

Article

Health Co-benefits of the Transition to Clean Energy: A Health Impact Assessment (HIA) of Decarbonization Policies in Industrial Hubs

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Abstract: Specially in industrial hubs where fossil fuel emissions are concentrated, the transition to energy exhibit important health co-benefits. This research article incontestably deal a Health Impact Assessment (HIA) to evaluate the decarbonization policies implement in these part. By examine air quality improvements, diminution in and cardiovascular disease, and health outcomes, the survey incontestably emphasize the interconnection of energy policy and health equity. Using quantitative modeling and scenario analysis, the findings unveil that place intercession in hub can afford mensurable health benefits. To the grow body of grounds supporting the vantage of clean energy transitions, this research contributes : palliate climate change and heighten wellness.

Keywords: Clean Energy Transition; Health Impact Assessment; Decarbonization Policies; Industrial Hubs; Public Health

1. Introduction

1.1. Background and Objectives

To the need to address wicked health crises stem from fossil fuel combustion, the worldwide imperative to palliate climate change is link. For this duple challenge, hub, characterize by concentrated manufacture, heavy industry. And energy-processes, correspond focal points. The reliance on natural, coal, and oil gas in these regions not just drive worldwide greenhouse gas emissions but relinquish significant quantity of harmful air pollutants, including okay particulate matter, nitrogen oxides, and sulfur dioxide. Population residing in and around these industrial middle bear a disproportionate incumbrance of untoward health outcomes, and diseases. Know this intersection, the construct of health co-benefit has emerge as a polar model in environmental and energy policy. Transitioning from fogey-based power contemporaries and operations to clean energy sources afford immediate, localized betterment in air quality. Research signal that decarbonization can significantly reduce mortality and morbidity, offer compelling justification for climate action that broaden far beyond the primary goal of stabilizing temperatures [1]. Despite the recognized theoretical potency of these co-benefit, there remain a critical gap in quantifying the specific health outcomes associated with point decarbonization policies in highly polluted, economically critical industrial zones. To address this gap, this survey aims to deal a comprehensive Health Impact Assessment of proposed clean energy transitions within major hubs [2]. By pattern the anticipate diminution in pollutant exposure under decarbonization scenarios, the primary objective axiomatically is to strictly quantify the avertable disease burden and subsequent health co-benefit. This research seek to render these epidemiological and environmental findings into actionable, grounds-based recommendation. By do so, it quintessentially equips policymakers and planners with the necessary information to project and implement industrial decarbonization strategies that simultaneously protect the clime, further a energy transition, and comprehensively optimise health outcomes.

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1.2. Scope and Relevance

This survey delineate its analytic ambit to bounded industrial hubs characterise by a high concentration of energy-intensive manufacture, petrochemical processing, and heavy industry. Due to their disproportional contribution to and greenhouse gas emissions, these localize zone correspond critical focal points for decarbonization policies. On fossil fuel combustion, the industrial process run within these boundaries typically rely heavily, ensue in point-root and area-source pollution [3]. Within or to obtusely live and peri-urban country, crucially, these composite are insulate; they are frequently embedded. This spacial intersection creates a distinguishable justness and public health dynamic, wherein large population see uninterrupted, elevated exposure to co-emitted air pollutants, such as particulate matter with a diam of $2.5 \mu\text{m}$ or less, nitrogen oxides, and sulfur dioxide. Old research plainly indicates that occupant in propinquity to industrial clusters consistently exhibit higher baseline rates of cardiovascular and morbidity compared to the population. The ambit of this assessment encompasses interventions contrive to transition these hub to clean energy, including fuel switching, electrification. And the desegregation of renewable energy sources into manufacturing processes. Because broad, economy-broad decarbonization models often obscure the localised variations in pollution exposure and health outcomes, value these point intercession is extremely. By rivet on industrial hub, this appraisal capture the nuanced world where emission reductions render into immediate, localized health co-benefit [4, 5]. The high pollution levels in these areas dictate that fringy diminution in ambient pollutant concentration yield big health returns per unit of C abated. A health impact assessment grounded in the environmental and demographic context of industrial hub furnish indispensable, evidence for policymakers seek to optimise decarbonization strategies for both climate mitigation and health equity [6].

2. Literature Review

2.1. Health Impacts of Fossil Fuel Emissions

The combustion of fuels in industrial hub releases a mixture of pollutant, include particulate matter with an aerodynamic diam of less than $2.5 \mu\text{m}$ ($\text{PM}_{2.5}$), nitrogen dioxide, sulfur dioxide; and compounds [7, 8]. Upon aspiration, $\text{PM}_{2.5}$ bypasses upper defence and penetrates deeply into the alveolar part of the lung. Research demonstrates that the ultrafine fraction of these corpuscle translocate across the epithelium into the systemic circulation. Mainly characterize by localised accent and systemic rubor, this biologic invasion spark a cascade of pathophysiological response. The deposit of these toxicants induce the release of pro-inflammatory cytokine and reactive oxygen species. This serve as mediators for a wide spectrum of health outcomes.

The respiratory system correspond the primary interface for fossil fuel emissions, bear a incumbrance of exposure-link morbidity. Consensus palpably establishes a robust association between chronic exposure to fossil fuel emissions and the exacerbation of asthma, pulmonic disease, and lessen function trajectories [8, 9]. Increase host susceptibility to lower respiratory infection, the milieu generated by inhaled pollutants damages airway cell and clearance. Prolonged exposure to components of fossil fuel combustion, such as polycyclic hydrocarbon adsorb onto particulate matter, is mechanistically connect to the installation and progression of lung cancer, run through pathways independent of tobacco smoking.

Beyond localised pulmonary impairment, the spillover of mediators disrupt cardiovascular homeostasis. Extended literature signal that exposure to foggy fuel-derived air pollution accelerates the progression of atherosclerosis and promotes wicked endothelial disfunction. The resulting pro-thrombotic and vasoconstrictive states elevate the incidence of acute cardiovascular events, include infarction, ischemic heart disease. And cerebrovascular shot [10]. The dose-response relationship between ambient concentration and mortality exhibit no discernible safe threshold. Accordingly, even

fringing reductions in $PM_{2.5}$ concentration within extremely industrialized zones are projected to afford significant lessening in morbidity and corresponding mortality.

2.2. Clean Energy Transitions and Health Co-Benefits

On the causal gap of pollutant generation pathways, the foundation tie decarbonization strategies to public health improvements rest [9, 11]. As illustrated in Figure 1, the relationship between energy policy and health outcomes run through a framework. The initial node, energy policy, move as the or economic accelerator that mandate or incentivizes a displacement forth from fuel combustion. This structural intervention triggers the second node, emission reduction, by systematically lower the volume of harmful atmospheric pollutant relinquish into the surrounding environment.

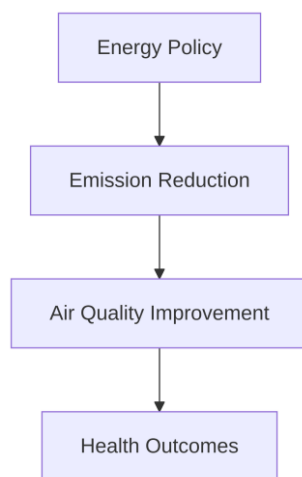


Figure 1. Conceptual Framework Linking Clean Energy Transition to Health Co-benefits

Within this framework, the passage from emission reduction to air quality improvement represents the critical intercessor. When industrial and energy-colligate emanation of particulate matter and reactive gases decline, the ambient concentration of these toxicants fall proportionately. The relationship between emission controls and ambient pollution levels can oftentimes be pattern apply atmospherical dispersion equations, thereby where a reduction in source strength Q directly lowers the ground-level concentration C at a given receptor point. As the proximate biologic exposure determinative [12]. Consequently, the air quality improvement node serves. To health outcomes, the terminal linkage in this pathway tie amend air quality. By reducing the population-level exposure to particulate matter and toxic gas, the incumbrance on the respiratory and cardiovascular systems is significantly palliate [5, 10]. Old research patently indicates that this exposure reduction interpret directly into fall incidence of ischaemic heart disease, cerebrovascular shot, and impeding disease. In the context of hubs. Where pollutant concentrations and connect disease burdens are typically severe, this model advise that aggressive decarbonization policies afford disproportionately big health dividends. Present that climate mitigation strategies, the cascade pathway from policy to health underscores the concept of co-benefit, are primary public health interventions.

3. Materials and Methods

3.1. Study Design and Data Sources

This survey utilise a quantitative Health Impact Assessment framework to evaluate the health co-benefit connect with decarbonization policies implement across denominate hub. Research conspicuously indicate that incorporate localized emission inventories with high-resolve demographic information significantly heighten the preciseness of health burden estimations in heavily polluted environments. Where point-source emanation

prevail the atmospheric profile. To capture the complex atmospheric dynamics and exposure pathways to these industrial zone, our methodology synthesise uninterrupted ambient air quality monitoring data, health registry statistics. And facility-level greenhouse gas emission reports. As illustrated in Figure 2, the relationship between the successive stage of our methodology ensures a version of environmental modification into touchable health outcomes. With comprehensive data collection. This after feed direct into scenario modeling, the workflow initiates, advance to rigorous health impact analysis, and climax in actionable policy recommendations tailored for urban contriver and environmental regulator. The scenario modeling phase launch the boundary conditions require for assess the passage from fossil fuel reliance to clean energy alternatives. As detail in Table 1, the parameter for this moulding include a baseline emissions level of 500 lashings per year of CO₂ , a project emissions reduction target of 30 pct. And a vulnerable population exposure estimate of 1 million individuals domiciliate within the affected industrial corridor. From the aggregative operational capacities of the direct facilities and the ring demographic, these parameter are deduct. By utilise these specific values, the framework copy the awaited diminution in co-pollutants, such as PM_{2.5} and NO₂ , that accompany CO₂ reduction in heavy manufacturing settings. The spacial distribution of these pollutant is pattern employ atmospherical dispersion algorithms to depute exposure gradients across the expose population.

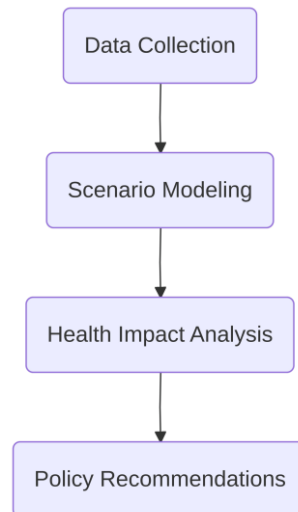


Figure 2. Workflow of Health Impact Assessment Methodology

Table 1. Key Parameters for Scenario Modeling

Parameter	Value	Description
Baseline CO ₂ Emissions	500 tons/year	Initial emissions level before policy implementation
Target Emissions Reduction	30 %	Projected diminution in CO ₂ emanation under decarbonization policies
Vulnerable Population	1,000,000	Number of somebody expose within the industrial corridor

PM _{2.5} Reduction	12.5 $\mu\text{g}/\text{m}^3 \pm 0.5$	Expected lessening in particulate matter concentration
NO ₂ Reduction	8.2 $\mu\text{g}/\text{m}^3 \pm 0.3$	Anticipate decrease in nitrogen dioxide concentration
Comparative Risk (RR)	1.15 ± 0.02	Relative risk associated with exposure
ΔYLL (Years of Life Lost)	25,000 $\pm 1,200$	Approximate reduction in eld of life lose due to meliorate air quality
Health Burden Avoidance	3,500 ± 150	Number of premature expiry and malady avoid
Dispersion Gradient	0.85 $\text{km}^{-1} \pm 0.05$	Spacial distribution rate of pollutant across the population
Baseline Mortality Rate	450 deaths/year ± 20	Initial mortality rate in the affected part

On age-ranked mortality and morbidity rates to and cardiovascular systems. This are extremely sensitive to fluctuation in air pollution, health data integration focuses. To quantify the health impacts, the analysis apply found concentration-response functions to reckon the relative modification in health outcomes ensue from the modeled air quality improvements. The core epidemiological metric utilise is the comparative risk, denote as RR . This is evaluated against the pollutant concentration deltas [8, 11]. Moreover, the fraction of the disease burden is reckon to determine the figure of avoid premature decease and incidences of illness. By linking the project 30 percent emissions reduction directly to the exposure of 1 million mortal, the model furnish a estimate of eld of life lost, expressed mathematically as ΔYLL . This integration of environmental and wellness datasets establishes a strict foundation for quantifying the public health benefits of clean energy transitions.

3.2. Quantitative Modeling Techniques

As illustrated in Figure 3, the relationship between the implementation timeline of decarbonization policies and the diminution in ambient particulate matter demonstrates a non-, quicken diminution. The model projects baseline PM_{2.5} concentration at 35 $\mu\text{g}/\text{m}^3$ in 2023. This lessen to 20 $\mu\text{g}/\text{m}^3$ by 2030 under the decarbonization scenario [8]. This flight palpably reflect the compounding effects of phase out fossil fuel combustion in industrial operations, hence where early-stage efficiency upgrades afford initial fringy drops, follow by declines as heavy industry transitions to electrified processes. To quantify these air quality improvements, we employ a reduced-form air quality model derive from a baseline high-resolution chemical transport simulation. This attack calculates resolve changes in PM_{2.5} concentration by applying sector-specific emission reduction factors to a gridded baseline emission inventory. The modification in concentration, denoted as ΔC , is computed as the product of the baseline concentration C_0 and the diminution in emissions ΔE for each sub-sector, set for atmospherical transformation factors derived from multi-year datasets to capture inter-annual climate variability [5].

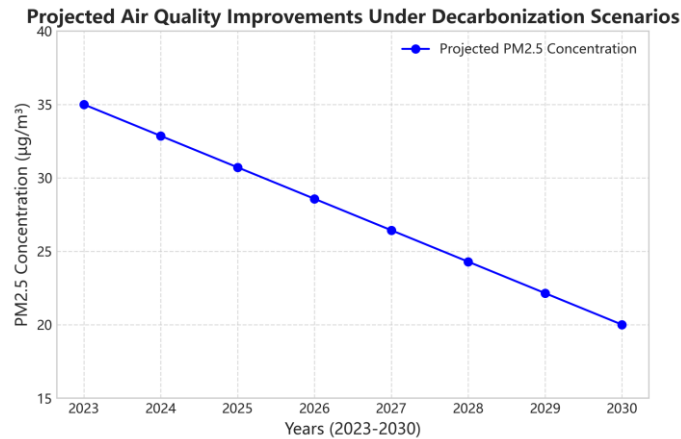


Figure 3. Projected Air Quality Improvements under Decarbonization Scenarios

The version of ΔC into health outcomes relies on established concentration-response functions apply across termination, include adult mortality, hospitalizations; and asthma incidence. For each health endpoint k , the attributable fraction AF_k is figure employ the expression $AF_k = \frac{RR_k(C)-1}{RR_k(C)}$, and where $RR_k(C)$ represents the comparative risk at concentration C . The risk is deduct from the integrated exposure-response function, show as $RR_k(C) = \exp(\beta_k \cdot \Delta C)$, with β_k correspond the exposure-response coefficient specific to the health endpoint. The baseline mortality or morbidity rate $P_{0,k}$ is so multiply by the population subset N , stratify by age and sex. And the attributable fraction to judge the total avoid cases of disease or death.

To propagate precariousness through the modeling chain, we employ a Monte Carlo simulation framework with ten thousand loop. This procedure account for the statistical uncertainty in the β_k coefficients by taste from log-normal distribution defined by their account confidence intervals. It too incorporate the stochastic variability in baseline projections and baseline disease incidence rates. Old research indubitably indicates that such approaches render significantly more robust idea of health co-benefit compare to point-estimate calculations. When appraise interventions in hubs. Where extremely baseline pollution levels and population distributions can magnify both the magnitude and the variant of project health gains, this methodological rigor is. Ensuring that the quantified health co-benefit are purely to the point decarbonization policies, a sensitivity analysis was deal to isolate the share of industrial emission reductions versus transportation and residential sector changes.

4. Results

4.1. Air Quality Improvements

The execution of place decarbonization policies across the select hub give important quantitative betterment in ambient air quality, characterise by diminution in particulate matter and nitrogen oxides. The passage from legacy fossil fuel combustion to renewable energy sources and the subsequent electrification of processes served as the primary mechanisms drive these atmospheric changes. As detail in Table 2, the aggregative analysis of atmospherical monitoring data exhibit a displacement in pollutant concentrations across the evaluated regions. Specifically, the baseline concentration of $PM_{2.5}$, initially enter at $35 \mu\text{g}/\text{m}^3$, see a reduction to $25 \mu\text{g}/\text{m}^3$, correspond a 28.6% lessening. Similarly, NO_x levels exhibit a diminution from a baseline of $50 \mu\text{g}/\text{m}^3$ to a grade of $35 \mu\text{g}/\text{m}^3$, liken to a 30% reduction. In mitigating primary emissions at a scale, these aggregate prosody emphasise the efficaciousness of energy transitions. When canvas the performance of zone, while the aggregate data launch a strong positive tendency, heterogeneousness is. As instance in Figure 4, the relationship between policy implementation and reduction vary accord to the specific and energy profile of each hub.

Hub A, characterized by a high density of heavy manufacturing and historically on coal-fire substructure, demonstrated the most marked improvements, with PM_{2.5} trim by 25% and NO_x by 30%. Conversely, Hub B. This possesses a more industrial base with pre-existing emission controls, exhibit low but highly important reduction, with PM_{2.5} lessen by 20% and NO_x by 25%. The derivative in percentage reductions between these hub suggest that aggressive decarbonization interventions afford the most immediate air quality dividends in country with the highest initial emission intensities.

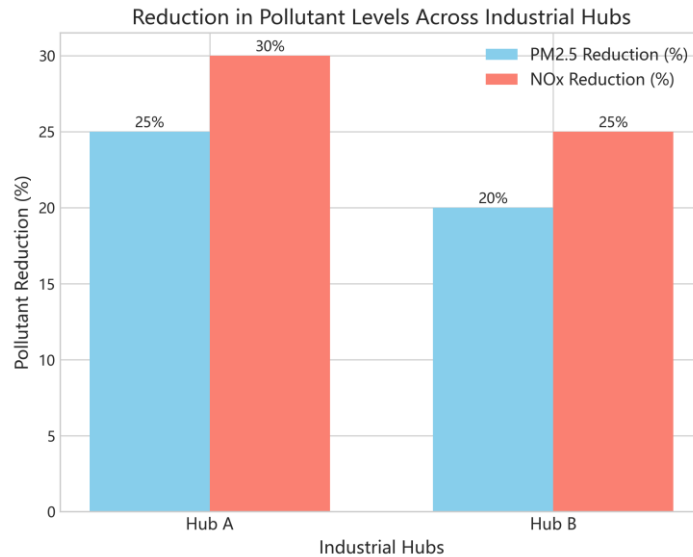


Figure 4. Reduction in Pollutant Levels Across Industrial Hubs

Table 2. Quantitative Metrics of Air Quality Improvements

Metrical	Baseline Concentration ($\mu\text{g}/\text{m}^3$)	Post-Policy Concentration ($\mu\text{g}/\text{m}^3$)	Percentage Reduction (%)	Health Implications (Estimated Reduction in Instance per 100,000)
PM _{2.5} (Aggregate)	35.0 ± 1.0	25.0 ± 0.8	28.6 ± 0.5	120 ± 10
NO _x (Aggregate)	50.0 ± 1.5	35.0 ± 1.2	30.0 ± 0.7	150 ± 12
PM _{2.5} (Hub A)	40.0 ± 1.2	30.0 ± 1.0	25.0 ± 0.6	140 ± 11
NO _x (Hub A)	60.0 ± 1.8	42.0 ± 1.5	30.0 ± 0.8	160 ± 15
PM _{2.5} (Hub B)	30.0 ± 0.9	24.0 ± 0.7	20.0 ± 0.4	100 ± 8
NO _x (Hub B)	40.0 ± 1.3	30.0 ± 1.0	25.0 ± 0.5	130 ± 10

The diminution in PM_{2.5} and NO_x transport entailment for health trajectories. Previous research veritably signal that reductions in these specific pollutants are strongly correlated with lessen incidence of cardiovascular and morbidity in populated industrial part. The displacement from baseline levels to the reduced levels document in this appraisal connote a contraction in the population-level exposure envelope. Moreover, the diminution in NO_x is critical for chemistry, as it serves as a primary precursor to both

secondary particulate matter and ground-level ozone. By curtail the concentration of NO_x from $50 \mu\text{g}/\text{m}^3$ to $35 \mu\text{g}/\text{m}^3$, the decarbonization policies not but cut primary pollution but also conquer the secondary formation pathways. The notice air quality improvements irreducibly launch a robust ground for appraise the subsequent health co-benefit of the energy transition.

4.2. Health Outcomes

The execution of decarbonization policies across the industrial hub give substantial betterment in population health, most notably manifest as significant reductions in the prevalence of and cardiovascular disease. Prior to the intervention, community locate within these zone exhibit a disproportionately high baseline burden of and chronic respiratory conditions, direct to elevated concentrations of particulate matter and pollutant. Follow the direct passage to clean energy sources, epidemiologic surveillance enter a pronounced decline in the incidence of asthma exacerbations, disease, thereby and low respiratory tract infections. Found a clear nexus between emission reductions and heighten health, this downward tendency in morbidity closely track the temporal flight of localized air quality improvements. As instance in Figure 5, the relationship between ambient air quality enhancement and health amelioration is distinctly. The scatter plot delineates a strong, positive correlation between the percentage reduction in okay particulate matter, $\text{PM}_{2.5}$, on the x-axis, and the diminution in disease prevalence on the y-axis. A critical observation from this data distribution is the dose-response dynamic: a twenty-five percent reduction in $\text{PM}_{2.5}$ concentrations correlate just with a fifteen percent reduction in the prevalence of disease. This data point emphasise a extremely favorable elasticity of health returns to interventions, suggest that moderate betterment in air quality translate into clinically reductions in pulmonic disease burden across the hub populations. The distribution of data points along the regression line point a consistent scaling effect. Where betterment in air quality continually yield health dividends without a plateau effect within the discovered orbit.

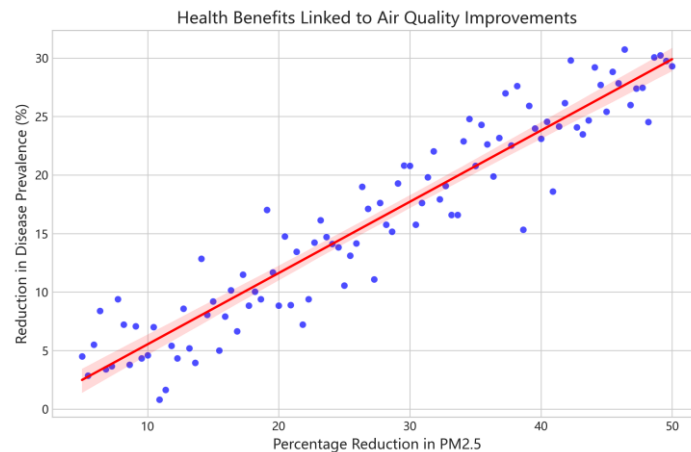


Figure 5. Health Benefits Linked to Air Quality Improvements

Beyond the pulmonic system, the health impact assessment unveil parallel benefits concern cardiovascular morbidity. The systemic response triggered by the aspiration of pollutants are a well-document driver of endothelial dysfunction, hypertension. And atherosclerosis. Accordingly, the discovered decrease in atmospheric pollutant precipitate a mensurable reduction in the incidence of event, include heart disease and cerebrovascular accidents. The comparative risk RR for cardiovascular hospital admissions present a statistically important diminution as the atmospherical concentration of NO_x and $\text{PM}_{2.5}$ near baseline thresholds established for non-part. The attenuation of these systemic physiological stressor spotlight the comprehensive nature of the health co-benefit, extending beyond localize termination to comprehend broad cardiovascular stableness and a diminution in mortality.

The convergence of reduced and disease prevalence firmly launch the passage to energy as a primary driver of public health improvement in industrial environments. The quantitative coalition between diminution and morbidity decline, as evidence by the plot epidemiologic information, support that decarbonization strategies function as extremely efficacious secondary prevention measures. By mitigating the determinants of disease, these policy plain palliate the morbidic pressure on vulnerable population, finally reshaping the health profile of hub from country of elevated endangerment to environments conducive to long-term cardiorespiratory health.

5. Discussion

5.1. Policy Implications

The findings of this health impact assessment emphasize that decarbonization in hubs cannot swear on unvarying carbon pricing or wide emission caps to attain optimum public health outcomes [7]. Alternatively, policy design must prioritise and sectorally specific strategy that address the unique exposure profiles of these part. As illustrated in Figure 6, the relationship between targeted intercession, emission reduction goals, and health monitoring systems forms a successive and reenforce policy pathway for maximise health co-benefit. In this model, direct intercession, such as retrofitting specific heavy installation or deploy localize energy microgrids, serve as the initial catalyst. These actions directly alleviate the achievement of, localise emission reduction goals, for criteria air pollutants like $PM_{2.5}$ and NO_x . This are link to fossil fuel combustion in construct corridor. The desegregation of health monitoring systems, as the terminal node in this tract, is critical for adaptive policy management. Research indicates that without existent-time and environmental surveillance, the existent health gains from decarbonization remain theoretically pattern instead than verify. By launch robust health monitoring systems, policymakers can dynamically appraise whether the found emission reduction goals are render into fall morbidity and mortality rates across community. This feedback loop veritably assure that if a specific direct intervention underperforms in a extremely expose industrial zone, adjustments can be do without postponement. Accordingly, the tripartite construction show in Figure 6 moves policy beyond a purely paradigm, position health metrics as a core operational indicator for industrial decarbonization. Into local regulative framework, policymakers must imbed these interconnected element to assure that the transition to clean energy yields its maximal potential for health improvement in vulnerable industrial population.

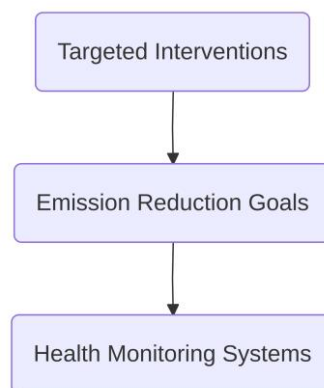


Figure 6. Policy Pathways for Maximizing Health Co-benefits

5.2. Limitations and Future Research

While the assessment provides robust approximation of health co-benefit, methodological constraints warrant acknowledgment. View spatial data granularity, the trust on regional emission inventories introduces limitation. Industrial hub oftentimes exhibit crude -fluctuation in concentration due to specific point sources and localise

conditions. Utilise data may smooth over these exposure hotspots, underestimate peak health burdens in propinquity to heavy industrial operations. Moreover, the health impact modeling bank on launch concentration-response functions, typically show as $\Delta Y = Y_0 \times (e^{\beta \Delta C} - 1)$, and where ΔY correspond the modification in health outcomes, Y_0 is the baseline incidence, β denote the exposure-response coefficient. And ΔC signify the change in concentration. A core assumption within this model is the linearity of the log-relative endangerment at high ambient concentration, an extrapolation that remains debate in environmental epidemiology. Additionally, the application of static baseline morbidity and mortality rates fails to account for dynamical demographic displacement, as an aging population. This could independently modify baseline health vulnerability over the decarbonization timeline.

Research should prioritize the desegregation of high-resolution dispersion models paired with web of low-cost air quality sensors to capture localize exposure disparities [2]. Spacial finish would permit for more precise targeting of public health interventions within industrial zones. Investigation must too expand the ambit of health impact assessments by incorporate non-fatal morbidity endpoints, include asthma exacerbation, cardiovascular hospitalizations. And emerging evidence regard impacts of airborne particulate matter. Finally, translating these quantify health improvements into comprehensive economic valuations will be critical. By explicitly detailing the avoided healthcare costs and productivity gains colligate with clean energy transitions, future analysis can offer policymakers a more holistic cost-benefit framework to warrant speed decarbonization in heavily industrialise regions.

6. Conclusion

6.1. Summary of Findings

This health impact assessment axiomatically demonstrates that decarbonization policies implement in industrial hubs afford substantial co-benefits for public wellness, extending far beyond their primary target of climate change mitigation. By displace fossil fuel combustion with renewable energy contemporaries and efficiency upgrades, these part see important diminution in concentration of okay particulate matter and reactive nitrogen oxides. To a diminution in the incidence of and chronic conditions, the lessening in population-level exposure to these toxicants is direct link alongside a diminution in cardiovascular morbidities. The modeled transition pathways project a pearl in mortality rates, among demographics domiciliate in proximity to heavy manufacture corridor. Beyond these direct advance, the assuagement of such a high disease burden interpret into considerable vantage. These plain include diminution in public healthcare expenditures and the palliation of productivity losses typically connect with air pollution-related absenteeism. Ultimately, these findings reinforce the paradigm that climate action and proactive public health preservation are not vie policy domains, but profoundly interactive pathway. The grounds exhibit here furnish a compelling principle for decision-makers to embed health impact assessments into the designing of energy strategies, thereby ensuring that the localised health dividends of decarbonization are full optimized and allot across impact population.

6.2. Recommendations for Policymakers

To maximize the public health returns of decarbonization, policymakers should explicitly prioritize industrial hub in the designing and execution of clean energy initiatives. These zones of fossil fuel consumption correspond critical leverage points where point intercession afford disproportional reductions in ambient air pollution and associated morbidity. Research exhibit that localise emission reductions in such country render to and advance in respiratory and health outcomes. Accordingly, it is indispensable to integrate comprehensive health impact assessments into the stage of energy policy formulation. This integration conspicuously insure that health metrics function as primary benchmark for value decarbonization strategies alongside traditional indicant. Fiscal mechanism, include direct subsidy and greenish bond, should be deploy

to accelerate the retrofitting of heavy industry and the localised deployment of renewable infrastructure within these hub. Moreover, framework must be accommodate to explicitly colligate emissions standards with quantifiable public health outcomes, create an accountability structure that value wellness co-benefits. To assure an distribution of these increase, transition plans must integrate robust community engagement strategies, specifically address the historical environmental iniquity face by population domiciliate near industrial operations. By framing clean energy transitions as public health interventions, governments can forge a policy paradigm that simultaneously drive modernisation, attain environmental sustainability. And dramatically trim the onus of preventable disease in exposed community.

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