Chapter 4

Climate change and air pollution: what's in a name?

The modesty of the announcement, in January 2010, belied its significance. "After 35 years working for the environment the Norwegian Pollution Control Authority (SFT) changes name to Climate and Pollution Agency (KLIF). Our extensive and important field of work in climate change is now underlined."

Like SFT, KLIF reports to the environment ministry. The basic task of its 325 employees, mainly based in Oslo, is to implement government policy on pollution. In addition to climate change, its most important work involves chemicals, water and the marine environment, waste management, air quality and noise. KLIF says: "We act as guides, guardians and a driving force for a better environment. Our vision is a future without pollution."

Climate change – in particular, global warming – has become the top environmental concern of the new century for many governments and individuals, particularly in industrialized countries.

Most are convinced that the earth's climate has become appreciably warmer during the past hundred years, the so-called "greenhouse effect", and that unless we can reduce certain emissions we risk major changes in our global climate.

Such changes might well occur faster than natural ecosystems could adapt, with serious environmental and socioeconomic consequences. Changes in regional temperature and in rainfall patterns would alter conditions for farming, possibly reducing food production and agricultural income. Extreme weather phenomena might become more frequent and more violent, and our health would suffer as diseases such as malaria spread to new regions with the rising temperatures.

Rising sea levels would drown low-lying land and increase the risk of flooding. Many of the world's most diverse and productive ecosystems lie near the coast, and in most countries the population centres – and economic hubs – tend to be concentrated in coastal zones.

Because there are large natural variations in climate, it is difficult to determine the extent to which climate change is caused by human activities. But the UN Intergovernmental Panel on Climate Change (IPCC) has argued that emissions due to human activities continue to alter the atmosphere in ways that are expected to affect the climate, mainly by the generation and emission of a range of "greenhouse gases", which are thought to trap the radiant heat of the sun within the atmosphere just as glass raises the interior temperature of the greenhouse.

The majority of the IPCC's scenarios assume continued growth in emissions of carbon dioxide, the most important greenhouse gas, for most of the 21st century. Atmospheric concentrations of greenhouse gases will thus continue to rise, and average temperatures with them, until at least 2050.

In these circumstances, Norway would experience warmer winters, particularly in the northern and inland areas, while coastal and northern areas would be most affected by increased precipitation. In general, the Norwegian climate would change towards a more coastal weather pattern with less seasonal variation. Large areas of open mountain would probably become forested, and cultivation of cereals and other crops that need a warmer climate would be possible at higher latitudes than at present. On the other hand, farmers would have to deal with more kinds of plant diseases and insect pests. Fisheries might be affected by migration of key species. A warmer climate could also disrupt traditional reindeer herding in the far north.

Changes in rain and snowfall patterns would affect recreational activities and tourism. New areas might become vulnerable to avalanches and landslides. If the Arctic sea ice were to retreat, parts of the far north would become more accessible for industrial activities such as oil drilling and shipping, and to tourism – all of which would put additional strains on the environment.

There is still a great deal of uncertainty as to the most likely impact of regional changes in climate: indeed, in the past year or two the entire concept of global warming has come under fire from an increasingly influential minority of sceptics questioning the science, and in some cases the motives, behind the growth of what has become a multi-billion-dollar "climate change industry".

Norway, in the meantime, has become something of a world leader in developing clean technologies (backed up by government policies) in response to some of the challenges posited in the global warming scenario, a development examined in more detail in Chapter 6.

The ozone layer

In recent decades, man-made chemicals have broken down some of the ozone in the stratospheric ozone layer. Depletion

of the ozone layer allows larger doses of harmful ultraviolet (UV) radiation to reach the surface of the earth and increases the risk of skin cancer and infectious diseases. Almost 200 countries have signed the 1987 Montreal protocol, in which they agreed to phase out the use of substances that deplete the ozone layer.

The ozone layer is still being depleted, but recent measurements suggest that concentrations of ozone-depleting substances in the atmosphere have peaked and begun to drop. Consumption of these substances is dropping rapidly in Norway and in the world as a whole, and concentrations in the atmosphere are expected to be back to the 1980 level by 2050. The ozone layer is expected to recover significantly by 2060-2075 above Antarctica and around 2050 elsewhere.

The greenhouse effect may, however, disturb this process. Ozone-depleting substances are among the so-called "industrial" or "F" gases – synthetic fluorine compounds known as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) – controlled under the Kyoto protocol along with CO_2, methane (CH_4) and nitrous oxide (N_2O). It is the last four of these gases which contribute most to the greenhouse effect.

Greenhouse gas emissions are linked to our reliance on fossil fuels like oil, coal, and natural gas. Other major sources are waste dumps, agriculture, and household heating. In Norway, CO_2 emissions from transport, industry and petroleum activities are the main culprits.

During the 1990s, transport and petroleum emissions rose substantially while industrial emissions remained more or less stable, mainly because the increased CO_2 emissions were counterbalanced by reduced emissions of other greenhouse gases. The practical measures and policy instruments needed to limit emissions of greenhouse gases are often more wide-reaching than for other types of pollution: partly because levels of carbon dioxide emissions are closely related to general economic development, and partly because there is currently no practical means of removing CO_2 from industrial and other emissions. As a result, the way policy instruments are applied frequently involves a compromise between environmental and other interests.

A complex issue

The national instruments used to control greenhouse emissions reflect the natural complexity of the issue which affects all walks of life. In addition to traditional pollution permits under the Pollution Control Act, the Norwegian authorities now use a range of different regulations, economic measures and incentives, many of which are "works in progress" and subject to change in response to political pressures.

Most instruments still focus on technical measures, both national and international, since this is the most realistic way to achieve results in the short and medium term. A more lasting solution to the climate change issue, however, would probably demand more fundamental instruments with a far-reaching impact on how large parts of society are organized.

The Pollution Control Act has generally been used to regulate emissions of greenhouse gases other than CO_2. The environmental authorities have also negotiated voluntary agreements with various sectors of industry to limit emissions. In order to promote the development of more environment-friendly and energy-efficient technology, various grant schemes and collaborative frameworks have been established. At local level, the government encourages the drafting of "action plans" based on planning regulations to reduce emissions.

A global environmental problem like climate change can only be mitigated by binding international cooperation. Such co-operation is mandated through the UN Framework Convention on Climate Change, which provides the framework for the Kyoto Protocol, and the IPCC, which has a central role in scientific research.

Acid rain

The main causes of local air pollution in Norway are road traffic and (in winter) wood-burning stoves, mainly in towns and cities. Other important sources are industrial emissions and long-range transport of pollution from other European countries.

At national level, acid rain remains a problem in parts of southern Norway.

The expression "acid rain" first came into widespread public use during the late sixties and early seventies as a useful short-hand description – especially in newspaper headlines – of a certain kind of air pollution and its effects on the environment.

Acidification begins when fossil fuels such as coal, oil or natural gas are burned, as in power stations, factories or motor cars, releasing sulphur dioxide (SO_2) and nitrogen oxides (NO_x). Chemical reactions in the atmosphere transform these compounds into dilute forms of sulphuric or nitric acid, which may then travel very long distances, often from one country to another. The acids are deposited not only as rain, but also as snow, mist, fog, invisible gases, or dust particles.

Anthropogenic (man-made) emissions of sulphur dioxide are primarily the result of burning fossil fuels in industry and in shipping and other mobile sources. By far the largest sources of sulphur emissions in Europe are coal-fired power plants, direct oil heating and maritime traffic. About 60 per cent of all such emissions in Europe originate from power plants that burn fossil fuel, and about 20 per cent from energy use in industrial processes and manufacturing industries, especially the metallurgical industry.

Photo: Stockbyte

Most NOx emissions are products of combustion in engines and furnaces. In Europe, power plants and mobile sources – road traffic, shipping and aircraft – are the primary causes of NOx emissions. Nitrogen is also released as ammonia (NH3) from manures and in the decomposition of other organic materials.

Lightening the load

A wide range of measures has been introduced to reduce sulphur emissions in Norway and the rest of Europe, and since 1980 the pollution load has been substantially reduced as a result: in eastern Europe, mainly as a result of economic problems that have led to the closure of many factories and lower energy production; in western Europe, thanks to technological improvements.

Nitrogen emissions in Europe have proven more intractable, largely because they arise from large numbers of small and often mobile sources, such as motor vehicles, while much of the sulphur, by comparison, is emitted by a limited number of large point sources such as coal-fired power plants. The amount of energy used for transport purposes in the EU has risen steadily for decades.

Much of the southern half of Norway still suffers damage caused by acid rain, in particular the acidification of fresh water in lakes and rivers, especially in the southernmost counties. Acid rain has wiped out salmon in a number of rivers; entire fish populations have been lost and others are endangered. Even though the deposition of acid rain over Norway has been dramatically reduced since 1980, it appears to be taking many years to repair the damage to aquatic animals and plants.

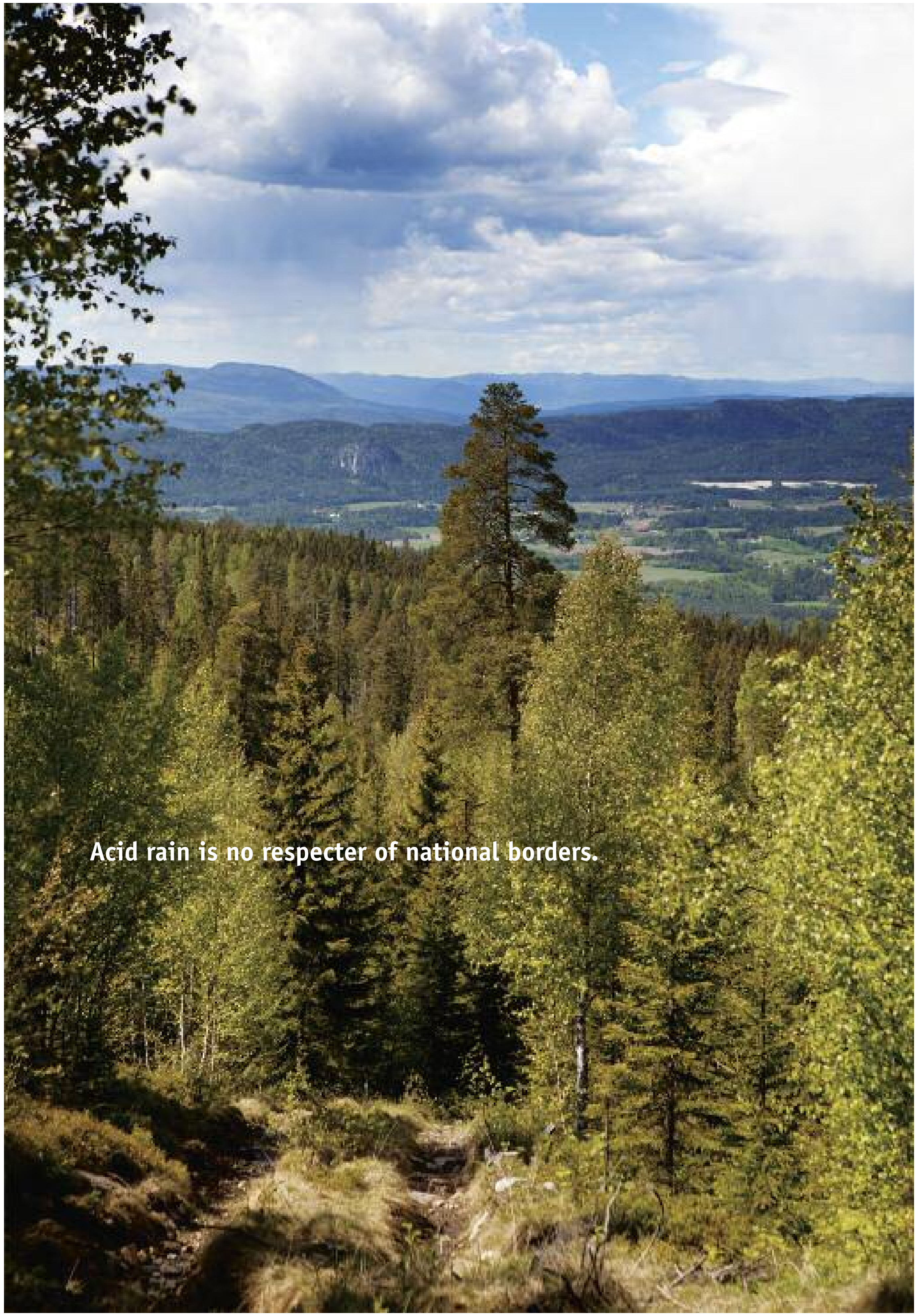
Critical loads

Most European countries are now cooperating to reduce the damage caused by acid rain. In this context, critical loads for various ecosystems – i.e. the amount of acid rain they can absorb without damage to the natural environment – have been calculated. Scientists have found a close relationship between acid rain in excess of critical loads and environmental damage.

In Norway, it is freshwater ecosystems that are most sensitive to acidification. Critical loads are particularly low in the southern half of the country, mainly because soils are thin and the bedrock consists of acidic rocks such as gneiss and granite. Sulphur has been the main cause of acid rain in Norway, and sulphur deposition is heaviest in the southern half of the country.

In the 1980s, it was found that there was widespread damage to forests in the border areas between the former East Germany, Czechoslovakia and Poland, caused by a combination of acid rain and direct deposition of sulphur. In response to concerns about similar damage in Norway, the Norwegian Monitoring Programme for Forest Damage was launched in 1984.

On the whole, Norwegian forests appear to have tolerated sulphur and nitrogen deposition without serious effects. After a decrease in the vitality of the forests during the 1990s, conditions have improved, and in mire recent years the health of Norwegian forests has been stable. Damage to fish stocks and forests results in heavy economic losses, as do the corrosive effects of acid rain on buildings, sculptures, rock art and other aspects of our cultural heritage. Acidification therefore has serious consequences for society as a whole.



About 90 per cent of the sulphur and 80 per cent of the nitrogen deposited in Norway originates in other European countries. This means that the amount of acid rain falling on Norway is determined by developments elsewhere. Some of the largest quantities of acid pollution have come from the UK, Germany and Poland. As Norway is clearly unable to solve all of its air pollution problems unless other countries reduce their emissions, the government is a keen supporter of international efforts to reduce long-range transport of pollutants.

Rising demand

As acid rain is mainly caused by combustion of fossil fuels, technological fixes such as greater energy efficiency, technological progress and the installation of equipment to control emissions can only partially offset the growing demand for energy-intensive products and services. Although the economies of the European countries have become more energy-efficient, until recently economic growth has fuelled this steadily rising demand for energy, as have growing volumes of transport and greater mobility in the EU area.

In Norway itself, the main sources of sulphur emissions are metal production, stationary combustion and other industrial processes. Norwegian emissions have been reduced from about 160,000 tonnes in the 1970s to historically low levels of around 20,000 tonnes. Continuing high levels of road traffic and coastal shipping, the most important domestic sources of nitrogen oxides, mean that improvement has been more uneven since NOx emissions peaked in 1986.

In 2008 the government signed an agreement with more than a dozen large employers' organizations exempting member companies from an unpopular tax on NOx emissions in return for voluntary cuts and annual contributions of NOK 500m to a new fund to invest in reduction measures. The three-year deal, primarily involving the shipping, fisheries and offshore petroleum sectors, is expected to reduce annual emissions by about 30,000 tonnes.

Nitrogen has more complex ecological effects than sulphur, because it can also act as a fertilizer, causing eutrophication. If nitrogen is deposited in areas where it is naturally in short supply, it can encourage the growth of vegetation; but excessive nitrogen aggravates acidification of soils and water. However, as Norway has normally had a nitrogen deficit, sulphur has been the main cause of acidification.

Since acid rain is no respecter of national borders, the answer has been to join forces to reduce overall European emissions of sulphur and nitrogen. Most countries in Europe are signatories to the 1979 Convention on Long-Range Transboundary Air Pollution, which means they have undertaken to reduce their emissions of acidifying substances. Several binding protocols have been adopted under the Convention, including two on sulphur emissions in 1985 and 1994, and another on emissions of nitrogen oxides in 1988.

The Gothenburg Protocol

A rise in nitrogen oxide emissions in 1999 caused Norway to exceed the limit set in the NOx protocol for the first time. In the same year, a new Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, known as the Gothenburg Protocol, was signed. This sets limits for emissions of several substances including sulphur and nitrogen in Europe up to 2010, when new targets are expected to be set.

Norway has undertaken to reduce its emissions of sulphur dioxide to a maximum of 22,000 tonnes in 2010 – a target, as we have seen, which has already been fulfilled – corresponding to a reduction of 58 per cent compared with the 1990 level. The targets for nitrogen are maximum emissions of 156,000 tonnes NOx and 23,000 tonnes of ammonia (NH3), corresponding to a reduction of 28 per cent for NOx and stabilization of ammonia emissions at 1990 levels. However, even with the emissions reductions expected by the end of 2010, it has been calculated that critical loads will still be exceeded in too many areas. Mortality and damage to fish stocks will therefore persist unless preventive measures such as liming of rivers and lakes are also continued.

Liming, usually carried out by boat or helicopter once a year, is an important means of remedying the worst of the damage caused by acid rain. The aim is to give animals and plants a chance to re-establish themselves by artificially reducing the acidity of their habitats. The liming programme is most extensive in the counties of Telemark, Aust-Agder, Vest-Agder and Rogaland.

Urban aromatics

At local level, air pollution is primarily a problem in urban areas. The most important components of local air pollution are particulate matter (PM10 and PM2.5), nitrogen dioxide (NO2), sulphur dioxide (SO2), ground-level ozone (O3), carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), benzene (C6H6) and other aromatic compounds.

The health risks associated with the various substances that make up local air pollution depend on their concentrations and on the length of time people are exposed to them. In the largest towns, nitrogen dioxide and particulate matter (PM10) are currently thought to pose the most serious risks to health. Exposure to these substances can result in a higher frequency of various types of respiratory complaints; particulates can also cause cardiovascular disease.

SO2 can cause lung disease, and can affect both asthmatics and otherwise healthy people. Benzene and other aromatic compounds, such as PAHs, may be carcinogenic. Carbon monoxide (CO) reduces the capacity of the blood to transport oxygen and can cause headaches, nausea and problems for heart patients. Lead levels are no longer a serious problem today, but lead can affect the nervous system, reproduction, and the formation of haemoglobin in the body, and can cause cancer.

Elusive targets

As recently as 1995, an estimated 700,000 people in Norway were exposed to levels of air pollution posing a risk of injury to health. Within a few years, however, these numbers had been reduced dramatically – by up to 80 per cent in Oslo.

Although it is clear that local air quality has improved since the 1990s, there are still problems especially in the major towns and cities. National targets for particulate matter (PM10) and sulphur dioxide have not been universally achieved.

The social costs of health damage and other adverse effects of local air pollution run into the billions, although such calculations are rather hazy because the effects at low concentrations are very uncertain and it is difficult to put a price on premature death. And of course local air pollution also injures animals and plants. NO2 and SO2 both contribute to acidification and eutrophication of lakes and rivers, while CO and NO2 are involved in the formation of ground-level ozone, which can damage vegetation and some materials, much as SO2 can corrode buildings and other structures.

Ozone also rises

Ground-level ozone is caused by the reaction of bright sunlight with volatile organic compounds (VOCs) and nitrogen oxides. In the past hundred years concentrations have doubled as the result of long-range transport from other European countries.

Grand Hotel, Oslo

In Norway, high levels of ozone occur locally only in the summer and usually for only a few hours or days. Typically, the recommended air quality thresholds are exceeded on several occasions each year. The problem is again greatest in southern Norway. High ozone levels can cause discomfort and ill-health, particularly during hot spells.

Local air pollution is generated by stationary sources such as housing and commercial or industrial buildings, or mobile sources, mainly road traffic. Measured by annual emissions, the latter is by far the dominant source.

Measures to control pollution caused by road traffic are designed to reduce the volume either of traffic or of emissions. Traffic-reduction measures are most effective if several are used in concert – for instance a combination of road pricing and parking restrictions together with improvements of public transport in towns and urban areas. Another approach is to make more active use of the Planning and Building Act when siting commercial and industrial enterprises and residential areas. This can help to reduce overall transport needs and encourage a changeover to more environment-friendly forms of transport. The National Policy Guidelines for coordinated land-use and transport planning are helpful here.

Emission standards for road vehicles are constantly being tightened, and fuel (petrol and diesel) quality is being steadily improved. Emissions from road traffic can also be reduced by changing to alternative types of fuel, such as gas, biodiesel, hydrogen or electricity, and by discouraging the use of studded winter tyres, which release particulates as they erode the road surface.

Short-term measures

Acute measures are restrictions that can be imposed on days when high pollution levels are forecast. In the largest towns and cities, the public road authorities and local authorities are responsible for introducing such measures, generally involving lower speed limits on main roads.

In the winter months, emissions from wood-burning stoves also make a substantial contribution to emissions of particulate matter: on cold days in some areas this can be the dominant source of particulates. New wood-burning stoves sold since 1 July 1997 must meet legal standards for emissions of particulates. Oslo has also introduced a scheme of partial refunds to encourage the replacement of older stoves with new low-emission models.

Other important sources of local air pollution are industrial emissions and long-range transport of pollution from other European countries. In addition to the European Convention on Long-Range Transboundary Air Pollution, an EU Directive on emissions to air from large combustion plants is intended to control this problem, as is the ambitious national emission ceilings (NEC) directive.

Various guidelines and statutory limit values have been adopted to improve local air quality. The National Institute of Public Health and the Climate and Pollution Agency have drawn up recommended air quality guidelines for a number of pollutants based on international research indicating the levels at which health effects may begin to appear. National targets for air quality have been set for several specific pollutants based on socio-economic as well as public health considerations.

Statutory limit values for particulate matter, nitrogen dioxide, sulphur dioxide, benzene, carbon monoxide and lead are set out in the Norwegian Regulations relating to pollution control, based on EU directives for local air pollution. The limit values must not be exceeded after 2005 and 2010.

Problematic conditions

Occasionally environmental policy-makers have to deal with problems that are not – for a change – man-made, but simply a result of natural conditions.

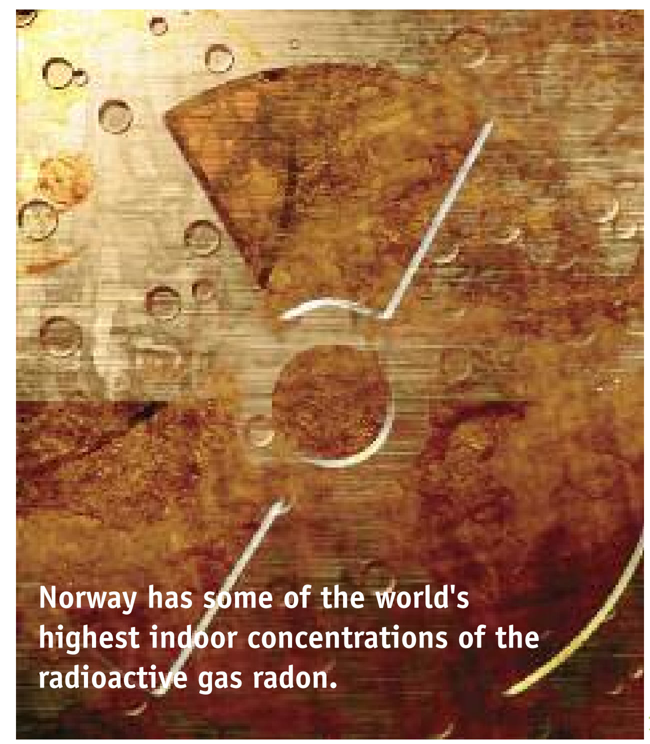
A classic example is radon, a radioactive inert gas that is formed when uranium breaks down. According to the Norwegian Radiation Protection Authority (NRPA), Norway is among the countries in the world where indoor radon reaches its highest concentrations: about 10 per cent of Norway's housing stock is at risk of high radon concentrations.

In most cases the soil and rock underneath the buildings is the source; the gas is sucked into the buildings because of small differentials in air pressure, which tends to be lower inside.

Indoor radon is estimated to cause between 100 and 300 cases of lung cancer in Norway each year. The WHO identifies radon as the second most important cause of lung cancer after smoking.

Local authorities in Norway are required to maintain an overview of the radon problem in their area. They are also required to ensure that radon levels remain below the intervention level in their buildings, e.g. schools, day care centres, municipal buildings and workplaces.

Once high radon levels have been confirmed by track-etch detectors, long-term monitors and the like, remedial measures usually involve the installation of mini-ventilation systems to equalize the air pressure. An added bonus is that such systems also save energy while improving all-round air quality.



Norway has some of the world's highest indoor concentrations of the radioactive gas radon.