

CRADLE TO GRAVE

The **Health Toll** of Fossil Fuels
and the Imperative for a **Just Transition**

2nd Edition

GLOBAL
CLIMATE & HEALTH
ALLIANCE



Acknowledgements

Authors:

This report was written and researched by Shweta Narayan and Jen Kuhl, and guided by Dr. Jeni Miller. A special thanks to Jess Beagley, for advancing the framework that connects the fossil fuel life cycle with every stage of human development in the first edition. GCHA is also deeply grateful to the reviewers for their meticulous attention, expertise, and the real-world insights they brought. Finally, we thank the individuals who generously shared their experiences of the health impacts of fossil fuels on themselves, their families, or their patients. All contributors were informed of how their stories would be used, gave written consent, and received no compensation for their participation.

Reviewers:

- **Prof. Sue Atkinson, CBE MB BChir BSc MA FRSPH FFPH**

Prof. Sue Atkinson is now an independent public health consultant and formerly Director of Public Health in several regions in the UK, including the first Director of Public Health for London. With decades of experience in local, national and international health policy, she brings expertise in health equity, environmental health, and the intersection of public policy and health. She instigated and led the Faculty of Public Health (UK) work on Climate and Health. As the inaugural Chair of the Board of Directors for the Global Climate and Health Alliance (GCHA), she helped establish its governance and strategic direction, and now serves as Immediate-Past-Chair. She continues to advise governments, global institutions, and advocacy coalitions on integrating health into sustainability and social justice agendas.

- **Dr. Mark Chernaik, PhD (Environmental Law Alliance Worldwide)**

A scientist with a doctorate in biochemistry, Dr. Mark Chernaik specializes in toxicology, environmental law, and public health impacts of pollution and climate change. As a Staff Scientist at the Environmental Law Alliance Worldwide (ELAW), he provides scientific expertise for environmental litigation and policy advocacy.

- **Ritwick Dutta (Doughty Street Chambers, UK)**

An environmental lawyer with extensive experience in environmental and climate litigation, Ritwick Dutta specializes in biodiversity protection, pollution control, and corporate accountability. As an associate at Doughty Street Chambers, he has played a key role in landmark environmental cases and governance reforms.

- **Lili Fuhr (Center for International Environmental Law)**

An environmental policy expert with a background in political science and geography, Lili Fuhr specializes in climate governance, fossil fuel phase-out, corporate accountability, and technology assessment. She leads CIEL's work on the fossil economy and false climate solutions and previously directed the International Environmental Policy Division at the Heinrich Böll Foundation.

- **Dr. Courtney Howard (MD, CCFP-EM, MPP)**

Dr. Courtney Howard is an emergency physician in Canada and a globally recognized leader in climate and health. She has served as President of the Canadian Association of Physicians for the Environment, founded POWER-Planetary Health Organizations for Wellbeing, Equity, and Regeneration, and contributes to international policy, advocacy, research, and movement building for a healthier future. She currently serves as the Chair of the Global Climate and Health Alliance (GCHA) Board of Directors. Her work through WHO, Lancet Countdown, and multiple global networks has helped position health professionals as key agents of change in service of long term wellbeing for all.

- **Dr. Edward Maibach, PhD, MPH (George Mason University)**

Dr. Edward Maibach is a Distinguished University Professor (Emeritus) at George Mason University and Founding Director (Emeritus) of the Center for Climate Change Communication. He is a leading expert in climate communication, specializing in public engagement strategies that advance climate and health solutions. His research and leadership have shaped public understanding and policy approaches worldwide, and he serves as a trusted advisor to national and international climate-health initiatives.

- **Hannah Marcus, (World Federation of Public Health Associations)**

A global health researcher with expertise in environmental health and epidemiology, Hannah Marcus specializes in the intersection of climate change, disaster risk response, and public health advocacy. She is the co-chair of the Environmental Health Working Group at the World Federation of Public Health Associations (WFPHA), and contributes to advancing policies to mitigate climate-related health impacts.

- **Diana Picon Manyari (Health Care Without Harm)**

Diana Picon Manyari is the International Climate Director at Health Care Without Harm, with over two decades of experience in global public health and international development. She leads the organization's work on healthcare decarbonization and climate resilience, with a focus on policy advocacy across Latin America, Africa, and Asia.

- **Dr. Peter Orris, MD, MPH (University of Illinois)**

A physician and public health expert, Dr. Peter Orris specializes in occupational and environmental health, with a focus on the health impacts of pollution and industrial exposure. As a Professor and former Chief of Occupational and Environmental Medicine at the University of Illinois, he has led research and advocacy on environmental justice, workplace health, and the public health risks of fossil fuels.

- **Nikki Reisch, JD (Center for International Environmental Law)**

An environmental and human rights lawyer, Nikki Reisch serves as the Director of the Climate and Energy Program at the Center for International Environmental Law (CIEL). With expertise in climate finance, corporate accountability, and climate litigation, she works to hold polluters and financial institutions responsible for climate and environmental harm, advance climate justice, and promote human rights-based responses to the crisis.

- **Dr. Linda Rudolph, MD, MPH (Steering Committee, Fossil Free 4 Health)**

A physician and public health expert, Dr. Linda Rudolph specializes in climate and health, health equity, environmental justice, and policy advocacy to advance fossil fuel phase out for public health protection. She previously led the Center for Climate Change and Health at the Public Health Institute and has extensive experience in policy development for health-centered climate solutions.

- **Dharmesh Shah, MPA (Center for International Environmental Law)**

An environmental policy expert with a background in public policy and environmental health, Dharmesh Shah focuses on plastic pollution, fossil fuel regulation, and just transition policies. At the Center for International Environmental Law (CIEL), he works on advancing policies to address environmental justice and the climate crisis.

- **Anitha Shenoy (Senior Lawyer, Supreme Court of India)**

A senior advocate specializing in constitutional and environmental law, Anitha Shenoy has extensive experience in public interest litigation. She has represented key environmental cases before the Supreme Court of India, shaping legal frameworks for environmental justice.

- **Dr. Tim K. Takaro, MD, MPH, MS**

A physician-scientist working at the intersection of climate change, environment and health. He has been gratefully relearning environmental health through collaborations with Indigenous colleagues and land-defenders, and founded the Planetary Health Research Group at Simon Fraser University.

- **Dr. Joe Vipond, MD, CCFP-EM**

Dr. Joe Vipond is an emergency physician based in Alberta, Canada, a prominent climate and health advocate, and Past-President of the Canadian Association of Physicians for the Environment. He is actively involved in national clean air and climate justice initiatives and has been instrumental in mobilizing the health community for climate action. As a founder of advocacy groups working to phase out coal and improve air quality, his efforts have helped shift public discourse and policy on environmental health in Canada.

Case Studies:

Health Impacts of Oil Extraction and Production in Bayelsa, *Nigeria*

Jharia Coal Seam Fires, *India*

Cancer Alley, Louisiana, *USA*

San Bruno Pipeline Explosion, *California, USA (2010)*

Exxon Valdez Oil Spill, Prince William Sound, *Alaska, (1989)*

San Juanico Gas Explosions, *Mexico (1984)*

Coal Slurry Spill in Borneo, *Indonesia (2021)*

Extreme Weather: Hurricanes, Cyclones and Typhoons

- US Gulf Coast: Hurricanes x Oil Infrastructure
- India's Eastern Coast: Cyclones x Refineries and Power Plants
- The Philippines: Typhoons x Oil Depots and Coal-fired Power Plants

Extreme Heat

- US Gulf Coast
- Mediterranean
- In the Middle East

A Healthy and Just Transition, and Clean Cooking

Addressing Critical Energy Transition Minerals for a Just Global Transition –

The UN Secretary-General's Panel on Critical Energy Transition Minerals

Accelerating Global Action on Coal: The Powering Past Coal Alliance (PPCA)

The impact of Canada's New Anti-Greenwashing Law on Oil Majors and their "Astroturf" groups

Case Study Contributors :

Nnimmo Bassey, *Health of Mother Earth Foundation, Nigeria*

Helena Gray, *Powering Past Coal Alliance*

Leah Temper, *Canadian Association of Physicians for the Environment*
groundWork, *South Africa*

Frontline Stories:

Health Impacts of Oil Extraction and Production in Bayelsa, *Nigeria*

Nalleli's Story – Oil Drilling in Los Angeles

Ali's Story – BP's Gas Flaring in Iraq

Rosamund's Story – Deadly Traffic Pollution in London

Testimonials:

Musa Dhlamini, *EMpumelweni, eMalahleni, South Africa*
R. L. Srinivasan, *Fisherman, Kattukuppam, Ennore (North Chennai), India*
Dr. Marina Romanello, *Executive Director, Lancet Countdown*
Winnie and Pfuluwani, *Phola, Ogies, South Africa*
Dr. Amanda Millstein, *Pediatrician and Co-founder of Climate Health Now, California, United States.*
Dr. Nicholas J. Talley AC, *Chair of the Board, Doctors for the Environment, New Castle, Australia*
Prudence Masilela, *Wayaya, Ogies, South Africa*
Canadian Association of Physicians for the Environment
Canadian Association of Nurses for the Environment
Dr. Yasmin Mahfouz, *Paediatrician, Evelina London Children's Hospital, London, England*
Sandra Cortés Arancibi, *Associate Professor, UC Chile School of Public Health, Santiago Chile*
Neha Dadsena, *Public Health Expert, Chhattisgarh, India*
Dr. Fithriyyah Iskandar, *Bhayangkara Pontianak Hospital, Indonesia.*
Dr. Linda Rudolph, *Steering Committee, Fossil Free For Health, US.*
Dr. Crystal Cavalier-Keck, *Citizen of Occaneechi Band of The Saponi Nation, Co-Director: 7 Directions of Service*
Anabela Lemos, *2024 Right Livelihood award winner, Director of Justiça Ambiental Mozambique*
Seth Harris, *Citizen of New River Catawba Nation, Program Director - 7 Directions of Service*
Dr. Katriona (Kate) Wylie, *General Practitioner, North Eastern Health Centre, Tea Tree Gully, South Australia, Executive Director of Doctors for the Environment Australia*
Desmond DSa, *Co-founder of South Durban Community Environmental Alliance (SDCEA).*
Dr. Jemilah Mahmood, *Executive Director, Sunway Center for Planetary Health, Malaysia.*

Design: Subhashis Roy

Citation Review: Pooja Kumar

Editing: Emily Benson

About GCHA:

The Global Climate and Health Alliance (GCHA) unites and mobilizes the health community worldwide and accelerates climate action to protect and improve health for all. With 200+ organizational members, from every region and reaching over 125 countries, we work at the frontline of a global movement of health professionals and health and development organizations dedicated to promoting a healthy, equitable, and sustainable future for all. We address the climate crisis through evidence-based advocacy, policy, movement building, research and strategic communications.

Contact: info@climateandhealthalliance.org

Website: www.climateandhealthalliance.org

Cover Photo: Noornisha, *Chennai, India*

#CradleToGrave

Acronyms

A&E	<i>Accident and Emergency</i>
ALL	<i>Acute Lymphoblastic Leukaemia</i>
ASEAN	<i>Association of Southeast Asian Nations</i>
BC	<i>Black Carbon</i>
BOGA	<i>Beyond Oil and Gas Alliance</i>
BPA	<i>Bisphenol A</i>
CCS	<i>Carbon Capture and Storage</i>
CCUS	<i>Carbon Capture, Utilisation, and Storage</i>
CEMS	<i>Continuous Emission Monitoring Systems</i>
CFPPs	<i>Coal Fired Power Plants</i>
COPD	<i>Chronic Obstructive Pulmonary Disease</i>
CO₂	<i>Carbon Dioxide</i>
COPs	<i>Conference of Parties</i>
DEHP	<i>Di(2-ethylhexyl) phthalate</i>
DNA	<i>Deoxyribonucleic Acid</i>
ED	<i>Emergency Department</i>
FABA	<i>Fly Ash and Bottom Ash</i>
FPIC	<i>Free, Prior and Informed Consent</i>
GDP	<i>Gross Domestic Product</i>
GHG	<i>Green House Gas</i>
GMP	<i>Global Methane Pledge</i>
HAP	<i>Hazardous Air Pollutants</i>
HIA	<i>Health Impact Assessment</i>
HiAP	<i>Health in All Policies</i>
IEA	<i>International Energy Agency</i>
IMF	<i>International Monetary Fund</i>
IPCC	<i>Intergovernmental Panel on Climate Change</i>
LNG	<i>Liquified Natural Gas</i>
LPG	<i>Liquified Petroleum Gas</i>
NHS	<i>National Health Service</i>
NO₂	<i>Nitrogen Dioxide</i>
OECD	<i>Organisation for Economic Co-operation and Development</i>
PAHs	<i>Polycyclic Aromatic Hydrocarbons</i>
PBDE	<i>Polybrominated diphenyl ethers</i>
PFAS	<i>Perfluoroalkyl Substances</i>
PM_{2.5}	<i>Particulate Matter 2.5</i>
PM₁₀	<i>Particulate Matter 10</i>
POPs	<i>Persistent Organic Pollutants</i>
PPCA	<i>Powering Past Coal Alliance</i>
SO₂	<i>Sulphur Dioxide</i>
TENORMs	<i>Technologically Enhanced Radioactive Materials</i>
TRAP	<i>Traffic Related Air Pollution</i>
UNFCCC	<i>United Nations Framework Convention on Climate Change</i>
US EPA	<i>U.S. Environmental Protection Agency</i>
UV	<i>Ultraviolet</i>
VOCs	<i>Volatile Organic Compounds</i>
WHO	<i>World Health Organization</i>

Foreword



The connection between the health of humanity and the health of our planet is undeniable and inescapable. As a physician and the immediate past president of the World Medical Association, I have witnessed the devastating impacts of environmental harm on the most vulnerable communities. This report, ***Cradle to Grave: The Health Toll of Fossil Fuels and the Imperative for a Just Transition***, sheds light on one of the gravest public health crises of our time—the lifecycle of fossil fuels and their profound and far-reaching impacts on human health, equity, and survival.

From the first extraction to the final emission, fossil fuels are the silent architects of suffering, claiming lives and undermining the quality of countless others. Air polluted by coal plants fills the lungs of our children. Rising temperatures caused by greenhouse gases push vulnerable populations to the brink of survival. Entire communities are displaced, their livelihoods destroyed, as fossil fuel extraction devastates ecosystems. These impacts are not abstract. They are felt in the lives of families, in the hospitals overwhelmed by preventable illnesses, and in the cries for climate justice that echo from every corner of the globe.

This report goes beyond documenting the toll of fossil fuels—it is a powerful call to action. It challenges each of us (and our governments) to take responsibility, as stewards of health, policy, and justice, to accelerate the transition toward a sustainable future. This transition must be just and inclusive. It must center the needs of the marginalized, the displaced, and the disproportionately affected, ensuring that no one is left behind in the move to cleaner energy systems.

Importantly, this report also offers hope. It highlights the immense opportunity before us: to redefine what it means to safeguard health, to create resilient systems, and to embrace solutions that can mitigate the climate crisis while fostering health equity. This is not merely an environmental imperative—it is a moral one, and it speaks to the very heart of why we, as medical professionals, as policymakers, and as global citizens, must act with urgency.

The stakes could not be higher, and the time for half-measures is long past. The findings of this report are a rallying cry to governments, businesses, institutions, and individuals alike to rise to the challenge of this defining moment in history. Fossil fuels may shape the crises we face, but they need not shape our future.

Lujain Alqodmani, MD, MPH
*Immediate Past President
World Medical Association*

Contents

Acknowledgements	ii
Acronyms	vi
Foreword.....	vii
Frontlines of Harm: The Human Story of Fossil Fuels	xi
Executive Summary.....	xiii
Key Findings	xiv
Key Policy Recommendations	xviii
A Call for Collective Action	xxi
01 Introduction	1
1.1 Scope of the Report	2
BOX I The Precautionary Principle	3
BOX II Climate Justice is Essential for Health Equity	4
02 Cradle to Grave: Fossil Fuels and the Human Body	7
2.1 Health Harm by Pollutant	7
2.1.1 Major Health Impacts of Toxicants Produced by Fossil Fuel Production, Transport and Use	9
POSTER 1: Fossil Fuel Harms on the Human Body	12
2.2 Harms by Age and Stage	13
2.2.1 Before Birth	13
2.2.2 Childhood	13
2.2.3 Adolescence	14
2.2.4 Adulthood	14
2.2.5 Elderhood	14
POSTER 2: Fossil Fuel Harms by Age and Stage	16
2.3 Communities most likely to be Harmed	18
2.3.1 Workers	18
2.3.2 Marginalized Communities	19
BOX III Health Impacts of Oil Extraction and Production in Bayelsa, Nigeria	21
03 The Fossil Fuel Life Cycle Impacts: Health Harms from Exploration to Closure.....	22
3.1 Site Preparation	24
3.2 Coal Extraction	24
3.3 Oil and Gas Extraction	25
3.3.1 Conventional Oil Extraction	25
3.3.2 Unconventional Oil and Gas Extraction – Including Fracking	25
BOX IV Nalleli's Story: Oil Drilling in Los Angeles	26
BOX V The Water Trade-Off in Fracking	27
BOX VI Carbon Capture and Storage – Dangerous Distraction	29

3.3.3 Disasters at Extraction Sites	30
3.3.4 Other Impacts of Extraction	30
BOX VII Jharia Coal Seam Fires, India (1916-present)	31
3.4 Processing and Refining	32
3.4.1 Coal Processing and Coke Production	32
3.4.2 Oil Refining	32
BOX VIII Cancer Alley, Louisiana, USA	33
3.5 Transportation of Fossil Fuels	33
3.5.1 By Pipeline	33
BOX IX San Bruno Pipeline Explosion, California, U.S. (2010)	34
3.5.2 By Rail	34
3.5.3 By Ship	34
BOX X Exxon Valdez Oil Spill, Prince William Sound, Alaska, (1989)	35
BOX XI San Juanico Gas Explosions, Mexico (1984)	35
3.6 Combustion and Use	36
3.6.1 Producing Electricity	38
3.6.1.1 Coal Fired Power Plants	38
3.6.1.2 Oil and Gas Power Plants	38
3.6.1.3 Fossil Fuel Powered Household and Single-building Generators	38
3.7 Fueling Transportation	41
BOX XII Rosamund's Story: Deadly Traffic Pollution in London	42
3.8 Residential Heating and Cooking	43
BOX XIII Cooking with coal harms health, but LPG is not the answer	43
BOX XIV Coal Slurry Spill in Borneo, Indonesia (2021)	44
3.9 Waste: Storage and Disposal	44
3.9.1 Contaminated Water	44
3.9.2 Coal Ash	45
3.9.3 Gas Flaring	47
BOX XV Ali's Story: BP's Gas Flaring in Iraq	48
3.10 Decommissioning and Site Remediation	49
POSTER 3: Health Harms of Fossil Fuel from Exploration to Closure	50
Fossil Fuel Atlas	53
Fossil Fuel-Based Products: Petrochemicals, Plastics and Agrochemicals	57
04 Multiplied Risk: Fossil Fuel and the Climate Crisis.....	60
4.1 Amplified Health Risks	60
4.2 Cascading Risks Prompted by Fossil Fuel Infrastructure	61
4.2.1 Cascading Risk: Hurricanes, Cyclones and Typhoons	61
4.2.2 Cascading Risk: Heat	61
BOX XVI The Philippines: Typhoons x Oil Depots and Coal-fired Power Plants	62
BOX XVII Mediterranean: Extreme Heat Prompts Cascading Health Risks	62
4.2.3 Cascading Risk: Sea Level Rise and Coastal Flooding	63

05 Societal Harms of the Fossil Fuel Industry:	
Fossil Fuel and the Climate Crisis	66
5.1 The Social Fallout of Fossil Fuel Projects at the Community Level	66
5.2 Resource Competition, Economic Disruptions and Economic Inequity	68
BOX XVIII Energy Equity Does Not require Fossil Fuel Dependence	69
5.3 Forced Displacement, Human Right Abuses, and Increase in Land Conflicts	70
5.4 Corruption, Undue Influence, and Disruption to Ethical Governance	72
BOX XIX Fossil Fuels and Climate Negotiations	73
06 A Just and Health-Focused Energy Transition	76
6.1 Transitions Across Sectors	77
BOX XX Principles of Just and Health-focused Transition	80
6.2 The Economic Case for a Just and Health-Focused Energy Transition	81
BOX XXI Addressing Critical Energy Transition Minerals for a Just Global Transition – The UN Secretary-General’s Panel on Critical Energy Transition Minerals	82
07 Policy Recommendations.....	83
1. Halt New Fossil Fuel Exploration and Development	84
BOX XXII Accelerating Global Action on Coal: The Powering Past Coal Alliance (PPCA)	85
2. End Fossil Fuel Subsidies and Redirect Savings to Health	86
3. Clean Up Existing Fossil Fuel Production	86
4. Internalize the Health Costs of Fossil Fuels through the “Polluter Pays” Principle	87
5. Initiate Community-Led Health Research and Action for Fossil Fuel-Affected Areas	88
6. Counter and Curb Fossil Fuel Industry Influence, Advertising and Disinformation	88
BOX XXIII The impact of Canada’s New Anti-Greenwashing Law on Oil Majors and their “Astroturf” groups	89
7. End Fossil Fuel Finance: Align Global Institutions with Climate Goals	90
8. Lead by Example in the Health Sector	91
08 Conclusion.....	92
References.....	94

Frontlines of Harm:

The Human Story of Fossil Fuels



Musawenkosi Dhlamini

EMpumelelweni, eMalahleni,
South Africa



Dylan Paul
Center for Environmental Rights

My name is Musawenkosi Dhlamini. I am 22 years old. In 2010 I was diagnosed with asthma. I grew up as a child who could not participate in sports, and other activities children partake in. My chest would close up and I wouldn't be able to do anything. The older I got I could tell what the cause of my asthma was. The place where I live is surrounded by mines. The asthma affected many things in my life. I was always being admitted to hospital, and had to carry my asthma pump everywhere I went. Living in Witbank is something else because even these mines surrounding us do not help us to get better medication at the clinics we go to. The only thing they do when your chest closes up is give you an asthma pump. They do not follow up. Living in a polluted area like this has affected me and put me in the condition I'm in right now.

**R. L. Srinivasan**

Fisherman, Kattukuppam,
Ennore (North Chennai),
India



*Global Climate and Health Alliance
(GCHA)*

Our waters are more than just a source of livelihood—they are the heart of our culture, the keeper of our traditions, and the essence of our identity. But relentless coal and oil refinery pollution and frequent oil spills have poisoned these waters, destroying the ecosystems we depend on and making fishing no longer viable. Stripped of our sustenance, many of us are forced to leave behind generations of tradition and take up menial jobs elsewhere just to survive. It doesn't just end our way of life—it erases our connection to the land and sea, our dignity, and the very fabric of our community. This is not just environmental harm—it is an attack on our identity and existence.

Executive Summary

When we think of fossil fuels, we often focus on the moment they are burned - when coal powers a plant, petrol fuels a car, or gas heats a home. However, the impact of fossil fuels starts far earlier than combustion, and extends long after it. From the moment oil, coal, and gas are extracted from the earth, through refining, transport, and distribution, to the eventual shutdown and cleanup of industrial sites, every stage of this process leaves a footprint on human health as well as the environment. Air and water pollution, habitat destruction, toxic waste, and long-term public health crises are woven into the value chain of fossil fuel production. This report maps the full lifecycle of fossil fuels, exposing the often-overlooked consequences that impact our ecosystems, economies, and communities long before and after a single drop of oil or lump of coal is burned.

Cradle to Grave: The Health Toll of Fossil Fuels and the Imperative for a Just Transition provides a comprehensive global overview of the health consequences associated with fossil fuel use at every stage of their lifecycle. It collates existing scientific evidence, and gathers personal testimonials and case studies, to explore the multidimensional interactions between fossil fuels and human health and social wellbeing, particularly for the world's most vulnerable people and communities.

Our approach to examining these health impacts follows the broad definition set out in the World Health Organization (WHO) Constitution: health as a state of complete physical, mental, and social well-being, not merely the absence of disease. Accordingly, this report pairs rigorous data on health outcomes with the lived experiences of communities and health professionals on the front lines, showing how social and environmental conditions shape people's capacity to live healthy lives.

Our collated research aims to equip policymakers, health professionals, advocates and labour movements with the necessary evidence to push for transformative action and a healthy, just transition (see Principles of Just and Health-Focused Transition, p.80).



Key Findings



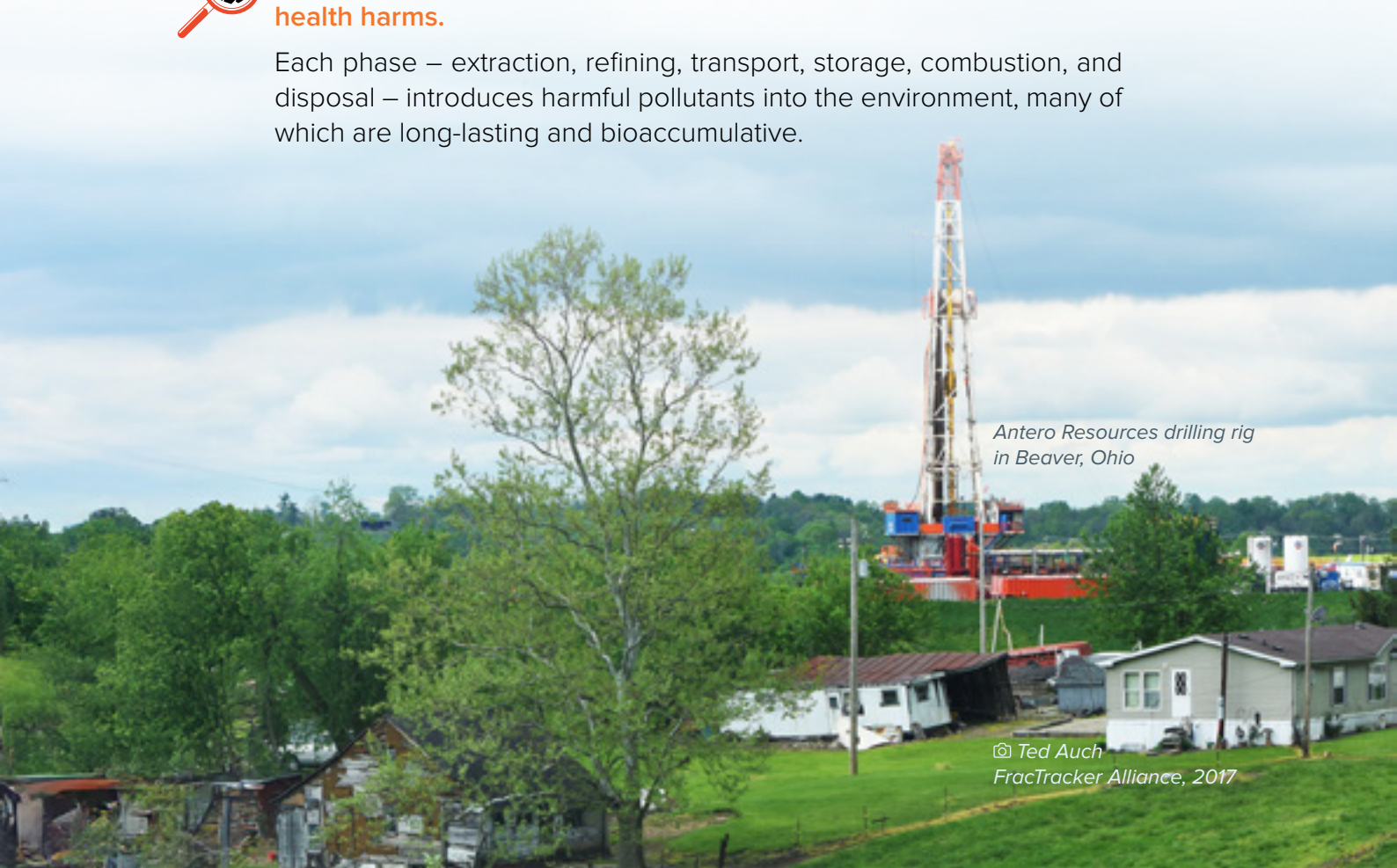
Fossil fuel-related pollution affects every stage of life, from fetal development to old age.

Exposure has been linked to increased risk of low birth weight, childhood cancer, asthma, neurological disorders, cardiovascular disease, and premature death. For instance, during the prenatal period, when vital organs are forming, exposure to pollutants from coal, oil, and gas extraction and combustion is linked to low birth weight, preterm birth, miscarriage, and a range of congenital abnormalities. Many of these health harms are permanent, impairing the child throughout their lifetime. Children are also particularly vulnerable due to their faster breathing rates, narrower airways, and developing organs. Fossil fuel pollutants are linked to a wide range of health harms across multiple body systems. They impair lung function and exacerbate asthma and other respiratory diseases; increase the risk of cardiovascular disease and hospitalizations; disrupt cognitive function and mental health through impacts on the brain and nervous system; elevate the risk of cancers such as leukemia; cause reproductive damage; and contribute to premature mortality. Older adults face unique vulnerabilities due to declining organ function, pre-existing chronic diseases, and cumulative exposure.



At every stage of their lifecycle, fossil fuels cause severe health harms.

Each phase – extraction, refining, transport, storage, combustion, and disposal – introduces harmful pollutants into the environment, many of which are long-lasting and bioaccumulative.



*Antero Resources drilling rig
in Beaver, Ohio*

© Ted Auch
FracTracker Alliance, 2017

Key health impacts include:



Extraction (e.g., fracking, coal mining, offshore drilling) releases benzene, heavy metals, radioactive materials, and particulates, driving up rates of respiratory disease, cardiovascular illness, cancers, adverse birth outcomes, and neurological disorders in surrounding populations.



Refining and processing have been shown to emit carcinogenic chemicals such as benzene, toluene, and Volatile Organic Compounds (VOCs), posing serious risks to workers and nearby residents, especially in densely clustered industrial zones.



Transport and storage involve risks of chemical leaks and spills, which contaminate air and water and trigger acute and chronic health effects, including respiratory and neurological damage.



Combustion, whether in power plants, vehicles, or homes, generates particulate matter 2.5 (PM2.5), nitrogen oxides, and other pollutants, significantly increasing risks of asthma, heart disease, stroke, cancer, dementia, and premature mortality.



Post-combustion waste (e.g., coal ash, gas flaring) continues to expose communities to heavy metals and toxins, contributing to long-term environmental degradation and chronic disease.



Legacy pollution from abandoned fossil fuel sites causes sustained harm decades later.

Fossil fuels are the largest source of greenhouse gas emissions, driving the climate crisis that fuels extreme weather, spreads disease, and causes lasting and devastating harm to human health.

It's crucial to note here that many health harms remain dangerously understudied—often unfolding over decades, by which time the damage is irreversible. Worse still, the cumulative toll of multiple projects in the same region is rarely accounted for, leaving entire communities exposed without adequate scrutiny or protection.

Coal plants in central India are associated with emissions that affect local air quality.

Amirtharaj Stephen



The health impacts of fossil fuels are persistent and systemic.

Fossil fuel harm doesn't end with exposure. The persistent nature of many pollutants, such as heavy metals, benzene, and particulate matter, means that they linger and build up in the environment and harms endure long after operations cease and can cause chronic health issues. Pollutants remain in soils, water systems, and food chains for decades or even centuries, causing continuous exposure and multiplying the health risks through the lifetime and for future generations. Exposure to heavy metals like mercury, lead, and arsenic has cumulative health impacts – damaging neurological development in children, causing cognitive impairment, kidney dysfunction, cardiovascular diseases, and multiple cancers long after fossil fuel activities have ceased.



Fossil fuel health harms are unevenly and unjustly distributed in communities and across nations.

Social determinants—conditions in which people are born, grow, live, work, and age, shaped by the distribution of power, resources, and opportunity—significantly influence exposure to fossil fuel pollutants and their impacts. Economic, political, racial, and geographical factors compound these risks. Marginalized groups, including Indigenous peoples, racial minorities, low income populations and migrant workers, disproportionately live near polluting infrastructure and face systemic barriers to healthcare, housing and a safe environment. These communities experience heightened rates of respiratory illness, cancer and cardiovascular disease, often in 'sacrifice zones' where a power imbalance between project proponents and the local community mean that people are forced to live in the midst of pollution.

Coal mines in Mozambique are located in close proximity to residential areas.

© Justiça Ambiental, Mozambique





Fossil fuels drive wider societal health impacts and exacerbate other pre-existing health disparities in communities and between nations.

Fossil fuel operations have profound societal consequences, often linked to rising inequality, disruptions to community well-being and human rights violations. Across the world, extraction projects have displaced Indigenous and marginalized communities, disrupting traditional livelihoods, and becoming linked to long-term mental and physical impacts. Fossil fuel operations can destabilise local economies and social structures, and have been linked to increased rates of substance abuse, violence, human trafficking, and mental health crises, particularly in communities surrounding extraction zones.



Climate policy and health policies have largely ignored these multidimensional health harms of fossil fuels.

While climate negotiations have focused on CO₂ and, more recently, methane emissions, they have overlooked the broader health consequences of fossil fuel dependence. Carbon capture technologies and emission offsets cannot mitigate the full range of health, social and ecological damages. Nor can they address the lasting legacies of toxic contamination or exposure. Furthermore, the fossil fuel industry's disproportionate political influence has eroded environmental and labour protections, weakened regulation, and permitted misinformation, compounding health impacts.



The cost of inaction is rising by the day.

In 2022, global fossil fuel subsidies reached an estimated US\$7 trillion, according to the International Monetary Fund (IMF), including explicit subsidies such as tax breaks and price caps (US\$1.3 trillion) and implicit subsidies of US\$5.7 trillion. The latter are due to the unpriced societal costs of fossil fuel use including air pollution, climate change, traffic congestion and other health and environmental damages. Phasing out fossil fuel subsidies and investing in clean, renewable energy could prevent millions of premature deaths, unlock over US\$4 trillion in public revenue currently lost to unpriced pollution and climate impacts, and deliver long-term economic and health benefits.



A rapid and just transition away from fossil fuels—and to clean, renewable energy—is imperative for health.

A just transition not only implies shifting toward renewable, clean and healthy energy sources but ensuring equitable access to these resources, particularly for historically marginalized and disproportionately impacted communities. It necessitates robust social policies, substantial investment in public healthcare, comprehensive environmental remediation, community involvement in decision-making, and fair economic opportunities for transitioning workers. Only through such integrated approaches can we address the root causes of climate injustice, improve overall community resilience, and secure long-term health benefits for all populations.

This report offers a cautionary framework as the world accelerates the extraction of critical minerals. We must apply the lessons of fossil fuel exploitation – prioritizing transparency, human rights, and environmental protection – to avoid repeating the same mistakes and prevent yet another cycle of harm disproportionately affecting the world’s poorest and most vulnerable.

Ultimately, shifting from fossil fuels toward health-focused, energy efficient and just renewable energy systems is economically advantageous, ethically necessary, and essential for global health and climate resilience. To address these issues, we make several key policy recommendations.

Women near coal mines in Mozambique carry biomass for household cooking and heating needs.



📷 *Justiça Ambiental, Mozambique*

Key Policy Recommendations



Halt New Fossil Fuel Exploration and Development

Ending new fossil fuel exploration and development is essential for meeting global climate targets, particularly the 1.5°C threshold set by the Paris Agreement. Despite mounting scientific evidence and economic concerns, including over stranded assets, new projects continue to receive approval.

Initiatives such as the Beyond Oil and Gas Alliance (BOGA), the Fossil Fuel Non-Proliferation Treaty, and the Powering Past Coal Alliance signal a growing international commitment to ending fossil fuel expansion. However, these efforts must be reinforced by legally binding commitments to phase out existing production and provide structural support for a just transition, including support for workers, communities, and countries dependent on fossil fuels. Precedents set by countries like Costa Rica, Colombia, France, and the Small Island Developing States illustrate political feasibility, yet persistent policy contradictions underscore the need for coordinated, comprehensive global action.



End Fossil Fuel Subsidies and Redirect Savings to Health

Despite all the science, fossil fuel subsidies continue to increase, reinforcing dependence on polluting energy sources and undermining health and climate goals. Phasing out subsidies and redirecting funds toward renewable energy, resilient infrastructure, and pollution mitigation would yield major public health gains and long-term savings. While some international commitments exist, stronger enforcement and accountability are needed to ensure funds support a healthier, more sustainable future.



Clean Up Existing Fossil Fuel Production

Immediate actions to mitigate harms from existing fossil fuel production, particularly methane emissions (e.g. the Global Methane Pledge (GMP)), are essential but must not replace the ultimate goal of fully phasing out fossil fuels. Reducing methane through ending flaring, plugging leaks, and stricter regulations can quickly decrease climate impacts and improve public health, though these interim measures should not justify prolonged fossil fuel extraction.

Beyond methane, fossil fuel production releases toxic chemicals harming frontline communities. Governments should enforce stringent emission standards, mandate real-time pollution monitoring, strictly limit flaring and hazardous waste disposal, enhance environmental enforcement and community-led oversight, require cumulative environmental and health impact assessments for new facilities, and support targeted pollution remediation programs. Remediation efforts and stricter regulation must be accompanied by transition planning and economic alternatives for workers and communities historically dependent on fossil fuel industries



Internalize the Health Costs of Fossil Fuels through the “Polluter Pays” Principle

The “Polluter Pays” principle asserts that those responsible for environmental harm should bear the associated costs. Currently, these costs - including respiratory diseases, cardiovascular conditions, and premature deaths - are externalized onto public health systems, allowing fossil fuel companies to profit without accountability.

Internalizing these costs creates clear financial and regulatory incentives to reduce toxic emissions and accelerate the transition to clean, renewable energy. Legal instruments, including the internationally recognized right to a clean, healthy, and sustainable environment, provide a foundation for enforcing such accountability. Strengthening this principle - through policy mechanisms such as reversing the burden of proof to require companies to demonstrate safety - can help ensure greater environmental and public health protection, while easing the economic strain on health systems.



Initiate Community-Led Health Research and Action for Fossil Fuel-Affected Areas

Prioritize community-partnered research to assess the health harms of fossil fuels and climate change on highly impacted communities, integrating both Western scientific methods and Traditional Knowledge. These studies should examine physical, mental, and cultural health impacts in a holistic manner. Crucially, the findings must lead to concrete policy changes, resource allocation, and remediation efforts that reflect the priorities identified by the communities themselves.



Regulate, Limit and Counter Fossil Fuel Industry Advertising and Disinformation

Banning fossil fuel advertising and sponsorship, alongside evidence-based counter-marketing, can reduce industry influence, challenge disinformation, and shift public norms, as seen in successful tobacco control campaigns. Policies implemented in France, Amsterdam, and Canada demonstrate that such measures help build cultural and political momentum toward clean energy transitions.

Fossil fuel companies and petrostates have long used their presence at climate and pollution conferences to undermine policy progress. As tobacco companies are excluded from health conferences on lung disease, fossil fuel entities should likewise be barred from COPs and other international forums focused on environmental and public health protection.



End Fossil Fuel Finance: Align Global Institutions with Climate Goals

Global financial institutions, including the World Bank and major investment banks, continue to fund fossil fuel projects, undermining climate goals and delaying the transition to renewable energy. Redirecting these funds to clean, renewable energy is essential, with the International Energy Association (IEA) calling for a tripling of renewable investments to US\$4.5 trillion annually by 2030. Additionally, continued funding risks creating stranded assets worth up to US\$1 trillion, making fossil fuel investments financially unsound.



Lead by example in the Health Sector

The health sector holds considerable influence as a trusted voice and major economic actor. By decarbonizing healthcare systems, divesting from fossil fuels, and adopting sustainable practices, it can play a critical role in accelerating the fossil fuel phase-out and leading by example. Health professionals can humanize the impacts of fossil fuels by sharing firsthand accounts from patients and communities. Through these actions, the sector can lead a transition toward a healthier, more equitable, and sustainable future and inspire a society-wide transformation.

A Call for Collective Action



Fossil fuel dependence is driving a triple crisis—devastating the environment, inflicting widespread harm on human health, and reducing the stability required for health systems to function. The extensive health impacts outlined in this report, from respiratory illnesses to long-term chronic diseases, provide an undeniable imperative for urgent, collective action. While scientific research highlights the scale of the crisis, lived experiences reveal a deeper toll, particularly on marginalized communities living near polluting infrastructure.

At the same time, the world stands at a turning point. The falling cost of renewable energy and battery storage has made clean electricity cheaper than fossil fuels in much of the world. The IEA now projects oil and gas demand will peak before 2030. When the hidden health costs of fossil fuels are considered, the case for transitioning becomes even more urgent. Yet, fossil fuel companies continue to delay this shift to protect their profits—at the expense of ecological, economic, and human wellbeing.

This moment demands bold leadership from governments, civil society, businesses, and the global health community to swiftly transition away from fossil fuels. By prioritizing public health, safety, health system stability, social justice, and environmental sustainability, this transition can not only mitigate harm but also create transformative change—protecting the most vulnerable and building a healthier, more equitable future for generations to come.



Dr. Marina Romanello

Executive Director,
Lancet Countdown



University College of London

The science is clear: our persistent dependence on fossil fuels is claiming lives and livelihoods today, and putting the world on track to a potentially catastrophic future of climate change. A prompt and just transition away from fossil fuels and towards renewable energy and energy efficiency is essential to ensure our world can continue to support healthy human lives. It can also help save over 2 million lives every year from improved air quality, enable a transition to more affordable and reliable energy, support the generation of healthier jobs, and enable a thriving and more equitable future for all. With this burden of evidence, there are no more excuses for further delays.



U.S. Steel Plant in
Clairton, Pennsylvania.

📷 Mark Dixon

Introduction

Fossil fuels have powered economies and societies for over a century. Since coal became a driver of the industrial revolution in the mid-1800s, fossil fuels have powered homes, hospitals, and cities, have enabled travel to work, school and vital services, and have contributed to the production, delivery and preparation of food, medicines, and all manner of consumer products¹. However, the health costs of this energy system – across its entire life cycle have been profound and are accelerating^{2,3}.

In 2024, fossil fuel combustion and related industries contributed 90% of global CO₂ emissions⁴. Increases in atmospheric gases, including CO₂, have resulted in a global rise in temperatures since the turn of the last century⁵. Also well established is that this increase in temperatures is changing weather patterns, with devastating consequences.

As twelve-month temperature averages breach the Paris Agreement target of limiting global warming to 1.5°C, communities around the world are facing deadly heat waves, droughts, storms, floods, wildfires, sea level rise, extreme weather events, biodiversity loss and species extinction. More subtle health impacts, including shifting regional disease patterns, and increased food and water scarcity, are also being felt⁶. As global temperature rise puts peoples' safety and well being at risk, health systems are struggling to meet the novel and worsening challenges caused by the climate crisis^{7,8}.

In addition to the health impacts of climate change, a myriad negative health impacts are directly associated with fossil fuels. Throughout the entire fossil fuel cycle — exploration, extraction, processing, transport, storage, use, waste disposal and site reclamation — and throughout the course of a human life, fossil fuels exert impacts from “cradle to grave”⁹. Fossil fuel health risks include an elevated risk of poor birth outcomes, increases in asthma and other respiratory diseases, several cancers, cardiovascular disease and neurodegenerative disorders¹⁰.

Despite clear scientific consensus and the availability of cleaner, more equitable alternatives, fossil fuel development continues to expand. Without an urgent and just transition away from fossil fuels, both planetary stability and public health remain in jeopardy.

1.1 Scope of the Report

Cradle to Grave: The Health Toll of Fossil Fuels and the Imperative for a Just Transition explores the far-reaching health impacts of fossil fuels across their entire lifecycle and the human life course — from birth to old age.

This updated edition builds on a 2022 report of the same name, and incorporates a broader and more current body of evidence. The academic literature remains constrained by funding gaps, industry influence, and access barriers. This report pairs peer-reviewed studies with global case studies, community testimonies, and insights from healthcare professionals to offer a more comprehensive picture of what is happening to our populations.

The report is structured around the following

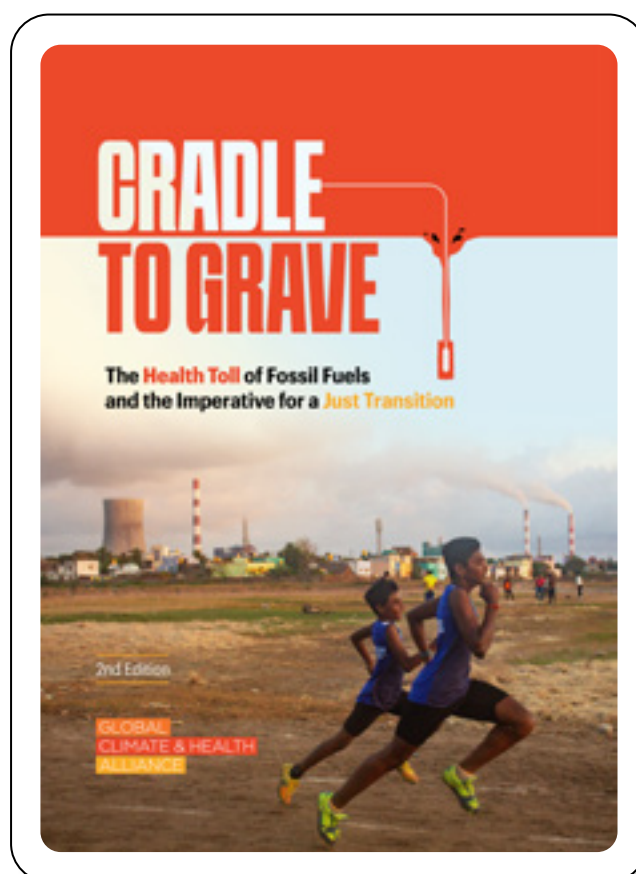
guiding questions:

- **When and how is the human body most vulnerable to fossil fuel pollution?**

This section explores susceptibility across the life course, identifying how different stages — prenatal, childhood, adulthood, and old age — face different health risks. It also asks which communities bear disproportionate risks demonstrating socio-political and economic inequality.

- **What are the health impacts at each stage of the fossil fuel lifecycle?**

It investigates how activities such as exploration, extraction, refining, transport, use, and disposal produce distinct health harms that can persist for decades, and examines the risks associated with fossil fuel-derived products like plastics and petrochemicals.



- **Who is most at risk of harm?**

This report examines how the health impacts of fossil fuels and the climate crisis, though widespread, are unevenly distributed. It asks why low-income communities, workers, Indigenous Peoples, and people of color face disproportionate health risks shaping their vulnerability and access to care.

- **How do the health risks from fossil fuels and climate change compound?**

The study analyses the risks to fossil fuel infrastructure from the climate-induced extreme weather events like hurricanes, floods, extreme heat etc and the consequent health risks to people, especially in low-income and climate-vulnerable regions.

- **What are the local and community-level consequences of fossil fuel development?**

It documents patterns of land conflict, forced displacement, social and economic disruptions, and human rights violations, and considers both the physical and mental health toll on affected populations. The report also assesses the sector's use of disinformation, lobbying, and regulatory capture that distort public debate and erode democratic processes.

- **What would a just and health-centred energy transition look like?**

This report documents and challenges narrow interpretations of a just transition and outlines principles for a holistic approach that prioritises equity, public health, and long-term sustainability.

THE PRECAUTIONARY PRINCIPLE

By bringing data and lived experience together, the report exposes the often-overlooked health costs embedded throughout the fossil-fuel lifecycle and underscores why public-health principles—especially the precautionary principle—must guide decision-making. The precautionary principle means taking action to prevent harm even when some cause-and-effect relationships are not fully established scientifically—especially when people's health is at stake. Crucially, while data gaps remain in some regions, their existence cannot be allowed to excuse inaction; instead, the stories documented here strengthen the case for urgent, preventive measures and shift the burden of proof away from communities already experiencing harm.



7 year old, Princess, developed asthma from growing up near coal mines in Witbank's Vosman community, Emalahleni, Mpumalanga Province, South Africa.

© Dylan Paul
Center for Environmental Rights

CLIMATE JUSTICE IS ESSENTIAL FOR HEALTH EQUITY

The health and economic burdens of fossil fuel production and use are unequally distributed, with marginalized communities, both in the Global South and within industrialised nations, bearing the brunt of environmental degradation and health harms^{11,12}. While the Global North has been responsible for 92% of historical excess greenhouse gas emissions¹³, the adverse effects of air pollution, climate change, and fossil fuel infrastructure are most acutely felt by those with the least historical responsibility and the fewest resources to respond.

Fossil fuel activities often occur in so-called “sacrifice zones,” defined by the Special Rapporteur on the issue of human rights as “extremely contaminated areas where vulnerable and marginalized groups bear a disproportionate burden of the health, human rights and environmental consequences of exposure to pollution and hazardous substances”¹⁴. Indigenous peoples, communities of color, low-income populations, and youth¹⁴ face heightened exposure to air pollution, increased rates of respiratory and cardiovascular disease, displacement, economic instability, and erosion of cultural practices¹⁵. One US study found that communities of color were exposed to 1.25 times more particulate matter than white communities¹⁶. Advocates have long raised concerns that low income communities and communities of color are at disproportionate risk of air pollution related health harms^{17–20}.



Bill Salazar, Pexels

Climate change further compounds these injustices. The Intergovernmental Panel on Climate Change (IPCC) has highlighted how vulnerable populations are at higher risk of extreme weather, food and water insecurity, and worsening health inequities. Fossil fuel extraction on Indigenous lands, in particular, undermines both environmental integrity and community health, prompting repeated calls for stronger protections of Indigenous rights, including from the United Nations Permanent Forum on Indigenous Issues²¹.

Addressing these systemic injustices requires robust policy interventions: equitable distribution of environmental benefits and burdens, stringent emissions regulation, inclusive decision-making, and targeted financial and technical support for affected communities. Legal safeguards for Indigenous and marginalized populations must be strengthened to uphold health and human rights in the face of expanding fossil fuel infrastructure.



Winnie and Pfuluwani

Phola, Ogies, South Africa



Dylan Paul

Center for Environmental Rights

A lot of people think the chest problems are family illnesses but it is because we are all breathing the same polluted air. Pfulu has had asthma since he was a few months old. As you can hear, he breathes loudly and sometimes you can see he is struggling. I don't have money to take him to doctors because they ask for R700 per session and he gets sick often. I just want him to be like other children.



Dr. Amanda Millstein

Pediatrician and Co-founder of
Climate Health Now, California,
United States

I am a primary care pediatrician, working in community-based clinics in the California Bay Area since 2015. My current clinical practice is primarily in Oakland, where I work in urgent care and Teen and Adolescent Clinic. I am a mother of two school-aged children and the co-founder of Climate Health Now.

I practiced primary care pediatrics in Richmond, California from 2018-2023. Richmond is home to an oil and gas refinery and there are multiple refineries in nearby cities. One of the very first experiences I had shortly after I started working in Richmond was when there was an explosion at a nearby refinery and the community and our clinic had to shelter in place. There was dark smoke visible outside and for the next two days families came in to have their kids checked out, concerned about what sorts of toxins their children were exposed to during the explosion and if it might have impacted their kids' lungs.

Perhaps most profoundly, there have been times when I've been administering albuterol treatments at the same time the refinery is flaring, making it all the more obvious that the treatments I offer my patients in the clinic are a mere bandaid compared to what they are being exposed to in the community.

In Contra Costa County, where Richmond is located, about 1 in 6 people (17.9%) has been diagnosed with asthma, higher than the statewide prevalence of 15.1%. A comparison of Emergency Department (ED) visits for asthma for people living in the zip code containing the refinery and the next zip code over to people living two other zip codes in the same county without a refinery show a difference in ED visit rates for asthma of 10-fold. Children in Richmond are estimated to visit urgent care for asthma at triple the rate of kids across California.



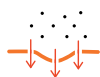
02
Stones extraction process is going on in the coal mine in Jharia, Dhanbad, India,

iStock

Cradle to Grave: Fossil Fuels and the Human Body

2.1 Health Harm by Pollutant

Fossil fuel activities—from extraction and processing to combustion and waste—release a range of pollutants detailed below. Such pollutants can enter the human body in **three ways**^{21,22}:



Contact or Absorption – materials come in contact with and are absorbed through the skin and eyes



Ingestion – materials are swallowed and are absorbed by the digestive system



Inhalation – materials are breathed in and are absorbed by the respiratory system

The harm caused by toxic chemicals and heavy metals depends on the dose, duration of exposure, and the individual's age, size, and health. Some fossil fuel pollutants can cause serious effects even at low doses, while others require prolonged or higher exposure. Certain pollutants, like lead and mercury, accumulate in the body over time, a process known as bioaccumulation. In addition, some fossil fuel processes, such as fracking and firefighting operations, contribute to the spread of per- and polyfluoroalkyl substances (PFAS), commonly known as “forever chemicals”. They do not break down over time, persist in soil and water, and accumulate with each exposure—earning them the name “forever.” As these toxins move up the food chain, their concentration increases, a phenomenon called biomagnification.

These chemicals do not break down over time, they persist in soil and water, and accumulate with each exposure—earning them the name “forever”.

Oil well contamination in Nigeria pollutes ecosystems, leaving land, water, and communities at risk.



2.1.1 Major Health Impacts of Toxicants Produced by Fossil Fuel Production, Transport and Use

Toxicants	Linkages	Health Impacts
Particulates: Fine particulate matter (PM _{2.5}), produced during fossil fuel extraction, refining, and combustion, is small enough to penetrate deeply into the lungs and bloodstream ^{23,24} .		
Particulate Matter 2.5 (PM_{2.5})	Extraction, refining, combustion	Preterm births, premature death, reduced respiratory function, cardiovascular disease, strokes, cancers ^{23,24} .
Black Carbon (BC)	Combustion	Cardiopulmonary hospitalizations, increased risk of all-cause and cardio pulmonary mortality ²⁵ .

Poisonous Gases

Sulphur dioxide (SO₂)	Combustion, especially coal and petroleum power plants	Respiratory challenges, increased risk of developing asthma and asthma exacerbations in children, premature death ^{26–29} .
Nitrogen dioxide (NO₂)	Combustion, gas extraction and transport	Airway inflammation asthma and chronic obstructive pulmonary disease (COPD) exacerbations requiring hospitalization ³⁰ . Reduced lung function in children and with increased risk of pre-eclampsia in pregnant women ^{31,32} .

Volatile Organic Compounds (VOCs)³³: VOCs are primarily released during fossil fuel extraction, refining, storage, and transportation (including leaks in pipelines and equipment). VOCs can be found in air and water close to gas wells, refining and fracking sites^{34,35}. VOCs, combined with oxides of nitrogen and exposed to sunlight produce ground level ozone (O₃)³⁶ linked to asthma and COPD exacerbations. Long term exposure is associated with cardiovascular mortality respiratory disease and COPD^{37,38}.

Benzene ³⁹	Extraction, refining, leaks	Linked to leukaemia and lung cancer ⁴⁰ including in children ^{41,42} , as well as anemia, immune suppression and other serious non-cancer outcomes ⁴³ . No safe level for cancer prevention has been found.
Toluene ⁴⁴	Extraction, refining, leaks	Neurological symptoms like headaches, dizziness, and memory loss at low to moderate exposure levels. Prolonged exposure can result in hearing and vision loss, and developmental effects in children if exposure occurs during pregnancy.

Toxicants	Linkages	Health Impacts
Ethylbenzene ⁴⁵	Extraction, refining, leaks	Short-term exposure can irritate the eyes and throat, while chronic exposure may damage the liver, kidneys, and respiratory system.
Xylene ⁴⁶	Extraction, refining, leaks	Dizziness, confusion, and respiratory distress. Prolonged exposure affects the liver and kidney.
1,3 Butadiene ⁴⁷	Extraction, refining, leaks	A human carcinogen particularly blood and lymphatic cancers.
Polycyclic Aromatic Hydrocarbons (PAHs) ⁴⁸	Combustion of coal, oil, gas, and diesel; also present in flaring, vehicle exhaust, and coal tar	Linked to various cancers, respiratory and cardiovascular diseases, reproductive health problems, immunosuppression, and endocrine disruption ⁴⁹ .

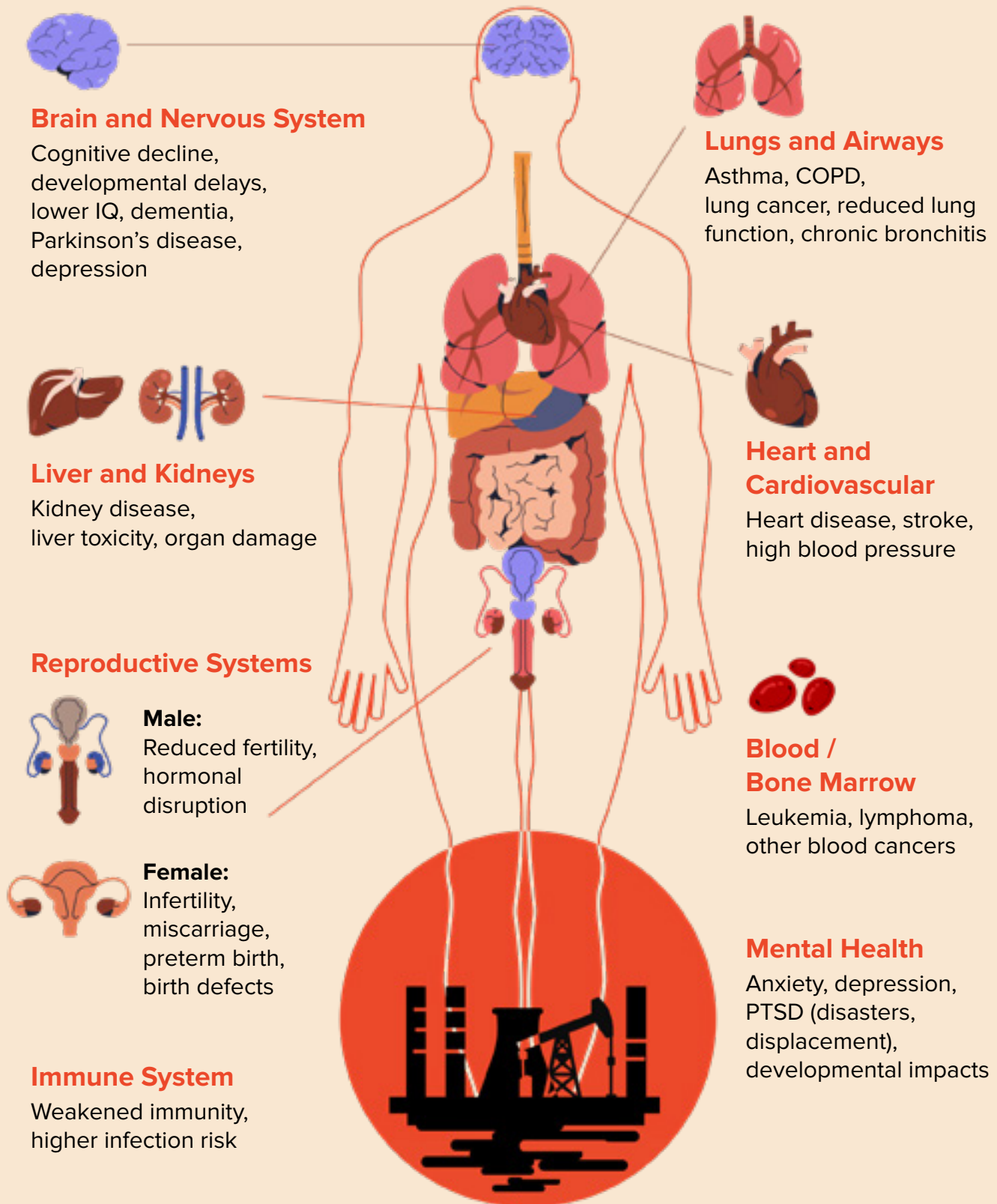
Heavy Metals: Coal contains heavy metals⁵⁰, which are released into the environment when coal is mined or burned. Wastewater generated during oil and gas production contains heavy metals. These heavy toxicants can cross the placental barrier and are associated with adverse neurological and other developmental outcomes⁵¹.

Arsenic (As) ⁵²	Coal mining, burning; oil and gas wastewater	Potent carcinogen linked to skin, lung, and bladder cancers. Chronic exposure can cause cardiovascular disease, diabetes, developmental issues, neurological effects, and reduced cognitive function.
Chromium (Cr) ⁵³	Coal mining, burning; oil and gas wastewater	Linked to lung cancer, kidney and liver damage, and respiratory problems. Skin contact with chromium can lead to ulcers and allergic reactions. Inhaling chromium fumes can result in “metal fume fever”, a flu-like condition. Prenatal chromium exposure may be associated with increased risk of orofacial clefts ⁵⁴ . Coal ash ponds are known to leach hexavalent chromium, a form of chromium that is extremely toxic at very low doses.
Lead (Pb) ⁵⁵	Coal mining, burning; oil and gas wastewater	A neurotoxin that impairs cognitive development in children, linked to reduced IQ and behavioural problems. Chronic exposure can harm the kidneys, cardiovascular system, reproductive health, and contribute to anaemia and hypertension.
Mercury (Hg) ⁵⁶	Coal mining, burning; oil and gas wastewater	A neurotoxin that can cause brain and kidney damage and developmental issues in fetuses and young children. Prenatal exposure may lead to developmental disability, brain damage, and sensory or motor impairments.

Toxicants	Linkages	Health Impacts
Selenium (Se)⁵⁷	Coal mining, burning; oil and gas wastewater	Pollutants released in power plants are linked to respiratory issues, gastrointestinal symptoms, and potential reproductive effects, as well as skin and eye irritation, hair and nail loss, and neurological symptoms such as irritability and fatigue.
Cadmium⁵⁸	Coal mining, burning; coal, oil and gas wastewater	Acute cadmium exposure, through ingestion or inhalation, can cause gastrointestinal distress, respiratory irritation, and at high doses, damage to the kidneys, liver, and nervous system—sometimes leading to organ failure and death. Chronic exposure harms kidney function, disrupts vitamin D metabolism, and can lead to bone disease. Long-term inhalation may cause bronchitis, lung damage, and obstructive lung disease. Cadmium is a known human carcinogen.
Technologically Enhanced Radioactive Materials (TENORMs)⁵⁹ (uranium, thorium and radium)	Coal mining, burning; coal, oil and gas wastewater	Increase the risk of cancer, particularly lung, stomach, esophagus, bone, thyroid, brain, and nervous system cancers, and may cause radiation-related damage to organs and tissues with prolonged exposure ⁶⁰ .
Tropospheric ozone³⁶	Combustion in power plants, vehicles and industrial facilities	Contributes to respiratory problems, particularly among vulnerable populations such as children, the elderly, and individuals with pre-existing lung conditions, and is a key component of urban smog ^{37,38} .
Methane⁶¹	Extraction, processing, and transportation of gas, coal, and oil	High methane levels reduce oxygen in the air, leading to symptoms like headache, nausea, vision and memory issues, and in severe cases, breathing problems, unconsciousness, and death with prolonged exposure⁶². Emerging research shows that methane leaks from fossil fuel operations are more widespread than previously believed and often accompanied by harmful pollutants such as VOCs and NO₂⁶³. One study linked prenatal exposure near a major methane leak to low birth weight⁶⁴.
Novel Entities⁶⁵ (Synthetic chemicals, engineered materials, and modified organisms)	Extraction and use.	Linked to adverse human health outcomes including respiratory illnesses, cancer, and endocrine disruption.

FOSSIL FUEL HARMS ON THE HUMAN BODY

GLOBAL
CLIMATE & HEALTH
ALLIANCE



2.2 Harms by Age and Stage

While exposure to fossil fuel pollutants puts health at risk for people of all ages, there are stages of life when the human body is particularly vulnerable to harm.

2.2.1 Before Birth

The prenatal months are a critical window during which an infant's brain, lungs, heart and other organs are developing. Exposure to fossil fuel pollutants during this time can have a detrimental impact on a person's long term health⁶⁶.

The prenatal months are a critical window during which an infant's brain, lungs, heart and other organs are developing. Exposure to fossil fuel pollutants during this time can have a detrimental impact on a person's long term health.

Prenatal proximity to coal mining is associated with early births and low birth weight as well as with gastrointestinal congenital abnormalities^{67,68}. Similarly, proximity to unconventional oil and gas activities, including fracking and flaring, has been correlated with increased risk of preterm birth, low birth weight, miscarriage and infant death, as well as congenital abnormalities including anencephaly, spina bifida, neural tube defects, orofacial clefts and heart defects^{69–81}.

Health risks associated with exposure to the byproducts of fossil fuel combustion are also concerning. Prenatal exposure to coal smoke, when coal is burned indoors for cooking or heating, may be associated with increased risk of oral clefts as well as with low birth weight^{54,82,83}. Maternal residential proximity to a major roadway, a proxy measure for traffic related air pollution (TRAP) is associated with lower birth weight, smaller gestational size and may increase the risk of cardiometabolic ill-health in later life^{84–87}. Higher in-utero exposure to diesel pollution may impact cognitive

development as measured by test scores in third grade⁸⁸. Prenatal exposure to benzene and other chemicals associated with gasoline and diesel combustion have been found to increase the risk of childhood cancers^{42,89}.

While most recently published research on fossil fuel exposures during pregnancy focuses on birth outcomes and infant health, some studies do explore the health impacts for the pregnant person. Some evidence suggests exposure to coal air pollution may make it more challenging to successfully conceive and may increase the risk of miscarriage, outcomes that can negatively impact a potential parent's physical and mental health^{90,91}. Studies from Denmark and Sweden suggest that exposure to TRAP increases the risk of pre-eclampsia and pregnancy induced hypertension^{32,92}. Some association has been found between residential proximity to unconventional natural gas development during pregnancy and increased risk of poor mental health^{93,94}. Exposure to particulate matter from a coal mine fire in Australia was found to be associated with an increased risk of developing gestational diabetes⁹⁵. Studies have also noted that exposure to endocrine disruptors from fossil fuels may put the long term health of pregnant people at risk⁹⁶.

2.2.2 Childhood

Children are especially vulnerable to health harms caused by fossil fuel pollution. Children breathe more rapidly than adults and inhale more air, and therefore airborne pollutants, relative to their body weight than adults do, and once inhaled, pollutants may be more damaging to children's narrower airways⁹⁷. Children are less able to metabolize many pollutants than adults⁹⁸. In addition to air pollution risks, when fossil fuel pollutants settle on surfaces, young children may ingest toxins due to their being closer to the ground and more likely to engage in hand-to-mouth behaviours. Toxic exposures in childhood, when cells are dividing and a child's brain and organs are developing put

children at increased risk of developing cancer and other illnesses in later life⁹⁹.

Exposure to various fossil fuel activities is associated with childhood cancers, most consistently with leukemia. Studies suggest that children living in close proximity to petroleum facilities, unconventional oil and gas developments, major roads, petrol stations and other sources of fossil fuel benzene, are at an increased risk of developing acute lymphoblastic leukemia and acute myeloid leukemia^{89,100–104}. Children with parents who are occupationally exposed to hydrocarbon solvents or engine exhaust are additionally at risk of lymphomas, epithelial tumors and soft tissue sarcomas^{105,106}.

Exposure to various fossil fuel activities is associated with childhood cancers, most consistently with leukemia.

Fossil fuel pollution is also connected with childhood respiratory illness. Proximity to fossil gas development, to coal fired power plants and to major roads are all associated with increased asthma exacerbations and hospitalizations in children^{107–110}. Children exposed to VOCs during an oil spill exhibited lung function loss up to 5 years after the spill¹¹¹.

Exposure to fossil fuel pollution may hamper neurological development and negatively impact mental health. British children with intellectual disabilities were more likely to live in areas with high levels of TRAP, and exposure to elevated levels of black carbon was found to be associated with slightly lower test scores in elementary school aged children^{112,113}. American children exposed to coal fly ash had higher scores on the Depressive Problems Diagnostic and Statistical Manual of Mental Disorders (DSM)¹¹⁴. A recent review and meta-analysis of PM 2.5 exposure in young children showed significant reductions in IQ by age 9¹¹⁵. This effect must be considered in the context of all of the other neurotoxic exposures faced by children from lead, mercury, arsenic, tobacco smoke, pesticides, perfluoroalkyl substances (PFAS) and other common exposures^{116–119}.

Social inequities may put some children at greater risk than other children. Children from lower-income families or from communities that face discrimination and oppression, may live closer to extraction sites, industrial areas, or busy roads. Limited access to healthcare and poor nutrition in these communities can further exacerbate these effects, as children may not receive adequate medical care or nutrition that might counteract some of the damage from pollutants^{120–122}.

2.2.3 Adolescence



Adolescence is a time of important neurological and physical development, and there is evidence that exposure to stress and environmental contaminants during this time can have lasting negative consequences for health^{123–125}. Research exploring the health risks of fossil fuels for adolescents is sparse, however lack of available research does not indicate lack of risk. In some instances, study design may obscure adolescent focused data, if, for example, adolescents are included in studies that look at health risks for children broadly^{110,126}. There is some evidence that exposure to Polycyclic Aromatic Hydrocarbons (PAHs) may impact the timing of puberty onset^{127–129}.

2.2.4 Adulthood



The vulnerabilities of adulthood are frequently less related to a unique form of physiology and more related to life circumstances. During this stage of life, people may take on jobs or live in places that increase their exposure to fossil fuel pollutants. Notably, it is often young adults who take on the most hazardous, high-exposure jobs in the fossil fuel industry — work that is so physically demanding and harmful that most people cannot continue it for long¹³⁰. Risks to workers and other socially vulnerable groups are outlined in the next section.

2.2.5 Elderhood



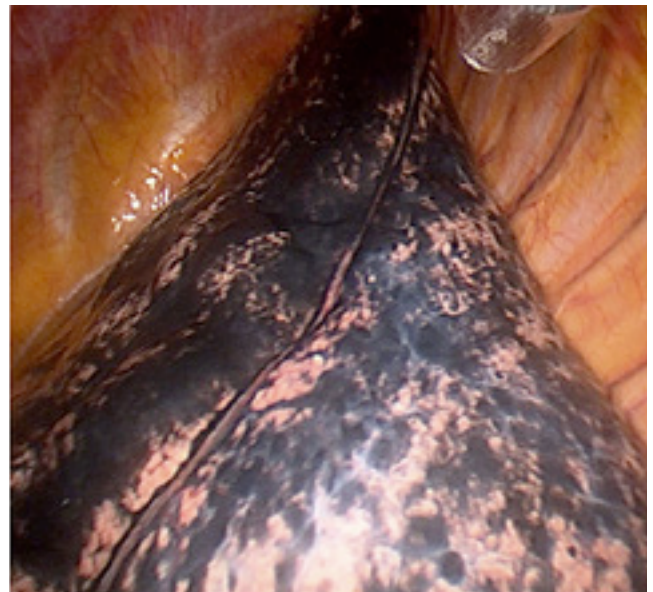
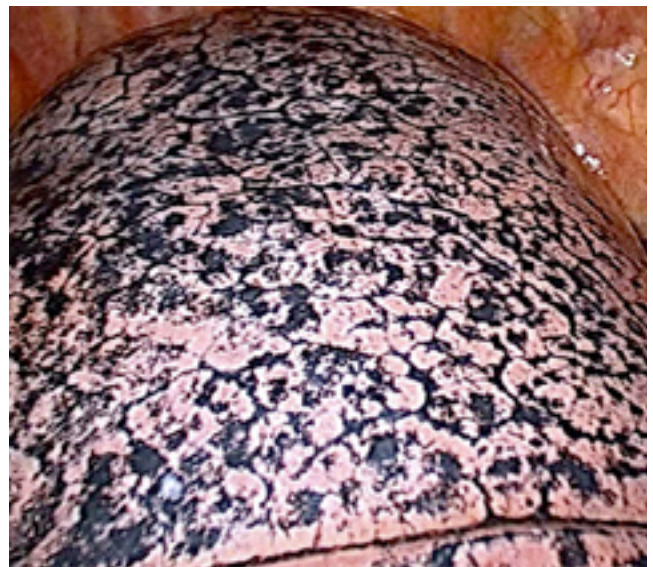
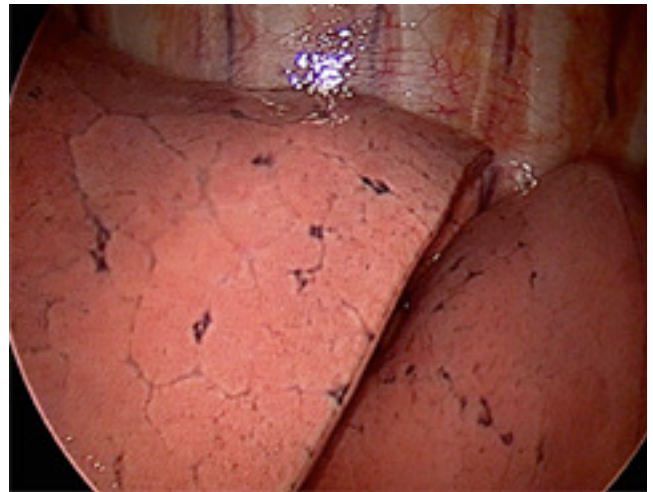
Elders are also vulnerable to fossil fuel pollutants due to intertwined physiological, health, and socioeconomic factors. As people

age, their respiratory and cardiovascular systems become less efficient in their work of providing well oxygenated blood to vital tissues. Cumulative exposures over a lifetime may contribute to additional morbidity^{131,132}. Elderly individuals frequently develop chronic conditions including heart disease, stroke, asthma, and COPD, dementia and metabolic diseases that are exacerbated by air pollution¹³³. For these people, fossil fuel driven air pollution may increase the risk of complications, with one study showing PAHs reduced small airway function in patients with COPD, and another noting an increase in medical visits on days with higher air pollution^{134,135}. Exposure to fossil fuel pollution causes premature death¹³⁶. Another study of older adults in China found that increased exposure to SO₂, mostly from burning coal and oil, was associated with premature mortality¹³⁷.

In addition to premature death, exposure to fossil fuel pollutants over a lifetime increases the risk of developing health conditions that make aging well more difficult. Several studies show exposure to PM_{2.5}, NO₂ and nitrogen oxide (NO) can contribute to cognitive decline and increase the risk of developing dementia^{138–140}. Studies suggest that exposure to PM_{2.5}, NO₂, CO₂ and black carbon, as well as residential road proximity, are also associated with an increased risk of developing dementia and Parkinson's disease^{141–144}.

Several studies show exposure to PM_{2.5}, NO₂ and nitrogen oxide (NO) can contribute to cognitive decline and increase the risk of developing dementia.

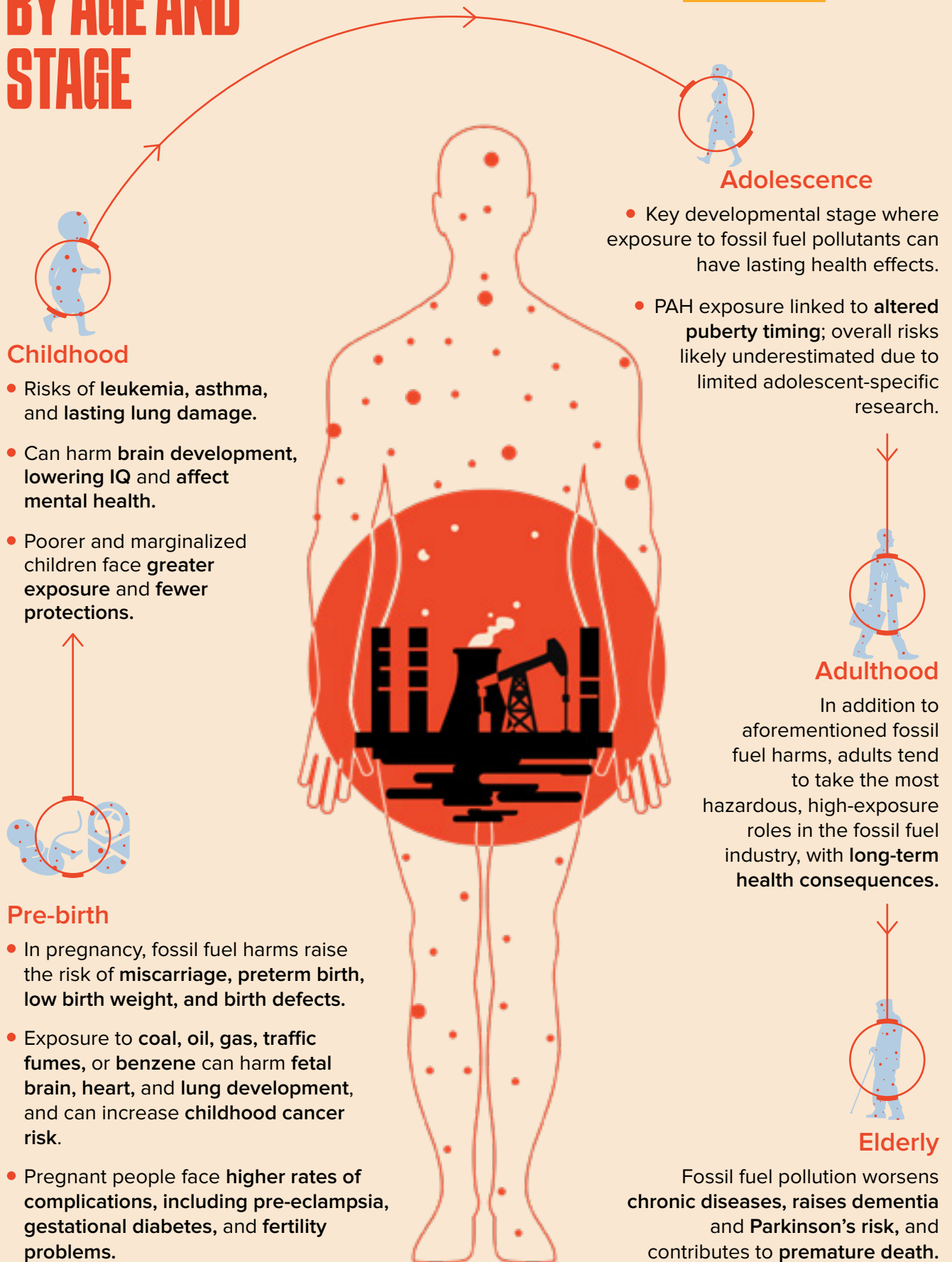
Image shows healthy lungs (top), teenage lungs affected by air pollution (center), and adult smoker's lungs (bottom).



© Lung Care Foundation, India

FOSSIL FUEL HARMS BY AGE AND STAGE

GLOBAL
CLIMATE & HEALTH
ALLIANCE





Dr. Nicholas J. Talley

AC – Chair of the Board,
Doctors for the Environment,
New Castle, Australia

I live in Newcastle, Australia, home to the largest coal exporting port in the world. My family's property with horses is nestled amongst coal mines that feed the port. On the land I can see the worsening health impacts of climate change. More and more excess heat days. Droughts. Bushfires. Floods. All worsening! Not only is the science clear that global warming is worsening from our use of fossil fuels, my family and many others are personally experiencing it.

It has been estimated that combustion of coal and other fossil fuels releasing fine particulate matter, directly results in the premature deaths of over 8 million people a year globally. The coal Australia exports is a major contributor here (over 4% of the world total). According to a research paper in the prestigious journal *Science*, exposure to particulate matter from coal burning power stations results in twice the death rate compared to other sources of particulate matter.

As a physician I see the impact of burning fossil fuels including coal on health. Air pollution near where I live close to coal mining for example is putting my community and many others at risk. Mining, transporting and burning coal releases tiny invisible tasteless particulate matter that we breathe in, is absorbed, and results in inflammation in our bodies leading to increased risks of heart and lung disease, stroke, asthma, diabetes, cancer, damage in utero, impaired neurodevelopment and learning in children, and premature deaths. There is compelling evidence there are spikes in hospital admissions when particular matter (for example, from bushfire smoke) engulfs our region, and frontline doctors and nurses see daily the devastating outcomes of fossil fuel pollution.

Fossil fuels including coal are a serious health hazard for Australians. And fossil fuels are feeding climate change. We know quitting smoking is life-saving. We now know quitting our dependence on and export of coal and other fossil fuels will not only reduce greenhouse gas emissions, it will save Australian lives.

2.3 Communities most likely to be Harmed

In addition to the specific risk posed throughout a person's life, social factors may increase one's likelihood of exposure, and/or vulnerability in the face of exposure. Vulnerabilities are multiple and may be overlapping.

2.3.1 Workers

Working with or in proximity to fossil fuels puts people's health at risk as a result of exposure to fossil fuel products and byproducts, proximity to chemicals used or released through the extraction and processing of fossil fuels, and hazardous work conditions. A community already facing poverty can face pressure to work in hazardous jobs in the fossil fuel industry due to limited work options. These conditions are most prevalent in rural areas.

Workers exposed to fossil fuels face an elevated risk of developing cancer. A systematic review conducted by the International Agency for Research on Cancer found working in the petroleum industry was associated with "an increased risk of mesothelioma, skin melanoma, multiple myeloma, and cancers of the prostate and urinary bladder" and that workers at offshore petroleum sites were also at "an increased risk of lung cancer and leukaemia"¹⁰⁰. Offshore workers exposed to crude oil and benzene also may be at increased risk of developing skin cancer on their hands and forearms¹⁴⁵. Workers in the petrochemical plants may be exposed to high levels of benzene and other health harming pollutants, and a study in Korea found these workers were at an increased risk of developing oral cancers^{146,147}. To reduce freshwater use, the fracking industry often relies on toxic produced water¹⁴⁸—putting workers at risk of skin disorders, chemical burns¹⁴⁹, and long-term harms like endocrine disruption and cancer (see 3.3.2 Unconventional Oil and Gas Extraction - including Fracking, p.25).

Workers exposed to fossil fuels face an elevated risk of developing cancer.

Coal mine workers face significant health risks from workplace exposures. Coal dust causes coal workers' pneumoconiosis or black lung and COPD. Coal miners may also be exposed to crystalline silica dust, which also causes pneumoconiosis and contributes further to cardio-respiratory disease. These lung diseases contribute to impairment, disability, and premature death^{150,151}. Coal miners are also at increased risk of lung and stomach cancer compared with the general population^{152,153}.

Globally, the oil and gas and mining industries are among the most hazardous sectors, with high rates of workplace fatalities¹⁵⁴. Mining activity accounts for approximately 8% of fatal work-related injuries worldwide, making it one of the most hazardous occupations¹⁵⁴. National statistics in the U.S. show that the oil and gas extraction industry has a higher fatality rate than many other sectors¹⁵⁵. For example, in the U.S., oil and gas workers are approximately seven times more likely to die on the job compared to workers in other industries, though in more recent years safety measures have improved¹⁵⁶.

Mining activity accounts for approximately 8% of fatal work-related injuries worldwide, making it one of the most hazardous occupations.

In fossil fuel regions, the rate of road traffic collisions is often higher due to increased motor vehicle activities. For example, one study found that counties in Pennsylvania with high levels of shale gas drilling saw up to 23% more vehicle crashes and over 60% more heavy truck crashes than counties without drilling¹⁵⁷. Heavy machinery, frequent transportation of materials, and the influx of transient workers all contribute to greater traffic congestion, road wear and risk of collisions. Motor vehicle collisions are the leading cause of death in fossil fuel industries, with long hours, demanding work, and inadequate safety measures¹⁵⁸.

According to the Centers for Disease Control and Prevention, vehicle-related incidents accounted for more than a quarter of worker deaths in the oil and gas extraction industry from 2014 to 2019¹⁵⁹.

Long shifts, heat and physically demanding work can cause fatigue, increasing the risk of accidents and long-term health issues^{160,161}. High-pressure environments, job insecurity, and isolation (especially on offshore rigs and remote fly-in job sites) can lead to stress, anxiety, depression, and other mental health problems^{162,163}. Irregular work hours and night shifts disrupt sleep patterns, leading to sleep disorders and related health problems¹⁶⁴.

These hazards extend beyond workers, affecting families and communities. Health problems resulting from workplace risks lead to increased medical expenses, loss of income, and reduced quality of life. The mental and physical toll on workers also affects community stability, leading to broader social issues such as increased healthcare costs, economic strain, substance abuse, domestic violence and social disruption¹⁶⁵. Although many countries have workers' compensation systems, they are often difficult to navigate, provide incomplete compensation, and fail to adequately cover illnesses linked to toxic exposures¹⁶⁶.

Migrant workers in the fossil fuel industry often face heightened vulnerabilities due to their precarious legal status, which can undermine their access to protections against workplace harms. This vulnerability enables employers to exploit regulatory loopholes, particularly regarding occupational health and safety standards^{167,168}. As climate change drives an increase in migration, with many individuals unrecognized as "climate migrants," the number of migrant workers subjected to such legal and workplace precarity is likely to rise, further exacerbating their exposure to occupational risks and limiting their ability to seek justice and compensation^{169,170}.

While they may not be the first group that one considers when thinking about fossil fuel workers, people working to deliver and

distribute fossil fuels, most notably gas station attendants, are also at risk. Studies have found that gas and petrol station attendants showed more signs of oxidative stress, genotoxic damage, and hematological changes than control subjects^{171–173}.

2.3.2 Marginalized Communities

Racially, ethnically, socially, economically, and politically marginalized communities around the world face greater exposure to climate impacts and fossil fuel pollution, resulting in disproportionate health, economic, and social harms^{6,174–176}.

While pollution affects all populations, marginalized groups bear the brunt due to limited access to healthcare, clean technologies, alternative employment, and safe relocation options. Health risks are often under-researched in these communities, and even when studies exist, critical information may be inaccessible—particularly for ethnic minorities facing language barriers. Chronic stress from persistent pollution and socioeconomic hardship further worsens health outcomes^{174–176}. With limited political and social power, these communities are less able to oppose the siting of industrial facilities, landfills, and extractive operations, or to demand health impact assessments. As a result, they experience higher rates of disease, disability, and premature death—fueling a cycle of vulnerability, declining health, and reduced resilience^{177,178}.

While pollution affects all populations, marginalized groups bear the brunt due to limited access to healthcare, clean technologies, alternative employment, and safe relocation options.

This pattern is a global issue, often affecting minority and/ or low-income populations worldwide. In the U.S, fossil fuel facilities¹⁷⁴ like coal plants¹⁷⁵, refineries, and hazardous waste sites are more frequently located near African American, Hispanic, Native American, and low income communities than near

In the U.S., fossil fuel facilities¹⁷⁴ like coal plants¹⁷⁵, refineries, and hazardous waste sites are more frequently located near African American, Hispanic, Native American, and low income communities than near higher income and White communities^{176–178}.

higher income and White communities^{176–178}. In Africa, communities near coal mining and power generation sites face environmental and health challenges, including deforestation, water contamination, and air pollution, which devastate local ecosystems and livelihoods while causing chronic respiratory and other health problems^{179,180}. In India¹⁸¹ and China^{182,183}, poor, and socially marginalized groups often reside in the most polluted urban areas or near industrial zones, facing daily exposure to hazardous air¹⁸⁴ and water pollution. Similarly, in Chile, communities in the area Quintero¹⁸⁵ and Puchuncaví¹⁸⁶ endure toxic emissions from coal plants and refineries, leading to health crises and environmental destruction.

Areas that have been allowed to become extensively polluted, and that are not being remediated by industry or government, have been referred to as “sacrifice zones” — (see Climate Justice Is Essential for Health Equity, p.4). Health impacts in these communities include higher rates of asthma^{187,188}, bronchitis, lung cancer, heart disease, and other respiratory and cardiovascular conditions due to chronic pollution exposure^{189,190}. Emerging research indicates that air pollution also negatively affects mental health and cognitive development, exacerbating educational and social challenges^{191,192}. Marginalized communities experience higher rates of adverse birth outcomes, such as preterm births, low birth weight, and developmental disabilities linked to environmental exposures^{193,194}. Social and psychological factors, such as chronic stress from constant exposure to environmental hazards and socioeconomic challenges, further exacerbate health problems. Additionally, higher poverty and lower levels of health literacy and awareness about pollution risks can hinder protective behaviors and advocacy for cleaner environments.

Residents of Pennsylvania community protest against the health and environmental impacts of fracking.



© Mark Dixon

ON THE FRONTLINES

Health Impacts of Oil Extraction and Production in Bayelsa, Nigeria¹⁹⁵

Bayelsa State is located in the core of the Niger Delta region and is a major center of Nigeria's oil and gas industry, hosting a significant proportion of the country's crude oil reserves and production facilities. Despite its resource wealth, Bayelsa faces substantial environmental and health challenges linked to the intensive oil extraction activities that have taken place over several decades.

The Governor of Bayelsa State commissioned an independent report into the impacts from oil extraction in the region. It revealed that more than 100 million gallons of oil have been spilled since 1950 – equivalent to approximately 1.5 barrels per resident. It found that groundwater samples exceeded WHO safety limits for petroleum hydrocarbons by up to 1 million times.

Prolonged exposure to pollutants such as sulfur dioxide, nitrogen oxides, and heavy metals has been associated with high rates of respiratory disease, skin disorders, cancer, and chronic illnesses. Contaminated water and food sources have contributed to malnutrition and stunted growth in children. Environmental degradation has also been linked to increased mental health challenges among affected communities.

Bayelsa records one of Nigeria's highest infant mortality rates (31 deaths per 1,000 live births), and oil spills across the Niger Delta are estimated to have caused over 16,000 additional neonatal deaths in 2012 alone. Life expectancy in the region is approximately 50 years, compared to Nigeria's national average of 53 years and 80 years in OECD countries; some estimates place it even lower.

Community testimonies reveal the extent of the suffering. Residents of oil-impacted areas recount how oil spills have led to widespread sickness and death, with inadequate relief efforts compounding their plight. In one community, an oil spill in 2018 resulted in severe water shortage in the community, with many children dying due to contaminated water and food. Another incident in 2017 caused skin peeling and burning sensations among residents, who were also unable to fish in their polluted waters.

More information: www.bayelsacommission.org

Provided by:
Nnimmo Bassey,
Executive Director,
HOMEF, Nigeria





Pipelines carrying coal ash slurry from power plants in Ennore, North Chennai, India

 Shweta Narayan

The Fossil Fuel Life Cycle Impacts: Health Harms from Exploration to Closure

The life cycles of coal, oil, and gas—from site preparation to site decommissioning—present risks to the health of families, workers, communities and ecosystems at every stage. Understanding and addressing these risks and impacts is crucial for developing any strategy to protect the environment and public health. It is also crucial for developing regulatory structures, accountability mechanisms, and to inform responsible policies and governmental decision making.



Prudence

Waya-way, Ogies,
South Africa



*Dylan Paul
Center for Environmental Rights*

We have a big problem with this mine for their reckless blasting. When they blast, the air blows our way and we are affected because our children are always sick. If you look inside my fridge, it is full of medicine. I am a single parent with no money to always be taking my children to a doctor.

It is better for these mines to leave because they never consulted us in the first place before they mined and not that we are getting sick they are not helping us. I think it is better that they leave.

3.1 Site Preparation



The exploration and site development phase for coal, oil, and gas often results in environmental destruction, which can have health impacts before extraction even begins. For example, coal mining is a major driver of deforestation, and as trees are cleared to access coal, this may lead to soil erosion, disrupted clean water access, and increases in flooding all of which put health at risk^{196,197}. Dust and other air pollution associated with site development, from increased traffic and site preparation, may also present increased health risks. Researchers noted an increase in hospitalizations for children with asthma during periods of both conventional and unconventional gas drilling¹⁰⁸. Another study found that “the introduction of drilling [for gas]” was associated with increases in low birth weight among infants born to mothers living near drill sites¹⁹⁸.

Site development may displace people from their homes and communities. While involuntary displacement is likely to negatively impact most people’s well-being, it can be especially harmful for Indigenous people that have millennia-long relationships with lands and ecosystems. One recent systematic review re-affirms something Indigenous communities have long highlighted – “land dispossession due to industrial resource development” is associated with negative mental health impacts for Indigenous people¹⁹⁹.

3.2 Coal Extraction



The health risks of coal mining first garnered attention in the mid-1800s when doctors identified coal worker’s pneumoconiosis more commonly known as black lung disease²⁰⁰. Coal miners around the world are still dying from black lung, and mine workers are also at increased risk of other serious respiratory diseases including COPD, silicosis, and lung cancer^{151,152,201–204}. Exposure to coal associated pollutants may also put coal miners

at elevated risk of stomach cancer, DNA damage, rheumatoid arthritis and physical injury^{153,205–209}.

Communities in close proximity to coal mines also face increased health risks. One Australian study found that PM10 air pollution exposure was higher in communities close to coal mines than in non-mining communities and studies on health impacts reflect this increased exposure, with another Australian study finding that increases in regional coal outputs were associated with increased hospitalizations for respiratory and circulatory illness^{210,211}. People exposed to open pit mines in Colombia were found to be more likely to have DNA damage and shortened telomeres than control subjects²¹². Coal seam mining is associated with increased hospitalizations for blood and immune diseases in nearby communities and increased respiratory disease in children^{126,213}. Maternal residential proximity to coal mining during the prenatal period has been associated with negative birth outcomes including low birth weight and gastrointestinal birth defects^{214,215}. Mountaintop removal, a coal mining practice prevalent in the Appalachia and elsewhere significantly alters the landscape, risking water contamination, soil erosion, and reportedly increasing the risk of COPD, heart disease, tooth loss and reductions in health-related quality of life^{216–220}. Coal mining may also release heavy metals like Selenium and other pollutants into the environment, potentially contaminating soil and water in the surrounding area²²¹.

Coal miners around the world are still dying from black lung, and mine workers are also at increased risk of other serious respiratory diseases including chronic obstructive pulmonary disease, silicosis, and lung cancer.

3.3 Oil and Gas Extraction



Oil and gas extraction activities are a significant source of methane emissions, which contribute to global warming and health risks²²². Oil and gas extraction produces air pollution, which among other things, is associated with asthma exacerbations, premature deaths, and health care costs²²³.

Much of the health research on oil and gas extraction has been conducted in wealthy countries, including the U.S, but it should not be assumed that the health implications identified in the current literature exist only in these places. It is possible that the health impacts may be worse in countries or regions where research is more limited, if these places have weaker environmental or health regulations or greater industry capture of regulatory bodies.

3.3.1 Conventional Oil Extraction

There is some evidence to suggest that populations living near oil fields, particularly in low and middle income countries, face health risks as a result of long term environmental contamination²²⁴. Oil industry pollutants have been found in water sources, food and soils around oil sites, however, multi-site research is still limited, highlighting the urgent need for more robust studies.

3.3.2 Unconventional Oil and Gas Extraction – Including Fracking

Unconventional oil and gas extraction includes oil sands extraction, directional drilling and hydraulic fracturing (fracking). These extraction methods and their potential health impacts have been a source of concern in recent decades, especially as the expanding use of these technologies has outpaced the ability to evaluate their potential, and increasingly reported, health impacts. As fracking use expands, health professionals have joined frontline communities in raising the alarm^{225–227}.

Fracking uses a mix of water, chemicals, and sand to break apart rock and release oil or gas²²⁸. Each fracking event uses between 6 to 60 million litres of freshwater, potentially putting water security at risk especially in drought prone regions²²⁹. There are concerns about the volume of water used for fracking, the potentially irredeemable contamination of that water once it has been used, and the growing “water footprint” of the industry^{225,229,230}. Fracking can also destabilize deep rock formations leading to earthquakes where there was previously no seismic activity. This is concerning because buildings in these regions are less likely to be earthquake proof.

North Dakota's Bakken oil fields

Trudy E. Bell
FracTracker Alliance, 2015



ON THE FRONTLINES

Nalleli's Story: Oil Drilling in Los Angeles

When Nalleli Cobo talks about the neighbourhood where she grew up - she will tell you that she liked all her neighbours, except for one.

Like thousands of Angelenos, Nalleli and her family lived within a quarter mile of an oil well. The well in Nalleli's neighbourhood was just 30 feet from her family home. It made the air smell like rotten eggs, even if the windows were closed. As a child, Nalleli constantly worried that someone working at the plant would forget to release the pressure valve, causing an explosion and killing everyone she loved.

When she was nine, Nalleli started getting severe nosebleeds - she slept sitting up to prevent her from choking on blood. Nalleli had headaches and heart palpitations, and also developed asthma. Other members of her family had similar symptoms, and they soon learned that their neighbours were getting sick too. Nalleli and her mother started organizing. They worked with other members of their community to launch a grassroots campaign called "People not Pozos" (pozo means "well" in Spanish), with Nalleli as the spokesperson. Thanks to the group's activism, the oil company was pressured to temporarily stop operations at the well in 2013. When the well stopped operating, Nalleli's nosebleeds stopped and her asthma improved, but her fight was far from over.

Nalleli knew that many other communities in Los Angeles were dangerously close to oil wells, and that Latino, Black and other People of Color were disproportionately affected. To address this, Nalleli co-founded the South Central Youth Leadership Coalition. In 2015, the group sued the city of Los Angeles for a violation of the California Environmental Quality Act and for environmental racism. They won. Since then, the LA City Council has voted to ban oil extraction in the city. Activism by "People not Pozos" forced the the oil well near Nalleli's home to permanently close in 2020, and company executives are now facing criminal charges for environmental and health violations

Some illnesses associated with fossil fuel exposures develop slowly. At 19, Nalleli was diagnosed with stage two reproductive cancer, and her first thoughts were about the signs on the gate of the oil drilling site, warning about carcinogenic chemicals. After several surgeries and years of treatment, thankfully Nalleli is now cancer free. She continues to champion environmental justice and in 2022 Nalleli received the Goldman Environmental Prize in recognition of her efforts.

More information: <https://www.goldmanprize.org/recipient/nalleli-cobo/>



Nalleli Cobo stands in front of the closed AllenCo site

📷 Tamara Leigh
Goldman Environmental Prize

THE WATER TRADE-OFF IN FRACKING

Hydraulic fracturing (fracking) demands vast quantities of water, forcing a trade-off for communities and worker health. When companies use freshwater, they often draw from limited community supplies, straining access to clean drinking water, agriculture, and sanitation—especially in drought-prone or marginalized regions. To reduce freshwater use, the industry sometimes turns to *produced water*—a highly toxic wastewater generated during oil and gas extraction. Produced water can contain heavy metals, radioactive materials TENORMs, hydrocarbons, and chemical additives¹⁴⁸. Workers handling or exposed to it are at risk of serious skin disorders, chemical burns, rashes¹⁴⁹, and potential long-term effects²³¹ from chronic exposure, including endocrine disruption²³² and increased cancer risk. Either choice carries significant environmental or health consequences, highlighting the hidden costs of fossil fuel extraction.

In Clearfield County, Pennsylvania, large water impoundments are used for fracking operations



📷 Ted Auch
FracTracker Alliance, 2021

Most research on unconventional oil and gas extraction focuses on extraction sites where fracking is occurring, however many health studies use proximity to oil and gas wells as the measure of exposure. This can make it challenging to determine which observed health impacts are associated with fracking specifically, and which are associated with factors that accompany the arrival and/or expansion of fossil fuel activities, such as increased traffic and traffic related air pollution, increased noise and light pollution, loss of nature, and increased air pollution.

Several studies suggest that maternal proximity to unconventional oil and gas projects is associated with negative birth outcomes. Babies born to birthing parents who lived closer to wells or close to a higher density of wells seem to be at an increased risk of a low birth weight and of birth defects including neural tube defects, anencephaly, spina bifida and heart defects^{233–237}. Children whose parents within 2km of at least one fracking well during the “perinatal window (preconception to birth)”, had more than twice the odds of developing acute lymphoblastic leukemia in childhood, compared with children whose parents did not live near

Babies born to birthing parents who lived closer to wells or close to a higher density of wells seem to be at an increased risk of a low birth weight and of birth defects including neural tube defects, anencephaly, spina bifida and heart defects.

a well when they were in utero¹⁰¹. One study in Pennsylvania cross-referenced maternal residence, community water source location, and shale gas fracking site location, and found an association between fracking related water quality changes and increased rates of preterm birth and low birth weight²³⁸. A study in Texas found that periods of increased drilling and production activity at unconventional oil and gas sites were associated with an increased number of preterm births⁷⁶.

Unconventional oil and gas extraction are also associated with respiratory and cardiovascular health impacts. One study in Pennsylvania found that all phases of unconventional gas were associated with asthma exacerbations and found that pad preparation in particular was associated with hospitalization for asthma exacerbation²³⁹. Other research in Pennsylvania found that in zip codes with unconventional oil and gas activity, there were more hospitalizations of older adults for cardiovascular diseases when compared with zip codes in a neighbouring state without oil and gas, and that patients with acute myocardial infarction and heart failure were more likely to be hospitalized if they were exposed to unconventional oil and gas activity or increased density of oil and gas activity^{240–242}.

Residential proximity to unconventional oil and gas may also negatively impact sleep and mental health. People living near unconventional oil and gas sites often report disturbed sleep and other impacts, including stress, that are related to industry noise^{243,244}. Some studies suggest an association between proximity to unconventional oil and gas and increased rates of anxiety and depression particularly among adolescent girls and pregnant people^{93,94,245}.

Water contamination – through spills, waste discharge, and underground chemical migration – has been suggested as a primary mechanism for the health impacts of unconventional oil and gas²²⁵. Water sampling near extraction sites has identified fracking chemicals in surface and groundwater, some of which are endocrine disruptors^{246–248}.

Oil sands extraction, where oil is mixed with sand and clay, and must be separated in order to be used, is another form of unconventional fossil fuel extraction that has raised the alarm of frontline communities and health professionals. Residents living near a large oil sands extraction site in Alberta, Canada have reported suffering from headaches, fainting, nasal and throat congestion, and health professionals noted higher than expected rates of several cancers in a small nearby Indigenous community^{249,250}.

In Trempealeau County, Wisconsin, sand mines supply quartz sand used in fracking.



© Ted Auch, FracTracker Alliance, 2024.

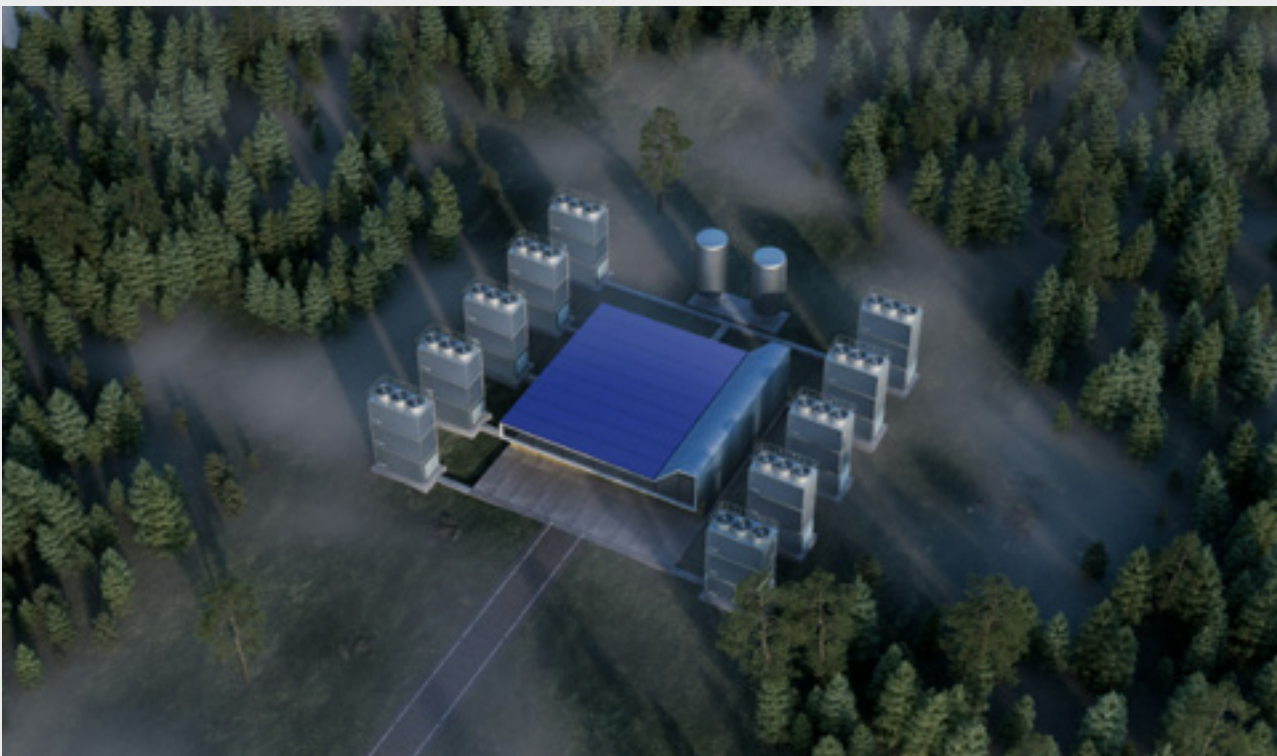
CARBON CAPTURE AND STORAGE – DANGEROUS DISTRACTION

Carbon capture and storage (CCS) is often promoted as a solution for reducing CO₂ emissions in “hard to abate” sectors. While the COP28 cover decision emphasized its role in energy transitions²⁵¹, IPCC analysis shows that CCS could contribute only about 2% of required emissions reductions by 2030 and 6% by 2050⁵. By the end of 2023, no CCS project had met its CO₂ capture targets. Among 200 IPCC mitigation scenarios consistent with limiting warming to 1.5°C, none allow continued fossil fuel use at current levels—let alone expansion—through CCS alone⁵. Despite public claims about its promise, industry documents reveal internal acknowledgment of CCS’s limitations²⁵².

Relying on CCS in net-zero plans allows fossil fuel use, and its associated health harms from air pollution and extraction, to persist. CCS also consumes significant energy and materials, meaning fossil-powered CCS can actually increase both greenhouse gas emissions and air pollution²⁵³. The process poses additional risks across the CO₂ capture, transport, and storage chain. Amine-based solvents release toxic ammonia near capture sites²⁵⁴, and high concentrations of CO₂ can cause asphyxiation, circulatory failure and death²⁵⁵. Pipelines transporting compressed CO₂ create so-called “kill zones,” as seen in a 2020 leak in Satartia, Mississippi, which caused vehicles to stall and led to hospitalizations from dizziness and nausea²⁵⁶. These risks add to the serious technical and economic challenges facing CCS.

In another irony of the fossil fuel era, CCS is being rolled out in fracking zones. Fracking causes earthquakes, and earthquakes increase the risk of breaches in underground storage. Physics drives the gas to seek an escape into the atmosphere. Faults, cracks, drilled wells and fracking make underground storage dangerous²⁵⁷ through these escape routes.

Commercial Direct Air Capture facility, Alberta, Canada



3.3.3 Disasters at Extraction Sites

Coal mine fires, oil spills, and other acute disasters at extraction sites have health impacts for workers, for nearby communities and for those who assist with clean up efforts. A review of fatal incidents at US oil and gas extraction sites found that 14% of worker deaths within the study period were caused by explosions¹⁵⁵.

In 2014, the Hazelwood coal mine fire was associated with an increase in cardiovascular deaths in the six months after the fire, and increased emergency room visits for cardiovascular and respiratory disease and increased hospitalizations for asthma and COPD in the years following the fire^{258–260}.

In 2010, the Deepwater Horizon oil drilling rig exploded, killing 11 people and causing an estimated 4.9 million barrels of oil to spill into the Gulf of Mexico. The disaster exposed coastal communities to elevated levels of PM2.5 and benzene, and had devastating impacts for marine animals and ecosystems^{261–263}. Immediately following the spill, oil exposed clean up workers reported coughing, headaches, rashes, and stomach issues among other symptoms. In the years following, oil exposed clean up workers were at greater risk of developed chronic respiratory conditions including asthma and COPD, cardiovascular conditions including hypertension and coronary heart disease, and dermal conditions^{264–267}.

There is some evidence that exposure to the chemical dispersants used in spill clean up may have further increased the risks of developing respiratory and cardiovascular conditions, and of cellular changes “toward carcinogenesis”^{265,266,268}.

A blowout in the Oil India Ltd facility in Assam in 2020 led to a fire which came under control after nearly five months²⁶⁹. There was a serious impact on local communities including contamination of their soil, water and agricultural land leading to long term health consequences such as breathing difficulties, nausea, noise-induced headaches and chronic anxiety and palpitations²⁷⁰.

3.3.4 Other Impacts of Extraction

All fossil fuel extraction activities may contribute to elevations in local noise pollution from blasting and drilling²⁷¹. Fossil fuel extraction often leads to an increase in the volume of local traffic, and with this an increase in traffic related air pollution, the potential for accidents and injuries of workers and residents in the vicinity of mining and drilling operations^{157,160}.

Oil exposed clean up workers were at greater risk of developing chronic respiratory conditions including asthma and COPD, cardiovascular conditions including hypertension and coronary heart disease, and dermal conditions.

Workers clean up the oil spill along Chennai's coast in 2017

© Shailendra Yashwant



AROUND THE WORLD

Jharia Coal Seam Fires, India (1916-present)

The Jharia coalfields in Jharkhand, India, have been burning underground for over a century, creating one of the world's longest-running coal seam fires. Since 1916, these fires have released a toxic mix of gases, including carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxide, coal dust, and particulate matter, leading to ongoing air pollution and posing significant health risks to the local population. The emissions from the fires have been linked to respiratory diseases such as asthma and chronic bronchitis, and life threatening conditions including strokes and pulmonary heart disease²⁷².

Beyond health impacts, the continuous burning has caused widespread environmental degradation, including land subsidence, destruction of vegetation, and the displacement of entire communities. Many areas in Jharia have become virtually uninhabitable due to these ongoing fires²⁷³. Despite efforts by the Indian government to mitigate the situation, the total area affected by these fires has continued to increase, with studies indicating a further expansion through 2019^{274,275}.

This century-long environmental disaster not only underscores the severe consequences of uncontrolled coal extraction but also highlights the urgent need for effective interventions to protect both human health and the environment.

In Jharia, India, children are exposed to smoke from underground coal fires.



📷 Amirtharaj Stephen

3.4 Processing and Refining



Processing and refining coal, oil and gas pose environmental and health risks. A review of Hazardous Air Pollutants (HAP) emitted throughout the various initial stages of oil and gas production found that 1-3 butadiene, benzene, cumene, formaldehyde, hydrogen sulfide, mercury, methanol, styrene, toluene, xylenes, were released during the processing and production phase²⁷⁶ – all of these chemicals have been found in studies to have significant health impacts. Stack or vent emissions are often identified as the most significant sources of emissions in fossil fuel processing plants. However, fugitive emissions²⁷⁷ from the storage tanks and yards, cooling tanks, pipe connectors, valves, equipment leaks, flanges, pumps, compressors, pressure release devices etc. can violate the ambient air quality standards and even exceed the stack emissions^{278,279}. Pollution control agencies often do not monitor fugitive emissions.

3.4.1 Coal Processing and Coke Production

Some coal is heated to very high temperatures in an airless kiln, resulting in porous high carbon fuel called “coke”. Coke produces less smoke when burned than raw coal, and while this may make it slightly less harmful at the point-of-use, coke production is associated with health impacts for workers and the surrounding community. Coke oven workers are at an increased risk of lung cancer and possibly kidney cancer^{280,281}. Genetic abnormalities associated with poor health outcomes have been found among coke plant workers: workers in Slovakia were found to have higher rates of chromosomal abnormalities than control subjects, and workers in Egypt were more likely to have oxidative DNA damage than control subjects^{282,283}. Studies measuring the presence of PAHs and metals in the urine of coke oven workers, found that elevated levels of copper, zinc and 4-hydroxyphenanthrene were associated with increased risk of

diabetes^{284,285}. On a hopeful note, the closure of a coking plant in the US was found to be associated with “an immediate drop in cardiovascular emergency room visits” as well as a reduction in cardiovascular hospitalizations over time²⁸⁶.

3.4.2 Oil Refining

Petroleum refineries put the health of workers & nearby communities at risk. A 2021 systematic review found that working in the petroleum industry was associated with an increased risk of some cancers including “mesothelioma, skin melanoma, multiple myeloma, and cancers of the prostate, and bladder” as well as lung cancer and leukemia for offshore workers²⁸⁷. This same review suggested that living near petroleum facilities was associated with increased risk of childhood leukemia²⁸⁷.

In Finland, oil refinery workers were found to be at increased risk of kidney cancer, and in Iran, petroleum refinery workers who had been exposed to organic solvents were at increased risk of developing metabolic syndrome^{288,289}. People living, working or studying close to refineries are also at risk. Children attending a school near a refinery in Saudi Arabia were found to have higher blood pressure and higher rates of prehypertension than those at schools that were farther from the refineries²⁹⁰. A cross-sectional study in Montreal showed that children exposed to higher levels of SO₂ from a nearby refinery had more poorly controlled asthma²⁸. In addition, populations in the US living closer to oil refineries were found to have higher prevalence of coronary heart disease, compared with those living farther away²⁹¹. It is likely that some of the health impacts are due to pollutants, including sulphur oxides, nitrous oxides and heavy metals released by refineries²⁹².

In Finland, oil refinery workers were found to be at increased risk of kidney cancer, and in Iran, petroleum refinery workers who had been exposed to organic solvents were at increased risk of developing metabolic syndrome.

AROUND THE WORLD

Cancer Alley, Louisiana, USA^{293,294}

An 85-mile stretch along the Mississippi River is home to numerous petrochemical plants and oil refineries. The area has been nicknamed “Cancer Alley” due to the high incidence of cancer. The residents also face elevated rates and risks of maternal, reproductive, and newborn health harms, and respiratory ailments. These harms are disproportionately borne by the area’s Black residents in a situation so egregious that the UN Environment Programme chastised Louisiana state regulators in a public letter, noting that “the Departments’ actions or inactions have resulted and continue to result in disparate adverse impacts on Black residents” of the area, as part of an ongoing investigation into civil rights complaints filed by local citizens’ groups and others^{295,296}.

In Louisiana’s ‘Cancer Alley,’ refineries are located near homes and schools.



📷 Ted Auch
FracTracker Alliance, 2024

3.5 Transportation of Fossil Fuels



Transporting fossil fuels—whether by pipelines, trucks, or ships—presents environmental and health risks. These risks are present during routine activities and are magnified when transportation related disasters, like spills and explosions, occur. Explosions may cause injury or death. Spills and leaks may release harmful pollutants including VOCs into the air and can also impact marine²⁹⁷, freshwater²⁹⁸, and land ecosystems²⁹⁹. Similar risks exist during fossil fuel storage^{300,301}.

3.5.1 By Pipeline

Pipelines that transport oil and gas span tens of thousands of kilometers, endangering the health of people, communities, ecosystems and communities along their routes. Construction

can lead to community displacement, habitat destruction, farmland disruption and drinking water contamination^{302–304}. Once pipelines are operational, leaks and spills occur somewhat regularly — in the US alone 2,595 gas incidents were reported between 2010 to 2021 — akin to a gas leak every 40 hours³⁰⁵. These leaks can result in deadly explosions and threaten food production and water security particularly where pipelines intersect with aquifers³⁰².

Once pipelines are operational, leaks and spills occur somewhat regularly — in the US alone 2,595 gas incidents were reported between 2010 to 2021 — akin to a gas leak every 40 hours.

In North America, Indigenous communities have frequently and stalwartly opposed pipeline construction on their territories, citing the threats to the land, water, ecosystems, and people as a reason for this opposition, and flagging their internationally recognized right to Free, Prior and Informed Consent (FPIC) for projects on their lands³⁰⁶. In response to this opposition, land defenders have often faced harassment, intimidation, and violence from state governments³⁰³.

3.5.2 By Rail

Historically, trains were the primary means of fossil fuel transportation, and where railways are prevalent coal and oil are still transported by train. Routine transport of coal by train can lead to increased PM2.5 exposure for people and communities along the rail routes, increasing the risk of PM2.5 related health impacts³¹¹. In 2013, the derailment and explosion of a train carrying crude oil killed 47 people in Lac-Mégantic, Quebec, an event which caused physical destruction and led to an increase in psychological distress (including increases in anxiety disorders and depressive episodes)³¹². Communities along rail routes are at an increased risk of similar disasters³¹³.

3.5.3 By Ship

Coal, oil and gas are frequently transported across oceans by tankers. During routine activities these ships may leak small amounts of oil in an ongoing way, and in more dramatic instances, can spill large volumes of oil, which can have devastating consequences for the health of marine ecosystems and coastal communities^{314–316}. Following the Hebei Spirit oil spill in 2007, when a collision that punctured oil tanks on an anchored crude carrier caused over 10,000 tonnes of oil to spill into a port area, children in high exposure coastal areas and those who were exposed to spill-related VOCs were observed to have increased asthma symptoms and a decline in lung function respectively^{111,317}. As with the Deepwater Horizon spill, clean up workers were found to be at a greater risk of negative health consequences – one study

found an association between longer time spent cleaning up and increases in the risk of developing thyroid cancer nine years later³¹⁸.

AROUND THE WORLD

San Bruno Pipeline Explosion, California, U.S. (2010)

A gas pipeline explosion in a suburban neighbourhood caused an explosion on the scale of a magnitude 1.1 earthquake and a massive fire, killing eight people, injuring dozens, and destroying 38 homes. The explosion highlighted the risks associated with ageing infrastructure and the potential for catastrophic failures in densely populated areas. The utility responsible, Pacific Gas & Electric (PG&E), was found guilty on six felony charges in connection with the event²⁶⁹. These charges seem to have been of little consequence to PG&E – in 2018, after their poorly maintained transmission lines caused the Camp Fire in Northern California, it was found that the company had continued to violate safety regulations and to falsify records in the years following the 2010 explosion^{307–310}.

Burned Home Debris, San Bruno Gas Line Explosion 2010



© Thomas Hawk

AROUND THE WORLD

Exxon Valdez Oil Spill, Prince William Sound, Alaska, (1989)³¹⁹

The Exxon Valdez oil tanker spilled around 11 million gallons of crude oil, affecting 1,300 miles of coastline. It resulted in the death of hundreds of thousands of seabirds, thousands of sea otters, and countless fish and invertebrates. The spill had long-term effects on the ecosystem, with some species and habitats still not fully recovered decades later. The Exxon Valdez oil spill jeopardized the long-term survival of resource-dependent fishing communities and Alaska Native villages that relied on commercial fishing and subsistence harvests, leaving a legacy of economic, cultural, social, and psychological impacts.

<https://www.arlis.org/docs/vol1/B/243478793.pdf>

San Juanico Gas Explosions, Mexico (1984)

A series of explosions at a liquefied petroleum gas (LPG) storage and distribution facility caused one of the deadliest industrial accidents in history. The explosions killed over 500 people and injured thousands. The disaster resulted in extensive environmental damage, including air and soil contamination, and had long-lasting emotional trauma on the surrounding population.

Wreckage from the Norfolk Southern train derailment in East Palestine, Ohio, after the burning of vinyl chloride tank cars.



 Ted Auch, FracTracker Alliance, 2023

3.6 Combustion and Use

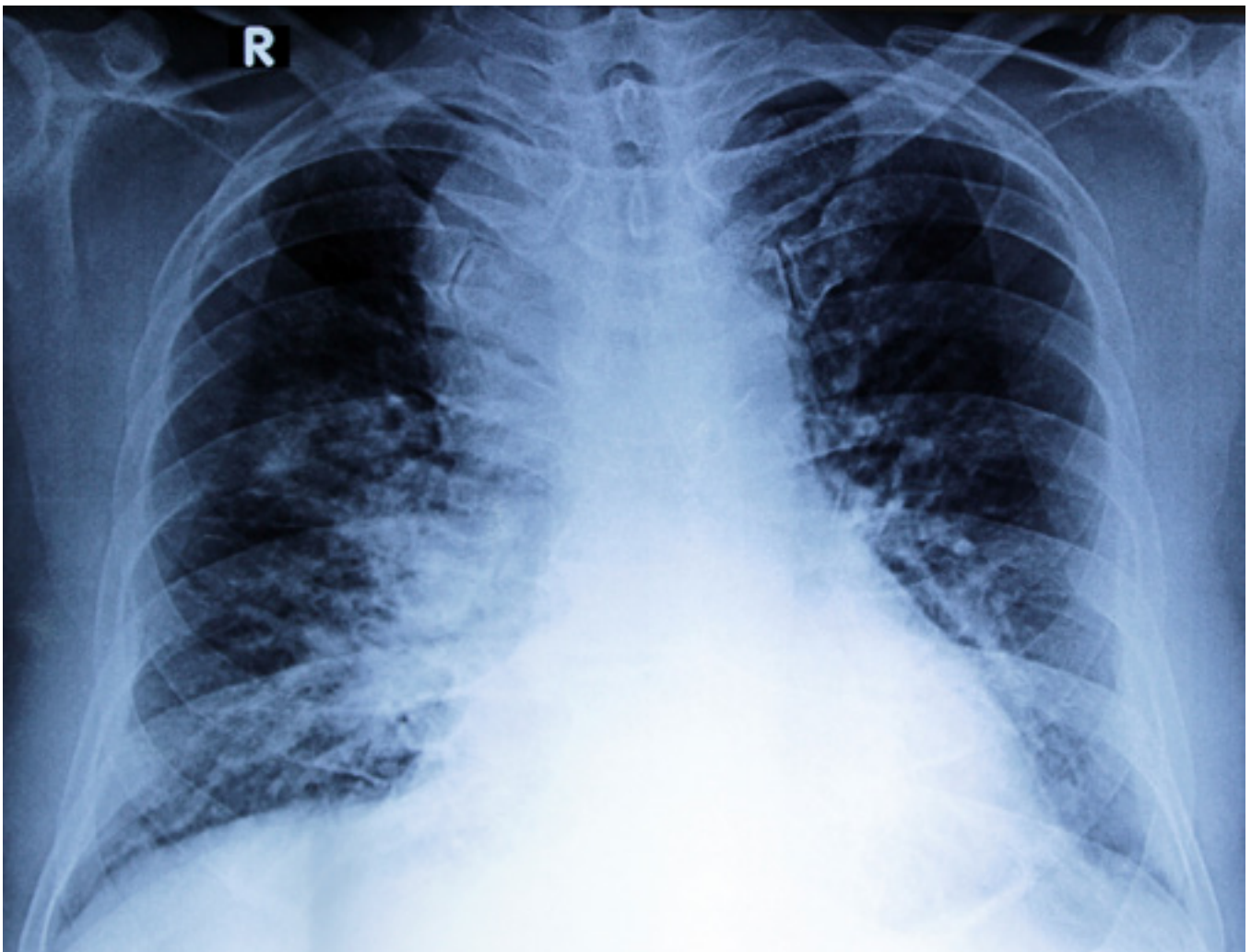


The combustion of oil, gas, and coal to produce electricity, fuel vehicles, heat buildings and power human activity is a major contributor to air pollution globally. A 2016 report by the IEA estimates that fossil fuel combustion releases the majority of health harming air pollutants: “85% of particulate matter and almost all of the sulfur oxides and nitrogen oxides”³²⁰.

The WHO has long raised the alarm about the health risks of air pollution exposure and evidence of the negative health impacts of all-cause air pollution is robust. Exposure to higher levels of air pollution has been found to increase a person’s risk of dying

from lung cancer, COPD, cardiovascular illness and stroke, and has been associated with an increased risk of type 2 diabetes, developmental delays and other concerning outcomes^{321,322}. The International Agency for Research on Cancer has classified air pollution, particularly PM_{2.5}, as a leading cause of cancer¹⁸³. Exposure to higher levels of PM_{2.5} seems to be associated with an increased risk of developing Parkinson’s disease, Alzheimer’s disease and related dementias³²³. Increased exposure to PM_{2.5}, NO₂ and SO₂, pollutants that are strongly associated with fossil fuel combustion, has also been associated with an increased risk of chronic kidney disease³²⁴.

X-ray showing lungs damaged by prolonged exposure to air pollution.





Dr. Yasmin Mahfouz

Paediatrician,
Evelina London Children's Hospital,
London, England

I am a Paediatrician working in the National Health Service (NHS) in London, with a focus on air quality and its impact on children's health. My research on air quality around schools in England has been presented at international conferences worldwide. Through my work with a specialised Paediatric Respiratory team in inner London, I became deeply concerned by the number of children admitted to high dependency and intensive care units due to severe asthma and respiratory exacerbations, often triggered by poor air quality despite optimal medical management.

Research has shown that children are especially vulnerable to the harmful effects of fossil fuel emissions and the poor air quality they create. With their less developed immune systems and rapidly growing respiratory tissues, children are more susceptible to damage from these pollutants. Higher exposure to fossil fuel pollution leads to increased rates of allergies, asthma attacks, severe respiratory illnesses, pneumonia, impaired growth, and cognitive delays. These impacts are not just theoretical; they are seen every day in paediatric clinics, on brain MRIs, and in studies tracking biological pathways. Even unborn children suffer, with pregnant women exposed to pollution experiencing intrauterine growth restrictions and changes to the placental network.

For children living in polluted areas, the consequences are severe: more frequent hospital visits, more time in Accident & Emergency (A&E), and less time in school or simply enjoying childhood. It's in the air we breathe, every minute, and yet many families remain unaware of the harmful exposure and long-term effects their children face.

Shockingly, 86% of new schools set to open in England will exceed all three WHO air quality targets, with no UK legislation in place to reduce exposure at these critical sites. This is a public health emergency that demands urgent action. We need compulsory air quality monitoring and alarm systems when pollutants exceed safe levels. We must legislate to fund and enforce modifications to public buildings and schools to protect children's health and development.

This issue impacts every aspect of our lives, and all public agencies must be involved in creating meaningful policy change. The threat is immediate and often invisible, and it's time for us to confront it head-on for the sake of our children and their future.

3.6.1 Producing Electricity

Burning coal, oil and gas for electricity, at large power plants or on a smaller scale with a generator, creates air pollution that can be harmful to health.

3.6.1.1 Coal Fired Power Plants

Although the share of electricity generated by burning coal has decreased from ~60% in 1900 to 35% in 2024, increases in total energy demand mean that coal combustion for energy production is the highest it has ever been^{325–327}. This is concerning because coal combustion emits more particulate matter, pollutants and heavy metals per kilowatt hour than do other fossil fuels, resulting in increased health risks per unit of electricity³²⁸.

Health risks associated with exposure to pollution from coal fired power plants (CFPPs) include respiratory illness (including lung cancer and asthma), increased cardiovascular disease (including heart attacks and strokes), reduced neurological health, increased premature mortality and higher infant mortality^{329–332}. One US study estimates that 460,000 deaths between 1999–2020 can be attributed to coal PM_{2.5} and this same study suggests that coal PM_{2.5} carries twice the mortality risk of PM_{2.5} overall³³³. A modelling study focused on South East Asia estimated that if all existing and planned CFPPs are allowed to be operational, pollution from them will contribute to between 20,000 and 70,000 excess deaths in the region per year by 2030³³⁴.

Systematic reviews exploring the impact of CFPP emissions on children's health found associations with negative birth outcomes including lower birth weight, smaller head circumference, and premature birth as well as "adverse effects on pediatric neurodevelopment... and pediatric respiratory morbidity"^{335,336}. Studies in India found an association between the number of CFPPs in an area and an increased risk of anemia in young children (337).

Some of the most compelling evidence about the health risks of CFPPs comes from studies showing health improvements after a CFPP closes. After three CFPP closures Chicago, asthma related emergency department visits fell among young children (0–4) who lived near CFPPs, while there was no such change for children who lived farther away¹⁰⁹. In Tongliang, China, a cohort of children born after a local CFPP closure had larger head circumferences, lower levels of DNA showing signs of alteration by PAHs in their cord blood, and better overall neurocognitive development than the cohort of children born while the plant was still operational^{338,339}. Studies in California evaluating the combined closure of coal fire and oil power plants found plant closure to be associated with an increase in fertility and a reduction in preterm births in nearby communities^{340,70}.

3.6.1.2 Oil and Gas Power Plants

Since the 1960s, oil and gas have increasingly been burned to generate electricity³²⁷. While research on the health impacts of oil and gas power plants seems to be somewhat limited, a report from the Health and Environmental Alliance estimates that gas plant emissions cause 2,800 premature deaths in Europe as well as ~15,000 cases of respiratory illness including lung cancer, COPD, and childhood asthma, and incurring health and productivity costs in excess of 8.7 billion euros (US\$9.11 million USD)³⁴¹.

3.6.1.3 Fossil Fuel Powered Household and Single-building Generators

Air pollution from household and single-building generators poses health risks, particularly in regions with unreliable electricity grids. These generators burn diesel, gasoline, or kerosene, emitting fine particulate matter (PM_{2.5}), carbon monoxide (CO), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). Indoor and outdoor exposure to these pollutants increases the risk of respiratory diseases, cardiovascular conditions, and neurological damage, with children, the elderly, and those with preexisting conditions being most vulnerable^{342,343}.

Coal Fired Power Plant

Testimonial



Sandra Cortés Arancibia

Associate Professor,
UC Chile School of Public Health,
Santiago Chile

I consider myself a protector of nature, since I can remember, that is why I found it very rewarding to study plants, insects, and other animals and that is why I also understood early on that our lives depend on many other living beings.

When I visited the coal-affected communities that I have studied for the first time, I was very struck by their loneliness, the lack of green areas, of safe spaces where children could play. I also found it striking that in these places the color is lost, they turn gray, possibly due to the accumulation of particles, the permanent transit of trucks. On several occasions I have noticed the scarce presence of birds. It seems that in these places other living beings prefer to leave, but when the air improves, or the wind blows, they return.

In Chile there are 28 coal-fired thermoelectric plants, of which 3 were already retired in 2020, in compliance with agreements with the Ministry of Energy, and its Plan for the Retirement and/or

Reconversion of Coal units. With this plan, it is expected to reach total closure by 2040. While this occurs, it is important to account for the damage to both the environment and people's health for a long period of time, since several of these thermoelectric plants will be closed. installed in the late 60s throughout the country. Exposure to pollutants associated with the burning of fossil fuels in the communities of northern Chile was demonstrated in our study carried out in 2019 for the Sustainable Chile Foundation, where we analyzed a time series of hospital discharges and deaths among the years 2010-2016. These indicators were obtained from public databases collected and validated by the Ministry of Health. In our design, we consider urban areas that are distinguished from others by having coal-fired thermoelectric plants, with known data on Particulate Matter emissions. In our analyses we were able to show that the risk of dying from any cause in the commune of Tocopilla is 22% higher than expected in Chile. Furthermore, people from Tocopilla have a 2.7 times higher risk of mortality from malignant tumors of the trachea, bronchi and lung, when compared to Chile. In the case of Huasco, another commune in the area that has coal-fired thermoelectric plants, its inhabitants have a 70% higher risk of dying from cardiovascular disease compared to the country and the region. Cardiovascular diseases are also part of the consequences of long-term exposure of the people who live in this commune, their occurrence being 4 times higher when compared to Chile and the Antofagasta region. These results represent an alert that we must heed, making it urgent to cut the exposure to emissions from this type of thermoelectric plants, through the replacement of coal with other cleaner fuels for the production of electricity. From international studies we already know that these types of exposures also affect the optimal development of our children. We also already know that there are clean and safe energies, which contribute to improving the respiratory and cardiovascular health of these communities.

In these communities we also face other challenges, it is not only environmental deterioration or their social conditions, we also know that they are more vulnerable to the various changes associated with the climate. It is urgent not only to reduce their vulnerability, but also to prepare them for the challenges associated with their adaptation to these changes, especially by strengthening health teams and carrying out public and private efforts with local authorities and the community.

3.7 Fueling Transportation

Traffic related air pollution (TRAP) describes all pollution created by motor vehicles, a significant proportion of which comes from fossil fuel combustion. TRAP exposure, which is frequently estimated using air pollution modelling or residential proximity to major roads, is associated with myriad negative health outcomes including increased risk of death from ischemic heart disease, lung cancer, and all cause mortality^{344,345}. Exposure to TRAP during pregnancy is associated with an increased risk of low birthweight and small size for gestational age for infants, with an increased incidence of markers of cardiometabolic risk in childhood and with an increased risk of hypertensive disorders for pregnant people^{85,86,92,346}. Children who are exposed to TRAP are at an increased risk of developing asthma and atopic eczema, and of reduced lung function and altered brain connectivity^{31,347–350}. TRAP exposure has also been associated with increases in asthma related pediatric emergency department visits¹⁰⁷. Prenatal and childhood exposure to high traffic density, and to traffic-associated NO₂ and benzene may be associated with an increased risk of childhood leukemia^{89,102,105}.

Exposure to traffic pollution poses health risks for adults as well. A UK study found



that exposure to higher levels of NO₂ from vehicle emissions was associated with increased risk of heart failure³⁵¹. Studies in China and Taiwan found that residential or activity based proximity to many busy roads was associated with an increased risk of developing COPD^{352,353}. Studies in the US and China suggest that increased exposure to traffic related CO and PM_{2.5} is associated with an increased risk of developing Parkinson's disease^{142,354,355}. Residential road proximity may also be associated with an increased risk of developing type 2 diabetes³⁵⁶. And while exercise is usually beneficial for health, a 2019 meta-analysis suggests that exercising in places with high traffic pollution may pose more risks than benefits³⁵⁷.

Some transportation focused research has focused specifically on exposure to diesel related pollution. Diesel exposure in the prenatal and childhood period is associated with increased risk of preterm birth and increased aeroallergen sensitization in early childhood^{358,359}. Time limited exposure to diesel exhaust while travelling on diesel powered trains was associated with reduced lung function and altered heart rate³⁶⁰. Workers whose work exposed them to elevated levels of diesel exhaust seem to be at greater risk of developing colorectal cancer and dying from lung cancer^{361,362}.

Communities living near busy roads in Ennore, North Chennai, India are exposed to traffic-related air pollution.



© Adhil
North Chennai, India

ON THE FRONTLINES

Rosamund's Story: Deadly Traffic Pollution in London

Rosamund Adoo-Kissi-Debrah's eldest daughter Ella Roberta was a creative, energetic and happy child who loved football, biking, swimming, singing and dancing. A few months shy of her seventh birthday, Ella developed a persistent cough, which was eventually diagnosed as asthma. Ella's asthma caused severe coughing fits and coughing syncope, a condition that caused her to lose consciousness from coughing. Rosamund had to learn how to resuscitate her daughter so that Ella would make it to hospital alive, and her younger siblings had to learn what the warning signs were, when to call for help. After her diagnosis, Ella spent the next two years in and out of hospital, surviving nearly thirty emergency hospital admissions and five comas. Ella had her final, fatal asthma attack shortly after her ninth birthday on 15th February 2013.

While Ella was alive, Rosamund and Ella's medical team struggled to identify her asthma triggers. The first clue came when the pathologist conducting the inquest likened Ella's lungs to those of a smoker and suggested that Ella's lungs had been harmed by "something in the air." No one in the family was a smoker. Rosamund began a years-long battle to discover what that "something" might have been. Finally, through the advice of eminent researchers and scientists, the legal team working on Ella's case found that the timing of Ella's hospital admissions coincided with spikes in air pollution near her home. The night Ella died, air pollution levels were especially high.

Rosamund's family lives near the South Circular, an extremely busy road in South London. Ella passed the South Circular each day on her way to and from school, and breathed air polluted by the cars, trucks and other vehicles each time she left the house³⁶³. Rosamund notes that around her family's home, air pollution levels frequently exceed the air quality standards recommended by WHO³⁶⁴.

Rosamund often reiterates the words of the Coroner from Ella's second inquest: "if it wasn't for the excessive traffic emissions where we live, not only would Ella not have got asthma at all, she never would have died on that fatal night"³⁶⁴. Rosamund's tireless advocacy resulted in a remarkable outcome – Ella is the first person in the world to have "air pollution" listed as a cause of death on her death certificate.

No parent should have to bury their child. In Ella's memory, Rosamund has become a powerful advocate for clean air, calling on governments to protect the health of children by ensuring the right to clean air and enacting measures to reduce traffic emissions and other air pollution.

*Ella Roberta suffered a fatal asthma attack in 2013.
The coroner's report listed excessive traffic emissions.*



More information: <https://www.ellaroberta.org/>

📷 Ella Roberta Foundation

3.8 Residential Heating and Cooking



In recent years, a spotlight has been shone on the health impacts of gas stoves in homes. Estimates from the U.S. and Australia suggest that in-home gas stoves may be responsible for 12% of childhood asthma cases, possibly due to the release of NO_2 ^{365–367}. Indoor NO_2 from cooking with gas, which can exceed the WHO's 1 hour exposure guideline when the stove is in use, also seems to be associated with increased asthma wheeze in children^{368,369}. One US study found that families living in smaller homes were more exposed to concerning levels, and found that lower income households and households facing historic racial discrimination (Black, Native and Hispanic households), were more exposed to NO_2 than were wealthier households or white households³⁶⁷. Although using the venting hood or opening windows while cooking may reduce the respiratory risk, in places where healthier options are accessible, there is little reason to risk a family's health by installing a gas stove. Given that gas stoves also release methane, a potent greenhouse gas, people should be supported to transition away from gas stoves to non-polluting health protective options as quickly as possible³⁷⁰.

COOKING WITH COAL HARMS HEALTH, BUT LPG IS NOT THE ANSWER

It is well documented that burning coal indoors for cooking and heating is associated with adverse health outcomes. These include an increased risk of “lung cancer in never smokers”, increased risk of death from cancer and cardiovascular diseases and increases in all cause mortality^{371–374}. In Mongolia, seasonal increases in coal use for heating are associated with reduced fertility³⁷⁵. Prenatal exposure to coal-related indoor air pollution (including chromium and cadmium) is associated with an increased risk of neural tube defects, orofacial clefts and low birth weight^{54,82,83,376}.

As with coal, burning wood, biomass, and other solid fuels indoors is associated with negative health outcomes^{377–379}. International health advocates have called for an urgent move away from solid fuels. Within this effort, liquified petroleum gas (LPG) has been promoted as a “clean” cooking fuel, especially in low income countries.

Some studies suggest there are benefits from switching from solid fuel to LPG stoves, including measured reductions in indoor $\text{PM}_{2.5}$ and NO_2 ^{380–382}. In one large multi-country, LPG stoves did not deliver the hoped for improvements in measured health outcomes, however this may be due to confounding variables including complications related to the COVID-19 pandemic^{383–387}.



Some studies have suggested that there are barriers to LPG stove use, with some participants in a study in Ghana noting that LPG is expensive, hard to access, and poses safety concerns^{388,389}. Other research suggests that these concerns are warranted – hospital studies in Nigeria, Turkey, India and China note that increasingly LPG stoves are a cause of severe burns, mostly due to gas leaks and explosions^{390–395}.

Given these risks and access challenges, it seems that any benefits offered by LPG stoves, including asthma reduction and less time spent by women gathering firewood and cooking, could be provided more safely by other smokeless cooking options³⁹⁶. Where possible, people should be supported to shift as quickly as possible away from coal and biomass to electric or induction stoves, skipping LPG and its risks, all together.

3.9 Waste: Storage and Disposal



Fossil fuel extraction and processing result in unneeded by-products including coal ash, contaminated water and excess gas. These waste products can pose environmental and health risks, due to inefficient or unsafe waste disposal practices, such as excess gas flaring, and due to risky waste storage practices, as tailings ponds for produced water.

3.9.1 Contaminated Water

In the service of fossil fuel extraction and processing, massive amounts of fresh water are mixed with chemical and other components.

For example, hydraulic fracturing uses water mixed with sand and a potentially “proprietary” array of chemicals to break apart underground rock formations to release oil and gas³⁹⁸. Extracting oil and gas can also create “produced water” as existing ground water is pushed to the surface along with the target fossil fuel³⁹⁹. Produced water may contain hydrocarbons, salts, bacteria, heavy metals, radioactive materials, and fluids or chemicals used during the extraction process^{399,400}.

Some percentage of the water produced by hydraulic fracturing is re-used for further fracking, and some is treated and released into waterways, occasionally with concerning results for local drinking water⁴⁰¹. Fracking wastewater that cannot be reused or treated is often injected deep underground or stored in surface ponds to evaporate.

Waste water resulting from oil sands processing that cannot be treated is similarly held in enormous tailings ponds. Wastewater spills and leaks are not infrequent, and there are ongoing concerns that stored water leakage may contaminate streams, lakes, aquifers and the surrounding environment⁴⁰². These concerns are amplified because extraction companies have an unreliable history when it

AROUND THE WORLD

Coal Slurry Spill in Borneo, Indonesia (2021)³⁹⁷

In 2021, a coal-slurry spill in Indonesian Borneo’s Malinau River, originating from PT Kayan Putra Utama Coal’s waste facility, killed hundreds of fish and forced a shutdown of water lines to households. The company apologised for the incident and pledged to provide clean water to affected residents. Industry watchdogs and locals report that such incidents are frequent in North Kalimantan province, a major coal mining hub.

comes to reporting accidents. For example, it took nine months for Imperial Oil (a subsidiary of Exxon/Mobil) to inform the nearby municipality and First Nations groups that a leak at their facility contained tailings spillage, nine months during which people fished, hunted, and harvested food on potentially contaminated lands⁴⁰³. When it comes to fossil fuel waste water management, hoping for the best is an unacceptable public health strategy.

3.9.2 Coal Ash

Health studies conducted in central India have documented elevated rates of chronic conditions among communities living near coal mines and coal ash ponds. Reported health issues include hair loss, brittle hair, musculoskeletal pain, dry or discolored skin, cracked soles, and persistent cough. Increased incidences of kidney and gastrointestinal disorders have also been observed⁴⁰⁴. The U.S. Environmental Protection Agency (US EPA)⁴⁰⁵, in its report, “*Human and Ecological Risk Assessment for Coal Combustion Wastes*,” states that living next to a coal ash disposal site can increase the

risk of cancer or other diseases, especially if people live near an unlined wet impoundment that contains coal ash commingled with other wastes. According to the report, people in those circumstances have as much as 1 in 50 chances of getting cancer from drinking water contaminated by arsenic, one of the most prevalent pollutants found in coal ash. Along with an increased risk of cancer from toxic heavy metal exposure, coal ash can affect human development, create lung and heart problems, cause stomach ailments, and contribute to premature mortality^{406,407}.

People living next to coal ash disposal sites can have as much as a 1 in 50 chances of getting cancer from drinking water contaminated by arsenic.

Breaches in fly ash ponds have been reported from many sites resulting in loss of lives and livestock, property damage, and contamination of vast tracts of agricultural and residential land rendering it unfit for habitation⁴⁰⁸.

Coal ash from power plants is discharged into nearby rivers and lakes in Ennore, North Chennai.



Amirtharaj Stephen



Neha Dadsena

Public Health Expert,
Chhattisgarh, India



Neha Dadsena

I have been deeply engaged with communities suffering from industrial pollution, and the consequences are alarming. In areas near coal plants and mining operations, respiratory illnesses are rampant, with many families experiencing a rise in birth defects and skin infections. The air quality is visibly deteriorating, leading to frequent health issues. The pollution from fossil fuel activities profoundly impacts the health of local residents, particularly children and the elderly, who are increasingly affected by asthma, bronchitis, and other respiratory ailments. Additionally, water contamination from improper waste disposal is causing widespread gastrointestinal problems and skin diseases.

Immediate action is crucial. Stricter environmental regulations and rigorous compliance monitoring can dramatically reduce these health risks. Moreover, educating community members about environmental health and preventive measures is essential to mitigate the adverse effects. The health and well-being of these communities depend on our swift and decisive action.

3.9.3 Gas Flaring

Flaring is a waste management method where excess gas produced or released during oil and gas extraction or refining is burned off, often as a cost saving measure⁴⁰⁹. Designed as an emergency safety measure to manage unplanned over-pressurization, flaring has increasingly become a routine operation at extraction sites, sometimes as a cost-cutting measure, allowing facilities to avoid the expenses associated with capturing and processing these gases⁴⁰⁹. In addition to releasing CO₂ and methane, flaring can produce black carbon, NO_x, SO₂, VOCs including benzene and other pollutants, putting the health of surrounding and downwind communities at risk⁴¹⁰. As with many oil and gas activities, flaring seems to impact birth outcomes – exposure to frequent nightly flaring may be associated with an increased odds of preterm birth⁴¹¹. Children exposed to benzene from exposure to daily flaring were found to have altered liver enzymes

and blood cells⁴¹². Flaring also seems to negatively impact respiratory health. A study in North Dakota found that small increases in the amount of flared gas were associated with similar increases in hospital visits for respiratory concerns, and researchers in Nigeria found an association between flaring and respiratory illness in young children^{413,414}.

Flaring is also an environmental justice issue. Researchers note that hispanic communities in Texas, and economically disadvantaged communities and communities of color in North Dakota were more likely to be exposed to flaring than their white or wealthy counterparts^{224,413}.

Children exposed to benzene from exposure to daily gas flaring were found to have altered liver enzymes and blood cells.

Gas flaring has become a routine practice, releasing pollution into the air.



 Ted Auch, FracTracker Alliance, 2018.

ON THE FRONTLINES

Ali's Story: BP's Gas Flaring in Iraq

Ali Hussein Juloud's life, though tragically short, is an example of resilience and a call to action for justice⁴¹⁵. Born and raised in Rumaila, Iraq, at fifteen Ali was diagnosed with Acute Lymphoblastic Leukaemia (ALL), a childhood cancer that is associated with benzene exposure⁴¹⁶.

ALL and other cancers are common in Ali's community. One environmental scientist described cancer as being "like the flu" for local families⁴¹⁷. Ali's illness was not a random misfortune, but rather a consequence of exposure to chemicals produced by the relentless gas flaring operations by British Petroleum (BP). These operations, conducted in unlawful proximity to his home, released carcinogenic pollutants into the air, poisoning the community and its children⁴¹⁸.

Despite his deteriorating health, Ali refused to be a silent victim. He became a determined advocate, documenting his daily struggles through video diaries. His courage caught the attention of the BBC, and his story was featured in the powerful documentary "Under Poisoned Skies"⁴¹⁹. The

film revealed the grim reality of Rumaila, a region with the highest levels of gas flaring in the world, and showcased the health crisis caused by these operations.

Ali's fight was not just against his illness but against the powerful corporations responsible for the environmental disaster. His unwavering spirit led him to share his story at COP27 in Egypt, where he presented the documentary to a global audience. His testimony called on the world to confront the destructive impact of fossil fuels and the gross injustice faced by those living near extraction sites⁴²⁰.

Ali's fight ended on April 21, 2023, when he succumbed to leukaemia⁴²¹. His death was a profound loss to his family, community, and all who knew him. However, his legacy lives on. Ali's fight continues, carried forward by those inspired by his bravery and determination. His life serves as a powerful reminder of the urgent need to hold polluters accountable and to protect the health and well-being of vulnerable communities worldwide.

Ali Hussain Julood from Iraq was exposed to gas flaring and later died from leukemia.



📷 Hussein Faleh, BBC

3.10 Decommissioning and Site Remediation



The final phase of the fossil fuel life cycle—decommissioning and site reclamation—presents significant risks and challenges⁴²². This phase involves dismantling and removing fossil fuel infrastructure, as well as restoring the site to a condition that is safe for future use. If remediation and decommissioning efforts are not thorough, residual pollutants can remain in the soil and water years after an extraction site, production facility, power plant or gas/petrol station has been shut down. These pollutants can include heavy metals, hydrocarbons, VOCs including benzene, and other pollutants used or produced during fossil fuel life cycle^{423–426}. In addition, the IEA estimates that abandoned oil and gas wells and coal mines produced about 8 metric tonnes of methane in 2024 alone⁴²⁷. Methane emissions

The IEA estimates that abandoned oil and gas wells and coal mines produced about 8 metric tonnes of methane in 2024 alone.

from abandoned sites not only contribute to climate change, they put people living and working near these sites at an increased risk of methane exposure and gas explosions⁴²⁸. Individuals living near abandoned/ orphaned sites or improperly remediated fossil fuel sites can be at risk of long-term exposure to residual pollutants⁴²⁹. Exposure to certain toxic substances found around these sites, such as benzene and heavy metals, can increase the risk of developing cancer²⁷⁶, cognitive impairments, and other neurological issues⁴³⁰.

Decommissioning and remediating fossil fuel projects also incurs very high costs⁴³¹, compounded by a process often characterised by opacity and lack of accountability. Companies who have made considerable profits extracting fossil fuels often shirk their remediation responsibilities, leaving communities to face the health risks of their incomplete remediation efforts and unaddressed contamination⁴³².

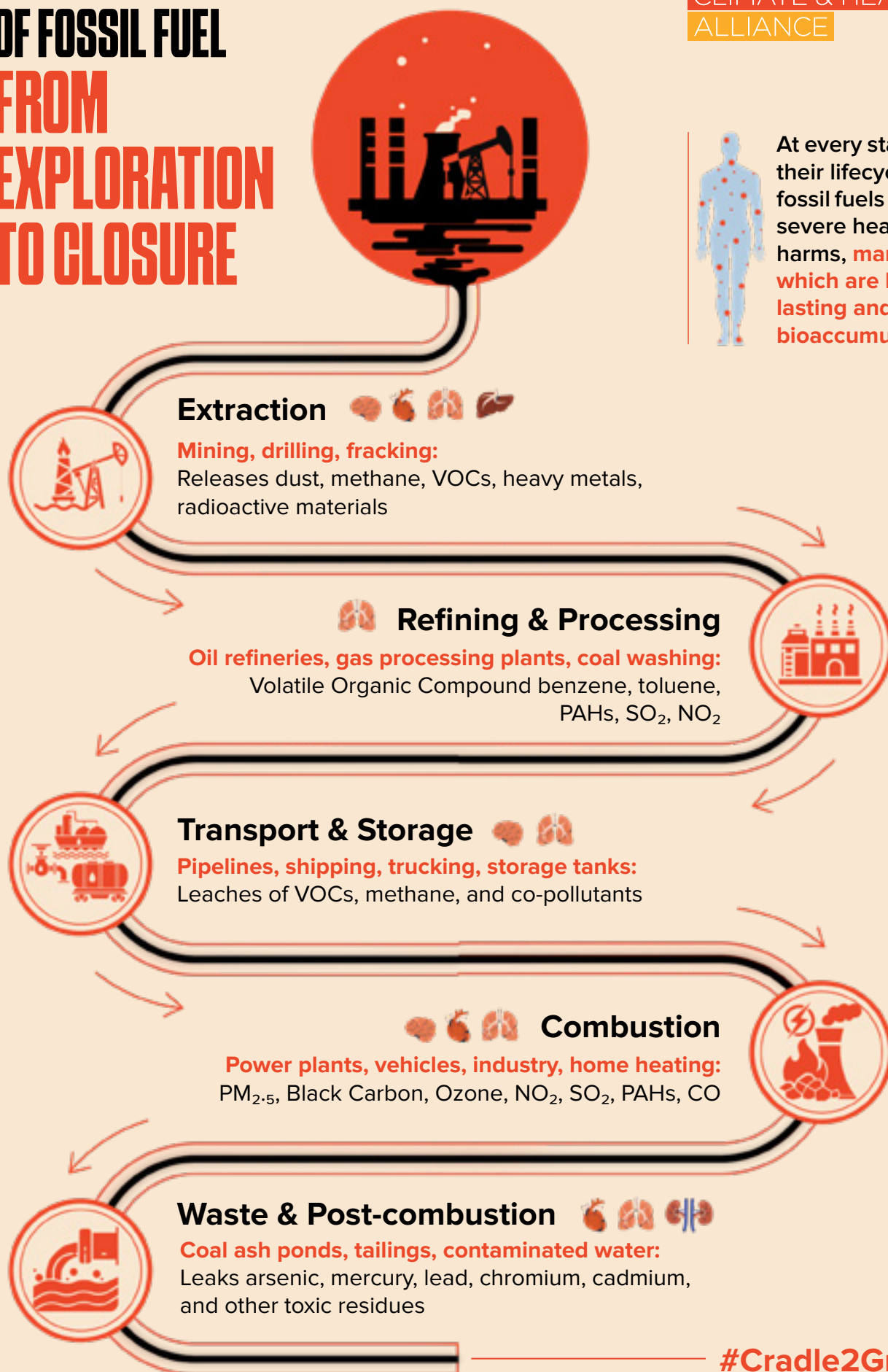


Heavy machinery works around the clock at a coal ash-contaminated site in Korba, India.

HEALTH HARMS OF FOSSIL FUEL FROM EXPLORATION TO CLOSURE

GLOBAL
CLIMATE & HEALTH
ALLIANCE

At every stage of their lifecycle, fossil fuels cause severe health harms, many of which are long-lasting and bioaccumulative



#Cradle2Grave



Dr. Fithriyyah Iskandar

Bhayangkara Pontianak
Hospital, Indonesia

I am a Medical Doctor and environmental youth activist from Indonesia. I have been actively advocating for the right to a safe, clean, healthy, and sustainable environment at the regional and international levels. I am also a member of the UN Women 30 For 2030 Network and Youth Advisory Group at the London School of Hygiene and Tropical Medicine Centre for Climate Change and Planetary Health. I was a fellow in YSEALI Academic Fellowship Program 2021 in East-West Center, USA on Environmental Issues and am now a member of Regional Executive Body in ASEAN Youth Forum and represents them to the ASEAN Environmental Rights Working Group on behalf of the youth group representative. My aspiration is to create a healthy and just future for everyone.

Borneo is a land with many fossil fuel companies operating, mainly to harvest coal from the deep part of the island, particularly in the Eastern province. West Borneo has three power plants that largely depend on coal imports from East Borneo, home to the largest coal companies. One of these power plants, located in the Pontianak area, produces ash and

smoke that are visibly emitted daily as I and people pass by the road. Recently, there has been a move by some coal companies to establish operations in West Borneo, which has raised community concerns about the potential impact, despite the promise of job opportunities and welfare to the people^{433,434}.

The coal industry is widely known for its impact on the environment and human health, it causes deforestation and loss of natural wildlife habitats, destruction of the land, and produces pollutants such as Fly Ash and Bottom Ash (FABA) which contaminates soil and water around the area. In the context of human health, there are various effects resulting from the toxic substances, ozone, and heavy metals. Severe health impacts are caused by microscopic particles (PM_{2.5}) that form from the emissions of sulfur, nitrogen oxides, and dust. These fine particles penetrate into the lungs and bloodstream, causing death and various health problems. In East Borneo, there are many cases where the community complained about the impact caused by the coal mine in the area, including environmental damage and a pungent odor, especially at night, which has been disturbing the local community⁴³⁵.

One of the case studies provided by Greenpeace Indonesia is Tanjung Jati B, a 2640 MW coal-fired power plant in Jepara, Central Java, with four units that have been operational since 2006-2012. The emissions from the Jepara power plant are estimated to cause 1,020 premature deaths per year. This includes 450 deaths due to stroke, 400 deaths due to ischemic heart disease, 60 deaths due to lung cancer, 90 deaths due to chronic respiratory diseases, and 20 child deaths due to acute respiratory infections⁴³⁶.

Therefore, having the fact that the coal industry still poses harm to people, animals, and humans, the worries of the West Borneo community to welcome the coal companies on their land is justifiable. Additionally, as the main home of tropical biodiversity, Borneo's natural habitats must be protected from industry, if it's not, then what we're going to achieve is only the loss of biodiversity and violations of human rights to a healthy environment.

As Indonesia is progressing to achieve net zero emissions, serious and firm actions must be implemented. Transitioning to more green and sustainable solutions is needed to make a healthy environment that can lead to healthy people

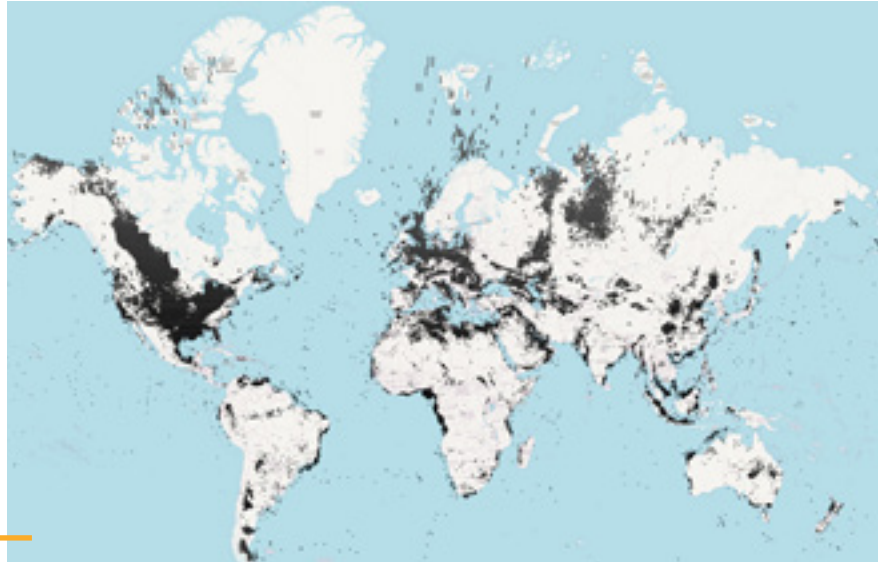
Fossil Fuel Atlas

A project of Stockholm Environment Institute, Institute for Governance and Sustainable Development, and Global Energy Monitor

<https://www.fossilfuelatlasportal.org/catalogue/#/map/582>

Oil Wells

Global Coal Mines
Global Lease Blocks
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines



Oil Wells

Global Coal Mines

Global Lease Blocks
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines

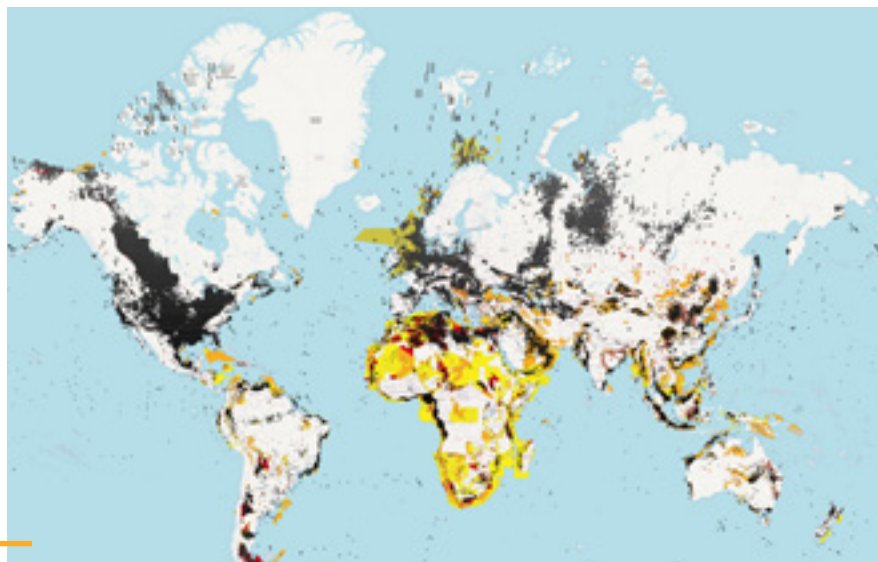


Oil Wells

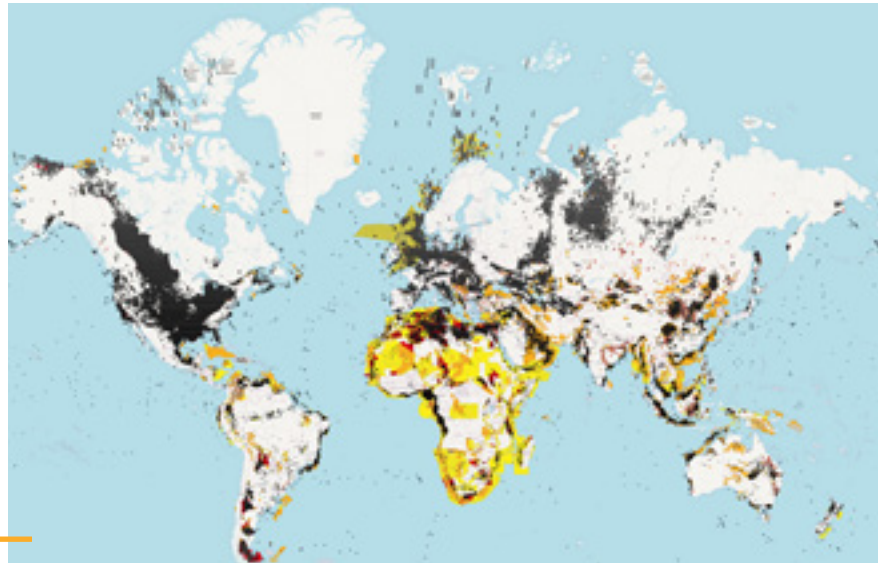
Global Coal Mines

Global Lease Blocks

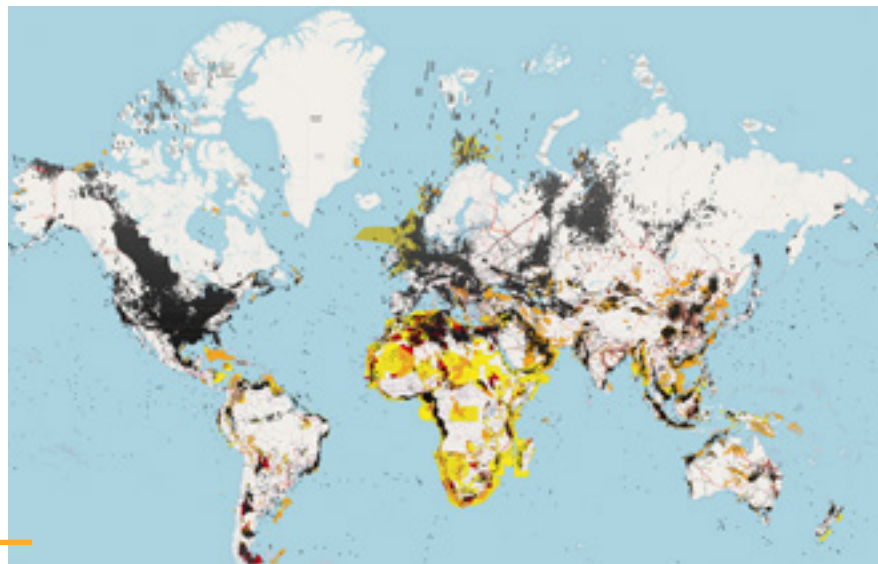
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines



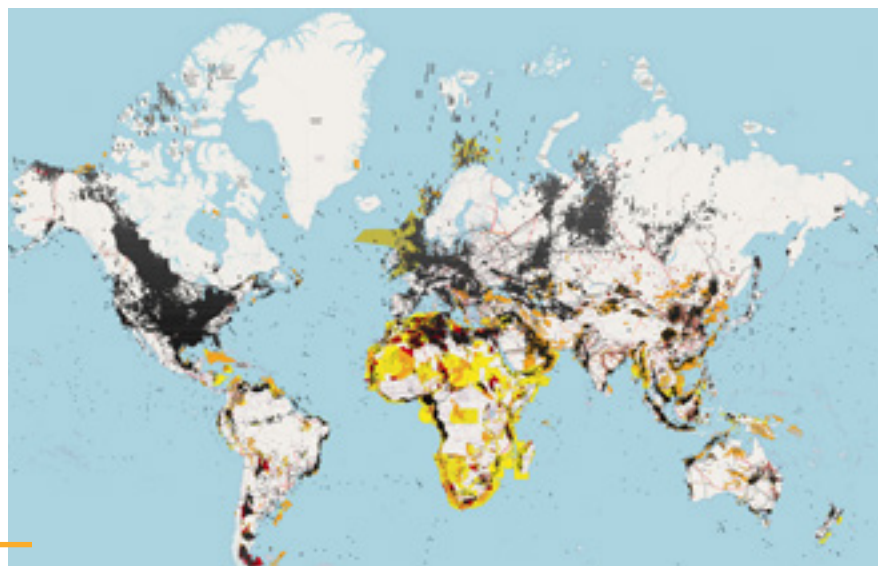
Oil Wells
Global Coal Mines
Global Lease Blocks
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines



Oil Wells
Global Coal Mines
Global Lease Blocks
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines



Oil Wells
Global Coal Mines
Global Lease Blocks
Oil & Gas Extraction
Gas Pipelines
Oil Pipelines





Dr. Linda Rudoph

Steering Committee, Fossil
Free For Health, US

We're all in this together. We must unite to fight for health, justice, and a livable future for our children and grandchildren.

I'm a public health physician who has lived in Oakland, California for decades. It's a vibrant, diverse city, but also one of deep inequality. Nowhere is this more evident than in West Oakland, a community burdened by some of the highest levels of air pollution in the region. Freight trucks, freeways, industry, and the operations of the Port of Oakland contribute to a toxic mix that has left generations suffering from asthma, heart disease, and other serious health conditions. Despite years of community organizing, harmful projects keep coming.

In 2012, a developer secured approval for a bulk commodity export terminal at the decommissioned Oakland Army Base—without mentioning coal. Shortly after, Kentucky-based Bowie Resource Partners sought to use the terminal to export Utah coal to Asia. The coal would be extracted from mines in Utah, transported by rail through communities in Nevada and California, stored at the Oakland terminal, then loaded onto ships bound for Asia. At every step—extraction, transport, storage, and combustion—people would be exposed to pollution with devastating health consequences.

When Oakland residents learned of the coal export plan, hundreds mobilized. I was part of a group that conducted a health impact assessment that found that coal transport would increase exposure to PM2.5, mercury, and lead—pollutants linked to respiratory diseases, neurological damage, and cardiovascular conditions.

In 2016, I traveled to the Philippines for a workshop on health impact assessments and energy policy. In Bataan province, I visited a small rural town where homes had been demolished to expand a coal-fired power plant. The air was thick with pollution. Coal dust settled on every surface—homes, food, even the vegetable gardens that sustained local families. Residents, especially children, suffered from severe asthma and other illnesses.

One of the local organizers, Gloria Capitan, was a grandmother who had seen the health impacts firsthand. She began speaking out, filing complaints, organizing petitions, and mobilizing her neighbors. Her advocacy forced the company to cover its exposed coal piles, reducing airborne pollution. But she paid the ultimate price—shortly after my visit, Gloria was murdered, one of many environmental defenders silenced for challenging corporate power.

Meanwhile, Bowie Resource Partners funneled tens of thousands of dollars to Utah legislators to pass a March 2016 bill allocating US\$53 million for Oakland port expansion. At a climate and health conference in Salt Lake City the following month, I met organizers from Utah Physicians for a Healthy Environment, who, alongside community groups, condemned the use of public funds to support coal exports—citing the health risks of coal dust exposure and the industry's global climate harms.

In June 2016, Oakland's City Council unanimously banned coal handling at the port. Yet, the terminal's fate remains uncertain amid business failures, persistent opposition from local officials and activists, and ongoing legal battles. In 2018, the City revoked the developer's lease. But a Kentucky bankruptcy judge—2,000 miles away—recently allowed a hedge fund holding a sublease to proceed with a billion-dollar lawsuit against Oakland for blocking coal exports.

What have I learned from these different experiences? Across the world, fossil fuel expansion follows the same pattern: profit-driven projects extract resources from one region, transport them through another, and burn them elsewhere—leaving a trail of damage in their wake.

But we are not connected only by this chain of harms. We are also connected by resistance. In Utah, physicians fought against coal exports. In Oakland, community advocates organized and won policies to stop coal exports. In Bataan, Gloria Capitan's legacy lives on in those continuing to fight for clean air.

These struggles are not isolated—they are part of a global movement demanding health, justice, and an end to fossil fuel dependence. Breaking the fossil fuel supply chain isn't just an environmental necessity—it's a public health imperative. Our collective power lies in organizing, standing together, and refusing to accept that our communities are sacrifice zones. We must fight back, across borders and generations, to build a future that prioritizes people over polluters.

Fossil Fuel-Based Products:

Petrochemicals, Plastics and Agrochemicals

Petrochemicals

Some fossil fuels are converted into petrochemicals which are used for a vast array of products and purposes. Petrochemical workers were at an increased risk of developing oral and pharyngeal cancers¹⁴⁷. Meta-analyses found that people living within 8km of a petrochemical industrial complex had an increased risk of developing leukemia^{437,438}. Maternal proximity to petrochemical plants may be associated with miscarriage and stillbirth⁶⁹.

Plastics

As the world shifts towards renewable energy and reduces reliance on fossil fuels for electricity, plastic has become “Big Oil’s Plan B”. The industry is increasingly turning to plastic production⁴³⁹ and other petrochemicals (such as fertilisers, pesticides, and industrial chemicals) as a means to sustain its profits.

The full lifecycle of plastics comprises the extraction of raw materials; the production of polymers, the manufacture of products, sales and distribution; use and maintenance; recycling, reuse, recovery or final disposal; and the persistence of plastics in the environment and in the human bodies. There is a common misconception that plastic pollution is merely a waste issue. In fact, plastics pollute throughout their entire life cycle.

Climate Impacts of Plastic Production

In 2019, the production of monomers and polymers —the building blocks of plastics—generated 2.24 gigatons of CO₂e, accounting for 5.3% of global greenhouse emissions⁴⁴⁰. The growth in plastic production is expected to accelerate, increasing by up to 4% annually, tripling by 2060, and reaching approximately 1 billion tons per year⁴⁴¹. If this trend continues, plastic production could consume up to 25% to 31% of the remaining global carbon budget⁴⁴⁰. Plastics would thus surpass even the transport and energy sectors in terms of their share of global greenhouse emissions.

Health and Economic Impacts of Plastic-Associated Chemicals

At every stage of its lifecycle, plastic poses distinct risks to human health, from exposure to plastic particles themselves, and to plastics-associated toxic chemicals (e.g. toxic flame retardants, certain UV stabilisers, per- and polyfluoroalkyl substances (PFASs), phthalates, bisphenols, alkylphenols and alkylphenol ethoxylates, biocides, certain metals and metalloids, polycyclic aromatic hydrocarbons)⁴⁴².

Most people worldwide are exposed at multiple stages of the plastic lifecycle⁴⁴³. Recent studies have identified over 16,000 chemicals in plastics, with at least 4,200 of them known to be toxic⁴⁴⁴. Alarming evidence shows that plastic particles and their associated chemicals can be found throughout the human body, including in the brain, heart, lungs, and even in placenta and breast milk, leading to profound negative health impacts.

The economic costs of these health impacts are staggering. In 2015, the global health-related costs of plastic production exceeded US\$250 billion⁴⁴⁵. In the U.S. alone, the health costs associated with plastic-related chemicals, such as PBDE, BPA, and DEHP, surpassed US\$920 billion⁴⁴⁵.

Rising global temperatures may exacerbate the toxicity of certain chemicals in plastics, increasing their harmful effects on the human body^{445,446}. Higher temperatures can also reduce the ability of organisms to cope with these toxins, making them more vulnerable to their adverse effects⁴⁴⁷. Additionally, some chemicals in plastics can impair the body's ability to regulate temperature, further endangering individuals in a warming world⁴⁴⁸.

The intersection of these issues highlights the urgent need to address plastic production as a key component of both climate and public health strategies.

Agricultural Chemicals

Fossil fuels are used in the production of chemical fertilisers and pesticides, together known as agrochemicals. Agrochemicals are an integral part of a monoculture-based industrial food system and are known to contribute to catastrophic biodiversity collapse and toxic pollution. Synthetic nitrogen fertiliser and most pesticides are fossil fuels in another form, driving fossil fuel expansion even as other sectors started to decarbonize.

Climate and Environmental Impacts of Agrochemicals

Making ammonia, the basis for synthetic nitrogen fertilisers, requires fossil gas or coal as feedstocks, as well as a large amount of energy to produce the high temperatures and pressures needed for the reaction process. Ammonia produces more greenhouse gases than the production of any other industrial chemical, including making steel or cement⁴⁴⁹. However, less than 40% of the emissions related to synthetic nitrogen fertilisers comes from the production stage. Around 60% comes for their use⁴⁵⁰. This is primarily because microbes in the soil break down nitrogen fertilisers to produce nitrous oxide (N₂O) – a climate “super pollutant” nearly 300 times as powerful as CO₂⁵. Globally, the synthetic nitrogen fertiliser supply chain represents 10.6%



of agricultural emissions and 2.1% of global GHG emissions - more than commercial aviation⁴⁵⁰. In Korea, a community near a fertilizer plant had an increased risk of all cancers including non-melanoma skin cancers and gastric cancers⁴⁵¹.

Beyond the climate impacts, synthetic nitrogen use in farming is behind a cascade of environmental impacts including soil acidification, inland and coastal water eutrophication (over-enrichment with nutrients, resulting, e.g., in algae growth), biodiversity loss, and impacts on regional air quality⁴⁵².

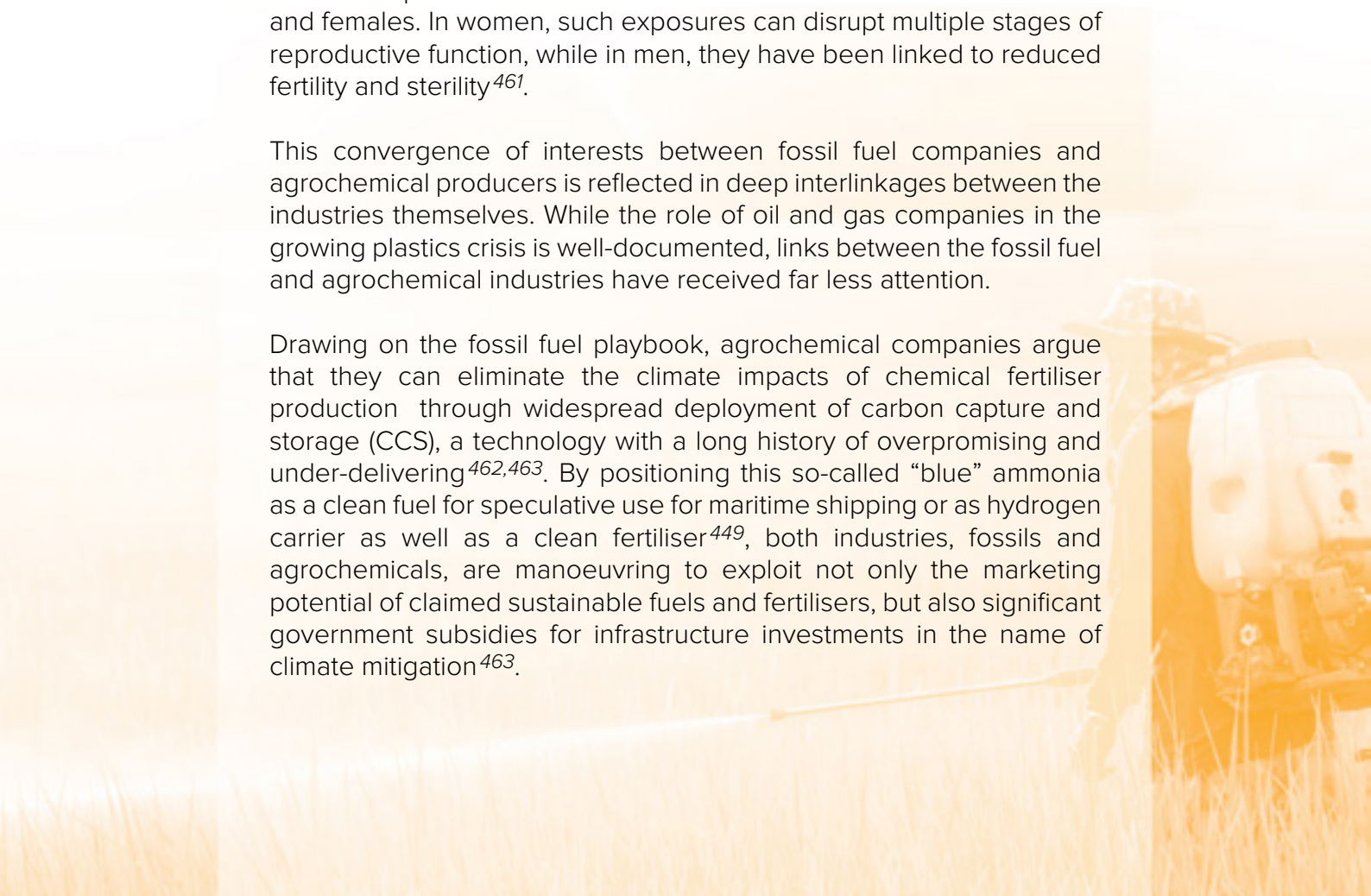
Health Impacts of Agrochemicals and Industrial Agriculture

Synthetic nitrogen fertilisers and chemical pesticides make the current industrial food system, which is based on a few crops and intensive grain-fed livestock, possible in the first place – with known adverse health outcomes⁴⁵³. The IEA projects petrochemicals will account for more than two-thirds of global oil demand growth through 2026, and could account for more than half (55%) of all petroleum usage by 2050⁴⁵⁴. 40% of petrochemicals are food-related plastics and fertilisers⁴⁵⁵.

Moreover, overuse of synthetic fertilizers depletes the nutritional quality of crops, reducing essential micronutrients^{456–460}. Some research has found pesticide exposure to be associated with adverse reproductive and developmental health effects across the life course for both males and females. In women, such exposures can disrupt multiple stages of reproductive function, while in men, they have been linked to reduced fertility and sterility⁴⁶¹.

This convergence of interests between fossil fuel companies and agrochemical producers is reflected in deep interlinkages between the industries themselves. While the role of oil and gas companies in the growing plastics crisis is well-documented, links between the fossil fuel and agrochemical industries have received far less attention.

Drawing on the fossil fuel playbook, agrochemical companies argue that they can eliminate the climate impacts of chemical fertiliser production through widespread deployment of carbon capture and storage (CCS), a technology with a long history of overpromising and under-delivering^{462,463}. By positioning this so-called “blue” ammonia as a clean fuel for speculative use for maritime shipping or as hydrogen carrier as well as a clean fertiliser⁴⁴⁹, both industries, fossils and agrochemicals, are manoeuvring to exploit not only the marketing potential of claimed sustainable fuels and fertilisers, but also significant government subsidies for infrastructure investments in the name of climate mitigation⁴⁶³.





After Hurricane Katrina in Louisiana, oil spills from nearby refineries added to the damage caused by wind and floods.

 Denny Larson,
2005

Multiplied Risk: Fossil Fuel and the Climate Crisis

Fossil fuels are the primary source of greenhouse gas emissions, which are driving the climate crisis. This crisis presents a growing number of risks to human health⁴⁶⁴. In many cases, the health harms caused by fossil fuels and the climate impacts they generate are not separate—they interact and reinforce one another, creating a compounding threat.

4.1 Amplified Health Risks

Fossil fuel-driven climate change amplifies health risks, creating a compounding crisis. Warmer temperatures worsen air pollution, increasing ground-level ozone and PM2.5, which contribute to respiratory and cardiovascular diseases. Wildfire smoke and fossil fuel emissions can combine, pushing air pollution to hazardous levels. Extreme heat interferes with one's ability to work, causes heat exhaustion and heat stroke and exacerbates many chronic diseases.

The combined effects of wildfire smoke and extreme heat are particularly dangerous. A recent study from British Columbia found that mortality during these overlapping events was more than seven times higher than under normal conditions⁴⁶⁵.

The combined effects of wildfire smoke and extreme heat are particularly dangerous. A recent study from British Columbia found that mortality during these overlapping events was more than seven times higher than under normal conditions.

At the same time, climate change is shifting disease patterns—such as the spread of vector-borne diseases like malaria and dengue—place additional strain on health systems. Disruptions from storms, floods, and extreme weather events can damage hospitals, reduce access to care, and displace vulnerable populations, compounding public health emergencies.

4.2 Cascading Risks Prompted by Fossil Fuel Infrastructure

Fossil fuel infrastructure—refineries, pipelines, power plants, and storage depots—is increasingly at risk from the climate crisis it helps drive. Located disproportionately in coastal and low-lying areas, these facilities are exposed to intensifying weather extremes, including hurricanes, cyclones, heatwaves, and sea level rise⁴¹⁴. When compromised, these facilities can release toxic chemicals, causing environmental contamination, health risks and community displacement^{467,468}. The disruption of healthcare services during extreme weather events may mean that people facing toxic exposures cannot access care. Economic impacts include costly repairs, environmental clean up and energy price volatility⁴⁶⁹. Fossil fuel companies rarely bear the full cost of cleanup, repair, and remediation following climate-related disasters, shifting the

burden to taxpayers, local communities, and governments.

4.2.1 Cascading Risk: Hurricanes, Cyclones and Typhoons

Storm-related damage of fossil fuel infrastructure has led to major health and environmental crises. On the U.S. Gulf Coast Hurricane Katrina in 2005 damaged refineries and chemical plants, causing oil spills and toxic emissions linked to respiratory illness, gastrointestinal infections, and skin conditions^{470,471}. Hurricane Rita soon followed, releasing over 600 hazardous substances, exacerbating respiratory and skin conditions, and increasing the risk of waterborne illnesses⁴⁷². Estimates calculate that the amount of oil spilled was about 10.8 million gallons – similar to the amount spilled by the 1989 Exxon Valdez disaster into the Prince William Sound in Alaska⁴⁷³.

4.2.2 Cascading Risk: Heat

Heat extremes can overheat power plants, reduce refinery efficiency, and weaken pipelines, increasing public health risks connected with equipment failures, leaks, explosions. For example, the Middle East is home to some of the world's largest oil and gas reserves, with major fossil fuel infrastructure concentrated in countries including Saudi Arabia, Kuwait, the United Arab Emirates, and Iraq⁴⁷⁶.

Across the region, fossil fuel infrastructure is increasingly threatened by rising temperatures, water scarcity, and sandstorms – conditions that are intensifying with climate change⁴⁸¹. In Saudi Arabia, refineries in coastal cities like Jubail and Yanbu face heightened risks of equipment failure, oil spills, and fires due to reduced cooling efficiency in high temperatures⁴⁷⁸. In southern Iraq, particularly around Basra, extreme heat, frequent power outages, and inadequate infrastructure has led to unsafe refinery shutdowns, toxic chemical releases, and worsened public health outcomes, including heat-related illnesses and respiratory conditions^{479,480}.

THE PHILIPPINES: TYPHOONS X OIL DEPOTS AND COAL-FIRED POWER PLANTS

In the Philippines, which is hit by an average of 20 typhoons annually, much of the fossil fuel infrastructure, such as the oil depots in Batangas and coal-fired power plants in Luzon, are at constant risk. Typhoon Haiyan in 2013, one of the strongest storms ever recorded, caused massive damage to a power barge in Estancia town, spilling hundreds of thousands of litres of oil onto the shoreline, making the area unsafe for human habitation⁴⁷⁴. The health impacts on the affected populations were severe, with outbreaks of leptospirosis, increased respiratory problems due to polluted air, and long-term psychological trauma from the disaster⁴⁷⁵.

MEDITERRANEAN: EXTREME HEAT PROMPTS CASCADING HEALTH RISKS

In 2023, extreme heat across the Mediterranean forced Spanish and Italian refineries to cut output by up to 10% due to cooling system failures, exposing the sector's lack of preparedness for escalating temperatures. Drought conditions further strained water supplies needed for cooling, with some refineries tapping underground reserves shared with drinking water systems. Despite isolated upgrades, most operators lacked adaptation plans, leaving infrastructure vulnerable. By 2024, El Niño-driven heat compounded risks, tightening fuel supplies in Europe – already impacted by heat-related disruptions at refineries in the U.S. Gulf Coast – underscoring the cascading health and energy security risks of fossil fuel dependence.

After heavy rains, a coal fly ash pond breach in Raigarh, central India, contaminated agricultural land, endangering farmers and their crops.



4.2.3 Cascading Risk: Sea Level Rise and Coastal Flooding

The vulnerability of global oil refining infrastructure to sea level rise and coastal flooding has been identified as a critical risk, particularly as climate change exacerbates these hazards⁴⁸¹. Approximately 32% of refineries worldwide are located in low-elevation coastal zones, exposing over 35% of global refining capacity to annual flood risks. These risks are projected to intensify under warming scenarios, with disruptions anticipated in refining hubs. The highly interconnected nature of global petroleum distribution networks means that localized disruptions could propagate widely, resulting in significant impacts on global energy supply chains. Economies with high dependence on energy imports or concentrated refining infrastructure are expected to face amplified economic repercussions. These disruptions could further lead to cascading public health and social

consequences, as energy price volatility, reduced availability of essential services, and heightened community vulnerabilities are likely to emerge.

A study⁴⁸² assessing the risks of sea level rise and extreme precipitation found that flooding could trigger toxic chemical releases from hazardous facilities in California, disproportionately affecting low-income communities of color. Using regression models and probabilistic projections of sea level rise, the study estimates that 423 facilities will be at risk of flooding by 2100 under a high-emissions scenario. Social vulnerability factors—including poverty, renter status, racial demographics, linguistic isolation, and low voter turnout—were significantly associated with a higher likelihood of living near at-risk sites.

A woman is standing in front of her house which is under water due to tidal flood in Mousuni Island, Sundarbans





Dr. Crystal Cavalier-Keck

Citizen of Occaneechi
Band of The Saponi Nation,
Co-Director: 7 Directions
of Service

I am a citizen of the Occaneechi Band of the Saponi Nation. I have been on the frontlines of the fight against methane gas expansion in the southeast for almost a decade. Beginning with the Mountain Valley Pipeline (MVP), we have amplified the voices for marginalized communities facing fossil fuel expansion and environmental destruction. We were instrumental in stopping the MVP Southgate from crossing Occaneechi Saponi territory in Alamance County. We are currently fighting the Southeast Supply Enhancement Project (SSEP) methane gas expansion project.

The marginalization of Indigenous women's voices is central to the continued destruction of our planet. When women's voices are silenced, the planet and all its inhabitants suffer. The fossil fuel and extractive industries rely on this silencing to perpetuate their destruction. In our communities we have seen increased rates of childhood health problems, respiratory issues, and cancer. The continuation of imperial colonial practices on the land has a devastating impact on the mental health of those communities that have experienced this for hundreds of years. Generational trauma is a real issue, and its effects can be seen in our Indigenous communities in the form of alcohol and substance abuse.

The fossil fuel and extractive industries and the politicians funded by them must accept the impacts that these industries have on the planet. Their descendants will also suffer from this continued destruction.

**Anabela Lemos**

2024 Right Livelihood Award Winner,
Director of Justiça Ambiental
Mozambique

In Mozambique, for decades the fossil fuel developments have directly and indirectly harmed human health and well-being. In inland Tete province, transnational corporations mining coal have blatantly disregarded human health. Some companies have been operating open pit mines alongside communities, without relocating affected peoples, forcing them to live in the midst of coal dust clouds for years. Coal dust settles thick in peoples' lungs, their homes, their clothes, and their lives. Meanwhile, gas developments in the northern Cabo Delgado province have taken land from farmers, and robbed fisherfolk of their access to the sea. The gas industry has contributed to an ongoing violent conflict that has claimed the lives of nearly 6,000 people, with reports of disappearances, rape, murder, and torture. Almost a million children, women and men were internally displaced. All this has also led to a crisis of nutrition and survival. The malnutrition among children today will affect their development and future health. For the survivors, these traumas will persist for decades to come.



Women from an oil-impacted community in Nigeria take part in a local hearing.

HOMEF

Societal Harms of the Fossil Fuel Industry: Fossil Fuel and the Climate Crisis

5.1 The Social Fallout of Fossil Fuel Projects at the Community Level

While new fossil fuel projects are often promoted to proposed host communities and government leaders as a source of jobs and economic benefits, evidence emerging over the past decade instead shows a picture of significant social disruption and economic volatility.

Fossil fuel projects often displace local communities, resulting in significant social disruption and economic hardship⁴⁸³. This displacement creates loss of livelihood as well as conflicts⁴⁸⁴, as the displaced populations compete for limited resources in their new locations. The economic disruption caused by the influx of fossil fuel

industry workers, heavy workload among the industry workers, and hazardous working conditions often leads to increased alcohol and drug abuse among both local residents and transient workers^{485,486}. According to a World Bank report, while income for male workers who are employed through the fossil fuel project may increase, this increased income frequently fails to benefit women and children, being spent instead on alcohol, cigarettes, and other similar consumables⁴⁸⁷. In addition the social isolation, distress, and high-stress work

environment experienced by fossil fuel industry workers fosters increased substance abuse⁴⁸⁸. The stress of displacement and economic uncertainty can exacerbate domestic conflicts, leading to an increase in violence within households. It also adversely impacts the mental health⁴⁸⁹ and is associated with increased cases of depression and suicides⁴⁹⁰. A study of 20 major industries in the US from the Centers for Disease Control and Prevention found the suicide rate was nearly double among workers in mining, quarry work, and oil and gas extraction as compared to the rate across all industries⁴⁹¹.

The economic instability brought on by displacement and the influx of transient workers is closely linked to higher rates of domestic and sexual violence and higher crime rates^{445,446}. Studies from Pennsylvania and Texas found elevated rates of chlamydia and gonorrhea in counties with unconventional oil and gas activities, and during years where more gas drilling was occurring, respectively, suggesting that fossil fuel activities may increase risky sexual behaviour^{494,495}.

The presence of large work camps, often referred to as “man camps,” established for fossil fuel projects can further aggravate social disruptions in the communities⁴⁹⁶. These camps, often situated near Indigenous and rural communities, are associated with increased rates of sexual violence and exploitation, posing safety risks to local women and girls⁴⁹⁷. Moreover, displaced and economically vulnerable populations become more susceptible to exploitation and human trafficking, including sexual exploitation, including “a rise in forced prostitution, the

trafficking of women (particularly young women), acceleration of sexually transmitted disease, and local prevalence of alcohol and narcotics,” according to the World Bank⁴⁸⁷. Women and children are thereby made more vulnerable to poverty, domestic violence, and the breakdown of healthy family structures. These dynamics heighten the vulnerability of women and children—leading to greater poverty, family breakdowns, antisocial behaviors, and a rising burden on female caregivers as the health of household members deteriorates. In Papua New Guinea, new oil wealth changed marriage patterns, leaving many local women unmarried as men sought marriage partners from outside the community. This in turn increased pressure on women to provide for the local community⁴⁸⁷.

Women working in mining are also vulnerable to violence. IndustriALL convened a global network meeting for women in mining in 2021. The workshop found that, “The abuse of women working in the mines is driven by a toxic masculinity culture. Gender-based violence, both physical and verbal, is prevalent. Women face sexism and sexual harassment on a daily basis; 40% of women mine workers surveyed in Canada had experienced unacceptable behavior like sexist remarks or unappropriated touching; women miners have been raped and killed in South African mines. Although some mining companies have developed policies, little action is taken to protect women workers, with some companies turning a blind eye to the reported cases”⁴⁹⁸. Limited legal protections, and the absence of women leadership roles in mining projects, contribute to limited recourse for women facing workplace violence in these contexts^{498,499}.

The combination of economic hardship, social disruption, and the presence of transient workers creates an environment where exploitation, crime and human trafficking can thrive. This situation exacerbates the already difficult conditions faced by displaced communities, leading to further social and economic instability and profound physical and mental health consequences.

The combination of economic hardship, social disruption, and the presence of transient workers creates an environment where exploitation, crime and human trafficking can thrive.

5.2 Resource Competition, Economic Disruptions and Economic Inequity

The nature of fossil fuel extraction and processing often results in boom-and-bust cycles in the local economy where periods of rapid economic growth are followed by sharp declines⁵⁰⁰. When fossil fuel resources are first discovered and developed, local economies may experience a surge in employment opportunities, increased investment, and improved infrastructure. However, these benefits are often short-lived. Once the resources are depleted or when market conditions change, the industry contracts, leading to widespread job losses and economic instability^{501,502}.

The volatility of fossil fuel markets exacerbates this cycle⁵⁰³. Fluctuating oil, gas, and coal prices can lead to sudden layoffs and reduced investment, leaving communities that are now dependent on these industries vulnerable. This instability can hinder long-term economic planning and development, making it difficult for affected regions to diversify their economies and recover from downturns⁵⁰⁴.

Economic inequality is another significant issue associated with the fossil fuel industry⁵⁰⁵. The

profits from fossil fuel extraction and processing are typically concentrated among a small group of stakeholders, including company executives, investors, and sometimes national governments. By contrast, local communities that host these industries frequently bear the brunt of environmental degradation, health problems, and social disruption caused by fossil fuel activities, with little compensation and investment in return^{506,507}.

Beyond economic hardship, fossil fuel infrastructure devastates local livelihoods by polluting air, water, and soil, disproportionately impacting fisheries and agriculture-dependent communities⁵⁰⁸. Oil refineries, coal mines, fracking sites, and pipelines release toxic pollutants that harm human health and degrade rivers and farmlands⁵⁰⁹. Fossil fuel extraction consumes and contaminates water supplies, exposing crops and livestock to heavy metals and chemicals, reducing yields, and threatening food security⁵¹⁰. For communities reliant on farming and livestock, this pollution means lost income, dwindling resources, and greater economic vulnerability, deepening the cycle of inequity.

Beyond economic hardship, fossil fuel infrastructure devastates local livelihoods by polluting air, water, and soil, disproportionately impacting fisheries and agriculture-dependent communities.

The disparity in economic benefits can lead to social tensions and a sense of injustice among local populations. While a few individuals or entities accrue significant wealth, much of the population may experience declining living standards, higher energy costs⁵¹¹, reduced access to clean air and water, and compromised health outcomes. This economic inequality can also hinder efforts to transition to more sustainable and equitable economic models, as those benefiting from the status quo may resist changes that threaten their financial interests.

ENERGY EQUITY DOES NOT REQUIRE FOSSIL FUEL DEPENDENCE

The argument that the Global South must follow the fossil-fuelled development trajectory of wealthier nations disregards 21st-century realities. Today, we possess the knowledge, technology, and resources to build energy systems that are clean, equitable, and resilient, without replicating the environmental and health harms of the past. Communities in the Global South already bear a disproportionate burden of fossil fuel-related harms. Air pollution has the highest mortality in low- and middle-income countries. Climate-related disasters, driven by fossil fuel use, have inflicted over US\$525 billion in economic losses across the Global South over the past two decades, exacerbating poverty and undermining development⁵¹².

The notion of a trade-off between energy access and fossil fuel use is a false dichotomy. Decentralised renewable technologies - particularly solar and wind - now offer the fastest, most cost-effective pathway to universal energy access. Solar prices have declined by 89% in the past decade, and off-grid and mini-grid solutions are already reaching underserved communities without the need for expensive fossil fuel infrastructure. Countries such as Kenya demonstrate that renewable energy can power development, with more than 90% of its electricity sourced from renewables.

Conversely, continued investment in fossil fuel infrastructure locks countries into volatile global markets and diverts public resources into subsidies, often at the expense of health, education, and climate resilience. Wealthier nations, having profited from fossil fuel expansion, have a responsibility to support a just energy transition in the Global South – through financing, technology transfer, and capacity building – not by promoting outdated, polluting models in the name of equity.

In Mpumalanga, South Africa, residents demand their right to breathe clean air.



© Daylin Paul
Center for Environmental Rights

5.3 Forced Displacement, Human Right Abuses, and Increase in Land Conflicts

The increase in land conflicts and the forced displacement of Indigenous people and fence line communities due to fossil fuel industry activities have profound and far-reaching impacts on the affected communities^{513,514}. One significant consequence is the loss of livelihoods. Many Indigenous and fence line communities depend on their traditional land for farming, hunting, and fishing to sustain themselves. When communities are forcibly removed from their lands, their ability to carry out these practices is disrupted, leading to food insecurity and malnutrition⁵¹⁵. The loss of access to natural resources essential for subsistence can force communities into economic instability and poverty.

Forced displacement can lead to severe mental health issues and being removed from ancestral lands has been found to cause psychological stress, anxiety and other negative mental health impacts for Indigenous people¹⁹⁹. The profound sense of loss and disconnection from cultural roots often results in higher rates of depression, anxiety, and suicide⁵¹⁶. This distress is compounded by solastalgia⁵¹⁷, a term describing the emotional and existential grief experienced when one's home environment is degraded or lost—a growing concern in the context of climate change and environmental destruction. Forced removal not only strips away community members' physical homes but can also erode a sense of identity and belonging, compounding the psychological distress. In addition, Indigenous communities often have a rich cultural heritage and traditional knowledge that are closely tied to the land. When forced to leave ancestral territories, the community loses access to sacred sites, cultural practices, and at times traditional knowledge that have been passed down through generations. This loss of cultural heritage diminishes the communities' identity and disrupts the transmission of cultural values and practices to future generations^{518,519}.

Displacement and land conflicts often lead to violence and human rights abuses⁵²⁰. Fossil fuel companies and government forces defending them have frequently clashed with local communities over land rights, at times resulting in violent confrontations. Companies have funded private security, collaborated with state police⁵²¹, and used legal retaliation to suppress protests, often leading to surveillance, harassment, and deadly violence against activists^{522,523}. There have been numerous instances of forced evictions, beatings, and even killings of activists and community leaders who oppose fossil fuel projects^{524,525}. Over the past decade alone, a shocking 1,910 people have been murdered according to well-documented reports for speaking out against fossil fuel projects⁵²⁶. The power imbalance between well-funded companies and vulnerable communities exacerbates these conflicts and human rights violations^{527–530}.

Over the past decade alone, a shocking 1,910 people have been murdered for speaking out against fossil fuel projects.

As with other marginalized groups, for Indigenous peoples legal and economic marginalization frequently compounds the challenges and harms of the situation. Many Indigenous groups lack the legal resources and economic power to defend their land rights effectively. This lack of legal protection and economic leverage opens the door to exploitation and even greater marginalization. The inability to secure and protect their land rights can perpetuate a cycle of poverty and disenfranchisement, making it difficult for communities to achieve sustainable development and economic self-sufficiency.



Seth Harris

Citizen of New River Catawba Nation,
Program Director - 7 Directions of
Service

My name is Seth Harris, and I am a citizen of the New River Catawba Nation. I hold a Bachelor of Science in Geography with a minor in Geology, and I spent 24 years working as a county planner for local government. After years of volunteering for environmental justice groups, I joined the staff of 7 Directions of Service in 2022, and I also serve on the administrative council for my Nation.

I became deeply involved in the movement to stop the Atlantic Coast Pipeline in eastern North Carolina. I volunteered with a primarily Lumbee group to ensure that the Indigenous voice was present in discussions about the pipeline that was directly impacting our communities. Through the dedication of grassroots activists, we successfully stopped the Atlantic Coast Pipeline. That victory strengthened my resolve, and I became part of the fight against the Mountain Valley Pipeline and MVP Southgate. I've lobbied state and federal elected officials, urging them to halt fossil fuel expansion and protect our lands and people.

One of the challenges we face in North Carolina is the division among Indigenous communities. Large industries exploit this division to advance their agendas, particularly the expansion of fossil fuel projects. These industries thrive on our disunity, and it's become one of my goals to educate our communities about their rights and the manipulative tactics these corporations use.

The impacts on our communities are devastating. We've seen alarming increases in childhood health problems, respiratory issues, and cancer. The continuation of imperial colonial practices on our lands has deeply affected the mental health of our people, compounding the generational trauma we've endured for hundreds of years. This trauma manifests in our communities through substance abuse and alcohol dependency, creating cycles of pain and struggle.

The effects of fossil fuel extraction on our communities cannot be ignored. These projects don't just harm the environment; they harm our people, our health, and our future. Indigenous sovereignty must be respected, and it's vital that Indigenous community leaders—not just tribal governments—are included in these discussions. Our voices matter, and we must be at the table when decisions are made about our lands and our lives.

5.4 Corruption, Undue Influence, and Disruption to Ethical Governance

Beyond the localized harms inflicted on communities, fossil fuel companies, both private and state-owned, engage in systemic practices that undermine governance, justice, and climate policy. While this section focuses on publicly traded companies, national oil entities from countries such as the UAE, Saudi Arabia, and Azerbaijan also maintain troubling records of corruption, repression, and unethical influence in international negotiations. Operating with limited transparency and deeply intertwined with authoritarian regimes, these state-backed firms wield disproportionate influence on global energy policy while suppressing dissent.

Bribery is a recurrent issue. A review of UK cases from 2008–2012 found the oil and gas sector responsible for nearly one-fifth of all bribery prosecutions, primarily for foreign payments and kickbacks⁵³¹. In 2021, a Paris court fined Total €500,000 for bribing an Iranian official between 1997 and 2004⁵³². Such misconduct facilitates operations with minimal oversight⁵³³.

A review of UK cases from 2008–2012 found the oil and gas sector responsible for nearly one-fifth of all bribery prosecutions, primarily for foreign payments and kickbacks.

The industry also invests heavily in lobbying and public relations to shape policy. In the U.S., fossil fuel companies have systematically misled the public through greenwashing, astroturfing, funding climate denialism, and exaggerating scientific uncertainty^{534–537}.

These efforts have fueled one of the highest global rates of climate denialism^{538,539}, even as polls show broad public support for a clean energy transition⁵⁴⁰. Despite this, the industry continues to obstruct climate action through extensive lobbying⁵³⁷. For instance, in 2023, a gas-linked dark money group succeeded in labeling gas as “green energy” in Ohio⁵⁴¹, and in 2018, fossil fuel money helped defeat major climate initiatives in Washington and Colorado⁵⁴². From 2008 to 2018, trade associations tied to the industry spent \$2 billion, 27 times more than climate advocacy groups, lobbying against climate policies⁵⁴³.

Conflicts of interest are widespread. In 2023, over 1,500 U.S. lobbyists were found to represent fossil fuel firms while also lobbying for liberal cities, universities, and environmental groups^{548,549}. Examples include State Farm, which halted new insurance policies in California due to climate risks while employing lobbyists for fossil fuel firms⁵⁴⁴, and Baltimore, which sued ExxonMobil for climate damages while sharing a lobbyist with the company⁵⁴⁵. Syracuse University, despite divesting from fossil fuels, retained a lobbyist with oil and gas clients⁵⁴⁶.

Fossil fuel influence has also permeated international climate negotiations. At COP meetings, industry actors have promoted language favoring continued fossil fuel use via terms like “unabated” combustion and proposed technologies such as Carbon Capture and Storage (CCS)—which to date have not delivered (see Carbon Capture and Storage, p.29). At COP26, there were 503 fossil fuel lobbyists; that number rose to 636 at COP27 and surged to 2,456 at COP28^{547,548}.

FOSSIL FUELS AND CLIMATE NEGOTIATIONS

Fossil fuels were formally named in a UNFCCC decision for the first time at COP26⁵⁵⁴, which called for phasing down unabated coal and eliminating inefficient subsidies. However, this language was weakened from initial drafts. At COP28, the decision advanced to call for a “transition away from fossil fuels” and ending “inefficient fossil fuel subsidies...as soon as possible”²⁵⁶. Yet, vague definitions and lack of time-bound commitments continue to hinder alignment with the 1.5°C goal.

Over the past three decades, climate negotiations have narrowly focused on reducing emissions, particularly CO₂. This CO₂ emissions-centric lens ignores broader harms tied to fossil fuel production, including ecological destruction, health risks, and social injustice. Technologies like CCS cannot address these impacts. Addressing the climate crisis requires confronting the full extent of fossil fuel harm.

The entrance to UNFCCC COP 29



Matthew TenBruggencate

Industry corruption and collusion with governments also enable subsidies, deregulation, and enforcement failures⁵⁵⁵. Tactics include rigged bidding for public land^{556,557}, tax breaks that distort energy markets⁵⁵⁸, and weakening of environmental and labor protections^{559,560}. These efforts erode regulatory frameworks and legal protections, while practices like selling old assets to shell firms that then declare bankruptcy help companies evade cleanup responsibilities^{549,550}.

Public perception is shaped through PR campaigns, which promote fossil fuels as essential to economic stability while downplaying harms^{551,552}. In low- and middle-income countries—and even some

wealthier states—weak enforcement enables environmental degradation and labor exploitation. Underfunded public institutions cannot counter powerful polluters, whose practices often include deforestation, land grabbing, and toxic waste disposal. In Nigeria’s Niger Delta, Shell and others have caused extensive environmental and health damage through oil spills and neglect^{553,554}.

Labor rights violations are also endemic. In countries with weak protections, fossil fuel workers face unsafe conditions, long hours, low pay, and in some cases, child or forced labor^{555–558}. These patterns underscore the broader exploitative nature of the fossil fuel economy and its obstruction of ethical governance.



Dr. Katriona (Kate) Wylie

General Practitioner, North Eastern
Health Centre, Tea Tree Gully,
South Australia

Executive Director of Doctors for
the Environment Australia

As a general practitioner in suburban Adelaide I have seen many patients who have had their health impacted by fossil fuels. Patients impacted by heat and heatwaves, patients impacted by fire and smoke, by air pollution, by increased frequency and severity of asthma and hayfever; so many impacts of fossil fuel induced climate change.

But the thing that I see most frequently is the mental health impacts brought about by people's awareness of the climate health emergency and the successive failures of our governments to protect our health from the hazards of fossil fuels. Grandparents and parents worried about their children and what kind of world they are being left in, young people scared about their future and disillusioned by the ongoing expansion of coal and gas exports in Australia and our continued dependence on fossil fuels.

The case I find most personally troubling is that of a young woman requesting a referral for permanent contraception. This young woman was twenty-eight at the time and was wanting to see a gynaecologist for a tubal ligation. When I asked her why, and especially in light of her age and our expectation as doctors that at thirty she might change her mind, she said that she didn't want to bring a child into this world because of climate change. This intelligent, inquisitive young woman looked to the future and saw no hope for future generations and did not want the heartbreak of seeing her future child experiencing the horrors of our warming world. She understood that the climate health emergency means water insecurity, civil unrest and displacement, generally a harder world and she had made the call, that it would be unethical to bring a baby into such an inhospitable planet. As a parent my child is a fundamental motivation for my advocacy for climate action, but I understood her position and that it came from her profound grief for the tragedy of climate change. I will not share here what her final outcome was, but needless to say we have had many a conversation about the ethics of the fossil fuel industry as they continue to pedal their dangerous product and what that means for personal and planetary health. To think that we have created a world where people are choosing childlessness, when having a child is considered by many as the very essence of our humanity, is a profoundly upsetting thing.

My call is to the executives of the fossil fuel industry to use their capacity and power to phase out fossil fuels to protect the health of our planet, so that human civilization can flourish, where young adults do not have to face impossible choices and where children can live long and healthy lives on a safe planet.



Desmond DSa

Co-Founder of South Durban
Community Environmental Alliance
(SDCEA)



Shweta Narayan
Global Climate and Health Alliance

Durban rich coastal zone and one of South Africa's National Treasures eg. unique flora and fauna, wetlands, dune grasslands, estuary, and a wonderful display of marine life. Our wonderful spaces are been degraded by the largest industrial polluting centre specifically in South Durban which has impacted negatively on the quality of the living environment for all residents. South Africa's growth and economic framework put profits before people.

Our families have had to breathe toxic pollution for generations; many have died from cancer, asthma and Leukemia and other related sickness. We have since COVID 19 experienced the shutdown of the 2x refineries and chemical industry. We have seen clear skies and no smells in our area as the two refineries remain close. The Malaysian owned Petronas refinery exploded on the 4th December 2020 and the biggest crude oil refinery in South Africa Shell & BP closed on the 12th April 2022 after the rain bomb that affected Durban and over 500 people lost their lives including women and children. This refinery was completely flooded out and has since not reopened. Shell has pulled out of South Africa which we are quite happy as residents as we breathe fresh air. We expect that Shell and Petronas management in the Hague or London or in Malaysia will be held accountable for the damage of their facilities on the peoples and communities of South Durban health.

We call on the governments of the world to start the Just Transition by phasing out toxic industries and hazardous landfill sites. Not in our backyard and not in anyone else's backyard.



06
Family fun near windmills
showcases global
innovation in renewable
energy.

iStock

A Just and Health-Focused Energy Transition

Major international bodies, including the WHO, agree that phasing out fossil fuels is essential to limiting global warming to levels compatible with human health. The IEA's Net Zero Report underscores the urgency, stating that “the path to net-zero emissions is narrow” and demands “immediate and massive deployment of all available clean and efficient energy technologies.” It further affirms that achieving net zero requires “a huge decline in the use of coal, oil and gas” and that no new fossil fuel infrastructure is needed beyond projects underway as of 2021. However, the transition to clean energy is not solely a technological endeavor – it must be shaped by policy frameworks that ensure it is fair, inclusive, and health-promoting. Without such safeguards, existing inequalities may be deepened⁵⁵⁹.

The IPCC's Sixth Assessment Report⁵ highlights that equity, climate justice, social justice, inclusion, and just transition principles are essential for ambitious climate mitigation and resilient development. A just transition entails respect and dignity for vulnerable groups, the creation of decent work, social protection, employment rights, equitable access to energy, and inclusive stakeholder dialogue.

Recognizing this, Parties at COP27 launched the Just Transition Work Programme under the UNFCCC – a multilateral framework to define and implement just transition policies. This was further operationalized at COP28, where governments committed to holding regular dialogues, formally embedding just transition within international climate governance^{560,561}. This represents a critical opportunity: to design transitions that not only reduce emissions but also protect health, uphold dignity, and promote equity. A just energy transition must extend beyond labor market protections to include health safeguards, social protection, and restorative measures for all communities affected by both fossil fuel extraction and the transition itself.

6.1 Transitions Across Sectors

There are key sectors that account for the majority of all fossil fuel use (see table). Bringing a healthy, just transition lens to phasing out fossil fuels from these sectors is necessary to ensure a healthy and equitable transition for populations around the world.

Challenges

Solutions

Electricity

- Over 60% of global electricity still comes from fossil fuels, driving air pollution and climate change⁵⁶².
- 685 million people lack electricity access, particularly in rural and low income regions, undermining health and development^{563,564}.
- Reliance on biomass for energy leads to over 3 million deaths annually due to household air pollution, disproportionately affecting women and children⁵⁶⁵.
- Poor electricity access degrades healthcare delivery^{565,566}.
- Transition risks from renewable energy, including negative health impacts from poorly managed hydropower and critical mineral extraction^{567–569}.

- Phase out fossil fuel based electricity through the investment in clean, renewable energy systems that improve public health.
- Expand decentralized renewable energy systems (e.g., solar microgrids) to underserved areas, leapfrogging the need for fossil fuel infrastructure and supporting energy sovereignty.
- Replace biomass with clean cooking and heating solutions, such as electric and solar-powered systems, prioritising marginalized and frontline communities.
- Prioritize electrification of health facilities using reliable, off-grid renewables with storage.
- Regulate and manage renewable energy supply chains to protect community health and ecosystems.



Challenges

Solutions

Industry

- Steel and cement production rely heavily on coal, contributing significantly to GHG emissions and air pollution, with the steel industry alone responsible for ~7% of global emissions⁵⁷⁰.
- Fossil fuel combustion in industrial processes generates hazardous air pollution, increasing risks of respiratory and cardiovascular diseases in nearby communities, often low-income or marginalized.
- Plastics are produced from oil, gas liquids (NGLs) and coal, and can generate toxic pollutants in the production process.



- Accelerate adoption of cleaner production methods such as hydrogen-based steelmaking (e.g., HYBRIT) and electric arc furnaces powered by renewables, while supporting affected communities to avoid job losses and economic marginalization.
- Implement stronger pollution controls and environmental regulations to reduce toxic emissions. Prioritize health protections for frontline communities and include them in environmental decision-making.
- Prioritize systemic reduction in plastic production, invest in reuse systems, and avoid false solutions like bioplastics. Support a strong, binding global plastics treaty that includes provisions on health, chemical safety, human rights, and corporate accountability. Ensure affected communities have a voice in negotiations.

Transport

- Road transport, aviation, and shipping drive air pollution, disproportionately affecting communities near roads, ports, and airports^{571,572}.
- Electric vehicles reduce tailpipe emissions but do not address inequality or non-exhaust pollution (e.g., tyre & brake wear). Analysis shows that almost 2,000 times more particle pollution is produced by tyre wear than is pumped out of the exhausts of modern cars, polluting air, water and soil with a wide range of toxic organic compounds, including known carcinogens⁵⁷³.
- Low-income and marginalized communities lack access to safe, affordable, and reliable transport.
- Fossil fuel transport policies are often costlier to public health systems.



- Accelerate shift to zero-emission vehicles, with strong emissions regulations and targeted protections for overexposed communities.
- Invest in active and public transport, including safer non-vehicle options like separated bike lanes and improved walking and biking infrastructure, to reduce overall car dependence and address equity, physical inactivity, and air pollution^{574–576}.
- Design inclusive transport systems that prioritize underserved areas and integrate health equity into planning.
- Implement low-emission zones and reinvest health savings, as seen in London's Ultra Low Emissions Zone which is estimated to save the National Health Service 5 billion GBP over three decades through air quality improvements alone^{577,578}.

Challenges

Solutions

Food and Agriculture

- Food systems account for 15% of fossil fuel use annually—more than the emissions of the EU and Russia combined⁵⁷⁹.
- Fossil fuel use in food systems alone would overshoot the 1.5°C budget by 2037, even if 2030 pledges are met⁵⁷⁹.
- Most agrochemicals (fertilizers and pesticides) are derived from fossil fuels⁵⁸⁰.



- Shift to agroecological and regenerative farming to reduce fossil dependence, restore ecosystems, and improve nutritional quality.

Align agricultural policies with climate goals, prioritizing sustainable, low-carbon food systems.

- Support fossil-free alternatives and reduce chemical inputs to improve soil health and reduce exposure risks.

Buildings and Residences

- 2.1 billion people lack access to clean cooking fuels and technologies⁵⁸¹. Household air pollution causes over 3 million deaths annually from stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer⁵⁶⁶.
- Poor insulation and inefficient buildings increase energy poverty and vulnerability to extreme heat.
- Household fossil fuel use undermines decarbonization and harms community health.



- Prioritise electric stoves and heat pumps powered by renewables. Subsidise efficient biofuels stoves, local biogas, and electrical appliances for those living in poverty.

Retrofit homes for energy efficiency and passive cooling. Incentivize adoption of electric heating and cooling systems.

- Integrate clean household energy into national fossil fuel phase-out and public health strategies.

Health Sector

- The health sector is responsible for nearly 5% of global GHG emissions⁵⁸².



- At COP26, and in the years since, 85 national governments have committed to resilient and/or low-carbon sustainable health systems (of which 37 have set net zero target dates), and over 60 health care institutions representing the interests of over 14,000 hospitals and health centres have joined the UNFCCC Climate Champions Race to Zero health care cohort^{583–585}. In their 2024 Communiqué G7 leaders reaffirmed “the objectives of the COP28 Declaration on Climate and Health to transform health systems to be climate-resilient, equitable, low-carbon, and sustainable”⁵⁸⁶.

There are two specific areas in which just transition considerations are emerging that require awareness and consideration: The question of clean cooking, for households currently dependent on burning coal or biomass (see 3.8 Residential Heating and Cooking, p.43); and the extraction of critical minerals needed for renewable energy (see Critical Energy Transition Minerals, p.82). Both of these issues are important in their own right, and also illustrate some dimensions of applying a healthy and just transition approach.

PRINCIPLES OF JUST AND HEALTH-FOCUSED TRANSITION

The following principles can guide fossil fuel transition in the above sectors. These principles are adapted from Principles of just and health energy transitions, developed by Health Care Without Harm⁵⁸⁷.

1. Reduce Emissions: The Most Urgent Imperative

The most urgent health intervention is to rapidly phase out fossil fuels to limit warming and prevent climate-related health crises, including heatwaves, malnutrition, vector-borne diseases, and air pollution-related deaths. Every fraction of a degree matters.

2. Provide finance commensurate with historical responsibility

High-income countries, accountable for 92% of global historical emissions⁵⁸⁸, have a responsibility under international law to lead fossil fuel phase-out and finance equitable transitions in lower-income countries – supporting clean, renewable energy, healthcare, and sustainable livelihoods.

3. Protect and promote public health

Health must guide all decisions to avoid transitions that create new harms (e.g., unsafe mining for clean, renewable energy tech). Maximize health gains via clean air, active mobility, safe jobs, and healthy environments. Integrating Health in All Policies (HiAP) approaches and conducting health impact assessments (HIAs) to systematically evaluate the health implications of energy, transport, and industrial projects is key.

4. Develop safe, productive, and sustainable livelihoods

Transitioning away from fossil fuels must ensure safe, sustainable employment for workers – particularly in fossil fuel, transport, agriculture, and chemical industries. Retraining, income support, and social protection are essential for long-term health and dignity^{501,589}.

5. Maintain and improve equitable access to essential services

Access to clean, renewable energy, transport, healthcare, education, and housing are key health determinants. Transition policies must expand access to these services, especially for communities made vulnerable by fossil fuel dependency or exclusion.

6. Ensure participation and autonomy of people and communities

Communities most affected by fossil fuel harms, or by the transition, must shape decisions. Indigenous knowledge, community ownership (e.g., of renewables), and participatory governance is essential for context-specific, effective, and equitable health outcomes.

7. Require remediation by polluters

From 1988 onwards, over half of the global industrial greenhouse gases (GHGs) can be traced back to just 25 corporate and state-owned producers. As per the Polluter Pays Principle, enshrined in the Rio Declaration and international law and instruments, “the polluter should, in principle, bear the cost of pollution” (UN, 1992). Reparation and remediation should fund land restoration, health care, and clean, renewable energy infrastructure in affected communities, reducing intergenerational health harms.

6.2 The Economic Case for a Just and Health-Focused Energy Transition

Fossil fuels impose vast and undercounted economic burdens, largely through their health and environmental externalities. In 2022, the International Monetary Fund estimated global fossil fuel subsidies at US\$7 trillion – of which US\$5.7 trillion represented indirect costs, including healthcare expenditures, productivity losses, and climate-related damages. These costs are disproportionately borne by governments, communities, and households, diverting public resources away from essential services such as healthcare and education⁵⁹⁰.

Air pollution alone, primarily driven by fossil fuel combustion, cost the global economy US\$2.9 trillion in 2018 – equivalent to 3.3% of global GDP – through premature mortality, lost labour, and diminished quality of life^{591,592}. In the U.S., fossil fuel-related air pollution and climate impacts account for over US\$820 billion annually¹⁴. Specific sources such as oil and gas flaring contribute US\$7.4 billion in health damages⁴¹⁰, while the U.S. oil and gas sector caused an estimated 7,500 premature deaths and US\$77 billion in health costs in 2016 – triple the climate costs of methane emissions alone²²³.

Air pollution alone, primarily driven by fossil fuel combustion, cost the global economy US\$2.9 trillion in 2018 – equivalent to 3.3% of global GDP – through premature mortality, lost labour, and diminished quality of life.

Globally, heat exposure – worsened by climate change – resulted in the loss of 490 billion labour hours in 2022, translating into US\$863

billion in productivity losses⁵⁸². The monetized value of heat-related mortality surpassed US\$240 billion, or 6.7% of global GDP⁵⁹³. In high-income countries, air pollution accounts for 3.5% of total health expenditure, rising to 7.4% in rapidly industrialising nations such as Sri Lanka⁵⁹⁴.

The cumulative effect is stark: every US\$1 of fossil fuel subsidy in G20 countries generates an estimated US\$6 in health-related costs⁵⁹⁵. By contrast, the economic case for renewables is compelling. Redirecting fossil fuel subsidies – US\$1.3 trillion in 2022 – toward clean, renewable energy and health systems would yield powerful returns⁵⁹⁶. Removing these subsidies and pricing pollution could avert 1.6 million deaths annually, raise US\$4.4 trillion in revenue, and reduce global CO₂ emissions by 43% by 2030, within the limits needed to avoid catastrophic warming⁵⁹⁷.

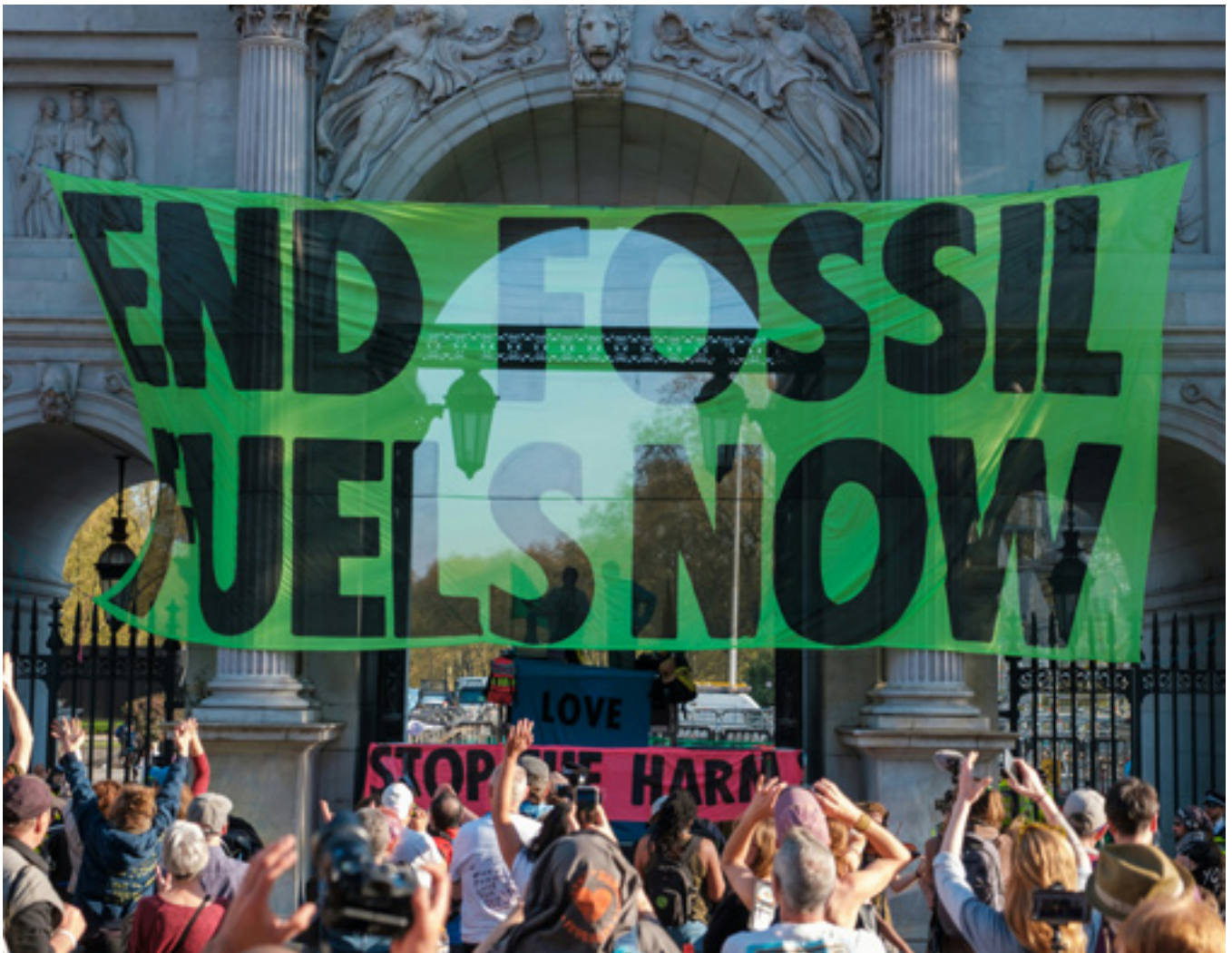
Health benefits alone can offset or exceed the cost of climate action. The UNFCCC estimated that meeting Paris climate targets would generate up to US\$564 billion in health and productivity gains in European countries⁵⁹⁸. Research has found that in China and India, the health co-benefits from improved air quality due to climate mitigation policies could fully compensate for the costs of implementing these policies in most scenarios⁵⁹⁹.

Air quality improvements in the U.S. since 1970 have returned US\$30 for every US\$1 invested⁶⁰⁰. A clean, renewable energy transition aligned with 1.5°C could prevent trillions in health losses, including US\$3.9 trillion from air pollution in major cities by 2050⁶⁰¹.

ADDRESSING CRITICAL ENERGY TRANSITION MINERALS FOR A JUST GLOBAL TRANSITION – THE UN SECRETARY-GENERAL’S PANEL ON CRITICAL ENERGY TRANSITION MINERALS⁶⁰²

The shift to renewable energy is driving soaring demand for critical minerals like lithium, cobalt, and rare earths, expected to triple by 2030. While vital for technologies such as batteries and solar panels, their extraction could repeat the same pattern as historical models - causing human rights abuses, environmental harm, and economic inequities in resource-rich countries. To ensure a just transition, the UN Secretary-General’s Panel proposes seven guiding principles: human rights protection, environmental sustainability, economic diversification, transparent trade, inclusive governance, international cooperation, and a circular economy. Key actions include traceability systems, global cooperation, and capacity building to enable equitable, sustainable mineral supply chains.

Campaigners advocating for the end of fossil fuels, London.



 *Ehimetalor Akhere Unuabona*
Unsplash



Children from a coastal village near a power plant in Gujarat, India.

📷 Joe Athaly /
Rewa Images

Policy Recommendations

The response to climate change provides an unparalleled opportunity to improve health and redress health inequities, as many climate solutions deliver immediate and significant health benefits. A just phase-out of fossil fuels is critical to achieving these goals. More broadly, there is a fundamental need to address global injustices that underpin both the climate and health crises, ensuring that future energy systems are equitable and provide fair access to resources. There is a clear need to carefully assess the health benefits and trade-offs of climate action, including how the phase-out of fossil fuels is implemented, to ensure a just and equitable transition that prioritizes public health. To this end, we offer eight policy recommendations.

1. Halt New Fossil Fuel Exploration and Development

To effectively address the climate crisis, halting new fossil fuel exploration and development is essential. Expanding extraction directly undermines global climate targets, including the 1.5°C goal of the Paris Agreement. The IEA stated in 2021 that no new coal, oil, or gas fields should be approved to stay on track for net-zero by 2050⁶⁰³. Research in *Nature* reinforces this, estimating that 60% of oil and gas and 90% of coal reserves must remain unextracted to limit warming to 1.5°C⁶⁰⁴. Yet, new fossil fuel projects continue to be approved, threatening climate goals and risking irreversible damage.

New fossil fuel infrastructure also carries major economic risks. Carbon Tracker estimates up to US\$1 trillion in assets could be stranded by shifting regulations and the transition to renewables⁶⁰⁵. These projects often harm marginalized communities through pollution, health impacts, and displacement.

Approving new fossil fuel and petrochemical projects is incompatible with climate commitments. Countries such as Denmark, Colombia, and Costa Rica have formed the Beyond Oil and Gas Alliance (BOGA) to end new exploration and phase out existing production⁶⁰⁶. Initiatives like the Fossil Fuel Non-Proliferation Treaty⁶⁰⁷ seek a global agreement to end new exploration, phase out production, and ensure a just transition. The Treaty has gained support from at least 15 countries—including Colombia⁶⁰⁸—as well as cities like Los Angeles, Sydney, and Barcelona. The WHO has endorsed the Treaty's goals,

alongside thousands of health professionals and organizations worldwide⁶⁰⁹. A new initiative aims to establish a World Commission on Fossil Fuel Phase Out to identify barriers and build consensus for a global transition⁶¹⁰.

Despite growing momentum, contradictions persist. In 2018, New Zealand banned new offshore oil and gas permits⁶¹¹, aligning policy with climate goals, but reversed the ban in 2024⁶¹². France banned new oil and gas exploration and pledged to phase out production by 2040⁶¹³, yet French company TotalEnergies continues expanding fossil fuel operations abroad, especially in Africa—highlighting the gap between domestic policy and corporate action.

Halting new fossil fuel development must be paired with time-bound commitments to phase out existing extraction. A just transition requires deadlines, support for fossil fuel-dependent economies, job creation in clean energy, and strong social protections. The IEA's Net Zero Roadmap calls for phasing out coal by 2030 in advanced economies and by 2040 globally, with steep declines in oil and gas use thereafter⁵⁵⁹. However, voluntary pledges have proven insufficient as production expands⁶¹⁴. Legally binding targets, backed by regulatory and financial frameworks, are essential to align with climate science and protect health, communities, and economies.

Halting new fossil fuel development must be paired with time-bound commitments to phase out existing extraction.

CASE STUDY

Accelerating Global Action on Coal: The Powering Past Coal Alliance (PPCA)

The Powering Past Coal Alliance (PPCA) is the world's leading coalition of governments and businesses working to accelerate global coal phase out. PPCA members commit to take concrete action as a national or subnational government, utility, business, or industry institution by not building new coal power assets and achieving the phase out of unabated coal-fired power on timelines aligned with the Paris Agreement.

Since its launch, more than 180 governments, organizations, and businesses have joined the Alliance, and through their policies and investments, committed to advancing the coal-to-clean transition in a just manner and safeguarding public health. Many members have even accelerated coal phase out commitments with support from the Alliance, despite global energy security concerns, as the growing economic and social benefits of the transition stack up in favour of clean, renewable energy alternatives⁶¹⁵.

The growing body of coal transition research and evidence continues to tell the same story. For example, an early phase out of all coal plants around the world could help avoid over 14.5 million premature deaths from air pollution over the next three decades while for every US\$1 invested in coal phase out and renewables replacement globally can bring US\$3 in social and economic benefit^{616,617}. Significant financial and technical challenges exist, particularly in Asia, where new coal plants are being built and adverse health impacts from coal-fired electricity generation are most acute, but scalable solutions to accelerate the coal-to-clean transition in a just and economically sound way are being piloted today⁶¹⁸.

By committing to No New Coal and coal power phase out with the PPCA, countries and businesses send clear signals to industry, communities and investors helping to unlock finance and ensure an orderly transition to cleaner, healthier energy systems.

Children collecting coal ash from power plant waste in India.



Amirtharaj Stephen

2. End Fossil Fuel Subsidies and Redirect Savings to Health

Direct fossil fuel subsidies, estimated at US\$1.3 trillion globally in 2022⁵⁹⁷, encourage the use of harmful energy sources that contribute to climate change and threaten public health. These subsidies, including financial support, tax breaks, and incentives, reduce the cost of fossil fuels, thereby promoting their continued use over cleaner alternatives.

Redirecting these subsidies to health-protecting investments and climate mitigation measures can yield both immediate and long-term benefits. Investments in renewable energy, such as solar and wind infrastructure, can reduce greenhouse gas emissions and improve air quality and health. Strengthening public health infrastructure, especially in vulnerable regions, would enhance the capacity to respond to climate-induced health crises. Additionally, funding climate-resilient infrastructure, like flood defences and drought-resistant crops, can protect communities from adverse climate impacts. Moreover, pollution mitigation efforts, such as electric public transport and waste management systems, could significantly decrease disease burdens related to environmental pollutants. Eliminating fossil fuel subsidies and reallocating funds to these areas offers a powerful strategy for fostering a healthier future.

Redirecting these subsidies to health-protecting investments and climate mitigation measures can yield both immediate and long-term benefits.

3. Clean Up Existing Fossil Fuel Production

While a full transition away from fossil fuels is essential to meet long-term climate goals, immediate action is also necessary to reduce the most harmful impacts of ongoing fossil fuel production. This includes prioritizing cleanup of facilities near communities and rapidly

cutting methane emissions—through halting venting and flaring and fixing leaks—to reduce both short-term climate impacts and public health risks. These measures, however, must not be used to justify continued fossil fuel development. Mitigation efforts should occur alongside a clear phase-out strategy and support for a just transition for affected workers and communities.

Mitigation efforts should occur alongside a clear phase-out strategy and support for a just transition for affected workers and communities.

The oil and gas sector is a major source of methane, a potent greenhouse gas that also contributes to ground-level ozone and carries toxic co-pollutants throughout the production cycle. The IEA estimates that existing, cost-effective technologies could reduce methane emissions by 75% by 2030⁶¹⁹. In the U.S., the EPA has proposed regulations aiming for an 87% reduction from 2005 levels by 2030⁶²⁰. Stronger regulations on flaring and venting are essential, as oil-related flaring alone emitted over 400 million metric tons of CO₂ equivalent in 2020⁶²¹.

The Global Methane Pledge (GMP), launched at COP26 by the EU and the U.S., now includes 159 participants as of January 2025⁶²². Signatories commit to voluntary action to help reduce global methane emissions by at least 30% from 2020 levels by 2030. Achieving this target requires national or subnational policies that enforce these commitments, including mandatory leak detection and repair using satellite and drone technology, and economic incentives like methane fees to drive investment in cleaner infrastructure.

Beyond methane, fossil fuel operations release numerous toxic chemicals and co-pollutants, posing serious and ongoing health risks to frontline communities. To effectively curb these harms, governments must implement stringent regulations and enforcement measures, including:

- **Stronger emission standards for refineries and processing facilities** – Governments should adopt and enforce stricter air and water pollution limits, including the phase-out of hazardous emissions from oil and gas operations, similar to the EU Industrial Emissions Directive⁶²³.
- **Mandatory real-time air and water quality monitoring** – Operators should be required to install continuous emissions monitoring systems (CEMS) at all fossil fuel facilities, with publicly accessible data to ensure transparency and accountability.
- **Stricter limits on flaring, venting, and hazardous waste disposal** – Policies must mandate the elimination of routine flaring and venting, with strong penalties for non-compliance, and require safe disposal of hazardous byproducts, preventing contamination of drinking water sources and farmland.
- **Stronger environmental enforcement and community-led oversight** – Governments should increase penalties for pollution violations, strengthen independent regulatory agencies, and fund community monitoring initiatives that empower local residents to track pollution and file legal complaints against violators.
- **Cumulative impact assessments** – Permitting processes should require comprehensive health and environmental impact assessments that consider the cumulative pollution burden in affected areas before approving new fossil fuel infrastructure.
- **Targeted pollution reduction programs for frontline communities** – Governments must allocate funding for pollution remediation, such as soil and water cleanup projects, in communities suffering from decades of fossil fuel-related contamination.

These policies must be implemented without delay, ensuring that fossil fuel companies clean up existing production while a just transition away from fossil fuels progresses.

4. Internalize the Health Costs of Fossil Fuels through the “Polluter Pays” Principle

The “Polluter Pays” principle ensures that those responsible for pollution bear the costs of its environmental and health impacts (see Principles of Just and Health-Based Transition, p.80). Despite well-documented harms from fossil fuel combustion—including respiratory illness, cardiovascular disease, and premature death—these health costs are typically externalized, falling on public health systems and communities. Internalizing these costs would shift the financial burden to polluters and create incentives to reduce emissions.

The “Polluter Pays” principle ensures that those responsible for pollution bear the costs of its environmental and health impacts.

In the U.S., the Clean Air Act allows for fines based on the public health damage caused by pollution⁶²⁴. Expanding this approach to cover broader health costs would encourage fossil fuel companies to invest in cleaner technologies and transition to renewables.

Legal frameworks are also essential. In 2021, Friends of the Earth Netherlands won a lawsuit against Shell, with a Dutch court ordering the company to reduce CO₂ emissions by 45% by 2030 in line with the Paris Agreement⁶³⁷. Although Shell’s appeal succeeded in 2024⁶²⁵, the ruling affirmed that corporations have a legal duty to cut emissions—setting a key precedent for future climate litigation.

National laws requiring companies to pay for pollution-related health damages can further reinforce this principle. Sweden’s carbon tax is a proven example, reducing emissions while sustaining economic growth by internalizing environmental and health costs⁶²⁶. In India, the National Green Tribunal ruled in *Samir Mehta vs. Union of India* that companies responsible for a sunken, polluting coal- and oil-laden vessel must reimburse the government for cleanup and remediation^{627,628}.

5. Initiate Community-Led Health Research and Action for Fossil Fuel-Affected Areas

Initiate and support community-partnered research to assess the full spectrum of health harms caused by fossil fuel activities and climate change on highly impacted communities. This research should be co-designed and co-led with affected communities, combining Western scientific approaches with Traditional and Indigenous Knowledge systems to reflect a more holistic understanding of health — including mental, physical, spiritual, and cultural dimensions.

Such studies should not only document the lived realities of harm — including pollution exposure, climate-driven displacement, loss of cultural practices, and psychological distress — but also build community ownership and leadership in shaping the research agenda. Importantly, this work must not stop at data collection: the results must directly inform concrete action, including targeted health interventions, policy reforms, environmental remediation, and investments in community resilience. Governments, funders, and public health institutions have a responsibility to ensure that the findings of these studies lead to justice-driven outcomes and real change for the communities affected.

6. Counter and Curb Fossil Fuel Industry Influence, Advertising and Disinformation

Fossil fuel advertising and sponsorships play a significant role in sustaining oil, gas, and coal consumption by shaping public perception and downplaying environmental and health harms. Like the tobacco industry, fossil fuel companies market their products as essential to modern life while concealing their destructive impacts. They misleadingly promote liquefied natural gas (LNG) as a “bridge” fuel despite its substantial greenhouse gas emissions and

continued role in driving climate change and pollution⁶²⁹.

This disinformation undermines climate action, public health, and environmental justice. Banning fossil fuel ads, including digital and social media, and investing in counter-marketing can help dismantle greenwashing and reduce the normalization of fossil fuels. Such bans have been implemented in cities like Amsterdam, which prohibited fossil fuel advertising in public spaces in 2021⁶³⁰. Medical professionals in Canada⁶³¹ and Australia⁶³² have also called for comprehensive ad bans.

Ad bans support climate and health goals by limiting corporate influence over policy and public discourse, while shifting attention and investment toward clean energy. These efforts align with the Paris Agreement and promote a cultural transition to sustainable energy. Notable examples include the Hague’s municipal ban⁶³³, France’s national prohibition on petrol and diesel ads in 2021^{634,635}, and UK rulings against misleading advertisements by ExxonMobil⁶³⁶ and Shell⁶³⁷. Banning fossil fuel advertising is a critical step toward ensuring accurate public information and advancing a just transition.

Ad bans support climate and health goals by limiting corporate influence over policy and public discourse, while shifting attention and investment toward clean energy.

At the same time, it is essential to restrict fossil fuel companies and petro-states from influencing international negotiations, including the UN plastics treaty and climate COPs. Their lobbying power has repeatedly delayed progress and weakened outcomes in favor of continued fossil fuel production. Safeguards must be put in place to ensure transparency, prevent conflicts of interest, and protect the integrity of global agreements focused on public health, environmental protection, and climate justice.

CASE STUDY

The impact of Canada's New Anti-Greenwashing Law on Oil Majors and their "Astroturf" groups

In June 2024, Canadian oil majors and their affiliated astroturf groups responded dramatically to the enactment of new amendments included in Bill C-59 designed to crack down on greenwashing in Canada's Competition Act, requiring all corporations to substantiate their environmental claims with evidence based on "adequate and proper" products tests or "adequate and proper substantiation in accordance with internationally recognized methodology" for claims regarding businesses. The law reverses the burden of proof on green claims. Whereas before the Competition Bureau had to prove the claims were false, the onus is now on companies to show they can back them up with proof.

In response to these new truth in advertising provisions, the Pathways Alliance, a consortium of the six largest oil sands companies in Canada, removed all content from its website and social media channels. Known for promoting carbon capture and storage (CCS) as a "net-zero" solution, this digital blackout suggests a deeper concern over the new regulations. Similarly, industry-backed groups like CanadaAction have begun blocking Twitter followers en masse, and pro-gas websites like BCLNGHelps.ca have disappeared entirely. Even the Alberta government shut down the controversial Alberta Energy "War Room" in response to the threat of federal fines⁶³⁸.

The new provisions represent a significant victory against corporate greenwashing, driven by relentless advocacy from groups like the Canadian Association of Physicians for the Environment (CAPE), Ecojustice, Équiterre, the Centre québécois du droit de l'environnement (CQDE), and a formal complaint by Greenpeace Canada against the Pathways Alliance's ad campaign. These efforts have brought misleading environmental claims into the spotlight, challenging the oil industry's portrayal of CCS as a "silver bullet" for climate change.

Predictably, the oil industry and its allies are pushing back, arguing that the new regulations create "policy uncertainty," suppress free speech, and harm Canadian businesses. They continue to lobby to weaken the guidance currently under consultation on how the law is to be applied. Despite this opposition, Bill C-59 aims to ensure that all businesses are held to the same standard of evidence and transparency, representing a crucial step toward genuine corporate accountability. By dismantling the façade of false solutions and promoting a more honest discussion about environmental responsibility, this legislation sets a new precedent for corporate practices and could inspire similar efforts worldwide.

The Canadian flag with the top of Ottawa's Parliament building.



© Dennis Ludlow, iStock

7. End Fossil Fuel Finance: Align Global Institutions with Climate Goals

Global financial institutions, such as the World Bank, multilateral development banks, and international investment banks, continue to invest billions in fossil fuel projects, which undermines climate goals and delays the transition to renewable energy. Stopping these investments is critical for achieving a sustainable, low-carbon future. Despite their commitments to the Paris Agreement, institutions like the World Bank still fund fossil fuel projects, with US\$12 billion invested from 2016 to 2020 alone⁶³⁹. Halting these investments is essential to align their financial practices with climate targets. Redirecting funds from fossil fuels to renewable energy is vital for achieving net-zero emissions by 2050, as the IEA calls for clean, renewable energy investments to triple to US\$4.5 trillion annually by 2030⁶⁴⁰.

Despite their commitments to the Paris Agreement, institutions like the World Bank still fund fossil fuel projects, with US\$12 billion invested from 2016 to 2020 alone.

Fossil fuel investments often cause significant harm to low-income communities, contributing to environmental damage, displacement, and human rights abuses^{641,642}. Ending such investments would reduce these harms and help protect vulnerable populations. Continued funding for fossil fuels also poses financial risks, with potential stranded assets

reaching up to US\$1 trillion⁶⁴³. The European Investment Bank (EIB) has already phased out fossil fuel funding, signaling that this move is both environmentally and financially prudent. When global financial institutions stop funding fossil fuels, it sets a powerful precedent that encourages private investors to shift toward sustainable finance⁶⁴⁴.

However, there remains an urgent need for more change. For example, despite its pledges, the World Bank continues to directly and indirectly⁶⁴⁵ fund fossil fuel projects, highlighting the need for a comprehensive divestment policy. Similarly, several major international banks, including Citigroup and HSBC, have committed to net-zero emissions by 2050 but undermine these goals by continuing to invest in fossil fuel projects. Reports indicate that JPMorgan Chase, for instance, has financed US\$317 billion in fossil fuels since the Paris Agreement⁶⁴⁶. While some progress has been made—such as through the Glasgow Statement and commitments by a number of countries to end international public financing for fossil fuels—the implementation has been uneven, with notable gaps and backtracking^{647–649}.

Ending fossil fuel investments by global financial institutions is crucial for meeting international climate targets, accelerating the global clean, renewable energy transition, reducing financial and environmental risks, and protecting vulnerable communities. Immediate and decisive action is required to align these institutions' financial flows with a climate-resilient future and to inspire the entire financial sector to follow suit.

8. Lead by Example in the Health Sector

To help propel the rapid phase out of fossil fuels and mitigate their detrimental health impacts, the health community should leverage its significant social and economic influence to drive meaningful change. Health organisations and systems can commit to ambitious decarbonization targets, aiming for net-zero carbon emissions by 2040 or sooner, through reducing energy use, investing in renewable energy sources, and improving energy efficiency. They can also implement green healthcare practices, such as waste reduction, sustainable procurement, and the adoption of low-carbon medical technologies.

Health organisations and systems can commit to ambitious decarbonization targets, aiming for net-zero carbon emissions by 2040 or sooner, through reducing energy use, investing in renewable energy sources, and improving energy efficiency.

A strong focus on divestment can send a powerful message; health organizations, including hospitals, clinics, and professional associations, can publicly commit to divesting from fossil fuel assets and redirecting investments toward renewable energy and sustainable technologies. The impact of health organizations' divestment can be compounded by advocating for financial institutions to divest from fossil fuels and reinvest in health-promoting industries. Additionally, health organizations can adopt sustainable procurement policies, setting high standards for vendors and suppliers that prioritize environmental, social, and governance (ESG) criteria and support local, sustainable businesses to minimize carbon footprints. By taking these steps, the health community has the potential to play a pivotal role in accelerating the transition to a healthier, fossil-free future, reducing greenhouse gas emissions, and enhancing public health outcomes while reinforcing its leadership and credibility. Immediate integration of these strategies into operational plans and advocacy efforts could catalyze the structural change needed for a healthy future.



FG Trade Latin, iStock

Conclusion

The devastating impacts of fossil fuel dependence on the environment and human health are undeniable. While formal research highlights the immense scale of this crisis, personal testimonies reveal a far deeper and more pervasive toll on communities. Yet, amidst this urgent reality lies a transformative opportunity: the transition to a sustainable, equitable future is not only achievable but imperative.

This transition must be grounded in the principles of justice and inclusion, ensuring respect for human dignity, the creation of sustainable and decent jobs, robust social protections, equitable energy access, and the meaningful participation of all rights holders. It is a call to action to reimagine a world where the well-being of both people and the planet takes precedence over short-term profits.



Dr. Jemilah Mahmood

Executive Director, Sunway Center for
Planetary Health, Malaysia

As a medical professional, I have witnessed firsthand the devastating health impacts of fossil fuel pollution—rising respiratory diseases, cardiovascular conditions, and the disproportionate burden on vulnerable communities. This report makes it undeniably clear: fossil fuels are not just an environmental crisis; they are a public health emergency. But this is also a moment of profound opportunity. A just transition to clean, renewable energy is more than an environmental necessity—it is a prescription for healthier lives, cleaner air, and a more equitable future. By moving beyond fossil fuels, we can achieve intergenerational justice for our future children who are owed a healthy planet.

The science is clear. Now is the time for bold action. We as scientists and health practitioners must summon the courage to embrace change, to advocate for policies that prioritise health, and to invest in a future where clean air and clean water are fundamental rights, not privileges.

*The cost of inaction is measured in lives. This transition is not just possible—it is imperative. **The time for a healthier, just world is now.***

References

1. Ritchie H, Rosado P. Our World in Data. 2024. Fossil Fuels. Available from: <https://ourworldindata.org/fossil-fuels>
2. The World Bank. World Bank. [cited 2025 July 14]. Climate Explorer: Climate Change and Air Pollution. Available from: <https://www.worldbank.org/en/news/feature/2022/09/01/what-you-need-to-know-about-climate-change-and-air-pollution>
3. Savannah Bertrand. Environmental and Energy Study Institute. [cited 2025 July 14]. Climate, Environmental, and Health Impacts of Fossil Fuels (2021). Available from: <https://www.eesi.org/papers/view/fact-sheet-climate-environmental-and-health-impacts-of-fossil-fuels-2021>
4. Friedlingstein P, O'Sullivan M, Jones MW, Andrew RM, Hauck J, Landschützer P, et al. Global Carbon Budget 2024 [Internet]. Earth System Science Data; 2024 [cited 2025 Jan 25]. Available from: <https://essd.copernicus.org/articles/17/965/2025/essd-17-965-2025.html>
5. Calvin K, Dasgupta D, Krinner G, Mukherji A, Thorne PW, Trisos C, et al. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. [Internet]. First. Intergovernmental Panel on Climate Change (IPCC); 2023 July [cited 2025 Jan 1]. Available from: <https://www.ipcc.ch/report/ar6/syr/>
6. Seervai S, Gustafsson L, Abrams MK. The Impact of Climate Change on Our Health and Health Systems [Internet]. The Impact of Climate Change on Our Health and Health Systems. Commonwealth Fund; 2022 [cited 2025 Mar 6]. Available from: <https://www.commonwealthfund.org/publications/explainer/2022/may/impact-climate-change-our-health-and-health-systems>
7. Floro, Maria. The Conversation. 2024. Climate change is making it harder for people to get the care they need. Available from: <https://theconversation.com/climate-change-is-making-it-harder-for-people-to-get-the-care-they-need-240557>
8. Beagley J. Cradle to grave: The health harms of fossil fuel dependence and the case for a just phase out [Internet]. Global Climate and Health Alliance; 2022 July p. 16. Available from: <https://climateandhealthalliance.org/resource/cradle-to-gravethe-health-harms-of-fossil-fuel-dependence-and-the-case-for-a-just-phase-out/>
9. United Nations. United Nations. United Nations; [cited 2025 Apr 3]. Taking action for the health of people and the planet. Available from: <https://www.un.org/en/climatechange/science/climate-issues/health>
10. Sushree Mishra. Low-Income Communities Bear the Brunt of Climate Change [Internet]. Earth.Org. 2023 [cited 2025 July 14]. Available from: <https://earth.org/climate-changes-unequal-burden-why-do-low-income-communities-bear-the-brunt/>
11. Md Saidul Islam,. Rethinking Climate Justice: Insights from Environmental Sociology. Climate. 2024 Dec 2;12(12):203.
12. Rishika Pardikar. EOS.org. 2020 [cited 2025 July 14]. Global North Is Responsible for 92% of Excess Emissions - Eos. Available from: <https://eos.org/articles/global-north-is-responsible-for-92-of-excess-emissions>
13. The Climate Reality Project. The Climate Reality Project. [cited 2024 Dec 18]. Sacrifice Zones 101. Available from: <https://www.climateRealityproject.org/sacrifice-zones>
14. Dr. Vijay S. Limaye, Donald De Alwis. The Costs of Inaction: The Economic Burden of Fossil Fuels and Climate Change on Health in the U.S. [Internet]. Medical Society Consortium on Climate Change and Health, Natural Resources Defense Council; 2021 May [cited 2024 Dec 18] p. 16. Available from: <https://www.nrdc.org/sites/default/files/costs-inaction-burden-health-report.pdf>
15. Tessum CW, Paoletta DA, Chambliss SE, Apte JS, Hill JD, Marshall JD. PM 2.5 pollutants disproportionately and systemically affect people of color in the United States. Sci Adv. 2021 Apr 28;7(18):6.
16. James Kelly, Jess Warren. Air pollution death settlement is not a win - mum. BBC [Internet]. 2024 Oct 31; Available from: <https://www.bbc.com/news/articles/c5yx6leg4nqo>
17. American Lung Association. American Lung Association. [cited 2025 Apr 3]. Disparities in the Impact of Air Pollution. Available from: <https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities>
18. Elisabeth Currit. Ballard Brief. 2022 [cited 2025 Apr 3]. Disproportionate Exposure to Air Pollution for Low-Income Communities in the United States. Available from: <https://ballardbrief.byu.edu/issue-briefs/disproportionate-exposure-to-air-pollution-for-low-income-communities-in-the-united-states>

19. UNICEF East Asia and Pacific. UNICEF. [cited 2025 Apr 3]. Air pollution in East Asia and the Pacific: A threat to every child. Available from: <https://www.unicef.org/eap/air-pollution-childrens-rights>
20. State of the world's indigenous peoples [Internet]. New York: United Nations; 2009. Report No.: ST/ESA/328. Available from: https://www.un.org/esa/socdev/unpfii/documents/SOWIP/en/SOWIP_web.pdf
21. Cornell University. Environment, Health and Safety. [cited 2025 May 13]. Routes of Chemical Entry. Available from: <https://ehs.cornell.edu/book/export/html/1381>
22. Agency for Toxic Substances and Disease Registry. Agency for Toxic Substances and Disease Registry Public Health Assessment Guidance Manual. 2022 [cited 2025 Jan 2]. Exposure Routes. Available from: https://www.atsdr.cdc.gov/pha-guidance/conducting_scientific_evaluations/exposure_pathways/exposure_routes.html
23. US EPA O. United States Environmental Protection Agency. 2016 [cited 2025 Jan 1]. Health and Environmental Effects of Particulate Matter (PM). Available from: <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>
24. Thangavel P, Park D, Lee YC. Recent Insights into Particulate Matter (PM_{2.5})-Mediated Toxicity in Humans: An Overview. *Int J Environ Res Public Health*. 2022 June 19;19(12):7511.
25. Health Effects of Black Carbon [Internet]. Copenhagen: The WHO European Centre for Environment and Health, Bonn and WHO Regional Office for Europe; 2012 [cited 2025 Mar 28] p. 96. Available from: https://salud-ambiental.com/wp-content/uploads/2012/10/Health-effects-of-black-carbon_UNECE_WHO-2012.pdf
26. US EPA O. Sulfur Dioxide Basics [Internet]. 2016 [cited 2025 Jan 1]. Available from: <https://www.epa.gov/so2-pollution/sulfur-dioxide-basics>
27. Deng Q, Lu C, Norbäck D, Bornehag CG, Zhang Y, Liu W, et al. Early life exposure to ambient air pollution and childhood asthma in China. *Environ Res*. 2015 Nov;143(Pt A):83–92.
28. Deger L, Plante C, Jacques L, Goudreau S, Perron S, Hicks J, et al. Active and Uncontrolled Asthma Among Children Exposed to Air Stack Emissions of Sulphur Dioxide from Petroleum Refineries in Montreal, Quebec: A Cross-Sectional Study. *Can Respir J [Internet]*. 2012 Jan 1 [cited 2024 Dec 4];19(2). Available from: <https://onlinelibrary.wiley.com/doi/10.1155/2012/218957>
29. Fan M, Jiang H, Zhou M. Beyond particulate matter: New evidence on the causal effects of air pollution on mortality. *J Health Econ*. 2023 Sept;91:102799.
30. US EPA O. Basic Information about NO₂ [Internet]. 2016 [cited 2025 Jan 1]. Available from: <https://www.epa.gov/no2-pollution/basic-information-about-no2>
31. Barone-Adesi F, Dent JE, Dajnak D, Beevers S, Anderson HR, Kelly FJ, et al. Long-Term Exposure to Primary Traffic Pollutants and Lung Function in Children: Cross-Sectional Study and Meta-Analysis. *PLoS One*. 2015 Nov 30;10(11):e0142565.
32. Pedersen M, Halldorsson TI, Olsen SF, Hjortebjerg D, Ketzel M, Grandström C, et al. Impact of Road Traffic Pollution on Pre-eclampsia and Pregnancy-induced Hypertensive Disorders. *Epidemiology*. 2017 Jan;28(1):99–106.
33. US EPA O. What are volatile organic compounds (VOCs)? [Internet]. 2019 [cited 2025 Jan 1]. Available from: <https://www.epa.gov/indoor-air-quality-iaq/what-are-volatile-organic-compounds-vocs>
34. Doris M, Daley C, Zalzal J, Chesnaux R, Minet L, Kang M, et al. Modelling spatial & temporal variability of air pollution in an area of unconventional natural gas operations. *Environ Pollut Barking Essex* 1987. 2024 May 1;348:123773.
35. Caron-Beaudoin É, Whyte KP, Bouchard MF, Chevrier J, Haddad S, Copes R, et al. Volatile organic compounds (VOCs) in indoor air and tap water samples in residences of pregnant women living in an area of unconventional natural gas operations: Findings from the EXPERIVA study. *Sci Total Environ*. 2022 Jan 20;805:150242.
36. Climate & Clean Air Coalition. Tropospheric ozone | Climate & Clean Air Coalition [Internet]. [cited 2025 Jan 2]. Available from: <https://www.ccacoalition.org/short-lived-climate-pollutants/tropospheric-ozone>
37. Lim CC, Hayes RB, Ahn J, Shao Y, Silverman DT, Jones RR, et al. Long-Term Exposure to Ozone and Cause-Specific Mortality Risk in the United States. *Am J Respir Crit Care Med*. 2019 Oct 15;200(8):1022–31.
38. Glad JA, Brink LL, Talbott EO, Lee PC, Xu X, Saul M, et al. The Relationship of Ambient Ozone and PM 2.5 Levels and Asthma Emergency Department Visits: Possible Influence of Gender and Ethnicity. *Arch Environ Occup Health*. 2012 Apr;67(2):103–8.

39. U.S. Department of Health and Human Services, Public Health Service. Agency for Toxic Substances and Disease Registry. Benzene - ToxFAQsTM [Internet]. 2007 [cited 2025 Jan 1]. Available from: <https://www.atsdr.cdc.gov/toxfaqs/tfacts3.pdf>
40. Chiavarini M, Rosignoli P, Sorbara B, Giacchetta I, Fabiani R. Benzene Exposure and Lung Cancer Risk: A Systematic Review and Meta-Analysis of Human Studies. *Int J Environ Res Public Health*. 2024 Feb 9;21(2):205.
41. Carlos-Wallace FM, Zhang L, Smith MT, Rader G, Steinmaus C. Parental, In Utero, and Early-Life Exposure to Benzene and the Risk of Childhood Leukemia: A Meta-Analysis. *Am J Epidemiol*. 2016 Jan 1;183(1):1–14.
42. Heck JE, Park AS, Qiu J, Cockburn M, Ritz B. Retinoblastoma and ambient exposure to air toxics in the perinatal period. *J Expo Sci Environ Epidemiol*. 2015 Apr;25(2):182–6.
43. Bahadar H, Mostafalou S, Abdollahi M. Current understandings and perspectives on non-cancer health effects of benzene: a global concern. *Toxicol Appl Pharmacol*. 2014 Apr 15;276(2):83–94.
44. U.S. Department of Health and Human Services, Public Health Service. Agency for Toxic Substances and Disease Registry. Toluene - ToxFAQsTM. [Internet]. 2017 [cited 2025 Jan 1]. Available from: <https://www.atsdr.cdc.gov/toxfaqs/tfacts56.pdf>
45. U.S. Department of Health and Human Services, Public Health Service,. Agency for Toxic Substances and Disease Registry - Ethylbenzene - ToxFAQsTM [Internet]. [cited 2025 Jan 2]. Available from: <https://www.atsdr.cdc.gov/toxfaqs/tfacts110.pdf>
46. Centers for Disease Control and Prevention (CDC). “ToxFAQsTM for Xylene.” Agency for Toxic Substances and Disease Registry,. Agency for Toxic Substances and Disease Registry,. [cited 2025 Jan 2]. Agency for Toxic Substances and Disease Registry. Xylene - ToxFAQs. Available from: <https://www.atsdr.cdc.gov/toxfaqs/tfacts71.pdf>
47. Centers for Disease Control and Preventio. Agency for Toxic Substances and Disease Registry- Butadiene. ToxFAQs [Internet]. [cited 2025 Jan 2]. Available from: <https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=458&toxid=81>
48. Mallah MA, Changxing L, Mallah MA, Noreen S, Liu Y, Saeed M, et al. Polycyclic aromatic hydrocarbon and its effects on human health: An overreview. *Chemosphere*. 2022 June 1;296:133948.
49. Montano L, Baldini GM, Piscopo M, Liguori G, Lombardi R, Ricciardi M, et al. Polycyclic Aromatic Hydrocarbons (PAHs) in the Environment: Occupational Exposure, Health Risks and Fertility Implications. *Toxics*. 2025 Feb 23;13(3):151.
50. Healthy Energy Initiative, Community Environmental Monitoring. Coal Ash in India [Internet]. India: Healthy Energy Initiative and Community Environmental Monitoring; 2023 July [cited 2025 Jan 2] p. 31. Available from: https://carboncopy.info/wp-content/uploads/FLY-ASH-REPORT-FINAL_JULY-23.pdf
51. Caserta D, Graziano A, Lo Monte G, Bordi G, Moscarini M. Heavy metals and placental fetal-maternal barrier: a mini-review on the major concerns. *Eur Rev Med Pharmacol Sci*. 2013 Aug;17(16):2198–206.
52. New Jersey Department of Health. Right to Know - Hazardous Material Factsheet - Arsenic [Internet]. New Jersey Department of Health; 2008 [cited 2024 Aug 21]. Available from: <https://www.nj.gov/health/eoh/rtkweb/documents/fs/0152.pdf>.
53. New Jersey Department of Health. Right to Know - Hazardous Substances Factsheet - Metallic Chromium [Internet]. Trenton, NJ: New Jersey; 2009 [cited 2024 Aug 21]. Available from: <https://www.nj.gov/health/eoh/rtkweb/documents/fs/0432.pdf>
54. Tian T, Yin S, Chen Y, Wang C, Liu M, Jin L, et al. Elevated concentrations of chromium in maternal serum, umbilical cord serum, and cord tissue are associated with an increased risk for orofacial clefts. *Environ Res*. 2022 Nov;214(Pt 1):113799.
55. New Jersey Department of Health. Right to Know - Hazardous Substances Factsheet - Lead [Internet]. New Jersey Department of Health; 2016 [cited 2024 Aug 21]. Available from: <https://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf>.
56. Agency for Toxic Substances and Disease Registry. Agency for Toxic Substances and Disease Registry. Mercury - ToxFAQsTM [Internet]. [cited 2025 Jan 2]. Available from: <https://www.atsdr.cdc.gov/toxfaqs/tfacts46.pdf>
57. New Jersey Department of Health and Senior Services. Right to Know Hazardous Substance Fact Sheet: Selenium [Internet]. New Jersey Department of Health; 2002 [cited 2024 Aug 21]. Available from: <https://www.nj.gov/health/eoh/rtkweb/documents/fs/1648.pdf>.

58. UK Health Security Agency. GOV.UK. [cited 2025 July 14]. Cadmium: toxicological overview. Available from: <https://www.gov.uk/government/publications/cadmium-properties-incident-management-and-toxicology/cadmium-toxicological-overview>
59. US EPA O. TENORM: Oil and Gas Production Wastes [Internet]. 2015 [cited 2025 Mar 31]. Available from: <https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes>
60. Ali MMM, Zhao H, Li Z, Maglas NNM. Concentrations of TENORMs in the petroleum industry and their environmental and health effects. *RSC Adv.* 9(67):39201–29.
61. The Global Climate and Health Alliance. Methane & Health [Internet]. The Global Climate and Health Alliance. [cited 2025 Jan 2]. Available from: <https://climateandhealthalliance.org/initiatives/methane-health/>
62. GOV.UK [Internet]. [cited 2025 July 29]. Methane - Guidance. Available from: <https://www.gov.uk/government/publications/methane-properties-uses-and-incident-management/methane-general-information>
63. Linh Nguyen, Amanda Quintana, Amy Rowland. Mitigating Methane - A Global Health Strategy Overview [Internet]. ABT Associates for Global Climate and Health Alliance; [cited 2025 Mar 31] p. 13. Available from: <https://climateandhealthalliance.org/wp-content/uploads/2023/08/MethaneReport-Overview-FINAL.pdf>
64. Olga Grigoryants. UCLA study finds low weights in babies born near the 2015 Aliso Canyon gas leak. *Los Angeles Daily News* [Internet]. e-edition. 2024 Mar 21 [cited 2025 Mar 31]; Available from: <https://www.dailynews.com/2024/03/21/ucla-study-finds-low-weights-in-babies-born-near-the-2015-aliso-canyon-gas-leak/>
65. Persson L, Carney Almroth BM, Collins CD, Cornell S, De Wit CA, Diamond ML, et al. Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. *Environ Sci Technol.* 2022 Feb 1;56(3):1510–21.
66. MotherToBaby. MotherToBaby. [cited 2025 Jan 2]. Critical Periods of Development. Available from: <https://mothertobaby.org/fact-sheets/critical-periods-development/>
67. Cooper DB, Walker CJ, Christian WJ. Maternal proximity to mountain-top removal mining and birth defects in Appalachian Kentucky, 1997-2003. *PloS One.* 2022;17(8):e0272998.
68. Soares RD, Dos Santos M, de Moura FR, Muccillo-Baisch AL, Baisch PRM, Soares MCF, et al. Gestational and Neonatal Outcomes in Cities in the Largest Coal Mining Region in Brazil. *Int J Environ Res Public Health.* 2022 Sept 24;19(19).
69. Balise VD, Meng CX, Cornelius-Green JN, Kassotis CD, Kennedy R, Nagel SC. Systematic review of the association between oil and natural gas extraction processes and human reproduction. *Fertil Steril.* 2016 Sept 15;106(4):795–819.
70. Casey JA, Karasek D, Ogburn EL, Goin DE, Dang K, Braveman PA, et al. Retirements of Coal and Oil Power Plants in California: Association With Reduced Preterm Birth Among Populations Nearby. *Am J Epidemiol.* 2018 Aug 1;187(8):1586–94.
71. Cushing LJ, Vavra-Musser K, Chau K, Franklin M, Johnston JE. Flaring from Unconventional Oil and Gas Development and Birth Outcomes in the Eagle Ford Shale in South Texas. *Environ Health Perspect.* 2020 July;128(7):77003.
72. Casey JA, Savitz DA, Rasmussen SG, Ogburn EL, Pollak J, Mercer DG, et al. Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA. *Epidemiol Camb Mass.* 2016 Mar;27(2):163–72.
73. Currie J, Greenstone M, Meckel K. Hydraulic fracturing and infant health: New evidence from Pennsylvania. *Sci Adv.* 2017 Dec;3(12):e1603021.
74. Tang IW, Langlois PH, Vieira VM. Birth defects and unconventional natural gas developments in Texas, 1999-2011. *Environ Res.* 2021 Mar;194:110511.
75. Chevrier C, Dananché B, Bahuau M, Nelva A, Herman C, Francannet C, et al. Occupational exposure to organic solvent mixtures during pregnancy and the risk of non-syndromic oral clefts. *Occup Environ Med.* 2006 Sept;63(9):617–23.
76. Walker Whitworth K, Kaye Marshall A, Symanski E. Drilling and Production Activity Related to Unconventional Gas Development and Severity of Preterm Birth. *Environ Health Perspect.* 2018 Mar 20;126(3):037006.
77. Apergis N, Hayat T, Saeed T. Fracking and infant mortality: fresh evidence from Oklahoma. *Environ Sci Pollut Res Int.* 2019 Nov;26(31):32360–7.
78. Janitz AE, Dao HD, Campbell JE, Stoner JA, Peck JD. The association between natural gas well activity and specific congenital anomalies in Oklahoma, 1997-2009. *Environ Int.* 2019 Jan;122:381–8.

79. Tran KV, Casey JA, Cushing LJ, Morello-Frosch R. Residential Proximity to Oil and Gas Development and Birth Outcomes in California: A Retrospective Cohort Study of 2006–2015 Births. *Environ Health Perspect.* 2020 June;128(6):067001.
80. McKenzie LM, Guo R, Witter RZ, Savitz DA, Newman LS, Adgate JL. Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. *Environ Health Perspect.* 2014 Apr;122(4):412–7.
81. McKenzie LM, Allshouse W, Daniels S. Congenital heart defects and intensity of oil and gas well site activities in early pregnancy. *Environ Int.* 2019 Nov;132:104949.
82. Liu Y, Wang B, Li Z, Zhang L, Liu J, Ren A. Indoor air pollution and the risk of orofacial clefts in a rural population in Shanxi province, China. *Birt Defects Res A Clin Mol Teratol.* 2016 Aug;106(8):708–15.
83. Barn P, Gombojav E, Ochir C, Boldbaatar B, Beejin B, Naidan G, et al. Coal smoke, gestational cadmium exposure, and fetal growth. *Environ Res.* 2019 Dec;179(Pt B):108830.
84. Smith RB, Fecht D, Gulliver J, Beevers SD, Dajnak D, Blangiardo M, et al. Impact of London’s road traffic air and noise pollution on birth weight: retrospective population based cohort study. *BMJ.* 2017 Dec 5;j5299.
85. Kingsley SL, Eliot MN, Whitsel EA, Huang YT, Kelsey KT, Marsit CJ, et al. Maternal residential proximity to major roadways, birth weight, and placental DNA methylation. *Environ Int.* 2016 Aug;92–93:43–9.
86. Wang L, Guo P, Tong H, Wang A, Chang Y, Guo X, et al. Traffic-related metrics and adverse birth outcomes: A systematic review and meta-analysis. *Environ Res.* 2020 Sept;188:109752.
87. Fleisch AF, Rifas-Shiman SL, Koutrakis P, Schwartz JD, Kloog I, Melly S, et al. Prenatal exposure to traffic pollution: associations with reduced fetal growth and rapid infant weight gain. *Epidemiol Camb Mass.* 2015 Jan;26(1):43–50.
88. Stingone JA, McVeigh KH, Claudio L. Association between prenatal exposure to ambient diesel particulate matter and perchloroethylene with children’s 3rd grade standardized test scores. *Environ Res.* 2016 July;148:144–53.
89. Filippini T, Heck JE, Malagoli C, Del Giovane C, Vinceti M. A review and meta-analysis of outdoor air pollution and risk of childhood leukemia. *J Environ Sci Health Part C Environ Carcinog Ecotoxicol Rev.* 2015;33(1):36–66.
90. Warburton D, Warburton N, Wigfall C, Chimedsuren O, Lodoisamba D, Lodoysamba S, et al. Impact of Seasonal Winter Air Pollution on Health across the Lifespan in Mongolia and Some Putative Solutions. *Ann Am Thorac Soc.* 2018 Apr;15(Suppl 2):S86–90.
91. Li J, Yang B, Liu L, Gu J, Cao M, Wu L, et al. Relationship between air pollutants and spontaneous abortion in a coal resource valley city: a retrospective cohort study. *J Matern-Fetal Neonatal Med Off J Eur Assoc Perinat Med Fed Asia Ocean Perinat Soc Int Soc Perinat Obstet.* 2023 Dec;36(2):2281876.
92. Olsson D, Mogren I, Eneroth K, Forsberg B. Traffic pollution at the home address and pregnancy outcomes in Stockholm, Sweden. *BMJ Open.* 2015 Aug 14;5(8):e007034.
93. Aker AM, Whitworth KW, Bosson-Rieutort D, Wendling G, Ibrahim A, Verner MA, et al. Proximity and density of unconventional natural gas wells and mental illness and substance use among pregnant individuals: An exploratory study in Canada. *Int J Hyg Environ Health.* 2022 May;242:113962.
94. Casey JA, Goin DE, Rudolph KE, Schwartz BS, Mercer D, Elser H, et al. Unconventional natural gas development and adverse birth outcomes in Pennsylvania: The potential mediating role of antenatal anxiety and depression. *Environ Res.* 2019 Oct;177:108598.
95. Melody SM, Ford JB, Wills K, Venn A, Johnston FH. Maternal exposure to fine particulate matter from a large coal mine fire is associated with gestational diabetes mellitus: A prospective cohort study. *Environ Res.* 2020 Apr;183:108956.
96. Puche-Juarez M, Toledano JM, Moreno-Fernandez J, Gálvez-Ontiveros Y, Rivas A, Diaz-Castro J, et al. The Role of Endocrine Disrupting Chemicals in Gestation and Pregnancy Outcomes. *Nutrients.* 2023 Nov 3;15(21):4657.
97. Perera F, Nadeau K. Climate Change, Fossil-Fuel Pollution, and Children’s Health. *N Engl J Med.* 2022 June 16;386(24):2303–14.
98. Carroquino MJ, Posada M, Landrigan PJ. Environmental Toxicology: Children at Risk. In: Laws EA, editor. *Environmental Toxicology* [Internet]. New York, NY: Springer New York; 2013 [cited 2025 Jan 25]. p. 239–91. Available from: http://link.springer.com/10.1007/978-1-4614-5764-0_11
99. Carpenter DO, Bushkin-Bedient S. Exposure to Chemicals and Radiation During Childhood and Risk for Cancer Later in Life. *J Adolesc Health.* 2013 May;52(5):S21–9.

100. Onyije FM, Hosseini B, Togawa K, Schüz J, Olsson A. Cancer Incidence and Mortality among Petroleum Industry Workers and Residents Living in Oil Producing Communities: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health*. 2021 Apr 20;18(8).
101. Clark CJ, Johnson NP, Soriano M, Warren JL, Sorrentino KM, Kadan-Lottick NS, et al. Unconventional Oil and Gas Development Exposure and Risk of Childhood Acute Lymphoblastic Leukemia: A Case–Control Study in Pennsylvania, 2009–2017. *Environ Health Perspect*. 2022 Aug;130(8):087001.
102. Magnani C, Ranucci A, Badaloni C, Cesaroni G, Ferrante D, Miligi L, et al. Road Traffic Pollution and Childhood Leukemia: A Nationwide Case-control Study in Italy. *Arch Med Res*. 2016 Nov;47(8):694–705.
103. Tamayo-Uria I, Boldo E, García-Pérez J, Gómez-Barroso D, Romaguera EP, Cirach M, et al. Childhood leukaemia risk and residential proximity to busy roads. *Environ Int*. 2018 Dec;121(Pt 1):332–9.
104. Malavolti M, Malagoli C, Filippini T, Wise LA, Bellelli A, Palazzi G, et al. Residential proximity to petrol stations and risk of childhood leukemia. *Eur J Epidemiol*. 2023 July;38(7):771–82.
105. Kirkeleit J, Riise T, Bjørge T, Christiani DC, Bråttveit M, Baccarelli A, et al. Maternal exposure to gasoline and exhaust increases the risk of childhood leukaemia in offspring - a prospective study in the Norwegian Mother and Child Cohort Study. *Br J Cancer*. 2018 Oct;119(8):1028–35.
106. Rossides M, Kampitsi CE, Talbäck M, Mogensen H, Wiebert P, Feychting M, et al. Risk of Cancer in Children of Parents Occupationally Exposed to Hydrocarbon Solvents and Engine Exhaust Fumes: A Register-Based Nested Case-Control Study from Sweden (1960-2015). *Environ Health Perspect*. 2022 July;130(7):77002.
107. Khatri SB, Newman C, Hammel JP, Dey T, Van Laere JJ, Ross KA, et al. Associations of Air Pollution and Pediatric Asthma in Cleveland, Ohio. *ScientificWorldJournal*. 2021;2021:8881390.
108. Willis M, Hystad P, Denham A, Hill E. Natural gas development, flaring practices and paediatric asthma hospitalizations in Texas. *Int J Epidemiol*. 2021 Jan 23;49(6):1883–96.
109. Komisarow S, Pakhtigian EL. The Effect of Coal-Fired Power Plant Closures on Emergency Department Visits for Asthma-Related Conditions Among 0- to 4-Year-Old Children in Chicago, 2009-2017. *Am J Public Health*. 2021 May;111(5):881–9.
110. Newman NC, Ryan PH, Huang B, Beck AF, Sauers HS, Kahn RS. Traffic-related air pollution and asthma hospital readmission in children: a longitudinal cohort study. *J Pediatr*. 2014 June;164(6):1396-1402.e1.
111. Noh SR, Kim JA, Cheong HK, Ha M, Jee YK, Park MS, et al. Exposure to Crude Oil-Related Volatile Organic Compounds Associated with Lung Function Decline in a Longitudinal Panel of Children. *Int J Environ Res Public Health* [Internet]. 2022 Nov 24;19(23). Available from: <https://www.mdpi.com/1660-4601/19/23/15599>
112. Emerson E, Robertson J, Hatton C, Baines S. Risk of exposure to air pollution among British children with and without intellectual disabilities. *J Intellect Disabil Res JIDR*. 2019 Feb;63(2):161–7.
113. Suglia SF, Gryparis A, Wright RO, Schwartz J, Wright RJ. Association of Black Carbon with Cognition among Children in a Prospective Birth Cohort Study. *Am J Epidemiol*. 2007 Nov 27;167(3):280–6.
114. Zierold KM, Sears CG, Myers JV, Brock GN, Zhang CH, Sears L. Exposure to coal ash and depression in children aged 6-14 years old. *Environ Res*. 2022 Nov;214(Pt 3):114005.
115. Alter NC, Whitman EM, Bellinger DC, Landrigan PJ. Quantifying the association between PM2.5 air pollution and IQ loss in children: a systematic review and meta-analysis. *Environ Health Glob Access Sci Source*. 2024 Nov 18;23(1):101.
116. Bellinger DC. Comparing the population neurodevelopmental burdens associated with children’s exposures to environmental chemicals and other risk factors. *Neurotoxicology*. 2012 Aug;33(4):641–3.
117. Zhou Y, Li Q, Wang P, Li J, Zhao W, Zhang L, et al. Associations of prenatal PFAS exposure and early childhood neurodevelopment: Evidence from the Shanghai Maternal-Child Pairs Cohort. *Environ Int*. 2023 Mar 1;173:107850.
118. Kalloo G, Wellenius GA, McCandless L, Calafat AM, Sjodin A, Sullivan AJ, et al. Chemical mixture exposures during pregnancy and cognitive abilities in school-aged children. *Environ Res*. 2021 June;197:111027.
119. Alampi JD, Lanphear BP, Braun JM, Chen A, Takaro TK, Muckle G, et al. Association Between Gestational Exposure to Toxicants and Autistic Behaviors Using Bayesian Quantile Regression. *Am J Epidemiol*. 2021 Sept 1;190(9):1803–13.
120. United Nations Children’s Fund. Rights denied: The impact of discrimination on children, [Internet]. United Nations Children’s Fund; 2022. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.unicef.org/media/130801/file/rights-denied-discrimination-children-EN.pdf>

121. Kasapçopur Ö. Poverty and Discrimination: Big Enemies of Children All Over the World. *Turk Arch Pediatr.* 2023 Nov 1;58(6):564–5.
122. Chakraborty J, Zandbergen PA. Children at risk: measuring racial/ethnic disparities in potential exposure to air pollution at school and home. *J Epidemiol Community Health.* 2007 Dec;61(12):1074–9.
123. Holder MK, Blaustein JD. Puberty and adolescence as a time of vulnerability to stressors that alter neurobehavioral processes. *Front Neuroendocrinol.* 2014 Jan;35(1):89–110.
124. Carpenter DO, Bushkin-Bedient S. Exposure to Chemicals and Radiation During Childhood and Risk for Cancer Later in Life. *J Adolesc Health.* 2013 May;52(5):S21–9.
125. Terry MB, Michels KB, Brody JG, Byrne C, Chen S, Jerry DJ, et al. Environmental exposures during windows of susceptibility for breast cancer: a framework for prevention research. *Breast Cancer Res BCR.* 2019 Aug 20;21(1):96.
126. Werner AK, Watt K, Cameron C, Vink S, Page A, Jagals P. Examination of Child and Adolescent Hospital Admission Rates in Queensland, Australia, 1995–2011: A Comparison of Coal Seam Gas, Coal Mining, and Rural Areas. *Matern Child Health J.* 2018 Sept;22(9):1306–18.
127. Fang B, Bravo MA, Wang H, Sheng L, Wu W, Zhou Y, et al. Polycyclic aromatic hydrocarbons are associated with later puberty in girls: A longitudinal study. *Sci Total Environ.* 2022 Nov 10;846:157497.
128. Wang Y, Wu W, Bravo MA, Liu S, Xi X, Zhou Y, et al. Prepubertal exposure to polycyclic aromatic hydrocarbons are associated with early pubertal development onset in boys: A longitudinal study. *J Hazard Mater.* 2024 May 15;470:134160.
129. John EM, Keegan TH, Terry MB, Koo J, Ingles SA, Nguyen JT, et al. Urinary Biomarkers of Polycyclic Aromatic Hydrocarbons and Timing of Pubertal Development: The California PAH Study. *Epidemiol Camb Mass.* 2022 Nov 1;33(6):777–87.
130. Calvert GM, Luckhaupt SE, Sussell A, Dahlhamer JM, Ward BW. The Prevalence of Selected Potentially Hazardous Workplace Exposures in the US: Findings From the 2010 National Health Interview Survey. *Am J Ind Med.* 2012 July 20;56(6):635.
131. Sharma G, Goodwin J. Effect of aging on respiratory system physiology and immunology. *Clin Interv Aging.* 2006 Sept;1(3):253–60.
132. Lei Wang, Francis H.Y. Green, uzette M. Smiley-Jewell, Kent E. Pinkerton. Susceptibility of the Aging Lung to Environmental Injury. *Semin Respir Crit Care Med.* 2010 Oct 12;31(5):539–53.
133. Andrade A, D'Oliveira A, De Souza LC, Bastos ACR de F, Dominski FH, Stabile L, et al. Effects of Air Pollution on the Health of Older Adults during Physical Activities: Mapping Review. *Int J Environ Res Public Health.* 2023 Feb 16;20(4):3506.
134. Wang T, Song X, Xu H, Zhu Y, Li L, Sun X, et al. Combustion-Derived Particulate PAHs Associated with Small Airway Dysfunction in Elderly Patients with COPD. *Environ Sci Technol.* 2022 Aug 2;56(15):10868–78.
135. Hsu CY, Chiang HC, Chen MJ, Chuang CY, Tsen CM, Fang GC, et al. Ambient PM(2.5) in the residential area near industrial complexes: Spatiotemporal variation, source apportionment, and health impact. *Sci Total Environ.* 2017 July 15;590–591:204–14.
136. Aruni Bhatnagar. Cardiovascular Effects of Particulate Air Pollution - PubMed. *Annu Rev Med* [Internet]. [cited 2025 July 14]; Available from: <https://pubmed.ncbi.nlm.nih.gov/34644154/>
137. Zhang J, McLaughlin SJ, Li LW. Cumulative exposure to air pollution and subsequent mortality among older adults in China. *J Public Health.* 2019 Sept 30;41(3):518–26.
138. Wilker EH, Osman M, Weisskopf MG. Ambient air pollution and clinical dementia: systematic review and meta-analysis. *BMJ.* 2023 Apr 5;381:e071620.
139. Zhao YL, Qu Y, Ou YN, Zhang YR, Tan L, Yu JT. Environmental factors and risks of cognitive impairment and dementia: A systematic review and meta-analysis. *Ageing Res Rev.* 2021 Nov 6;72:101504.
140. Delgado-Saborit JM, Guercio V, Gowers AM, Shaddick G, Fox NC, Love S. A critical review of the epidemiological evidence of effects of air pollution on dementia, cognitive function and cognitive decline in adult population. *Sci Total Environ.* 2021 Feb 25;757:143734.
141. Yuchi W, Sbihi H, Davies H, Tamburic L, Brauer M. Road proximity, air pollution, noise, green space and neurologic disease incidence: a population-based cohort study. *Environ Health Glob Access Sci Source.* 2020 Jan 21;19(1):8.

142. Kwon D, Paul KC, Yu Y, Zhang K, Folle AD, Wu J, et al. Traffic-related air pollution and Parkinson's disease in central California. *Environ Res.* 2024 Jan 1;240(Pt 1):117434.
143. Christensen GM, Li Z, Liang D, Ebelt S, Gearing M, Levey AI, et al. Association of PM2.5 Exposure and Alzheimer Disease Pathology in Brain Bank Donors—Effect Modification by APOE Genotype. *Neurology.* 2024 Mar 12;102(5):e209162.
144. Abolhasani E, Hachinski V, Ghazaleh N, Azarpazhooh MR, Mokhber N, Martin J. Air Pollution and Incidence of Dementia: A Systematic Review and Meta-analysis. *Neurology [Internet].* 2023 Jan 10 [cited 2025 Mar 6];100(2). Available from: <https://www.neurology.org/doi/10.1212/WNL.0000000000201419>
145. Stenehjem JS, Robsahm TE, Bråtveit M, Samuelsen SO, Kirkeleit J, Grimsrud TK. Aromatic hydrocarbons and risk of skin cancer by anatomical site in 25000 male offshore petroleum workers. *Am J Ind Med.* 2017 Aug;60(8):679–88.
146. Harati B, Shahtaheri SJ, Yousefi HA, Harati A, Askari A, Abdolmohamadi N. Cancer Risk Assessment for Workers Exposed to Pollution Source, a Petrochemical Company, Iran. *Iran J Public Health.* 2020 July;49(7):1330–8.
147. Koh DH, Chung EK, Jang JK, Lee HE, Ryu HW, Yoo KM, et al. Cancer incidence and mortality among temporary maintenance workers in a refinery/petrochemical complex in Korea. *Int J Occup Environ Health.* 2014 June;20(2):141–5.
148. Liza Gross, Dylan Baddour. What Is Produced Water? [Internet]. Inside Climate News. 2023 [cited 2025 July 29]. Available from: <https://insideclimatenews.org/news/23052023/produced-water-climate-101/>
149. Anderson SE, Meade BJ. Potential health effects associated with dermal exposure to occupational chemicals. *Environ Health Insights.* 2014;8(Suppl 1):51–62.
150. American Lung Association. American Lung Association. [cited 2025 Apr 4]. Coal Worker's Pneumoconiosis (Black Lung Disease). Available from: <https://www.lung.org/lung-health-diseases/lung-disease-lookup/black-lung>
151. National Institute for Occupational Safety and Health. Coal Mine Dust Exposures and Associated Health Outcomes [Internet]. Centers of Disease Control and Prevention, Department of Health and Human Services; 2011 Apr. Report No.: 64. Available from: <https://www.cdc.gov/niosh/docs/2011-172/pdfs/2011-172.pdf>
152. Almberg KS, Halldin CN, Friedman LS, Go LHT, Rose CS, Hall NB, et al. Increased odds of mortality from non-malignant respiratory disease and lung cancer are highest among US coal miners born after 1939. *Occup Environ Med.* 2023 Mar;80(3):121–8.
153. Alif SM, Malcolm R. Sim, Ho C, Glass DC. Cancer and mortality in coal mine workers: a systematic review and meta-analysis. *Occup Environ Med.* 2022 May;79(5):347–57.
154. AlKazimi MA, Grantham K. Investigating new risk reduction and mitigation in the oil and gas industry. *J Loss Prev Process Ind.* 2015 Mar 1;34:196–208.
155. Wingate KC, Hill R, Ridl S, Hagan-Haynes K. Fatalities in Oil and Gas Extraction Database, an Industry-Specific Worker Fatality Surveillance System — United States, 2014–2019. *MMWR Surveill Summ.* 2023 Sept 1;72(8):1–15.
156. Mason KL, Retzer KD, Hill R, Lincoln JM. Occupational Fatalities Resulting from Falls in the Oil and Gas Extraction Industry, United States, 2005–2014. *MMWR Morb Mortal Wkly Rep.* 2017 Apr 28;66(16):417–21.
157. Graham J, Irving J, Tang X, Sellers S, Crisp J, Horwitz D, et al. Increased traffic accident rates associated with shale gas drilling in Pennsylvania. *Accid Anal Prev.* 2015 Jan;74:203–9.
158. Retzer KD, Hill RD, Pratt SG. Motor vehicle fatalities among oil and gas extraction workers. *Accid Anal Prev.* 2013 Mar 1;51:168–74.
159. Wingate KC. Fatalities in Oil and Gas Extraction Database, an Industry-Specific Worker Fatality Surveillance System — United States, 2014–2019. *MMWR Surveill Summ [Internet].* 2023 [cited 2025 Apr 4];72. Available from: <https://www.cdc.gov/mmwr/volumes/72/ss/ss7208a1.htm>
160. Occupational Safety and Health Administration. Occupational Safety and Health Administration. [cited 2024 Aug 19]. Health Hazards Associated with Oil and Gas Extraction Activities. Available from: <https://www.osha.gov/oil-and-gas-extraction/health-hazards>
161. Mahalkar V, Kumar S, Singhal S. Long term and short-term occupational health risks associated with petroleum industry in India. *World J Adv Eng Technol Sci.* 2022;5(2):054–61.
162. Sadeghniaat-Haghighi K, Mehrabinejad MM, Hajighaderi A, Najafi A, Rahimi-Golkhandan A, Zahabi A. Shift Work Disorder, Insomnia, and Depression among Offshore Oil Rig Workers. *Iran J Psychiatry.* 2021 Apr;16(2):162–7.
163. Parkes KR. Work environment, overtime and sleep among offshore personnel. *Accid Anal Prev.* 2017 Feb;99(Pt B):383–8.

164. Asare BYA, Kwasnicka D, Powell D, Robinson S. Health and well-being of rotation workers in the mining, offshore oil and gas, and construction industry: a systematic review. *BMJ Glob Health*. 2021 July;6(7):e005112.
165. International Labour Organization. Occupational safety and health and skills in the oil and gas industry operating in polar and subarctic climate zones of the northern hemisphere. In: Report for discussion at the Tripartite Sectoral Meeting on Occupational Safety and Health and Skills in the Oil and Gas Industry Operating in Polar and Subarctic Climate Zones of the Northern Hemisphere [Internet]. Geneva: ILO; 2016. p. 59. Available from: <https://www.ilo.org/media/438221/download>.
166. International Labour Office – Geneva. Exposure to hazardous chemicals at work and resulting health impacts: A global review [Internet]. International Labour Office – Geneva; 2021. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ilo.org/sites/default/files/2024-07/wcms_811455%20%284%29.pdf
167. Basdr Z. Climate Home News. 2023 [cited 2025 Apr 4]. Migrant workers face risks building the UAE's gas expansion plans. Available from: <https://www.climatechangenews.com/2023/04/05/migrant-workers-face-risks-building-europes-new-gas-supplies-in-the-uae/>
168. Nayak S. Migrant Workers in the Coal Mines of India: Precarity, Resilience and the Pandemic. *Soc Change*. 2022 June 1;52(2):203–22.
169. Lau K, Aldridge R, Norredam M, Mkoma GF, Kugan M, Lin RCY, et al. Workplace mortality risk and social determinants among migrant workers: a systematic review and meta-analysis. *Lancet Public Health*. 2024 Nov;9(11):e935–49.
170. Srivastava R. Labour Migration, Vulnerability, and Development Policy: The Pandemic as Inflexion Point? *Indian J Labour Econ*. 2020 Dec 1;63(4):859–83.
171. Adamu S, Akinosun OM, Abbiyesuku FM, O Kuti MA, El-Bashir JM, Abubakar JD. Are roadside petrol dispensers at risk of oxidative stress? a study from gombe, North East Nigeria. *Niger J Clin Pract*. 2018 Mar;21(3):276–9.
172. Elkama A, Şentürk K, Karahalil B. Assessment of genotoxicity biomarkers in gasoline station attendants due to occupational exposure. *Toxicol Ind Health*. 2024 June;40(6):337–51.
173. Sajid Jabbar A, Ali ET. Impact of Petroleum Exposure on Some Hematological Indices, Interleukin-6, and Inflammatory Markers of Workers at Petroleum Stations in Basra City. *J Environ Public Health*. 2020;2020:7693891.
174. Tim Donaghy, Charlie Jiang. Greenpeace.org. 2021 [cited 2025 Jan 2]. Fossil Fuel Racism: How phasing out oil, gas, and coal can protect communities - Greenpeace - Greenpeace. Available from: <https://www.greenpeace.org/usa/fossil-fuel-racism/>
175. Diane Toomy. Yale Environment 360. 2013 [cited 2025 Jan 2]. Coal Pollution and the Fight For Environmental Justice. Available from: https://e360.yale.edu/features/naacp_jacqueline_patterson_coal_pollution_and_fight_for_environmental_justice
176. U.S. Commission on Civil Rights. U.S. Commission on Civil Rights. [cited 2025 Jan 2]. Not in My Backyard: Executive Order 12,898 and Title VI as Tools for Achieving Environmental Justice. Available from: <https://www.usccr.gov/files/pubs/envjust/ch2.htm>
177. UCLA Institute of the Environment and Sustainability. Impacts of Oil and Gas Drilling on Indigenous Communities in New Mexico's Greater Chaco Landscape [Internet]. Los Angeles; [cited 2025 Jan 2] p. 25. Available from: <https://www.ioes.ucla.edu/wp-content/uploads/2020/09/ucla-ioes-practicum-impacts-of-oil-and-gas-on-indigenous-communities-in-new-mexico-final-report-9-2020.pdf>
178. Juhasz A. "We're Dying Here" [Internet]. Human Rights Watch. 2024 [cited 2025 Jan 2]. Available from: <https://www.hrw.org/report/2024/01/25/were-dying-here/fight-life-louisiana-fossil-fuel-sacrifice-zone>
179. Friends of the Earth International, Friends of the Earth Africa. Dirty Energy in Africa [Internet]. 2016 Nov [cited 2025 Apr 4]. Available from: <https://www.foei.org/wp-content/uploads/2016/11/DIRTY-ENERGY-IN-AFRICA-EN-FINAL.pdf>
180. Victor Munnik, Geraldine Hochmann, Mathews Hlabane, Stephen Law. The Social and Environmental Consequences of Coal Mining in South Africa [Internet]. 2010 Jan [cited 2025 Apr 4] p. 24. Available from: https://www.bothends.org/uploaded_files/uploadlibraryitem/1case_study_South_Africa_updated.pdf
181. deSouza PN, Chaudhary E, Dey S, Ko S, Németh J, Guttikunda S, et al. An environmental justice analysis of air pollution in India. *Sci Rep*. 2023 Oct 4;13(1):16690.
182. Mah A, Wang X. Accumulated Injuries of Environmental Injustice: Living and Working with Petrochemical Pollution in Nanjing, China. *Ann Am Assoc Geogr*. 2019 Nov 2;109(6):1961–77.

183. Loomis D, Huang W, Chen G. The International Agency for Research on Cancer (IARC) evaluation of the carcinogenicity of outdoor air pollution: focus on China. *Chin J Cancer*. 2014 Apr;33(4):189–96.
184. Rentschler J, Leonova N. Global air pollution exposure and poverty. *Nat Commun*. 2023 July 22;14(1):4432.
185. Larsson N. The brutal reality of life inside one of the world's most polluted cities. *Wired* [Internet]. [cited 2025 Apr 4]; Available from: <https://www.wired.com/story/chile-quintero-pollution/>
186. Center for Climate and Resilience Research - CR2. Environmental injustice and sacrifice zones: The Puchuncaví case [Internet]. [cited 2025 Apr 4]. Available from: <https://www.cr2.cl/eng/policy-brief-environmental-injustice-and-sacrifice-zones-the-puchuncavi-case/>
187. Johnston JE, Enebish T, Eckel SP, Navarro S, Shamasunder B. Respiratory health, pulmonary function and local engagement in urban communities near oil development. *Environ Res*. 2021 June;197:111088.
188. Giang A, Castellani K. Cumulative air pollution indicators highlight unique patterns of injustice in urban Canada. *Environ Res Lett*. 2020 Dec;15(12):124063.
189. Donaghy TQ, Healy N, Jiang CY, Battle CP. Fossil fuel racism in the United States: How phasing out coal, oil, and gas can protect communities. *Energy Res Soc Sci*. 2023 June 1;100:103104.
190. Beard S, Freeman K, Velasco ML, Boyd W, Chamberlain T, Latoni A, et al. Racism as a public health issue in environmental health disparities and environmental justice: working toward solutions. *Environ Health*. 2024 Jan 22;23(1):8.
191. Tzivian L, Winkler A, Dlugaj M, Schikowski T, Vossoughi M, Fuks K, et al. Effect of long-term outdoor air pollution and noise on cognitive and psychological functions in adults. *Int J Hyg Environ Health*. 2015 Jan 1;218(1):1–11.
192. Zijlema W, Cerin E, Cirach M, Bartoll X, Borrell C, Dadvand P, et al. Cities and mental health: The role of the built environment, and environmental and lifestyle factors in Barcelona. *Environ Pollut*. 2024 Apr 1;346:123559.
193. Eick SM, Cushing L, Goin DE, Padula AM, Andrade A, DeMicco E, et al. Neighborhood conditions and birth outcomes: Understanding the role of perceived and extrinsic measures of neighborhood quality. *Environ Epidemiol Phila Pa*. 2022 Oct;6(5):e224.
194. Terrell KA, St Julien GN, Wallace ME. Toxic air pollution and concentrated social deprivation are associated with low birthweight and preterm Birth in Louisiana*. *Environ Res Health*. 2024 Mar;2(2):021002.
195. The Bayelsa State Oil & Environmental Commission. An Environmental Genocide: Counting the Human and Environmental Cost of Oil in Bayelsa, Nigeria [Internet]. 2023 May [cited 2025 Jan 2] p. 216. Available from: <https://report.bayelsacommission.org/>
196. Serampore College, West Bengal, India, Goswami S. Impact of Coal Mining on Environment. *Eur Res*. 2015 Mar 25;92(3):185–96.
197. Moritz Kramer, Tobias Kind-Rieper, Raquel Munayer, Stefan Giljum. Extracted Forests: Unearthing the role of mining-related deforestation as a driver of global deforestation [Internet]. WWF, adelphi, WU, Satelligence; 2023 Apr. Available from: <https://climate-diplomacy.org/magazine/environment/extracted-forests-unearthing-role-mining-related-deforestation-driver-global>
198. Hill EL. Shale gas development and infant health: Evidence from Pennsylvania. *J Health Econ*. 2018 Sept; 61:134–50.
199. Ninomiya MEM, Burns N, Pollock NJ, Green NTG, Martin J, Linton J, et al. Indigenous communities and the mental health impacts of land dispossession related to industrial resource development: a systematic review. *Lancet Planet Health*. 2023 June 1;7(6):e501–17.
200. Donaldson K, Wallace WA, Elliot TA, Henry C. James Craufurd Gregory, 19th century Scottish physicians, and the link between occupation as a coal miner and lung disease. *J R Coll Physicians Edinb*. 2017 Sept;47(3):296–302.
201. Hall NB, Blackley DJ, Halldin CN, Laney AS. Current Review of Pneumoconiosis Among US Coal Miners. *Curr Environ Health Rep*. 2019 Sept;6(3):137–47.
202. Han S, Chen H, Harvey MA, Stemn E, Cliff D. Focusing on Coal Workers' Lung Diseases: A Comparative Analysis of China, Australia, and the United States. *Int J Environ Res Public Health* [Internet]. 2018 Nov 16;15(11). Available from: <https://www.mdpi.com/1660-4601/15/11/2565>
203. Torres Rey CH, Ibañez Pinilla M, Briceño Ayala L, Checa Guerrero DM, Morgan Torres G, Groot de Restrepo H, et al. Underground Coal Mining: Relationship between Coal Dust Levels and Pneumoconiosis, in Two Regions of Colombia, 2014. *BioMed Res Int*. 2015;2015:647878.

204. Hall NB, Reynolds L, Blackley DJ, Laney AS. Assessment of the Respiratory Health of Working US Coal Miners Since 2014-Radiography, Spirometry, and Symptom Assessments. *J Occup Environ Med*. 2024 Feb 1;66(2):123–7.
205. Idrees F, Batool AI, Rehman MFU, Habib SS, Akram A. Assessment of Genetic Damage in Coal Miners of Punjab, Pakistan. *Biol Trace Elem Res*. 2023 July;201(7):3144–51.
206. Sinitsky MY, Minina VI, Gafarov NI, Asanov MA, Larionov AV, Ponasenko AV, et al. Assessment of DNA damage in underground coal miners using the cytokinesis-block micronucleus assay in peripheral blood lymphocytes. *Mutagenesis*. 2016 Nov;31(6):669–75.
207. Schmajuk G, Trupin L, Yelin E, Blanc PD. Prevalence of Arthritis and Rheumatoid Arthritis in Coal Mining Counties of the United States. *Arthritis Care Res*. 2019 Sept;71(9):1209–15.
208. Schmajuk G, Trupin L, Yelin EH, Blanc PD. Dusty trades and associated rheumatoid arthritis in a population-based study in the coal mining counties of Appalachia. *Occup Environ Med*. 2022 May;79(5):308–14.
209. Tian J, Wang Y, Gao S. Analysis of Mining-Related Injuries in Chinese Coal Mines and Related Risk Factors: A Statistical Research Study Based on a Meta-Analysis. *Int J Environ Res Public Health* [Internet]. 2022 Dec 5;19(23). Available from: <https://www.mdpi.com/1660-4601/19/23/16249>
210. Hendryx M, Islam MS, Dong GH, Paul G. Air Pollution Emissions 2008-2018 from Australian Coal Mining: Implications for Public and Occupational Health. *Int J Environ Res Public Health* [Internet]. 2020 Feb 29;17(5). Available from: <https://www.mdpi.com/1660-4601/17/5/1570>
211. Cortes-Ramirez J, Wraith D, Sly PD, Jagals P. Mapping the Morbidity Risk Associated with Coal Mining in Queensland, Australia. *Int J Environ Res Public Health*. 2022 Jan 21;19(3):1206.
212. Miranda-Guevara A, Muñoz-Acevedo A, Fiorillo-Moreno O, Acosta-Hoyos A, Pacheco-Londoño L, Quintana-Sosa M, et al. The dangerous link between coal dust exposure and DNA damage: unraveling the role of some of the chemical agents and oxidative stress. *Environ Geochem Health*. 2023 Oct;45(10):7081–97.
213. Werner AK, Watt K, Cameron CM, Vink S, Page A, Jagals P. All-age hospitalization rates in coal seam gas areas in Queensland, Australia, 1995-2011. *BMC Public Health*. 2016 Feb 6;16:125.
214. Small DS, Firth DW, Keele LJ, Huber M, Passarella M, Lorch SA, et al. Surface mining and low birth weight in central appalachia. *Environ Res*. 2021 May;196:110340.
215. Cooper DB, Walker CJ, Christian WJ. Maternal proximity to mountain-top removal mining and birth defects in Appalachian Kentucky, 1997-2003. *PloS One*. 2022;17(8):e0272998.
216. Richard Schiffman. Yale E360. 2017 [cited 2025 Jan 1]. A Troubling Look at the Human Toll of Mountaintop Removal Mining. Available from: <https://e360.yale.edu/features/a-troubling-look-at-the-human-toll-of-mountaintop-removal-mining>
217. Hendryx M, Luo J. An examination of the effects of mountaintop removal coal mining on respiratory symptoms and COPD using propensity scores. *Int J Environ Health Res*. 2015;25(3):265–76.
218. Hendryx M, Ducatman AM, Zullig KJ, Ahern MM, Crout R. Adult tooth loss for residents of US coal mining and Appalachian counties. *Community Dent Oral Epidemiol*. 2012 Dec;40(6):488–97.
219. Zullig KJ, Hendryx M. Health-related quality of life among central Appalachian residents in mountaintop mining counties. *Am J Public Health*. 2011 May;101(5):848–53.
220. Hendryx M, Zullig KJ. Higher coronary heart disease and heart attack morbidity in Appalachian coal mining regions. *Prev Med*. 2009 Nov;49(5):355–9.
221. Gopinathan P, Subramani T, Barbosa S, Yuvaraj D. Environmental impact and health risk assessment due to coal mining and utilization. *Environ Geochem Health*. 2023 Oct 1;45(10):6915–22.
222. Sherwin ED, Rutherford JS, Zhang Z, Chen Y, Wetherley EB, Yakovlev PV, et al. US oil and gas system emissions from nearly one million aerial site measurements. *Nature*. 2024 Mar;627(8003):328–34.
223. Buonocore JJ, Reka S, Yang D, Chang C, Roy A, Thompson T, et al. Air pollution and health impacts of oil & gas production in the United States. *Environ Res Health*. 2023 June 1;1(2):021006.
224. Johnston JE, Chau K, Franklin M, Cushing L. Environmental Justice Dimensions of Oil and Gas Flaring in South Texas: Disproportionate Exposure among Hispanic communities. *Environ Sci Technol*. 2020 May 19;54(10):6289–98.
225. Concerned Health Professionals of NY, Physicians for Social Responsibility, Science and Environmental Health Network. Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking

and Associated Gas and Oil Infrastructure [Internet]. 2023 Oct p. 637. Report No.: 9. Available from: <https://concernedhealthny.org/compendium/>

226. Mash R, Minnaar J, Mash B. Health and fracking: should the medical profession be concerned? *South Afr Med J Suid-Afr Tydskr Vir Geneeskde*. 2014 Feb 26;104(5):332–5.
227. CAPE, CANE. LNG, Fracking and Healthcare System Costs in British Columbia [Internet]. 2024 [cited 2025 Mar 12]. Available from: <https://cape.ca/wp-content/uploads/2024/08/LNG-and-Healthcare-Campaign-Letter.pdf>
228. National Institute of Environmental Health Sciences. National Institute of Environmental Health Sciences. [cited 2024 Dec 18]. Hydraulic Fracturing and Health. Available from: <https://www.niehs.nih.gov/health/topics/agents/fracking>
229. Kondash AJ, Lauer NE, Vengosh A. The intensification of the water footprint of hydraulic fracturing. *Sci Adv*. 2018 Aug 15;4(8):eaar5982.
230. Lampe DJ, Stolz JF. Current perspectives on unconventional shale gas extraction in the Appalachian Basin. *J Environ Sci Health Part A Tox Hazard Subst Environ Eng*. 2015;50(5):434–46.
231. Occupational Safety and Health Administration. Occupational Safety and Health Administration. [cited 2025 July 29]. Potential Health Hazards Associated with Handling Pipe used in Oil and Gas Production. Available from: <https://www.osha.gov/publications/hib19890126>
232. Li Y, Reivan Ortiz GG, Uyen PTM, Cong PT, Othman SI, Allam AA, et al. Environmental impact of endocrine-disrupting chemicals and heavy metals in biological samples of petrochemical industry workers with perspective management. *Environ Res*. 2023 Aug 15;231:115913.
233. Currie J, Greenstone M, Meckel K. Hydraulic fracturing and infant health: New evidence from Pennsylvania. *Sci Adv*. 2017 Dec;3(12):e1603021.
234. Stacy SL, Brink LL, Larkin JC, Sadovsky Y, Goldstein BD, Pitt BR, et al. Perinatal outcomes and unconventional natural gas operations in Southwest Pennsylvania. *PloS One*. 2015;10(6):e0126425.
235. Gaughan C, Sorrentino KM, Liew Z, Johnson NP, Clark CJ, Soriano MJ, et al. Residential proximity to unconventional oil and gas development and birth defects in Ohio. *Environ Res*. 2023 July 15;229:115937.
236. Tang IW, Langlois PH, Vieira VM. Birth defects and unconventional natural gas developments in Texas, 1999–2011. *Environ Res*. 2021 Mar;194:110511.
237. Siegel KR, Bérubé R, Day M, Heldman S, Daley C, Murray BR, et al. IMPACT OF REAL-LIFE ENVIRONMENTAL EXPOSURES ON REPRODUCTION: Evidence for reproductive health effects following exposure to hydraulic fracturing chemical mixtures. *Reprod Camb Engl*. 2024 Oct 1;168(4):e240134.
238. Hill EL, Ma L. Drinking water, fracking, and infant health. *J Health Econ*. 2022 Mar 1;82:102595.
239. Rasmussen SG, Ogburn EL, McCormack M, Casey JA, Bandeen-Roche K, Mercer DG, et al. Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations. *JAMA Intern Med*. 2016 Sept 1;176(9):1334–43.
240. Trickey KS, Chen Z, Sanghavi P. Hospitalisations for cardiovascular and respiratory disease among older adults living near unconventional natural gas development: a difference-in-differences analysis. *Lancet Planet Health*. 2023 Mar;7(3):e187–96.
241. McAlexander TP, Bandeen-Roche K, Buckley JP, Pollak J, Michos ED, McEvoy JW, et al. Unconventional Natural Gas Development and Hospitalization for Heart Failure in Pennsylvania. *J Am Coll Cardiol*. 2020 Dec;76(24):2862–74.
242. Denham A, Willis MD, Croft DP, Liu L, Hill EL. Acute myocardial infarction associated with unconventional natural gas development: A natural experiment. *Environ Res*. 2021 Apr;195:110872.
243. Hays J, McCawley M, Shonkoff SBC. Public health implications of environmental noise associated with unconventional oil and gas development. *Sci Total Environ*. 2017 Feb 15;580:448–56.
244. Richburg CM, Slagley J. Noise concerns of residents living in close proximity to hydraulic fracturing sites in Southwest Pennsylvania. *Public Health Nurs Boston Mass*. 2019 Jan;36(1):3–10.
245. Gorski-Steiner I, Bandeen-Roche K, Volk HE, O'Dell S, Schwartz BS. The association of unconventional natural gas development with diagnosis and treatment of internalizing disorders among adolescents in Pennsylvania using electronic health records. *Environ Res*. 2022 Sept;212(Pt A):113167.
246. Bamberger M, Nell M, Ahmed AH, Santoro R, Ingraffea AR, Kennedy RF, et al. Surface water and groundwater analysis using aryl hydrocarbon and endocrine receptor biological assays and liquid chromatography-high resolution mass spectrometry in Susquehanna County, PA. *Environ Sci Process Impacts*. 2019;21(6):988–98.

247. Kassotis CD, Tillitt DE, Davis JW, Hormann AM, Nagel SC. Estrogen and androgen receptor activities of hydraulic fracturing chemicals and surface and ground water in a drilling-dense region. *Endocrinology*. 2014 Mar;155(3):897–907.
248. Shaheen SW, Wen T, Herman A, Brantley SL. Geochemical Evidence of Potential Groundwater Contamination with Human Health Risks Where Hydraulic Fracturing Overlaps with Extensive Legacy Hydrocarbon Extraction. *Environ Sci Technol*. 2022 July 19;56(14):10010–9.
249. Edwards J. Canada's oil sands residents complain of health effects. *The Lancet*. 2014 Apr;383(9927):1450–1.
250. Tenenbaum DJ. Oil Sands Development: A Health Risk Worth Taking? *Environ Health Perspect*. 2009 Apr;117(4):A150–6.
251. The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. Outcome of the first global stocktake [Internet]. Decision -/CMA.5. Available from: https://unfccc.int/sites/default/files/resource/cma5_auv_4_gst.pdf
252. Amy Westervelt. DRILLED. 2024 [cited 2025 Apr 28]. Documents, Whistleblowers, and Public Comments Are Clear: Oil Companies Know Carbon Capture Is Not a Climate Solution. Available from: <https://drilled.media/news/ccs>
253. Jacobson MZ. The health and climate impacts of carbon capture and direct air capture. *Energy Environ Sci*. 2019 Dec 4;12(12):3567–74.
254. OHCHR. OHCHR. [cited 2025 Apr 28]. The toxic impacts of some proposed climate change solutions - Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. Available from: <https://www.ohchr.org/en/documents/thematic-reports/ahrc5425-toxic-impacts-some-proposed-climate-change-solutions-report>
255. Permentier K, Vercammen S, Soetaert S, Schellekens C. Carbon dioxide poisoning: a literature review of an often forgotten cause of intoxication in the emergency department. *Int J Emerg Med*. 2017 Dec;10(1):14.
256. Simon J. The U.S. is expanding CO2 pipelines. One poisoned town wants you to know its story. NPR [Internet]. 2023 Sept 25 [cited 2025 Apr 28]; Available from: <https://www.npr.org/2023/05/21/1172679786/carbon-capture-carbon-dioxide-pipeline>
257. Natural Resources Canada. New Induced Seismicity Study: fracking and earthquakes in Western Canada [Internet]. 2019 [cited 2025 July 29]. Available from: <https://natural-resources.canada.ca/stories/simply-science/new-induced-seismicity-study-fracking-earthquakes-western-canada>
258. Dimitriadis C, Gao CX, Ikin JF, Wolfe R, Gabbe BJ, Sim MR, et al. Exposure to mine fire related particulate matter and mortality: A time series analysis from the Hazelwood Health Study. *Chemosphere*. 2021 Dec;285:131351.
259. Smith CL, Gao CX, Xu R, Ikin JF, Dimitriadis C, Carroll MT, et al. Long-term impact of the 2014 Hazelwood coal mine fire on emergency department presentations in Australia. *Environ Res*. 2023 Apr 15;223:115440.
260. Xu R, Gao CX, Dimitriadis C, Smith CL, Carroll MTC, Ikin JF, et al. Long-term impacts of coal mine fire-emitted PM2.5 on hospitalisation: a longitudinal analysis of the Hazelwood Health Study. *Int J Epidemiol*. 2022 Feb 18;51(1):179–90.
261. Nance E, King D, Wright B, Bullard RD. Ambient air concentrations exceeded health-based standards for fine particulate matter and benzene during the Deepwater Horizon oil spill. *J Air Waste Manag Assoc*. 2016 Feb 1;66(2):224–36.
262. Center for Biological Diversity. Center for Biological Diversity. [cited 2024 Dec 31]. A Deadly Toll. Available from: https://www.biologicaldiversity.org/programs/public_lands/energy/dirty_energy_development/oil_and_gas/gulf_oil_spill/a_deadly_toll.html#
263. Takeshita R, Bursian SJ, Colegrove KM, Collier TK, Deak K, Dean KM, et al. A review of the toxicology of oil in vertebrates: what we have learned following the Deepwater Horizon oil spill. *J Toxicol Environ Health B Crit Rev*. 2021 Nov 17;24(8):355–94.
264. Rusiecki J, Alexander M, Schwartz EG, Wang L, Weems L, Barrett J, et al. The Deepwater Horizon Oil Spill Coast Guard Cohort study. *Occup Environ Med*. 2018 Mar;75(3):165–75.
265. Rusiecki JA, Denic-Roberts H, Thomas DL, Collen J, Barrett J, Christenbury K, et al. Incidence of chronic respiratory conditions among oil spill responders: Five years of follow-up in the Deepwater Horizon Oil Spill Coast Guard Cohort study. *Environ Res*. 2022 Jan;203:111824.
266. Denic-Roberts H, Rowley N, Haigney MC, Christenbury K, Barrett J, Thomas DL, et al. Acute and longer-term cardiovascular conditions in the Deepwater Horizon Oil Spill Coast Guard Cohort. *Environ Int*. 2022 Jan;158:106937.

267. Chen D, Sandler DP, Keil AP, Heiss G, Whitsel EA, Edwards JK, et al. Volatile Hydrocarbon Exposures and Incident Coronary Heart Disease Events: Up to Ten Years of Follow-up among Deepwater Horizon Oil Spill Workers. *Environ Health Perspect.* 2023 May;131(5):57006.
268. Liu YZ, Zhang L, Roy-Engel AM, Saito S, Lasky JA, Wang G, et al. Carcinogenic effects of oil dispersants: A KEGG pathway-based RNA-seq study of human airway epithelial cells. *Gene.* 2017 Feb 20;602:16–23.
269. Kimi Colney. The Caravan. 2020 [cited 2025 Apr 14]. How Assam's Baghjan gas well blowout impacted lives, livelihoods and the environment. Available from: <https://caravanmagazine.in/communities/assam-gas-well-baghjan-blowout-fire>
270. Makepeace Sitlhou. Victims of Assam gas explosion fear mounting health costs [Internet]. Dialogue Earth. 2020 [cited 2025 Apr 14]. Available from: <https://dialogue.earth/en/pollution/assam-gas-explosion/>
271. Paltasingh T, Satapathy J. Unbridled coal extraction and concerns for livelihood: evidences from Odisha, India. *Miner Econ.* 2021 Oct 1;34(3):491–503.
272. Stracher GB, Taylor TP. Coal fires burning out of control around the world: thermodynamic recipe for environmental catastrophe. *Int J Coal Geol.* 2004 July 12;59(1):7–17.
273. Dutta A. TheQuint. 2023 [cited 2025 Apr 14]. 'Ground Is Sinking, Houses Are Cracking': People of Jharia Fear for Their Lives. Available from: <https://www.thequint.com/news/india/dhanbad-jharia-coal-fields-underground-fire-ground-sinking>
274. Biswal SS, Gorai AK. Studying the coal fire dynamics in Jharia coalfield, India using time-series analysis of satellite data. *Remote Sens Appl Soc Environ.* 2021 Aug 1;23:100591.
275. Ministry of Coal, Government of India. PIB, New Delhi. 2023 [cited 2025 Apr 14]. Jharia Master Plan: Coal Ministry Efforts Bring Down Surface Fire identified from 77 to 27 sites. Available from: <https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1960543>
276. Garcia-Gonzales DA, Shonkoff SBC, Hays J, Jerrett M. Hazardous Air Pollutants Associated with Upstream Oil and Natural Gas Development: A Critical Synthesis of Current Peer-Reviewed Literature. *Annu Rev Public Health.* 2019 Apr 1;40(Volume 40, 2019):283–304.
277. Fugitive Emission - an overview | ScienceDirect Topics [Internet]. [cited 2024 Dec 20]. Available from: <https://www.sciencedirect.com/topics/engineering/fugitive-emission>
278. LACONDE T. Climate Chance. [cited 2024 Dec 20]. Fugitive emissions: a blind spot in the fight against climate change. Available from: <https://www.climate-chance.org/wp-content/uploads/2019/03/new-fugitive-emissions-a-blind-spot-in-the-fight-against-climate-change.pdf>
279. David Picard. <https://www.ipcc-nggip.iges.or.jp/>. [cited 2024 Dec 20]. FUGITIVE EMISSIONS FROM OIL AND NATURAL GAS ACTIVITIES. Available from: https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/2_6_Fugitive_Emissions_from_Oil_and_Natural_Gas.pdf
280. National Toxicology Program (NTP). 15th Report on Carcinogens [Internet]. U.S. Department of Health and Human Services; 2021. Available from: <https://doi.org/10.22427/NTP-OTHER-1003>
281. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Chemical Agents and Related Occupations: COKE PRODUCTION. [Internet]. Lyon, France: International Agency for Research on Cancer; 2012. (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans). Available from: <https://www.ncbi.nlm.nih.gov/books/NBK304422/>
282. Sedlák V, Bujňák A, Gajdoš A, Gajdošová D, Poráčková J, Konečná M, et al. Cytogenetic analysis of coke oven workers in Eastern Slovakia. *Cent Eur J Public Health.* 2023 Dec;31(Suppl 1):S95–100.
283. Samir AM, Shaker DAH, Fathy MM, Hafez SF, Abdullatif MM, Rashed LA, et al. Urinary and Genetic Biomonitoring of Polycyclic Aromatic Hydrocarbons in Egyptian Coke Oven Workers: Associations between Exposure, Effect, and Carcinogenic Risk Assessment. *Int J Occup Environ Med.* 2019 July;10(3):124–36.
284. Liu B, Feng W, Wang J, Li Y, Han X, Hu H, et al. Association of urinary metals levels with type 2 diabetes risk in coke oven workers. *Environ Pollut Barking Essex* 1987. 2016 Mar;210:1–8.
285. Yang L, Yan K, Zeng D, Lai X, Chen X, Fang Q, et al. Association of polycyclic aromatic hydrocarbons metabolites and risk of diabetes in coke oven workers. *Environ Pollut Barking Essex* 1987. 2017 Apr;223:305–10.
286. Yu W, Thurston GD. An interrupted time series analysis of the cardiovascular health benefits of a coal coking operation closure. *Environ Res Health.* 2023 Dec 1;1(4):045002.

287. Onyije FM, Hosseini B, Togawa K, Schüz J, Olsson A. Cancer Incidence and Mortality among Petroleum Industry Workers and Residents Living in Oil Producing Communities: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health*. 2021 Apr 20;18(8):4343.
288. Anttila A, Pokhrel A, Heikkilä P, Viinanen R, Pukkala E. Kidney cancer risk in oil refining in Finland: a nested case-referent study. *J Occup Environ Med*. 2015 Jan;57(1):68–72.
289. Hosseininejad M, Salehi F, Mirzamohammadi E, Mohsenizadeh SA, Mohammadi S. The relationship between occupational exposure to organic solvents and metabolic syndrome in petroleum refinery workers in Tehran, Iran. *Diabetes Metab Syndr*. 2021 Oct;15(5):102223.
290. Trasande L, Urbina EM, Khoder M, Alghamdi M, Shabaj I, Alam MS, et al. Polycyclic aromatic hydrocarbons, brachial artery distensibility and blood pressure among children residing near an oil refinery. *Environ Res*. 2015 Jan;136:133–40.
291. Kim H, Festa N, Burrows K, Kim DC, Gill TM, Bell ML. Is residential exposure to oil refineries a novel contextual risk factor for coronary heart disease? *Environ Res*. 2024 Mar 1;244:117965.
292. Al-Rubaye AH, Jasim DJ, Jassam SA, Jasim HM, Ameen HFM, Al-Robai HA. The Side Effect of Oil Refineries on Environment: As a mini Review. *IOP Conf Ser Earth Environ Sci*. 2023 Dec;1262(2):022024.
293. Steven Cohen. The Endless Shame of Louisiana's Cancer Alley – State of the Planet. *State of the Planet - News from the Columbia Climate School* [Internet]. 2024 Mar 18 [cited 2025 Jan 1]; Available from: <https://news.climate.columbia.edu/2024/03/18/the-endless-shame-of-louisianas-cancer-alley/>
294. Tristan Baurick. ProPublica. 2019 [cited 2025 Jan 1]. Welcome to “Cancer Alley,” Where Toxic Air Is About to Get Worse. Available from: <https://www.propublica.org/article/welcome-to-cancer-alley-where-toxic-air-is-about-to-get-worse>
295. Younes LS Lylla. ProPublica. 2022 [cited 2025 Apr 14]. EPA Calls Out Environmental Racism in Louisiana's Cancer Alley. Available from: <https://www.propublica.org/article/cancer-alley-louisiana-epa-environmental-racism>
296. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY. 2022 [cited 2025 Apr 14]. EPA Complaint Nos. 01R-22-R6, 02R-22-R6, and 04R-22-R6. Available from: <https://www.epa.gov/system/files/documents/2022-10/2022%2010%2012%20Final%20Letter%20LDEQ%20LDH%2001R-22-R6%2C%2002R-22-R6%2C%2004R-22-R6.pdf>
297. Ismail M.K. Saadoun. Impact of Oil Spills on Marine Life. In: *Emerging Pollutants in the Environment - Current and Further Implications* [Internet]. 2015 [cited 2024 Dec 31]. p. 240. (IntechOpen). Available from: <https://www.intechopen.com/chapters/48738>
298. U.S. Environmental Protection Agency., Office of Emergency and Remedial Response, EPA. Understanding Oil Spills and Oil Spill Response | Understanding Oil Spills in Freshwater Environments [Internet]. Washington DC: U.S. Environmental Protection Agency.; 1999 Dec [cited 2024 Dec 31] p. 49. (OSWER 9200.5-104A, PB2000-963401). Report No.: 540-K-99–007. Available from: <https://www.epa.gov/sites/default/files/2018-01/documents/ospguide99.pdf>
299. Rita-Igboanugo I. OIL SPILL: AN OVERVIEW IMPACT ON OUR ECOSYSTEM AND CLIMATE CHANGE. *J Fac Environ Sci*. 2021;8(2):7.
300. Ibrahim HA, Syed HS. Hazard Analysis of Crude Oil Storage Tank Farm. *Int J ChemTech Res*. 2018;11(11):300–8.
301. Tecam Group. TECAM. 2024 [cited 2024 Dec 31]. Main environmental risks in tank storage terminals and how to mitigate them. Available from: <https://tecamgroup.com/main-environmental-risks-in-tank-storage-terminals-and-how-to-mitigate-them/>
302. Mall A. NRDC. 2021 [cited 2024 Dec 31]. Gas Pipelines: Harming Clean Water, People, and the Planet. Available from: <https://www.nrdc.org/bio/amy-mall/gas-pipelines-harming-clean-water-people-and-planet>
303. Amnesty International. Amnesty International. 2022 [cited 2024 Dec 31]. Construction of pipeline on Indigenous territory in Canada endangers land defenders. Available from: <https://www.amnesty.org/en/latest/news/2022/10/canada-pipeline-indigenous-territory-endangers-land-defenders/>
304. Soares MO, Rabelo EF. Severe ecological impacts caused by one of the worst orphan oil spills worldwide. *Mar Environ Res*. 2023 May;187:105936.
305. Dutzik T, Scarr FGA, Casale IPEFM, REPORT USPEFT. PIRG. 2022 [cited 2024 Dec 31]. Methane Gas Leaks. Available from: <https://pirg.org/resources/methane-gas-leaks/>
306. Garcia Sanchez G. When Drills and Pipelines Cross Indigenous Lands in the Americas. *Seton Hall Law Rev*. 2021 May 1;51(4):1121–92.

307. Kate Larsen. ABC 7 News. 2017 [cited 2025 Apr 22]. PG&E receives maximum sentence for 2010 San Bruno pipeline explosion - ABC7 San Francisco. Available from: <https://abc7news.com/pge-fine-pacific-gas-and-electric-san-bruno-fire-explosion/1722674/>
308. Sammy Roth. Los Angeles Times. 2018 [cited 2025 Apr 22]. PG&E falsified gas pipeline records for years after deadly explosion, regulators say. Available from: <https://www.latimes.com/business/la-fi-pge-safety-investigation-20181214-story.html>
309. Jason Hanna, Sarah Moon. CNN. 2019 [cited 2025 July 29]. PG&E's failure to maintain transmission tower helped lead to the deadly Camp Fire, report says. Available from: <https://www.cnn.com/2019/12/03/us/pge-transmission-lines-camp-fire>
310. Hayes J, Maslen S, Schulman P. A case of collective lying: How deceit becomes entrenched in organizational safety behavior. *Saf Sci*. 2024 Aug 1;176:106554.
311. Ostro B, Fang Y, Sospedra MC, Kuiper H, Ebisu K, Spada N. Health impact assessment of PM_{2.5} from uncovered coal trains in the San Francisco Bay Area: Implications for global exposures. *Environ Res*. 2024 July 1;252(Pt 1):118787.
312. Génereux M, Maltais D, Petit G, Roy M. Monitoring Adverse Psychosocial Outcomes One and Two Years After the Lac-Mégantic Train Derailment Tragedy (Eastern Townships, Quebec, Canada). *Prehospital Disaster Med*. 2019 June;34(3):251–9.
313. Burton L, Stretesky P. Wrong side of the tracks: the neglected human costs of transporting oil and gas. *Health Hum Rights*. 2014 June 14;16(1):82–92.
314. Eco-Business. Eco-Business. 2016 [cited 2025 Apr 22]. Another catastrophe: Ship carrying 1,235 metric tons of coal sinks in Sundarbans. Available from: <https://www.eco-business.com/news/another-catastrophe-ship-carrying-1235-metric-tons-of-coal-sinks-in-sundarbans/>
315. Park MH, Lee WJ. Marine oil spill analyses based on Korea Coast Guard big data from 2017 to 2022 and application of data-driven Bayesian Network. *J Clean Prod*. 2024 Jan 10;436:140630.
316. K.W. Ketkar, A.J.G. Babu. An analysis of oil spills from vessel traffic accidents - ScienceDirect. *Transp Res Part Transp Environ*. 1997 Mar;Volume 2(Issue 1):35–41.
317. Noh SR, Kim JA, Cheong HK, Ha M, Jee YK, Park MS, et al. Hebei Spirit oil spill and its long-term effect on children's asthma symptoms. *Environ Pollut Barking Essex* 1987. 2019 May;248:286–94.
318. Choi YH, Kim L, Huh DA, Moon KW, Kang MS, Lee YJ. Association between oil spill clean-up work and thyroid cancer: Nine years of follow-up after the Hebei Spirit oil spill accident. *Mar Pollut Bull*. 2024 Feb;199:116041.
319. NOAA. governmental. [cited 2025 Jan 1]. Exxon Valdez | Oil Spills | Damage Assessment, Remediation, and Restoration Program. Available from: <https://darrp.noaa.gov/oil-spills/exxon-valdez>
320. International Energy Agency. Energy and Air Pollution [Internet]. Paris: IEA; 2016. Available from: <https://www.iea.org/reports/energy-and-air-pollution>
321. Schraufnagel DE, Balmes JR, Cowl CT, De Matteis S, Jung SH, Mortimer K, et al. Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 2: Air Pollution and Organ Systems. *Chest*. 2019 Feb;155(2):417–26.
322. Rajagopalan S, Brook RD, Salerno PRVO, Bourges-Sevenier B, Landrigan P, Nieuwenhuijsen MJ, et al. Air pollution exposure and cardiometabolic risk. *Lancet Diabetes Endocrinol*. 2024 Mar;12(3):196–208.
323. Shi L, Wu X, Yazdi MD, Braun D, Awad YA, Wei Y, et al. Long-term effects of PM_{2.5} on neurological disorders in the American Medicare population: a longitudinal cohort study. *Lancet Planet Health*. 2020 Dec 1;4(12):e557–65.
324. Ye JJ, Wang SS, Fang Y, Zhang XJ, Hu CY. Ambient air pollution exposure and risk of chronic kidney disease: A systematic review of the literature and meta-analysis. *Environ Res*. 2021 Apr;195:110867.
325. Evolutionary Development of Coal-Fired Power Plants. In: Clean and Efficient Coal-Fired Power Plants [Internet]. ASME Press; 2003 [cited 2025 Feb 4]. p. 3–25. Available from: <https://asmedigitalcollection.asme.org/ebooks/book/118/chapter/23126/evolutionary-development-of-coal-fired-power>
326. Energy Institute. Statistical Review of World Energy [Internet]. Energy Institute; 2024. Report No.: 73rd Edition. Available from: <https://www.energyinst.org/statistical-review>
327. Cleveland C. Institute for Global Sustainability: Visualizing Energy. 2023 [cited 2025 Feb 3]. World electricity generation since 1900. Available from: <https://visualizingenergy.org/world-electricity-generation-since-1900/>
328. Hendryx M, Zullig KJ, Luo J. Impacts of Coal Use on Health. *Annu Rev Public Health*. 2020 Apr 2;41:397–415.

329. Buchanan S, Burt E, Orris P. Beyond black lung: scientific evidence of health effects from coal use in electricity generation. *J Public Health Policy*. 2014 Aug;35(3):266–77.
330. Ruiz Bautista L. Cardiovascular impact of PM(2.5) from the emissions of coal-fired power plants in Spain during 2014. *Med Clin (Barc)*. 2019 Aug 2;153(3):100–5.
331. Liebig-Gonglach M, Neunhäuserer L, Kuenen J, Hoffmann B, Soppa V, Diegmann V, et al. Environmental Burden of Disease due to Emissions of Hard Coal- and Lignite-Fired Power Plants in Germany. *Int J Public Health*. 2023;68:1606083.
332. Kravchenko J, Lyster HK. The Impact of Coal-Powered Electrical Plants and Coal Ash Impoundments on the Health of Residential Communities. *N C Med J*. 2018 Oct;79(5):289–300.
333. Henneman L, Choirat C, Dedoussi I, Dominici F, Roberts J, Zigler C. Mortality risk from United States coal electricity generation. *Science*. 2023 Nov 24;382(6673):941–6.
334. Koplitz SN, Jacob DJ, Sulprizio MP, Myllyvirta L, Reid C. Burden of Disease from Rising Coal-Fired Power Plant Emissions in Southeast Asia. *Environ Sci Technol*. 2017 Feb 7;51(3):1467–76.
335. Amster E, Lew Levy C. Impact of Coal-fired Power Plant Emissions on Children's Health: A Systematic Review of the Epidemiological Literature. *Int J Environ Res Public Health* [Internet]. 2019 June 5;16(11). Available from: <https://www.mdpi.com/1660-4601/16/11/2008>
336. Cortes A. S, Yohannessen V. K, Tellerías C. L, Ahumada P. E. Exposición a contaminantes provenientes de termoeléctricas a carbón y salud infantil: ¿Cuál es la evidencia internacional y nacional? *Rev Chil Pediatría*. 2019 Feb 19;90(1):102.
337. Datt G, Maitra P, Menon N, Ray R. Coal Plants, Air Pollution and Anaemia: Evidence from India. *J Dev Stud*. 2023 Apr 3;59(4):533–51.
338. Tang D, Li TY, Chow JC, Kulkarni SU, Watson JG, Ho SSH, et al. Air pollution effects on fetal and child development: a cohort comparison in China. *Environ Pollut Barking Essex 1987*. 2014 Feb;185:90–6.
339. Tang D, Lee J, Muirhead L, Li TY, Qu L, Yu J, et al. Molecular and neurodevelopmental benefits to children of closure of a coal burning power plant in China. *PloS One*. 2014;9(3):e91966.
340. Casey JA, Gemmill A, Karasek D, Ogburn EL, Goin DE, Morello-Frosch R. Increase in fertility following coal and oil power plant retirements in California. *Environ Health Glob Access Sci Source*. 2018 May 2;17(1):44.
341. Health and Environment Alliance. Health and Environment Alliance. 2022 [cited 2024 Dec 31]. False fix: the hidden health impacts of Europe's fossil gas dependency. Available from: <https://www.env-health.org/false-fix/>
342. Ifeanyi O, Nnaji JC. Electricity Generator Emission and Its Impacts on Air Quality to the Environment. *Asian J Green Chem*. 2023 May 1;7(2):132–9.
343. Mokbil L Nicholas L, Wallach, Eli, Hsu, Chih Wei, Jacobson, Arne, Alstone, Peter Michael, Purohit, Pallav, Klimont, Zbigniew, Sturm, Russell, Tomlinson, Daniel Bruce, Gallery, Bill, Gharib, Rwaida. World Bank. [cited 2025 Apr 22]. The Dirty Footprint of the Broken Grid : The Impacts of Fossil Fuel Back-up Generators in Developing Countries (Vol. 2 of 2) : Full Report. Available from: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/en/144941573017592423>
344. Boogaard H, Patton AP, Atkinson RW, Brook JR, Chang HH, Crouse DL, et al. Long-term exposure to traffic-related air pollution and selected health outcomes: A systematic review and meta-analysis. *Environ Int*. 2022 June;164:107262.
345. Sophia Scott Roussey, Jennifer Kuhl, Jessica Nicole Burnside, Jane E McArthur, Anjali Helferty. Mobilizing Evidence: Activating Change on Traffic-Related Air Pollution (TRAP) Health Impacts [Internet]. Canadian Association of Physicians for the Environment; Available from: <https://cape.ca/wp-content/uploads/2022/05/CAPE-TRAP-2022-2.pdf>
346. Fleisch AF, Luttmann-Gibson H, Perng W, Rifas-Shiman SL, Coull BA, Kloog I, et al. Prenatal and early life exposure to traffic pollution and cardiometabolic health in childhood. *Pediatr Obes*. 2017 Feb;12(1):48–57.
347. Min KD, Yi SJ, Kim HC, Leem JH, Kwon HJ, Hong S, et al. Association between exposure to traffic-related air pollution and pediatric allergic diseases based on modeled air pollution concentrations and traffic measures in Seoul, Korea: a comparative analysis. *Environ Health Glob Access Sci Source*. 2020 Jan 14;19(1):6.
348. Mphahlele R, Lesosky M, Masekela R. Prevalence, severity and risk factors for asthma in school-going adolescents in KwaZulu Natal, South Africa. *BMJ Open Respir Res* [Internet]. 2023 May;10(1). Available from: <https://bmjopenrespres.bmj.com/content/10/1/e001498>

349. Pujol J, Martínez-Vilavella G, Macià D, Fenoll R, Alvarez-Pedrerol M, Rivas I, et al. Traffic pollution exposure is associated with altered brain connectivity in school children. *NeuroImage*. 2016 Apr 1;129:175–84.
350. Lau N, Smith MJ, Sarkar A, Gao Z. Effects of low exposure to traffic related air pollution on childhood asthma onset by age 10 years. *Environ Res*. 2020 Dec;191:110174.
351. Carey IM, Anderson HR, Atkinson RW, Beevers S, Cook DG, Dajnak D, et al. Traffic pollution and the incidence of cardiorespiratory outcomes in an adult cohort in London. *Occup Environ Med*. 2016 Dec;73(12):849–56.
352. Hsu HT, Wu CD, Chung MC, Shen TC, Lai TJ, Chen CY, et al. The effects of traffic-related air pollutants on chronic obstructive pulmonary disease in the community-based general population. *Respir Res*. 2021 Aug 3;22(1):217.
353. Zheng J, Liu S, Peng J, Peng H, Wang Z, Deng Z, et al. Traffic-related air pollution is a risk factor in the development of chronic obstructive pulmonary disease. *Front Public Health*. 2022;10:1036192.
354. Yu Z, Wei F, Zhang X, Wu M, Lin H, Shui L, et al. Air pollution, surrounding green, road proximity and Parkinson's disease: A prospective cohort study. *Environ Res*. 2021 June;197:111170.
355. Rajendran R, Ragavan RP, Al-Sehemi AG, Uddin MS, Aleya L, Mathew B. Current understandings and perspectives of petroleum hydrocarbons in Alzheimer's disease and Parkinson's disease: a global concern. *Environ Sci Pollut Res Int*. 2022 Feb;29(8):10928–49.
356. Zhao Z, Lin F, Wang B, Cao Y, Hou X, Wang Y. Residential Proximity to Major Roadways and Risk of Type 2 Diabetes Mellitus: A Meta-Analysis. *Int J Environ Res Public Health* [Internet]. 2016 Dec 22;14(1). Available from: <https://www.mdpi.com/1660-4601/14/1/3>
357. Qin F, Yang Y, Wang ST, Dong YN, Xu MX, Wang ZW, et al. Exercise and air pollutants exposure: A systematic review and meta-analysis. *Life Sci*. 2019 Feb 1;218:153–64.
358. Costello JM, Steurer MA, Baer RJ, Witte JS, Jelliffe-Pawlowski LL. Residential particulate matter, proximity to major roads, traffic density and traffic volume as risk factors for preterm birth in California. *Paediatr Perinat Epidemiol*. 2022 Jan;36(1):70–9.
359. Codispoti CD, LeMasters GK, Levin L, Reponen T, Ryan PH, Biagini Myers JM, et al. Traffic pollution is associated with early childhood aeroallergen sensitization. *Ann Allergy Asthma Immunol Off Publ Am Coll Allergy Asthma Immunol*. 2015 Feb;114(2):126–33.
360. Andersen MHG, Frederiksen M, Saber AT, Wils RS, Fonseca AS, Koponen IK, et al. Health effects of exposure to diesel exhaust in diesel-powered trains. *Part Fibre Toxicol*. 2019 June 11;16(1):21.
361. Kachuri L, Villeneuve PJ, Parent MÉ, Johnson KC, Harris SA. Workplace exposure to diesel and gasoline engine exhausts and the risk of colorectal cancer in Canadian men. *Environ Health Glob Access Sci Source*. 2016 Jan 14;15:4.
362. Silverman DT, Bassig BA, Lubin J, Graubard B, Blair A, Vermeulen R, et al. The Diesel Exhaust in Miners Study (DEMS) II: Temporal Factors Related to Diesel Exhaust Exposure and Lung Cancer Mortality in the Nested Case–Control Study. *Environ Health Perspect*. 2023 Aug;131(8):087002.
363. Gentleman A. Mother of girl whose death was linked to air pollution sues UK government. *The Guardian* [Internet]. 2024 Jan 25 [cited 2025 May 28]; Available from: <https://www.theguardian.com/environment/2024/jan/25/mother-of-girl-who-died-from-air-pollution-sues-uk-government>
364. Health and Energy. Youtube.com. 2025. Setting the scene: SDGs and triple wins – air quality, climate change mitigation & health protection. Available from: https://www.youtube.com/watch?v=nAQBBRXBN0I&ab_channel=Health%26Energy
365. Gruenwald T, Seals BA, Knibbs LD, Hosgood HD. Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. *Int J Environ Res Public Health*. 2022 Dec 21;20(1):75.
366. Knibbs LD, Woldeyohannes S, Marks GB, Cowie CT. Damp housing, gas stoves, and the burden of childhood asthma in Australia. *Med J Aust*. 2018 Apr 16;208(7):299–302.
367. Kashtan Y, Nicholson M, Finnegan CJ, Ouyang Z, Garg A, Lebel ED, et al. Nitrogen dioxide exposure, health outcomes, and associated demographic disparities due to gas and propane combustion by U.S. stoves. *Sci Adv*. 2024 May 3;10(18):eadm8680.
368. Paulin LM, Samet JM, Rice MB. Gas Stoves and Respiratory Health: Decades of Data, but Not Enough Progress. *Ann Am Thorac Soc*. 2023 Dec;20(12):1697–9.
369. Lin W, Brunekreef B, Gehring U. Meta-analysis of the effects of indoor nitrogen dioxide and gas cooking on asthma and wheeze in children. *Int J Epidemiol*. 2013 Dec 1;42(6):1724–37.

370. Lebel ED, Finnegan CJ, Ouyang Z, Jackson RB. Methane and NO(x) Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes. *Environ Sci Technol*. 2022 Feb 15;56(4):2529–39.
371. Bhurosy T, Marium A, Karaye IM, Chung T. Where there are fumes, there may be lung cancer: a systematic review on the association between exposure to cooking fumes and the risk of lung cancer in never-smokers. *Cancer Causes Control CCC*. 2023 June;34(6):509–20.
372. Kim C, Seow WJ, Shu XO, Bassig BA, Rothman N, Chen BE, et al. Cooking Coal Use and All-Cause and Cause-Specific Mortality in a Prospective Cohort Study of Women in Shanghai, China. *Environ Health Perspect*. 2016 Sept;124(9):1384–9.
373. Nagaradona T, Bassig BA, Hosgood D, Vermeulen RCH, Ning B, Seow WJ, et al. Overall and cause-specific mortality rates among men and women with high exposure to indoor air pollution from the use of smoky and smokeless coal: a cohort study in Xuanwei, China. *BMJ Open*. 2022 Nov 15;12(11):e058714.
374. Li J, Ran J, Chen LC, Costa M, Huang Y, Chen X, et al. Bituminous coal combustion and Xuan Wei Lung cancer: a review of the epidemiology, intervention, carcinogens, and carcinogenesis. *Arch Toxicol*. 2019 Mar;93(3):573–83.
375. Badarch J, Harding J, Dickinson-Craig E, Azen C, Ong H, Hunter S, et al. Winter Air Pollution from Domestic Coal Fired Heating in Ulaanbaatar, Mongolia, Is Strongly Associated with a Major Seasonal Cyclic Decrease in Successful Fecundity. *Int J Environ Res Public Health* [Internet]. 2021 Mar 9;18(5). Available from: <https://www.mdpi.com/1660-4601/18/5/2750>
376. Chen H, Zhang Y, Zhang L, Liu J, Jin L, Ren A, et al. Indoor air pollution from coal combustion and tobacco smoke during the periconceptional period and risk for neural tube defects in offspring in five rural counties of Shanxi Province, China, 2010-2016. *Environ Int*. 2023 Jan;171:107728.
377. Amegah AK, Quansah R, Jaakkola JJK. Household air pollution from solid fuel use and risk of adverse pregnancy outcomes: a systematic review and meta-analysis of the empirical evidence. *PloS One*. 2014;9(12):e113920.
378. Jiang M, Qiu J, Zhou M, He X, Cui H, Lerro C, et al. Exposure to cooking fuels and birth weight in Lanzhou, China: a birth cohort study. *BMC Public Health*. 2015 July 28;15:712.
379. Yu K, Qiu G, Chan KH, Lam KBH, Kurmi OP, Bennett DA, et al. Association of Solid Fuel Use With Risk of Cardiovascular and All-Cause Mortality in Rural China. *JAMA*. 2018 Apr 3;319(13):1351–61.
380. Islam MM, Wathore R, Zerriffi H, Marshall JD, Bailis R, Grieshop AP. In-use emissions from biomass and LPG stoves measured during a large, multi-year cookstove intervention study in rural India. *Sci Total Environ*. 2021 Mar 1;758:143698.
381. Gould CF, Schlesinger SB, Molina E, Lorena Bejarano M, Valarezo A, Jack DW. Long-standing LPG subsidies, cooking fuel stacking, and personal exposure to air pollution in rural and peri-urban Ecuador. *J Expo Sci Environ Epidemiol*. 2020 July;30(4):707–20.
382. Kephart JL, Fandiño-Del-Rio M, Williams KN, Malpartida G, Lee A, Steenland K, et al. Nitrogen dioxide exposures from LPG stoves in a cleaner-cooking intervention trial. *Environ Int*. 2021 Jan;146:106196.
383. Younger A, Alkon A, Harknett K, Kirby MA, Elon L, Lovvorn AE, et al. Effects of a LPG stove and fuel intervention on adverse maternal outcomes: A multi-country randomized controlled trial conducted by the Household Air Pollution Intervention Network (HAPIN). *Environ Int*. 2023 Aug;178:108059.
384. Checkley W, Williams KN, Kephart JL, Fandiño-Del-Rio M, Steenland NK, Gonzales GF, et al. Effects of a Household Air Pollution Intervention with Liquefied Petroleum Gas on Cardiopulmonary Outcomes in Peru. A Randomized Controlled Trial. *Am J Respir Crit Care Med*. 2021 June 1;203(11):1386–97.
385. Checkley W, Thompson LM, Sinharoy SS, Hossen S, Moulton LH, Chang HH, et al. Effects of Cooking with Liquefied Petroleum Gas or Biomass on Stunting in Infants. *N Engl J Med*. 2024 Jan 4;390(1):44–54.
386. Clasen TF, Chang HH, Thompson LM, Kirby MA, Balakrishnan K, Díaz-Artiga A, et al. Liquefied Petroleum Gas or Biomass for Cooking and Effects on Birth Weight. *N Engl J Med*. 2022 Nov 10;387(19):1735–46.
387. Younger A, Ye W, Alkon A, Harknett K, Kirby MA, Elon L, et al. Effects of a liquefied petroleum gas stove intervention on stillbirth, congenital anomalies and neonatal mortality: A multi-country household air pollution intervention network trial. *Environ Pollut*. 2024 Mar 15;345:123414.
388. Abdulai MA, Afari-Asiedu S, Carrion D, Ae-Ngibise KA, Gyaase S, Mohammed M, et al. Experiences with the Mass Distribution of LPG Stoves in Rural Communities of Ghana. *EcoHealth*. 2018 Dec;15(4):757–67.
389. Dalaba M, Alirigia R, Mesenbring E, Coffey E, Brown Z, Hannigan M, et al. Liquefied Petroleum Gas (LPG) Supply and Demand for Cooking in Northern Ghana. *EcoHealth*. 2018 Dec;15(4):716–28.

390. Ademola SA, Michael AI, Iyuan AO, Isamah CP, Aderibigbe RO, Olawoye OA, et al. Current Trend in the Epidemiology of Thermal Burn Injury at a Tertiary Hospital in South Western Nigeria. *J Burn Care Res Off Publ Am Burn Assoc.* 2024 Jan 5;45(1):190–9.
391. Baranwal S, Roy N, Chowdri A, Bhattacharya S. Etiological & clinical spectrum of Liquefied Petroleum Gas (LPG) related burns: A three-year study from a tertiary care burn centre in New Delhi. *Burns J Int Soc Burn Inj.* 2022 Sept;48(6):1481–7.
392. Jin R, Shao J, Ho JK, Yu M, Han C. A Retrospective Multicenter Study of 1898 Liquefied Petroleum Gas-Related Burn Patients in Eastern China From 2011 to 2015. *J Burn Care Res Off Publ Am Burn Assoc.* 2020 Nov 30;41(6):1188–97.
393. Tarim MA. Evaluation of burn injuries related to liquefied petroleum gas. *J Burn Care Res Off Publ Am Burn Assoc.* 2014 May 1;35(3):e159-163.
394. Paliwal G, Agrawal K, Srivastava RK, Sharma S. Domestic liquefied petroleum gas: are we using a kitchen bomb? *Burns J Int Soc Burn Inj.* 2014 Sept;40(6):1219–24.
395. Olawoye OA, Isamah CP, Ademola SA, Iyuan AO, Michael AI, Aderibigbe RO, et al. Changing Epidemiology and Outcome of Pediatric Thermal Burn Injury in South Western Nigeria. *J Burn Care Res Off Publ Am Burn Assoc.* 2024 Mar 4;45(2):404–9.
396. Williams KN, Kephart JL, Fandiño-Del-Rio M, Simkovich SM, Koehler K, Harvey SA, et al. Exploring the impact of a liquefied petroleum gas intervention on time use in rural Peru: A mixed methods study on perceptions, use, and implications of time savings. *Environ Int.* 2020 Dec;145:105932.
397. Syahni D, Saturi S. Mongabay Environmental News. 2021 [cited 2025 Jan 1]. Calls for accountability after coal-slurry spill in Indonesian river. Available from: <https://news.mongabay.com/2021/02/calls-for-accountability-after-coal-slurry-spill-in-indonesian-river/>
398. Erickson BE. Wastewater from fracking: Growing disposal challenge or untapped resource? *Chemical & Engineering News* [Internet]. 2019 Nov 17 [cited 2025 May 5];97(45). Available from: <https://cen.acs.org/environment/water/Wastewater-fracking-Growing-disposal-challenge/97/i45>
399. Healy RW. The water-energy nexus—an earth science perspective. Reston, Virginia: U.S. Geological Survey; 2015.
400. Wollin KM, Damm G, Foth H, Freyberger A, Gebel T, Mangerich A, et al. Critical evaluation of human health risks due to hydraulic fracturing in natural gas and petroleum production. *Arch Toxicol.* 2020 Apr;94(4):967–1016.
401. Wilson JM, Van Briesen JM. Source Water Changes and Energy Extraction Activities in the Monongahela River, 2009–2012. *Environ Sci Technol.* 2013 Nov 5;47(21):12575–82.
402. Arnaud CH. Figuring Out Fracking Wastewater. *Chemical & Engineering News* [Internet]. 2015 Mar 16 [cited 2025 May 5];93(11). Available from: <https://cen.acs.org/environment/water/Wastewater-fracking-Growing-disposal-challenge/97/i45>
403. Weber B. CBC.ca. 2024 [cited 2025 May 5]. Alberta regulator fines Imperial Oil over Kearl tailings pond leaks. Available from: <https://www.cbc.ca/news/canada/edmonton/alberta-energy-regulator-kearl-leak-1.7302069>
404. Rinchin, Chatterjee P, Ganguli M, Jana S. The health and environmental impact of coal mining in Chhattisgarh [Internet]. People First Collective, India (PFCI); 2017 Nov [cited 2024 Dec 31] p. 52. Available from: <http://archive.nyu.edu/handle/2451/42299>
405. U.S. Environmental Protection Agency. Human and Ecological Risk Assessment of Coal Combustion Wastes I Draft [Internet]. 2007 Aug [cited 2025 Apr 22]. Available from: <http://18.190.132.27/wp-content/uploads/2012/05/epa-coal-combustion-waste-risk-assessment.pdf>
406. Barbara Gottlieb, Steven G. Gilbert, Lisa Gollin Evans. Coal Ash - the toxic threat to our health and environment [Internet]. Earthjustice and Physicians for Social Responsibility; 2010 Sept [cited 2024 Dec 31] p. 38. Report No.: Physicians for social responsibility. Available from: https://earthjustice.org/wp-content/uploads/coalash_earthjustice.pdf
407. Hendryx M, Zullig KJ, Luo J. Impacts of Coal Use on Health. *Annu Rev Public Health.* 2020 Apr 1;41(Volume 41, 2020):397–415.
408. Lisa Evans, Pete Harrison, Jessica Lawrence, Danny Thiemann, Jina Kim, Jenny Casell. Coal Ash Primer [Internet]. Earthjustice; [cited 2024 Dec 31] p. 34. Available from: https://earthjustice.org/wp-content/uploads/coal-ash-primer_earthjustice_2023.pdf
409. World Bank. World Bank. [cited 2024 Dec 31]. What is Gas Flaring? Available from: <https://www.worldbank.org/en/programs/gasflaringreduction/gas-flaring-explained>

410. Tran H, Polka E, Buonocore JJ, Roy A, Trask B, Hull H, et al. Air Quality and Health Impacts of Onshore Oil and Gas Flaring and Venting Activities Estimated Using Refined Satellite-Based Emissions. *GeoHealth*. 2024;8(3):e2023GH000938.
411. Cushing LJ, Vavra-Musser K, Chau K, Franklin M, Johnston JE. Flaring from Unconventional Oil and Gas Development and Birth Outcomes in the Eagle Ford Shale in South Texas. *Environ Health Perspect*. 2020 July;128(7):77003.
412. D'Andrea MA, Singh O, Reddy GK. Health consequences of involuntary exposure to benzene following a flaring incident at British Petroleum refinery in Texas City. *Am J Disaster Med*. 2013 Summer;8(3):169–79.
413. Blundell W, Kokoza A. Natural gas flaring, respiratory health, and distributional effects. *J Public Econ*. 2022 Apr 1;208:104601.
414. Alimi OB, Gibson J. The impact of gas flaring on child health in Nigeria [Internet]. World Bank; 2022 Aug [cited 2024 Dec 31]. Report No.: 10153. Available from: <https://blogs.worldbank.org/en/developmenttalk/impact-gas-flaring-child-health-nigeria>
415. Stern B. 21-year-old dies days before he could challenge BP on dangerous pollution of his community: “Cancer is so common here, it’s like the flu” [Internet]. The Cool Down. 2023 [cited 2025 Jan 1]. Available from: <https://www.thecooldown.com/green-business/ali-hussein-jaloud-iraq-oil-fields-bp/>
416. Reynoso-Noverón N, Santibáñez-Andrade M, Torres J, Bautista-Ocampo Y, Sánchez-Pérez Y, García-Cuellar CM. Benzene exposure and pediatric leukemia: From molecular clues to epidemiological insights. *Toxicol Lett*. 2024 Oct;400:113–20.
417. Arab News. Arab News. 2022 [cited 2025 Apr 23]. UN sounds alarm over leukaemia in Iraq linked to oil fields. Available from: <https://arab.news/zrmsb>
418. Antonia Juhasz. Human Rights Watch. 2023 [cited 2025 Jan 1]. Iraq Gas Flaring Tied to Cancer Surge | Human Rights Watch. Available from: <https://www.hrw.org/news/2023/05/03/iraq-gas-flaring-tied-cancer-surge>
419. Poisoned Air: Undercover in BP’s dirtiest oil field - BBC News [Internet]. 2022 [cited 2025 Jan 1]. Available from: <https://www.youtube.com/watch?v=TJvLXcPBGwI>
420. Jess Kelly, Owen Pinnell, Esme Stallard. BP in oil field where ‘cancer is rife.’ BBC News [Internet]. 2022 Sept 30 [cited 2025 Jan 1]; Available from: <https://www.bbc.com/news/science-environment-63083634>
421. Kelly J. Ali died days before he could challenge BP’s CEO on the dangers of gas flaring. Don’t let his death be in vain. *The Guardian* [Internet]. 2023 Apr 27 [cited 2025 Jan 1]; Available from: <https://www.theguardian.com/commentisfree/2023/apr/27/ali-smoke-choked-bp-oilfield-death-gas-flaring>
422. Partridge T, Barandiaran J, Triozzi N, Valtierra VT. Decommissioning: another critical challenge for energy transitions in: *Global Social Challenges Journal* Volume 2 2 (2023) [Internet]. Bristol; 2023 [cited 2024 Dec 31]. Available from: <https://bristoluniversitypressdigital.com/gsc/view/journals/gscj/2/2/article-p188.xml>
423. Zhang M, Cheng L, Yue Z, Peng L, Xiao L. Assessment of heavy metal(oid) pollution and related health risks in agricultural soils surrounding a coal gangue dump from an abandoned coal mine in Chongqing, Southwest China. *Sci Rep*. 2024 Aug 12;14(1):18667.
424. Mason Leavitt, Zach Mulholland, Nathan Wilson, Lisa Arkin. Beneath the Pump: The Threat of Petroleum Contamination [Internet]. Beyond Toxics; 2023 Oct. Available from: https://www.beyondtoxics.org/wp-content/uploads/2023/10/BeneathThePump_TheThreat-of-PetroleumContamination_FINAL_10-13-23.pdf
425. DiGiulio DC, Rossi RJ, Lebel ED, Bilsback KR, Michanowicz DR, Shonkoff SBC. Chemical Characterization of Natural Gas Leaking from Abandoned Oil and Gas Wells in Western Pennsylvania. *ACS Omega*. 2023 June 6;8(22):19443–54.
426. Townsend-Small A, Hoschouer J. Direct measurements from shut-in and other abandoned wells in the Permian Basin of Texas indicate some wells are a major source of methane emissions and produced water. *Environ Res Lett*. 2021 May;16(5):054081.
427. IEA. IEA. [cited 2025 Mar 31]. Methane and climate change – Global Methane Tracker 2022 – Analysis. Available from: <https://www.iea.org/reports/global-methane-tracker-2022/methane-and-climate-change>
428. NRDC.org. NRDC.org. 2021 [cited 2025 May 7]. Millions of Leaky and Abandoned Oil and Gas Wells Are Threatening Lives and the Climate. Available from: <https://www.nrdc.org/stories/millions-leaky-and-abandoned-oil-and-gas-wells-are-threatening-lives-and-climate>
429. Pskowski M. A Legal Fight Over Legacy Oil Industry Pollution Heats Up in West Texas [Internet]. Inside Climate News. 2024 [cited 2024 Dec 31]. Available from: <https://insideclimatenews.org/news/06082024/texas-oil-industry-pollution-lawsuit/>

430. Gross L. Abandoned Oil and Gas Wells Emit Carcinogens and Other Harmful Pollutants, Groundbreaking Study Shows [Internet]. Inside Climate News. 2023 [cited 2024 Dec 31]. Available from: <https://insideclimatenews.org/news/06062023/abandoned-oil-gas-wells-health/>
431. World Bank. Scaling Up to Phase Down: Financing Energy Transitions in the Power Sector [Internet]. Washington, DC: World Bank; 2023 [cited 2025 July 14]. Available from: <https://hdl.handle.net/10986/39689>
432. Simi Jolaoso. BBC. 2025 [cited 2025 July 14]. Nigeria oil: Shell ignored warnings of spill clean-up “scam”, whistleblower tells BBC. Available from: <https://www.bbc.com/news/articles/c0rqe85q1jno>
433. Jurnal. Pro Kontra Masuknya Perusahaan Batu Bara di Kapuas Hulu [Internet]. Jurnal.co.id. 2023 [cited 2025 Apr 23]. Available from: <https://jurnal.co.id/2023/01/17/pro-kontra-masuknya-perusahaan-batu-bara-di-kapuas-hulu/>
434. Investor Tambang lirik Batu Bara di Melawi, Pemerintah Diminta Hati Hati Ambil Keputusan [Internet]. SUARAKALBAR.CO.ID. 2021 [cited 2025 Apr 23]. Available from: <https://www.suarakalbar.co.id/2021/03/investor-tambang-lirik-batu-bara-di/>
435. admin. Warga Keluhkan Dampak Tambang Batu Bara Di Desa Sesulu, Pj Bupati PPU Panggil Pihak Perusahaan [Internet]. Website Pemerintah Kabupaten Penajam Paser Utara. 2024 [cited 2025 Apr 23]. Available from: <https://penajamkab.go.id/warga-keluhkan-dampak-tambang-batu-bara-di-desa-sesulu-pj-bupati-ppu-panggil-pihak-perusahaan/>
436. Agustus P. KITA, BATUBARA & POLUSI UDARA - Riset Dampak PLTU Batubara oleh Tim Peneliti Universitas Harvard - Atmospheric Chemistry Modeling Group (ACMG) dan Greenpeace Indonesia [Internet]. [cited 2026 Apr 23]. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.greenpeace.org/static/planet4-indonesia-stateless/2019/02/605d05ed-605d05ed-kita-batubara-dan-polusi-udara.pdf>
437. Lin CK, Hsu YT, Brown KD, Pokharel B, Wei Y, Chen ST. Residential exposure to petrochemical industrial complexes and the risk of leukemia: A systematic review and exposure-response meta-analysis. *Environ Pollut Barking Essex* 1987. 2020 Mar;258:113476.
438. Jephcote C. A systematic review and meta-analysis of haematological malignancies in residents living near petrochemical facilities. 2020 June 26 [cited 2024 Dec 31]; Available from: https://figshare.com/articles/journal_contribution/A_systematic_review_and_meta-analysis_of_haematological_malignancies_in_residents_living_near_petrochemical_facilities/12572483/1
439. Environmental Integrity Agency. Plastics Pollution on the Rise - Growth of Houston Area Plastics Industry Threatens Air Quality and Public Safety [Internet]. 2019 [cited 2024 Nov 17]. Available from: <https://environmentalintegrity.org/wp-content/uploads/2019/09/Plastics-Pollution-on-the-Rise-report-final.pdf>
440. Karali N, Khanna N, Shah N. Climate Impact of Primary Plastic Production. 2024 Apr;129.
441. OECD [Internet]. 2022 [cited 2025 Jan 4]. Global Plastics Outlook. Available from: https://www.oecd.org/en/publications/global-plastics-outlook_aa1edf33-en.html
442. United Nations Environment Programme, and Secretariat of the Basel, Rotterdam and Stockholm Conventions. Chemicals in Plastic - Summary and Key Findings [Internet]. Geneva: United Nations; 2023 [cited 2025 Jan 1]. Available from: https://wedocs.unep.org/bitstream/handle/20.500.11822/42505/Chemicals-in-plastics_Summary.pdf?sequence=1&isAllowed=y
443. David Azoulay, Priscilla Villa, Yvette Arellano, Miriam Gordon, Doun Moon, Kathryn Miller, et al. www.ciel.org/plasticandhealth. 2019 [cited 2025 Jan 1]. Plastic and Health-The Hidden Costs of a Plastic Planet. Available from: <https://www.ciel.org/wp-content/uploads/2019/02/Plastic-and-Health-The-Hidden-Costs-of-a-Plastic-Planet-February-2019.pdf>
444. Wagner M, Monclús L, Arp HPH, Groh KJ, Løseth ME, Muncke J, et al. State of the science on plastic chemicals - Identifying and addressing chemicals and polymers of concern [Internet]. Zenodo; 2024 Mar [cited 2025 Jan 1]. Available from: <https://zenodo.org/records/10701706>
445. Philip J. Landrigan, Hervé Raps, Maureen Cropper, Caroline Bald, Manuel Brunner, Elvia Maya Canonizado, et al. The Minderoo-Monaco Commission on Plastics and Human Health | *Annals of Global Health*. Ann Glob Health [Internet]. [cited 2025 Jan 1]; Available from: <https://annalsofglobalhealth.org/articles/10.5334/aogh.4056#abstract>
446. Balbus JM, Boxall ABA, Fenske RA, McKone TE, Zeise L. Implications of global climate change for the assessment and management of human health risks of chemicals in the natural environment. *Environ Toxicol Chem*. 2013 Jan;32(1):62–78.

447. Pamela D. Noyes, Sean C. Lema. Forecasting the impacts of chemical pollution and climate change interactions on the health of wildlife | *Current Zoology* | Oxford Academic. *Curr Zool.* 2015 Aug 1;61(4):669-689.
448. Truchon G, Zayed J, Bourbonnais R, Lévesque M, Deland M, Busque MA, et al. Thermal stress and chemicals: Knowledge review and the highest risk occupations in Québec. *États Quest Rapp D'expertise Rev Litt* [Internet]. 2014 July 1; Available from: <https://pharesst.irsst.qc.ca/expertises-revues/41>
449. IEA. IEA. 2021 [cited 2025 Jan 1]. Ammonia Technology Roadmap – Analysis. Available from: <https://www.iea.org/reports/ammonia-technology-roadmap>
450. Stefano Menegat, Alicia Ledo, Reyes Tirado. Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture | *Scientific Reports* [Internet]. 2022 [cited 2025 Jan 1]. Available from: <https://www.nature.com/articles/s41598-022-18773-w#Sec8>
451. Lim H, Lee YH, Bae S, Koh DH, Yoon M, Lee BE, et al. Cancer cluster among small village residents near the fertilizer plant in Korea. *PLOS ONE*. 2021 Feb 25;16(2):e0247661.
452. UNEP. UNEP - UN Environment Programme. [cited 2025 Jan 1]. What is Nitrogen Pollution? Available from: <https://www.unep.org/interactives/beat-nitrogen-pollution/>
453. Gunnar Rundgren. resilience. [cited 2025 Jan 1]. You are what you eat - resilience. Available from: <https://www.resilience.org/stories/2024-06-06/you-are-what-you-eat/>
454. IEA. IEA. 2021 [cited 2025 Jan 1]. Oil 2021 – Analysis. Available from: <https://www.iea.org/reports/oil-2021>
455. Global Alliance For The Future Of Food. Power Shift: Why We Need to Wean Industrial Food Systems Of Fossil Fuels [Internet]. Global Alliance For The Future Of Food; 2023 [cited 2025 Jan 1] p. 27. Available from: https://futureoffood.org/wp-content/uploads/2023/10/ga_food-energy-nexus_report.pdf
456. Curl CL, Spivak M, Phinney R, Montrose L. Synthetic Pesticides and Health in Vulnerable Populations: Agricultural Workers. *Curr Environ Health Rep.* 2020 Mar;7(1):13–29.
457. Mostafalou S, Abdollahi M. Pesticides: an update of human exposure and toxicity. *Arch Toxicol.* 2017 Feb;91(2):549–99.
458. Zhou W, Li M, Achal V. A comprehensive review on environmental and human health impacts of chemical pesticide usage. *Emerg Contam.* 2025 Mar 1;11(1):100410.
459. Lane MM, Gamage E, Du S, Ashtree DN, McGuinness AJ, Gauci S, et al. Ultra-processed food exposure and adverse health outcomes: umbrella review of epidemiological meta-analyses. *BMJ.* 2024 Feb 28;384:e077310.
460. Zhao-Hui Wang, Sheng-Xiu Li, Sukhdev Malhi. Effects of fertilization and other agronomic measures on nutritional quality of crops - Wang - 2008 - *Journal of the Science of Food and Agriculture - Wiley Online Library*. *J Sci Food Agric.* 2008;88:7–23.
461. Wojciech Hanke, Joanna Jurewicz. The risk of adverse reproductive and developmental disorders due to occupational pesticide exposure: An overview of current epidemiological evidence. *Int J Occup Med Environ Health.* 17(2):223–43.
462. Kevin Morrison. IEEFA. [cited 2025 Jan 1]. Why carbon capture and storage is not the solution. Available from: <https://ieefa.org/resources/why-carbon-capture-and-storage-not-solution>
463. Center for International Environmental Law. Fossils, Fertilizers, and False Solutions: How Laundering Fossil Fuels in Agrochemicals Puts the Climate and the Planet at Risk (October 2022) [Internet]. Center for International Environmental Law. [cited 2025 Jan 1]. Available from: <https://www.ciel.org/reports/fossil-fertilizers/>
464. Romanello M, Walawender M, Hsu SC, Moskeland A, Palmeiro-Silva Y, Scamman D, et al. The 2024 report of the Lancet Countdown on health and climate change: facing record-breaking threats from delayed action. *The Lancet.* 2024 Nov;404(10465):1847–96.
465. Coker ES, Cleland SE, McVea D, Stafoggia M, Henderson SB. The synergistic effects of PM2.5 and high temperature on community mortality in British Columbia. *Npj Clean Air.* 2025 June 11;1(1):15.
466. DTN Team. DTN. 2023 [cited 2025 Jan 3]. How Extreme Weather Disrupts the Oil and Gas Sector. Available from: <https://www.dtn.com/how-extreme-weather-disrupts-the-oil-and-gas-sector/>
467. Jinxin Dong, Zunaira Asif, Yarong Shi, Yinying Zhu, Zhi Chen. Climate Change Impacts on Coastal and Offshore Petroleum Infrastructure and the Associated Oil Spill Risk: A Review. *J Mar Sci Eng* [Internet]. 2022 [cited 2025 Jan 3];10(7). Available from: https://www.researchgate.net/publication/363010509_Climate_Change_Impacts_on_Coastal_and_Offshore_Petroleum_Infrastructure_and_the_Associated_Oil_Spill_Risk_A_Review

468. World Health Organization. Chemical releases caused by natural hazard events and disasters: information for public health authorities [Internet]. Geneva: World Health Organization; 2018 [cited 2025 Jan 3]. Available from: <https://iris.who.int/handle/10665/272390>
469. Indiana Lee. The Economic Implications: How Weather and Cost-Driven Disruptions Influence the Global Market [Internet]. WITA. [cited 2025 Jan 3]. Available from: <https://www.wita.org/blogs/implications-weather-global-market/>
470. U.S. Environmental Protection Agency. Murphy Oil USA Refinery Spill Chalmette & Meraux, LA [Internet]. 2006 May [cited 2025 Jan 3] p. 32. (U.S. EPA Region 6 Response and Prevention Branch Oil Team). Available from: https://archive.epa.gov/emergencies/content/fss/web/pdf/franklin_2.pdf
471. Louis A. Arana-Barradas. Katrina floodwaters a biohazard-laden 'soup.' Air Force Print News [Internet]. 2005 Sept 6 [cited 2025 Jan 3]; Available from: <https://www.af.mil/News/Article-Display/Article/133459/katrina-floodwaters-a-biohazard-laden-soup/https%3A%2F%2Fwww.af.mil%2FNews%2FArticle-Display%2FArticle%2F133459%2Fkatrina-floodwaters-a-biohazard-laden-soup%2F>
472. Ana Maria Cruz, Elisabeth Krausmann. Hazardous-materials releases from offshore oil and gas facilities and emergency response following Hurricanes Katrina and Rita. J Loss Prev Process Ind. 2009 Jan;22(1):59–65.
473. Meiners J. *NOLA.com*. 2019 [cited 2025 Apr 24]. There were 540 oil spills after Katrina. Oil companies have yet to be held accountable for any of them. Available from: https://www.nola.com/news/environment/there-were-540-oil-spills-after-katrina-oil-companies-have-yet-to-be-held-accountable/article_ae173ac4-2377-11ea-8f3f-37710b50344c.html
474. Petro Industry News. Petro Online. 2013 [cited 2025 Jan 3]. Philippines survivors forced from homes due to oil spill. Available from: <https://www.petro-online.com/news/safety/15/breaking-news/philippines-survivors-forced-from-homes-due-to-oil-spill/27729>
475. Action Against Hunger. Action Against Hunger. 2013 [cited 2025 Apr 24]. Typhoon Yolanda Emergency Response strengthens humanitarian support following oil spill in Estancia, Iloilo. Available from: <https://actionagainsthunger.ph/tag/estancia-oil-spill/>, <https://actionagainsthunger.ph/tag/estancia-oil-spill/>
476. Nikolaos Christidis, Dann Mitchell, P. A. Stott. Rapidly increasing likelihood of exceeding 50 °C in parts of the Mediterranean and the Middle East due to human influence. Npj Clim Atmospheric Sci [Internet]. [cited 2025 Jan 3];6. Available from: https://www.researchgate.net/publication/371084665_Rapidly_increasing_likelihood_of_exceeding_50_C_in_parts_of_the_Mediterranean_and_the_Middle_East_due_to_human_influence
477. Jinsun Lim, Nadim Abillama, Chiara D'Adamo. IEA. 2023 [cited 2025 Jan 3]. Climate resilience is key to energy transitions in the Middle East and North Africa – Analysis. Available from: <https://www.iea.org/commentaries/climate-resilience-is-key-to-energy-transitions-in-the-middle-east-and-north-africa>
478. Calendar Climate Intelligence. Saudi Aramco - Climate Risk [Internet]. 2019 Nov [cited 2025 Jan 3]. Available from: <https://callendar.climint.com/wp-content/uploads/2019/11/Saudi-Aramco-climate-risk-Ven.pdf>
479. Camille Dubourg. eismena. [cited 2025 Jan 3]. The impact of oil development in Basra province on the water crisis: an analysis through the prism of the Gas Growth Integrated Project (GGIP). Available from: <https://cfri-irak.com/en/article/the-impact-of-oil-development-in-basra-province-on-the-water-crisis-an-analysis-through-the-prism-of-the-gas-growth-integrated-project-ggip-2024-03-08>
480. Zeinab Shuker. The Century Foundation. 2023 [cited 2025 Jan 3]. The Deep Roots of Iraq's Climate Crisis. Available from: <https://tcf.org/content/report/the-deep-roots-of-iraqs-climate-crisis/>
481. Kendall Capshaw, Jamie Ellen Padgett. A global analysis of coastal flood risk to the petrochemical distribution network in a changing climate. Resilient Cities Struct. 2024 Dec 9;1(3):52–60.
482. Cushing LJ, Ju Y, Kulp S, Depsky N, Karasaki S, Jaeger J, et al. Toxic Tides and Environmental Injustice: Social Vulnerability to Sea Level Rise and Flooding of Hazardous Sites in Coastal California. Environ Sci Technol. 2023 May 16;57(19):7370–81.
483. Lo CS Joe. Climate Home News. 2024 [cited 2025 Apr 25]. Displaced farmers bemoan “bad deal” on EACOP project. Available from: <https://www.climatechangenews.com/2024/07/12/where-east-african-oil-pipeline-meets-sea-displaced-farmers-bemoan-bad-deal-eacop/>
484. Ksenija Hanaček a, Markus Kröger b, Arnim Scheidel a, Facundo Rojas c, Joan Martinez-Alier. On thin ice – The Arctic commodity extraction frontier and environmental conflicts - ScienceDirect. Ecol Econ [Internet]. 2022 Jan [cited 2025 Apr 25];191. Available from: <https://www.sciencedirect.com/science/article/pii/S0921800921003062>
485. Michael Kaliszewski. American Addiction Centers. [cited 2025 Jan 3]. The Mining Industry and Addiction - Substance Abuse Statistics. Available from: <https://americanaddictioncenters.org/workforce-addiction/blue-collar/miners>

486. Ramirez-Cardenas A. Substance use related fatalities in the Oil and Gas Extraction (OGE) industry [Internet]. Talk presented at: NORA OGE Sector Council Spring Health and Safety Summit 2023: Psychosocial Stressors in the Oilfield; 2023 Apr 12. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://coloradosph.cuanschutz.edu/docs/librariesprovider151/default-document-library/ramirez_fog-substance-use_spring-summit_2023.pdf?sfvrsn=6ca627bb_2
487. Scott J, Dakin R, Heller K, Eftimie A. Extracting Lessons on Gender in the Oil and Gas Sector. [Internet]. 2013 May. Report No.: Extractive Industries for Development Series #28. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://documents1.worldbank.org/curated/en/266311468161347063/pdf/798940NWP0280E0Box0379795B00PUBLIC0.pdf>
488. EHN Canada. Stress, Shift Work, and Little Support: Alcohol and Substance Use Disorders In Canadian Oil & Gas Workers - EHN [Internet]. Addiction. [cited 2025 Jan 3]. Available from: <https://www.edgewoodhealthnetwork.com/resources/blog/stress-shift-work-and-little-support-substance-use-disorders-in-canadian-oil-gas-workers/>
489. Rajini Karduri. Impacts of Fossil Fuels on Rural Communities [Internet]. 1st ed. Vol. 1. 2023 [cited 2025 Jan 3]. Available from: https://www.researchgate.net/publication/375715102_Impacts_of_Fossil_Fuels_on_Rural_Communities
490. Elizabeth Fitz. Suicide rates among the highest in oil and agriculture industries; West Texas blue collar workers react [Internet]. EverythingLubbock.com. 2022 [cited 2025 Jan 3]. Available from: <https://www.everythinglubbock.com/news/local-news/suicide-rates-among-the-highest-in-oil-and-agriculture-industries-west-texas-blue-collar-workers-react/>
491. Peterson C. Suicide Rates by Industry and Occupation — National Violent Death Reporting System, 32 States, 2016. MMWR Morb Mortal Wkly Rep [Internet]. 2020 [cited 2025 Jan 3];69. Available from: <https://www.cdc.gov/mmwr/volumes/69/wr/mm6903a1.htm>
492. Hilditch S. International Alert. 2014 [cited 2025 Apr 25]. What's in it for us? Gender issues in Uganda's oil and gas sector. Available from: <https://www.international-alert.org/publications/whats-in-it-for-us/>
493. Seydlitz R, Jenkins P, Gunter V. Impact of petroleum development on lethal violence. Impact Assess Proj Apprais. 1999 June 1;17(2):115–31.
494. Beleche T, Cintina I. Fracking and risky behaviors: Evidence from Pennsylvania. Econ Hum Biol. 2018 Sept;31:69–82.
495. Johnson NP, Warren JL, Elliott EG, Niccolai LM, Deziel NC. A Multiregion Analysis of Shale Drilling Activity and Rates of Sexually Transmitted Infections in the United States. Sex Transm Dis. 2020 Apr;47(4):254–60.
496. University of Colorado Boulder. I First Peoples Worldwide I. [cited 2025 Jan 3]. Violence from Extractive Industry “Man Camps” Endangers Indigenous Women and Children. Available from: <https://www.colorado.edu/program/fpw/2020/01/29/violence-extractive-industry-man-camps-endangers-indigenous-women-and-children>
497. Man Camps: An Oil Industry Business that Affects Native American Women | Real Archaeology [Internet]. 2022 [cited 2025 Jan 3]. Available from: <https://pages.vassar.edu/realarchaeology/2022/12/04/man-camps-an-oil-industry-business-that-affects-native-american-women/>
498. IndustriALL - Global Union. <https://www.industrialunion.org/>. 2021 [cited 2025 Jan 3]. Women miners confronting gender inequality together. Available from: <https://www.industrialunion.org/women-miners-confronting-gender-inequality-together>
499. Mishra PP, Sravan Ch, Mishra SK. Extracting empowerment: A critical review on violence against women in mining and mineral extraction. Energy Res Soc Sci. 2024 Mar 1;109:103414.
500. Klasic M, Schomburg M, Arnold G, York A, Baum M, Cherin M, et al. A review of community impacts of boom-bust cycles in unconventional oil and gas development. Energy Res Soc Sci. 2022 Nov 1;93:102843.
501. Faulkner L. The future of work in the oil and gas industry - Opportunities and challenges for a just transition to a future of work that contributes to sustainable development [Internet]. Geneva; 2022. Available from: <https://www.ilo.org/media/369081/download>
502. Boom and Bust Economics — Fossil Fuel Connections [Internet]. [cited 2025 Jan 3]. Available from: <https://www.fossilfuelconnections.org/boom-and-bust-economics>
503. Latifa Ghalayini. The Interaction between Oil Price and Economic Growth. Rev Middle East Econ Finance. 2024 Oct 22;13(13):127–41.
504. Rudolfs Bems, Lukas Boehnert, Andrea Pescatori,, Martin Stuermer. IMF. [cited 2025 Apr 25]. Economic Consequences of Large Extraction Declines: Lessons for the Green Transition. Available from:

<https://www.imf.org/en/Publications/WP/Issues/2023/05/08/Economic-Consequences-of-Large-Extraction-Declines-Lessons-for-the-Green-Transition-533196>

505. Generation____. Generation Investment Management. 2022 [cited 2025 Jan 3]. Fossil Fuels, the Economy and Instability: Why the world's dependence on fossil fuels hurts the economy and creates instability. Available from: <https://www.generationim.com/our-thinking/insights/fossil-fuels-the-economy-and-instability-why-the-world-s-dependence-on-fossil-fuels-hurts-the-economy-and-creates-instability/>
506. Lisa Göldner. Greenpeace International. 2024 [cited 2025 Jan 3]. 4 Ways Fossil Fuel Companies Are Worsening Injustice During the Energy Crisis. Available from: <https://www.greenpeace.org/international/story/58256/4-ways-fossil-fuel-companies-worsen-injustices-during-energy-crisis/>
507. Cho H. Impact of income inequality on carbon-intensive extractivism. Cogent Econ Finance. 2023 June 15;11(2):2226482.
508. Onyena AP, Sam K. A review of the threat of oil exploitation to mangrove ecosystem: Insights from Niger Delta, Nigeria. Glob Ecol Conserv. 2020 June 1;22:e00961.
509. Paltasingh T, Satapathy J. Unbridled coal extraction and concerns for livelihood: evidences from Odisha, India. Miner Econ. 2021 Oct 1;34(3):491–503.
510. Karduri RKR. Impacts of Fossil Fuels on Rural Communities. Int J Eng Res Technol [Internet]. 2023 Oct 28 [cited 2025 Apr 25];12(10). Available from: <https://www.ijert.org/research/impacts-of-fossil-fuels-on-rural-communities-IJERTV12IS100037.pdf>, <https://www.ijert.org/impacts-of-fossil-fuels-on-rural-communities>
511. Jessica Kelly. International Institute for Sustainable Development. 2024 [cited 2025 Jan 3]. How Fossil Fuels Drive Inflation and Make Life Less Affordable for Canadians. Available from: <https://www.iisd.org/articles/deep-dive/fossil-fuels-drive-inflation-canada>
512. V20 Finance Ministers of the Climate Vulnerable Forum. V20 Ministerial Dialogue XII Communiqué [Internet]. V20: The Vulnerable Twenty Group. 2024 [cited 2025 May 30]. Available from: <https://www.v-20.org/v20-ministerial-dialogue-xii-communique/>
513. Amnesty International [Internet]. [cited 2025 Jan 2]. Indigenous Peoples' Rights. Available from: <https://www.amnesty.org/en/what-we-do/indigenous-peoples/>
514. Fossil fuel extraction is harming Indigenous communities, say experts | Harvard T.H. Chan School of Public Health [Internet]. 2022 [cited 2025 Jan 2]. Available from: <https://hsph.harvard.edu/news/fossil-fuel-extraction-harming-indigenous-communities/>
515. Radwin M. Mongabay Environmental News. 2022 [cited 2025 Jan 2]. Displaced and deprived, Indigenous communities suffer from hunger in Nicaragua. Available from: <https://news.mongabay.com/2022/01/displaced-and-deprived-indigenous-communities-suffer-from-hunger-in-nicaragua/>
516. McGill Summer Program in Social & Cultural Psychiatry and the Aboriginal Mental Health Research Team. The Mental Health of Indigenous Peoples [Internet]. 2000 May [cited 2025 Jan 2]. Report No.: Culture&Mental Health Research Unit Report No. 10. Available from: <https://www.mcgill.ca/tcpsych/files/tcpsych/Report10.pdf>
517. Albrecht G, Sartore GM, Connor L, Higginbotham N, Freeman S, Kelly B, et al. Solastalgia: the distress caused by environmental change. Australas Psychiatry Bull R Aust N Z Coll Psychiatr. 2007;15 Suppl 1:S95-98.
518. Bar Book Project. Cultural Dispossession Experienced by Aboriginal and Torres Strait Islander Peoples [Internet]. Public Defenders NSW; 2020. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://bugmybarbook.org.au/wp-content/uploads/2023/07/BBB-Cultural-Dispossession-chapter.pdf>
519. BHUGRA D, BECKER MA. Migration, cultural bereavement and cultural identity. World Psychiatry. 2005 Feb;4(1):18–24.
520. Terminski B. Oil-induced Displacement and Resettlement. Available from: <http://ssrn.com/abstract=2029770>
521. Alice Harrison. Global Witness. 2021 [cited 2025 Apr 25]. Big Oil is paying the police for protection. Here's why that's a problem. Available from: <https://globalwitness.org/en/campaigns/land-and-environmental-defenders/big-oil-is-paying-the-police-for-protection-heres-why-thats-a-problem/>
522. Augustin BKG Mathilde. New Report Condemns Increasing Violence and Legal Retaliation Against Environmental Activists [Internet]. Inside Climate News. 2024 [cited 2025 Apr 25]. Available from: <https://insideclimatenews.org/news/16102024/violence-legal-retaliation-against-environmental-activists-condemned/>
523. Watts M. Human Rights, Violence and the Oil Complex [Internet]. USA; Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://geography.berkeley.edu/sites/default/files/2-watts.pdf>

524. Amnesty International [Internet]. 2017 [cited 2025 Jan 2]. Nigeria: Shell complicit in the arbitrary executions of Ogoni Nine as writ served in Dutch court. Available from: <https://www.amnesty.org/en/latest/press-release/2017/06/shell-complicit-arbitrary-executions-ogoni-nine-writ-dutch-court/>
525. Global Witness. www.globalwitness.org. [cited 2025 Jan 2]. Blood and tears: Indigenous people on the frontline of defending our planet. Available from: <https://www.globalwitness.org/en/campaigns/environmental-activists/blood-and-tears/>
526. Global Citizen. Almost 2,000 Environmental Activists Have Been Killed Over the Past Decade [Internet]. [cited 2025 July 14]. Available from: <https://www.globalcitizen.org/en/content/environmental-activists-land-defenders-killed/>
527. Mukpo A. Mongabay Environmental News. 2022 [cited 2025 Jan 2]. More than half of activists killed in 2021 were land, environment defenders. Available from: <https://news.mongabay.com/2022/04/more-than-half-of-activists-killed-in-2021-were-land-environment-defenders/>
528. Kumar M. Violent transitions: towards a political ecology of coal and hydropower in India. *Clim Dev* [Internet]. 2024 Oct 20 [cited 2025 Apr 25]; Available from: <https://www.tandfonline.com/doi/abs/10.1080/17565529.2023.2264259>
529. Rainforest Action Network. www.ran.org. 2023 [cited 2025 Jan 2]. Complicit: Bank of America's Role in Fossil Fuel Expansion and the Violation of Human Rights. Available from: https://www.ran.org/wp-content/uploads/2023/11/RAN_BofA_2023-FINAL-WEB.pdf
530. Special Rapporteur on the right to adequate housing. OHCHR. [cited 2025 Apr 25]. Forced evictions. Available from: <https://www.ohchr.org/en/special-procedures/sr-housing/forced-evictions>
531. Financial Times. Financial Times. [cited 2025 Jan 4]. Oil and gas has highest bribery rate. Available from: <https://www.ft.com/content/c84ead24-ce7e-11e1-bc0c-00144feabdc0>
532. Jarry E. French court fines oil group Total in Iran bribery case | Reuters. Reuters [Internet]. 2018 Dec 21 [cited 2025 May 30]; Available from: <https://www.reuters.com/article/business/french-court-fines-oil-group-total-in-iran-bribery-case-idUSKCN10K1ID/>
533. Edward Wyatt. Oil and Gas Bribery Case Settled for \$236 Million. *The New York Times* [Internet]. 2010 Nov 4 [cited 2025 Apr 28]; Available from: <https://www.nytimes.com/2010/11/05/business/global/05bribe.html>
534. Supran G, Rahmstorf S, Oreskes N. Assessing ExxonMobil's global warming projections. *Science*. 2023 Jan 13;379(6628):eabk0063.
535. U.S. Senate Committee On The Budget. New Joint Bicameral Staff Report Reveals Big Oil's Campaign of Climate Denial, Disinformation, and Doublespeak [Internet]. [cited 2025 Apr 28]. Available from: <https://www.budget.senate.gov/chairman/newsroom/press/new-joint-bicameral-staff-report-reveals-big-oils-campaign-of-climate-denial-disinformation-and-doublespeak>
536. Lamb WF, Mattioli G, Levi S, Roberts JT, Capstick S, Creutzig F, et al. Discourses of climate delay. *Glob Sustain*. 2020 Jan;3:e17.
537. Chris Martinez, Laura Kilbury, Joel Martinez. These Fossil Fuel Industry Tactics Are Fueling Democratic Backsliding [Internet]. Center for American Progress. 2023 [cited 2025 Apr 28]. Available from: <https://www.americanprogress.org/article/these-fossil-fuel-industry-tactics-are-fueling-democratic-backsliding/>
538. Times TNY. The Road to a Paris Climate Deal - Environment. *The New York Times* [Internet]. 2015 Dec 18 [cited 2025 Apr 28]; Available from: 2015-paris-climate-talks
539. Milman O, Harvey F. US is hotbed of climate change denial, major global survey finds. *The Guardian* [Internet]. 2019 May 8 [cited 2025 Apr 28]; Available from: <https://www.theguardian.com/environment/2019/may/07/us-hotbed-climate-change-denial-international-poll>
540. Tyson BK Cary Funk and Alec. Majorities of Americans Prioritize Renewable Energy, Back Steps to Address Climate Change [Internet]. Pew Research Center. 2023 [cited 2025 Apr 28]. Available from: <https://www.pewresearch.org/science/2023/06/28/majorities-of-americans-prioritize-renewable-energy-back-steps-to-address-climate-change/>
541. Joselow M. How dark money groups led Ohio to redefine gas as 'green energy.' *The Washington Post* [Internet]. 2023 Jan 17 [cited 2025 Apr 28]; Available from: <https://www.washingtonpost.com/climate-environment/2023/01/17/ohio-natural-gas-green-energy/>
542. Vox [Internet]. 2018 [cited 2025 Apr 28]. Election results 2018: big oil money crushed clean energy ballot initiatives | Vox. Available from: <https://www.vox.com/energy-and-environment/2018/11/7/18069940/election-results-2018-energy-carbon-fracking-ballot-initiatives>

543. Contributor CSG. Big Oil's allies spend big money on ads and lobbying to keep fossil fuels flowing | Analysis • Pennsylvania Capital-Star [Internet]. Pennsylvania Capital-Star. 2023 [cited 2025 Apr 28]. Available from: <https://penncapital-star.com/commentary/big-oils-allies-spend-big-money-on-ads-and-lobbying-to-keep-fossil-fuels-flowing-analysis/>
544. Milman O. State Farm stopped insuring California homes due to climate risks. But it shares lobbyists with big oil. The Guardian [Internet]. 2023 July 5 [cited 2025 Apr 28]; Available from: <https://www.theguardian.com/us-news/2023/jul/05/state-farm-stopped-insuring-california-homes-due-to-climate-risks-but-it-shares-lobbyists-with-big-oil>
545. Noor D. As some US cities confront the climate crisis, their lobbyists work for big oil. The Guardian [Internet]. 2023 July 6 [cited 2025 Apr 28]; Available from: <https://www.theguardian.com/us-news/2023/jul/06/climate-fossil-fuel-lobbyist-baltimore-bay-area-charleston>
546. Milman O. 'Double agents': fossil-fuel lobbyists work for US groups trying to fight climate crisis. The Guardian [Internet]. 2023 July 5 [cited 2025 Apr 28]; Available from: <https://www.theguardian.com/us-news/2023/jul/05/double-agent-fossil-fuel-lobbyists>
547. Kickbigpollutersout.org. Record number of fossil fuel lobbyists at COP28 | Kick Big Polluters Out [Internet]. [cited 2025 Jan 2]. Available from: <https://kickbigpollutersout.org/articles/release-record-number-fossil-fuel-lobbyists-attend-cop28>
548. Global Witness. Global Witness. [cited 2025 Apr 28]. 636 fossil fuel lobbyists granted access to COP27. Available from: <https://globalwitness.org/en/campaigns/fossil-fuels/636-fossil-fuel-lobbyists-granted-access-to-cop27/>
549. Grist. grist.org. 2021 [cited 2025 July 14]. How bankruptcy lets oil and gas companies evade cleanup rules. Available from: <https://grist.org/accountability/oil-gas-bankruptcy-fieldwood-energy-petroshare/>
550. Clark Williams-Derry, Energy Finance Analyst. Cleaned Out by Bankruptcy - A Primer on Environmental Cleanup Duties in Bankruptcy. IEEFA; 2019.
551. Geoffrey Supran, Naomi Oreskes. The forgotten oil ads that told us climate change was nothing | Environment | The Guardian. The Guardian [Internet]. [cited 2025 Jan 2]; Available from: <https://www.theguardian.com/environment/2021/nov/18/the-forgotten-oil-ads-that-told-us-climate-change-was-nothing>
552. Audrey Schreiber. Big Oil Dumps Billions Into Misleading Advertising Campaigns [Internet]. EarthRights International. [cited 2025 Jan 2]. Available from: <http://earthrights.org/blog/big-oil-dumps-billions-into-misleading-advertising-campaigns/>
553. Amnesty International. Amnesty International. 2015 [cited 2025 Jan 2]. Niger Delta: Shell's manifestly false claims about oil pollution exposed, again. Available from: <https://www.amnesty.org/en/latest/press-release/2015/11/shell-false-claims-about-oil-pollution-exposed/>
554. Seventy thousand voices tell Shell to clean up its mess in Nigeria [Internet]. Friends of the Earth Europe. [cited 2025 Jan 2]. Available from: <https://friendsoftheearth.eu/news/seventy-thousand-voices-tell-shell-to-clean-up-its-mess-in-nigeria/>
555. Sommers Schwartz. Wage Abuse Rampant in the Oil and Gas Extraction Industry [Internet]. 2016 [cited 2025 Jan 2]. Available from: <https://www.sommerspc.com/blog/2016/05/wage-abuse-rampant-oil-gas-extraction-industry/>
556. Gupta K. Are oil and gas firms more likely to engage in unethical practices than other firms? Energy Policy. 2017 Jan 1;100:101–12.
557. Bensonch C, Argyropoulos CD, Dimopoulos C, Varianou Mikellidou C, Boustras G. Analysis of safety climate factors and safety compliance relationships in the oil and gas industry. Saf Sci. 2022 July 1;151:105744.
558. Bureau of International Labor Affairs. Bureau of International Labor Affairs. [cited 2025 July 14]. List of Goods Produced by Child Labor or Forced Labor. Available from: <https://www.dol.gov/agencies/ilab/reports/child-labor/list-of-goods>
559. IEA. IEA. 2021 [cited 2025 May 30]. Net Zero by 2050 – Analysis. Available from: <https://www.iea.org/reports/net-zero-by-2050>
560. Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. Work programme on just transition pathways referred to in the relevant paragraphs of decision 1/CMA.4. UNFCCC; 2023.
561. Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. Sharm el-Sheikh Implementation Plan [Internet]. UNFCCC; 2022. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://unfccc.int/sites/default/files/resource/cma2022_L21_revised_adv.pdf

562. Ritchie H, Rosado P. Electricity Mix. Our World Data [Internet]. 2020 July [cited 2025 May 30]; Available from: <https://ourworldindata.org/electricity-mix>
563. IEA. Progress on basic energy access reverses for first time in a decade - News. IEA [Internet]. 2024 June 12 [cited 2025 May 30]; Available from: <https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade>
564. IEA. IEA. [cited 2025 May 30]. Access to electricity – SDG7: Data and Projections – Analysis. Available from: <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>
565. Irwin BR, Hoxha K, Grépin KA. Conceptualising the effect of access to electricity on health in low- and middle-income countries: A systematic review. *Glob Public Health*. 2020 Mar;15(3):452–73.
566. World Health Organization. World Health Organization. [cited 2025 May 30]. Health risks - Nearly 3.2 million people die prematurely each year from diseases caused by household air pollution. Available from: <https://www.who.int/teams/environment-climate-change-and-health/air-quality-energy-and-health/sectoral-interventions/household-air-pollution/health-risks>
567. Yang X, Wen H, Liu Y, Huang Y, Zhang Q, Wang W, et al. Lithium Pollution and Its Associated Health Risks in the Largest Lithium Extraction Industrial Area in China. *Environ Sci Technol*. 2024 July 2;58(26):11637–48.
568. RAID. New report exposes the environmental and human costs of DRC's cobalt boom [Internet]. RAID. 2024 [cited 2025 May 30]. Available from: <https://raid-uk.org/report-environmental-pollution-human-costs-drc-cobalt-demand-industrial-mines-green-energy-evs-2024/>
569. CBS News. The toll of the cobalt mining industry on health and the environment - CBS News. CBS News [Internet]. 2018 Mar 6 [cited 2025 May 30]; Available from: <https://www.cbsnews.com/news/the-toll-of-the-cobalt-mining-industry-congo/>
570. IEA. IEA. 2020 [cited 2025 May 30]. Iron and Steel Technology Roadmap – Analysis. Available from: <https://www.iea.org/reports/iron-and-steel-technology-roadmap>
571. Canadian Association of Physicians for the Environment (CAPE). Mobilizing Evidence Activating Change on Traffic-Related Air Pollution (TRAP) Health Impacts. 2021.
572. Hudda N, Durant LW, Fruin SA, Durant JL. Impacts of Aviation Emissions on Near-Airport Residential Air Quality. *Environ Sci Technol*. 2020 July 21;54(14):8580–8.
573. Carrington D. Car tyres produce vastly more particle pollution than exhausts, tests show. *The Guardian* [Internet]. 2022 June 3 [cited 2025 May 30]; Available from: <https://www.theguardian.com/environment/2022/jun/03/car-tyres-produce-more-particle-pollution-than-exhausts-tests-show>
574. Rissel C, Curac N, Greenaway M, Bauman A. Physical activity associated with public transport use--a review and modelling of potential benefits. *Int J Environ Res Public Health*. 2012 July;9(7):2454–78.
575. World Health Organization. World Health Organization. [cited 2025 May 30]. Physical activity. Available from: <https://www.who.int/health-topics/physical-activity>
576. Active Travel: evidence and insights from UK longitudinal population studies. [Closer.ac.uk](https://www.closer.ac.uk)
577. WRI Ross Centre. Prize for Cities. [cited 2025 May 30]. London's Ultra Low Emission Zone. Available from: <https://prizeforcities.org/project/ultra-low-emission-zone>
578. Mayoral Press Release. World's first Ultra Low Emission Zone to save NHS billions by 2050 | London City Hall [Internet]. London Assembly; [cited 2025 May 30]. Available from: <https://www.london.gov.uk/press-releases/mayoral/ulez-to-save-billions-for-nhs>
579. Global Alliance for the Future of Food. Power Shift: Why we need to wean industrial food systems off fossil fuels [Internet]. Global Alliance for the Future of Food. [cited 2025 May 30]. Available from: <https://futureoffood.org/insights/power-shift-why-we-need-to-wean-industrial-food-systems-off-fossil-fuels/>
580. Claydon S. Pesticides and the climate crisis [Internet]. Pesticide Action Network UK. [cited 2025 May 30]. Available from: <https://www.pan-uk.org/pesticides-and-the-climate-crisis/>
581. IEA, IRENA, UNSD, World Bank, WHO. The Energy Progress Report. 2024.
582. Romanello M, Napoli C di, Green C, Kennard H, Lampard P, Scamman D, et al. The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *Lancet Lond Engl*. 2023 Dec 16;402(10419):2346–94.
583. Alliance for Transformative Action on Climate and Health. Commitment tracker - The Community of Practice for Climate Resilient and Low Carbon Sustainable Health Systems [Internet]. [cited 2025 May 30]. Available from: <https://www.atachcommunity.com/our-impact/commitment-tracker/>

584. World Health Organization. World Health Organization. [cited 2025 May 30]. Commitments to climate change and health. Available from: <https://www.who.int/initiatives/alliance-for-transformative-action-on-climate-and-health/commitments>
585. Health Care Without Harm. Health Care Climate Action. [cited 2025 May 30]. Health Care Climate Action. Available from: <https://healthcareclimateaction.org/racetozero>
586. Leaders of the Group of Seven (G7). Apulia G7 Leaders' Communiqué [Internet]. G7 Italia; 2024. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.g7italy.it/wp-content/uploads/Apulia-G7-Leaders-Communique.pdf>
587. Narayan S. Just Transition for Healthy People on a Healthy Planet. *NEW Solut J Environ Occup Health Policy* [Internet]. 2023 [cited 2025 May 30];33(1). Available from: <https://journals.sagepub.com/doi/10.1177/10482911231167566>
588. Hickel J. Quantifying national responsibility for climate breakdown: an equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary. *Lancet Planet Health*. 2020 Sept 1;4(9):e399–404.
589. de-Assis MP, Barcella RC, Padilha JC, Pohl HH, Krug SBF. Health problems in agricultural workers occupationally exposed to pesticides. *Rev Bras Med Trab Publicacao Of Assoc Nac Med Trab-ANAMT*. 2021 Feb 11;18(3):352–63.
590. International Monetary Fund. IMF. 2023 [cited 2025 July 29]. Fossil Fuel Subsidies Surged to Record \$7 Trillion. Available from: <https://www.imf.org/en/Blogs/Articles/2023/08/24/fossil-fuel-subsidies-surged-to-record-7-trillion>
591. Webb D, Hanssen ON, Marten R. The health sector and fiscal policies of fossil fuels: an essential alignment for the health and climate change agenda. *BMJ Glob Health*. 2023 Oct 9;8(Suppl 8):e012938.
592. Greenpeace Southeast Asia. Toxic Air: The Price of Fossil Fuels [Internet]. Greenpeace Southeast Asia. 2024 [cited 2025 May 30]. Available from: <https://www.greenpeace.org/southeastasia/publication/3603/toxic-air-the-price-of-fossil-fuels-full-report/>
593. International Institute for Sustainable Development. Doubling Back and Doubling Down: G20 scorecard on fossil fuel funding [Internet]. Washington DC: International Institute for Sustainable Development; 2020 [cited 2025 May 30] p. 57. Available from: <https://primarysources.brillonline.com/browse/climate-change-and-law-collection/doubling-back-and-doubling-down-g20-scorecard-on-fossil-fuel-funding;cccc0210202002101180>
594. Landrigan PJ, Fuller R, Acosta NJR, Adeyi O, Arnold R, Basu NN, et al. The Lancet Commission on pollution and health. *Lancet Lond Engl*. 2018 Feb 3;391(10119):462–512.
595. International Monetary Fund. International Monetary Fund. Fossil Fuel Subsidies. Available from: <https://www.imf.org/en/Topics/climate-change/energy-subsidies>
596. Moses MW, Pedroza P, Baral R, Bloom S, Brown J, Chapin A, et al. Funding and services needed to achieve universal health coverage: applications of global, regional, and national estimates of utilisation of outpatient visits and inpatient admissions from 1990 to 2016, and unit costs from 1995 to 2016. *Lancet Public Health*. 2019 Jan;4(1):e49–73.
597. Black S, Liu AA, Ian W. H. Parry, Vernon-Lin N. IMF. [cited 2025 May 30]. IMF Fossil Fuel Subsidies Data: 2023 Update. Available from: <https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281>
598. World Health Organization. COP24 Special Report - Health and Climate Change [Internet]. World Health Organization; Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://unfccc.int/sites/default/files/resource/WHO%20COP24%20Special%20Report_final.pdf
599. Markandya A, Sampedro J, Smith SJ, Van Dingenen R, Pizarro-Irizar C, Arto I, et al. Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study. *Lancet Planet Health*. 2018 Mar;2(3):e126–33.
600. Nicholas A. Mailloux, David W. Abel, Tracey Holloway, Jonathan A. Patz. Nationwide and Regional PM2.5-Related Air Quality Health Benefits From the Removal of Energy-Related Emissions in the United States. *GeoHealth* [Internet]. [cited 2025 May 30]; Available from: <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022GH000603>
601. C40 Cities. The Cost of Fossil Gas : The Health, Economic and Environmental Implications for Cities [Internet]. [cited 2025 May 30]. Available from: <https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000ggOS/IFT5Gq0MZg95h1T6XPMFFSOVQ5FjGjByWuUt0llgxvI>

602. United Nations. United Nations. United Nations; [cited 2025 June 6]. The UN Secretary-General's Panel on Critical Energy Transition Minerals. Available from: <https://www.un.org/en/climatechange/critical-minerals>
603. David Elliott. World Economic Forum. 2021 [cited 2025 June 6]. Are net zero emissions by 2050 possible? Yes, says IEA. Available from: <https://www.weforum.org/stories/2021/05/net-zero-emissions-2050-iea/>
604. Welsby D, Price J, Pye S, Ekins P. Unextractable fossil fuels in a 1.5 °C world. *Nature*. 2021 Sept;597(7875): 230–4.
605. Benham H. Carbon Tracker Initiative. [cited 2025 June 6]. Are we winning? Available from: <https://carbontracker.org/are-we-winning/>
606. Beyond Oil & Gas Alliance [Internet]. [cited 2025 June 6]. Beyond Oil & Gas Alliance. Available from: <https://35.155.231.36/>
607. The Fossil Fuel Non-Proliferation Treaty Initiative [Internet]. [cited 2025 June 6]. The Fossil Fuel Non-Proliferation Treaty Initiative. Available from: <https://fossilfueltreaty.org>
608. Megan Darby, Paola Yanguas Parra, Eduardo Posada Perlaza. Why the international community should back Colombia's post-fossil fuel plan [Internet]. [cited 2025 June 6]. Available from: <https://www.climatechangenews.com/2024/11/17/why-the-international-community-should-back-colombias-post-fossil-fuel-plan/>
609. Neslen A. Health groups call for global fossil fuel non-proliferation treaty. *The Guardian* [Internet]. 2022 Sept 14 [cited 2025 June 6]; Available from: <https://www.theguardian.com/environment/2022/sep/14/fossil-fuel-non-proliferation-treaty-who-environmental-vandalism>
610. The Commission Project [Internet]. [cited 2025 June 6]. Bridges and Barriers to Fossil Fuel Phase Out. Available from: <https://www.fossilfuelcommission.earth>
611. Roy EA, Jong E de. New Zealand bans all new offshore oil exploration as part of “carbon-neutral future.” *The Guardian* [Internet]. 2018 Apr 12 [cited 2025 June 6]; Available from: <https://www.theguardian.com/world/2018/apr/12/new-zealand-bans-all-new-offshore-oil-exploration-as-part-of-carbon-neutral-future>
612. Leake J. New Zealand abandons Jacinda Ardern's net zero push. *The Telegraph* [Internet]. 2025 May 22 [cited 2025 July 14]; Available from: <https://www.telegraph.co.uk/business/2025/05/22/new-zealand-abandons-jacinda-arderns-net-zero-push/>
613. Reuters. France plans to end oil and gas production by 2040 | Reuters. Reuters [Internet]. 2017 Sept 6 [cited 2025 June 6]; Available from: <https://www.reuters.com/article/business/france-plans-to-end-oil-and-gas-production-by-2040-idUSKCN1BH1AB/>
614. Production Gap [Internet]. [cited 2025 June 6]. The Production Gap. Available from: <https://productiongap.org/>
615. Callum Mason. PPCA - Powering Past Coal Alliance. 2025 [cited 2025 June 6]. PPCA Solutions Dialogues serve as a springboard for action on coal - PPCA. Available from: <https://poweringpastcoal.org/news/ppca-solutions-dialogues-serve-as-a-springboard-for-action-on-coal/>
616. The climate and health double dividend | NewClimate Institute [Internet]. [cited 2025 June 6]. Available from: <https://newclimate.org/news/the-climate-and-health-double-dividend>
617. Kleinnijenhuis TA Patrick Bolton, Alissa M. IMF. [cited 2025 June 6]. The Great Carbon Arbitrage. Available from: <https://www.imf.org/en/Publications/WP/Issues/2022/05/31/The-Great-Carbon-Arbitrage-518464>
618. Republic of France, Bloomberg Philanthropies, Powering Past Coal Alliance. Accelerating Coal-to-Clean Energy Transitions - First Report and Recommendations of the Coal Transition Commission. Paris; p. 65.
619. IEA [Internet]. [cited 2025 June 6]. Methane Abatement - Energy System. Available from: <https://www.iea.org/energy-system/fossil-fuels/methane-abatement>
620. The White House. Delivering on the US Methane Emissions Reduction Action Plan. The White House; 2021.
621. The World Bank. 2022 Global Gas Flaring Tracker Report [Internet]. The World Bank Group; 2022. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://thedocs.worldbank.org/en/doc/1692f2ba2bd6408db82db9eb3894a789-0400072022/original/2022-Global-Gas-Flaring-Tracker-Report.pdf>
622. Global Methane Pledge. Global Methane Pledge [Internet]. Available from: <https://www.globalmethanepledge.org/#about>
623. European Commission. <https://environment.ec.europa.eu/>. [cited 2025 June 6]. Industrial and Livestock Rearing Emissions Directive (IED 2.0). Available from: https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/industrial-and-livestock-rearing-emissions-directive-ied-20_en

624. US EPA. <https://www.epa.gov/>. 2015 [cited 2025 June 6]. Progress Cleaning the Air and Improving People's Health. Available from: <https://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health>
625. Appeal Ruling Grants Shell Temporary Reprieve but Reaffirms Obligation for Fossil Fuel Companies to Limit Carbon Emissions [Internet]. Center for International Environmental Law. [cited 2025 June 6]. Available from: <https://www.ciel.org/news/appeal-ruling-grants-shell-temporary-reprieve-but-reaffirms-obligation-to-limit-carbon-emissions/>
626. News from the Government and Government Offices. Government Offices Of Sweden. Regeringen och Regeringskansliet; 2017 [cited 2025 June 6]. Swedish government increasing pressure on Israel. Available from: <https://government.se/>
627. National Green Tribunal Principal Bench New Delhi. Samir Mehta Vs. Union of India I Original Application No. 24 of 2011 I Before the National Green Tribunal Principal Bench New Delhi [Internet]. Original Application No. 24 of 2011 Aug 23, 2016 p. 223. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/http://www.indiaenvironmentportal.org.in/files/oil%20spill%20M%20V%20Rak%20NGT%20order%20mumbai%20coastline.pdf>
628. Sucheta. "Environmental compensation" of Rs 100 crore imposed upon shipping company for causing marine pollution [Internet]. SCC Times. 2016 [cited 2025 June 6]. Available from: <https://www.sconline.com/blog/post/2016/09/01/environmental-compensation-of-rs-100-crore-imposed-upon-shipping-company-for-causing-marine-pollution/>
629. Robert W. Howarth. The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States. *Energy Sci Eng.* 2024 Oct 3;12(11):4843–59.
630. Hope Talbot. Amsterdam to become first city in the world to ban this type of advert. *euronews* [Internet]. 13:48:14 +02:00 [cited 2025 June 6]; Available from: <https://www.euronews.com/green/2021/05/20/amsterdam-becomes-first-city-in-the-world-to-ban-this-type-of-advert>
631. National Observer, Canada [Internet]. [cited 2025 June 6]. Doctors demand ban on fossil fuel ads to save lives I Canada's National Observer: Climate News. Available from: <https://www.nationalobserver.com/2023/06/13/opinion/doctors-demand-ban-fossil-fuel-ads-save-lives>
632. Doctors for the Environment Australia. Doctors for the Environment Australia. [cited 2025 June 6]. Fossil Fuel advertising and sponsorship Position Statement. Available from: https://www.dea.org.au/fossil_fuel_advertising_and_sponsorship_position_statement
633. Kaminski I. The Hague becomes world's first city to pass law banning fossil fuel-related ads. *The Guardian* [Internet]. 2024 Sept 13 [cited 2025 June 6]; Available from: <https://www.theguardian.com/world/2024/sep/13/the-hague-becomes-worlds-first-city-to-ban-fossil-fuel-related-ads>
634. France bans ads for gasoline and diesel [Internet]. World without fossil Ads. [cited 2025 June 6]. Available from: <https://www.worldwithoutfossilads.org/listing/france-bans-ads-for-gasoline-and-diesel/>
635. Rosie Frost. France becomes the first European country to ban fossil fuel adverts. *euronews* [Internet]. 12:55:10 +02:00 [cited 2025 June 6]; Available from: <https://www.euronews.com/green/2022/08/24/france-becomes-first-european-country-to-ban-fossil-fuel-ads-but-does-the-new-law-go-far-e>
636. Reuters. UK media watchdog bans ExxonMobil ad. *Reuters* [Internet]. [cited 2025 June 6]; Available from: <https://www.reuters.com/article/business/environment/uk-media-watchdog-bans-exxonmobil-ad-idUSL3493371/>
637. Adfree Cities. Greenwashing Shell adverts banned by watchdog [Internet]. Adfree Cities. 2023 [cited 2025 June 6]. Available from: <https://adfreecities.org.uk/2023/06/shell-adverts-banned-for-greenwashing/>
638. Don Braid. *calgaryherald*. [cited 2025 June 6]. Braid: Threat of huge federal fines pushes "War Room" into UCP government fold. Available from: <https://calgaryherald.com/opinion/columnists/braid-threat-federal-fines-war-room-ucp-government>
639. [urgewald.org](https://www.urgewald.org/). <https://www.urgewald.org/>. [cited 2025 June 6]. The World Bank Drives Billions into Fossil Fuel Investments. Available from: <https://www.urgewald.org/world-bank-drives-billions-fossil-fuel-investments>
640. World Economic Forum. World Economic Forum. [cited 2025 June 6]. IEA: Clean energy investment must reach \$4.5 trillion per year by 2030 to limit global warming to 1.5°C. Available from: <https://www.weforum.org/stories/2023/09/iea-clean-energy-investment-global-warming/>
641. Say No Gas in Mozambique. Human Rights [Internet]. StopMozGas. [cited 2025 June 6]. Available from: <https://stopmozgas.org/why-no-to-gas/human-rights/>

642. Friends of the Earth Europe. Total Energies Human Rights Due Diligence Mozambique LNG Project [Internet]. Friends of the Earth Europe. [cited 2025 June 6]. Available from: <https://friendsoftheearth.eu/publication/totalenergies-fails-on-human-rights-in-mozambique-lng-project/>
643. Semieniuk G, Holden PB, Mercure JF, Salas P, Pollitt H, Jobson K, et al. Stranded fossil-fuel assets translate to major losses for investors in advanced economies. *Nat Clim Change*. 2022 June;12(6):532–8.
644. Ekblom J. European Investment Bank to cease funding fossil fuel projects by end-2021. Reuters [Internet]. 2019 Nov 15 [cited 2025 June 6]; Available from: <https://www.reuters.com/article/business/european-investment-bank-to-cess-funding-fossil-fuel-projects-by-end-2021-idUSKBN1XO2OT/>
645. Blaeser J. Report: World Bank invested nearly \$15 billion in fossil fuel projects despite climate commitment [Internet]. Grist. 2022 [cited 2025 July 14]. Available from: <https://grist.org/economics/report-world-bank-invested-nearly-15-billion-in-fossil-fuel-projects-despite-climate-commitment/>
646. Banktrack [Internet]. [cited 2025 June 6]. JPMorgan Chase 2030 climate targets a “fig leaf for fossil fuel expansion,” says Rainforest Action Network. Available from: https://www.banktrack.org/article/jpmorgan_chase_2030_climate_targets_a_fig_leaf_for_fossil_fuel_expansion_says_rainforest_action_network
647. Adam McGibbon, Laurie van der Burg. Eaders & Laggards: Tracking Implementation of Commitments to End International Public Finance for Fossil Fuels [Internet]. Oil Change International; 2023. Available from: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.oilchange.org/wp-content/uploads/2024/02/Leaders-and-Laggards-February-2024.pdf>
648. International Institute for Sustainable Development. Out With the Old, Slow With the New: Countries are underdelivering on fossil-to-clean energy finance pledge.
649. Public Enemies: Assessing MDB and G20 international finance institutions’ energy finance [Internet]. Oil Change International. 2024 [cited 2025 July 14]. Available from: <https://oilchange.org/publications/public-enemies-assessing-mdb-and-g20-international-finance-institutions-energy-finance/>

The **Global Climate and Health Alliance (GCHA)**

works at the forefront of a growing global movement of health professionals and health and development organisations dedicated to promoting a healthy, equitable, and sustainable future for all. We address the climate crisis through evidence-based advocacy, policy, movement building, research and strategic communications.

With 200+ organisational members, from every region and reaching over 125 countries, the Alliance co-chairs the WHO-Civil Society Working Group on Climate & Health and collaborates with organisations and agencies around the world to ensure that people's health is protected in the climate change era, in national, regional, and international decision-making. We are committed to tackling the climate crisis to preserve a healthy home for humanity.

GLOBAL
CLIMATE & HEALTH
ALLIANCE