Mitigating Methane from the Energy Sector

a Global Health Strategy

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Abt ASSOCIATES

THE GLOBAL CLIMATE & HEALTH ALLIANCE

About GCHA

The Global Climate and Health Alliance (GCHA) is the leading global convenor of health professional and health civil society organizations addressing climate change. We are a consortium of health and development organizations from around the world united by a shared vision of an equitable, sustainable future, in which the health impacts of climate change are minimized, and the health benefits of climate solutions are maximized. GCHA works to elevate the influential voice of the health community in policymaking to address the climate crisis.

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All interviewees were informed of the purpose of the interview and how the information from the interview would be used. Oral consent was given and no interviewees received compensation for their engagement with the research.

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https://climateandhealthalliance.org/initiatives/methane-health/

1 Introduction

Fossil fuels, including oil, natural gas *(Note: while natural gas" is commonly used and so will be used in this report to avoid confusion, the term mistakenly implies that gas is healthy and sustainable. GCHA finds the term "fossil gas" more accurate.)*, and coal, have been a fundamental driver of global, technological, social, and economic progress for over a century. Since the industrial revolution, humans have extracted fossil fuels—formed from decomposed plants and animals buried deep within the earth's crust—and burned them as a source of energy. Today, fossil fuels account for 80 percent of global energy consumption[1]. They currently generate most of the energy used for heating homes, fueling cars, and powering healthcare facilities, sanitation systems, food production, and other essential infrastructure and services. However, the reliance on fossil fuel as an energy source is driving climate change and wreaking havoc on human health and livelihoods, and there are now a diverse range of renewable technologies available to replace them.

Fossil fuel activities are not only responsible for over half of carbon dioxide emissions[2], but also over one third of global anthropogenic methane emissions. Methane is a powerful greenhouse gas (GHG) that is accelerating global warming and worsening air quality by contributing to the formation of ground-level ozone, a toxic air pollutant. Pollutants emitted along with methane—otherwise referred to as methane co-pollutants—contaminate the air, water, and soil humans depend on [see Overview Report for how methane impacts human health]. Recognizing the importance of a rapid and deep reduction in methane emissions as a key component of limiting global warming, 150 countries have now signed the Global Methane Pledge (GMP), launched in 2021. Signatories to the GMP have committed to collectively reduce methane emissions by 30 percent by 2030 relative to 2020 levels[3].

This report examines methane emissions sources from oil and natural gas extraction, production, and combustion, as well as coal mining; the associated human health benefits of methane reduction solutions; and suggested methane reduction solutions at the international, national, and local levels. This report is part of the Global Climate and Health Alliance's *Mitigating Methane, A Global Health Strategy* report series, which aims to bridge the knowledge gap on the intersection of methane and human health.

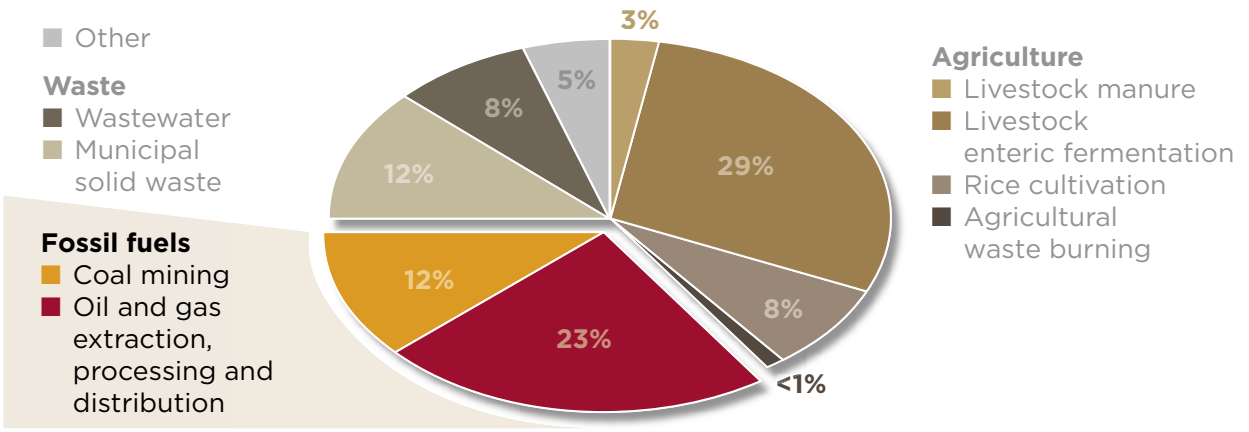
"I think it's really important that we recognize as health professionals just how powerful our voices can be in terms of helping the public to appreciate the immediate and long-term health and equity benefits that can result from policies to address climate change." –Kim Perrotta, Canadian Health Association for Sustainability and Equity (CHASE), Interview

2 Methane Sources from the Energy Sector

Oil and Natural Gas

Oil and natural gas activities contribute to roughly 23 percent of total global anthropogenic methane emissions[4] (see Figure 1). Natural gas, also known as "fossil gas" or "fracked gas", is only considered "natural" because it is naturally formed from decomposed animal and plant remains within the Earth's crust. Methane is a primary component natural gas, making up roughly 70 to 90 percent of its composition[5]. As such, the direct release of unburned natural gas into the atmosphere is a major source of methane. Methane may be released during extraction from underground deposits to production in wells, transmission in pipelines, and end-use in power plants, cars, and other end-uses[6].

Figure 1: Anthropogenic Methane Emissions from the Energy Sector



Source: United Nations Environment Programme and Climate and Clean Air Coalition (2021). Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions. Nairobi: United Nations Environment Programme

The International Energy Agency found that around 80 percent of methane emissions from the oil and natural gas sector come from oil and natural gas extraction and production because of leakage, venting, and flaring[7]. Natural gas can leak directly from oil and natural gas production wells, immediately after they have been extracted from the earth's crust. In the early 2000s, hydraulic fracturing, which may also be referred to as "fracking," became a common drilling technique to recover more oil and natural gas from deposits far deeper in the earth's crust and more difficult to extract[8]. A 2019 study found that, since 2008, the rise in atmospheric methane emissions is likely attributed to the extraction of shale gas—a hard-to-extract form of natural gas—through fracking[9]. The fracking boom opened the possibility of extracting oil and gas in more geographic locations, increasing the risks of methane leakages at production wells, and slowing down fossil fuel phase-out.

In addition to leakages at well pads, natural gas can unintentionally leak from a range of oil and natural gas production equipment, including liquid storage tanks, produced water tanks, dehydrators, pneumatic controllers, and other leakage points[10]. Oil and natural gas facility operators

vent natural gas into the atmosphere to meet the safety and operational requirements of a production facility or equipment[11]. They also flare, or burn, excess natural gas. While the primary by-product of burning natural gas is carbon dioxide, some portions of natural gas may not be fully combusted, resulting in its direct release into the atmosphere[12].

As methane is released into the atmosphere, so are other health-damaging air pollutants, including nitrogen oxides (NOx), particulate matter 2.5 (PM 2.5), and non-methane volatile organic compounds (NMVOCs), such as benzene, toluene, ethylbenzene, and xylene—collectively known as BTEX[13]. A recent study by PSE Healthy Energy found that sources of methane emissions are nearly always sources of other air pollutants. Therefore, targeted measures to reduce methane will also lead to reductions in other air pollutants[14].

During the end-use phase of the oil and natural gas supply chain, methane is released from natural gas leakages at power plants, refineries, distribution systems, as well as the incomplete combustion of natural gas in vehicles, and equipment or appliances, such as ovens or cookstoves[15]. PSE Healthy Energy found significantly fewer studies on methane emissions from oil and natural gas end-use compared to extraction, production, and transmission. Some studies have indicated that because distribution systems are often located in densely populated areas, even small leakages of methane and air pollutants co-emitted with methane can present detrimental health risks. Studies focused on indoor air pollution have found that natural gas-fueled ovens and stovetops not only leak methane, but also other hazardous pollutants such as BTEX and NOx[16,17]. A recent study also found that natural gas usage for indoor heating of buildings contributed to outdoor NOx levels exceeding WHO air quality guidelines, in a dense urban setting.[18] Limited studies are focused on methane from natural gas vehicles. One recent study found that methane emissions from on-road vehicles in China were severely underestimated, highlighting the need to conduct more studies in this area[19].

Coal Mining

Coal mining accounts for 12 percent of total global anthropogenic methane emissions[20] (see Figure 1). Methane is generated from the coal formation process, stored underground, and released into the atmosphere during coal mining[21]. Coal mine methane emissions are released through seepage from coal seams exposed in surface or open pit mines; ventilation and drainage processes, where methane is intentionally released from underground coal mines to achieve a concentration level that is safer for coal miners; post-mining activities, like processing, storage, and transport, when methane trapped in coal seeps out; and abandoned mines, since methane can continue to escape from coal even after mining operations have ended[22].

Coal mining processes not only emit methane, but also other health-damaging air pollutants, such as coal mine dust. Coal mine dust is a fine-powdered form of coal that is created as a result of crushing, grinding, and pulverizing coal rock[23]. In addition to air pollution, coal mining pollutes nearby waterways by releasing toxic metals such as copper, arsenic, and lead[24].

3 Methane and Health: Energy Sector

Targeted technical solutions to reduce methane emissions from fossil fuels can deliver multiple human health benefits. First, they can limit tropospheric ozone, a harmful air pollutant created by methane emitted from sources such as oil and natural gas extraction, production, combustion, as well as coal mining. Methane-driven tropospheric ozone can lead to adverse health outcomes, such as cardiovascular diseases, asthma, respiratory illness, and premature death[25], resulting in roughly 1 million premature deaths yearly[26], as discussed in the Overview Report. Furthermore, reducing methane can avoid health impacts from exposure to air pollutants co-emitted with methane, including:

- NOx, which is linked to asthma incidences and hospitalization, respiratory illnesses, cardiovascular disease mortality;
- PM2.5, which can lead to the same adverse health outcomes as NOx, as well as premature birth, lung cancer, and low birth weight;
- Hydrogen sulfide (H2S), which can cause eye and respiratory system irritations, as well as apnea, coma, convulsions, dizziness, headache, weakness, irritability, insomnia, and upset stomach[27];
- BTEX, which can increase cancer risks[28].

Finally, reducing methane can avoid safety risks from explosions and fires caused by methane leaks in natural gas pipelines or high methane concentrations in coal mines[29].

Phasing out coal consumption, and thus coal mining, will not only reduce methane, but also coal mine dust. Coal mine dust can cause potentially disabling and fatal lung diseases to coal mine workers known as "coal workers' pneumoconiosis," more commonly called black lung disease or silicosis. Coal mine dust can also cause birth defects, cancer, cardiovascular and respiratory diseases among individuals living near coal mines[30]. Once contracted, there is no cure for these lung diseases, making prevention essential[31]. Furthermore, ending coal mining can reduce the release of heavy metals, such as arsenic, copper, and lead, in nearby waterways. Consuming water with high levels of heavy metals may lead to acute and chronic liver and kidney diseases, as well as intestinal damage, anemia, and cancer[32]. The complete phase-out of methane-emitting fossil fuels must occur to avoid all irreversible impacts of fossil fuels on human health, including those not directly linked to methane gas release.

Case Study: Natural Gas Flaring in Iraq Linked to Rising Cancer Rates

Smoke and flames from gas flaring in an Iraq oilfield

On 21 April 2023, Ali Hussein Jaloud, an Iraqi man in his early 20s, died of leukemia linked to natural gas flaring. A few days before his death, Ali made an Instagram post pleading with oil companies to stop routine natural gas flaring, to "save the youth of the country from kidney failure and cancer." Ali's death stirred public outrage[33]. Iraqi government officials have acknowledged a strong link between natural gas flaring and cancer[34]. Former environment minister of Iraq, Jassem al-Falahi, told the BBC that flaring is a main reason for increases in cancer in Basra[35].

While the only way to end these harmful emissions is the full phase out of fossil fuels, a number of technologies can be implemented now in existing oil, gas and coal processes, including legacy emissions from mines, to minimize methane leakage and the harmful co-pollutants. The table below summarizes the human health co-benefits of technical methane mitigation solutions and of the complete phase-out of methane emitting fossil fuels.

Phase in Supply Chain	Methane Emission Sources	Technical Solutions	Human Health Co-Benefits of Reducing Methane and Phasing Out Methane-Emitting Fossil Fuels
Oil and natural gas end-use	• Natural gas stoves • Natural gas-fueled vehicles • Power generation	• Electric stoves • Electric vehicles, low- or zero-emission fuels • Solar, wind, or other renewable power generation sources	• Avoid cardiovascular diseases, asthma, respiratory illness, and premature death linked to methane- driven ozone • Avoid asthma incidences and hospitalization, respiratory illnesses, cardiovascular disease mortality linked to exposure to NOx and PM2.5 co-emitted with methane • Avoid premature birth, lung cancer, and low birth weight linked to exposure to PM2.5 co-emitted with methane • Avoid cancer risks linked to exposure to BTEX co-emitted with methane
Oil and natural gas pre-combustion activities	• Well-heads • Open storage tanks	• Leak detection and repair technologies • Tankless designs or vapor recovery units on liquid storage tanks	• Avoid cardiovascular diseases, asthma, respiratory illness, and premature death linked to methane-driven ozone • Avoid cancer risks linked to exposure to BTEX co-emitted with methane • Avoid eye and respiratory system irritations, as well as apnea, coma, convulsions, dizziness, headache, weakness, irritability, insomnia, and upset stomach associated with exposure to H2S

Natural gas planned and unplanned releases	• Venting • Pneumatic controllers • Fugitive (methane leaks) • Compressor station blowdowns	• Leak detection and repair technologies • Electrification of compressor engines • Zero-bleed technologies	• Avoid cancer risks linked to exposure to BTEX co-emitted with methane • Avoid eyes and respiratory system irritations, as well as apnea, coma, convulsions, dizziness, headache, weakness, irritability, insomnia, and upset stomach associated with exposure to H2S • Avoid cardiovascular diseases, asthma, respiratory illness, and premature death linked to methane-driven ozone • Avoid injuries and casualties from explosions and fires caused by methane leakage
Natural gas combustion	• Flaring • Combustion	• Vapor recovery units to capture natural gas that would otherwise be flared • Tankless designs or vapor recovery units on liquid storage tanks	• Avoid cancer risks linked to exposure to BTEX co-emitted with methane • Avoid cardiovascular diseases, asthma, respiratory illness, and premature death linked to methane-driven ozone
Coal mining	• Active underground mines • Abandoned mines • Surface mines	• Pre-mining degasification; air methane oxidation with improved ventilation • Flooding abandoned coal mines	• Avoid injuries and casualties from explosions and fires caused by high methane concentrations in coal mines • Avoid asphyxiation from exposures to high levels of methane gas without air ventilation in coal mines • Avoid black lung disease, birth defects, cancer, cardiovascular, and respiratory diseases associated with inhaling coal mine dust • Avoid liver and kidney diseases, as well as intestinal damage, anemia, and cancer from ingesting heavy metals leaked in groundwater from coal mining operations

Source: United Nations Environment Programme and Climate and Clean Air Coalition (2021). Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions. Nairobi: United Nations Environment Programme; **PSE Healthy Energy** (2021). Methane and Health-Damaging Air Pollutants from the Oil and Gas Sector: Bringing 10 Years of Scientific Understanding; **Buonocorem, J. et al.** (2023). Air Pollution and Health Impacts of Oil and Gas Production in the United States.

4 Ways Forward: Methane Mitigation Strategies and Health Benefits

The phase-out of fossil fuels is imperative and must occur to avoid catastrophic impacts to human health from both climate change in the long-term, and fossil fuel extraction, production, and combustion in the short-term[36]. However, the transition away from fossil fuels to 100 percent clean energy sources will take time due to the required transformational social, economic, and political changes. Low-income countries will need additional support — through climate finance and technology transfer — to make the switch, but may have significant opportunities to develop on cleaner energy pathways, leapfrogging over greater dependence on fossil fuels and avoiding the associated harms to health.

The energy sector must take rapid action to reduce methane emissions from existing production and use, even while the full transition from fossil fuels to clean, renewable energy is underway. Cutting methane emissions from fossil fuel production, distribution, and end use through readily available, cost-effective solutions is a powerful lever for reducing near-term warming and avoiding dangerous warming tipping points, while also yielding benefits for people's health.

This section focuses on methane reduction strategies at the international, national, and local levels. These strategies offer important near-term health benefits, while mitigating climate change and reducing longer-term health impacts. Elevating the health benefits of strategies that reduce methane, and pushing governments and industry to select strategies that deliver the maximum health benefits, has the potential to accelerate action in this space.

International actions focus on increasing global awareness, calling for financing mechanisms for technical solutions, and policy support from multinational organizations. Below are some actions that can drive the implementation of methane mitigation strategies that improve health and health equity around the world.

- Call for the inclusion of the methane mitigation strategies for the fossil fuels sector in Nationally Determined Contributions (NDCs). Emphasize the importance of these strategies by highlighting the health co-benefits. Across all 168 NDCs, only 18 percent and 2 percent of countries included measures to reduce fugitive methane emissions from oil and natural gas, and coal mining, respectively, and only 1 country committed to halting the expansion of fossil fuel infrastructure[37].
- Convene and catalyze discussions of methane emissions from oil and natural gas, and coal mining operations and the associated public health benefits and potential avoided health costs of well-chosen strategies in climate conferences, such as Regional Climate Weeks[38] or the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC)[39].

- Participate in and integrate health benefits into ongoing initiatives focused on building the capacity of Global Methane Pledge signatories to reduce methane from the energy sector and improve health. Some examples include:
  - The Global Methane Initiative (GMI), which is focusing on reducing the barriers to recovering and using methane from high methane-leakage sectors, such as oil and natural gas[40] and coal mining[41]. During the transition to clean energy, while some fossil fuels are still in use, recovering and using methane rather than allowing it to leak ensures the maximum energy for human use from the fossil fuels being extracted, and converts a highly potent greenhouse gas — methane — to a less potent one, CO_2. GMI facilitates knowledge exchange between Partner Countries on the best practices and lessons learned from implementing methane reduction strategies.
  - The Climate and Clean Air Coalition, which is helping countries develop Methane Roadmap Action Plans to identify and implement priority strategies to translate Global Methane Pledge commitments into action that mitigates methane, in the energy sector and other methane-emitting sectors[42].
- Advocate for electrifying or transitioning to clean energy sources for cooking, power generation, and other end-uses, and increasing energy efficiency to reduce overall demand. Call on high-income countries to take the lead, and advocate for financing and technical support for low- and middle-income countries.

Case Study: Fossil Fuel Subsidies are Undermining Nigeria's Pledge to Eliminate Natural Gas Flaring by 2030

Nigeria is one of the world's top seven natural gas flaring countries[43]. An estimated 2 million people in Nigeria live less than 4 kilometers away from a natural gas flaring site[44]. A study by the World Bank found a relationship in Nigerian communities between flaring and increased number of children with coughs, respiratory illnesses, and fever, as well as being underweight[45].

Nigeria's updated Nationally Determined Contributions released in 2021 pledged an elimination of natural gas flaring by 2030. To deliver on this target, Nigeria is committed to deploying technologies to capture and utilize the excess gas that would otherwise be flared, while rapidly rolling out clean energy[46].

Despite these ambitious commitments, Nigeria continues to provide fossil fuel subsidies, significantly undermining efforts to eliminate natural gas flaring and transition away from fossil fuels. In 2019, the government provided at least $1.7 billion in oil subsidies.[47] The government could align with its national climate mitigation objectives and protect the health of Nigerians by ending fossil fuel subsidies. These public funds could then be allocated to deploying clean energy and methane mitigation technologies — including those that capture and use excess natural gas that would otherwise be flared, and implementing just energy transition policies and programs.

National actions center on informing national environmental and health agencies and decision-makers about the near- and long-term health benefits of national-level methane mitigation actions. These agencies and decision-makers should be called upon to prioritize the actions discussed below.

- Conduct inclusive stakeholder engagement when developing policies to control methane and co-pollutant emissions from oil and natural gas or coal mining facilities. Communities most vulnerable to the health impacts of methane driven ozone and co-pollutants may face barriers to engaging with public officials and public processes. Engaging with specific health ministries or agencies can help focus and accelerate targeted methane reduction efforts. Actively reaching out to communities and other key stakeholders can help decision-makers better understand community needs.
- Enact stringent regulations on minimum distances between oil and natural gas or coal mining facilities and areas inhabited or frequented by local communities. Minimum distance setbacks should be long enough to protect sensitive populations from harmful exposures to methane-driven ozone and co-pollutants.
- Implement oil and natural gas and coal mining methane mitigation strategies, prioritizing facilities located near population centers. Methane mitigation strategies may include:
    - Requirements to monitor or publicly report methane emissions at oil and natural gas or coal mining facilities. One of the main barriers to deploying methane abatement technologies is the lack of information on the location and scale of methane leaks.
    - Strengthened limits on how much methane can be emitted at oil and natural gas and coal mining facilities.
    - Phase out of outdated equipment that leaks methane at existing oil and natural gas and coal mining facilities.
    - Bans on flaring to encourage the use of vapor recovery unit installations to capture and use the methane that would otherwise be released or flared.
- Ban fracking approaches to oil and natural gas extraction to immediately stop the expansion of oil and natural gas production. As previously discussed, fracking opens vast new deposits of oil and natural gas, increasing the potential for more methane emissions.
- End fossil fuel subsidies for new oil and natural gas, and coal exploration and production, and redirect this funding to clean energy transition projects. Assess the true health costs of fossil fuel subsidies, including the cost of the impacts of methane and its co-pollutants on health.
- Ensure the transition away from coal, oil and natural gas does not lead to degraded operation and maintenance practices that could contribute to further emissions.

Case Study: Large Methane Plumes Detected from Underground Coal Mines in South Africa

South Africa is heavily reliant on underground coal mining, with approximately 85 percent of its electricity powered by coal. Around 50 percent of South Africa's coal mines are at the surface, while the rest are underground and involve drilling.[48] South Africa is the 5th largest coal mine methane emitter in the world[49]. Despite the significance of coal mine methane in South Africa, there are currently very limited studies focusing on this issue.

On 16 June 2021, Kayrros SAS, a Paris-based satellite company detected a large methane leak near a coal mine around 125 kilometers east of Johannesburg, South Africa[50]. Karryos also detected two other large methane plumes in the vicinity on 27 May 2023, which it estimated emitted 40 tons of methane per hour[51]. These methane plumes are degrading local air quality and impacting the health of communities surrounding coal mining sites.

In an interview, Rico Euripidou, Campaign Coordinator at groundWork, Friends of the Earth South Africa, emphasized that "until the public health sector begins to internalize that our energy choices and our energy models are essentially public health issues and that there is currently an acute public health emergency in South Africa because of our energy choices, then I fear that we will never internalize what those external costs are and never have a true understanding of how impactful and how costly our energy choices are."

Case Study: Hydraulic Fracking Impacts on Indigenous Communities in Canada

Indigenous people in Canada, who are at greater risk of poor health than other populations in Canada due to historic and ongoing colonial violence, are among the people most deeply and frequently affected by air and water pollution from hydraulic fracturing, or "fracking", operations.

Many fracking sites in Canada are located on or in proximity to northern and remote Indigenous Communities, both because this is where the fossil fuel reserves have been discovered, and because, as is true around the world, governments more frequently put the health of Indigenous people at greater risk than they would the health of politically dominant populations.

An interview with Kim Perrotta, Executive Director of the Canadian Health Association for Sustainability and Equity (CHASE), revealed that Indigenous Communities impacted by fracking typically do not have a loud voice politically and have less access to the media. A policy brief co-authored by Perrotta for the Canadian Association of Physicians for the Environment[52] urges policymakers to integrate a health and equity impact assessment into decision-making to identify and mitigate adverse impacts from fracking. The principles and practices of this assessment framework would include meaningful community engagement, address all facets of sustainable development, and respect for human rights.

Local actions at the workplace and community level include immediate actions to mitigate methane and co-pollutants from the energy sector and address associated health risks. Some examples may include:

- Lead initiatives to transition healthcare facilities to 100 percent clean renewable energy, as health care facilities consume high levels of electricity and contribute to GHGs. Advocate for energy efficiency measures to reduce overall energy demand and reduce the need to procure more power from fossil-fueled power plants. Promote cleaner transportation and fleets and promote telemedicine and telehealth to reduce GHG emissions from traveling with fossil-fueled vehicles.
- Leverage the media to build public support, including through op-eds, local newspapers, letters to editors, blogs, TV interviews etc. to amplify information on the health harms of methane and co-pollutants from fossil fuels.
- Inform patients and the public about how methane affects local air quality and worsens climate change, which impacts human health.
- Call on local districts and/or municipalities to improve or provide infrastructure to facilitate active modes of transportation (e.g., public transit, biking lanes, sidewalks).
- Encourage patients and the public to use active modes of transportation, which not only reduces GHG emissions, but also improves health.
- Support and advocate for initiatives to phase out gas heating and cookstoves. Inform patients and community members about the health risks of indoor exposures to co-pollutants from gas cookstoves.

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