



LIFE Emerald

Summary of the Socio-economic Impacts of the Project

Deliverable No.: Action C2.1

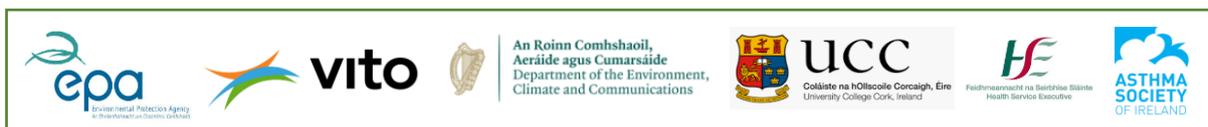
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Contents

Document Version Record	2
List of Acronyms	3
1. Introduction	4
2. Health Impacts	5
2.1 Mortality attributable to poor air quality	5
2.2 Healthcare costs related to poor air quality	6
2.3 Impacts on mental health due to long-term exposure to PM_{2.5}	7
2.4 Summary of health impacts	7
2. Behavioural change & awareness and attitudes regarding air quality	8
2.1 Behavioural change	8
2.2 Awareness / knowledge and attitudes	9
2.3 Implications for future actions	9
3. Job creation	10
4. After-LIFE actions	10
Attachments & References	11

LIST OF TABLES

TABLE 1 NUMBER OF PREMATURE DEATHS (PD) AND YEARS OF LIFE LOST (YLL)	5
TABLE 2 HOSPITAL RESOURCE USE FOR CONDITIONS RELATED TO AIR POLLUTION, 2016-2019	6

LIST OF FIGURES

FIGURE 1 EPA/RED C SURVEY – CHANGES TAKEN TO REDUCE AIR POLLUTION (2021 & 2024)	9
FIGURE 2 EPA/RED C NATIONAL SURVEY – FUTURE CHANGES CONSIDERED TO REDUCE AIR POLLUTION	9

Document Version Record

Date of Issue	Version	Section	Pages	Who	Comment
22/05/2024	Draft 1	ToC & Section 1	4	HB	First draft / outline
26/08/2024	Draft 2	All Sections	11	HB	Completed final draft for review



List of Acronyms

ASI	Asthma Society of Ireland
CAT	Clean Air Together (Citizen Science project)
COPD	Chronic Obstructive Pulmonary Disease
DECC	Department of Environment, Climate & Communications
DRG	Diagnosis Related Group
EEA	European Environmental Agency
EPA	Environmental Protection Agency
ESRI	Economic & Social Research Institute
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, Australian Modification, 10 th Edition.
IHD	Ischaemic Heart Disease
NO ₂	Nitrogen Dioxide
PD	Premature Deaths
PM	Particulate Matter
UCC	University College Cork
TILDA`	The Irish Longitudinal Study on Ageing
VITO	Vlaamse Instelling voor Technologisch Onderzoek NV
WHO	World Health Organization
YLL	Years of Life Lost

1. Introduction

This document summarises the socio-economic impacts of LIFE Emerald, focusing on the following aspects:

- Health impacts: The health impacts of air pollution on the Irish public and associated health care costs.
- Behaviours and behavioural change: Impacts on citizens' behaviour.
- Jobs: Jobs created by the project.

The main objectives of LIFE Emerald include the following, which are directly related to socio-economic impacts:

- **Implementation of an air quality modelling system**, including:
 - A 3-day air quality forecast – which allows the public to plan their activities, especially benefitting individuals at risk from poor air quality e.g. asthmatics.
 - Hourly updated maps of the Air Quality Index for Health (AQIH) – allowing the public to take short term action.
 - Annual average high-resolution air pollutant maps - providing detailed information to facilitate assessments of air pollution assessments and associated health impacts
- **Strengthening awareness raising** amongst the public, policymakers, and stakeholders regarding the sources of air pollution, the negative health effects and how effective measures can be implemented.

This summary incorporates findings from a number of key sources which are detailed in the *List of Attachments and References* section below. These include:

- The report by ESRI (the Economic & Social Research Institute): *The healthcare costs of poor air quality in Ireland: An analysis of hospital admissions*. This ESRI research was funded by the EPA and the report is submitted together with this Summary – as Attachment 1.
- ESRI report: *Long-term exposure to PM2.5 air pollution and mental health: a retrospective cohort study in Ireland*. This ESRI research was funded by the EPA and the report is submitted together with this Summary – Attachment 2.
- LIFE Emerald Deliverable B4.2: *Recommendations for the health service*. [Reference 1].
- LIFE Emerald Deliverable C.2: *End-of-project review on behavioural change*. [Reference [2].
- The national survey conducted for the EPA by RED C Marketing and Research in 2024. *LIFE Emerald: Environmental Protection Agency Public Attitudes to Air Quality*. [Reference 3].
- ESRI report: *Clean Air Together Dublin: Impact on air quality awareness, attitudes and behaviour*. [Reference 4].

Preparation of this summary also included review of other previous studies on socio-economic and health impacts of air pollution including: The report for LIFE project, LIFE13 ES/ENV/417, on exposure of cyclists to urban pollutants [Reference 5]; and the World Health Organization (WHO) guidelines on cost benefit analysis methods for health impacts of air pollution [References 6 & 7].

Most of the information presented is related to the current levels of socio-economic impacts, since the duration of the LIFE Emerald project was relatively short and significant changes in impacts generally require longer timeframes. Where relevant, any changes in impacts over the lifetime of the project are noted.



2. Health Impacts

2.1 Mortality attributable to poor air quality

LIFE Emerald Deliverable B4.2 (*Recommendations for the Heath Service* – Ref [1]) includes estimations of Premature Deaths (PD) and Years of Life Lost (YLL) from exposure to PM_{2.5} and NO₂, based on the high-resolution annual assessment maps for these pollutants developed within the LIFE Emerald project, and applying the WHO (World Health Organization) guideline levels for these pollutants. As noted in Deliverable 4.2: “Air pollution is the largest environmental health risk in Europe causing cardiovascular and respiratory diseases that lead to the loss of healthy years of life and, in the worst cases, to premature deaths.”

The estimates of premature deaths and years of life lost for 2019, 2021 and 2022 are shown in Table 1. Exposure to PM_{2.5} above the WHO-guideline level is estimated to have resulted in approximately 620, 370 and 800 premature deaths and 6,800, 4,000 and 8,800 years of life lost in Ireland in 2019, 2021 and 2022, respectively. If all air pollution was removed entirely, below the WHO limits the European Environment Agency estimate 1600 premature deaths in 2021 would be avoided. Exposure to NO₂ above the WHO-guideline level is estimated to have resulted in approximately 80 premature and 900 years of life lost in both 2021 and 2022, and approximately 160 premature deaths and 1,800 years of life lost in 2019. Overall, this data highlights the severe health risks associated with PM_{2.5}, which are much higher than for NO₂.

Year	PM _{2.5}			NO ₂		
	PM _{2.5} (µg m ⁻³)	PD	YLL	NO ₂ (µg m ⁻³)	PD	YLL
2019	7.6	623	6810	8.2	158	1771
2021	6.6	372	4020	6.3	80	901
2022	8.2	800	8752	6.7	81	901

TABLE 1 NUMBER OF PREMATURE DEATHS (PD) AND YEARS OF LIFE LOST (YLL) BY EXPOSURE TO YEARLY MEAN PM_{2.5} AND NO₂ YEARLY MEAN CONCENTRATIONS GIVEN IN µg m⁻³

The data also provides some indication of the potential reductions in premature deaths and years of life lost due to reduced levels of PM_{2.5} - if Ireland was to achieve the WHO air quality guideline of 5 µg m⁻³. Lower values of premature deaths and years or life lost have been estimated for 2021 compared to 2019 and 2022, due to the lower calculated annual PM_{2.5} concentration in 2021 (6.6 µg m⁻³).

The study also includes a County-specific analysis. For NO₂, the highest estimated impacts are in urban areas with dense traffic, such as in the counties of Dublin, Louth (Drogheda), Cork, and Limerick, with similar estimated impacts across different years. For PM_{2.5}, however, impacts vary among Counties and across different years.

Please refer to Deliverable 4.2 for further details of the analysis, the methodology adopted, and on comparison with studies of health impacts in reports from the European Environmental Agency (EEA).

2.2 Healthcare costs related to poor air quality

In 2023, the ESRI was commissioned by the EPA to conduct a study to estimate the acute healthcare costs of air pollution in Ireland. The full results are published in ESRI Working Paper Number 769, which is included as Attachment 1 with this Deliverable. The paper notes that, although air pollution levels in Ireland are generally within the limits set in EU air quality directives, the levels remain above WHO air quality guidelines in many towns and cities in Ireland, in particular for levels of PM_{2.5}.

The study analysed data on emergency in-patient hospital admissions and associated costs over the period 2016-2019 – for seven risk-outcome pairs, related to circulatory and respiratory disease:

- PM_{2.5} - Asthma (Aged 0-14)
- PM_{2.5} - COPD (Aged 25+) – Chronic Obstructive Pulmonary Disease
- PM_{2.5} - IHD (Aged 25+) - Ischaemic Heart Disease
- PM_{2.5} – Stroke (Aged 25+)
- NO₂ – Asthma (Aged 25+)
- NO₂ – Stroke (Aged 25+)
- O₃ – Respiratory (Aged 65+)

The analysis utilised the diagnosis classification code system which was updated in Ireland in 2020 to ICD-10-AM (International Statistical Classification of Diseases and Related Health Problems, Australian Modification, 10th Edition), and the Diagnosis Related Group (DRG) scheme which enables hospital discharges to be categorised into homogenous groups, which undergo similar treatment processes and incur similar levels of resource use. Table 2 below is an extract from the study, summarising the estimated numbers of hospital bed-days and associated costs, in the period 2016-19, for each of the risk-outcome pairs. Please refer to Attachment 1 for complete details of the methodology and conclusions.

Risk-outcome pair	ICD-10-AM code	Bed days attributable to air pollution			DRG cost attributable to air pollution (€)		
		lower bound	mean	upper bound	lower bound	mean	upper bound
1. PM _{2.5} Asthma (aged 0-14)	J45-J46	281	811	1,287	492,709	1,421,277	2,255,093
2. PM _{2.5} COPD (aged 25+)	J40-44; J47	14,431	36,776	57,725	11,498,105	29,301,622	45,992,420
3. PM _{2.5} IHD (aged 25+)	I20-I25	0	2,914	12,980	0	3,727,667	16,605,063
4. PM _{2.5} Stroke (aged 25+)	I60-69	2,220	21,759	42,186	2,046,870	20,059,322	38,890,523
5. NO ₂ Asthma (aged 15+)	J45-46	835	1,312	1,819	925,149	1,453,805	2,015,502
Total		17,767	63,572	115,996	14,962,833	55,963,694	105,758,601
6. NO ₂ Stroke (aged 25+)	J45-46	5,329	10,214	14,654	4,912,487	9,412,487	13,509,340
7. O ₃ Respiratory (aged 65+)	J00-J99	575	3,567	6,751	479,345	2,971,939	5,624,315

Notes:

¹See Table 1 for data on the population attributable fraction (or attributable hospital cases) for each risk-outcome pair.

²In order to focus on discharges with unique ICD-10-AM codes, the total includes the first five risk-outcome pairs only (i.e., we cannot add NO₂ stroke estimates to the total as these ICD-10-AM codes are already used in the estimates for PM_{2.5} stroke).

TABLE 2 EMERGENCY INPATIENT HOSPITAL RESOURCE USE FOR CONDITIONS RELATED TO AIR POLLUTION, 2016-2019.

Source: Nolan, A. (2023), Table 3. (Please see Attachment 1.)

Over the four-year period examined, the acute healthcare costs of treating five conditions attributable to ambient air pollution (asthma in children, COPD, IHD, stroke, and asthma in adults) were estimated to be €56.0 Million (range €15.0m to €105.8m). Hospitalisations attributable to air pollution (mainly PM_{2.5}) for these five conditions accounted for 63,572 bed days (range 17,767 to 115,996) over the

period. (Please refer to Attachment 1 for details regarding the exclusion of the other two risk-outcome pairs, NO₂ – Stroke, and O₃ – Respiratory, from the estimated total costs and bed days.)

The study notes that potential policy measures to achieve the final WHO air quality guideline values by 2040 would include moving away from burning solid fuels, and that policy measures to mitigate climate change (e.g. promoting decarbonisation of home heating, active travel, and electric vehicles) would also have benefits for air quality and human health.

The study also includes data on the demographic and socioeconomic characteristics of the hospital discharges included in the study sample:

- 55% of circulatory and respiratory discharges were aged 65+
- 54% were male; 46% female.
- Medical Card holders accounted for 67%. Medical Card status is a useful proxy for socioeconomic status, indicating that air pollution has a greater impact on those with lower socioeconomic status.

2.3 Impacts on mental health due to long-term exposure to PM_{2.5}

The ESRI has also conducted research on the impacts on mental health due to long-term exposure to PM_{2.5}. The full results of this study were published in 2024 in the Environmental Health research paper which is included as Attachment 2 with this Deliverable.

The study used data on mental health and wellbeing from The Irish Longitudinal Study on Ageing (TILDA), a nationally representative survey of the population aged over 50 in Ireland. Annual average PM_{2.5} concentrations at respondents' residential addresses over the period 1998–2014 are used to measure long-term exposure to ambient PM_{2.5}. The results show strong associations between exposure to PM_{2.5} and two mental health conditions: Depression; and anxiety. The study notes that these effects are evident even at concentration levels of PM_{2.5} in Ireland, which are low by international standards.

2.4 Summary of health impacts

Overall, the findings of these three studies highlight the significant health impacts of poor air quality in Ireland - both economic and in terms of the wellbeing of the population - and provide a baseline for monitoring estimated health impacts in line with future concentrations of pollutants.

2. Behavioural change & awareness and attitudes regarding air quality

2.1 Behavioural change

LIFE Emerald Deliverable C.2.2 (*End-of-project review on behavioural change* – [Ref 2]) provides details of the activities and analysis undertaken by the LIFE Emerald project in relation to Awareness, Attitudes, and Behaviours regarding air quality – including the results of the national surveys conducted in 2021 and 2024 [Ref 3]. The review found some evidence of positive behavioural change already undertaken by the general public and of intended/planned future changes. Some of the main findings are presented below; please refer to Deliverable C2.2 for further details, including comparisons with results of Eurobarometer surveys.

Changes already taken included:

- Survey respondents reported a significant increase in the use of **public transport** (from 18% to 32%), with the highest use of public transport in the 18 to 34 age bracket (42%).
- 47% of respondents reported increased **walking/cycling**.
- Reported use of **less smoky solid fuels** has increased (from 27% to 31%).

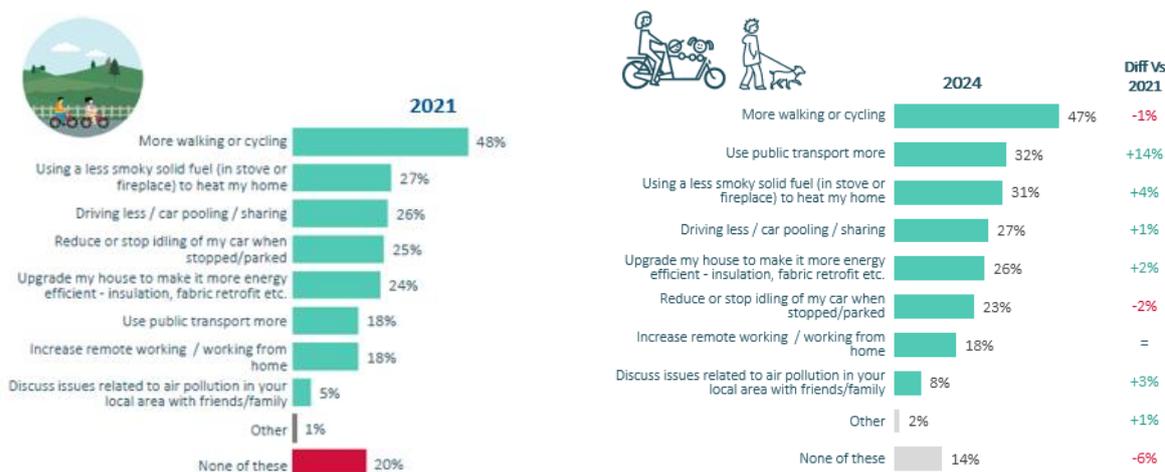


FIGURE 1 EPA/RED C SURVEY – CHANGES TAKEN TO REDUCE AIR POLLUTION (2021 & 2024)

For planned future changes, **home energy upgrades/retrofits** remained the highest future measure considered by respondents, with little changes in the percentages reported for the various measures.

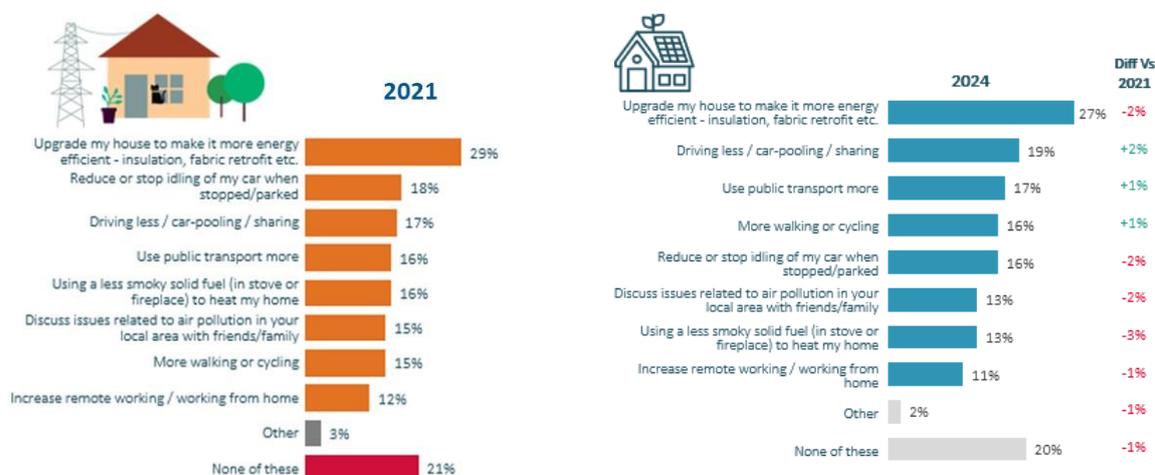


FIGURE 2 EPA/RED C NATIONAL SURVEY – FUTURE CHANGES CONSIDERED TO REDUCE AIR POLLUTION

2.2 Awareness / knowledge and attitudes

The review on behavioural change and the national surveys also addressed awareness/knowledge and attitudes regarding air quality. Key findings include:

Awareness / knowledge

- **Familiarity with the two main air pollutants** impacting health remains low, with PM at 32% and NO₂ at 30%. **Knowledge of the main sources** of these pollutants is even lower, with PM at 8% and NO₂ at 28%.
- The participant surveys conducted before and after the Dublin Clean Air Together (**CAT**) **citizen science campaign** found evidence that that **participants' knowledge and awareness increased** significantly, for example the percentage correctly identifying the most significant source of NO₂ increased from 50% to 70%.

Attitudes

- In general, both the LIFE Emerald national surveys and the Eurobarometer reports showed **declining support for many policy options**.
- Increased investment in **public transport** received the highest level of support in both the CAT survey and the EPA/RED C national survey.
- Support for a number of measures remains quite low, including:
 - **LEZ's / congestion charges** (45%);
 - **banning sales of petrol/diesel vehicles** (35%); and
 - **prohibiting the burning of smoky fuels** (53%).
- Support for all policy options is **higher among CAT participants** than among the general public in the national survey.

2.3 Implications for future actions

The duration of the LIFE Emerald project was relatively short compared to the timeframes required to deliver behaviour change and reduced socio-economic impacts in relation to air quality. The project's results and findings do, nonetheless, provide a basis for future monitoring, analysis, and actions.

The analysis in the ESRI study regarding the CAT survey [Ref 4] is worth noting in the regard; the study notes: "Policy options that required increased **investment on the part of the State** (e.g., increased investment in public transport) were favoured over those options that involved **restrictions or curbs on individual behaviour** (e.g., implementing congestion charges in cities)". This is true for both CAT participants and respondents to the national survey, which is consistent with previous research cited in the ESRI study, including findings that incentives are favoured over disincentives. Hence, the ESRI study concludes that "in order to achieve lower levels of air pollution, **individual-level behaviour change** will need to be **accompanied by targeted public policies**".

3. Job creation

Although job creation was not a major focus of the LIFE Emerald project, the project did lead to some job creation which is captured as one of the performance indicators of the project.

The main impacts on job creation are as follows:

- 3 positions created as part of LIFE Emerald project
 - 1 Project management - EPA
 - 1 Atmospheric Modeller – VITO
 - 1 PhD student - UCC
- In addition, the project focus on upskilling of the existing EPA modelling team
 - 3 FTE working full time
 - Actively looking for additional resources

Please refer to Deliverable C1.1 – Performance indicator Excel [Ref 9] for full details.

4. After-LIFE actions

After completion of the LIFE Emerald project, the EPA (together with other partners and stakeholders including DECC, HSE, ESRI and the Health Information Working Group) will continue its activities in key areas including:

- Monitoring and modelling of air pollutant concentrations and associated health impacts.
- Awareness raising and engagement with the public to impact citizens' awareness, attitudes, and behaviours.
- Participate in policy formation on air quality to reduce negative health and socio-economic impacts.

Attachments & References

Attachments

Attachment 1: Nolan, A. (2023). *The healthcare costs of poor air quality in Ireland: An analysis of hospital admissions*. Dublin: ESRI (Working Paper No. 769).

Attachment 2: Lyons, L. et al. (2024). *Long-term exposure to PM2.5 air pollution and mental health: a retrospective cohort study in Ireland*. Dublin: ESRI.

References

[Ref 1] LIFE Emerald Deliverable B.4.2: *Recommendations for the health service*.

[Ref 2] LIFE Emerald Deliverable C.2.2: *End-of-project review on behavioural change*.

[Ref 3] EPA & RED C (2024). *LIFE Emerald: Environmental Protection Agency Public Attitudes to Air Quality*.

[Ref 4] A Nolan & A Hoy (2023). *Clean Air Together Dublin: Impact on air quality awareness, attitudes and behaviour*. ESRI Survey and Statistical Report Series Number 120, October 2023

[Ref 5] LIFE13 ES/ENV/417 – University of Navarra (2018). *LIFE+ RESPIRA: Reduction of exposure of cyclists to urban pollutants*.

[Ref 6] Holland, M. (2014). *Implementations of HRAPIE recommendations for CBA of air policies*.

[Ref 7] WHO (2013). *Health risks of air pollution in Europe – HRAPIE project: Recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide*.

[Ref 8] LIFE Emerald Deliverable C.1.1: *Performance indicator Excel*.

