Maximizing health and equity gains of mitigation policies to deliver the Paris Agreement: submission to the third call for technical inputs to the first Global Stocktake

This submission is intended to complement the GST technical submission made by the Global Climate and Health Alliance and partners in August 2022, the political submission made by the World Health Organization and partners in February 2023, and the technical submission made by the World Health Organization and partners in March 2023, by providing additional detail on mitigation policies which maximize health and equity gains. It comprises two documents; the compendium of policies below, and a second document which details criteria to support the identification of policies which maximize health and equity co-benefits by decision makers.

The contents of this submission respond to question 5a proposed by the SB Chairs "In order to achieve the goals defined in Articles 2.1(a) and 4.1 of the Paris Agreement: What further action is required?" while also considering how climate action can respect, promote and consider Parties' respective obligations on the right to health and equity described in question 19.

The concept for this submission was jointly developed by the Global Climate and Health Alliance and the University of Wisconsin. Preparation of the submission was led by Nova Tebbe, based within Professor Jonathan Patz' research team at the University of Wisconsin-Madison, with support from Jess Beagley, Madison Xiong, and Jonathan Patz. Review and co-signatory support has been provided by: the Global Climate and Health Alliance, University of Wisconsin-Madison Nelson Institute for Environmental Studies, Consortium of Universities for Global Health, Health Care Without Harm, International Society of Doctors for the Environment (ISDE; Global and Italian offices), Pathfinder Initiative (based within the London School of Hygiene and Tropical Medicine), Enhancing Belmont Research Action to support EU policy making on climate change and health (ENBEL), MMBSHS Trust (India), EXHAUSTION project, International Society on Children's Health, Environment, and Safety (INCHES).

Executive Summary

The right to health and the principle of equity are acknowledged in the Paris Agreement, and are thus essential elements of the Global Stocktake. This technical submission to the GST identifies mitigation policies in various sectors with the potential and opportunity for health and equity co-benefits using detailed multi-goal policy criteria. Health gains of mitigation interventions include improved air quality, healthy diets, and increased physical activity, leading to decreased burdens of disease, specifically cancer, cardiovascular disease, type 2 diabetes, and chronic respiratory diseases. Equity gains yielded by strategic planning and implementation of mitigation interventions include those related to decent work, access to basic human needs, and participation in decision-making for populations which have been historically marginalized.

The table below summarizes the health and equity gains of the policies featured in the body of this submission, which can be tailored for implementation across multiple regions.

Some Parties and subnational jurisdictions have made progress in developing and implementing mitigation measures while enhancing health and equity. Full integration of health and equity into mitigation policies can maximize co-benefits to health and equity.

The GST can enhance the integration of health into climate policy discussions by recommending that future NDCs and LT-LEDS include quantification of the health co-benefits of climate action. The political outcome of the GST should recommend the development of an evidence infrastructure for the GST, including data on health and equity co-benefits of climate action.

Table 1: Summary of Health and Equity Gains in Mitigation Policies

Sector	Policy	Health Gains	Equity Gains
Energy	Enable Fast and Just Fossil Fuel Phase-Out Plans	(+): Improve air quality	(+): Improve energy access, give ownership to communities
	Community-based Renewable Energy Projects		
Industry	Incentivize the Use of Renewable Energy in Industrial Processing	(+): Improve air quality, reduce occupational health hazards	(+): Improve working conditions, job opportunities, community engagement
	Incentivize Efficiency Measures and Retrofits for Industrial Facilities		
Food & Agriculture	Sustainable Agriculture, including Community and Urban Agriculture	(+): Improve built environment, reduce air pollution and urban heat island effect, improve access to nutritious food	(+): Increase low-income and frontline communities' food sovereignty and nutrition security
	Preventing and Reducing Food Waste		
Built Environment	Engage in Creative Placemaking for Community Development and Urban Planning	(+) Safe and efficient homes,improve air quality	(+) Reduce household costs, community engagement and ownership in local urban development
	Green Buildings and Weatherized Housing and Buildings		
Transportation	Electrify Public Transportation with Renewable Energy	(+): Reduce road injuries, improve air quality	(+): Access to travel and amenities for low-income and frontline communities
	Complete Streets in Urban Design Planning		
Waste	Promote System-Wide Life Cycle Assessments on Global Supply Chains	(+) Improve air quality, reduce environmental hazards	(+): Reduce hazards for workers and local communities
	Ban Incineration to Promote Zero Waste Infrastructure		
Land-use land-use change and forestry	Terrestrial Forest and Coastal Zone Conservation	(+): Promote physical and mental health and wellbeing	(+): Protects Indigenous rights and recognises traditional ways of knowing
Health Care Sector	Promote Renewable Energy and Microgrids for Hospitals and Clinics	(+): Improve air quality	(+): Improve access to health services for populations living in remote areas or vulnerable to climate related disruptions to healthcare
	Minimize Use of or Find Alternatives for Anesthetic and Refrigerant Gases in Hospitals and Clinics		

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Introduction and Rationale

Health is intrinsically relevant to the Paris Agreement, and thus to the Global Stocktake. The Paris Agreement acknowledges the relevance of the right to health, to climate action, with the right to a clean, healthy and sustainable environment additionally recognised in the Sharm el-Sheikh Implementation Plan.[1] The IPCC describes the scientific evidence confirming climate change to be a "threat to human well-being" as "unequivocal".[2] The health impacts of climate change include slow onset and emerging health risks such as increasing heat stress, migrating vector borne diseases and water and nutrition insecurity,[3] undermining the right to health and a healthy environment, and driving severe productivity losses. These impacts constitute extensive losses and damages around the world. Mitigation action reduces these impacts, and can reduce the need for loss and damage finance.

In addition, climate action can yield near-term health co-benefits: emissions reductions in the energy sector through transitioning from fossil fuels to renewable energy sources improve air quality; multimodal transport systems improve air quality and support physical activity; and sustainable food and agriculture systems promote nutrition. For example, according to a study of just nine countries[4], mitigation in the energy, food and agriculture, and transport sectors in line with the Paris Agreement would avoid 1.18 million, 5.86 million, and 1.15 million deaths through improved air quality, healthier diets, and increased physical activity respectively each year by 2040.[5] These reductions in risk factors will lead to decreased burdens of disease, specifically cancer, cardiovascular disease, type 2 diabetes, and chronic respiratory diseases. Nature-based solutions offer physical and mental health benefits, and resilient water and sanitation systems ensure safe and adequate drinking water and hygiene. In this submission, "equity" refers primarily to the equality and social equity in societies within countries, although the interventions identified will also contribute to reductions in inequalities between world regions. Typically, marginalized populations are most vulnerable to the impacts of climate change and ill-health, as well as insecurity, exclusion from decision-making, and other forms of inequality. Strategic planning and implementation of mitigation interventions can reduce these inequalities. It is critical that climate policy decision-making maximizes such health and equity gains, while reducing greenhouse gas (GHG) emissions in line with the Paris Agreement goal to limit warming to 1.5C above pre-industrial levels.

[1] UNFCCC (2022). Decision -/CMA.4 Sharm el-Sheikh Implementation Plan. Online: https://unfccc.int/sites/default/files/resource/cma4_auv_2_cover_decision.pdf
[2] IPCC (2022). AR6 Working Group II Summary for Policymakers
[3] IPCC (2022). AR6 Working Group II Report, Chapter 7, box 7.2
[4] *Brazil, China, Germany, India, Indonesia, Nigeria, South Africa, the UK, and the USA*
[5] Hamilton et al, 2021. The public health implications of the Paris Agreement: a modeling study. *Lancet Planetary Health* 5(2), E74-E83

Protecting and promoting public health also has economic benefits. In China and India, investment costs of implementing policies to reduce greenhouse gas emissions would be substantially offset by the health co-benefits that emerge from a low-carbon economy, while they would be partially offset in the United States and Western Europe.[6] Furthermore, healthy populations are more economically productive. Populations with good public health and access to medicines and medical technologies are also more likely to be able to withstand and recover from climate shocks, and restore economic productivity - this can be understood as "health resilience", and is a key component of adaptation.

As determined by the IPCC, in order to limit warming to 1.5C above pre-industrial levels, GHG emission must fall 43% by 2030 compared to 2019 levels.[7] **Our submission to the GST identifies mitigation policies (grouped by sector[8]) which also offer potentially substantial health and equity co-benefits,** selected according to criteria detailed in the second document comprising this submission. Mitigation is, of course, only one component of climate action. Health co-benefits of adaptation across sectors, for instance, are described in the health community submission to the fifth workshop on the Global Goal on Adaptation[9].

Integration of these policies into Nationally Determined Contributions (NDCs) and national mitigation plans will not only accelerate emissions reductions but will furthermore protect and promote health and equity, provided they are implemented rapidly and with attention to justice. For each type of policy, benefits to climate, health and equity are described, followed by brief examples of political context and implementation at national and subnational level.[10]

The list of policies identified are relevant across multiple regions, with implementation tailored according to national context. It is important to note that while the list of sectors and policies covered includes comprehensive examples of highly relevant policies, it is not exhaustive: a wide range of additional policies which yield climate, health and equity benefits also exist.

Our analysis shows that some Parties, and indeed subnational jurisdictions, have made progress across sectors in developing and implementing strategies to achieve GHG reductions while enhancing health and equity. Full integration of health and equity into the delivery of the Paris

[6] Markandya et al (2018). Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study. *Lancet Planetary Health*, 2(3), E126-E133

[7] IPCC (2018). Special Report: Global Warming of 1.5C.

[8] *While the health and equity gains of mitigation in the health sector may not be comparable to actions in other sectors, the health care sector has been included in this submission by the health community in recognition of the need for action across all sectors in order to achieve emissions reductions in line with the Paris Agreement*

[9] WHO, Global Climate and Health Alliance and partners, 2022. Submission in advance of the fifth Workshop on the Global Goal on Adaptation Transformational adaptation: changing mindsets, indigenous issues, and cross-cutting themes. https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202303011625---Health%20Community%20GGA%20Submission_Workshop%205_Transformational%20adaptation_%20February%202023.pdf

[10] *Initial examples were gathered from the United States, India, South Africa, South Korea, and Trinidad and Tobago, based on existing prior research by the University of Wisconsin. Additional countries were subsequently added.*

Agreement into NDCs and Long-Term Low Emissions and Development Strategies (LT-LEDS) can both protect people and yield economic and developmental gains. In order for these gains to be maximized, such policies should be implemented in all countries. As such, international financing will be crucial. In order to support the delivery and allocation of such finance, developing country Parties should include details in NDCs on the expected health gains made feasible by investments, and clarify which actions outlined in their NDCs are unconditional and can be funded through domestic resources, and which are conditional on donor contributions.

As described in the political submission[11] to the GST made by WHO and partners in February 2023, an important function of the GST should be to monitor and quantify the health harms avoided, and the health co-benefits that are generated, by climate policies. The GST should recommend that future NDCs and LT-LEDS include quantification of the health co-benefits of climate action.

Health Criteria

Climate change has severe negative health impacts across societies. As well as being a leading driver of climate change (and its associated health threats), unsustainable energy, food and agriculture, and transport systems (and in particular, dependence on fossil fuels across sectors) also generate health risks such as air pollution (including but not limited to SO_2, NO_2, and particulate matter), unhealthy diets, and physical inactivity. Reducing these health risks can, in turn, provide health benefits. To better assess both the health risks and benefits, the health impact of mitigation policies should be evaluated.

Each policy included in this submission was selected on account of being assessed to have a **positive impact on population health,** indicated by five main policy goals and subsequent impact categories (see complementary document in submission): **(1)** reduce premature mortality, **(2)** reduce preventable morbidity, **(3)** enable healthy habits and behavior, **(4)** reduce health disparities and exposure to marginalized groups, and **(5)** improve mental health and wellbeing. Influence on the social determinants of health was also considered, such as education, employment, socioeconomic status, wealth, and the built environment. Policies included in this submission yield several of these benefits and are rated as positive. With due attention to avoiding negative impacts of response measures, policies that maximize health co-benefits have been prioritized. For example, while increasing the use of electric vehicles can contribute to emissions reductions provided the electricity is generated from renewable

[11] WHO and partners (2022). Submission from the global health community: Views on the approach to the consideration of outputs component of the first Global Stocktake.
https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202302151425---Political%20Submission%20to%20the%20GST-WHO.GCHA.LC.Wellcome-15.02.23.pdf

sources, it does not address the negative health impacts of road safety as it does not take any cars off the road. Instead, policies to electrify and expand public transportation are included, as such actions reduce the need for personal vehicles, improving road safety and congested roads while also reducing GHG emissions when electrified by renewable energy sources.

Equity Criteria

Health and equity are inextricably linked. As climate change severely impacts human health, it also worsens and exacerbates inequities in all societies. Inequities can be embedded and perpetuated in societies through structures based on income inequality and on prejudices against race, ethnicity, class, sexuality, sex and gender, faith, immigration status, political status, and disability (and any intersection of these groups). As a result, low-income, excluded and marginalized communities suffer the negative health impacts of climate change much more severely than other social groups. In addition, frontline communities, or those who experience the impacts of the climate crisis first and worst, in addition to several other relevant stakeholders are often ignored in decision-making processes and excluded from interventions and policies to tackle climate change. For these reasons, policies to reduce GHG emissions should also be evaluated on the basis of equity.

The equity impact of each climate policy is based on whether the policy will have a **positive impact on equity through various equity indicators. Policies included in this submission were selected based on potential to deliver several positive equity impacts** based on 6 policy goals and subsequent impact categories (see complementary document in submission): **(1)** improve community ownership, **(2)** enhance meaningful community engagement and input, **(3)** promote equitable redistribution and predistribution (distributing rewards equitably in the first place) of resources and power, **(4)** strengthen inclusivity and intersectionality of experiences and ways of knowing, **(5)** respect social and cultural traditions and context, and **(6)** ensure universal human rights, including Indigenous rights.

Healthy and Equitable Interventions by Sector

This submission focuses on the seven main sectors that contribute to GHG emissions: energy, industry, food & agriculture, built environment, transportation, waste (e.g., in landfills), land-use land-use change and forestry (LULUCF) and health care. For each sector, policies are included which have the potential for successful and beneficial implementation in countries across various regions, economic development, and political landscape. For each policy, this submission considers the health and equity gains.

Energy

The energy sector is the largest source of GHG emissions globally, contributing 73.2 percent, mainly from the use of fossil fuels in all sectors of society including industry, transport, buildings, and electricity production.[12] The main immediate health risk of this sector is from air pollution, which increases the risk of respiratory and cardiovascular diseases and mortality. The main equity risk of this sector is the proximity of power plants and other energy facilities to communities who are historically marginalized and low-income as well as often lacking access to energy. The following policies offer strategies to reduce the use and need of fossil fuels and incentivize renewable energy and ensure access to it.

Enable Fast and Just Fossil Fuel Phase-Out Plans

Fossil fuel phase-out plans outline legislative action steps for countries to reduce and ultimately eliminate the use of fossil fuels from their energy infrastructure. They often encompass gradual elimination of fossil fuel subsidies while incentivizing accessible renewable energy, especially for low-income and frontline communities.

The combustion of fossil fuels for energy contributes both to increased GHG emissions, and to adverse health effects including cancer, lung-related illnesses, and cardiovascular disease. Phase-out of fossil fuels would prevent 3.6 million deaths annually from air pollution reductions.[13] The phase-out of coal, oil, and natural gas would lower GHG emissions, leading to improved air quality and overall human health. In addition, fossil fuel phase out would prevent health harms of fossil fuel extraction and processing.[14] Additionally, this phase-out would protect the health of communities that live near fossil fuel combustion, extraction or processing sites by reducing exposure to toxic pollutants. These plans should be implemented with attention to a just transition. In the interest of health and equity, there must be a just transition so that communities most at risk to the effects of climate change and/or have been dependent on fossil fuel extraction have affordable access to clean energy and fair job opportunities in a low-carbon economy. Furthermore, local communities must be protected from the health harms of mineral extraction for solar panels and batteries as part of renewable energy infrastructure.

It should be noted that some technologies presented as solutions, such as carbon capture and storage and blue hydrogen from fossil gas, would not solve the health risks from methane leakage, fuel extraction, transport and processing.

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[12] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector

[13] Lelieveld, J., Klingmüller, K., Pozzer, A., Burnett, R. T., Haines, A., & Ramanathan, V. (2019). Effects of fossil fuel and total anthropogenic emission removal on public health and climate. *Proceedings of the National Academy of Sciences*, *116*(15), 7192–7197. https://doi.org/10.1073/pnas.1819989116

[14] Global Climate and Health Alliance (2022). Cradle to Grave: The health harms of fossil fuel dependence and the case for a just phase-out https://climateandhealthalliance.org/wp-content/uploads/2022/07/Cradle-To-Grave-Fossil-Fuels-Brief.pdf

Vanuatu was the first country to support the Fossil Fuel Non-Proliferation Treaty to end the expansion of all new fossil fuel projects.[15] In addition, at COP26 in Glasgow, several countries launched and joined the Beyond Oil and Gas Alliance, to set an end date for oil and gas extraction and halting new licensing and leasing agreements, including Denmark, France, Ireland, Portugal, Sweden, Greenland, Quebec, and Wales among other associate members.[16] While there are few countries who have agreed to a fossil fuel phase-out plan, several cities and states have agreed to no longer build fossil fuel plants. Two major states in India, Gujarat and Chhattisgarh have already made announcements to not build any new coal-fired power plants.[17] Sweden is replacing fossil fuels both in the production of the iron pellets, the key ingredient of steel, and in the removal of oxygen from the iron by replacing carbon and coke with green hydrogen.[18]

Community-based Renewable Energy Projects

Community-based renewable energy projects give communities more ownership over where and how they access their energy.[19] Community-led boards can oversee the projects to ensure that community members are involved in the transition to a green economy. Policies should provide incentives for communities to invest in renewable energy projects, such as subsidies and grant programs. The long-term goal of community-based renewable energy projects is to be sustainable and completely citizen-run, with special attention to frontline, traditionally excluded and underserved communities, including migrant and Indigenous communities.

Community-based renewable energy projects can improve both health and equity. A transition to renewable energy will reduce harmful air pollution and GHGs that would otherwise be produced by burning fossil fuels and reduce dependence on burning polluting biomass. Improved air quality can lessen health care costs, sick days, and air pollution-related deaths and illnesses.[20] In addition, scaling up community-based renewable energy infrastructure can improve the built environment, create more local jobs and thus shift towards green jobs, and reduce energy insecurity. When targeted at vulnerable and marginalized populations, these projects empower communities by ensuring they have more input and control over their electricity sources.[21]

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[15] *Vanuatu makes historic call for treaty to end the fossil fuel era*. (n.d.). The Fossil Fuel Non-Proliferation Treaty Initiative. Retrieved February 5, 2023, from https://fossilfueltreaty.org/vanuatu

[16] Farand, C. (2021, November 11). *A space is opening to discuss oil and gas exit at Cop26. Lobbyists are pushing back*. Climate Home News. https://www.climatechangenews.com/2021/11/11/space-opening-discuss-oil-gas-exit-cop26-lobbyists-pushing-back/

[17] Sarkar, S. (2019, December 6). Major Indian states could declare no new coal. *India Climate Dialogue*. https://indiaclimatedialogue.net/2019/12/06/indian-states-signal-beginning-of-no-new-coal/

[18] Vetter, D (2021, August 19). How Sweden Delivered The World's First Fossil Fuel-Free Steel. Forbes https://www.forbes.com/sites/davidrvetter/2021/08/19/how-sweden-delivered-the-worlds-first-fossil-fuel-free-steel/ accessed 28 Feruary 2022,

[19] *Consumer Advocacy – Public Utilities (DCA) | Community-Based Renewable Energy (CBRE)*. (n.d.). Retrieved August 24, 2021, from https://cca.hawaii.gov/dca/community-based-renewable-energy/

[20] Millstein, D., Wiser, R., Bolinger, M., & Barbose, G. (2017). The climate and air-quality benefits of wind and solar power in the United States. *Nature Energy*, *2*.https://doi.org/10.1038/nenergy.2017.134

[21] Community-led Program Brings Solar Energy to India's Poorest. (2016, June 17). *Aga Khan Foundation USA*. https://www.akfusa.org/our-stories/community-led-program-brings-solar-energy-to-indias-poorest/

Community-based renewable energy projects already exist, such as utility-scale Community Choice Aggregation (CCA)[22] in the U.S. and the Rampura Community Solar Power Plant (CSPP) for off-grid community energy in India.[23] In Trinidad and Tobago the Community Centers Project installs solar panels on community centers to provide exterior lighting and enable them to function as disaster relief centers.[24] While there are many pilot programs and small projects related to community-based renewable energy projects in the world, these projects are not widespread and are not yet scaled nationally.

Industry

Industrial processes to produce cement and chemicals and petrochemicals account for a total of 5.2 percent of global GHG emissions.[25] Within the energy sector's total GHG emissions, energy use in industry accounts for 24.2% of global GHG emissions, mainly from iron, steel, and other industries such as mining and quarrying, construction, textiles, and wood products.[26] The main health risks within industry are allergic reactions, air and water pollution, respiratory and cardiovascular diseases, and cancer. The main equity risks are occupational hazards such as direct exposure of pollution for workers and the surrounding communities. The following policies focus on the electrification of industrial processes with renewable energy and promotion of energy efficiency within industrial facilities.

Incentivize the Use of Renewable Energy in Industrial Processing

Manufacturing and industry are the backbone of many economies but are among the highest GHG emitting sectors. As demand for minerals and other materials needed for the energy transition increases, it is essential that the manufacturing and industry sectors decarbonize while also meeting demand and ensuring the protection of human rights and avoidance of environmental pollution. Currently, most manufacturing relies on fossil fuels for energy-intensive processes, e.g., heating systems.

Industry also releases non GHG air pollutants such as SO_2, $PM_{2.5}$, CO, ozone, VOCs, NO_x, polycyclic aromatic hydrocarbons (PAH) and heavy metals, contaminating both air and water. These environmental pollutants are associated with allergic reactions, respiratory and cardiovascular diseases, skin and eye diseases, and cancer.[27] Residents living near industrial

[22] US EPA, O. (2022, January 13). *Community Choice Aggregation* [Overviews and Factsheets]. https://www.epa.gov/green-power-markets/community-choice-aggregation
[23] Joshi, G., & Yenneti, K. (2020). Community solar energy initiatives in India: A pathway for addressing energy poverty and sustainability? *Energy and Buildings*, *210*, 109736. https://doi.org/10.1016/j.enbuild.2019.109736
[24] *Ministry of Energy and Energy Industries | Pilot Projects*. (n.d.). Retrieved February 5, 2023, from https://www.energy.gov.tt/our-business/alternative-energy/pilot-projects/
[25] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector
[26] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector
[27] Pascal, M., Pascal, L., Bidondo, M.-L., Cochet, A., Sarter, H., Stempfelet, M., & Wagner, V. (2013). A review of the epidemiological methods used to investigate the health impacts of air pollution around major industrial areas. *Journal of Environmental and Public Health*, *2013*, 737926. https://doi.org/10.1155/2013/737926

facilities and complexes are at high risk of acute and chronic disease, including respiratory and allergic conditions.[28,29] Reducing industrial pollution by using renewable energy can decrease these health risks. In addition, reducing industrial pollution can decrease the burden placed on communities who live near industrial complexes, who are disproportionately low-income.

Incentivizing the use of renewable energy for electricity in heating and cooling systems and general material processing can reduce the dependence on fossil fuels and resulting GHG emissions. When renewable energy systems are locally built, owned, and managed, community engagement and ownership are also improved.

Recently, there has been some attention to industrial pollution, such as the European Union's "zero pollution vision for 2050" which includes revising measures to address pollution from large industrial installations.[30] In the United States, states are required to implement policies in line with measures such as the Clean Air Act[31] and Clean Water Act.[32] Further action is however needed to decarbonize the manufacturing and industry sector.

Incentivize Efficiency Measures and Retrofits for Industrial Facilities

Industrial facilities and complexes may rely on outdated equipment with low efficiency, contributing to the energy intensity of the sector. Programs and incentives to upgrade, replace, and retrofit facilities that enhance efficiency and minimize waste can reduce GHG emissions and air pollution. This includes efficient motors, electronic control systems, and reducing air or steam leaks to optimize performance. According to a 2014 IPCC report, the energy intensity of the industry sector can be reduced up to 25 percent by wide scale upgrading, replacement, and deployment of the best available technology.[33] These retrofits can also create employment opportunities and better engage the community in the sector.

Retrofits to industrial facilities can reduce GHG emissions and overall waste generated from industrial processes. While industrial waste (metals, chemicals, fertilizers, etc.[34]) can be treated to reduce its harm to the environment and human health, the treated industrial waste is

[28] Eom, S.-Y., Choi, J., Bae, S., Lim, J.-A., Kim, G.-B., Yu, S.-D., Kim, Y., Lim, H.-S., Son, B.-S., Paek, D., Kim, Y.-D., Kim, H., Ha, M., & Kwon, H.-J. (2018). Health effects of environmental pollution in population living near industrial complex areas in Korea. *Environmental Health and Toxicology*, *33*(1), e2018004. https://doi.org/10.5620/eht.e2018004

[29] Alwahaibi, A., & Zeka, A. (2016). Respiratory and allergic health effects in a young population in proximity of a major industrial park in Oman. *Journal of Epidemiology and Community Health*, *70*(2), 174–180. https://doi.org/10.1136/jech-2015-205609

[30] *Zero pollution action plan*. (2023, January 13). European Commission. https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

[31] US EPA, O. (2013, February 22). *Summary of the Clean Air Act* [Overviews and Factsheets]. https://www.epa.gov/laws-regulations/summary-clean-air-act

[32] US EPA, O. (2013, February 22). *Summary of the Clean Water Act* [Overviews and Factsheets]. https://www.epa.gov/laws-regulations/summary-clean-water-act

[33] Fischedick M., J. Roy, A. Abdel-Aziz, A. Acquaye, J. M. Allwood, J.-P. Ceron, Y. Geng, H. Kheshgi, A. Lanza, D. Perczyk, L. Price, E. Santalla, C. Sheinbaum, and K. Tanaka, 2014: Industry. In: *Climate Change 2014: Mitigation of Climate Change. Contri- bution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[34] US EPA. (2015, May 26). *Typical Wastes Generated by Industry Sectors* [Overviews and Factsheets]. United States Environmental Protection Agency. https://www.epa.gov/hwgenerators/typical-wastes-generated-industry-sectors

detrimental to the surrounding ecosystem and human endocrine systems.[35] Minimizing waste through better equipment and more efficient processes can reduce these health impacts. In addition, risk to factory workers (who may be of lower socio-economic backgrounds), is reduced, while performing retrofits and upgrades also creates opportunities for new workers.[36]

While there are many examples of countries mobilizing to retrofit buildings and homes such as South Africa, Chile, and the U.S., there are limited records of efforts to retrofit existing industrial facilities. This lack of incentive for industrial facilities and complexes may present barriers to reducing GHGs in the sector .

Food and Agriculture

Agriculture accounts for 18.4 percent of global GHG emissions, with livestock and manure (5.8 percent) and agricultural soils (4.1 percent) contributing the most for the sector.[37] The main health risks for this sector include air and water pollution and lack of healthy and sustainable diets. The main equity risks include access to healthy and sustainable foods in local food systems and farm and ranch workers rights. The following policies aim to localize food systems and ensure access to nutritious food to populations and communities most in need, particularly those who are at high risk of hunger and malnutrition.

Sustainable Agriculture, including Community and Urban Agriculture

Sustainable agriculture can promote the transition to plant-based diets by increasing the availability and accessibility of fruits and vegetables as well as reducing GHG emissions. Regenerative practices include organic management practices, an emphasis on ecological diversity, traditional knowledge, agroforestry, and complexity in landscape ecology. Urban and community agriculture can be a form of sustainable agriculture, in which local farmers and other community members grow crops on small plots of vacant public land. Governments can incentivize sustainable agriculture by investing in programs, grants, or subsidies with a specific focus on frontline and low-income communities.

Sustainable agriculture offers valuable health co-benefits while also maximizing justice and equity for disadvantaged communities. Developing a sustainable agriculture system can reduce GHG emissions, reduce air pollution, and improve the built environment. Urban and community agriculture, in particular, can promote both community building and resilient food systems. Therefore, increasing the availability of healthy foods can reduce food insecurity while

[35] Saravanakumar, K., De Silva, S., Santosh, S. S., Sathiyaseelan, A., Ganeshalingam, A., Jamla, M., Sankaranarayanan, A., Veeraraghavan, V. P., MubarakAli, D., Lee, J., Thiripuranathar, G., & Wang, M.-H. (2022). Impact of industrial effluents on the environment and human health and their remediation using MOFs-based hybrid membrane filtration techniques. *Chemosphere*, *307*, 135593. https://doi.org/10.1016/j.chemosphere.2022.135593

[36] Ungar, L., Barrett, J., Nadel, S., Elliot, R. N., Rightor, E., Amann, J., Huether, P., & Specian, M. (2020). *Growing a Greener Economy: Job and Climate Impacts from Energy Efficiency Investments*. American Council for an Energy-Efficient Economy. https://www.aceee.org/white-paper/2020/09/growing-greener-economy-job-and-climate-impacts-energy-efficiency-investments

[37] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector

promoting healthier diets. In addition, sustaining small-scale urban farms increases green space in cities, which has been shown to improve mental and physical health and reduce the urban heat island effect.[38] Low-income and frontline communities would benefit the most from having greater food sovereignty, with a greater variety of and in cases more nutritious and culturally significant foods that otherwise would be less available.

While sustainable agriculture practices may be more focused in more rural areas, cities and other urban areas have begun to incentivize urban and community agriculture to grow more produce locally. Seoul, Republic of Korea has started to invest in urban farming infrastructure and jobs to enable more people to grow their own food while also providing better insulation, reducing energy bills and emissions, and reducing air pollution.[39] Addis Ababa, Ethiopia also has an urban agriculture program called the Extensive Urban Agricultural Scheme, which provided both agricultural products and job opportunities during the COVID-19 pandemic.[40]

Preventing and Reducing Food Waste

One-third of all food produced is wasted, accounting for 6-8% of all GHG emissions globally.[41] Reducing food waste is the third most impactful action in terms of emissions reduction and can lead to more than 90 gigatons of carbon reduction.[42] Food waste can be reduced through better storage infrastructure to avoid spoilage, improved processing facilities, efficient distribution facilities, clear labeling, and public education.

Squandering food exhausts seeds, water, labor, land, energy and financial capital, while producing GHG at every stage of production. In developing countries, food waste may occur due to poor storage infrastructure across the supply chain, and a lack of manufacturing and processing facilities. In developed countries, food is more typically wasted as a result of overbuying, spoilage at home, and unclear labels. Improving storage infrastructure and intervening at the retail level can reduce food waste and thus GHG emissions. Investing in food storage infrastructure can increase availability of healthy and safe food to people experiencing food insecurity and living in food deserts.

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[38] World Health Organization. (n.d.). Urban green spaces and health—A review of evidence (2016). Retrieved April 29, 2021, from https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/publications/2016/urban-green-spaces-and-health-a-review-ofevidence-2016

[39] *Seoul unveils plan to create 1m urban farmers*. (n.d.). Retrieved February 6, 2023, from https://news.cgtn.com/news/2020-10-24/Seoul-unveils-plan-to-create-1m-urban-farmers-UQG8jAGUY8/index.html

[40] *Urban agriculture in Addis Ababa to ease COVID-19 impact – New Business Ethiopia*. (2020, May 27). https://newbusinessethiopia.com/agribusiness/urban-agriculture-in-addis-ababa-to-soften-covid-19-impact/

[41] World Wildlife Fund. (n.d.). *Fight climate change by preventing food waste*. WWF. Retrieved September 10, 2021, from https://www.worldwildlife.org/stories/fight-climate-change-by-preventing-food-waste.

[42] *Reduced food waste @projectdrawdown #climatesolutions*. Project Drawdown. (2021, August 26). Retrieved August 2021, from https://drawdown.org/solutions/reduced-food-waste.

In India, the Ministry of Health and Family Welfare established an initiative, Save Food, Share Food, Share Joy (IFSA) to bring together stakeholders to prevent food being lost or wasted throughout the supply chain.[43] South Korea also has a mandatory composting scheme that requires residents to use specific bags to throw out uneaten food, which also costs a specific amount per bag to reduce food waste.[44]

Built Environment

Elements of building and retaining infrastructure contribute to global GHG emissions, namely cement (3 percent), residential buildings (10.9 percent), and commercial buildings (6.6 percent).[45] The main health risks of the infrastructure sector is air pollution, lack of walkable or bikeable areas presenting barriers to physical activity, and lack of greenspace that benefits mental health. Equity risks stem from past "redlining"[46] and ongoing gentrification to those communities who have been historically marginalized and left out of infrastructure planning. The following policies focus on ways to build community well-being and decision-making for sustainable infrastructure.

Engage in Creative Placemaking for Community Development and Urban Planning

Creative placemaking is a way to facilitate the design of social infrastructure to support communities' quality of life. Creative placemaking involves a cross-sectoral approach that integrates art, culture, and design activities to deeply engage communities.[47] Communities not only need to prepare for the climate crisis as extreme weather events become more common but also need an active change in behavior to reduce GHG emissions. Engaging in creative placemaking can include planning festivals that celebrate nature and educate about the harms of pollution, creating community gardens with art spaces that utilize vacant lots, or using visualization techniques and storytelling to reimagine how spaces could be used.[48] This approach offers a unique opportunity for communities to take ownership of their built environment and advocate for green spaces, walkable and bikeable streets, museums, sustainable buildings, local renewable energy among other things and support positive behavior change. When the community has ownership over its built environment and can freely express their emotions through art, health and equity may rise in priority. Importantly, when communities' historical context is acknowledged and funding is allocated based on this context,

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[43] *IFSA - SAVE FOOD, SHARE FOOD, SHARE A SMILE (IFSA)*. (n.d.). Retrieved July 15, 2021, from https://sharefood.fssai.gov.in/about.html
[44] Kim, S. (2022, July 19). South Korea's Food Waste System is a Model for Developed Nations. *Korea Economic Institute of America*. https://keia.org/the-peninsula/south-koreas-food-waste-system-is-a-model-for-developed-nations/
[45] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector
[46] Redlining is a discriminatory practice that entails systemic denial of services such as mortgages, insurance loans, and other financial services based on their ethnicity and/or race
[47] National Endowment for the Arts. (n.d.). *Creative Placemaking*. Retrieved September 10, 2021, from https://www.arts.gov/impact/creative-placemaking
[48] Helicon Collaborative. (2018). *Farther, Faster, Together: How Arts and Culture Can Accelerate Environmental Progress*. Art Place. https://heliconcollab.net/wp-content/uploads/2018/04/Farther-Faster-Together-1.pdf

particularly those who have been historically marginalized, these communities will have the resources to build resiliency and rapidly be part of existing and future mitigation strategies.

Ensuring the community has the opportunity to actively engage with local decisions can improve the health of the community, particularly if the community has been or is currently disenfranchised. Funding and incentives to promote quality public spaces can give opportunities for physical activity and play, such as having attractive walking and biking paths, as well as providing a more calming environment.[49] In addition, more access to green spaces, as agreed upon by the community, can reduce the incidence of mental illness, such as depression and anxiety, and bring people closer to nature.[50]

Several cities have initiated or implemented creative placemaking projects and have seen positive results on health, equity, and the environment. The City of Johannesburg in South Africa, for example, recently had a colloquium dedicated to culture-led placemaking to document how arts-oriented practitioners worked with culture in neighborhood development.[51] In Seoul, South Korea, a project was implemented to remove the Cheonggye Freeway, which had high levels of noise and congestion in the city and upset most of the local residents, and replaced it with green corridors around a rediscovered waterway and a new bus rapid transit system.[52] Creative placemaking has also been successfully implemented in smaller cities and towns, such as in Utica, Mississippi, where community members used an abandoned building to come together and share stories from their history rooted in agriculture, to support redevelopment of the local food system.[53]

Green Buildings and Weatherized Housing and Buildings

Buildings produce 6% of heat-trapping emissions worldwide and use more than half of all electricity.[54] Buildings and homes must be efficient, green, and resilient to climate change impacts in order to transition to a 100% renewable energy society and improve the health and wellbeing of the population. Measures such as efficient and affordable cooling and heating, insulation, energy and water efficient appliances, adequate air flow, and using low-carbon building materials can reduce energy consumption and make it easier for renewable energy to supply the world's energy needs. Updated building codes can accelerate implementation. In addition, utility company regulators can obligate those companies to decarbonize by 2045.

[49] Garau, P. (2016). *Global Public Space Toolkit: From Global Principles to Local Policies and Practice*. United National Human Settlements Programme. https://unhabitat.org/sites/default/files/2019/05/global_public_space_toolkit.pdf
[50] Dodgen, D., Donato, D., Kelly, N., La Greca, A., Morganstein, J., Reser, J., Ruzek, J., Schweitzer, S., Shimamoto, M. M., Thigpen Tart, K., & Ursano, R. (2016). *Ch. 8: Mental Health and Well-Being. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program. https://doi.org/10.7930/J0TX3C9H
[51] *Culture-Led Placemaking in Johannesburg: Practitioner Perspectives*. (2019, October 30). Creative City South. https://creativecitysouth.org/blog-1/2019/10/30/culture-led-placemaking-in-johannesburg-practitioner-perspectives
[52] *Cheonggye Freeway*. (2017, July 26). [Text]. Congress for the New Urbanism. https://www.cnu.org/what-we-do/build-great-places/cheonggye-freeway
[53] Kobersmith, K. (2021, April 14). *These Four Rural Towns Are Using Creative Placemaking to Thrive*. The Daily Yonder. http://dailyyonder.com/how-four-rural-towns-are-building-vibrant-communities-through-the-tools-of-creative-placemaking/2021/04/14/
[54] *Buildings: ProjectDrawdown*. (2020, February 5). Project Drawdown. https://drawdown.org/sectors/buildings

Energy efficient buildings and weatherized (resistant to weather extremes and damages) housing will also create healthier living environments, especially for low-income and frontline communities, by reducing indoor air pollution, and heat or cold related illnesses.

Affordable, resilient, and sustainable homes are vital for living a healthy life as it is the place where most people gather, spend time, and cook. When housing is substandard or has poor energy efficiency , several health risks emerge, such as respiratory diseases including asthma, cardiovascular disease, injuries, mental illness, and infectious diseases.[55] Between 1991-2018, 37 percent of warm-season heat-related deaths were attributed to anthropogenic climate change in 43 countries.[56] It is also estimated that between 2000-2019 there were over 5 million deaths per year globally associated with non-optimal temperatures, with most excess deaths related to cold temperatures.[57] As heatwaves and cold spells become more common, a lack of access to efficient and sustainable heating and cooling systems will increase mortality and other health concerns.[58] Retrofitting and weatherizing homes can reduce energy use, and hence GHG emissions, and make them more resilient to extreme weather events. Weatherizing and retrofitting housing and other buildings will create jobs, which may be of particular benefit to frontline, low-income, and former fossil fuel working communities.

Both cities and national governments initiated projects and programs for retrofitting and greening homes. In 2014, Chile launched a program to replace 200,000 firewood heaters with more energy-efficient heaters in the center-south region.[59] In addition, Chile launched the Regeneration of Housing Complexes Program to improve dwellings and neighborhoods by upgrading existing housing units, constructing new ones, and installing green spaces.[60] In Cape Town, South Africa, a ceiling retrofit project was created in low-income communities to improve existing housing by making them more energy efficient and reducing financial burdens on residents.[61] Also, the historic township of Cato Manor in Durban received a green retrofit in

[55] *Housing impacts health: New WHO guidelines on housing and health*. (2018, November 26). World Health Organization. https://www.who.int/news/item/26-11-2018-housing-impacts-health-new-who-guidelines-on-housing-and-health
[56] Vicedo-Cabrera, A. M., Scovronick, N., Sera, F., Royé, D., Schneider, R., Tobias, A., Astrom, C., Guo, Y., Honda, Y., Hondula, D. M., Abrutzky, R., Tong, S., de Sousa Zanotti Stagliorio Coelho, M., Saldiva, P. H. N., Lavigne, E., Correa, P. M., Ortega, N. V., Kan, H., Osorio, S., … Gasparrini, A. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. *Nature Climate Change*, *11*(6), 492–500. https://doi.org/10.1038/s41558-021-01058-x
[57] Zhao, Q., Guo, Y., Ye, T., Gasparrini, A., Tong, S., Overcenco, A., Urban, A., Schneider, A., Entezari, A., Vicedo-Cabrera, A. M., Zanobetti, A., Analitis, A., Zeka, A., Tobias, A., Nunes, B., Alahmad, B., Armstrong, B., Forsberg, B., Pan, S.-C., … Li, S. (2021). Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: A three-stage modelling study. *The Lancet Planetary Health*, *5*(7), e415–e425. https://doi.org/10.1016/S2542-5196(21)00081-4
[58] Gronlund, C. J., Sullivan, K. P., Kefelegn, Y., Cameron, L., & O'Neill, M. S. (2018). Climate change and temperature extremes: A review of heat- and cold-related morbidity and mortality concerns of municipalities. *Maturitas*, *114*, 54–59. https://doi.org/10.1016/j.maturitas.2018.06.002
[59] UN Environment. (2017, August 21). *Chile takes action on air pollution*. Climate & Clean Air Coalition. https://www.ccacoalition.org/en/blog/chile-takes-action-air-pollution
[60] RUCAS-Chile. (2021, April 20). *Measuring the Impact on Well-being and Health of Dwelling and Envionmental Regeneration in Chile*. Urban Health Network for Latin America and the Caribean. https://drexel.edu/lac/data-evidence/policy-evaluations/measuring-the-impact-on-well-being-health-of-dwelling-environmental-regeneration-in-Chile/
[61] Ghojeh, M., & Sarfatti, C. (n.d.). *Inclusive Climate Action in Practice: How to jointly tackle climate change and inequality with case studies from leading global cities*. C40 Cities. https://cdn.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ab410fb74c4833febe6c81a/5c4204754722d40016c4eda6/files/C40_Inclusive_Climate_Action_in_Practice.pdf?1547830389

2011 as part of a project with the Green Building Council of South Africa to upgrade low-income communities with thirty low-cost houses with sustainable design and efficiency measures.[62]

Transportation

The transportation sector contributes a total of 16.2 percent of global GHG emissions, with road transport contributing 11.9 percent, aviation with 1.9 percent, shipping with 1.7 percent, rail with 0.4 percent, and pipelines with 0.3 percent.[63] The main health risks for this sector are air pollution, particularly in areas with heavy vehicle use, and road safety. The main equity risks are from limited access to affordable and safe travel options, particularly for marginalized and low-income communities who live near major highways. The following policies aim to promote transportation options that facilitate safe travel around neighborhoods, communities, and cities and reduce the need for a personal vehicle.

Electrify Public Transportation with Renewable Energy

Public transport is central to mitigation . According to Project Drawdown, public transit alone can reduce 7.51-23.36 gigatons of CO_2 worldwide, even without taking into account the additional benefits of fully electrifying public transport with renewable energy sources.[64] Electrification of public transit like buses and trains using renewable energy, and expansion of public transport networks, offers climate mitigation and health co-benefits.

Gasoline-powered vehicles emit air pollutants such as fine particulate matter that negatively impact health. Ambient fine particulate matter ($PM_{2.5}$) pollution is responsible for millions of premature deaths each year, with estimates ranging from 4 million to 9 million deaths annually.[65,66,67] However, transitioning to zero-emission transportation solutions, in conjunction with increasing levels of renewable energy, is estimated to save 6,300 lives, avoid 93,000 asthma attacks and 416,000 avoided work day loss in, mainly due to reductions in ambient outdoor pollution.[68]

Electrified public transport will reduce ambient concentrations of air pollutants including particulate matter, thereby improving respiratory and cardiac health. Electrifying buses and

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[62] Green Building Council of South Africa. (2012). *Improving Lives by Greening Low-Cost Housing: Case Study Report of the Cato Manor Green Street Retrofit*. https://gbcsa.org.za/wp-content/uploads/2018/01/Improving-lives-by-greening-low-income-homes-Case-Study-2012-FINAL.pdf
[63] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector
[64] *Public transit @projectdrawdown #climatesolutions*. Project Drawdown. (2021, August 26). Retrieved August 2021, from https://drawdown.org/solutions/public-transit.
[65] Murray CJL, Aravkin AY, Zheng P, Abbafati C, Abbas KM, Abbasi-Kangevari M, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet. 2020 Oct;396(10258):1223–49.
[66] Lelieveld J, Klingmüller K, Pozzer A, Burnett RT, Haines A, Ramanathan V. Effects of fossil fuel and total anthropogenic emission removal on public health and climate. Proc Natl Acad Sci USA. 2019 Apr 9;116(15):7192–7.
[67] Vohra K, Vodonos A, Schwartz J, Marais EA, Sulprizio MP, Mickley LJ. Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. Environmental Research. 2021 Apr;195:110754.
[68] *Road to Clean Air: Benefits of a Nationwide Transition to Electric Vehicles*. (n.d.). The American Lung Cancer Association. Retrieved March 24, 2021, from https://www.lung.org/getmedia/b9efc73e-aeba-4cd8-b789-942166c38ca6/EV_Technical_Documentation.pdf

trains will not only improve health outcomes but also reduce the healthcare cost incurred due to poor air quality. In addition, affordable and efficient public transit will decrease the need for personal vehicles, reducing traffic congestion and road accidents. An affordable transit system connected to neighborhoods, businesses, schools, and recreational facilities improves accessibility of essential amenities for low-income communities and reduces the need to own a personal vehicle, particularly in urban environments, with high associated household costs in addition to GHG emissions. Accessible and electrified public transport improves health, sustainability, and mobility, especially in urban areas.

In India, some major states are working on electrifying parts of their public transportation. As of 2019, 60% of Delhi Metro is solar powered. In settings like India, provision of fare subsidies can also support expansion of public transport networks by increasing affordability and use. Cape Town, the capital of South Africa, was the first city in Africa to have electric public transportation, specifically using renewable sources. Transportation accounts for about 28% of U.S. greenhouse gas emissions, making it the largest source for emissions. The CLEAN Future Act, which was recently introduced in the House Committee on Energy and Commerce, also invests in transportation with specific attention to zero-emissions school buses.

Complete Streets in Urban Design Planning

Complete Streets is an urban design process prioritizing pedestrians, bikes, and public transportation as opposed to dependence on personal vehicles, by having spacious sidewalks, clearly marked biking lanes, safe crossings, curb extensions, priority lanes for public transit, and public transit stops. Shifting from transportation infrastructure focused on personal vehicles to one centered around active transportation requires efforts at the national and local levels to maximize its health benefits.

Designing streets which promote biking, walking, and public transit use will reduce vehicular air pollution, can increase physical activity and reduce road traffic injuries, while reducing inequalities. A recent study found that four million children develop asthma every year from NO_2, a byproduct associated with burning fossil fuels emitted by cars and trucks.[69] Creating a built environment that supports physical activity will also reduce the risk of cardiovascular diseases, depression, and anxiety.[70] Along with numerous other health benefits, a well-designed street reduces the risk of motor accidents and crashes.[71] These improvements in safety can especially benefit persons with disabilities.[72] Improving access to public transit and cheaper

[69] Achakulwisut, P., Brauer, M., Hystad, P., & Anenberg, S. C. (2019). Global, national, and urban burdens of pediatric asthma incidence attributable to ambient NO2 pollution: Estimates from Global Datasets. *The Lancet Planetary Health*, *3*(4). https://doi.org/10.1016/s2542-5196(19)30046-4
[70] CDC. (2021, January 22). *Benefits of Physical Activity*. Centers for Disease Control and Prevention. https://www.cdc.gov/physicalactivity/basics/pa-health/index.htm
[71] Complete Streets Improve Safety. (2018, August). Retrieved August 2021, from https://smartgrowthamerica.org/wp-content/uploads/2016/08/cs-safety.pdf.
[72] *People with Disabilities: Benefits of Complete Streets*. (n.d.). Smart Growth America. Retrieved October 8, 2021, from https://smartgrowthamerica.org/resources/people-with-disabilities-benefits-of-complete-streets/

modes of transport makes it easier and affordable for low-income and frontline communities to access essential resources around them, such as food, education, and health facilities.[73]

Countries including India, South Africa, and South Korea have already taken interest in a complete streets design. There is also great potential for integrating complete streets into existing urban initiatives, such as the Smart Cities Mission, launched by the government of India in 2015, that aims to build better cities.[74] New Zealand's Model Communities Programme uses infrastructure investment to improve urban active travel networks in the cities of New Plymouth and Hastings. This resulted in a 30 percent higher level of active bike or pedestrian trips and avoided an estimated 34 disability adjusted life years (DALYs) and two deaths between 2011-2013.[75] Initiatives such as the Model Communities Programme, which has already seen health and climate benefits from implementing complete streets show there is potential for complete streets to be scaled nationally.

Waste

Waste contributes 3.2 percent of global GHG emissions, mainly from decomposing wastewater and landfills producing methane and nitrous oxide.[76] Global plastic production has increased to nearly 400 million tons per year.[77] 50% plastic ends up in landfills and 22% ends up in uncontrolled disposals, which lead to terrestrial and marine environment degradation.[78] The main health risks are from air and water pollution, including bioaccumulation of 'forever' chemicals (PCBs, PFAS, PFAs) in food, water, and air[79], and microplastics which pass through the food chain and harm human health.[80] The main equity risks are to communities who live near landfills and other waste facilities who are historically marginalized and low-income as well as workers within waste management systems. Waste management is an important service to reduce the health and social impacts of solid waste and thus to transition to low-carbon economies.[81] In order to transition to low emission economies, waste must actively be avoided and reduced. The following policies look to prevent waste generation in the first instance, focusing on upstream solutions.

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[73] *Complete Streets Mean Equitable Streets* . Complete Streets Mean Equitable Streets. (2018, August). Retrieved August 2021, from https://smartgrowthamerica.org/wp-content/uploads/2016/08/cs-equity.pdf.
[74] *Complete Streets Framework Toolkit*. (n.d.). ITDP India. Retrieved February 5, 2023, from https://www.itdp.in/resource/complete-streets-framework-toolkit/
[75] Chapman, R., Keall, M., Howden-Chapman, P., Grams, M., Witten, K., Randal, E., & Woodward, A. (2018). A Cost Benefit Analysis of an Active Travel Intervention with Health and Carbon Emission Reduction Benefits. *International Journal of Environmental Research and Public Health*, *15*(5), Article 5. https://doi.org/10.3390/ijerph15050962
[76] Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and Greenhouse Gas Emissions. *Our World in Data*. https://ourworldindata.org/emissions-by-sector
[77] United Nations Environment Programme (2021). Drowning in Plastics – Marine Litter and Plastic Waste Vital Graphics.
[78] *Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD*. (n.d.). Retrieved January 20, 2023, from https://www.oecd.org/environment/plastic-pollution-is-growing-relentlessly-as-waste-management-and-recycling-fall-short.htm
[79] US EPA. (2021, October 14). *Our Current Understanding of the Human Health and Environmental Risks of PFAS*[Overviews and Factsheets]. United States Environmental Protection Agency. https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas
[80] Mamun, A. A., Prasetya, T. A. E., Dewi, I. R., & Ahmad, M. (2023). Microplastics in human food chains: Food becoming a threat to health safety. *Science of The Total Environment*, *858*, 159834. https://doi.org/10.1016/j.scitotenv.2022.159834
[81] Solid waste. In: Compendium of WHO and other UN guidance on health and environment. Geneva: World Health Organization; 2021 (WHO/HEP/ECH/EHD/21.02)

Promote System-Wide Life Cycle Assessments on Global Supply Chains

Life cycle assessments (LCA) can be conducted to evaluate environmental and health impacts of products, processes, or activities throughout the supply chain. This includes identifying and quantifying the energy and materials used at the beginning and the end of the process. LCAs, when performed in an industry-wide and holistic way with ISO 14044 standards[82], can provide insight into negative environmental and health impacts of global supply chains, particularly if there is international cooperation on these assessments. By using transparent LCA results, alternative solutions to those which depend on energy-intensive and wasteful processes can be identified .

The continued use of plastics and other materials reliant on fossil fuels for production further deepens the dependence on fossil fuels in the world economy, exacerbating air quality issues and negative health implications. Additionally, plastics contain toxic and endocrine-disrupting chemicals , particularly affecting susceptible populations, such as pregnant people and children.[83] Results of LCAs can inform reductions in the use of plastics, and thus dependence on fossil fuels for products and supply chains (to be replaced with reusable and recyclable alternatives), ultimately reducing carbon output and other GHG emissions.

Reducing the quantity of waste in landfills can decrease levels of methane and CO2 generated during waste degradation This can improve the health of communities living near landfills who may experience higher cases of eye irritation from bad air quality and illnesses such as flu.[84] When LCAs are conducted with local communities who are near or work within supply chains, these communities are able to give more input and full engagement with the supply chain and perhaps be able to find solutions. In addition, if LCAs are conducted across country boundaries, it allows countries with limited market power to engage and have ownership over their part in the supply chain.

LCAs are becoming more common both in the private and public sectors. Companies have used LCAs to determine ways to reduce environmental burdens of specific products, such as the Polyethylene Terephthalate (PET) bottle used to package sodas, water, juices, salad dressings, among others.[85] LCAs have also been used to better understand organic waste management strategies for “zero waste” policies from local and state governments such as in California.[86]

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[82] International Organization for Standardization. (2014, August 12). *ISO 14044:2006*. ISO. https://www.iso.org/standard/38498.html
[83] Halden, R. U. (2010). Plastics and Health Risks. *Annual Review of Public Health*, *31*(1), 179–194. https://doi.org/10.1146/annurev.publhealth.012809.103714
[84] Njoku, P. O., Edokpayi, J. N., & Odiyo, J. O. (2019). Health and Environmental Risks of Residents Living Close to a Landfill: A Case Study of Thohoyandou Landfill, Limpopo Province, South Africa. *International Journal of Environmental Research and Public Health*, *16*(12), 2125. https://doi.org/10.3390/ijerph16122125
[85] Borodin, Y. V., Aliferova, T. E., & Ncube, A. (2015). Waste management through life cycle assessment of products. *IOP Conference Series: Materials Science and Engineering*, *81*(1), 012085. https://doi.org/10.1088/1757-899X/81/1/012085
[86] Nordahl, S. L., Devkota, J. P., Amirebrahimi, J., Smith, S. J., Breunig, H. M., Preble, C. V., Satchwell, A. J., Jin, L., Brown, N. J., Kirchstetter, T. W., & Scown, C. D. (2020). Life-Cycle Greenhouse Gas Emissions and Human Health Trade-Offs of Organic Waste Management Strategies. *Environmental Science & Technology*, *54*(15), 9200–9209. https://doi.org/10.1021/acs.est.0c00364

National governments have also used LCAs for circular economy initiatives, such as with the European Commission's Integrated Product Policy. Many national governments have used LCAs to produce eco-labels to encourage consumers to purchase environmentally friendly products such as the European Union[87], Korea[88], and the U.S. Environmental Protection Agency.[89]

Ban Incineration to Promote Zero Waste Infrastructure

Zero waste infrastructure creates a closed-loop system to incentivize materials and products to be reused, repaired, composted, or recycled,[90] minimizing the solid waste being transported to disposal sites, particularly single-use plastics. Zero waste initiatives can also encompass shutting down infrastructure that exacerbates issues of waste, including incinerators and other burn technologies. The combination of reducing waste and preventing waste from occurring can reduce GHG emissions and other environmental risks of waste and pollution.

Waste incineration to reduce waste volume and/or produce electricity is highly hazardous to health. Incineration releases harmful pollutants in the air, water, and soil such as particulate matter, lead, mercury, and PFAS. These pollutants cause lung and heart diseases, neurological diseases, and cancer.[91] In addition, incineration of biomedical waste further releases pollutants including acid gasses, oxides of nitrogen, and sulfur.[92] Shutting down incinerators and ending construction of new incinerators protects the health of the general population through air quality improvements and also reduces risk to waste pickers.[93] Implementing zero waste infrastructure can encourage responsible consumption habits and community engagement in this system by promoting community composting and neighborhood-scale collection of waste as opposed to a centralized system.

Zero Waste initiatives include the 2005 Zero Waste law[94] of Buenos Aires, Argentina and 2007 Zero Waste goal of Capannori, Italy.[95] South Korea also banned dumping food in landfills in 2005 and introduced food waste recycling in 2013.[96] South Africa passed its Waste Act 59 of 2008 that

[87] European Union. (2022, October 13). *EU Ecolabel*. https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel-home_en
[88] Korean Environmental Industry & Technology Institute. (n.d.). *Regulations on Eco-Label Use*. Retrieved January 26, 2023, from https://el.keiti.re.kr:9443/enservice/enpage.do?mMenu=1&sMenu=1
[89] US EPA, O. (2014, October 9). *Buying Green for Consumers* [Collections and Lists]. https://www.epa.gov/greenerproducts/buying-green-consumers
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includes provisions to reduce waste, reuse, recycling, and recovery, and places incineration as a last resort.[97]

Land-use land-use change and forestry

Land-use land-use change and forestry (LULUCF) can contribute to GHG emissions if land is being degraded and reduce emissions if land is restored. Currently, the emissions for land-use include crop burning (3.5 percent) and deforestation (2.2 percent). The main health risks for this sector are increased risk of infectious diseases from forest destruction, respiratory illness from air pollution due to land clearing, loss of land, and landslip risk in forested areas. The main equity risk is for Indigenous peoples who currently reside in much of the degraded land and are left out of decision-making processes regarding land-use change. The following policy focuses on conservation efforts to enhance nature-based carbon sequestration.

Terrestrial Forest and Coastal Zone Conservation

Protecting terrestrial forests, wetlands and coastal zones is vital for storage and sequestration of carbon, preventing the emergence of novel zoonotic diseases, and promoting biodiversity. Forest destruction can increase the risk of transmission of bat-borne Hendravirus[98], while Ebola virus outbreaks from 2004 to 2014 were linked to highly disturbed forest areas in Central and West Africa.[99]

Healthy forests also reduce the risk of vector-borne disease transmission from mosquitoes and other insects. These disease vectors can be strongly affected by losses of forest cover, either through changes in microclimate, local patterns of biological diversity, or other environmental factors. For example, deforestation has been shown to increase the biting rates of malaria mosquitoes and malaria incidence in the Amazon region.[100]

It is vital that there is a cessation of converting intact ecosystems for agriculture use or urban sprawl. Conservation efforts that protect current forests and coastal zones and restore lost or degraded areas is necessary to reduce GHG emissions and improve human health. Landscape restitution and green space in urban areas act as carbon sinks and improve health outcomes, especially mental health. It is also essential to respect and include Indigenous rights and

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knowledge throughout any conservation effort given the historical marginalization of these communities who also hold the solutions to the challenges faced.[101,102]

Health Care Sector

The health care sector produces 4.4 percent of global net emissions, equivalent to annual GHG emission from 514 coal-fired power plants.[103] This sector's emissions are to some extent dependent on energy and transport interventions, considering the vast majority of health care's emissions come from the health care supply chain, mainly the production, transport, and disposal of goods and services. However, there are also health care specific interventions to reduce GHG emissions that can act as a powerful enabler to more ambitious mitigation action. The main health risks from this sector stem from air pollution from fossil fuel combustion for electricity demand. The main equity risks include limited access to healthcare and health facilities with reliable electricity and the ability for small clinics and hospitals to make changes with limited capacity and resources. The following policies focus on reducing the use of fossil fuels and direct air pollution from other gasses within health facilities.

While the health and equity gains of mitigation in the health sector may not be comparable to actions in other sectors, the health care sector has been included in this submission by the health community in recognition of the need for action across all sectors in order to achieve emissions reductions consistent with the Paris Agreement.

Promote Renewable Energy and Microgrids for Hospitals and Clinics

Fossil fuel dependence and lack of reliable energy access in many hospitals and healthcare settings present barriers to sustainable and quality healthcare delivery. Fossil fuel combustion-related air pollution drives up hospital visits due to exposure to $PM_{2.5}$, which increases the risk of cardiovascular and respiratory conditions, particularly among vulnerable populations such as the elderly.[104] By transitioning to renewable energy, including solar panels and wind turbines, and microgrids, these hospitals and clinics can decarbonize while also ensuring reliable energy for quality healthcare. This can be achieved through incentives, such as tax credits or grant programs, to decrease fossil fuel use in hospitals and clinics.

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Some health care systems have already set goals and targets to decarbonize such as the United Kingdom's National Health Service net-zero target.[105] More than 100 health care organizations in the U.S. signed a pledge to cut GHG emission by 50% by 2030 and achieve net-zero emissions by 2050.[106] In addition, over 60 countries have committed to climate-resilient and low-carbon health systems as part of the COP26 Health Programme partnership between the UK government, World Health Organization, UNFCCC Climate Champions, and climate advocacy groups.[107]

Minimize Use of or Find Alternatives for Anesthetic and Refrigerant Gases in Hospitals and Clinics

Anesthetic gasses are essential for surgery, while refrigerant gasses may be used in cooling for healthcare facility buildings and as well as refrigeration of medications, vaccines, and blood. However, many of these gasses are also potent GHGs.[108] Efforts to reduce the use of anesthetic gasses include using alternative methods for anesthesia such as total intravenous anesthesia (TIVA), and utilizing low fresh gas flow (FGF) rates in operating rooms.[109] Meanwhile, the use of refrigerant gasses can be reduced by ensuring cooling systems are up-to-date and efficient, and designing passive cooling into new and existing buildings to reduce cooling load.[110]

While anesthetic gasses present a low direct risk to human health, they do contribute indirectly to health impacts of climate change. Refrigerants similarly have indirect health impacts from the warming effect of refrigerant gasses (R-22, R-410a, and R-32)[111] while also having direct health damages, specifically from direct inhalation causing refrigerant poisoning. Reducing both types of gasses in hospitals and clinics can not only reduce the health care sector's part in the health risks of climate change but also reduce its GHG emissions to prevent further warming of the planet.

Recently, Keck Medicine at the University of Southern California in the U.S. has discontinued the use of desflurane, an anesthetic gas, to reduce its impact on climate change.[112] Organizations in the National Health Service in the U.K. have also reduced the use of desflurane and turned to

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other alternatives.[113] Hospitals in Argentina, China, and the Philippines participated in the Kigali Cooling Efficiency Program to better understand the impacts of their cooling equipment and opportunities to improve efficiency.[114]

[113] *NHS organisations cut desflurane in drive for greener surgery*. (n.d.). Greener NHS. Retrieved February 3, 2023, from https://www.england.nhs.uk/greenernhs/whats-already-happening/nhs-organisations-cut-desflurane-in-drive-for-greener-surgery/
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