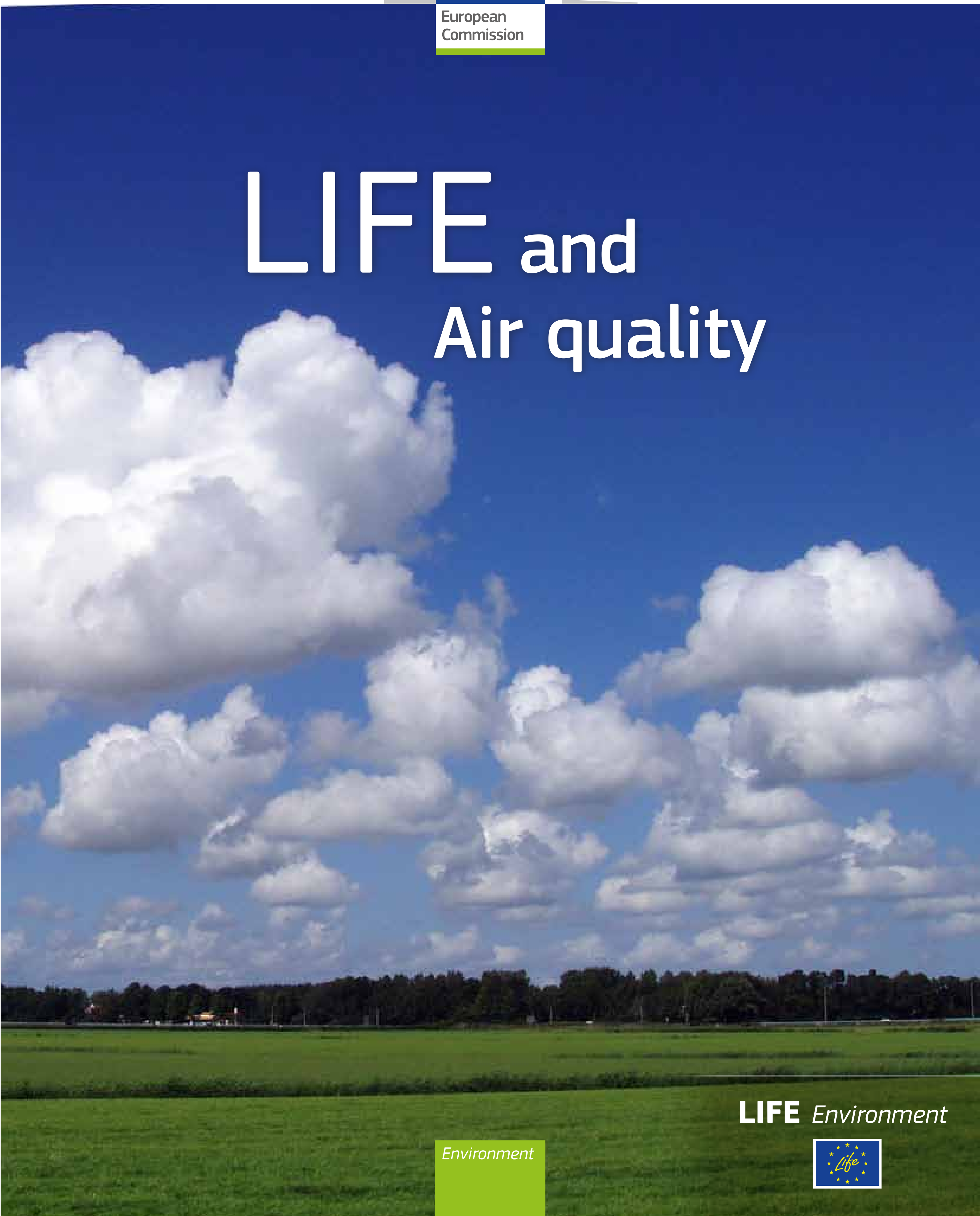
European Commission

LIFE and Air quality



LIFE *Environment*

Environment

EUROPEAN COMMISSION
ENVIRONMENT DIRECTORATE-GENERAL

LIFE ("*The Financial Instrument for the Environment*") is a programme launched by the European Commission and coordinated by the Environment Directorate-General (LIFE Units - E.3. and E.4.).

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Foreword

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The most recent Eurobarometer report* highlights the importance to citizens throughout the European Union of combating air pollution. The review of the EU air quality policy started in 2011 and confirmed that air pollution remains the prime environmental cause of death in the EU whilst also continuing to affect ecosystems, in particular through eutrophication (excess nutrients causing algal blooms, fish die-off and other ecosystem damage). The launch of the clean air policy package in December 2013 is the latest in a long line of policy and legislative initiatives introduced at European level that is designed to significantly reduce air pollution and its impacts in the EU.

The package includes legislative proposals for tightening national emission ceilings for six key pollutants (including fine particles), and a proposal for a new Directive to reduce pollution from small and medium-sized combustion plants. It sets out implementing measures to resolve the compliance problems with existing air quality standards and to clear the pathway for adjusting those towards the tighter levels recommended by the World Health Organisation for the period up to 2030. The package also sets out further capacity building measures supporting national, regional and local authorities in taking effective action explaining the benefits of those actions to the general public and specific interest groups (motorists, farmers, industry, etc.).

As this publication highlights, the LIFE programme is one of the tools through which such capacity can be built. LIFE Environment co-funding has been used to support projects that have mainstreamed air quality concerns in key areas such as transport, energy and agriculture. LIFE projects have demonstrated cost-effective ways of reducing air pollution either as a direct aim or as an indirect consequence of reducing pollution of soil and water, combating climate change and so on. The majority of projects have taken an integrated approach that has proven beneficial to the environment as a whole.

This publication also indicates areas where LIFE projects could be better aligned with air quality policy priorities to achieve a greater multiplier effect. Chapters focus on issues ranging from sustainable urban mobility to monitoring and modelling air pollution, building capacity, raising awareness and encouraging less-polluting behaviour. The thematic focus on the agricultural, industrial and energy sectors is designed to have a significant impact on air quality throughout Europe.

LIFE projects can also provide valuable information for those seeking to unlock the potential of EU Structural Funds to better mainstream air quality objectives in clean transport solutions, the low carbon economy and low-emission agriculture. In addition, the creation of 'Integrated Projects' under the new LIFE Programme (2014-2020) provides a means of jointly funding LIFE projects that implement environmental policy on a large territorial scale. The LIFE Environment Multiannual Work Programme for 2014-2017 foresees Integrated Projects as a new means of supporting the development and implementation of Air Quality Plans across Regions at national or transboundary level. These will be an important step towards delivering the objectives of the new European Clean Air Programme.

* *http://ec.europa.eu/public_opinion/flash/fl_360_en.pdf*

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INTRODUCTION

EU continues **to target improved air quality**

New policy initiatives to build on the valuable achievements of earlier European legislation.

Photo by Moises.on/CC BY 2.0

The clean air policy package will further reduce harmful emissions from industry, traffic, energy plants and agriculture

Eurobarometer surveys have shown the importance EU citizens place on ensuring good air quality. This is understandable when you consider that poor air quality is the leading environmental cause of premature death in the EU. Indeed, some 87% of Europeans believe that respiratory diseases, asthma and allergies are a serious problem[1], whilst a survey on urban mobility found that 81% of Europeans believe that air pollution is a problem within cities[2]. The European Union has long recognised the need to tackle issues affecting the air we breathe. Since the 1970s, a raft of legislation has been put in place to assess and manage air quality, as well as to limit harmful emissions, improve fuel quality and integrate requirements for environmental protection into a number of sectors (see box p.4).

These policy tools have played a significant role in reducing concentrations in ambient air of harmful pollutants such as sulphur dioxide (SO_2 - the main cause of acid rain), particulate matter (PM_1), lead, nitrogen oxides (NO_x – NO and NO_2), carbon monoxide and benzene. However more remains to be done, particularly with regard to airborne pollutants such as fine particulates and ozone, which present significant health risks when limits are exceeded.

Thus, in December 2013, the European Commission adopted a new clean air policy package designed to update existing legislation and further reduce harmful emissions from anthropogenic sources with a view to reducing their impact on human health and the environment. The clean air package includes the following components[3].

- A Clean Air Programme for Europe, comprising both measures to ensure existing air quality targets are met and new air quality objectives for 2030. The programme will focus in particular on improving air quality in cities, supporting research and innovation and promoting international cooperation, with the aim of avoiding 58 000 premature deaths and saving 123 000 km² of ecosystems from nitrogen pollution (an area three times the size of the Netherlands). The expected direct health benefits alone are calculated to be some €3 billion annually.
- A proposal for a revised NEC Directive, with stricter national emission reduction commitments for the

1 http://ec.europa.eu/public_opinion/flash/fl_360_en.pdf
2 http://ec.europa.eu/public_opinion/archives/ebs/ebs_406_en.pdf

3 http:// ec.europa.eu/environment/air/clean_air_policy.htm

six main pollutants - SO_2, NO_x, non-methane volatile organic compounds (NMVOC), ammonia (NH_3), fine particulate matter ($PM_{2.5}$) and methane (CH_4)[4]; and
- A proposal for a new Directive to reduce pollution from medium-sized (1-50 MW) combustion plants.

Urban mobility package

Also in December 2013, and in response to the concerns of European citizens highlighted above, the European Commission launched an "urban mobility package" designed to tackle air quality and other problems linked to urban transport, such as severe congestion, noise emissions and carbon dioxide (CO_2) emissions.

The package consists of a Communication, "Together towards competitive and resource-efficient urban mobility"[5], supported by an annex that sets out the concept of Sustainable Urban Mobility Plans, as well as four staff Working Documents (on urban logistics, urban access regulations, deployment of Intelligent Transport System solutions in urban areas, and urban road safety).

4 The new Directive ensures that the NECs set in Directive 2001/81/EC for 2010 onwards for SO_2, NO_x, NMVOC and NH_3 shall apply until 2020 and establishes new national emission reduction commitments applicable from 2020 and 2030 for SO_2, NO_x, NMVOC, NH_3, $PM_{2.5}$ and CH_4, as well as intermediate emission levels for the year 2025 applicable to the same pollutants.

5 http://ec.europa.eu/transport/themes/urban/doc/ump/com(2013)913_en.pdf

The Urban Mobility Package aims to foster cooperation, showcase best practices, provide targeted financial support and focus research and innovation to deliver solutions for urban mobility challenges.

Targeted measures

Transport and urban mobility is one of the key air quality themes supported by EU policy that is addressed by this publication. Another is agriculture, which is a major source of emissions of ammonia. The clean air package also addresses the impact of energy production on air quality, with PM generated from biomass and coal combustion a priority.

The revision of the NEC Directive also strengthens coherence with the assessment and management of air quality standards contained in the Ambient Air Quality Directive (2008/50/EC) and with climate change mitigation, and will contribute to limiting climate change. Annex V of the revised Directive, which includes enhanced provisions on inventories, projections, and ecosystem monitoring, emphasises the importance of modelling and monitoring the effects of pollutants in order to increase the effectiveness of implementation.

With regards to another important theme – reducing pollutant emissions at source from the industrial, waste and energy sectors – the key European-level policy tool is the Industrial Emissions Directive (IED), the successor to the IPPC Directive. The IED aims to prevent or control pollution from industry through an integrated approach that recognises the whole environmental performance of a plant, with permit conditions, including emission limit values (ELVs), based on the Best Available Techniques (BATs), as defined in the BAT conclusions adopted by the Commission. In addition, the IED sets EU-wide emission limit values for a number of activities (large combustion plants, waste incineration, activities using solvents).

The plethora of cross-cutting initiatives linked to air quality highlights the seriousness with which policy-makers take this issue. It also makes it doubly important to look more closely at the role the LIFE programme can play in demonstrating effective and cost-effective ways to implement these policies and packages.

EU air policy targeted by LIFE projects

There is an extensive body of EU policy relating to air quality that has been targeted by LIFE projects. This includes the following:
- Geneva Convention on Long-Range Transboundary Air Pollution and the related Council Decision on the conclusion of the Convention on long-range transboundary air pollution (81/462/EEC);
- Clean Air Policy Package (18 December 2013);
- Ambient Air Quality Directive (2008/50/EC);
- Industrial Emissions Directive (IED) (2010/75/EU). This brings together in one Directive on industrial emissions, the 'IPPC Directive' (2008/1/EC) and six other directives, including the Waste Incineration Directive (2000/76/EC), the VOC Solvents Emissions Directive (1999/13/EC) and from January 2016 the Large Combustion Plant Directive (2001/80/EC);
- The National Emission Ceilings for certain atmospheric pollutants Directive (2001/81/EC) (currently under revision);
- Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles;
- Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee of 28 April 2010 - A European strategy on clean and energy efficient vehicles [COM(2010)186 final]; and
- Directives relating to the reduction of VOC emissions from petrol storage and distribution (94/63/EC); and from the use of organic solvents (1999/13/EC).

INTRODUCTION

LIFE's contribution to air quality management

For more than two decades, LIFE Environment has helped support the implementation of air quality policy and legislation by co-financing innovative projects that explore ways to facilitate their enforcement throughout the EU.

Air quality has been the third biggest focus of the LIFE programme in terms of funding (behind water and waste). Since 1992, a total of 298[6] projects across Europe have directly sought to improve air quality, with many more having an indirect impact on the air we breathe as a co-benefit of their core actions. Total funding for the 298 LIFE projects amounts to €628 million, of which the EU contributed some €217 million.

Originally, these projects mainly focused on demonstrating integrated and innovative approaches to addressing air pollution from industrial activities. With the adoption of the former Air Package (2005) and Ambient Air Quality Directive (2008), the focus of LIFE projects has shifted to supporting local and regional authorities (LRAs) and dealing with the issues that hinder implementation. LIFE has demonstrated viable solutions for certain industries, agriculture and city administrations, developed modelling and monitoring tools and has contributed to changing citizens' behaviour. Notwithstanding these positive results, there is still great scope in the new programming period to more closely align project aims and outputs with policy priorities[7].

Photo: LIFE09 ENV/AT/000226

LIFE funding has helped in making urban mobility more sustainable across the EU

Sustainable urban mobility

For towns and cities to keep air pollution below limit values for key pollutants, policy-makers are increasingly focusing on sustainable urban mobility challenges. Since 2000, some 31 LIFE projects have targeted transport or mobility issues (see pp. 13-20), including demonstrating the use of alternative-fuelled vehicles, promoting cycling and other low-impact means of transport, implementing Low Emission Zones (LEZ) and greener logistics. Although valuable in their own right, these projects have tended to focus on single solutions, rather than contributing to an integrated Sustainable Urban Mobility Plan (SUMP) that was linked with or embedded in a wider Air Quality Plan. There are also significant gaps in terms of coverage, with issues such as the provision of infrastructure for non-petrol or diesel vehicles, rail and shipping solutions and urban freight logistics being little addressed by LIFE to date.

The LIFE programme (2014-2020) should thus concentrate more on projects that support local authorities in their efforts to integrate urban and peri-urban mobility within a SUMP and within sustainable urban planning in general. Other areas that would benefit from additional LIFE support include demonstrations of the practicality of LEZ and road-pricing schemes, development of alternative drive train technology, facilitation of cleaner driving, clean shipping and the use of innovative logistics platforms for last-mile delivery of goods.

6 Source LIFE project database

7 See LIFE multiannual work programme for 2014-2017 -(OJ L 116, 17/04/2014)

Photo: LIFE11 ENV/DE/000495/Kåre Press-Kristensen

CLEAN AIR project measuring ultrafine particles in Prague

Monitoring and modelling

LIFE has helped bridge the gap between European-scale air quality modelling and the local scale at which planners operate, through projects that respectively translate from emissions inventories and models common to the whole EU to models customisable by local and regional planning officers. LIFE has supported projects whose data collection takes the topography of a particular urban area into consideration, enabling the creation of emission inventories that are well targeted to the sources of pollution and updated as frequently as appropriate. The programme has also co-funded a whole set of projects that have mapped and modelled health risks linked to specific airborne pollutants.

More recent projects have attempted to make complex models more easily understandable and useful by city planners and the general public, including incorporating a cost-benefit analysis of the impact of different air quality management measures to improve decision-making. The success of such models has been built upon good input data and more detailed emission inventories, which in turn enable the most technically and economically effective pollution reduction measures to be introduced to help reach compliance with relevant air quality legislation.

Monitoring projects have focused not only on traffic pollution, but also on other 'hotspots' such as ports and industrial sites, and have provided some insight into micro- and macro-siting of monitoring stations. They have also focused on the objective of getting high resolution and timely information to citizens and decision-makers.

There is scope for LIFE projects to respond to the National Emission Ceilings Directive (NECD)'s call for Member States to monitor the impact of air pollution on different ecosystems. No LIFE projects to date have addressed this issue, yet 70% of the EU's protected natural sites within the Natura 2000 network suffer from eutrophication as a result of air pollution. The Integrated Projects sub-programme of the new LIFE programme could be a means of delivering large-scale capacity building, including monitoring across regions or whole countries and contributing to National Air Pollution Control Programmes.

Capacity building

Some LIFE projects have helped to reinforce the ability of local decision-makers to gather, interpret and act upon air quality data within the context of an integrated air quality plan based around the requirements of EU policy and legislation. In the past, LIFE projects tended to build this capacity as an indirect consequence of the objective of achieving compliance with air pollution thresholds. But in addition to tools and training packages, most of the more recent projects have begun to forge links between scientific/environmental agencies and consultants and local authorities. Such synergies increase the capacity to use monitoring and modelling tools and translate their results into effective measures. Future LIFE projects could build on these lessons and deepen such links, thereby strengthening the effectiveness (and cost effectiveness) of policy implementation.

Encouraging behavioural change

Air policy objectives can also be achieved using 'softer' non-regulatory measures such as awareness-raising programmes and events encouraging behavioural change. LIFE has been particularly effective at this and has helped catalyse the growth of the 'car-free days' movement and establish European Mobility Week as a major annual event. Other projects have used technology such as electronic roadside signs and smartphone apps to spread air quality alerts or provide easily understood real-time information.

In addition to using technological advances and educational campaigns - such as ones linking greener mobility with improved health and quality of life - projects have sought to provide less-polluting alternatives to existing modes of transport.

Going forward, the Environmental Governance and Information strand of the new LIFE programme for

2014-2020 could be used more effectively to raise awareness about air quality, to promote collective action and to influence personal behaviour. A future task for the programme could be to quantify the air quality benefits of softer measures. Ideally projects would report both on how behaviour has changed and on the impact of that change on air quality.

Agriculture

Many LIFE projects have assessed nitrogen management, taking into account the full nitrogen cycle leading to quantifiable impacts on reducing harmful ammonia emissions from agriculture, sometimes as a direct objective, but more frequently as an indirect co-benefit of actions to address water or soil pollution or to reduce greenhouse gas (GHG) emissions. However, these projects have almost never measured ammonia release. Tools developed by projects to measure GHGs could be extended to other pollutants such as ammonia and PM.

LIFE projects have brought sustainable results as they have produced economically-viable solutions addressing concerns from EU farming communities and by engaging actively with farmers to adopt farming practices that improve air quality, in particular through on-farm demonstrations in real-world conditions, accompanied by education and targeted knowledge transfer.

LIFE's existing work in addressing ammonia emissions challenges and its acceptance by the farming community could help Member States to make Codes of Practice for ammonia operational by 2020 (as required by the NECD).

Issues that LIFE has little addressed include: the production of black carbon from burning agricultural waste; and delivering low-protein feeding strategies for livestock that help reduce ammonia emissions. It will be important for future projects to focus their actions on farming systems with the greatest potential for making long-term positive improvements to the quality of Europe's air.

Industry, waste and energy

LIFE has helped reduce air emissions in a wide range of industrial sectors (see pp 59-65), with project actions often explicitly linked to targets set out in the Industrial Emissions Directive (IED) and its predecessor, the Integrated Pollution Prevention and Control (IPPC) Directive. One of the strengths of the programme has been that it has favoured projects with an integrated approach providing benefits for the environment as a whole, in line with the IPPC principle.


Photo: LIFE12 ENV/IT/000578/ERSAF

Application of fertilisers through precision farming reduces ammonia release

LIFE has developed and demonstrated clean technologies and end-of-pipe solutions, primarily targeting emissions of non-methane volatile organic compounds (NMVOCs), but also nitrogen oxides (NO_x), sulphur oxides (SO_x), and particulate matter (PM_{10} and $PM_{2.5}$).

By supporting the development of innovative prototypes that improve on current best available techniques (BATs), LIFE has contributed to the overall aim of reducing the negative impact of industry on human health and the environment.

LIFE-funded prototypes have sometimes proven to be commercially unviable when scaled up, so future projects need to consider the economics from the outset, particularly as the LIFE multiannual work programme for 2014-17 recommends that future project proposals include plans for upscaling and replicating technologies and solutions to mobilise their wider uptake.[8]

A programme-level gap has been in terms of action to reduce emissions from medium-sized combustion plants. In the current period LIFE should promote local and regional energy projects addressing air quality, targeting in particular emissions of particulate matter (PM) in PM "hotspot" areas with continued high use of coal- and biomass-fired heating installations.

In conclusion LIFE has made a meaningful contribution to the practical implementation of EU air policy. With fine tuning and careful targeting of resources and priorities, the programme can continue to multiply the impact of project outcomes to improve air quality.

8 See LIFE multiannual work programme for 2014-2017 -(OJ L 116, 17/04/2014)

INTRODUCTION

Struggle for clean air enters a new phase

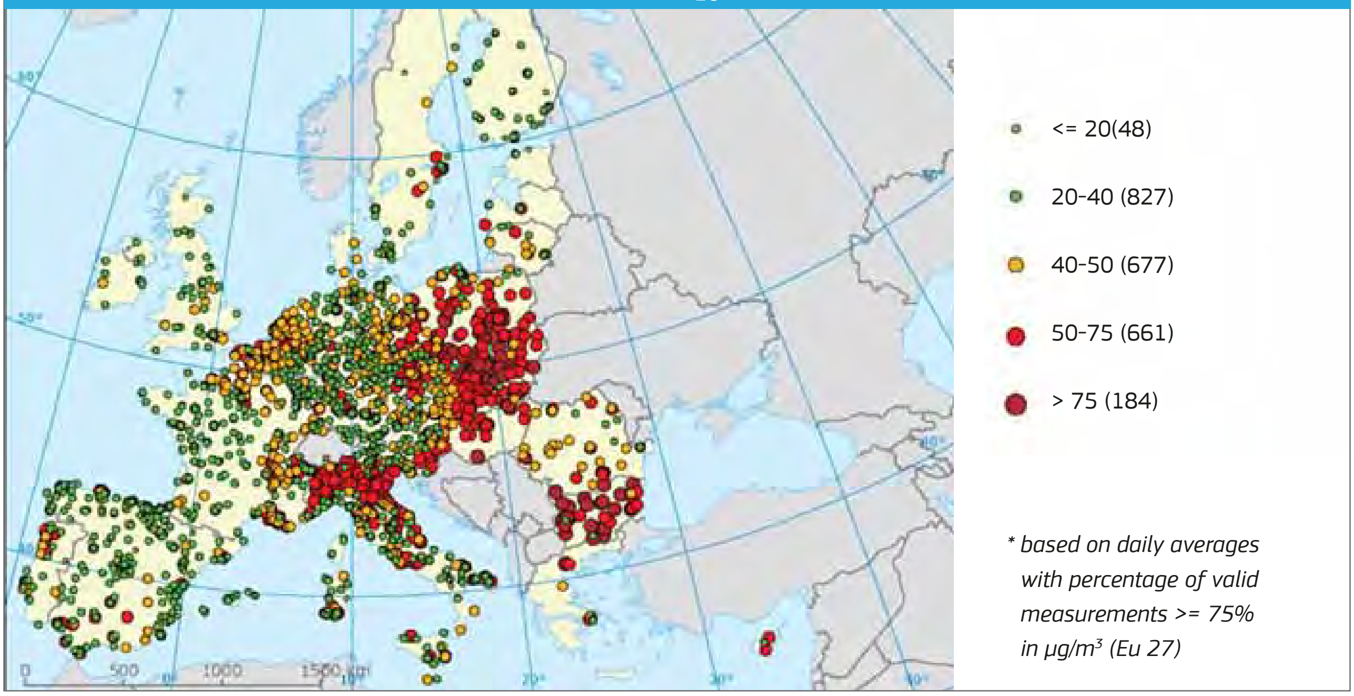
"Although we have made giant steps in reducing air emissions in the EU, air pollution is still damaging our health and the environment," warns Paul McAleavey, Head of the Air and Climate Change programme at the European Environment Agency (EEA).

Paul McAleavey

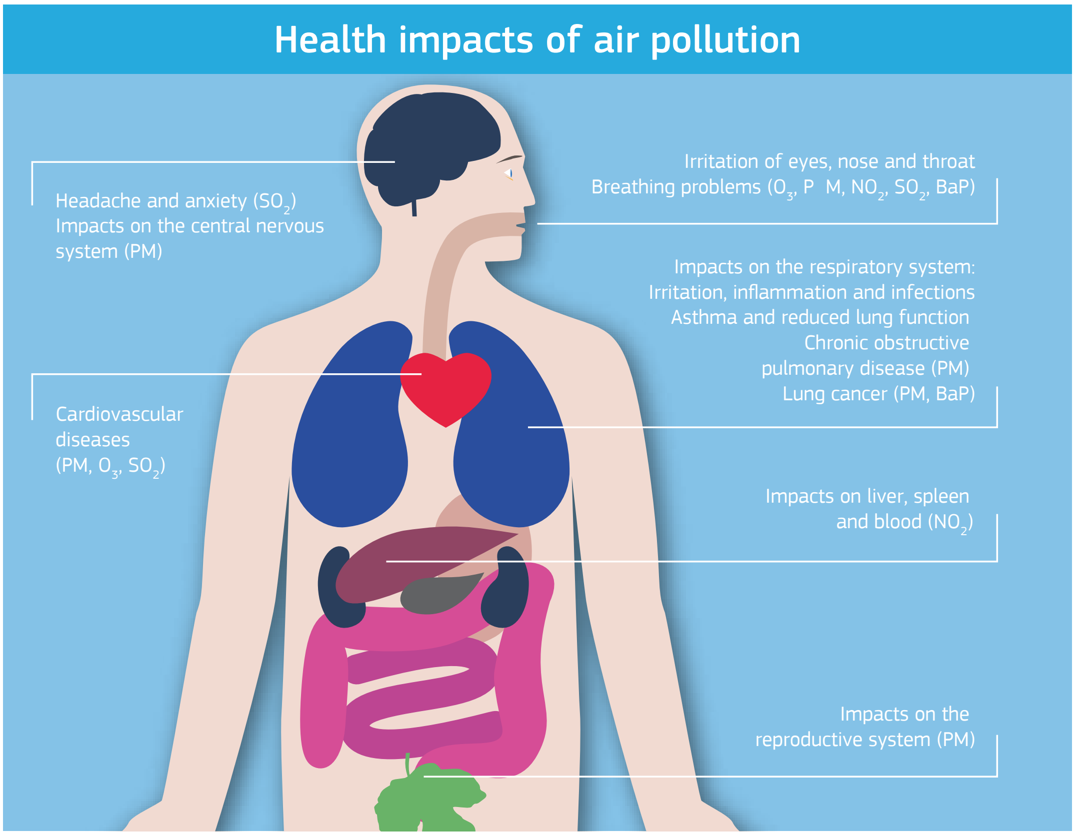
New measures proposed in the clean air package unveiled in December 2013 (see pp. 4-5) are essential to meet the challenge of improving air quality. Speaking on behalf of the EEA, Paul McAleavey says that "the package was a very important milestone, but Member States, regional and local authorities do not need to wait to introduce new emissions cuts. Action is needed at all scales now to address air quality attainment issues."

Whilst there is still a need for new legislation - such as the proposal for a Directive on medium-sized combustion plants - in order to achieve further reductions in NOx, SO_2 and PM - Mr McAleavey emphasises that the challenge is also to ensure the effective implementation of existing legislation. A European pilot project focusing on 12 European cities was carried out by the EEA and the European Commission, as part of the review process leading up to the clean air package, to identify and address the reasons for the 'gap' in the implementation of air quality policy, and thereby draw lessons of wider relevance (see box p.10). The aim was to find effective ways of dealing with 'problems on the ground' that hinder implementation of environmental policy. The main issues for local planners that were addressed were related to: setting up emission inventories, use of modelling tools, criteria for siting of monitoring networks, management practices, capacity building, and awareness raising.

Annual mean particulate matter (PM_{10}) 2011 and number of stations*



* *based on daily averages with percentage of valid measurements >= 75% in µg/m³ (Eu 27)*



Source: EEA

Air pollutants can have a serious impact on human health. Children and the elderly are especially vulnerable.

"It was very interesting and instructive to see the different ways in which the cities approached implementation and to see that they often faced common challenges," says Mr McAleavey. For example, cities had different experiences when it came to preparing emission inventories - data that are often fed into local air quality models. "The city of Dublin made a new investment in inventory work as a result of taking part in the pilot. So the cities clearly learned from each other. They also felt they needed standard guidance for setting up and siting the monitoring networks and for the modelling tools which could inform cost-benefit analyses and facilitate more informed choices," he adds.

"Overall, what we found was that there was no lack of willingness to implement legislation, but that local planners were having difficulties interpreting and then implementing the requirements linked to legislation," explains Mr McAleavey. "The pilot enabled them to exchange best practices and to identify solutions."

LIFE for air policy

The Air Implementation Pilot will continue to have resonance, according to Mr McAleavey. "We believe that the next calls of the LIFE programme could also be used to follow up on some of the issues that were highlighted through the pilot. The programme can finance projects in exactly the thematic areas that were identified, but this shouldn't be done in a scattered way. The focus needs to be on some of the priority geographical areas that face the greatest issues in terms of air quality."

LIFE could help facilitate the exchange of information amongst cities so that they can continue this dialogue, learn from one another and exchange best practices in a larger network of cities. "There is clearly a need for some sort of exchange or learning mechanism between cities," says Mr McAleavey, However, he suggests that this structure should not be too "heavy", but rather could draw lessons from the Covenant of Mayors and cities for climate adaptation[9]. "Maybe instead of just setting up another European structure for exchange of best practice on air quality, one could think of how to build upon these already existing structures," he adds.

EU legislation on air quality recognises the role that the LIFE programme can play in developing and implementing policy on air pollution control in Member States. LIFE funding might not only be

9 http://mayors-adapt.eu/

used to fund projects on those issues that were raised by the Air Implementation Pilot, but it could be used for other policy priorities, such as fuel switching. “Other projects could focus on local and regional energy projects addressing air quality and emission reductions in atmospheric particulate matter (PM) hotspots in areas with continued high use of coal- and biomass-burning heating installations,” he says.

Scope also exists for LIFE projects to demonstrate ways to reduce ammonia and PM emissions from agriculture; test prevention and abatement techniques referred to in the Industrial Emissions Directive; and demonstrate innovative approaches to sustainable urban planning and mobility.

Air Implementation Pilot

The Air Implementation Pilot aimed to better understand the challenges cities faced in implementing air quality policy, and also encouraged the 12 participating cities to share their experiences, so they could learn from each other and see what has worked and not worked and the reasons why. The pilot also aimed to develop common proposals to help improve implementation of air policy. The pilot focused on five ‘workstreams’, where lessons for implementation could most usefully be drawn. The workstreams were: local **Emission Inventories** (EI) - sets of data that show what pollutants are emitted and from which sources; **modelling** and the use of air quality models; **monitoring networks** that take regular measurements of air quality; **management practices** and different administrative measures; and, finally, **public information**.

The knowledge base

The EEA work programme for the next five years has recently been adopted. “Firstly, the time perspective of our assessment work is lengthening,” points out Mr McAleavey. “We are not just measuring the efficiency of policy in achieving short-term targets, but we are also trying to establish if, through these measures, we are on the right track for the long-term targets set for 2020 or even 2050.”

A good example is found in the emission targets for cars; the EEA is responsible for checking whether manufacturers are in line with the 130g CO_2/km limit for emissions from new vehicles by 2015. This target will be tightened to 95g CO_2/km in 2021, but as well as measurement, the EEA’s role will also be to question whether “we are on track for where we need to be in achieving sustainable mobility in the longer term, even if manufacturers achieve these short-term targets?,” says Mr McAleavey.

Secondly, the EEA is focusing on ‘societal transitions’ – for example, if the 2050 target of achieving air quality that is not harmful to human health is going to be reached, then there need to be changes in the way societal systems operate, such as those for mobility, energy and food. Societal transitions will not be brought about through legal instruments alone, but will require structural changes as well as changes in attitudes, values, norms and behaviour.

Another focus of the new EEA work programme is on policy evaluation: “Not just looking at numbers but assessing if policy is delivering what it’s intended to deliver,” Mr McAleavey explains.

The EEA is also eager to emphasise the importance of building up the knowledge base for EU environment policy, as prioritised in the 7th Environment Action Programme. “We see ourselves in the agency as being an organisation that contributes to the knowledge base and I think that LIFE can be, and should be, an important part of that too,” believes Mr McAleavey. For instance, LIFE projects could consider the societal transitions needed to achieve long-term policy targets when planning how to deliver their short-term objectives. “The EEA is interested to learn more from the LIFE programme and see how it can complement what we are doing, and to see how we can complement what LIFE is doing,” concludes Mr McAleavey.

INTRODUCTION

Prague experience highlights **importance of dialogue between cities**

"Improved dialogue and a platform for exchange of knowledge between stakeholders is a must for air quality implementation," believes Mária Kazmuková, Engineer with the Prague Institute of Planning and Development, who represented the Czech capital in the EU Air Implementation Pilot.

Ms Kazmuková says that the AIP provided "a great opportunity to share experiences, to see how other cities are trying to implement air quality legislation and to see that all cities are facing more or less the same problems."

The pilot exercise gave participating cities the chance to discuss the issues in order to find solutions, share knowledge and interface with the scientific community and EU policy-makers, she explains.

The AIP highlighted the fact that each city had its own Emissions Inventory (EI) and its own ways of compiling the inventories. This created problems of comparability and "it was sometimes difficult to comprehend all sources of pollution," says Ms Kazmuková. Holes in the data also affected the reliability of modelling. "If the EI is not reliable, then the model does not produce reliable results," she explains.

"It was a fruitful experience to be able to interface with top scientists from the EEA and other institutions and to see how they try to evaluate these discrepancies," reveals Ms Kazmuková. "For example with monitoring, there is a problem with the representativeness of the monitoring stations and we requested requirements for macro and micro-siting of the stations."

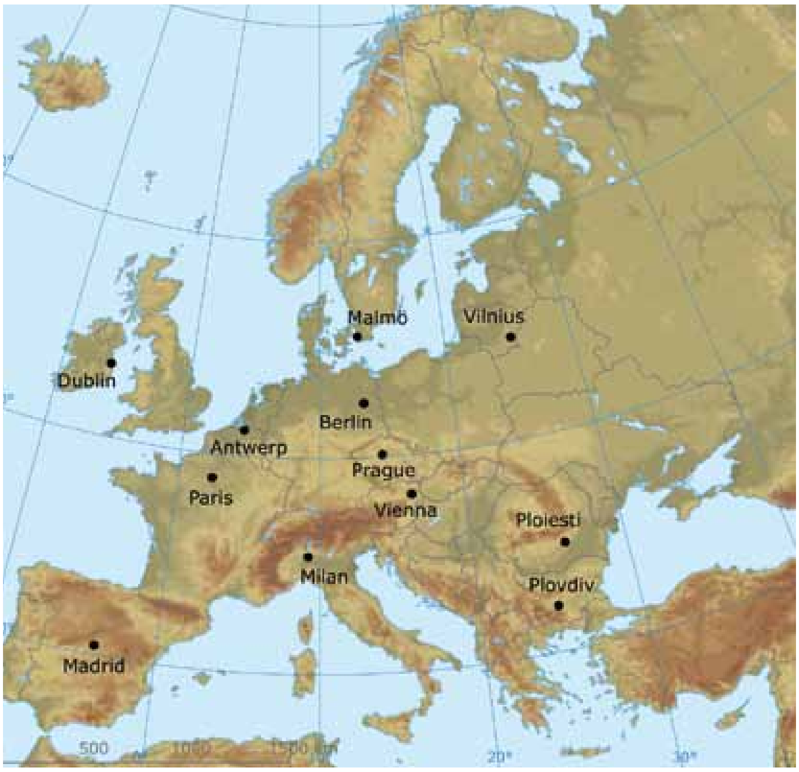
The pilot enabled participants to go through all the stages of air quality implementation and methodically pinpoint and discuss problem areas. "Of course the situation cannot change in one year but we all realised that there is much need for a continuous dialogue between the scientific community and the administrations responsible for air quality implementation," says Ms Kazmuková.

Mária Kazmuková

Speaking the same language

She highlights the importance of building upon the work of the AIP, for instance by means of a LIFE-funded project that would expand the pilot approach to more cities and set up a platform for exchange of best practices. "The scientific community should

The 12 cities that participated in the AIP



Source: EEA

Photo: Ing. Miroslav Zeman - MZO MHPP, Praha

Electric cars running in the city of Prague

be involved in creating this knowledge base. We need to have a platform where similar agglomerations can talk about their similar problems, believes Ms Kazmuková. "This would enrich us all."

She adds that "a platform at EU level where cities, regional planners and the scientific world can exchange information and discuss problematic areas would help in our capacity building. The platform would provide us with more information, knowledge, best practices. It would also allow [cities] to develop a common approach to data collection for EI, modelling tools and monitoring stations. It will allow us to speak the same language and to take larger steps in implementing air quality legislation; to speak about the same data, as that hasn't been the case until now."

Addressing Prague's air quality problems

The pilot demonstrated that Prague had many small problems at every stage of the implementation process. Some have already been solved and the others are being addressed. Ms Kazmuková stresses that "a clear set of standard guidelines on EI, monitoring and modelling would help us enormously in adopting correct measures in our planning documents and in implementing legislation. However, she adds the caveat that whilst models should be similar they must take into account an area's specificity: "We do not want a unique model for all cities but we want a common understanding of the approach."

Another issue that city or regional administrations face is how to choose between different measures, beyond a simple selection based on the results in terms of air quality. Models are "very rarely" accompanied by a cost-benefit analysis," she notes. "This makes it difficult to choose."

The AIP has helped Prague to take a more informed opinion on the models and scenarios provided by its external consultants. "We don't just receive the results passively from the consultants as we have a platform where we can compare these results," says Ms Kazmuková. Thus the pilot has demonstrated the importance of creating a knowledge base and this has, in turn, fed back to the scientific community.

Ms Kazmuková believes that Prague's urban planners would benefit from further training to interpret the results of the models and, with a cost-benefit analysis (something current models lack), translate those results into measures that are good for citizens' health and the environment: "We would like to learn how to collect the right data from the emission sources, how the models work, what are their limitations and how to interpret the results."

Future actions

The cities that took part in the AIP are continuing to exchange information. For instance, Prague is learning about Berlin's experience with Low Emission Zones (LEZ), prior to its own implementation, which is planned for 2015. The Czech capital is also considering following Vienna's lead by introducing 30 km/h zones. Paris's experience with car-sharing of electric vehicles and Madrid's online air pollution updates for citizens are other sources of inspiration for Prague.

"We also want to give more information and raise awareness on the health effects that air pollution causes," says Ms Kazmuková. "Changing people is very difficult, especially when we are talking about an invisible threat such as air pollution. People do not see how it is affecting and harming their health and environment. Before when air pollution was more linked to sulphur dioxide, it had a smell and people reacted. Now emissions are odourless and so citizens do not recognise the harm [being caused]. That is why our next campaigns will focus on health issues, so that people realise that their children, grandparents and friends are all endangered by air pollution."

SUSTAINABLE MOBILITY AND TRANSPORT

LIFE helps **tackle sustainable mobility challenges**

The LIFE programme has demonstrated a range of approaches to improving air quality in cities. Integrating these into Sustainable Urban Mobility Plans is the ultimate goal.

EU legislation has helped reduce vehicle emissions of many air pollutants (e.g. lead, SO_2). However, urban mobility is still heavily reliant on the use of conventionally-fuelled private cars. In many European towns and cities car use contributes to chronic traffic congestion, a problem that is estimated to cost €80 billion annually[10], as well as reducing the ability of municipalities to meet concentration limits for air quality pollutants. In 2011, annual limit values for nitrogen dioxide (NO_2), which can cause asthma and other respiratory problems, were exceeded at 42% of European Environment Agency (EEA) traffic monitoring stations and the daily limit value for PM_{10} was exceeded at 43% of sites[11].

Recent developments in EU policy are addressing the issue of urban air quality, in particular through the clean air policy and urban mobility packages (see pp. 3-4). The former focuses on general air pollution reduction requirements – setting National Emission Ceilings for the six main pollutants and introducing measures to ensure that existing targets are met in the short term, as well as new air quality objectives for the period up to 2030. Central to the latter is the need to develop sustainable practices, such as energy-efficient and affordable public transport, user-friendly cycling and walking routes, and a holistic approach that connects local and regional transport networks and positions peri-urban transport

10 *Together towards competitive and resource-efficient urban mobility COM(2013) 913 Final*

11 *A closer look at urban transport: TERM 2013: transport indicators tracking progress towards environmental targets in Europe*

Sustainable Urban Mobility Plan (SUMP)

A SUMP defines a set of interrelated measures designed to satisfy the mobility-related environmental needs of people and businesses. They are the result of an integrated planning approach and address all modes and forms of transport in cities and their surrounding area. So far, few European cities have implemented SUMPs and a wider understanding of their benefits is needed. Central to the SUMP concept is the idea of embedding urban mobility in a wider urban and territorial strategy. Therefore, these mobility plans should be developed by different branches and levels of local administrations (including - alongside transport - departments such as health, environment, economic development, spatial planning, energy policy, etc) and in cooperation with authorities in neighbouring (urban and rural) areas.

SUMPs aim to foster balanced development and better integration of different urban mobility modes. As a people-centric planning concept, SUMPs emphasise citizen and stakeholder engagement, as well as fostering changes in mobility behaviour.

CEMOBIL made electric vehicles available to organisations and the public in Klagenfurt (Austria)

networks within the context of overall land use and spatial development. Similarly, it is acknowledged that there is a need for better integration of different urban mobility systems, encouraging citizen and stakeholder engagement, as well as changes in behaviour.

Sustainable Urban Mobility Plans (SUMPs) are identified as an important element of the new urban mobility strategy (see box p.13) and should be linked to Air Quality Plans under Directive 2008/50/EC for coherence and synergy effects.

LIFE and urban air quality

Since 1992, the LIFE programme has co-financed some 80 projects covering aspects of urban mobility and transport-related themes[12]. Projects relevant to this chapter have varied considerably in scope and have tended to address urban mobility measures in isolation, rather than integrated into a SUMP.

The difficulty of doing the latter is shown by the example of the UK project CATCH, which attempted to address all the stages of urban mobility planning, from the development of advanced pollution monitoring techniques and infrastructure and use of hybrid buses to the development of community mobility plans and partnership initiatives with cities in Italy (Potenza) and Romania (Suceava).

Although the project achieved notable successes, such as demonstrating 95% reductions in PM emissions and 15% reductions in NO_x emissions from the buses used, the scale of the project implied considerable investments and some measures were not supported by a proper cost-benefit analysis. Consequently the SUMP was never implemented.

Several LIFE projects - examples include KALAIR and OPERA (see pp. 40-42) - have developed tools and methodologies that can help administrations improve their capacity to take decisions about air quality with a view to developing a SUMP. Improving monitoring and modelling processes is central to this.

Urban mobility measures

A closer analysis of the LIFE programme's implementation of urban mobility measures reveals that earlier projects (pre-2003) largely focused on encouraging the use of alternative modes of transport (such as cycling), whilst since 2003 there has been a steady increase in the number of projects demonstrating the

12 This subject was discussed by LIFE projects during a Platform Meeting on Alternative Future Urban Mobility, which took place in Berlin in November 2013, http://ec.europa.eu/environment/life/news/newsarchive2014/february/index.htm#mobility

use of electric- or other types of vehicles powered by alternative fuels (including renewables).

Amongst the first wave of projects from 1998-2003, which focused on behavioural change through 'softer' measures such as awareness-raising, three in particular stand out. European Day 'In Town Without My Car!' not only acted as a catalyst for the growth of car-free days (see pp. 43-47), it also became a platform for cities to announce innovations in sustainable mobility, such as cycle lanes, new bus routes and pedestrianised zones. Measurements by participating cities have shown the impact of such measures on reducing PM and NO_x emissions. A second project (SMILE) compared the impact of the car-free initiatives introduced by over 400 towns and cities to determine which had achieved their goals, why they had been successful, which initiatives were still active and which could be transferred to other urban areas in Europe. Finally, VOTE FOR BICYCLE developed new cycle lanes in Oradea, Romania and staged events in order to encourage more people to cycle.

Electro-mobility and hybrid vehicles

Much of LIFE's innovation in the last decade has focused on demonstrating and promoting electro-mobility solutions. For instance, the PARFUM project from 2003 conducted trials of an electric bus fleet in the city of Bremen, Germany. This reduced NO_x emissions by 223 kg and PM by 15.6 kg over the course of the project. The RAVE project in Novara, Italy additionally aimed to improve road safety. Lessons from the project could feed into the Commission's planned dissemination (2014-2015) of good practice examples for road safety planning[13].

More recent electro-mobility projects have focused on the progressive deployment of electric vehicles. Projects in Austria (CEMOBIL) and Spain (CONNECT) have respectively made such vehicles available to the general public and staff of targeted organisations. Users taking part in the trials have been offered free or subsidised recharging as a means of stimulating interest and uptake of this 'clean transport' alternative for medium-distance journeys in urban areas.

In Gothenburg, the HYPER BUS project is demonstrating a new plug-in technology and fast-charging service, based on renewable energy, for hybrid electric

13 *Together towards competitive and resource-efficient urban mobility COM(2013) 913 Final*

Photo: LIFE09 ENV/ES/000507

CONNECT established five 'zero-emission' electric recharging points for electric vehicles

buses. In trials to date, the new vehicles have met set goals in terms of fuel reduction (81% less), energy savings (61% less) and reductions of emissions and CO_2 (approximately 80% for both) in comparison with the company's standard diesel buses.

Projects introducing innovations often require significant investments. However, it can also be extremely difficult to predict their results, as state-of-the-art technologies don't always correspond to initial expectations. It is also important to take lifecycle considerations into account. For instance, is the energy for charging electric vehicles derived from renewables or fossil fuels? LIFE projects such as CEMOBIL and CONNECT have explicitly included such considerations in their initial proposals, providing an important demonstration value for others. CEMOBIL is deriving 3 800 MWh of electricity from non-fossil resources, whilst CONNECT developed the first network of recharging points (which includes installations in workplaces) run entirely off renewable energy.

Financial and other incentives have already been shown to encourage people to adopt greener solutions (such as solar power, through favourable feed-in

The Clean Air project created the "European Biking Cities" network of cycle-friendly cities to enable the transfer of best practices

Photo: LIFE11 ENV/DE/000495/Markus Bachmann

Photo: LIFE09 ENV/SE/000348/Christiaan Dirksen

BIOGASSYS is using by-products, waste and other biomass for biogas production to fuel different types of vehicles

tariffs). A LIFE project in Greece (IMMACULATE) demonstrated how this could effectively work in terms of urban transport through a system of incentives for the acquisition of electric vehicles (bikes, scooters and cars) in the city of Thessaloniki. Incentives included VAT refunds and tax breaks for purchasing the cleaner alternatives, as well as exemption from any future congestion charging scheme, free parking and free eco-driving training.

Provision of infrastructure (e.g. sufficient charging points for electric vehicles) has been identified as another barrier to cleaner mobility. This has been largely overlooked by LIFE, although a current Dutch project is providing one example of how the issue may be addressed (see box).

Another ongoing project in Sweden is making innovative use of existing public transport infrastructure for trials of a novel electric-powered bus (see pp. 21-23).

Alternative fuel vehicles

Alongside electric vehicles, LIFE has also demonstrated a number of other alternatives to petrol or diesel. For instance, another aspect of the already-mentioned PARFUM project was to provide individuals and companies with incentives to switch to using compressed natural gas (CNG)-powered vehicles. This was supported by a new network of fuelling stations and resulted in 154 new CNG cars being put into operation during the project's lifetime, reducing emissions of NO_x by 2 450 kg and of PM by some 171 kg. The implementation of these measures was important for the acceptance of Bremen's Low Emission Zone (LEZ).

LIFE11 ENV/NL/000793

E-mobility 3 cities NL

This project is working to introduce a number of charging points for frequent urban drivers, such as taxi and delivery van drivers, in Amsterdam, Rotterdam and Utrecht.

"In many cases electric driving is not only green and comfortable, but also financially attractive for these frequent urban drivers as they drive many kilometres a day," says project manager, Pieter Looitjestijn. He concedes however, that "the market for electric transport charging infrastructure is not yet fully developed." Yet despite the constraints (the business case is uncertain, as is public opinion) the project has already installed the first standard chargers, with the fast chargers set to follow.

An important element being addressed by the project is that "different locations require different chargers," says Mr Looitjestijn. Residential areas are well serviced by regular chargers, or semi-fast chargers. However, locations such as petrol stations and restaurants require fast chargers: "Here people can have a coffee or a meal while their car is charging. In about 20 minutes most cars can be charged up to 80%."

The plan is to install 16 fast chargers and at least 100 regular ones at a total cost of €384 000 and €500 000 respectively. Whilst the new fast chargers are currently much more costly than standard ones Mr Looitjestijn and his colleagues are convinced that following these initial investments, "the market size can be brought to a level where [electric-powered frequent urban driving] becomes economically feasible."

Hydro-methane powered buses have been trialled by LIFE projects in Italy (MHyBus and SIDDHARTA). The former project has tested in real-world conditions the efficiency and fuel consumption of the optimal hydro-methane blend (15% hydrogen, 85% methane). Results show a 15% reduction in CO_2 emissions and NO_x values within EU legal limits. The SIDDHARTA project pioneered an 'on demand' public transport service which is expected to reduce emissions of CO by 1%, NO_x by 4.1%, SO_x by 3.7% and VOCs by 0.3%, and health costs by €34 500 per year.

Projects that highlight links to public health are likely to find more favour with policy-makers and achieve greater public acceptance. One ongoing project, MEDETOX, is focusing on the development of innovative methods to assess the possible health risk connected with the exposure of the general public to diesel exhaust particles under real-life traffic conditions in the city of Prague. By September 2015, the project will deliver a set of standardised protocols for the sampling and toxicity testing of diesel emissions under real-life traffic conditions. These will enable 'hazard identification' and 'risk assessments' based on the toxic effects of vehicle emissions, thus potentially providing an important tool for decision-makers.

Urban traffic logistics

Urban logistics are essential for cities to function successfully and make up a significant share of urban traffic as part of regional, national and international supply chains. However, logistical needs are often neglected in urban planning and management. Member States and local and regional authorities need to provide a framework (delivery spaces, access regulations, enforcement etc.) to ensure there is a commercial case for private logistics operators to invest in the necessary new technologies and solutions. Urban logistics also needs to be inserted in SUMPs.

Some LIFE projects have demonstrated improvements in city traffic logistics in the context of sustainable urban mobility, if on a rather limited scale. Light- and heavy-duty vehicles are considerable sources of emissions in urban areas. Such fleets are also well-suited to testing alternatives to combustion engines, as shown by the Swedish project, CLEANTRUCK (see box).

Other solutions to reduce emissions from light-duty vehicles have focused on the creation of ur-

LIFE08 ENV/S/000269

CLEANTRUCK

Targeting heavy goods vehicles, this partnership project, coordinated by the city of Stockholm, aims to establish new filling stations for renewable truck fuel, and to demonstrate new types of 'clean trucks' in Stockholm. Eco-driving, nitrogen-filled tyres and cooling units with liquid CO_2 for refrigerated vehicles are also being promoted, with the aim of further reducing pollutants from goods distribution.

Spokesperson for the city of Stockholm, Helene Carlsson, says the project is now entering its evaluation phase. The results will feed into work on a 'fossil fuel free Stockholm 2050' strategy, and influence the regulatory framework for heavy transport applications, both nationally and internationally.

Over 50 clean trucks have been demonstrated in real-life operation by some 18 transport companies. "Preliminary evaluations suggest that the heavy traffic CO_2 emissions could be reduced by 40-50%*, or more, if all transport vehicles running in Stockholm were of the same type as in the project," she comments, adding that it seems likely that reductions of the "same magnitude" would be possible for NO_x and PM emissions.

"There is no universal solution to the problem of emissions from heavy traffic. The type of clean truck to use depends on the situation and the route," says Ms Carlsson. For instance, preliminary results indicate that a hybrid electric lorry is well suited to inner-city distribution, but not suitable for longer routes; methane diesel technology is most suitable over medium distances and ethanol ED95 vehicles provide good results in all scenarios. However, as the available engines for the latter are smaller, the vehicles are better suited to lighter loads.

** The project's expected results are a 1 500 tonne/yr reduction in carbon dioxide emissions, total NOx reduction of 17 tonnes/yr and a 240 kg/yr reduction of total PM2.5 or less.*

MHyBus tested hydro-methane powered buses in real world conditions

Photo: LIFE07 ENV/IT/000434

ban logistics systems that involve the last-mile delivery of goods using low-emission vehicles (C-DISPATCH, PARFUM, URBANNECY, CEDM – see box). These are often linked to the implementation of an LEZ in the city centre in question.

A similar system is being developed by ELBA, a LIFE project on the Italian island of the same name, where an eco-sustainable integrated mobility scheme for both people and goods is being demonstrated. Making use of eco-friendly vehicles, this mobility scheme will involve 'intermediate' and 'flexible' transport and logistics solutions.

Two projects have demonstrated sustainable approaches to peri-urban commuting to industrial areas (GESMOPOLI and I.MO.S.M.I.D). In both instances, the project developed a coordinating body to organise, plan, programme and promote services within the trial district, such as car sharing and public transport using hybrid buses (electricity and methane/clean diesel).

Smart technologies can also help improve urban logistics, particularly in towns and cities with a historic centre, where the impacts of individual and commercial traffic are more severe. The PEHRT project in Treviso, Italy, is trialling a system for delivering multi-modal travel information to commuters, visitors and businesses before and during trips. This ICT-based solution provides an integrated overview of different mobility services – including public transport, car parks (location, state, routing), bike-sharing, taxi-sharing and bike stations. As this project illustrates, there is scope for LIFE to do much more in terms of Intelligent Transport Systems (ITS).

LIFE05 ENV/IT/000870

CEDM

This pilot project implemented eco-friendly freight distribution in the historic centre of the city of Lucca, Tuscany. Central to this was the establishment of a 'city distribution terminal', or warehouse, as the main infrastructure to support eco- and business-efficient distribution schemes. The project led to a 19% reduction in circulation of freight vehicles, with measurable improvements in air quality, as well as energy and CO_2 savings.

Importantly, the legacy still continues, as Mauro Di Bugno of the Municipality of Lucca, confirms. After the project ended, he says the city has invested resources to further develop the distribution warehouse, now called 'LuccaPort' (www.luccaport.it), in cooperation with all relevant stakeholders and businesses. The aim is to achieve "further significant reductions" of traffic-related energy consumption, NO_xious gases emissions and noise, and to preserve the quality of the environment and the historical and tourist assets.

He emphasises that the strategic planning established under CEDM, has become "more and more relevant". Moreover, he says, the experience gained from the project is being disseminated to several European projects (e.g. IEE ENCLOSE - www.enclose.eu) and networks (e.g. CIVITASNET). Finally, in order to fully raise awareness about the benefits of sustainable city logistics, the city of Lucca has recently founded the Logical Town Association ("International Association for Sustainable City logistics for small and mid-sized historic towns").

CEDM is replicating its last mile delivery system in several EU countries

Photo: LIFE05 ENV/IT/000870

Surprisingly, given that they are such an indispensable part of the urban environment, the impact of refuse collection vehicles has been addressed by just one LIFE project (CLEANOWA - see box). This example from Sweden also shows how transfer of known technologies could be a viable (and cost-effective) alternative to new investment in sector-specific technologies.

Emission abatement

The LIFE programme has also demonstrated the possibility of introducing innovative emission-abatement technologies to tackle pollution in urban 'hot spots' or more sensitive areas. A project in Austria (CMA+) used liquid calcium-magnesium acetate (CMA) as a dust-binder on roads, reducing PM_{10} re-suspension by 1-4 µg/m^3. This was accompanied by other measures to reduce PM_{10} concentrations, such as retro-fitting with particle filters on buses and implementing new clean district heating and extending the natural gas connections to facilitate fuel shift.

Another emission-abatement technology being trialled by LIFE is heterogeneous photocatalysis, with the use of titanium dioxide (TiO_2) and solar radiation. The aim of the LIFE EQUINOX project is to reduce NO_x emissions by 30%. Earlier attempts to use TiO_2 in real-world situations have not matched the results of laboratory trials, so lessons from this ongoing LIFE project could provide a valuable best practice example.

Wider focus and more integration

Despite its overall positive impact on urban air quality, it could be argued that the focus of the LIFE programme has been too narrow, supporting clusters of projects that provide single solutions rather than an integrated approach to urban and peri-urban mobility. Co-financing for infrastructure and smart technologies – particularly ITS - is a key element of such integrated solutions and an area in which LIFE has the opportunity to make a difference.

Above all, the programme could be used to fill in the gaps [14] that act as barriers to the adoption of SUMPs by local and regional authorities.

14 Communication - Together towards competitive and resource-efficient urban mobility [COM(2013) 913 Final]

LIFE03 ENV/S/000592

CLEANOWA

The CLEANOWA project was carried out from 2003-2006 by the private waste and recycling company, Renova. Its purpose was to run a full-scale trial in the city of Gothenburg and evaluate the use of CNG-fuelled (compressed natural gas) engines for its waste collection fleet.

When the truck stops at a collection point, the internal engine automatically cuts out after 30 seconds. Instead, an electric motor is used to power the hydraulics for loading and compacting. This motor is quiet and does not generate emissions. Overall, the project was successful and reached its main objectives, achieving it is claimed, "significant improvements" in CO (90%), HC (80%), NO_x (50%), CO_2 (20%) and PM.

Today, the beneficiary is continuing to build upon the project. According to Renova spokesperson, Kurt Lindman, 10 of the original 16 eco-trucks are still in operation: "This is quite surprising as the specially-equipped trucks are more sensitive to wear and ageing," he says, noting that the electrical compaction unit and the battery package have "worked very well". Despite this, over the next 12 months or so these trucks will be phased out because there are "better solutions available today," he adds.

Mr Lindman believes the project "hastened development work" at Renova in the areas of energy efficiency and renewable fuels. For example, by the end of 2013, the company had substituted 79% of its diesel consumption from its then fleet of 170 trucks in favour of renewable fuels.

Photo: LIFE06 ENV/D/000465

The first fuel cell passenger ship was developed by the Zemships project

LIFE projects for 2014-2020 should also focus on issues that are essential for meeting air quality standards, such as the use of electric or very low-emission vehicles (including support infrastructure), new drive train technologies, development and implementation of high-impact Low Emission Zones and road pricing schemes, training for 'cleaner driving', retrofit programmes for public-service vehicles and innovative logistics platforms for last-mile delivery of goods.

There is also scope to address in more depth the impact of other forms of transport on urban air quality, such as ships and trains. LIFE has already made a small contribution through projects such as WINTECC and LNG Tanker, which demonstrated the reduction of pollutants (100% soot and methane, 80% NO_x, 60% hydrocarbons) alongside fuel and cost savings. The PVTRAIN project showed how photovoltaic cells could be used to charge accumulators on board locomotives, railway coaches and freight wagons.

Thirdly, it is important for LIFE to contribute to a better understanding of the impact of urban mobility measures during the new programming period. Few projects until now have incorporated the use of modelling tools that might gave a more accurate assessment of their impact beyond measurements for a particular place over a limited timeframe (e.g. the last year of the project). Furthermore, the new programme could be used to develop methods to assess the costs and benefits of proposed measures, allowing authorities to adopt realistic, cost-efficient and integrated solutions that deliver sustainable urban mobility and cleaner air for all.

The innovative wind propulsion technology for cargo vessels tested by WINTECC brought considerable fuel savings

SUSTAINABLE MOBILITY AND TRANSPORT

Passengers 'test' prototype SLIDE IN bus

The ongoing LIFE project, SLIDE IN, is demonstrating a new, energy efficient and fossil-free public transport concept for electric trolleybuses and trams. A prototype trolleybus is already in operation in the city of Landskrona, Sweden.

Photo: ASTRALE EEIG/Justin Toland

The new SLIDE IN bus is already in service

The overall objective of this partnership project, which runs until 2015, is to demonstrate how greenhouse gas emissions, and other forms of air pollution, can be reduced through the introduction of the unique 'SLIDE IN' concept for trolleybuses and trams. Led by Lund University, a prototype bus is currently being tested in the city of Landskrona (population c. 40 000), southern Sweden. Project coordinator Jesper König, says: "It's the first working prototype ever – as far as we know."

Trolleybuses have been around since the late 19th century (see box p 23) and hybrid trolleybuses that can travel beyond the limits of the electric cables since the late 20th century. The innovative aspect driving this LIFE project is the development of technology that allows the battery of a hybrid electric bus/trolleybus to be charged whilst the vehicle is in use – 'sliding in' rather than 'plugging in'.

Introduced in August 2013, the hybrid SLIDE IN vehicle runs alongside four traditional trolleybuses on the circular route connecting Landskrona's mainline railway station with the city centre and port, a line used by some half a million passengers each year.

Photo: ASTRALE EEIG/Justin Toland

One of Landskrona's existing trolleybus fleet

The vehicle can connect and disconnect with the trolleybus cables at two points and, after recharging on the move, then extend its route (fossil-free) beyond the limits of the existing infrastructure.

A key challenge for the LIFE team was to find out whether the battery fitted in the new bus would be powerful enough to allow it to run independently of the existing trolleybus line over the required distance. In the real-life traffic conditions currently being tested in Landskrona, this has already proved to be the case: "The bus operates for about 6 km 'under the wire' then goes 10 km offline, [before] returning to the wires," confirms Mr König. "The good thing is it doesn't have to be parked while charging the battery."

Another important objective was to ensure the system would be cost-effective. The project coordinator estimates that while there are extra costs for the SLIDE IN bus compared with existing trolleybuses (costs related to the batteries, monitoring equipment and adjustment of the poles), once in production, the unit price is expected to fall. Similar economies of scale are expected for the battery, which currently costs SEK 500 000-600 000 (c. €60 000).

Optimising operations

Jan-Erik Olsson is the driver/instructor in charge of operations of the SLIDE IN bus for Nobina (which operates public transport in Landskrona under franchise from Skånetrafiken). He says there is "no difference" from driving a regular trolleybus. Indeed, so straightforward is it to use that the SLIDE IN vehicle was put into service just three days after delivery. Since then, there have been "no mechanical failures", although one day the bus was taken off the route temporarily after the driver forgot to charge the battery, says Mr Olsson. Even then the vehicle had enough charge to complete its journey, however the project team has recommended that the battery is always kept at least 40% charged to extend battery life.

It is for this reason that the bus is charged overnight at the depot, using a small, plug-in electrical charger, explains technician Johan Björnstedt, a scientist from Lund University who is responsible for

Jan-Erik Olsson and Johan Björnstedt discuss the performance of the SLIDE IN bus as it travels round Landskrona

Photo: ASTRALE EEIG/Justin Toland

Photo: ASTRALE EEIG/Justin Toland

The new technology makes use of existing trolleybus infrastructure to charge the vehicle whilst in motion

assessing the performance of the bus, the battery and other equipment. Data from an onboard 'fleet management system' are sent 10 times a second, providing him with essential information about battery capacity, temperature and driving distances.

Mr König emphasises that the (four) SLIDE-IN drivers were carefully selected – and have received special eco-driving training. He says this is important for a number of reasons, not least because they are the "ambassadors for the project". "They will meet the passengers and be asked about the bus, especially when it is running on battery...They need to feel part of the project."

To find out what the general public thinks about the SLIDE IN concept, the project has just completed its first public attitude poll, carried out by Motivationshuset. Responses from 136 passengers questioned were generally positive. Key findings include the fact that 82% of respondents would prefer that Landskrona's buses were electric, rather than gas or diesel-powered, whilst 28% of respondents said that the SLIDE IN bus was better than a standard trolleybus and just 2% said it was worse. A second survey will take place at the end of the project.

Air quality impact

In 2009, a study to assess the environmental impact of installing a trolleybus line in Landskrona showed that - if the general performance of vehicle types was applied to this scenario - in comparison with (Euro 4) diesel buses, the trolleybus journeys would have contributed to annual reductions of 1 200 kg of NO_x, 5 kg of particulate matter and 11 kg of hydrocarbons (as well as 275 tonnes of CO_2). Trolleybuses are, in general, more energy efficient than the biogas-powered buses that have replaced diesel vehicles on Landskrona's other routes (consuming 1.6 kWh/km in comparison with 5.6 kW/h for a biogas bus). "Combustion engines waste roughly two-thirds of the energy input in heat, using only a third for forward motion. An electric engine wastes less than 10% in heat, using the rest for forward motion," explains Mr König.

Whilst tests of the SLIDE IN concept are ongoing, early results indicate that it could be a viable means of integrating existing trolleybus (and tram) lines into the sustainable urban mobility concept of many towns and cities across Europe, potentially contributing to improvements in air quality without the need for new infrastructure. "You can extend electrification without putting up more cables and wires," says Mr König. "Many cities are building tram lines – the technology could be used there as well of course. Also - and this is more a political decision - you could close off a city centre to regular trucks allowing only electric trucks to run into the centre, using batteries to reach each customer. These are potentials: It's not the aim of this project to tell people what to do, the aim is to show the world that we have a technology here, show that it works and could be used and, if it works, to inform people so that they have it in mind when they plan new systems."

Did you know?

- *Dr. Ernst Werner von Siemens invented the first trolleybus, or Elektromote, which made its maiden voyage in Berlin in 1882*
- *The first passenger-carrying trolleybus began operating at Bielatal near Dresden, Germany on 10 July 1901*
- *There are currently some 300 trolleybus systems in operation in 43 countries worldwide*
- *Since 2000, new trolleybus lines have been built in European towns and cities such as Castellón de la Plana (Spain - 2008), Landskrona (Sweden - 2003) and Lecce (Italy - 2012).*

Project number: LIFE10 ENV/SE/000035

Title: SLIDE IN - Life without oil: Slide in - energy efficient and fossil-free public transportation for a sustainable society

Beneficiary: Lund University

Contact: Jesper König

Email: jesper.konig@luopen.lu.se

Website: http://www.slidein.se/

Period: 01-Sept-2011 to 31-Dec-2015

Total budget: €1 665 000

LIFE contribution: €759 000

MONITORING AND MODELLING

Breathing LIFE into the Air Quality Directive

The LIFE programme has helped develop necessary tools for the monitoring and modelling of air quality in Europe to help mitigate against the negative impacts of pollutants. It has also played a pivotal role in shaping European air policy.

In May 2008, the European Parliament and the Council adopted the Directive on ambient air quality and cleaner air for Europe AQ Directive - (2008/50/EC). This sets legally-binding limits for concentrations of major air pollutants, to address their major public health impacts.

Traditionally monitoring data have been used to assess air quality. However, the limited spatial representativeness of these data does not allow for the complete spatial coverage required by the AQ Directive or to properly assess human and eco-system exposure. The use of models allows for complete

The AIRUSE team monitoring air quality in Athens

Photo: LIFE11 ENV/ES/000584

spatial coverage but these are generally considered to have a higher uncertainty than monitoring. By combining these two sources of data it is possible to provide more optimal estimates of the spatial distribution of air quality.[15] The AQ Directive foresees within its reporting requirements the combined use of monitoring and modelling tools for: assessing and reporting on current air quality and determining exceedance areas; for source apportionment; and for near-real time assessment, including forecasting, for public information and alerts.[16] In general, a modelling capability bridges the gaps between monitoring points, thereby improving the analysis of past pollution events and the forecasting of air quality.

To achieve policy targets for the 2008 AQ Directive and an earlier directive relating to heavy metals in ambient air (2004/107/EC), pollution emissions for all Member States need to be substantially reduced. The instrument for doing this, the National Emission Ceilings (NEC) Directive (2001/81/EC) under which EU Member States that exceed emission ceilings are liable to fines, under revision in 2013 with stricter national emission ceilings for six major air pollutants.

The LIFE programme has funded many projects that have developed monitoring and modelling tools to help implement AQ policy objectives. Typically, these have been LIFE Environment projects, but a little-used branch was activated that anticipated air policy development needs. LIFE Environment Preparatory Action projects were established to address clear gaps in knowledge; one such was the need to evaluate emission control strategies for both air pollutants and greenhouse gases to help steer the Thematic Strategy on Air Pollution (COM(2005)446), which was addressed by the EC4MACS project (see box).

Decision-making and planning

Planners face a range of problems when establishing air quality monitoring networks according to general criteria set out in AQ directives. To increase harmonisation, some local authorities have argued for clearer criteria, for example, regarding the siting of traffic-pollution monitoring stations in terms of distance from the roadside[17]. Monitoring data are used variously: to verify air quality compliance, to give real-time information to citizens, and to develop long-term actions and investments. There is thus a need for modelling systems, based on common criteria, that can provide comprehensive and easy-to-use information for decision-making and planning.

LIFE06 PREP/A/000006

EC4MACS

This LIFE project addressed the need for a comprehensive information base to provide scientific and economic analyses for the revision of the Thematic Strategy on Air Pollution (2013) and the European Climate Change Programme. Some air pollutants and greenhouse gases (GHGs) are known to have interactive effects, which highlights the need for such a multi-pollutant and multiple-effect approach.

The project, which was coordinated by IIASA (the International Institute for Applied Systems Analysis), integrated well-established modelling tools from relevant fields to explore the synergies and interactions between climate change, air quality and other policy objectives. The findings helped improve emission control strategies for air pollutants and GHGs.

EC4MACS was the first fully-integrated study for assessing government actions to reduce air pollution and GHG emissions across Europe. Its innovative approach incorporated all of the major contributors to air quality problems by sector, provided a full economic analysis of costs and benefits for mitigation methods, and identified the synergies and trade-offs resulting from policy responses in different sectors and regions. The system has helped update existing databases with current statistical data and projections on pollution emissions, from energy, transport, agriculture and other economic sectors for all EU Member States since 2011.

The EC4MACS toolbox is available on a dedicated website (www.ec4macs.eu). For example, actual emissions data (SO_2, NO_x, PM, NH3, VOC, CO_2, CH_4 and N_2O) can be obtained by economic sector (such as energy, transport, land-use, agriculture and forestry) for each EU Member State, as well as projections for future years.

EC4MACS has contributed to many policy proposals, including the EU Energy and Climate Package, the EU Roadmap for moving to a low-carbon economy in 2050 and the review of EU air quality legislation. It was used for numerous studies to help revise the NEC Directive, including integrated assessment modelling, cost-benefit analysis, and the valuation of ecosystem damage. Thus, it can be said to have played a pivotal role in shaping European air policy.

15 The application of models under the European Union's Air Quality Directive: A technical reference guide (EEA Technical Report – No10/2011 (https://www.eionet.europa.eu/events/EIONET/Technical%20report_3)

16 The combined use of models and monitoring for applications related to the European Air Quality Directive: a working sub-group of fairmode - Bruce Denby and Wolfgang Spangl (http://fairmode.ew.eea.europa.eu/monitoring-modelling-sg1/denby_harmo13_h13-261_updated_list.pdf/download)

17 The review of Annex III of the Air Quality Directive 2008/50/EC - JRC- AQUILA Position Paper "Assessment on siting criteria, classification and representativeness of air quality monitoring stations" (http://ec.europa.eu/environment/air/pdf/SCREAM%20final.pdf) - suggests a few improvements, such as macro-scale siting criteria for monitoring stations, criteria for siting of urban background monitoring stations, flexibility in the micro-scale criteria, better criteria on how monitoring networks should be designed and guidelines for defining station representativeness

Photo: LIFE04 ENV/AT/000006

KAPA GS retrofitted vehicles with particle filters to reduce PM

The basic problem addressed by LIFE projects is that existing European air quality monitoring networks and modelling capability does not provide the range of local information that decision-makers and planners need. This is not too surprising, given that European-scale networks were set up within global approaches to air pollution and climate change. The lack of precision offered by large-scale networks has driven work at the local demonstration level. Approximately 75% of LIFE's air quality projects fall into this category.

LIFE05 ENV/RO/000106

AIR-AWARE

Bucharest is one of Romania's most polluted cities, which has long-term public health consequences. The AIR-AWARE project helped implement AQ Directive requirements by developing a decision-making tool that is now used by local authorities in the Bucharest metropolitan area to predict the impact of air pollution episodes and improve air quality through better planning and urban development policies. The tool has also been used in updating Bucharest's Urban Zoning Plan. It provides user-friendly visual information on the current status of atmospheric pollution, by measuring emissions and reviewing bio-indicator species in the city's parks. The short-term effects of acute pollution episodes are calculated, using monitoring data and weather forecasting. The general public is informed and the relevant authorities can take remedial actions.

Reducing air pollution in Bucharest is expected to lead to a reduction in the incidence of diseases such as lung cancer, with consequent reductions in public health costs. Furthermore, the project manager believes that the system can easily be replicated in at least 20 other hotspot areas in Romania.

Traffic pollution

The 2008 AQ Directive introduced new provisions, such as the possibility of extensions of time limits for complying with limit values of three years for PM_{10} or up to five years for NO_2 and benzene. It also introduced new air quality objectives for new air quality objectives for $PM_{2.5}$ (fine particles), which is associated with traffic pollution and the burning of fossil fuels. Eight LIFE projects since 2000 have focused on traffic pollution, especially the modelling of traffic and air quality data to predict pollution episodes and to provide information for citizens and planners. The AIR-AWARE project developed a decision-support tool to predict air pollution episodes in Bucharest (see box), for instance, while ROMAIR implemented a forecasting system to help Romania meet EU PM_{10} targets. The forecast model developed by KAPA GS similarly helped to reduce PM_{10} and $PM_{2.5}$ levels in Austrian pollution hotspots. LIFE projects have also provided policy-relevant information on traffic pollutant sources. For example, the PARFUM project showed that heavy-duty vehicles contributed about 50% of NO_x levels even

though they only represented about 10% of road vehicles. The tools developed by this project cluster enable the costs of improving public transport and other actions to be set against estimated air quality improvements. Comparisons of available emission mitigation options also can be made and the best selected.

Several LIFE projects have dealt with the production or re-suspension of particulate matter (PM) caused by traffic. This is a problem exacerbated by particular climatic and seasonal conditions, for instance, it can be 26% worse in winter. Therefore, traffic patterns have been integrated with weather predictions to produce warnings and to trigger traffic restrictions (e.g. KAPA GS). Best winter practices in Finland were identified for reducing PM, using a mobile system to help focus dust-mitigating measures (REDUST). LIFE projects have led to the retro-fitting of public transport fleets with catalytic-converters for NO_x and particle filters for PM, and have even changed how roads are salted. The Austrian project SPAS developed roadside noise and dust filters, which cut PM levels by 15-30%.

Fine dust particles from natural sources can be especially problematic in arid areas when they combine with traffic pollution. The LIFE programme has helped to improve the understanding of air pollution in 14 Mediterranean cities, by quantifying incidences of Saharan dust and forest fires on PM particle size and composition in terms of potential health impacts (MED-PARTICLES) and has brought improvements in assessing this impact (see AIRUSE box).

In addition to traffic pollution, other hotspot areas include ports and industrial sites. These have been targeted by several LIFE projects. Ports are problematic because of the bulk handling of goods with high dust content. The HADA project developed a real-time decision-making and response tool to determine best working practices in Spanish ports, including delaying certain activities to reduce pollutant dispersion risk. One outcome of the SIMPYC project was the Valencia Port Authority expanding its air monitoring activities to improve air quality. Smelting has a range of work streams, some of which can be more polluting than others; the AIRFORALL project helped adjust these in Romanian smelting plants, taking into account the meteorological conditions that exacerbate pollution.

LIFE11 ENV/ES/000584

AIRUSE

"Several urban and industrial areas in Europe are not capable of meeting new standards for PM," according to Xavier Querol of CSIC, Spain's National Research Council. The problem is most acute in arid urban areas in southern Europe, where the health effects of road traffic pollution are worsened by PM from natural sources. "African dust and marine aerosols are the main natural sources contributing to increased PM_{10}, and to a lesser proportion $PM_{2.5}$, in the Mediterranean region," he explains.

In Barcelona, around 4% of annual PM_{10} levels were found to originate from African dust. On a daily basis, this can cause ambient PM levels to far exceed daily limits. "It is important for national authorities to be able to calculate the daily contribution of African dust," says Dr Querol. "Dust forecasts can raise public awareness and reduce health risks. Furthermore, additional measures could be applied to reduce anthropogenic emissions during episodes of high natural PM loads."

The AIRUSE project is testing mitigation methods to reduce road dust in cities. Kerbside measurements in Barcelona showed that street washing reduced daily PM_{10} concentrations by 7-10% on average. Dust suppressants, such as calcium-magnesium acetate (CMA), $MgCl_2$ and nano-polymers, are being tested. Technology to reduce PM from wood-burning activities is also being assessed. Appropriate measures will be proposed to regional and national policy-makers.

Health and the environment

Air quality is an extremely important issue for public health, the economy and the environment. A high proportion of Europe's population lives in cities, where air quality limit values are often breached. Poor air quality contributes to respiratory and cardiovascular diseases. Exposure to PM, ozone (O_3) and polycyclic

aromatic hydrocarbons (PAHs), in particular, is associated with serious health risks. The AQ Directive requires that local authorities monitor air pollution, inform the public if pollutants exceed EU limits, and take action to reduce the adverse health effects of air pollution.

A group of LIFE projects have developed health risk maps and models for air pollutants. One project (SINESBIOAR) developed a tool to evaluate air quality and its social impacts in the Sines area of Portugal, with air pollution and environmental cost risk maps being created for urban areas and natural habitats. Air quality is being monitored and modelled to study the links between different pollutants (e.g. PM, nitrogen oxides and PAHs) to provide estimated health risks for children (MAPEC_LIFE). Also in Italy, the links between air pollution, health risks and the weather are being analysed with seasonal exposure models for PAHs and $PM_{2.5}$ helping to provide health assessments for children and the elderly (EXPAH). The need for Member States to monitor the impacts of air pollution on ecosystems is a new provision of the revised National Emissions Ceiling Directive (NECD). The most significant LIFE contribution to this emerging field is FO3REST, which created ozone thresholds for trees (see box).

Cost benefits

A key challenge for LIFE projects has been the cost-benefit estimation of air quality mitigation measures. The challenge is to consider investments not just in terms of pollution reductions, but also in consideration economic, social and other factors. For instance, measures such as cycle lanes can seem ineffective compared to technical measures (e.g. particle filters) if emissions criteria alone are considered. However, cycle lanes have other benefits, such as reducing congestion. Calculating benefits from such structural measures can be difficult, but it is especially relevant for policy-makers and politicians.

In general terms, modelling and assessing the cost of technical measures is easier than doing the same for structural measures, which seek to change citizens' habits and may have several benefits. Several LIFE projects have calculated the costs of straightforward technological measures and compared them with existing measures (e.g. REDUST). Value for money is also a common theme in LIFE monitoring and modelling projects. ACEPT-AIR, for example, developed a cost-efficient policy tool for reducing PM, whilst OPERA developed an integrated assessment methodology for cost-effective local and regional air quality policies (see pp. 40-42).

The European Commission estimated the health costs of air pollution to be between €330 billion and €940 billion in 2010 (3-9% of EU GDP). Because most LIFE projects in the air monitoring and

Photo: LIFE10 ENV/FR/000208

LIFE10 ENV/FR/000208

FO3REST

The main objective of the FO3REST project has been to refine criteria and suggest validated thresholds for Mediterranean forest protection against ozone and climate change.

"Concentrations of ozone in the air are not representative of actual impacts on vegetation, as injury occurs only when ozone is absorbed into the plant," explains Pierre Sicard of project beneficiary ACR-ST. "The present European standard for vegetation protection (AOT40) is based on ozone concentrations in the air and is inadequate for the derivation of scientifically-sound thresholds."

Dr Sicard adds that "epidemiological evidence from the FO3REST project suggests that the responses of vegetation to ozone are related to the absorbed gas flux through the stomata." Therefore, the project proposes new critical levels, based on the actual quantity of ozone absorbed.

The project's findings are transferable. "Most European countries carry out forest monitoring, but the different approaches used make comparisons at the European level problematic," says Dr Sicard. "The FO3REST results serve as a harmonised forest monitoring technique for ozone and as a decision-support tool for national and European authorities."

Acknowledging the importance of cooperation with the JRC's Air and Climate Unit, Dr Sicard hopes that the FO3REST results will help reinforce collaboration between forest ecologists and atmospheric scientists.

modelling thematic area have gone on to deliver air quality benefits, real savings have been made. For example, as a result of AIR-AWARE, Bucharest's surveillance and warning plan was expected to reduce pollution by up to 50% and therefore make substantial savings.

Innovative methodologies

The LIFE programme has always aimed to meet the decision-making needs of policy-makers in a cost-effective manner. Therefore, existing systems have been adapted and used whenever possible. This aim has also been a driver for innovation, with low cost and reliable technology being developed by several projects. Volatile organic compounds (VOCs) from petrol engines in urban areas have been monitored by using a novel solution involving membrane technology (ARTEMIDE). Similarly, the need for cheaper technology than previously available to monitor ultra-fine particles such as $PM_{2.5}$ drove the development and demonstration of prototype systems in the UFIPOLNET project. Elsewhere, remote sensing was linked to ground data as an innovative solution to the management of air pollution exposure levels in an area of West Macedonia (Greece) that uses lignite for power production. The SMAQ project developed scenarios based on geo-referenced information to estimate the impacts of improved environmental technology at lignite power plants.

The importance of getting real-time information to citizens and decision-makers has been demonstrated by the LIFE programme. Policy support systems that link coupled multi-scale models to web-based tools have been developed within the ATMOSYS project (see pp. 32-34). In some cases, projects have identified constraints with existing methodologies and developed their own cheaper,

EXPAH is quantifying exposure amongst children and elderly people to PAH content in particulate matter in the city of Rome

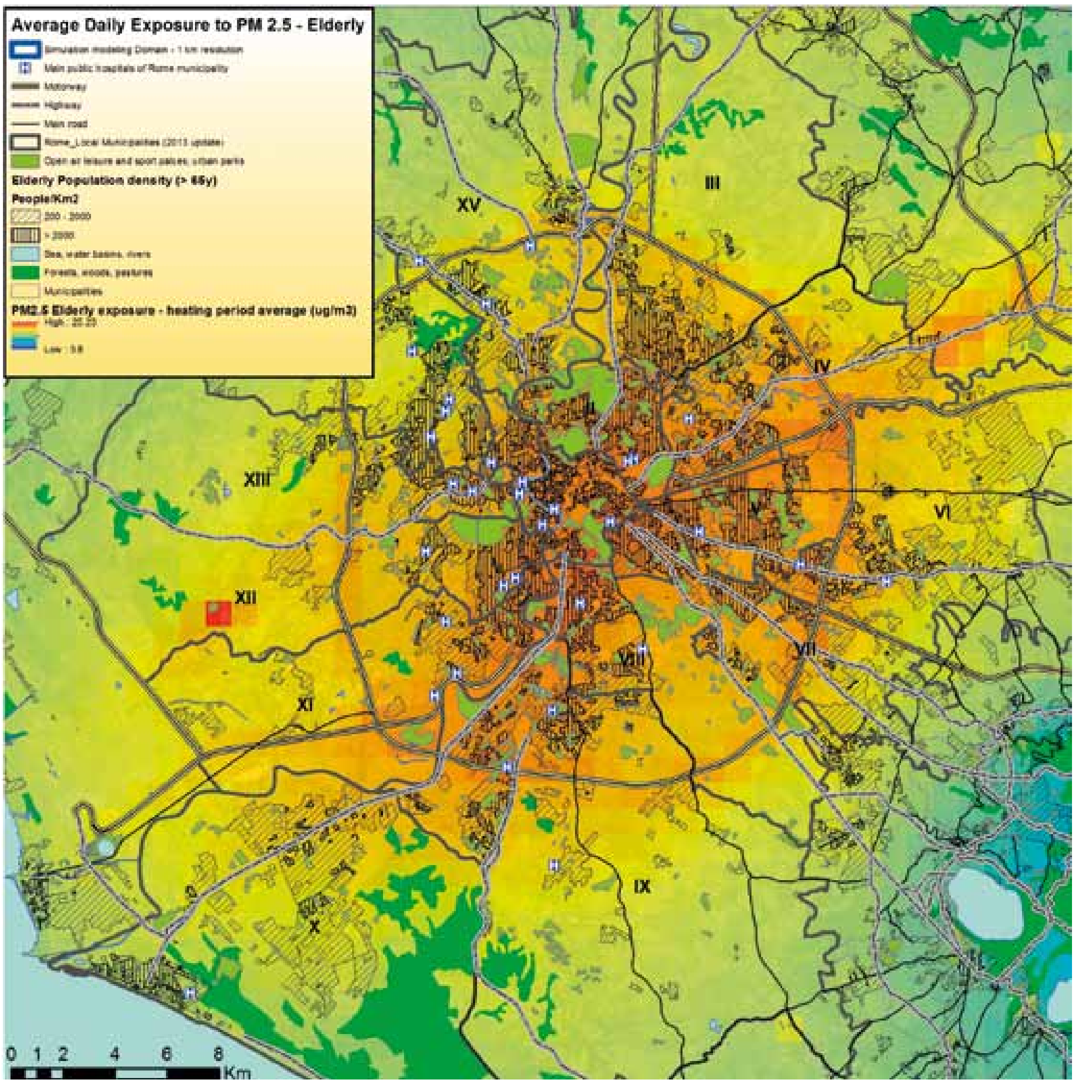


Photo: LIFE09 ENV/IT/000082

faster or more reliable alternatives. The DIAPASON project is developing prototype LIDAR ceilometers (to determine cloud heights by laser) and optical particle counters, whilst LIFE DIOXDETECTOR is developing a detection method for dioxins (see box p.31).

Involving citizens

The revised NECD foresees the mandatory indicators at all sites of the network that have to be adopted. This also allows citizens to see the progress of air quality actions. To this end, LIFE projects have begun to assess the impact of photo-catalytic building materials in reducing air pollution. The LIFE $MINO_x$-STREET project is testing and comparing the potential usefulness of a range of commercial photo-catalytic materials to act as NO_2 (NO_x) sinks, and see if promising solutions can be selected to be used on urban surfaces and in real conditions.

The LIFE programme has made significant contributions in enabling policy-makers, administrations and citizens to assess local actions, such as measures for dealing with traffic pollution hotspots (e.g. the ATMOSYS, SIMPYC, AIR-AWARE, OPERA and MAPEC_LIFE projects); although perhaps the most striking indicators are those relating to the implications of air pollution on public health (e.g. EXPAH, SINESBIOAR).

Building capacity to address the big picture

The LIFE programme has provided many innovative and cost-effective tools and methodologies for air pollution monitoring and modelling, by effectively building on existing knowledge, encouraging collaboration, and developing solutions that are diverse and multidisciplinary. In so doing, it has built capacity. For example, PM management planning guidelines have been produced for cities, communities and councils. Tools produced by the European Commission's Joint Research Centre (JRC) have been trialled within the LIFE programme under End User License Agreements (e.g. OPERA) and some outputs have been passed to the Clean Air For Europe (CAFÉ) programme (e.g. UFIPOLNET). LIFE has established guidelines to help regions and cities select the best means of pollution abatement and it has demonstrated ways to integrate local monitoring networks into regional, national and European networks. These tools can also be used as a stepping stone for future developments in LIFE.

The monitoring and modelling solutions developed have generally been for specific sets of pollutants and places, but recent projects are addressing the bigger picture. The LIFE programme has contributed

EuroBionet proposed a standardised method for the use of bioindicator plants as a means to assess and evaluate EU air quality

Photo: LIFE99 ENV/D/000453

to tackling severe air pollution problems, with financial savings and health benefits made possible by optimising preventive measures; although more could be done in the area of job creation. Policy development tools developed by LIFE already could help improve the cost-effectiveness of spending on air quality improvements, whether that money comes from local, regional, national or European (e.g. Structural) funds. Thus they can help contribute to better coherence and synergy between air quality measures and other environmental goals, such as sustainable transport, noise reduction, energy efficiency and renewable energy.

The programme is well placed to continue providing financial support to air pollution projects, especially given their trans-boundary nature. LIFE Environment is likely to remain at the forefront of air quality policy implementation in Europe, with LIFE offering an opportunity to develop more projects on the impacts of air pollution on ecosystems. Moreover, LIFE Environment Governance and Information is a potentially useful platform to develop and demonstrate the effectiveness of indicators, which will be increasingly needed to inform the public about the effectiveness of air pollution abatement measures.

LIFE12 ENV/ES/000729

LIFE DIOXDETECTOR

Incinerating solid waste releases pollutants into the environment, including dioxins. Analysis of these harmful substances is difficult, because dioxins are toxic at very low concentrations, meaning that very sensitive analysis techniques are required.

LIFE DIOXDETECTOR is developing a new analytical technique for the quantification and continuous monitoring of dioxins, namely 75 compounds (congeners) of polychlorinated dibenzo-p-dioxins (PCDDs) and 135 congeners of polychlorinated dibenzofurans (PCDFs), around a municipal solid waste incineration facility in Spain. It will provide a better understanding of different dioxin pathways and greater insight into population exposure, thus enabling pollution to be tackled more efficiently, for instance by establishing measures to protect people and the environment.

"It is very important to monitor and model PCDDs and PCDFs, to obtain dispersion maps that indicate to what areas these pollutants are dispersed," explains Marta Gómez of the coordinating beneficiary, Fundacion Cartif. "This identifies the areas of their highest concentration up to 5 km from the incinerator. The pollutants' dispersion depends mainly on weather conditions."

The main innovation of the project is the technique for dioxin analysis, which is more sensitive than previous methods. "This technology is capable of detecting dioxins below the parts per quadrillion (ppq) level," says Dr Gómez; "and by using measurements at short intervals from air, soil and vegetal biota, it represents a more realistic estimate of emissions."

The DIAPASON project's desert dust detection methodology will help to determine the contribution of Saharan dust to particulate matter (PM) levels in Europe

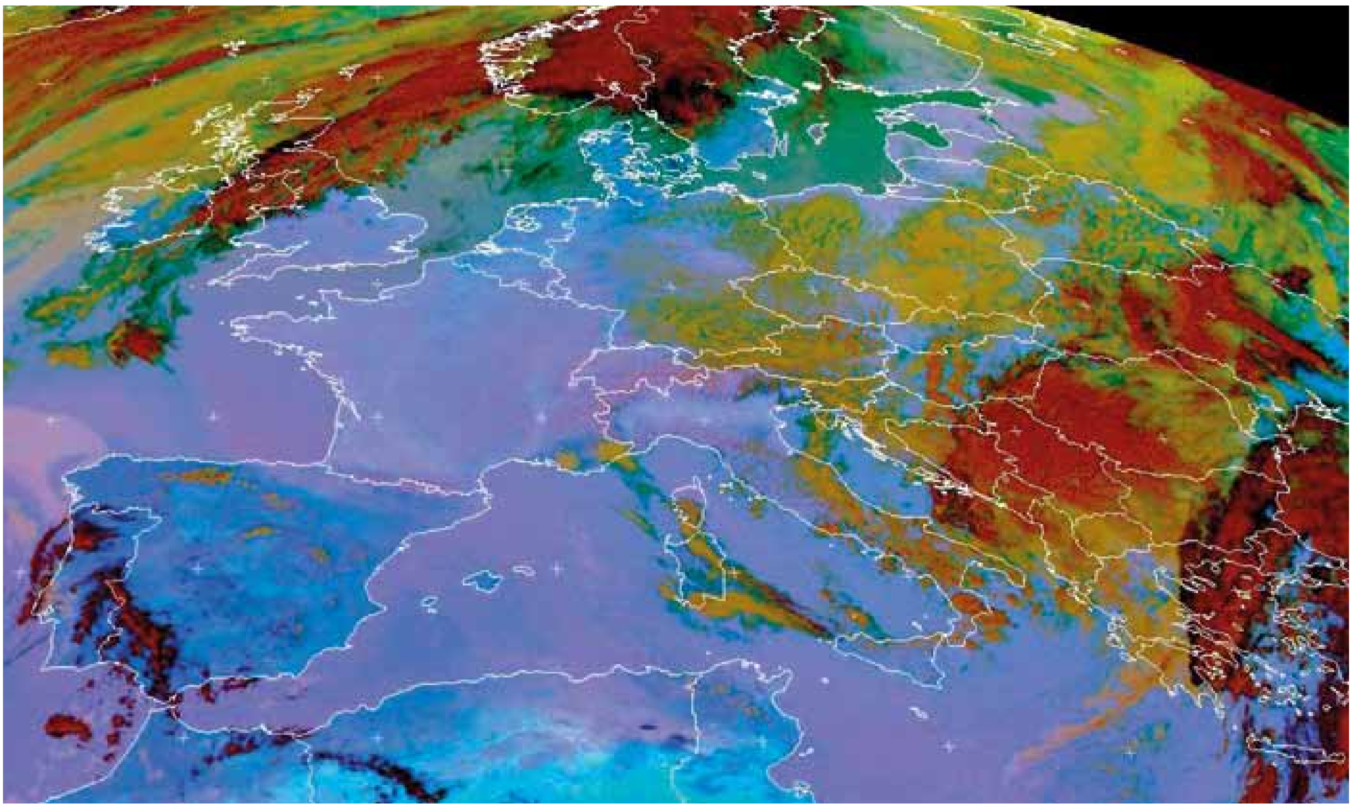


Photo: LIFE10 ENV/IT/000391 – EUMETSAT

MONITORING AND MODELLING

LIFE supports **ATMOSYS** innovation for healthier air

The ATMOSYS Air Quality Management Dashboard uses coupled regional and local models to display high-resolution maps for archive, near real-time and forecast air quality information.

The ATMOSYS Air Quality Management Dashboard uses coupled regional and local models to display high-resolution maps for archive, near real-time and forecast air quality information.

Traffic-related air pollution continues to be a major public health concern. Limits on air pollutants set in the European Air Quality (AQ) Directive are often exceeded in pollution hotspot areas. The ATMOSYS project was initiated in the light of this directive, with the aim of improving the assessment and forecasting of pollution episodes, to help improve urban air quality. VITO (the Flemish Institute for Technological Research) collaborated with end-user beneficiaries, the Flemish Environment Agency (VMM) and the Belgium Interregional Environmental Agency (IRCEL-CELINE) throughout the project.

Air quality measurement station

"We have an ongoing contract with the VMM and IRCEL-CELINE to help them on policy issues for air quality. When the 2008 AQ Directive came out, they realised they did not have an integrated system to get air quality information very quickly," explains VITO's Lisa Blyth. Tools developed by ATMOSYS now help these agencies to respond quickly when air pollution thresholds are exceeded.

"We firstly set up an improved air quality forecasting system for IRCEL," recalls Ms Blyth. "The more information you have, the more you reduce uncertainty. As with weather forecasts, the more models you have running in parallel the better the prediction will be of conditions tomorrow." The AURORA model uses traffic and industrial emissions data combined with meteorological data to predict concentrations of air pollutants. The ATMOSYS project enhanced this forecasting system using data simulation techniques, which link model output with actual measurements, and mapping innovations.

Merging models

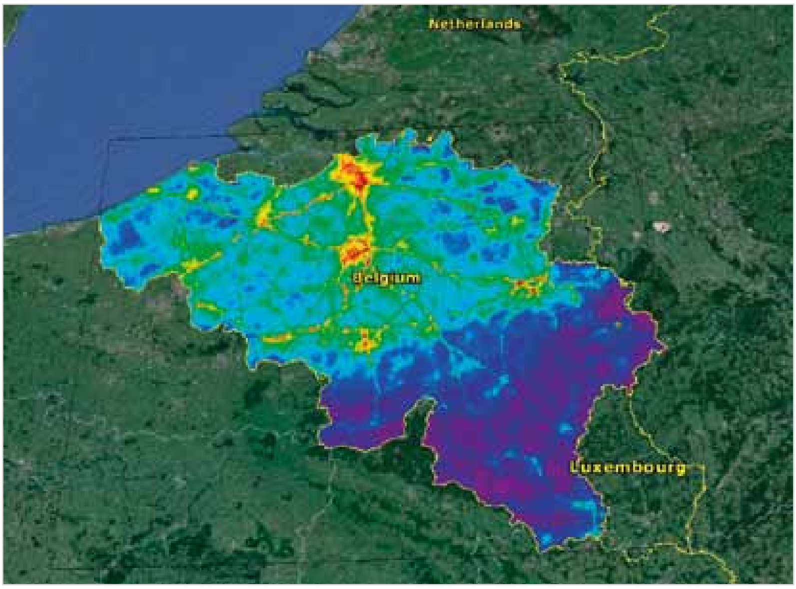
There has been greater attention on improved computer modelling since the adoption of the 2008 AQ Directive. "With measurements you can only gather so much information, because the measurement points are scattered around," Ms Blyth explains, "but what is the air quality in all the other areas? Models fill in the gaps."

A major project task was to combine regional and local models, to establish an archive of air quality maps for multiple scales: regional, urban, local, down to micro-scale. "Grid size is too large on regional models to capture hotspots and assess how many people are affected by them," says Ms Blyth. "The Directive wants to see whether anyone is exposed to overdose.

If, say, you look at the region of Flanders, you can see air quality for the whole region, but then zoom in and see the detail policy-makers want. They can then ask questions like: What is the extent of the problem? How many people live around this ring-road hotspot? How many people are exposed to air pollution over the EU-defined limits? Where do I start tackling the problem? It gives them a much better insight."

The project merged the regional RIO model, which interpolates data between measurement points using land use data, with a local Immission Frequency Distribution Model (IFDM) that calculates how emissions disperse in the air using hourly meteorological data. The coupling involved a great deal of development work; for example, care has to be taken to ensure no data are duplicated when combining models.

To focus on the micro-scale, the project used a computational fluid dynamic model called ENVI-MET, which incorporates local wind-flow patterns and building height. Such modelling is expensive, but for key locations provides planners with valuable information on how building design and tree planting can reduce air pollution.



Air quality modelling for Belgium

High-resolution mapping

One of the main project outcomes was the making of high-resolution maps from the archive of air quality information. These are one form of information displayed on an interactive website launched in June 2013 (www.atmosys.eu): the ATMOSYS Air Quality Management Dashboard. The services and tools on the dashboard were soon providing important policy-related and decision-making information. It is easy-to-use and also implements an AQ Directive requirement to supply the public with air quality information, in this case for every region in Belgium.

The daily air quality forecast service predicts concentrations of nitrogen dioxide (NO_2), ozone (O_3), two types of fine Particulate Matter (PM_{10} and $PM_{2.5}$) and elemental carbon for two days ahead, for example, whilst the exposure calculation tool informs users when EU thresholds have been exceeded for the four pollutants. Time evolution maps are animations that scroll through up to 8 760 hourly (one-year) archive maps, to show pollutant hotspots developing. "With ATMOSYS's reanalysis service, VMM can answer queries from policy-makers or the general public about air quality conditions at certain locations on particular dates," explains Ms Blyth. "The tools can also assess whether air quality has improved or deteriorated over time."

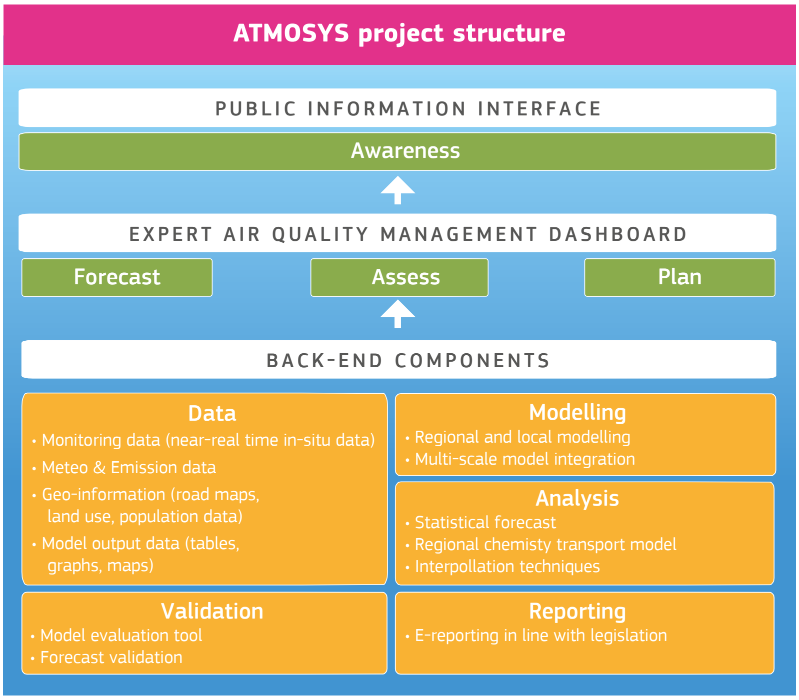
"Everyone can look up where they live and, if you put information on like 'this hotspot is due to traffic pollution', it is a very good visual public awareness tool," notes Ms Blyth. "The maps have generated a lot of interest in Belgium." ATMOSYS maps appear in the media, and one was held up in parliament to demonstrate poor air quality around Antwerp.

An evaluation tool was developed to quantify the accuracy of the maps. "You can click on a particular measurement station and validate the model data predicted for each pollutant at that location against the actual data," demonstrates Ms Blyth. This also helps to improve the models. Making the forecast maps as reliable as possible is important because EU Member States can be taken to the European Court fined for exceeding pollutant levels in line with the AQ Directive.

Monitoring campaigns

David Roet works in the VMM team responsible for air quality measurement in Flanders. In addition to gathering data from the permanent network of measuring stations, the project also conducted two specific monitoring campaigns, in four cities and along a busy motorway, to gain further insights into pollution hotspots. He explains: "In Antwerp, Ghent, Bruges and Ostend, we concentrated on three location types: street canyon, urban background and regional road." Street canyons are typically narrow roads enclosed by tall buildings, which means that pollution builds up and NO_2 and PM_{10} often exceed EU limits.

"When we looked at the average composition of PM_{10}, we saw secondary inorganic ions, mineral dust, sea



salt, compounds related to wood-burning, organic matter, and a small fraction of elemental carbon, roughly on average 4%. However, if you look at the toxicity of these compounds, elemental carbon is the fraction especially causing negative health effects." Monitoring also revealed previously lacking data on proportions of PM coming from car exhaust and non-exhaust (e.g. brake-wear) sources. "We also found that PM coming from wood-burning in winter is eight times higher than in summer," notes Dr Roet. This can make the difference between going over or staying below the threshold. Measurements on a busy motorway (the E40 between Brussels and Ghent) showed that NO_2, PM_{10} and $PM_{2.5}$ levels dropped away rapidly with distance from the road. This information is needed to calculate exposure levels for people living close to major roads, and has relevance for cycleway and other infrastructure planning.

"Elemental carbon is a fraction of particulate matter coming from the combustion of fossil fuels, so it is a very good indicator of traffic pollution and it is one of the most deadly components of PM in terms of health," explains Dr Roet. The ATMOSYS project established the first elemental carbon emissions inventory and maps for Flanders.

The AQ Directive requires the public to be informed of pollution episodes and mitigation plans. The ATMOSYS forecast system has been one of the models used at IRCEL this year to help issue smog alerts. If PM_{10} is forecast to exceed 70 µg/m³ for two days in a row, IRCEL sends out an alert and informs the media. Weather is a key factor, because when inversions occur and winds drop air pollution cannot disperse. In Belgium, short-term measures initiated by IRCEL to mitigate against the effects of air pollution include reducing traffic speed limits (from 120 to 90 km/hr) and advising people to use public transport whenever possible.

Modular dashboard aids transferability

"It was important that the tools we developed were easily transferable to other air pollution hotspot regions," says Ms Blyth. The analysis tools, for instance, were produced within a modular structure allowing selected parts to be transferred to new projects as needed.

Since the 2008 AQ Directive, there has been increased attention on using models. In response, the European Commission's Joint Research Centre (JRC) and European Environment Agency (EEA) established FAIRMODE (Forum for AIR quality MODElling), to ensure the reliability and compatibility of European air quality models. The ATMOSYS modelling system is based on the DELTA FAIRMODE tool, but in an easy-to-use online version compared to the JRC's desktop version.

The LIFE project built into the design of the ATMOSYS Air Quality Management Dashboard the possibility of tailoring its services and tools to the needs of any environmental agency in Europe. "Eventually, the idea is that other countries upload their data," concludes Ms Blyth, "and from a European map you could zoom in to any EU country or hotspot region."

Project number: LIFE09 ENV/BE/000409

Title: ATMOSYS - Policy support system for atmospheric pollution hot spots

Beneficiary: VITO (Vlaams Instituut voor Technologische Ontwikkeling)

Contact: Lisa Blyth
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Period: 01-Sept-2010 to 31-Dec-2013
Total budget: €2 354 000
LIFE contribution: €1 087 000

CAPACITY BUILDING

LIFE helps **build the capacity to implement policy**

The LIFE programme has helped build capacity in all aspects of air quality, through the understanding and removal of obstacles that prevent local authorities from implementing Air Quality Directive objectives.

Although improvements in urban air quality have been made over recent decades, there are major public health concerns relating to air pollutants, such as nitrogen dioxide (NO_2), particulate matter (PM), and ozone (O_3), which frequently exceed set limits. During the review of the latest Air Quality (AQ) Directive (2008/50/EC), it became apparent that legislation addressing these air pollutants had not been effectively implemented by EU Member States, and that steps needed to be taken to overcome challenges to policy implementation[18].

One of the conclusions of the 15-month Air Implementation Pilot (AIP) project[19] (see pp. 8-12) was that there was a lack of capacity to develop, implement and monitor plans to cut air pollution. With different systems evolving in different cities, influencing everything from emission inventories and monitoring networks to management practices for abatement and how the public is informed about air quality, there has been relatively poor harmonisation and coordination between national and local actions.

The central problems identified by the project were incompatibility between modelling tools used by different cities, difficulties in interpreting modelling results, and a lack of cost-benefit analysis to help planners and policy-makers choose between available measures. In all cases, experts, who were often external consultants, were required to run and interpret air quality models. Therefore, one of the

The AIR-AWARE project trained urban planners to use its air quality modelling tool

Photo: LIFE05 ENV/RO/000106

18 *EC Communication on 'Improving the delivery of benefits from EU environmental measures: building confidence through better knowledge and responsiveness' (COM/2012/095 final)*

19 *Air Implementation Pilot: Lessons learnt from the implementation of air quality legislation at urban level (EEA Report No 7/2013)*

Photo: LIFE11 ENV/DE/000495/David Gros

CLEAN AIR has organised workshops on the health effects of air pollution

lessons learnt from the pilot project was that local planners and policy-makers should be trained to work alongside experts in translating modelling results into cost-effective measures to mitigate pollution. The pilot project findings were integrated into the Clean Air Policy Package. One of the options suggested was to increase the use of LIFE co-funding to build capacity.

Approaches to capacity building

Capacity building is often thought of in terms of the training provided to local and regional authorities, who are seen as the deliverers of policy on the ground. However, when it comes to air pollution, capacity building needs are much broader than just training. Capacity building is required at numerous stages, from monitoring and modelling, through to generating expertise and best practice, drafting, implementing and evaluating air quality plans in government, and developing NGOs and other stakeholders' ability to act as consumer watchdogs.

Dealing with air pollution issues is expensive, technically difficult and involves a multi-disciplinary approach. Solutions include long-term changes in behaviour and attitudes, technological innovation, and better planning and decision-support systems. The LIFE programme is well-placed to support the additional efforts that Member States need to address capacity-building issues. It can also help provide access to other funding sources and help make the best use of available European Structural and Investments Funds to provide policy-support measures.

Air quality policy objectives can be achieved by using regulatory measures to deliver compliance ('hard' measures) or by using non-regulatory measures and actions to improve capacity building and coordination ('soft' measures). The LIFE programme has contributed to both of these areas (see the EC4MACS project on p. 25 for an example of the former). The driver for the development of a project is usually to achieve compliance with air pollution policy objectives or legislation, whilst non-regulatory activities appear as part of the cost-effective solution to achieving that. A good example of the latter is the AIRUSE project, which set out a comprehensive approach for solving air quality problems that included capacity building (see box opposite and pp. 25).

It is characteristic of the LIFE programme that where capacity-building needs have been identified, the projects have included those within demonstrated solutions. Most notably, LIFE has provided improvements in capacity building within the fields of air pollution monitoring and modelling.

Monitoring and modelling

The AIP showed that there was a great diversity of models used by European cities, hindering cooperation and data sharing; frequent shortcomings in emission inventories and other inputs (e.g. background pollutant concentrations, meteorological data and topography); and outputs that the cities

LIFE11 ENV/ES/000584

AIRUSE

"The aim of AIRUSE is to support decision-making in Southern Europe by generating new data on source apportionment and remediation measures for which local planners do not own the opportune methods because scientific tools are needed," explains project manager Xavier Querol of CSIC, Spain's National Research Council.

To address this issue the project has put together a multi-disciplinary consortium of professors, researchers and technicians to advise and train local planners in air quality management issues. The end result will be better trained planners who will be able to accurately assess the (scientific and economic) efficiency of a number of air quality measures, such as road dust cleaning, Low Emission Zones, speed restriction zones and eco-efficient biomass burners. "The ultimate goal is to give planners the right knowledge so that they can include correct measures in their plans," says Mr Querol.

found difficult and time-consuming to interpret. In particular, capacity was limited in the cost-benefit assessment of different pollution intervention options, because of the wide range of skills and variables involved. Therefore, capacity needs to be built if data are to be used and shared more effectively for solving local and regional air quality problems, e.g. when developing, implementing and evaluating air quality plans.

Predictive capability is central to designing effective solutions to air pollution problems. This requires measuring the right parameters with the right precision, whilst delivering compliance within resource constraints. It is also challenging for the technical teams within Member States to keep abreast of new developments elsewhere whilst also managing their own networks. Making improvements to existing networks, therefore, means developing skills and knowledge, and learning from others whenever possible. Collaborating to share expertise can reduce costs and help identify the best means available to achieve compliance. The provision of training is therefore a key factor.

A cluster of some 30 LIFE projects since 2000 have focused on air pollution monitoring and modelling. Most of these have capacity-building elements within them. As noted previously (see pp. 24-34), these projects are usually driven by local compliance issues, and often include improved data gathering methodology. Almost all of them adjust how the data collected are used, by developing modelling and decision-support tools.

In some cases, the tools and training developed in LIFE projects have focused on particular types of pollutants. For instance, the ARTEMIDE project provided training to enable local planners to use a high temporal resolution device for monitoring more frequently, and at a lower cost, airborne volatile organic compounds (VOCs) emitted by cars.


Photo: LIFE04 ENV/AT/000006/Prima Press

KAPA GS provided solutions for municipalities in combating fine particulate matter

Many LIFE projects have produced specific training courses or packages to promote the uptake of new tools and methodology (examples include SMAQ in Greece and ROMAIR in Romania). The LIFE programme has also helped forge links between scientific agencies and consultants and local and regional authority end-users. Such long-term stakeholder synergies increase authorities' capacity to use the monitoring and modelling tools and to translate results into effective measures. Such a synergy operates between the Cypriot authority running the National Air Quality Network, which is used to prepare cost-effective fine particulate matter management plans, and the scientific and technical partners developing state-of-the-art forecasting and scenario analysis software to improve this system (PM3 CYPRUS).

I.MO.S.M.I.D. set up a District Mobility Management Office in the Municipality of Corregio (Italy)

Photo: LIFE09 ENV/IT/000063

Photo: LIFE11 ENV/DE/000495

Other projects - such as OPERA (see pp. 40-42) - have developed guidelines for individual cities, communities and community councils on how to use their models and on how to develop emission-control strategies. OPERA is also an excellent example of trans-border cooperation, having worked with public authorities in both Italy and France. The trans-boundary nature of air pollution makes it important for projects to take a trans-national approach to dissemination and capacity-building activities. Projects that have envisaged from the start the need to test solutions with public authorities from more than one country have had a greater impact (aside from OPERA, examples include the CLEAN AIR project, which is working with NGOs from seven EU Member States and SMAQ, which held training seminars in Greece, Hungary and Italy).

Future LIFE projects could further emphasise trans-national capacity-building; the Environmental Governance and Information strand of the new LIFE Environment sub-programme offers a means of better disseminating best practices across borders and throughout the EU.

Capacity building for local authorities and NGOs

Capacity building is usually an indirect 'softer' consequence of LIFE projects aiming to achieve compliance with local air pollution standards, but one project dealing with traffic congestion addressed the issue directly by establishing a specific coordinating body to support local authorities. The I.MO.S.M.I.D. project set up a District Mobility Management Office to organise, plan, programme and promote services within a demonstration district of the Municipality of Correggio, Italy. This capacity building was viewed from the outset of the project as an integral part of efforts to improve mobility at a district level.

Capacity building is also a key objective of the CLEAN AIR project (see box).

LIFE11 ENV/DE/000495

CLEAN AIR

The aim of the project is to support the implementation of the Air Quality Directive by building an effective network of administrators and experts from environmental and consumer protection NGOs.

"Our main measure for capacity building is knowledge transfer," explains Heiko Balsmeyer of Verkehrsclub Deutschland (VCD), the project beneficiary. To date VCD and its project partners have organised two conferences focusing on measuring stations, Low Emission Zones, and the sources and health effects of ultrafine particles.

"We are working in different fields on capacity building," Mr Balsmeyer continues. "For example, our partner NABU organises workshops about clean ports." These workshops discuss issues such as the health effects of air pollution, particle filters for ships, onshore power supply and liquefied natural gas (LNG) barges.

The project has published guidelines aimed at city and port administrations about the benefits and costs of possible air quality measures. It has also set up workshops (led by legal experts) that provide NGOs with an understanding of applicable air quality legislation, thus building their capacity "to use law as an instrument for air quality," says Mr Balsmeyer.

The CLEAN AIR network prepares legal cases in different countries. "There are local cases, where citizens try to uphold their right to clean air," says Mr Balsmeyer. "The bigger cases are against Member States that don't hold to European limits for air quality; they can be forced to revise their national programmes and to take additional air quality measures. The aim is in both cases the same, civil society uses the law for the enforcement of European air quality policy."

The CLEAN AIR project represents a departure from usual approaches, in that it targets NGOs every bit as much as local authorities. The recognition of the consumer protection role of NGOs for air quality, for example, corresponds with the non-regulatory measures that the Clean Air Policy Package recognises as important. Indeed, the network that the project is establishing is almost tailor-made to be a platform as part of the European Clean Air Forum, which the Commission will use to bring relevant stakeholders together every two years.

Creating new opportunities

Although few LIFE air quality projects have explicitly aimed to do so, they have often indirectly built capacity where it is needed as part of the solution to a problem.

This has been achieved through training and the creation of guidelines that spread knowledge of the best tools and methods for air quality assessment across Europe, an important step towards the harmonisation of air monitoring systems. LIFE's greatest contribution has been in terms of building the capacity of local authorities to understand and apply monitoring and modelling tools (see the feature article on the OPERA project, pp. 40-42).

However, as the AIP highlighted, decision-makers need more and better tools to assess the cost-effectiveness of different air quality measures. The LIFE programme could provide an extremely valuable contribution in this area, which it has largely overlooked to date. Another future goal for the LIFE programme could be to assess the cost-effectiveness of projects in terms of their impacts on local, regional and national air pollution compliance, using transferable benchmarks.

Capacity 'building blocks' have already been put in place to deliver compliance with Air Quality Directive requirements. The Clean Air Programme for Europe (CAFE) has been providing policy advice since 2001, for example, whilst the EEA manages the European air pollution data set (Airbase). To help integrate and make best use of the expanding range of air quality models used in Europe, the JRC and EEA set up the FAIRMODE forum, which has a coordination role but relies on the input of EU projects and networks. One outcome of the AIP (see pp. 11-12) is a proposal that all the capacity 'building blocks' should be aligned and a platform for the exchange of best practices and knowledge created, perhaps initially through a LIFE project under the Environmental Governance and Information strand.

Analysis of the programme's existing capacity-building work shows that LIFE is ideally placed to develop and demonstrate solutions to air pollution at a scale sufficient to convince local and regional authorities of their 'workability' in real world situations.

INTEGREEN provides public authorities in Bolzano with integrated data to underpin eco-friendly traffic management policies

Photo: LIFE10 ENV/IT/000389

CAPACITY BUILDING

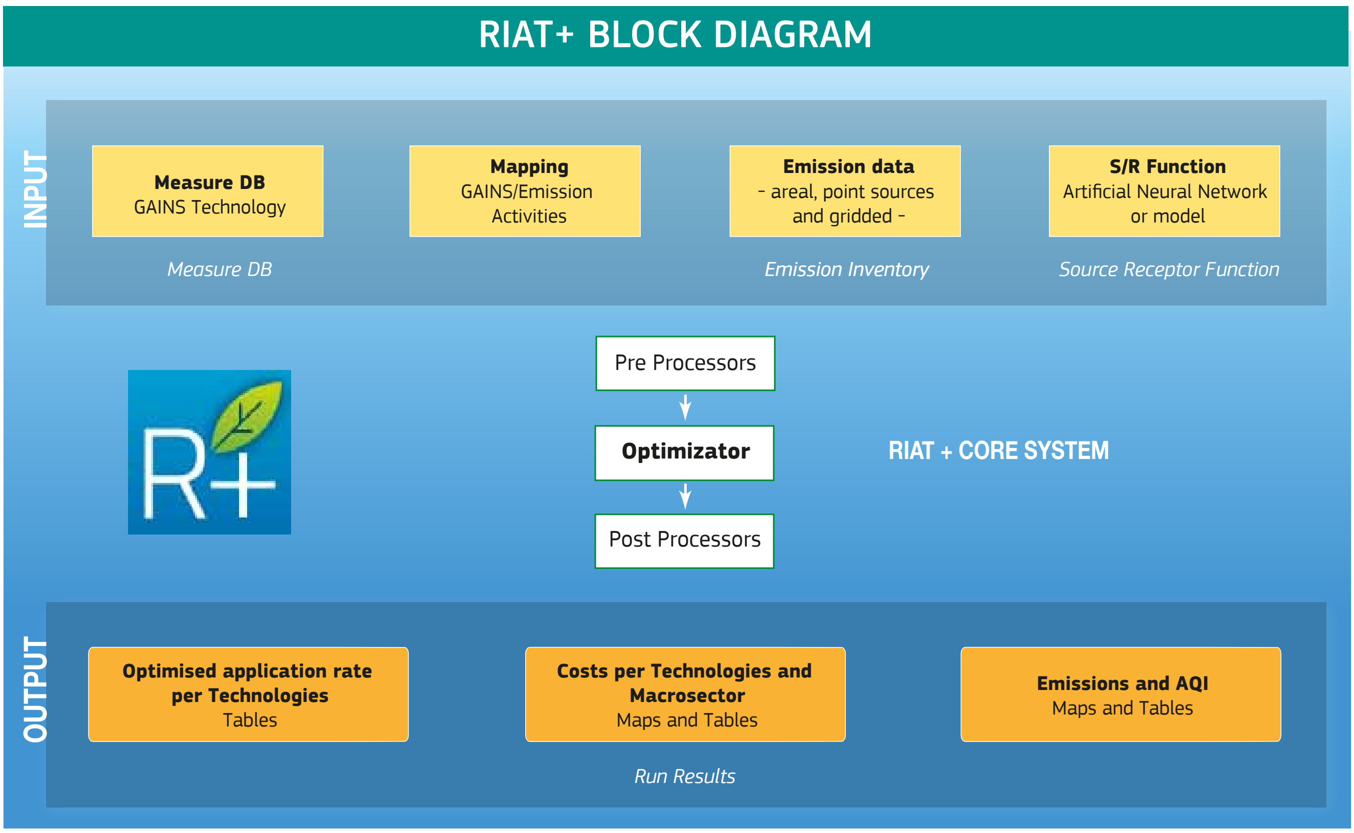
OPERA tool is building **capacity to reduce emissions**

The goal of the OPERA project was to develop a methodology that supports local and regional authority actions to improve air quality. This was implemented using an innovative software tool called RIAT+ (Regional Integrated Assessment Tool).

RIAT+ was designed for regional authorities with limited budgets to reduce population exposure to air pollutants and to meet air quality standards, especially for fine particulate matter (PM_{10}, $PM_{2.5}$), nitrogen dioxide (NO_2) and ozone (O_3). It differs from typical decision-support systems by using a closed loop (optimisation) rather than an open loop (scenario) analysis. RIAT+ can be set either to maximise environmental benefits at fixed cost or to minimise costs for a fixed environmental benefit. Each action within an air quality plan (AQP) is evaluated in terms of the change in air quality and in terms of cost, thereby enabling users to select cost-effective emissions-reduction measures.

The RIAT+ system acts both as a regional assessment software and as an integrated modelling environment through which air quality simulations on a regional scale can be produced. As a modelling system, RIAT+ uses air quality indicators to assess potential pollution abatement measures in light of EU limits and future concentration reduction deadlines. It incorporates Artificial Neural Networks (ANNs), to capture non-linear relationships between pollutant emissions and concentrations.

Between 2010 and 2013, the OPERA project tested RIAT+'s methodology and software in two



regions: Alsace (France) and Emilia-Romagna (Italy). In both regions, it highlighted effective measures to reduce air pollution. In Emilia-Romagna, for instance, the system's cost-effective analysis was used to set emissions targets within the regional AQP.

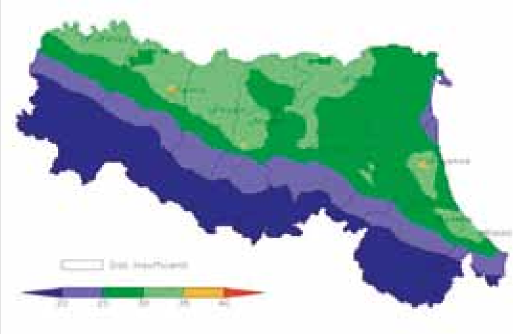
Emilia-Romagna's experience

The regional administration of Emilia-Romagna had previously worked on other modelling tools with ARPA, the environmental agency responsible for developing the software, and was interested in the possibilities of RIAT+, explains Katia Raffaelli, who is responsible for the region's AQP: "In the past we would make a hypothesis on which measures to adopt, we would verify the costs and the availability of the resources only in a second moment. [RIAT+] manages to create an interaction between the two immediately. Thus it gives us the most cost-effective solutions that will reach the best environmental results for each pollutant." Scenarios are based on the specific topography of the area, include a climatic model and incorporate the costs of the measures. The latter is "fundamental", says Ms Raffaelli: "We have to include in our AQP the best measures in terms of air quality effectiveness based on a limited budget."

"RIAT+ helps planners find the optimal compromise between air quality improvements and their implied costs, the maximum air quality improvements for a given budget and the most efficient abatement measures (both technical and non-technical) to achieve a given air quality improvement goal," explains Eriberto de Munari, ARPA Emilia-Romagna, OPERA project manager.

The tool's ability to determine the cost of measures in advance, particularly structural measures, makes it especially useful to public administrations. It is likely that other regional administrations thinking of using the tool would also need to work with a consultancy or other external agency, as Emilia-Romagna did with ARPA. There are two main elements to this collaboration: firstly, "the consultant and policy-makers must work together in determining the data, the costs and the estimates that will feed RIAT+, based on previous scenarios," says Ms Raffaelli. Secondly, and, she says, most importantly in terms of capacity building, "the consultant must help the policy-maker in translating the results that come from running the tool into cost-effective measures to insert in an air quality plan."

"To make it work we need continuous collaboration between the technician and the policy-maker," highlights



Spatial distribution of the annual mean concentration of PM10 for the Emilia-Romagna Region in 2012

Mr de Munari, who adds that one of the strengths of the system is the flexibility to define initial parameters based on the specificity of the territory in question: "A rigid tool could have been used directly by policy-makers, but it would have been less effective."

RIAT+ can thus be customised for use by any local or regional authority, whilst maintaining common features. "We use the GAINS [20] model along with the CORINAIR emission inventory which are common to the whole EU, thus making the tool usable all over the EU," explains Mr de Munari.

Supporting AQP implementation

RIAT+ supports decision-makers in the practical implementation of air quality plans by suggesting optimal emissions reduction measures to improve air quality, given a pre-defined budget. Users may introduce their own source of information/data (e.g. emissions inventories, air quality models, abatement technologies) on top of default assigned values. This allows a more precise assessment of the impact of user-defined abatement measures on regional/local air quality.

"The use of the RIAT+ tool has not only allowed us to adopt a first air quality plan, but it has allowed us to adopt measures that are based on scientific and technical data and for which we know the cost," points out Ms Raffaelli. This increases the credibility of the regional authority's decisions, which in turn "will translate into a stronger policy that can be enforced on the territory. It has also enabled us to give a technical and scientific response to all our stakeholders (citizens, local authorities, agricultural sector, and industries) on the issue of air quality manage-

20 The Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)-Model provides a consistent framework for the analysis of co-benefits of reduction strategies from air pollution and greenhouse gas sources.

JRC input

The JRC - the European Commission's Joint Research Centre - was one of the stakeholders of the project, and Philippe Thunis from the Air and Climate Unit in the JRC, is now working with this tool: "RIAT+ works at the regional scale in both "what-if" analysis and "optimisation" modes. This combination ("regional scale", "what-if analysis" and "optimisation") is quite unique. Other approaches either solve the problem through optimisation but at larger scale (European scale) or work at regional scale but only in "what-if" analysis mode," he explains.

The JRC will continue to work with the other project partners to develop the tool so that it can be applied at high spatial resolution across Europe and enable EU-wide impact assessment analysis with a focus on the regional scale. In particular, the JRC will support training courses and workshops so that local and regional authorities can learn how to use the tool and share best practices. The first such event is expected to take place in 2014.

ment which has a greater impact on changing their behaviour," she adds.

Emilia-Romagna began developing its AQP in early 2013. Results from the tool are being used to define the emissions-reduction objectives of the plan. "We are now in the phase of running the tool and singling out measures. It's a different approach because by using the tool we know exactly what are the objectives for each sector (energy, transport, agriculture) and what are the measures to adopt," says Ms Raffaelli.

Katia Raffaelli, Emilia-Romagna Regional Authority

The LIFE project is enabling the regional authority to evaluate the effects of measures on its territory and develop scenarios for implementation at local level. Support for proposed measures is being assessed through citizen surveys, as well as meetings with interest groups such as agricultural, energy and industrial associations and communal and provincial administrations. "We are finalising these meetings in order to guarantee integration among all policies. The tool allows for integration among policies and this is another one of its strengths," says Ms Raffaelli.

The tool developed with LIFE's support already has led to a change of objectives within the regional AQP, with less of a focus on PM reductions, stricter targets for NO_x and, for the first time, measures to address ammonia. Ms Raffaelli also notes that whilst SO_x values in Emilia-Romagna are low, because the substance is a precursor to PM, "we used the model to establish which economic areas are still problematic and which measures to adopt in order to reduce SO_2."

Emilia-Romagna plans to adopt the AQP by the end of 2014, after further discussions with local administrations and stakeholders within the region. The regional administration is also talking with neighbouring regions about using the RIAT+ tool throughout the Padana Plain "in order to develop coordinated measures for the whole of the Po river basin, given the similar territorial characteristics and given the trans-boundary nature of air pollution," says Ms Raffaelli. Regions elsewhere in Italy and in France have also expressed interest in the RIAT+ tool, which can be downloaded from the OPERA website.

"In the end the tool is fundamental for integrating policies because it provides scientifically and economically sustainable solutions and measures," says Ms Raffaelli. "If a policy is to be implemented and if it's going to be a winner it has to tackle all pollutants generated by the activities that are practiced on a given territory and this tool allows us to adopt these ambitious targets and for them to be accepted by all counterparts," she concludes.

Project number: LIFE09 ENV/IT/000092

Title: OPERA - An integrated assessment methodology to plan local cost-effective air quality policies harmonized with national and European actions

Beneficiary: ARPA (Agenzia Prevenzione Ambiente Emilia-Romagna)

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Period: 01-Sept-2010 to 30-Sept-2013
Total budget: €2 301 000
LIFE contribution: €1 090 000

ENCOURAGING BEHAVIOURAL CHANGE

LIFE shows **soft and hard side of behavioural change**

LIFE has helped encourage people to change their behaviour in ways that benefit Europe's air quality. What lessons can be learned from the programme's achievements?

The Air Quality Directive (2008/50/EC) includes an obligation for Member States to inform the public of the risks of exposure to elevated SO_2, NO_x and ozone concentrations. The National Emissions Ceiling Directive (NECD) also obliges EU Member States to keep citizens informed about air pollutant emissions (including when limits are breached), as well as providing information about inventories and control programmes. This information, which can be made available online and via public display boards, will help raise awareness of the need for behavioural change to improve air quality.

The Air Implementation Pilot (see pp. 8-12) highlighted ways in which air quality information could be more effectively communicated so as to encourage behavioural change, such as the adoption of a common system of indicators making information more understandable at the European level. Another conclusion was for enhanced use of smartphones and social media. To this end, the European Commission is now promoting smartphone apps (e.g. the free obsAIRve iPhone app) to deliver current and forecast air quality information across Europe.

The Clean Air Policy Package highlights different areas of focus. Information and advice must be targeted to have the appropriate impact upon different audiences (e.g. packaged differently for commuters and farmers). It should also be easy to understand and easy to access (i.e. requiring minimal effort and cost to do so).

Photo: LIFE00 ENV/F/000640

The European Day "In town, without my car!" project inspired the creation of European Mobility Week

LIFE's 'hard' and 'soft' approaches

Raising awareness about the risks of air pollution, as a precursor to changing behaviour, is therefore a major European air policy objective, which the LIFE programme is well-placed to address. Policy objectives can be achieved using 'hard' measures to deliver compliance or 'softer' non-regulatory measures. 'Hard' measures include laws and legislation, road tolls, obligatory road closures, enforced speed reductions and technological solutions. 'Soft' measures include awareness-raising programmes (e.g. to promote cycling and the use of public transport), educational campaigns and events encouraging behavioural change, such as car-free days (see below).

In most cases LIFE projects have been driven by the need to achieve compliance, and the 'softer' activities - such as making less polluting activities more attractive - appear as part of the cost-effective solution to deliver that.

LIFE has contributed to behavioural change across the full spectrum of thematic priorities identified in the Clean Air Policy Package. Traffic-related air pollution problems, for instance, have generated many LIFE projects. The starting point for these is that mobility is a social good and is

Photo: LIFE04 ENV/AT/000006

essential for growing the economy, but it needs to be controlled because it can have damaging consequences, especially for public health.

Driving the message home

Of the cluster of LIFE projects that deal with mobility issues (see pp. 13-20), a total of 10 since 1999 aim to raise awareness and change behaviour. These projects have sought to achieve their goals through a host of different means: from offering alternatives to private car use, such as the VOTE FOR BICYCLE project, which implemented cycle lanes and parking, promoted bike use and provided real-time pollution data via street signs; to encouraging a switch to cleaner types of private vehicles, including electric power-assisted bikes, electric scooters, hybrid cars and a natural gas minibus (e.g. see the IMMACULATE project).

LIFE has encouraged behavioural change by organising the first pan-European car-free days

Photo: LIFE98 ENV/B/000269/Provélo

Other projects have demonstrated park-and-ride schemes, car-sharing and methods of making public transport more attractive, such as reducing ticket prices (KAPA GS).

One lesson from this cluster of projects is the need for supporting infrastructure (e.g. charging stations, cycle parking) to be widely available in order for road users to feel comfortable about making a switch to a more innovative and cleaner technology. One recent LIFE project - E-mobility 3 cities NL (see pp.13-20) - attempts to demonstrate one solution through trials in cities in the Netherlands.

LIFE can also inspire behavioural change by focusing on the link between greener mobility, health benefits and improved quality of life. Emphasising this link in LIFE projects has been central to achieving behavioural changes[21], such as getting people to walk and cycle more to improve their health, which in turn can lead to reduced car use. Rising costs of providing health care and covering productivity losses due to air pollution is likely to mean that it will become more attractive to invest in prevention rather than cure. Several LIFE projects have led the way in this area. The GOAL project, for example, helped reduce noise and air pollution emissions through the promotion of alternative means of transport. An innovative approach to connecting environmental issues with personal well-being and fitness succeeded in motivating people and helping them to change their behaviour, while a 'silent driver' programme established by the project has been incorporated into driver training to reduce road noise, thus providing a good example of how holistic approaches can deliver coherence and synergy effects between air quality and noise reduction measures.

Reaching the public

Almost all LIFE projects addressing the monitoring and modelling of air quality have sought to present information on pollution levels in a more understandable format for the lay person as a precursor to behavioural change (either through hard measures such as congestion zones or softer measures such as 'leave the car at home' campaigns). Projects have begun using technology such as smartphones and roadside signs to help spread air quality alerts (see INTEGREEN box).

LIFE10 ENV/IT/000389

INTEGREEN

The INTEGREEN project in Italy is providing Bolzano's citizens and visitors with advanced real-time traffic and air pollution information that will be delivered through multiple platforms and devices to allow people to make "more informed and optimised travel choices," explains Roberto Cavaliere, from the Municipality of Bolzano.

The project is organising a number of awareness-raising events and campaigns aimed at particular groups, such as an eco-driving competition, to be held later in 2014. "Through public events we believe that is possible to significantly raise the awareness of the target audience," says Dr Cavaliere. One project action will focus on working with secondary school pupils to organise awareness-raising activities aimed at primary school children – and their parents.

Dr Cavaliere believes the key to behavioural change is the creation of "an 'engine' involving all relevant stakeholders that is able to strongly promote and exploit the local best-practices in a harmonised way, putting local travellers at the centre of the local mobility system." He adds: "We must build 'cooperative' systems not only from a technological point of view, but in particular from an institutional perspective, with the support of all relevant parties, including public administrations and private industry."

Raising citizens' awareness of alternative modes of transport has been a central component of urban mobility projects. Future projects should continue to focus on this whilst also recognising the need to encourage behavioural change to address other air quality issues (such as biomass which reduces CO_2 emissions, but may increase PM for example.

21 Behavioural change was also tackled during the Platform Meeting on Alternative Future Urban Mobility http://ec.europa.eu/environment/life/news/newsarchive2014/february/index.htm#mobility

One of LIFE's greatest successes in terms of behavioural change has been its multiplier effect on the car-free days movement through projects such as European Day 'In town, without my car!' and its follow-on, SMILE (see box).

Flexible and responsive tools

LIFE has demonstrated other tools for behavioural change, including planning initiatives, tools for urban investment and public-private cooperation. Such measures only succeed when accompanied by other actions that encourage citizen buy-in. Systems must also be flexible, as the LIFE project SIDDHARTA demonstrated. This project trialled a 'demand-responsive' public transport system (using methane-fuelled buses) to cope with seasonal fluctuations on an island with a significant tourism economy. Demand-responsive transport can be used to complement or replace conventional scheduled passenger services, and has increased the use of public transport by around 20% in some cases.

Two LIFE projects (I.MO.S.M.I.D and GESMOPOLI - see box p.47) drew up mobility plans specifically aimed at changing the behaviour of people commuting to industrial zones.

Photo: LIFE99 ENV/F/000459

The Italian I.MO.S.M.I.D project incentivised people in Emilia-Romagna to car pool by awarding 'mobility tickets' to groups of at least three people for every 300 km they travelled together. Worth 10 euros, these mobility tickets can be used to purchase goods and services related to sustainable mobility at participating businesses, such as bike shops, installers of LPG and methane fuel systems on vehicles, local public transport and car sharing and carpooling services.

Change on the farm

Changes to farming practices can be achieved through 'hard' means such as the greening requirement for Common Agricultural Policy (CAP) cross-compliance payments and through 'softer' measures such as farm-scale demonstrations of new techniques and practices.

All of the approximately 50 LIFE projects since 2000 that have addressed air pollution abatement in agriculture have involved farm-scale demonstrations. Projects such as Crops for better soil, AgriClimateChange and SINERGIA have encouraged behavioural change by showing the practical benefits (not only cost savings, but also reduced air emissions) of low-impact farming methods (see pp. 48-56).

Other farm-related projects have promoted a change in attitude towards livestock by-products (to see them as high-value nutrients rather than low-value waste). This helps to get them into the soil rather than into the atmosphere as pollutants or into water supplies as contaminating slurry. By encouraging such behavioural change, LIFE can not only benefit the environment, it can also help farmers avoid fines and penalties.

Agriculture projects provide several good examples of how awareness-raising comes before and leads to

(LIFE99 ENV/F/000459)

European Day 'In town, without my car!'

Following successful actions in France and then Italy, this project initiated the first Europe-wide car-free day on 22 September 2000 as a practical response to widespread concerns about air pollution and the quality of urban life. This project, which has helped inspire millions of people, promoted the then novel concept of car sharing, as well as the introduction of dedicated bus and cycle lanes, and pedestrian zones. European Day 'In town, without my car!' enabled people to reclaim their streets, often by holding special events, while measurements of air quality and noise on the car-free day compared to normal proved a valuable awareness-raising exercise.

Recognising the success of this LIFE project, which was strongly-backed by then Environment Commissioner, Margot Wallström, the European Commission launched the first European Mobility Week in 2002. A car-free day on 22 September is an integral part of this now annual event, which has grown from 320 participating towns and cities in 21 countries, to more than 2 000 participating municipalities across 43 countries in 2013, when the theme of European Mobility Week was 'Clean air – it's your move'.

The car-free days movement is today supported by the United Nations and the initiative has spread worldwide, encompassing cities such as Jakarta and Bogota.

SMILE, a second LIFE project led by the same beneficiary, ADEME, collected feedback from the conurbations that had participated in the LIFE-led car free day and in European Mobility Week. This helped in the drafting of recommendations and guidelines for both local authorities and public transport operators, offering multi-modal solutions for changing behaviour, enhancing public sector transport, and making it cleaner in terms of emissions.

behaviour change. The AgriClimateChange project, for example, developed and demonstrated an auditing tool to assess energy and greenhouse gas emissions from farms. This type of tool enables farmers to learn where pollution is occurring and where precious nutrients are being lost. Only when they are aware of that can they determine the best actions to take.

Assessing the programme's impact

The LIFE programme has helped to make technical information on air quality become more accessible and more easily understandable to citizens. This has enabled people to make informed decisions and to adjust their behaviour. The most useful LIFE projects in this respect have made information available in real-time and provided air quality forecasts that have allowed people to plan ahead, an important factor in changing behaviour. The programme has provided new opportunities to demonstrate the prevention of air pollution, rather than to only focus on controlling the problem once it exists.

LIFE projects have clustered around thematic areas such as mobility, traffic management, public transport, industry and agriculture. Findings have been easily transferable within these specialist areas, where in-depth work has added value in terms of levels of awareness. This has been achieved through actively engaging the people dealing with air pollution problems on the ground. In the case of agriculture, in particular, LIFE has helped pave the way for the establishment of an agriculture forum as part of the European Clean Air Forum, and it has fed into the development and implementation of the CAP.

Going forward, the Environmental Governance and Information strand of the new LIFE programme for 2014-2020 could be used more effectively to raise awareness about air quality, to promote collective action and to influence personal behaviour. Projects could, for example, provide useful information about real-time and expected air quality in relation to physical activities such as gardening or going to the shops, environmentally-friendly mobility or purchasing choices. The success of projects such as European Day 'In town, without my car!' or the European Week for Waste Reduction highlights the potential of LIFE as a multiplier of behavioural change. These examples suggest there may be scope for a similar pan-European campaign - kickstarted through a LIFE project - to help improve air quality across the EU (and eventually globally).

LIFE05 ENV/E/000262

GESMOPOLI

The Spanish GESMOPOLI project brought workers, management and municipalities from the participating industrial areas of Barcelona together in 'mobility roundtables'. Each roundtable had the task of drafting a mobility plan. "A mobility manager was in charge of monitoring the implementation and update of the plans in each industrial area," explains project manager Carlos González.

Each mobility manager received 60 hours of training and 900 hours of work practice. Awareness-raising sessions were organised for people working on the industrial estates, whilst employees from the local administrations were trained during the mobility roundtables, recalls Mr González.

He notes that it was not easy to change established commuting patterns: "We had to take into account the duration of the journey, which has to be competitive in order to change people's behaviour." The project established a 'magic formula': "a worker will be willing to use public transportation as long as the duration of the journey, compared to private car, does not increase by more than 15 minutes," explains Mr González.

GESMOPOLI also looked into car sharing, another promising action to reduce traffic-related pollution. One conclusion, highlighted by Mr González, is "that cars carrying more than one passenger should be 'privileged' both on the road and in the car park."

'Soft' approaches have been successfully demonstrated in many LIFE projects, so a future task for the LIFE programme could be to quantify the air quality benefits of these 'softer' measures. This has not happened sufficiently to date, so it would be beneficial if there were a greater overlap between social science and air quality analysis. Ideally projects would report on how behaviour has changed and the impact of that change on air quality. However, it is important to recognise that 'soft' measures are more likely to be cut when budgetary restrictions are in place, with funding tending to focus on meeting regulatory requirements, hard measures whose impacts are easier to quantify and whose costs are easier to justify. Ultimately, however, it is the routine daily choices made by individuals which multiply to have enormous effects. Changing people's habits is certain to remain a vital part of the Clean Air Policy Package.

AIRUSE organised summer courses to raise awareness amongst students

Photo: LIFE11 ENV/ES/000584

AGRICULTURE

LIFE's potential for **preventing agricultural air pollution**

Although much has been done to address air pollution from agriculture, problems linked to ammonia remain significant. LIFE projects have demonstrated tangible ways of implementing policy to address this and other air quality challenges.

The intensification of agriculture has helped keep Europe consistently supplied with high quality and affordable food. However, it also has been linked to an increase in air pollution from farms, especially livestock husbandry businesses. It is essential to improve knowledge about these issues and farmer confidence about the cost-effectiveness of associated mitigation measures. Here, LIFE continues to play a key role.

LIFE know-how

The LIFE programme has produced useful applied results for farms that both give it a degree

Sinergia demonstrated agricultural practices that mitigate ammonia emissions

Photo: LIFE03 ENV/E/000085

of credibility within the EU's agriculture sector and that feed back into agriculture policy. The pool of knowledge gathered in the LIFE project database is a significant source of advice and guidance for Member State authorities involved in designing or implementing the new Codes of Practice for air pollution that are foreseen in Annex III of the National Emission Ceiling Directive (NECD). However, there is also a need to further streamline the process of feeding back into policy.

Farm-based air pollution can be caused by emissions of ammonia (NH_3), methane (CH_4), nitrogen oxides (NO_x) and particulate matter (PM), which includes $PM_{2.5}$, PM_{10}, and black carbon. Ammonia is considered to be particularly problematic and is acknowledged as one of the EU's six main air pollutants. It can harm human health and acts as a building block for secondary PM. Ammonia also contributes to acidification and eutrophication.

Policy in practice

The EU's Clean Air Policy Package highlights the need to further reduce harmful emissions from agriculture[22]. Farm-based LIFE projects have already demonstrated measures for curbing air pollution that are highlighted in Annex III of the revised NECD.

Such LIFE projects have been used with good effect by Member States to put policy into practice. They include LIFE support for, among others: nitrogen management, taking into account the full nitrogen cycle; low-emission manure and slurry spreading and storage approaches; manure processing and composting systems; and reduced emissions from black carbon by avoiding incineration of agricultural waste.

A lot of the LIFE projects' results in these fields prove useful from multiple perspectives. This allows their findings to be replicated in ways that reduce environmental risks on various fronts. For example, farmers have benefitted from LIFE's involvement in demonstrating the advantages of EMAS certification, or nature conservation, or precision and organic agriculture by introducing agricultural practices that mitigate air pollution and ammonia emissions especially. These actions promote good agricultural and environmental conditions through best practices in tillage, irrigation, fertiliser use, timing of nitrogen inputs, etc. that can create co-benefits for air quality.

22 In addition to targeting agriculture, the policy also highlights the importance of reducing air pollution from industry, traffic, and energy plants.

Photo: LIFE09 ENV/IT/000214/ASTRALE EEIG/Tim Hudson

Low-protein feeding strategies for livestock reduce ammonia release on farms

One of the highest impact areas for LIFE projects in this multi-functional field involves demonstrating sound management of farm nitrogen use. Many farm-based LIFE projects here have been developed to address nitrate pollution in water but with outcomes that also help to improve air quality.

Sound nitrogen management

LIFE has consistently developed tools and pushed the boundaries of agricultural best practice by demonstrating what can be achieved through sound nitrogen management. A large percentage of these actions have helped local, regional, and national authorities to reduce air pollution via improved compliance with the Nitrates Directive[23].

An analysis of some 20 different LIFE projects (since 1998) related to nitrogen management on farms highlights the extent to which the programme's cofinance can be used to reduce air pollution[24]. This sample of LIFE projects exhibits strong similarities in their approach, with the majority tending to tackle several separate, but simultaneous and coordinated, ways of reducing pollution risks from nitrogen.

23 Targets in the Nitrates Directive require Member States to reduce ammonia emissions by 14% on 2000 levels by 2020.

24 Spain and Italy have made the most use of LIFE support for tackling agricultural air pollution problems. Opportunities exist for LIFE projects to better reflect the balance of ammonia pollution problems aligned with productivity patterns. Hence other major EU agricultural countries, notably France, Germany, Poland etc. could also make good use of LIFE in this area.

One project (AGRI-PERON) used a satellite tool called Farmstar to diagnose fertilisation requirements down to farm-scale across the whole territory. The maps and other information provided to farmers enabled them to better assess the environmental impact of their agricultural practices and modify their nitrogen inputs. The project developed codes of good agricultural practices and demonstrated tailored practices to reduce nitrogen applications on 76 farms. Developing low environmental impact agronomic techniques and monitoring their impacts on nitrate levels has helped establish regional nitrogen balance and crop requirements as well as control pollution (PETRIGNANO). Several other projects (SINERGIA, Crops for better soil, AgriClimateChange, SOLMACC) have focused on promoting organic farming techniques that helped reduce nitrogen application. Such techniques have been applied across a range of crops, from viticulture, to citruses, leguminous plants and wheat. In addition to nutrient application, such projects have focused on tilling, fertilisation, crop protection, irrigation and the reintroduction of traditional crops whose roots fix nitrogen, thus requiring less fertilisation.

A feature common to all 20 projects analysed has been to address economic considerations – a vital part of persuading farmers to adopt the new methods. Most techniques designed to reduce nitrogen losses have been shown to have other advantages for farmers, such as providing energy, reducing fuel costs or increasing the total fertiliser value. The Crops for better soil project has demonstrated that the same yield can be achieved from a lower nitrogen application. Recognising the cost saving, farmers who participated in the project are now applying the same methods on other parts of their land, as well as passing on the know-how to neighbouring farmers who are doing likewise. Many wineries participating in the SINERGIA project are now producing organic wine, whilst others (without certification), are following similar sustainable practices that lower nitrogen application.

LIFE's demonstration value extends beyond crop farming. Piggeries and poultry farms are considered to be a significant source of air pollution. LIFE has demonstrated a solution based on flushing techniques that have reduced ammonia emissions and nitrous oxide by up to 70% (Zero Nuisance Piggeries). Although the project found that its method is more expensive than existing techniques for treating manure (by some €5-8/m³), costs are expected to fall significantly with further technical adaptations.

Other projects - "Odour reduction" and "InfoNitrate"- have helped to identify cost-effective solutions for reducing piggery odours and atmospheric threats. However, few projects have addressed air pollution from poultry farms and one other area that could be addressed by LIFE in the future is for

The NITRATES project is defining best farming practices to reduce nitrate contamination

Photo: LIFE10 ENV/ES/000478/INTIA

Photo: LIFE10 ENV/IT/000321/Massimo Coltorti

Experimental field monitoring and sampling for nitrate concentrations

projects to clarify optimal nitrogen management methods on farms in upland areas, or operating in areas dominated by marginal land with low productivity.

Co-benefits from GHG reduction

Many of the more recent LIFE projects examining sound nitrate management on farms are concentrating on climate-related matters, and these too produce useful co-benefits for air quality. Greenhouse gas (GHG) reductions often remain the core goals for such projects, which normally exhibit stronger direct correlations with air quality agendas than LIFE projects dealing with water-based nitrate problems.

Techniques associated with measuring and reducing GHG emissions from Europe's farms offer useful insights into methods for tackling air pollution (see the box on AgriClimateChange). Indeed projects such as LIFE+AGRICARBON have shown how actions to mitigate the impact of GHGs through improved fertiliser management can contribute to reducing air pollutants such as ammonia and NO_x.

This trend towards using emission assessments, rather than water quality analysis, to evaluate air quality impacts from LIFE (and other) projects is expected to continue to grow in prominence. Thus LIFE could play an important role in helping to improve our ability to quantify environmental benefits such as emissions reductions.

Additional scope also arises to revisit past work and improve on the quantification of various agronomic techniques using standard emission assessment methodology. It would be useful to develop farm-scale audit tools for NECD parameters, combining these with GHG audit tools where possible. These could feed into the development of future cross-compliance requirements, and national reporting requirements for air pollutants.

Nitrogen management by precision farming

Precision farming provides win-win benefits for farmers (mainly through cost savings) and the environment (mainly through reduced use of agri-chemicals and energy). LIFE has been at the forefront of progressing resource–efficient approaches to precision agriculture through project actions that confirm the feasibility of reduced nitrate usage, and thus reduced air pollution threats.

Significantly, LIFE has highlighted the value of applying real-time monitoring data to establish a

LIFE09 ENV/ES/000441

AGRICLIMATECHANGE

This Spanish project focused on demonstrating the effectiveness of a toolkit that helps to quantify the impacts of on-farm interventions (such as ammonia emission reductions) in terms of environmental benefits and economic savings.

The project toolkit included methods that can be applied to tackle ammonia emissions, such as covering all slurry pits and liquid manure facilities on livestock farms. The AgriClimateChange team highlights scientific evidence that at least 17 000 tonnes of ammonia emissions could be prevented in this way. It also notes that around 75% of EU farms already have covered storage facilities for liquid manure but comment that countries such as France, Italy, and Spain "have a significant potential for progress".

The project also assessed the potential impact in terms of ammonia management of low-level slurry application techniques such as shallow or deep injection or the use of modern technology such as 'trailing hoses' and 'trailing shoes'. The project says that such methods could have "an average reduction potential of 350 000 tonnes of ammonia in the EU-27".

The project's success is being widely promoted at EU level and has attracted high-level interest from policy-makers. This includes invitations to the project team to present the results at meetings of EU agricultural ministries, and to act as key advisors to the European Parliament's Committee on Agriculture and Rural Development (COMAGRI) during production of a new policy document concerning lowering of farm emissions.

LIFE10 ENV/BE/000699

DEMETER

In Belgium's Flanders region the DEMETER project is testing a decision-support tool (DST) for agri-businesses that allows them to maximise organic matter and reduce nitrate residuals. Multi-purpose outcomes from the project to date can help to tackle both air quality and climate change challenges.

With a focus on sustainable management of both soils and nutrients, the DST is designed to be simple and user friendly. It helps farmers to translate technical and scientific details within practical applications and it is being made available online as a free resource for Dutch-speaking farmers in Flanders.

"The online DEMETER tool presents farmers with a hands-on report about the organic matter and nutrient management on their land. In this way, it offers the farmer practical advice for improving soil management and reducing emissions such as ammonia and GHGs," explains project leader Sarah Steyaer from the Flemish Land Agency.

"This uniquely integrated and sustainable approach is being tested on 80 farms where it makes it possible for farmers to improve their own farm management in ways that also make positive contributions to important policy priorities including reducing air pollution and other emissions," she concludes.

farm's ideal nitrogen requirements (the OptiMa-N project). This approach has attracted the interest of authorities dealing with nitrogen regulations, since LIFE project results have shown objectively that current nitrate usage levels on EU farms can be over-estimated (and thereby reduced) by as much as 30%.

Other LIFE projects exploring precision farming methods point to the importance of managing soil nutrients and organic matter simultaneously. Adding manure to soil can improve the soil's water retention, resistance to erosion, and nutrient uptake. However, adding too much manure exceeds nutrient requirements and leads to pollution. LIFE has demonstrated a decision-support tool for agri-businesses that helps farmers achieve the correct balance of manure inputs and thus avoid air pollution (see DEMETER box).

DEMETER's results add value to other LIFE projects such as SOWAP, which carried out a successful cost-benefit analysis for different precision-farming techniques (e.g. conservation tillage, nutrient management, etc.). Results from such multi-national applied research work show that whilst yields may decrease slightly from reduced nitrogen inputs, the associated financial savings counter any loss of overall profitability.

Such projects thus provide farmers with the objective information they need to make environmental business decisions, and ultimately boost farmer confidence in measures that reduce air pollution risks.

More emphasis on cost-benefit analysis in future LIFE projects will add more credibility to their results.

DEMETER is providing farmers with a practical tool that will support them in sustainable nutrient management

Photo: LIFE10 ENV/BE/000699

Photo: LIFE09 ENV/ES/000459

The ECOREGA team showing how to produce a natural fertiliser by mixing liquid manure from cattle farms with other types of organic waste

New LIFE projects in this field should aim to report on the cost of their environmental solutions against a conventional 'control' cost. Additionally, new projects could aim to better estimate the cost of commercialising prototypes, or of adapting them to different climates or agricultural sectors.

Manure management and composting

Most LIFE projects with a role in reducing air pollution on farms have found that improving manure management provides consistently effective results. New know-how has been developed by LIFE here, and this knowledge is now in the public domain, allowing it to be applied by agri-stakeholders responsible for implementing statutory manure management measures. For example, from the start of 2020, farms will be required to cover manure stores and emissions from livestock barns will need to be reduced by 20%.

LIFE's good practice approaches in manure management can also help implement the new codes and standards for low emission manure processing and composting that have been proposed by the NECD. Another cluster of some 20 recent LIFE projects offer new and proven ideas about effective methods for processing and composting manure - in ways that retain nutrient content but reduce emissions.

Mushroom farms use large quantities of manure compost. Consequently, they can be a significant source of EU ammonia emissions (estimated in 2004 at 13 000 tonnes per annum). LIFE's ECOFILTER project responded to this challenge by showing how a combination of bio-washers and bio-filters can reduce ammonia emissions by around 95% on such farms.

In this type of technological project, LIFE's ability to co-finance economic feasibility studies is vitally important to help promote replication of the technology by the sector. Follow-up work (via ex-post evaluations) provides even more valuable information to help broaden the knowledge transfer opportunities concerning mainstreaming of air pollution controls on farms.

LIFE's mainstreaming successes are demonstrated by France's Smelox project, which tackled both nitrogen and odours from manure through a new high temperature vapour process that oxidises ammonia. Largely self-sustaining on low-energy inputs and ex-

MIX FERTILISER is producing a new fertiliser containing a nitrification inhibitor which reduces NO_x emissions

Photo: LIFE12 ENV/ES/000689

Photo: LIFE06 ENV/E/000044

ES-WAMAR showed that direct injection of slurry can reduce ammonia emissions by 95%

othermic processes, this innovative high-tech system was endorsed by the local water authority, which meant that local businesses could apply for financial assistance to install it.

Another cluster of useful LIFE project results have demonstrated different ways of helping Europe's dairy farms to reduce air pollution threats using anaerobic digestion to improve manure management (LIFE-OPTIMAL 2012 - see box).

The cluster of manure-related projects highlights the potential for individual farms to cost-effectively treat different types of manure. However, wider uptake of aerobic and biogas treatment technologies requires a demonstration of their economic efficiencies. Such a comparison was one of the useful actions of the UNIDIGES project, whilst the ongoing ECOREGA project is combining composting with methane recovery for energy production in a coordinated project that aims to highlight the profitability of integrated on-farm approaches to manure management.

LIFE10 ENV/IT/000347

LIFE-OPTIMAL 2012

This ongoing project is testing an anaerobic digestion technology designed to transform the ammonia present in livestock manure from a potential pollutant into a high quality liquid fertiliser.

"We expect to significantly contribute to the NECD by demonstrating how the digestate can reduce ammonia emissions," explains Helmut Döhler from the project. "Manure digestate will emit much less ammonia compared to common practice, since it will be stored in covered tanks. In addition, the production of organic fertilisers will replace artificial fertilisers, which can cause high ammonia emissions during production. In our project, the conversion of liquid digestates into organic fertilisers is largely free of ammonia emissions because we have installed an air purification and treatment unit," he says.

Dr Döhler adds that the prototype liquid manure and digestates spreader "is designed to reduce environmental impacts to air, soil and water bodies by combining several technical components, including: online measuring of the nutrient content of the digestate during spreading by near-infrared spectroscopy detectors; low-emission spreading devices (trail hose spreader and open slot spreader) and electronic control of the application rate of digestate to provide an accurate distribution of nutrients." The project is also testing a carrier vehicle with a low centre of gravity that would enable farmers to work on steep slopes in alpine areas.

Low-emission spreading

Spreading nutrient onto fields presents a high risk of polluting emissions and nutrient loss. Thus, low-emission spreading is a specific requirement of the NECD. Until recently, spreading systems often sprayed manure and slurry high into the air and this increased its potential as a pollutant. Modern approaches generally favour direct injection methods and avoid spreading at times when crops or pastures are not growing. Such practices help to maximise nutrient uptake by plants and can reduce ammonia emissions by up to 95%.

Two LIFE projects - ES-WAMAR and Farms for the Future - have demonstrated spreading techniques

that help deliver nutrients where and when they are needed most. The former employed direct injection of treated piggery waste across a network of nearby arable farms, whilst the latter equipped tractors with computer-controlled spraying technology linked by satellite to a soil database. Business and environmental benefits resulted from ES-WAMAR's separation and managed redistribution of solid and liquid wastes for low-emission spreading using pipelines and transport, including the creation of 16 jobs. Outcomes from LIFE's low-emission spreading projects could be adopted by future cross-compliance controls.

Fertiliser control at source

Reduced use of chemical fertiliser is built-in to the NECD. This is referred to as 'controlling the source' of potential pollution. A cluster of around 15 LIFE projects dealing with manure processing and composting are tackling the issue by retaining farm nutrients and creating organic fertiliser.

Another group of some 10 projects are tackling the problem from a different angle – demonstrating options for increasing the efficiency of fertilisers to deliver nutrients (thus less fertiliser is needed). Several projects have shown that slowing down the release of nitrogen can reduce input requirements, and thus pollution risks. This can be done by incorporating a nitrification inhibiter with the chemical fertiliser, or by coating the fertiliser to manage the rate of release.

The MIX FERTILIZER project is working on mixing organic treated pig manure with chemical fertiliser to create a new type of fertiliser containing a special inhibitor (3-4 dimethylpyrazole phosphate). This project plans to achieve a 45-50% reduction in NO_x emissions from wheat plots, as well as a 30% reduction in chemical fertiliser use. Good replication of these results is anticipated because the slow release means one application of fertiliser may be possible (saving on operational costs) and a 10% increase in yields is forecast.

Zeolite-coated nitrogen fertilisers reduce ammonia and nitrous oxides

Photo: LIFE10 ENV/IT/000321/Massimo Coltorti

LIFE10/ENV/IT/000347

UNIZEO

Urea-based fertilisers are widely used by EU farmers because they deliver high quantities of nutrient at relatively low cost. However, they can have higher ammonia and NO_x emissions than other nitrogen fertilisers. This Italian project is testing the effects of coating urea-based nitrogen fertilisers with zeolite (micro-porous minerals) in order to control nutrient releases and reduce pollution risks. Zeolite is particularly efficient at holding and slowly releasing valuable nutrients to plants.

"The UNIZEO-coated product has the potential to reduce ammonia and nitrous oxide losses in two ways. Firstly, through the physical protection of urea granules once the fertiliser has been applied to soils, and secondly through soil-exchangeable ammonium retention in the zeolite coating material," explains project coordinator Simone Salvetti.

He adds that the project team is evaluating this product's overall environmental benefits in terms of ammonia emissions reduction, fertiliser nitrogen efficiency, and nitrate leaching and says that so far results are "promising". A pilot plant has been set up to produce 1 000 tonnes/yr of the new fertiliser treatment, which is expected to reduce application of urea on farms by as much as 40% throughout the test sites and provide a demonstration of an economically-viable way for farmers to reduce the overall amount of nitrogen used per hectare.

Another technique, coating fertilisers with zeolite (micro-porous minerals) to control nutrient release, is being demonstrated by the Italian projects Help-Soil and UNIZEO (see box).

Further reductions at source can be achieved by replacing chemical fertilisers with suitable substitutes. A number of LIFE projects have trialled the substitution of farm residues for commercial fertilisers. Alternatively, the substitute could contain urban organic waste or bio-char (charcoal produced from bio-mass) - the RESAFE project is currently blending farm residues with these other waste streams to establish soil fertility improvements.

Nutrition control at source

The NECD makes it clear that Member States will need to make use of low-protein feeding strategies for livestock. This reduces the nitrogen input to farm systems and subsequently may cause farmers to worry about productivity implications.

By way of abating such concerns, a cluster of holistic nitrogen management projects has looked at nitrogen efficiency. Most of these have assumed that high protein inputs will be maintained (in order to retain high yields) and few have worked out protein concentration requirements for livestock. Opportunities exist for new LIFE projects to fill this knowledge gap through more work with farmers and livestock nutrition experts, building on earlier successes such as the 1999 Swedish project, Ammonia (see box).

Black carbon reduction

When agricultural waste is burnt it can produce a specific type of PM called black carbon, which is an air pollutant highlighted in the NECD. Henceforth, certain burning activities will be restricted or prohibited (e.g. open field burning of agricultural residues).

More LIFE projects are expected to focus on this issue in the future because it is a priority within the clean air policy package. Aside from the previously-mentioned projects turning farmyard waste into compost, other LIFE projects have focused on alternatives to incineration of such waste. Initiatives through the ECORICE, BIOVID and BIOCOMPOST projects, for instance, have demonstrated successful ways to reduce burning of rice straw and vine shoots by developing marketable products from the material that was formerly burnt, such as blankets from rice straw or cardboard made from vine shoots.

Photo: LIFE04 ENV/ES/000184

Open burning of agricultural residues produces black carbon

LIFE99 ENV/S/000625

AMMONIA

Demonstrating the LIFE programme's capacity for innovation, this Swedish project from 1999 addressed nearly all of the requirements for ammonia reductions and manure/slurry management now included in the proposed National Emissions Ceiling Directive (NECD) Annex.

Knowledge developed by the pioneering LIFE project included: quantifying ammonia emission reductions; establishing Best Available Techniques (BATs) for spreading manure; identifying livestock diet changes; and creating an advisory service about ammonia that was joined by some 4 000 farmers. The service highlighted such ammonia-reduction measures as improving nitrogen efficiency in milk production; creating conditions within livestock barns to limit ammonia release; using bio-filters to trap ammonia particles in outgoing air from such barns; storing slurry in covered containers; and applying the BATs for spreading manure.

The bio-filters were shown to provide particularly useful benefits since total ammonia emissions from farms involved in the project were reduced by 66% when the effect of the bio-filter was included. Even without bio-filters, it was shown to be possible to reduce ammonia on farms by 48% using methods mentioned above. Furthermore, the project demonstrated that a 1-2% reduction in dietary protein per head of cattle could reduce Sweden's ammonium-nitrogen emissions by up to 1 700 tonnes per year.

Cleaner agriculture

The Clean Air Programme for Europe promotes "active engagement with the farming sector" and LIFE can be seen to offer many success stories in such engagement. It has provided on-farm demonstrations in real-world conditions. Education and targeted knowledge transfer have been an integral part of the projects in the sector. LIFE projects take account of the economic viability of their proposed solutions, and their cost assessments have been suitably robust to address concerns from EU farming communities.

In summary, LIFE has already made major progress in developing effective techniques that Member States can adopt within the NECD Codes of Practice for addressing ammonia emission challenges. These codes need to be operational before January 2020 and so LIFE's popularity with the EU farming sector could help Member States to identify more new farm-led solutions. It will be important for these future projects to focus their actions on farming systems that have the most potential for making long-term positive improvements to the quality of Europe's air.

AGRICULTURE

LIFE GAS-OFF: **reducing ammonia emissions from dairy farms**

Dairy farms can be a significant source of air pollution from ammonia emissions and an Italian LIFE project successfully identified methods for reducing such pollution risks

Geographic features can influence air pollution. A case in point is the Po Plain – a large enclosed river basin stretching from west to east across some 64 000 km^2 of northern Italy. Wind levels in the plain are very low which limits the ability of fresh air to circulate and cleanse. Consequently, it is prone to high levels of air pollution, especially during winter months when inversion occurs and cold air clings to the ground.

Air pollution associated with agriculture is exacerbated by this natural phenomenon and LIFE has been involved in helping the region's dairy farmers to better understand options for reducing air pollution. LIFE's GAS-OFF project undertook three years of applied studies in the Po Plain area to determine a toolkit of practical actions that dairy farmers can apply to reduce atmospheric emissions. Much of the project focused on challenges related to emissions from ammonia (NH_3) and the greenhouse gas (GHG) methane (CH_4).

GAS-OFF results offer useful insights for helping other EU dairy farms to reduce air pollution problems, as noted by project coordinator Flavio Cammi. "Our project produced findings that should be of interest and relevance to all countries because dairy farming is common to nearly every part of rural Europe," explains Mr Cammi. "We are pleased with the outcomes of the LIFE project because these prove that relatively easy actions on dairy farms can make a real difference to reducing air pollution."

Mitigation measures

LIFE co-finance was used to investigate a series of pollution mitigation measures. These included studies on pilot farms to: firstly, identify the main locations and sources of emissions on dairy farms; secondly, test mitigation measures in these areas; and thirdly, explore the effects on emissions from changing dairy cow diets. Other useful project work assessed effects of emission-reduction measures on farm-based biogas plants.

Federica Borgonovo was a member of the project team who was involved in confirming emission 'hotspot' areas for dairy farms: "We measured ammonia and GHG emissions in the feeding and resting areas inside the dairy farm barns. We also monitored seasonal emissions from different floor structures such as perforated floors, concrete floors, or floors covered by rubber matting. We compared emissions from floors that were cleared regularly and from different cleaning methods – such as scrapers and flushing systems. In addition we monitored the effect on emissions from husbandry practices using straw as bedding in the cows' resting areas."

Rubber matting increases cleaning effectiveness

Photo: ASTRALE EEIG/Tim Hudson


Photo: ASTRALE EEIG/Tim Hudson

Federica Borgonovo

The measurements showed that the highest emissions of ammonia and other gases occurred from concrete flooring in the feeding area, whilst farms with rubber flooring or that used flushing systems to remove manure produced less emissions. "It is possible to reduce emissions by manure management methods that frequently remove manure from both the surface of flooring and from underneath perforated floors in the feeding area," highlights Ms Borgonovo.

Changes in manure management systems therefore emerge as a key success factor for mitigating ammonia pollution problems from dairy farms. The LIFE project's results demonstrate the air quality benefits from regular cleaning of feeding and resting areas. Installation of rubber matting and flushing systems further helps to maximise air quality benefits. Such findings can help to inform Member States' Codes of Good Practice for ammonia emissions that are proposed via the new National Emissions Ceiling Directive.

Whilst being relatively simple in technological and practical terms, such changes to a dairy farm's daily operations may often require investments. EU funds from the 2014-2020 Rural Development Programmes are prioritising their support for actions on farms that create more environmental benefits, such as reducing air pollution and GHG emissions. Hence, Europe's dairy farmers could make good use of this EU funding to replicate the best practice methods demonstrated during GAS-OFF.

Dietary effects

Additional air quality benefits were shown to be possible from changing the diets of dairy cattle. "Changing the proportions of different feed ingredients can have an advantageous effect on reducing emissions," says Gianni Crovetto, who carried out a series of tests during the LIFE project. "Using feed supplements with more starch and sugar, like maize, rather than fibrous carbohydrates or soya bean for example, tends to produce lower emissions," he explains.

"Different factors have to be considered when changing diets, and it is important to achieve the correct balance of supplements in order to ensure good animal welfare, profitable economic performance, and overall environmental impacts," notes Professor Crovetto. "The GAS-OFF project has helped us to better understand some of these important interactions. In the future we are interested in expanding our knowledge about emissions reductions by looking more at the relationships between livestock genetics and livestock nutrition."

Policy coordination

Other opportunities for improving air pollution from dairy farms were identified during a lifecycle analysis of biogas plants. Much of this work centred on improving the quality and quantity of biogas that can be produced from the different manure management systems that were studied.

GAS-OFF identified a major conflict between agricultural and environmental policy support, as described by Professor Stefano Amaducci from the project team: "We found that we could reduce GHG emissions using biogas plants but farm subsidies for biogas plants here are based on producing electricity, which actually increases air pollution. Various atmospheric pollutants, including an increase of up to 40% in photochemical ozone, occur during the electricity production process. However, this could be avoided if farms were not forced to produce electricity and instead were able to concentrate their methane to supply the national grid of natural gas, which is feasible in this part of Italy."

This is another useful conclusion from the GAS-OFF project and it highlights the LIFE programme's strategic potential for identifying policy areas in need of improved flexibility and better integrated action.

Project number: LIFE09 ENV/IT/000214

Title: GAS-OFF - Integrated Strategies for GHG Mitigation in dairy farms

Beneficiary: Azienda Sperimentale Vittorio Tadini

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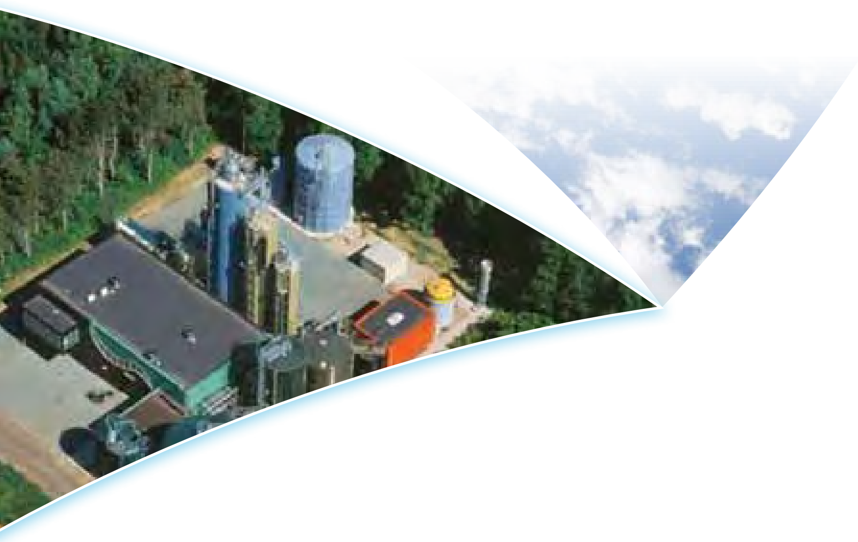
Website: http://www.gasoff.eu

Period: 01-Oct-2010 to 31-Dec 2013

Total budget: €1 806 000

LIFE contribution: €903 000



INDUSTRY, WASTE AND ENERGY

Assessing LIFE's impact on emissions from industry

LIFE has made a useful contribution to improving air quality by demonstrating ways to clean-up emissions from industry, energy and waste incineration. This article highlights the programme's strengths, points out areas where more could be done and features best practice examples suitable for follow-up and replication.

The industrial processes, energy and waste sectors are all sources of emissions of airborne pollutants in the EU (see Table 1).

The LIFE programme has, since 2000, funded close to 50 projects that have helped to reduce air emissions in different industrial sectors. Relevant projects can be divided into those that have developed and demonstrated less-polluting processes and technologies (63%), those that have implemented end-of-pipe emissions reduction solutions (29%) and those that have concentrated on disseminating information and providing training (8%).

The relevant projects have presented technical solutions for different pollutants emission reductions in various industrial sectors, often explicitly linked

Table 1 - Emissions in the EU by sector in 2011 (EEA, 2013)

Sector	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$
Energy use and supply (excl. transport)*	49%	28%	91%	1%	66%
Road transport	40%	14%	0%	2%	16%
Other transport	6%	2%	4%	0%	3%
Industrial processes	3%	8%	5%	1%	9%
Agriculture*	2%	2%	0%	93%	3%
Waste*	0%	1%	0%	3%	1%
Other	0%	44%	0%	0%	2%

** Partially covered by the IED and for the energy sector, also covered by the Large Combustion Plants Directive*

to the provisions and limits set out in the Integrated Pollution Prevention and Control (IPPC) Directive and its successor the Industrial Emissions Directive. Projects have targeted cuts in emissions of non-methane volatile organic compounds (NMVOCs), NO_x, SO_x and particulate matter (PM_{10} and $PM_{2.5}$ – fine particulates).

VOC emissions take precedence

As Table 2 shows, half of all LIFE air quality projects since 2000 have focused on reducing emissions of volatile organic compounds (VOCs) across a range of sectors, including application of industrial coatings, degreasing and printing. VOC emission limits were introduced under the VOC Solvents Emissions Directive (1999/13/EC). Of these 24 VOC-related projects, 16 have demonstrated innovative processes and technologies, some of which have achieved dramatic reductions in emissions to air. For instance, in the tannery sector, the Italian project N.E.S.S. - New EcoSpray System - implemented a method of precision spraying for the skin-finishing phase, which has been shown to reduce VOC emissions by 95% (accompanied by reduced operational costs through lower energy and water consumption).

Photo: LIFE05 ENV/L/000047

VOC emissions were reduced by 95% in wood panel manufacturing

Table 2 – Relevant LIFE projects since 2000 by key pollutant and sector

Pollutant	By sector	Total
Nitrogen dioxide	Food production (1)	8
	Glass production (2)	
	Iron and steel production (2)	
	Wastewater treatment (3)	
VOCs	Resins, polymers and textile production (1)	24
	Tanneries and leather production (4)	
	Coating (5)	
	Degreasing (1)	
	Dry cleaning (1)	
	Vehicle production (1)	
	Ceramic industry (2)	
	Printing (2)	
	Pulp production (2)	
	Construction (1)	
	Packaging (1)	
	Wood panel production (1)	
	Wastewater treatment (2)	
Sulphur dioxide	Oil refining (1)	3
	Glass production (2)	
Particulate matter	Road construction (1)	4
	Vehicle production (2)	
	Ceramic industry (1)	
Heavy Metals	Metal coating	4
	End-of-life vehicles	
	Electronic industry	
	Different industrial processes	
Ammonia	Wastewater treatment	2

Projects have demonstrated different methods for achieving dramatic reductions in VOC emissions in the metal coating business, including using a water-borne epoxy coating (the Zero Emission Lacquer project) or galvanising with physical vapour deposition (PVD) technology (as demonstrated by CLEAN DECO, a LIFE Best Environment project 2005-2006).

Other VOC-related projects have targeted the dry cleaning (DETECTIVE), newspaper printing (Resolve), degreasing (BIO DEGREASING SYSTEM), industrial decoration (VOC-Free Decals) and pulping industries (VOCless pulping and VOCless waste water – see pp. 66-68).

NO_x, SO_x and particulate matter

Since 2000, there have been just eight LIFE projects that have attempted to tackle NO_x emissions, including two projects in glass manufacturing, one in the food industry, one relating to water treatment and one in the ceramics sector (see LIFE ZEF-tile box p.61).

As well as scope for more NO_x-related projects in general, the LIFE programme needs to more effectively target the sectors that are responsible for the highest emissions, such as the pulp, paper and printing and iron and steel industries. Nevertheless, the lone project in the latter industry, ECOTRANSFLUX, does provide a good example of what LIFE co-funding can help achieve (see box p.61).

There are similar gaps in LIFE project coverage with regard to some of the most significant emitters of SO_x, including again iron and steel, food and pulp and paper, as well as cement and asphalt production.

Of the projects that have been funded, one particularly worthy of note is RefinARS, a LIFE Best Environment project from Italy that targeted one of the key sources of SO_x emissions: petroleum refineries, achieving 96% recovery of sulphur dioxide (SO_2) for the Eni di Sannazaro de' Burgondi (PV) refinery.

Few LIFE projects to date have tackled the impact of particulate matter and fine particulates and again key sectoral sources of such emissions have been largely overlooked by potential beneficiaries (e.g. cement, iron and steel, pulp and paper). One of the major sources of PM emissions, road construction, was addressed by the 2003 UK project, Ref Project, which developed the first modular and portable batch-heater plant for producing roadstone, achieving a particulate emission of less than 10 mg/m^3, well below the limit value of 50 mg/m^3 defined in UK legislation.

End-of-pipe solutions

Fewer LIFE projects have attempted to implement end-of-pipe solutions - technical measures to reduce emissions through effluent treatment or filtration prior to discharge into the environment, as opposed to making changes in the process. Again, VOCs have been the air pollutants most targeted by LIFE projects implementing end-of-pipe solutions (six of 14 such projects since 2000). Projects have addressed industries ranging from resin, polymer and textiles (VOCFREE), to wood-based panels (ECOSB). Projects such as SOREME and NT-Plasma demonstrated innovative end-of-pipe VOC reduction techniques applicable in a number of sectors. Methods trialled have proved effective, for instance ECOSB cut VOC emissions by more than 95% and VOCFREE by 98.5%. In Germany, the NT-Plasma project demonstrated a means of improving the efficiency of non-thermal plasma procedures for purifying waste air from the plastic foil coating process. The project most notably reduced odours by 97-99.9%, ending complaints from the plant's neighbours. The method used could also be applicable in other industries facing the same challenges, such as the processed food sector.

An integrated approach

EU industrial emissions policy assumes that permits should take into consideration the whole environmental performance of an installation, including emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and site restoration upon closure.

LIFE12 ENV/IT/000424

LIFE ZEF-tile

The objective of this Italian project is to demonstrate the feasibility of applying oxy-fuel technologies to the firing stage of ceramic tile production. The use of 95% oxygen instead of air is expected to reduce NO_x emissions in the manufacturing process by some 95%. Installation of ash filters "will reduce to zero particulate emissions…the resulting product will be only CO_2 and water vapour," explains Chiara Ghini from the project beneficiary, Ceramica Alta. The carbon dioxide produced in the firing stage will be converted into calcium carbonate and reused in the manufacturing process as a substitute for lime and dolomite.

The project will be implemented on a small-scale roller kiln (10 m x 1.5 m) with a single preheating module, a single firing zone (eight burners) and two single cooling modules. "Despite its small scale, the prototype oxy-fuel fired roller kiln will have dimensions relevant enough to allow us to correctly evaluate the mass and energy balance of a larger industrial-scale roller kiln," explains Ms Ghini. She cites two reasons why hot-oxy firing has not been attempted previously in ceramics manufacturing: "the roller kiln is a continuous open-ended furnace, which makes the proper control of the combustion air more complex; and (secondly) the apparent costs related to the need for an oxygen supply." The beneficiary's pilot plant will run at a lower load advancement speed to enable preheating of the ceramic tiles with a much smaller volume of exhaust gases.

The LIFE programme already demonstrates good implementation of this philosophy: Some 70% of LIFE projects addressing air pollutants since 2000 provided one or more additional environmental benefits, contributing to the reduction in emissions of other pollutants, greenhouse gases, smells and noise, or reduced energy consumption, generation of less waste (in particular hazardous waste) or less wastewater.

VOC emissions provide a good example, since they are often present in wastewater effluents, as well as emitted directly to the atmosphere. The LIFE pro-

LIFE09 ENV/FR/000591

ECOTRANSFLUX

ECOTRANSFLUX developed a technology that, if applied to 20% of existing stainless steel processing lines, would reduce annual consumption of nitric acid by 12 000 tonnes, and of hydrofluoric acid and associated sludge each by 4 000 tonnes. It would also avoid emissions of 3.2 tonnes/yr of hydrogen fluoride gas, 50 000 tonnes/yr of CO_2 and 4 000 tonnes/yr of NO_x (the latter through replacing natural gas furnaces with induction furnaces) . The project beneficiary, Five Celes, forecasts growing turnover and employee recruitment in the next five years thanks to the ECOTRANSFLUX process's "higher production rate, better process reactivity, and a lower-weight material with improved mechanical properties."

Photo: LIFE09 ENV/FR/000591

The ECOTRANSFLUX technology could reduce NO_x emissions from stainless steel processing lines by up to 4 000 tonnes/yr

LIFE11 ENV/IT/000075

BIOSUR

The project aims to demonstrate the effectiveness of an innovative moving bed biotrickling filter technology for treating polluted gaseous streams from Tuscany's tanneries.

"The measured annual average air concentration of hydrogen sulphide (H_2S), within the tannery district, ranges from 0.3 to 5.0 μg/m³ (depending on the location) and it is often above the olfactory threshold," explains project manager, Gualtiero Mori.

Wastewater and solid waste treatment facilities are the main point source of H_2S. Such facilities use chemical scrubbing systems to limit such emissions, but this requires significant consumption of sodium hydroxide (NaOH).

The BIOSUR project will introduce a biological reactor as a buffer before final chemical scrubbing, preventing peak loads entering the scrubbers and improving the quality of effluents. "To the best of our knowledge rotating bed biotrickling filters have never been tested at full scale for the treatment of gaseous effluent," says Mr Mori.

Using this technology will make it possible to control solids retention time (SRT), "hence dramatically improving not only the removal efficiency but also the removal capacity," he adds. The project will also test different types of innovative discs to support biomass growth and introduce an automated monitoring and control system for adjusting biomass retention time.

The project is expected to demonstrate that implementation of the rotating bio trickling filter, prior to the existing chemical scrubbers, will, in addition to reducing H_2S emissions, also reduce operating costs. Mr Mori highlights a potential "decrease in consumption of chemical reagents (especially sodium hydroxide, which could be reduced by approximately 80%), as well as energy for gas pumping or water recirculation, and water consumption."

gramme has supported the development of various emission-reduction techniques, particularly in the context of wastewater treatment from tanning and leather production (e.g. the TANEFTREAT, Tanwater, RIWAC and BIOSUR projects – see box). The example of the VOCless Pulping and VOCless waste water projects (see pp. 66-68), also provides a powerful illustration of the benefits of an integrated approach. This is taken even further by an ongoing Italian project (WW-SIP) that is creating a self-sustainable platform for the treatment of waste water at an urban wastewater treatment plant, introducing electro-chemical pre-treatment to enable the extraction of high-quality sludge for compost, a combined heat and power (CHP) plant with desuplhurisation technology to reduce SO_2 and sulphuric acid (H_2SO_4) emissions from biogas combustion and a CO_2-powered micro algae photo-bioreactor delivering a renewable fuel for biogas production.

Another strong example is the Italian RefinARS project, which set out to reduce SO_2 emissions from oil refineries by using an absorbing buffer. As well as achieving 96% recovery of SO_2 emissions across the whole refinery, the project generated only 460 kg/day of solid waste (in comparison with 24 000 kg/day with other techniques), cut concentrations of sulphates and sulphites in wastewater (from 9 tonnes/hr to 1 tonne/hr), reduced consumption of absorbing solution by 97%, energy consumption by 25%, and operating costs by 40%. Results are applicable to more than 150 refineries across Europe and project outcomes are expected to feed into reviews of the relevant BREF (BAT Reference Document).

LIFE and BAT

In this sense, RefinARS is indicative of a notable and lasting achievement of the LIFE programme: its impact on BAT - the application of Best Available Techniques to ensure that the largest industrial and energy facilities comply with the emission limits that correspond to the latest technological and environmental developments - and the incorporation of project results into BREFs developed under the EU's industrial emissions legislation.

For instance, in the tanneries sector, a project that ran from 2001 to 2004 (GIADA), successfully implemented a BATNEEC - Best Available Technology Not entailing Excessive Economical Costs - with the result that VOC emissions were reduced by 28% whilst leather production increased by 17%. The N.E.S.S. project (2004-2007) built on the work of the earlier

project, cutting VOC emissions by 95%, as well as lowering operating costs.

Tanwater, another LIFE Best Environment project relating to leather tanning, ran full-scale trials of a wastewater treatment system that reduced nitrogen discharge by 89%, above the forecast 80% and better than BAT performance at the time of the project. These exceptional results led to meetings between the beneficiary and the IPPC Bureau in Seville to discuss the revision of the BREF document for tanneries.

A Spanish project (PREVOC PLAN) demonstrated a means of significantly reducing VOC emissions from surface treatment plants by applying a zeolite molecule filter at the inlet of a thermal oxidiser plant to remove potential peak solvent concentrations. The resulting VOC concentration in waste gases was 8.5 mgC/Nm^3, which is significantly lower than the limit of 100 mgC/Nm^3 defined in the VOC Solvents Emissions Directive and IED.

Other relevant project examples include SONATURA, which successfully and cost-effectively used Vapour Phase Bioreactors for air pollution control in Portugal's leather and cork industries, transferring an existing BAT to two new sectors with positive results; and Zero Emission Lacquer, which demonstrated the benefits of a new low-solvent metal lacquer. The latter project not only achieved reductions in overall emissions, helping to ensure compliance with legislation, by limiting process-related odour it has helped improve the local environment. A further good example of how LIFE can help improve compliance and feed into BREF procedures comes from the pulp and paper sector (see pp. 66-68).

Constraints and cost benefits

The replicability of lessons from LIFE projects will be determined by the ease with which potential constraints can be overcome and cost benefits demonstrated. Over half (26) of the projects analysed for this chapter showed that their proposed emissions reduction solutions were economically viable, either having comparable investment costs to existing technologies or providing opportunities to cut operational costs. Only three projects concluded that their proposed technologies were less economically viable

The RefinARS project achieved 96% recovery of SO_2 emissions across a whole petroleum refinery

Photo: LIFE00 ENV/IT/000012

Photo: LIFE07 ENV/F/000179/ASTRALE EEIG/Marion Pinatel

HotOxyGlass tested the oxy-combustion technique, which avoids the production of nitrogen and reduces NO_x by 80%

than existing alternatives, although one of these, HotOxyGlass, could overcome these constraints with further development and higher production volumes (see box).

One weakness of the programme in terms of reducing air pollution from industry has been the lack of cost-benefit analysis of project results at an industrial scale. The 2012 thematic study on air quality[25] highlights the fact that a number of projects had significantly greater costs than originally foreseen, which threatens their ability to achieve full implementation of their objectives.

This is underlined in the case of the BioSOFC project, which sought to tap landfill gas and biogas from anaerobic digestion, but which was forced to modify certain project activities when high costs led to technical difficulties. In 2006, the project beneficiary predicted it would be another 10-15 years before investment cost and equipment size barriers were overcome. In another case, the Portuguese project BATinLoko, tests for the implementation of some BATS were not carried out because of the high costs involved.

An unexpected fall in the price of a competing technology (Sludge Redox) or sectoral changes (manufacturing moving outside the EU – Odourless casting) can also limit the impact of LIFE projects.

Other constraints could include the fact that a technology is not mature enough or is deemed unacceptable by the public or authorities. For instance, the Spanish GREENING BOOKS project faces a challenge to persuade publishers to switch to a new technology

LIFE07 ENV/F/000179

HotOxyGlass

This French project to limit the environmental impact of flat glass production demonstrated a furnace that combines the oxy-combustion technique (use of 92-100% pure oxygen instead of air) with the pre-heating of reactants (oxygen and natural gas). HotOxyGlass demonstrated significant reductions in energy use (-25%), and emissions of CO_2 (-15%), NO_x (-83%) and SO_x (-35%). According to Antonella Contino, from project beneficiary AGC, "the technology is now being further developed in other sites across Europe, for instance in AGC Glass Czech's production plant in Řetenice (where coloured glass is manufactured) and Trakya Glass Bulgaria's plant in Targovishte." Both these sites are further developing the technology with the support of LIFE co-funding. "It is possible that other key players are also adopting this technology, but it is difficult to have a clear overview of their actions, as such investments are often confidential in the industry for strategic reasons," says Ms Contino.

She notes that reductions in energy use, CO_2, NO_x and SO_x emissions could, depending on other factors, allow for operational cost savings. "Moreover, the technology can be combined with other energy-reduction technologies, thus adding to the financial benefit."

25 Assessing LIFE's impact on EU noise and air policy - Contribution of LIFE ENV/INF projects to the implementation, dissemination and further development of EU environmental policies and legislation, focusing in particular on resource efficiency (http://ec.europa.eu/environment/life/publications/lifepublications/generalpublications/documents/noise_air_study.pdf)

that offers significant benefits for air quality but which could also have a negative impact on their revenues. In the pulp and paper sector, efforts to measure and reduce VOCs are likely to be driven by external forces (i.e. legislation) as there is a limited appetite within the industry to implement project findings (see pp. 66-68). Political will and industry support and cooperation are thus also very important.

The energy sector

Taking a programme level view, it is clear that few LIFE projects have focused on energy production from biomass. Those projects that have been carried out have mainly focused on reductions of CO_2 and on climate change issues. Air quality issues have hardly been taken into consideration[26], even though it has been demonstrated that biomass burning may be highly polluting in terms of NO_x, PM, SO_x, CO, lead, mercury and hazardous air pollutants (HAPs).

A few projects have attempted to reduce SO_x, NO_x and PM in energy production (FUEL CELL IN PARIS, GREEN PELLETS, MICROPHILOX). The FUEL CELL in PARIS project, for example, demonstrated the potential of fuel cell technology to serve as an alternative heat and power production method. This highly efficient system does not emit NO_x or SO_x and produces 30% less CO_2 on average than a traditional combined cycle gas boiler and steam turbine. Another French project (GREEN PELLETS) carried out an environmental assessment of herbaceous energy crops which showed that whilst heat from the biomass produces 10 times less CO_2 than natural gas or fuel, this biofuel is more likely to cause air acidification than gas or wood. The project carried out combustion tests in laboratory and real conditions and concluded that if adjustments to boilers are made, use of the pellets could reduce emissions of CO_2, NO_x, SO_2 and dust.

Another programme-level gap has been in terms of action to reduce emissions from large-combustion plants, one of the focal points of EU emissions legislation. In addition, the programme has not yet addressed one of the main focus areas of the new clean air policy package - emissions from medium-sized combustion plants (thermal capacity 1-50 MW) as a significant gap in EU air quality policy. Future LIFE projects could help address this issue, alongside other EU funds dedicated to energy.

Waste incineration

Few LIFE projects have addressed the impacts on air quality of waste incineration. Of the seven projects to date, three have concerned the incineration of sludge from wastewater treatment plants (with two of those attempting to find alternative solutions rather than reducing emissions). The remaining four projects respectively tackle waste oil, hazardous waste, municipal waste (mostly pulp/wood waste) and methods of avoiding the incineration of bio-waste.

All seven projects concern types of waste covered by existing legislation and all focus on finding alternatives to incinerating waste rather than implementing end-of-pipe solutions. Other projects targeting the waste-air nexus have attempted to reduce emissions from landfills and wastewater treatment processes. The LIFE programme has a great number of wastewater treatment projects that focus on other environmental impacts and do not tackle air pollution.

26 Despite the frequent depiction of biomass as "clean" energy, data from permit applications and emission data demonstrate that burning wood and other biological materials for energy may generate as much or more pollution than burning fossil fuels, including coal. In general biomass burners are always more polluting than natural gas and emissions are similar to coal – admittedly better for some pollutants such as sulphur and mercury, but the same or worse for particulates and NO_x.

GREEN PELLETS showed how biomass burning reduces CO_2 but increases NOx, SO_2 and PM emissions unless adjustments are made to the boilers

Photo: LIFE07 ENV/F/000178

INDUSTRY, WASTE AND ENERGY

Making pulp without volatile organic compounds

Two LIFE projects in Finland have provided a valuable demonstration of effective ways to tackle VOCs from mechanical pulping, going beyond existing best available techniques.

Some 11 million tonnes of mechanical and semi-chemical pulp is produced in Europe each year[27]. Volatile organic compounds (VOCs) are released during the processes needed to make the pulp for paper production, such as debarking, washing wood chips, grinding and refining (about 1 kg of VOC per tonne of pulp produced). Mechanical pulping was excluded from the remit of 1999's VOC Solvents Directive[28] but installations may be covered by the Industrial Emissions Directive (formerly the IPPC Directive). Increasing concern about air quality has made VOC emissions from mechanical pulping a subject of growing regulatory interest.

In 2006, the Finnish company AX LVI Consulting secured LIFE co-funding to carry out a project called VOCless pulping. The aim of this project was to assess the efficacy of two 'end-of-pipe' VOC abatement technologies in trials at fully operational mechanical pulp mills. A system based on biofiltration technology was tested at Portonogaro mill in Italy, with Stora Enso Anjalankoski mill in Finland the site of trials of a catalytic incineration method. "Probably 70-80% of the VOC abatement systems in the painting, printing, chemical and pharmaceutical industries use thermal or catalytic incineration: that's why we wanted to use it as well," explains project manager, Markku Tapola.

The project set itself a target of achieving VOC concentrations below 50 mg/m^3. Measuring the VOCs proved more demanding than anticipated because exhaust gases are released at several different stages of the process. "It was not very easy," says Mr Tapola. "The experience [of measurement] we gained was very useful," says his colleague Sara Hihnala.

VOC emissions from the Finnish mill were measured at 0.41 kg per tonne of pulp, whilst the Italian facility produced just 0.03 kg/tonne. "This difference was because of the type of wood used, not the manufacturing process," explains Mr Tapola. Portonogaro uses poplar, a broadleaved tree, which naturally emits lower levels of VOCs than the spruce used in the Nordic countries at mills such as Stora Enso Anjalankoski.

Both trial technologies demonstrated their effectiveness in terms of VOC abatement. In the case of the catalytic system a cleaning efficiency of 82-94% was achieved, reducing VOC concentrations from both thermo-mechanical pulp (TMP) and pressurised groundwood (PGW) processes below 20 mg/m^3. The biofiltration system achieved a cleaning efficiency of 83%, cutting VOC concentrations in the exhaust gases to less than 10 mg/m^3.

The project also considered the potential of a full-scale hybrid VOC-abatement system, carrying out a cost-benefit analysis which showed the potential to reduce total VOC emissions in Europe by some 6 000 tonnes/yr, with only a marginal cost increase for pulp producers (of €0.3-3.3 per tonne of pulp, depending on the manufacturing process).

27 http://www.cobelpa.be/pdf/cepi%20Key%20Statistics%20Report%202012.pdf
28 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0013

Mechanical pulp mills produce VOCs when logs are processed

Photo: LIFE06 ENV/FIN/000201/ASTRALE EEIG/Justin Toland

In recognition of these positive results, VOCless pulping was a LIFE Environment Best Project for 2009. One of the project's key findings was that the measured VOC load was about half the forecast level. Where had the rest of the VOCs gone? "We took some samples and found that the missing fraction was in the clear filtrates," recalls Mr Tapola. Thus, in order to fully address the impact of VOCs from mechanical pulping, it would be necessary to take an integrated approach that also included the mill's wastewater treatment plant.

Stage two: VOCless waste water

As a result, LIFE provided the backing for a follow-up project, VOCless waste water, this time coordinated by Meehanite Technology, although led by the same individuals as the first project. The second project again sought to demonstrate the abatement potential of biofiltration and catalytic incineration technologies, this time at the effluent treatment stage, as well as a third technology, UV-filtration (a method typically used in hospitals, the shipping industry and shopping malls to abate odours and other emissions). The project aimed to test the three technologies in both aerobic and anaerobic wastewater treatment scenarios, with all trials taking place at pulp and paper mills in Finland this time (at Kotkamills – anaerobic – and again at Stora Enso Anjalankoski – aerobic). For Markku Tapola, being able to work again at Anjalankoski was important to the success of the project: "It was helpful for us because we were not experts in the process. Pekka Reponen, the mill's then environment manager, now retired] kept our feet on the ground." For Mr Reponen, the LIFE project was valuable because it could show others in the industry that there is no need to be afraid of the impact of VOCs, that aerobic treatment "is functioning and eating the VOCs".

At Anjalankoski, the VOC load was measured at the cooling tower and the moving bed bioreactors – MBBR – the places where preliminary measurements had shown they were strongest. Tests of the three abatement technologies took place at Anjalankoski from June-August 2011. "We needed three months because we tested a lot of combinations and tried to get the best available techniques and best cleaning efficiencies for each of the techniques. And also because VOC emission concentrations were really fluctuating," says Sara Hihnala. In fact, airborne emissions varied by up to 300%. The project also detected unexpectedly high levels of methane (CH_4) from the aerobic treatment process. "Some kind of fermentation or digestion takes place during the two days the wastewater is there," believes Mr Tapola. Whilst the LIFE project concentrated on non-methane VOCs, this knowledge could be useful when planning future air quality improvements.

Photo: LIFE09 ENV/FI/000568

Stora Enso Anjalankoski – aerobic wastewater treatment plant

During the trials the biofilters had an average cleaning efficiency of 80% at the cooling tower and 70% at the MBBR (rising to 75% with high initial VOC concentrations). The cleaning efficiency of catalytic incineration was 71-83%, with the best results achieved at oxidation temperatures above 400°C. By contrast, the effectiveness of the UV-filtration system fluctuated greatly, achieving 85% at best, but below 70% on average. "High humidity was a problem for this technique," says Ms Hihnala.

High humidity and acidity also hampered the effectiveness of the UV-filtration system when it was trialled at Kotkamills the following summer and achieved only 20-30% cleaning efficiency. This mill produces laminating paper, matt coated bulky paper and sawn timber from its own thermomechanical pulp and alongside an aerobic wastewater treatment system, treats the 10% of effluents with the highest pollutant loads anaerobically.

The biofiltration system was reasonably effective, but was sensitive to fluctuations in the VOC load, achieving an average cleaning efficiency of 65-70% at the aeration basin. "A more effective neutralising scrubber to control the acidity would have improved the performance," says Mr Tapola. The catalytic incinerator achieved an impressive VOC conversion rate at Kotkamills of 87-97%, meaning that if very low VOC limit values (below 10 mg/m^3) are imposed, it would be technically feasible to abate those emissions using this method.

Table 1 – Cost comparison of VOC abatement systems, including increase in production costs per tonne of pulp		
	Annual total cost of VOC abatement system	Increase in cost of produced pulp because of VOC abatement system
Unit	€/yr	€/tonne
TMP (Stora Enso Anjala)		
Catalytic incinerator	76 600	0.9
Biofilter	53 500	0.6
PGW (Stora Enso Anjala)		
Catalytic incinerator	109 700	0.3
Biofilter	116 700	0.3
Kotkamills anaerobic waste water treatment plant case study		
Catalytic incinerator	68 000	0.3
Biofilter	42 000	0.2

Results from both sets of trials were collated to produce a cost-benefit analysis of the respective technologies (see Table 1). Summarising the findings, Mr Tapola says: "We would recommend biofiltration as a first system; if it is not working well or you have to achieve a bigger reduction of VOCs you should go to the incineration system." He adds that "UV-filtration needs more development."

Next steps

One important finding of the second LIFE project was that VOC emissions from the mechanical pulp mill with aerobic wastewater treatment are already below 50 mg/m^3, so no additional abatement technology is needed to achieve this limit value. By contrast, anaerobic treatment was found to be insufficient by itself to reduce the VOC load below this target.

An industrial-scale installation of either biofiltration or catalytic oxidation abatement is feasible, but is unlikely without regulation, believes Mr Tapola. In the meantime, both techniques could be used by industries regulated by the VOC Solvents Emissions Directive (now Chapter VI of the IED). "When you have high concentrations you incinerate them. When you have low concentrations, and in the presence of odours, you use biofiltration," he explains.

There are some immediate outcomes of the two projects for the mechanical pulping sector, however, including a set of transferable techniques for the somewhat tricky task of measuring VOC emissions, which could be used by regulatory authorities, as well as by the beneficiary. Mr Tapola highlights the fact that because VOC emissions fluctuate greatly from mill to mill it is necessary to measure first in order to find the most appropriate solutions. Data such as those provided by the LIFE projects could then be used by the authorities to set appropriate VOC emission limit values for Europe's mechanical pulping industry.

The beneficiary now plans to submit its findings for inclusion in a future revision of the BREF document for the pulp and paper industry. Lessons from the LIFE projects could also influence the next generation of pulping technologies: "Some of the pulp mill designers have asked us what kind of techniques can and should be used for reducing VOCs," says Mr Tapola. "They speak about Vocless pulping as a goal."

Project number: LIFE06 ENV/FIN/000201

Title: VOCless pulping - Control of VOC emissions from mechanical pulping beyond BAT

Beneficiary: AX LVI Consulting Ltd

Contact: Markku Tapola
Email: markku.tapola@ax.fi
Website: http://voclesspulping.com/
Period: 01-Oct-2006 to 30-Sept-2009
Total budget: €579 000
LIFE contribution: €286 000

Project number: LIFE09 ENV/FI/000568

Title: VOCless waste water – Abatement of VOC load from waste water treatment in mechanical pulping

Beneficiary: Meehanite Technology Oy

Contact: Markku Tapola
Email: markku.tapola@meehanite.org
Website: http://voclesspulping.com/
Period: 01-Oct-2010 to 30-Sept-2013
Total budget: €1 840 026
LIFE contribution: €915 000

Project list

The table below provides the complete list of LIFE projects related to air quality mentioned in this publication. For more information on individual projects, visit the online database at: http://ec.europa.eu/environment/life/project/projects/index.cfm

PROJECT REFERENCE	ACRONYM	TITLE	PAGE
		SUSTAINABLE MOBILITY AND TRANSPORT	
LIFE02 ENV/UK/000136	CATCH	Clean Accessible Transport for Community Health	14
LIFE06 TCY/ROS/000269	KALAIR	Kaliningrad Air Pollution induced by traffic: modeling system design, installation and validation	14
LIFE09 ENV/IT/000092	OPERA	An integrated assessment methodology to plan local cost-effective air quality policies harmonized with national and European actions.	14, 28, 30, 38, 39
LIFE00 ENV/F/000640	SMILE	Sustainable Mobility Initiative for Local Environment	15, 46
LIFE99 ENV/F/000459	ADEME	European day 'In town, without my car?'	15, 46
LIFE00 ENV/RO/001002	Vote for Bicycle	Vote for bicycle, vote for a cleaner city	15, 44
LIFE06 ENV/D/000477	PARFUM	Particulates, Freight and heavy duty vehicles in Urban Environments	15, 16, 18, 26
LIFE02 ENV/IT/000106	RAVE	The Green Ray of Novara	15
LIFE09 ENV/AT/000226	CEMOBIL	CO2-neutral E-Mobility for the reduction of air pollutants (PM10, PM2.5 und NO2) and noise in the European cities, for example Klagenfurt	15
LIFE09 ENV/ES/000507	CONNECT	Creation Of New Network for Electric Cars Technology	15
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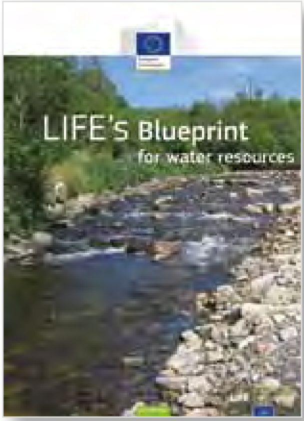

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LIFE "L'Instrument Financier pour l'Environnement" / The financial instrument for the environment

The LIFE programme is the EU's funding instrument for the environment and climate action

Period covered 2014-2020

EU funding available approximately €3.46 billion

Allocation of funds Of the €3.46 billion allocated to LIFE, €2.59 billion are for the Environment sub-programme, and €0.86 billion are for the Climate Action sub-programme. At least €2.8 billion (81% of the total budget) are earmarked for LIFE projects financed through action grants or innovative financial instruments. About €0.7 billion will go to integrated projects. At least 55% of the budgetary resources allocated to projects supported through action grants under the sub-programme for Environment will be used for projects supporting the conservation of nature and biodiversity. A maximum of €0.62 billion will be used directly by DG Environment and DG Climate Action for policy development and operating grants.

Types of projects Action Grants for the Environment and Climate Action sub-programmes are available for the following:

- "Traditional" projects – these may be best-practice, demonstration, pilot or information, awareness and dissemination projects in any of the following priority areas: LIFE Nature & Biodiversity; LIFE Environment & Resource Efficiency; LIFE Environmental Governance & Information; LIFE Climate Change Mitigation; LIFE Climate Change Adaptation; LIFE Climate Governance and Information.
- Preparatory projects – these address specific needs for the development and implementation of Union environmental or climate policy and legislation.
- Integrated projects – these implement on a large territorial scale environmental or climate plans or strategies required by specific Union environmental or climate legislation.
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Further information More information on LIFE is available at http://ec.europa.eu/life.

How to apply for LIFE funding The European Commission organises annual calls for proposals. Full details are available at http://ec.europa.eu/environment/life/funding/life.htm

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