC) which set air quality limit values for multiple air pollutants.
  > Amending Directives 96/62/EC, 1999/30/EC, 2000/69/EC, 2002/3/EC.
- The National Emissions Ceilings Directive (Directive 2001/81/EC) which sets emission limits for air pollutants for each Member State.
- The Industrial Emission Directive (Directive 2010/75 EU) which limits emissions from many industrial installations.
  > Replacing the Integrated Pollution Prevention and Control Directive.
- The Sulphur Content of Certain Liquid Fuels Directive (Directive (EU) 2016/802) which contains the latest sulphur content limits for marine fuels, heavy fuel oil (HFO), gasoil as decided by the International Maritime Organization (IMO).
- Commission Regulation 2016/427 for emissions from light passenger and commercial vehicles (Euro 6).
  > Amending Regulation (EC) No 692/2008.
- Commission Regulation 2017/1154 as regards to real-driving emissions from light passenger and commercial vehicles (Euro 6).
  > Amending Regulation (EU) 2017/1151, 2007/46/EC, 2016/1628, and Commission Regulation (EU) No 1230/2012, supplementing Regulation (EC) No 715/2007, and repealing Regulation (EC) No 692/2008.
- The Fuel Quality Directive (Directive 2009/30/EC) as regards to the specification of petrol, diesel, and gas-oil fuels.
  > Amending Directive 98/70/EC.
- IMO MARPOL ANNEX VI, Regulation 13 related to requirements for control of NO_x emissions from ships.

Air Quality Monitoring in EU

Ambient air quality monitoring is the measurement of pollutant levels in outdoor air at a given location for a given period of time. The location of a monitoring station and the type of monitor used depends on the purpose of the monitoring. Monitors may be placed near busy roads, in populated areas, at a particular location of concern, or away from emission sources to determine background levels. Often monitoring activities are used to assess exposure of people and therefore monitors are frequently placed in populated areas. Proper siting of ambient monitors is critical as station placement can greatly affect the measurements. Due to the seasonal effects of weather, long-term monitoring is useful to show the differences in air quality over time.

Ambient air quality monitoring began in EU in the mid-70s when 135 monitoring stations were installed in only a few countries (Denmark, France, Germany, Ireland, Italy, Netherland, Luxembourg and UK). Monitoring of NO_2 started in 1973 in the UK with a small number of stations, however broad monitoring of NO_2 didn't start until the 1990s. Monitoring of PM began in 1992 with PM_{10}. Monitoring of $PM_{2.5}$ started in 1998. Currently each member state is required to install sampling points and operate ambient monitoring stations as per the Ambient Air Quality Directive (2008/50/EC).

AirBase[1] is the European air quality database maintained by the European Environment Agency (EEA). The database contains ambient air quality monitoring data submitted by participating countries throughout Europe. It covers all EU member states, the EEA member countries and some EEA collaborating countries. Based on the latest AirBase 2017 data there are approximately 3,000 stations monitoring NO_2, 2,500 stations monitoring PM_{10} and around 1,000 stations monitoring $PM_{2.5}$ in Europe. Table 1 in the supplementary material provides the details for individual countries.

[1] (https://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8)

Air Quality Trends in EU

AirBase stations are classified as either Urban, Rural, or Traffic. The following graphs present the trends in annual mean concentrations for NO_2, PM_{10}, and $PM_{2.5}$ over the last two decades. The average concentration for each of these station types is given.

As shown in Figure 1, averaged over all stations, annual mean NO_2 concentrations in 2015 are 40% lower compared to 1991 levels, with traffic stations recording a steady decrease during the last 9 years. Urban stations also recorded a steady decrease of NO_2 levels from 2006-2014 with a slight increase thereafter.

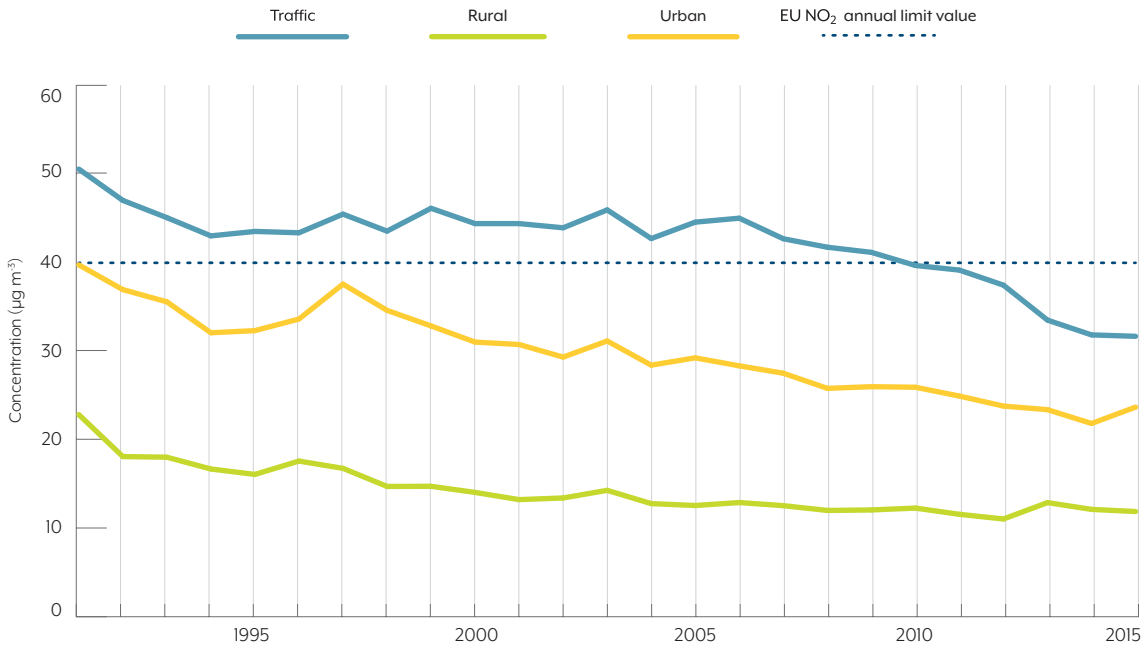

Figure 1. Annual mean concentration trends (µg m^{-3}) of NO_2 in EU-28 (1991-2015) per station type (763 traffic, 481 rural, and 1463 urban monitoring stations) (data source: AirBase – EEA).

As shown in Figure 2, the average decrease in annual mean concentrations for PM_{10} is 38% since 1992, with a steady reduction during the last 5 years.

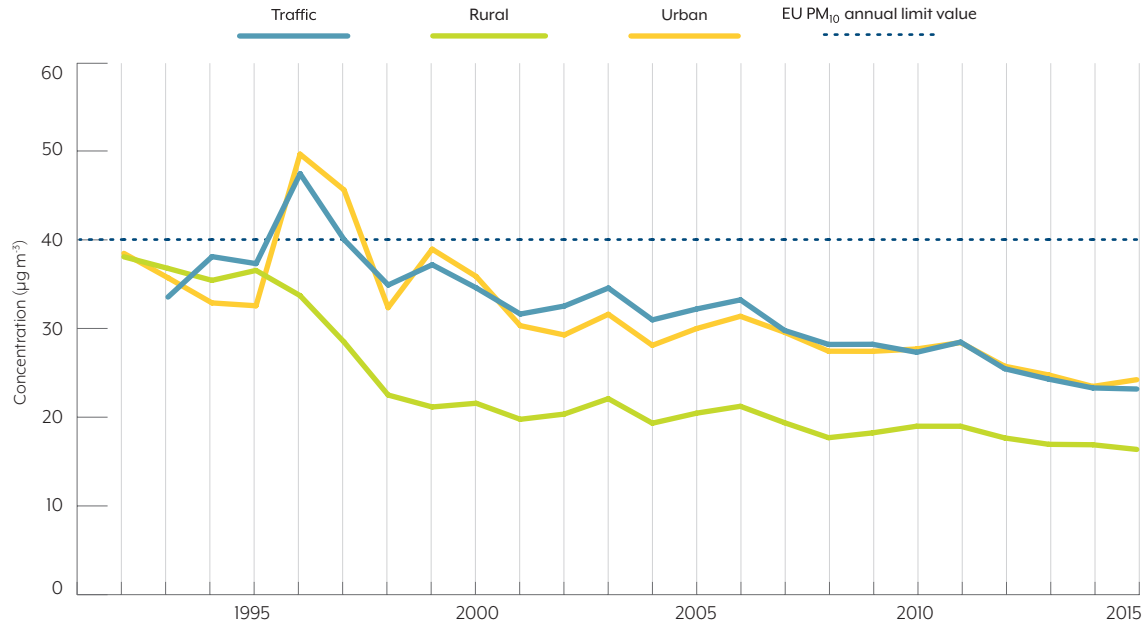

Figure 2. Annual mean concentration trends (µg m^{-3}) of PM_{10} in EU-28 (1992-2015) per station type (725 traffic, 393 rural, and 1433 urban monitoring stations) (data source: AirBase – EEA).

As shown in Figure 3, the average decrease in annual mean $PM_{2.5}$ concentrations since 1998 is 30%, with a steady reduction during the last 5 years.

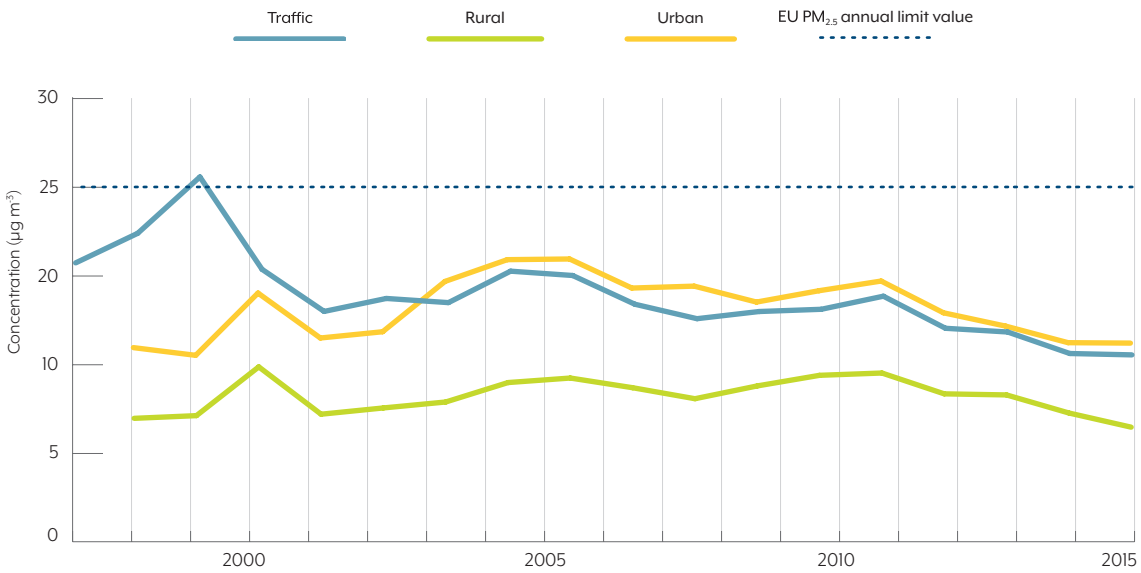

Figure 3. Annual mean concentration trends (µg m^{-3}) of $PM_{2.5}$ in EU-28 (1998-2015) per station type (205 traffic, 148 rural, and 575 urban monitoring stations) (data source: AirBase – EEA).

Concentrations of NO_2, PM_{10}, and $PM_{2.5}$ have substantially reduced over EU during the last two decades. Targeted air quality policies and implemented emission reduction measures have delivered, and continue to deliver, sustained decreases in concentrations. Issues of non-compliance do however still exist for a small number of monitoring stations. This is illustrated in the following graphs which show the number of AirBase monitoring stations[2] where annual mean concentrations for NO_2, PM_{10}, and $PM_{2.5}$, are greater or equal to the annual limit values set out in the Ambient Air Quality Directive.

[2] The number of AirBase monitoring stations differs as more stations became operational over the year.

Figure 4 shows that there has been a steady reduction in the number of non-compliant NO_2 monitoring stations. There remains a problem and NO_2 concentrations in 2015 were above the limit value of 40 µg m^{-3} at 9% (259) of stations.

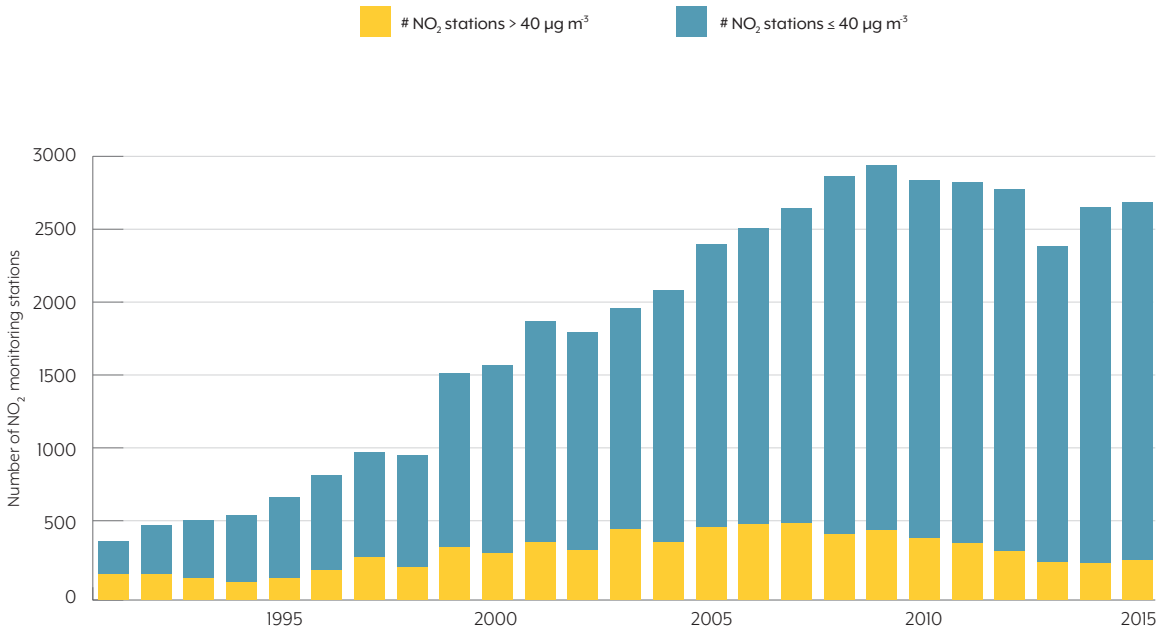

Figure 4. Number of EU-28 AirBase stations monitoring NO_2 annual mean concentrations (µg m^{-3}), above, and below the EU NO_2 annual limit value (40 µg m^{-3}) (1991-2015) (data source: AirBase – EEA).

As shown in Figure 5, since 2008 fewer than 200 (10%) monitoring stations show non-compliance regarding PM_{10} annual mean concentrations. In 2015, the PM_{10} compliance was 96%, and PM_{10} concentrations were above the limit value of 40 µg m^{-3} at 4% (85) of stations.

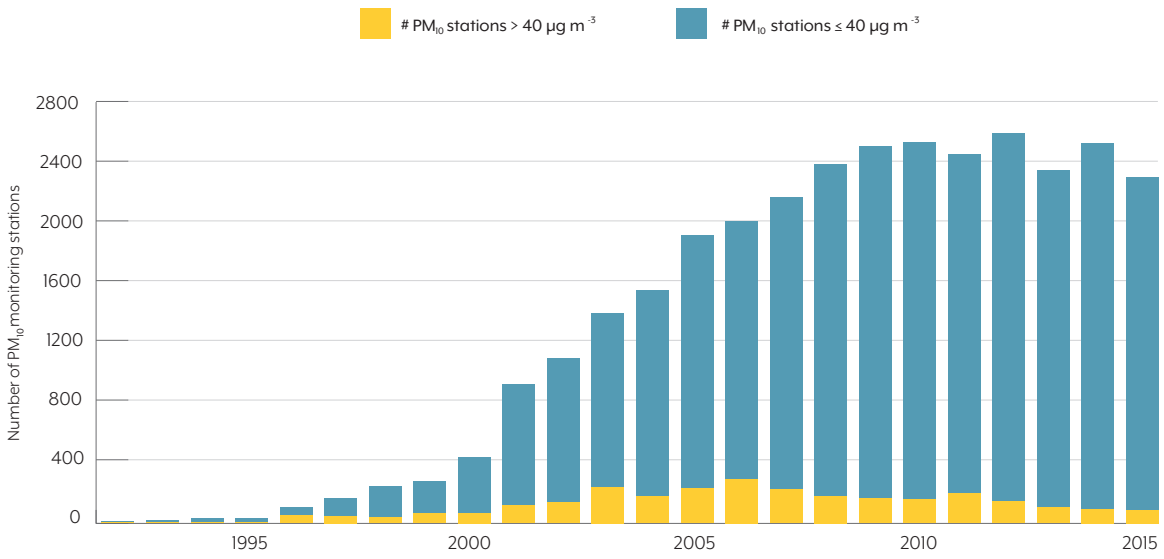

Figure 5. Number of EU-28 AirBase stations monitoring PM_{10} annual mean concentrations (µg m^{-3}), above, and below the EU PM_{10} annual limit value (40 µg m^{-3}) (1992-2015) (data source: AirBase – EEA).

As shown in Figure 6, in 2015, $PM_{2.5}$ concentrations were above the limit value of 25 µg m^{-3} at 7% (67) of stations.

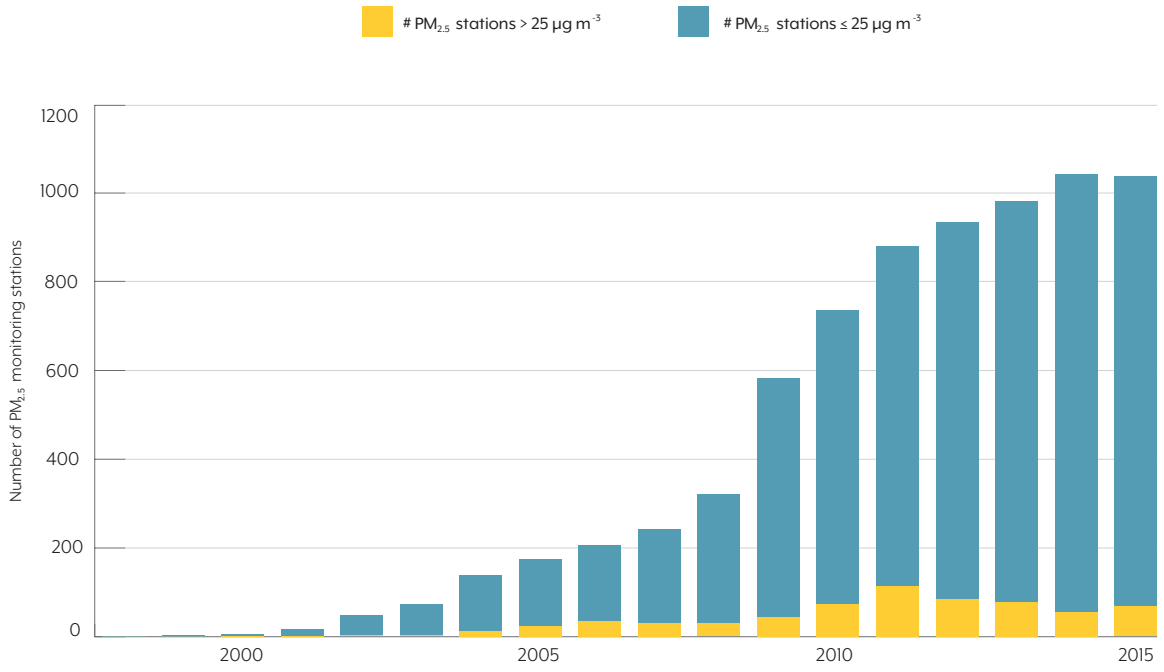

Figure 6. Number of EU-28 AirBase stations monitoring $PM_{2.5}$ annual mean concentrations (µg m^{-3}), above, and below the EU $PM_{2.5}$ annual limit value (25 µg m^{-3}) (1998-2015) (data source: AirBase – EEA).

The reasons for exceedance of air quality limit values are complex and arise from a combination of local and long-range effects as air pollutants released in one country can contribute to elevated concentrations in a neighbouring country. International, national, and local cooperation is needed to implement targeted measures that will continue to deliver air quality improvements towards the efforts for achieving full compliance with air quality limit values across EU.

Helpful Links

- The European Environment Agency publishes air pollution fact sheets for the EU-28 countries which provide emission trends and summaries of the national air quality situation in each country. These can be found at: https://www.eea.europa.eu/themes/air/country-fact-sheets/air-pollution-country-fact-sheets.
- Air quality in Europe – 2017 report: This report presents an updated overview and analysis of air quality in Europe from 2000 to 2015. It reviews the progress made towards meeting the requirements of the air quality directives. An overview of the latest findings and estimates on population and ecosystem exposure to the air pollutants with the greatest impacts and effects on human health and the environment is also given. It is an annual report and the current version can be found at: https://www.eea.europa.eu/publications/air-quality-in-europe-2017.

Supplementary material

[1] Refers to the year that monitoring started which may differ by pollutant.
[2] Based on the latest AirBase data.

EU Member State	Started Monitoring Year[1]	NO_2 Monitoring Stations[2]	PM_{10} Monitoring Stations	$PM_{2.5}$ Monitoring Stations
Austria	1981	143	125	26
Belgium	1985	86	62	41
Bulgaria	1998	25	40	8
Croatia	2006	8	7	3
Cyprus	1993	2	3	4
Czech Republic	1992	90	112	44
Denmark	1976	12	6	6
Estonia	1997	9	8	7
Finland	1990	33	42	18
France	1976	405	338	102
Germany	1976	402	448	146
Greece	1983	21	9	2
Hungary	1996	22	22	5
Ireland	1973	9	11	5
Italy	1976	513	467	145
Latvia	1997	9	8	4
Lithuania	1997	14	14	4
Luxembourg	1976	5	6	4
Malta	2002	3	2	2
Netherlands	1976	75	72	42
Poland	1997	131	194	67
Portugal	1986	47	46	14
Romania	1999	61	65	16
Slovakia	1995	13	27	15
Slovenia	1996	12	15	4
Spain	1986	420	303	114
Sweden	1985	31	34	14
United Kingdom	1970	106	65	66

For more information and other fact sheets visit **www.concawe.eu**

About Concawe

The scope of Concawe's activities has gradually expanded in line with the development of societal concerns over environmental, health and safety issues. These now cover areas such as fuels quality and emissions, air quality, water quality, soil contamination, waste, occupational health and safety, petroleum product stewardship and cross-country pipeline performance.

Our mission is to conduct research programmes to provide impartial scientific information in order to:

- Improve scientific understanding of the environmental health, safety and economic performance aspects of both petroleum refining and the distribution and sustainable use of refined products;
- Assist the development of cost-effective policies and legislation by EU institutions and Member States;
- Allow informed decision making and cost-effective legislative compliance by Association members.

Concawe endeavours to conduct its activities with objectivity and scientific integrity. In the complex world of environmental and health science. Concawe seeks to uphold three key principles: sound science, transparency and cost-effectiveness.

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