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Global Warming and Human Comfort: Shifting Mortality from Cold to Heat

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ABSTRACT

Global temperature variations have a profound impact on human health, with cold-related mortality significantly outweighing heat-related deaths. Empirical studies, including research published in The Lancet, indicate that excess deaths from cold exposure are highest in regions such as Sub-Saharan Africa, where energy access remains limited. Humans require a relatively narrow temperature range of 20–25°C (68–77°F) for optimal comfort and deviations from this range necessitate adaptive measures such as clothing or energy use. Over the past seven decades, global land temperatures have risen by approximately 1.1°C, contributing to a net reduction in temperature-related mortality. Data from Our World in Data and Berkeley Earth show that while rising temperatures have increased heat-related fatalities by 116,000 annually, they have simultaneously prevented 283,000 cold-related deaths, resulting in a net reduction of 167,000 deaths per year. These findings challenge prevailing narratives about the detrimental effects of global warming, suggesting that moderate increases in temperature may yield net benefits for human health by reducing cold-related mortality. This paper examines the implications of global temperature changes, the role of energy access in mitigating climate-related risks and the broader impact of warming on human well-being.

Keywords: Global warming; Temperature-related mortality; Cold-related deaths; Energy access; Climate change impact

Introduction

The global energy landscape is undergoing a profound transformation, driven by economic imperatives, technological advancements and policy shifts aimed at reducing carbon emissions. While renewable energy sources such as wind and solar are increasingly promoted as alternatives to fossil fuels, their viability as primary energy sources remain constrained by intermittency, storage limitations and their dependence on hydrocarbons for production and integration into existing infrastructure[1]. The oil and gas industry, long regarded as the backbone of global energy supply, faces mounting regulatory and financial pressures to transition toward lower-carbon solutions while continuing to meet growing energy demands[2].

Despite efforts to electrify transportation and expand renewable capacity, fossil fuels remain indispensable for industrial applications, off-grid energy needs and space exploration initiatives[3]. The reality of energy security necessitates a balanced approach that integrates conventional energy sources with technological innovations to optimize production efficiency and minimize environmental impacts[4]. Moreover, the economic consequences of constraining oil and gas supply have already manifested in volatile markets, rising energy costs and geopolitical instability[5]. This paper critically examines the trade-offs associated with energy production, the challenges of an accelerated energy transition and the unintended consequences of policies that constrain fossil fuel supply. By re-evaluating the role of hydrocarbons within a broader sustainability framework, this study highlights the necessity of a diversified energy strategy that prioritizes reliability, affordability and long-term energy security[6].

The Trade-Offs in Energy Production

The complexity of modeling oil production in U.S. shale wells has increased significantly due to the effects of infill drilling and well interference. Traditional statistical models that estimate production per lateral foot struggle to account for these dynamic interactions, necessitating more sophisticated approaches. Building upon prior work by industry experts, recent research has proposed incorporating well interference implicitly by analyzing production per acre as a function of both the number of wells per section and the total clean volume of hydraulic fracturing fluid per acre. This method acknowledges the inherent trade-off in shale oil recovery, where production is influenced by both the number of wells and the volume of fracturing fluid used per unit area **(Figure 1)**. The relationship between fracture surface area and fluid volume follows a power law, with an exponent typically ranging between 0.4 and 0.7, suggesting that while larger fracture volumes increase recovery, the efficiency of this approach eventually diminishes. At a certain point, adding more lateral feet of wellbore may yield higher returns than simply increasing fracture volume.

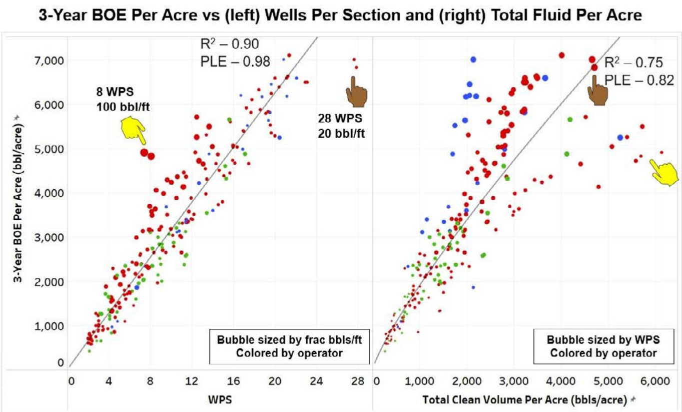

Figure 1: Oil Production Comparison in terms of fracs and pumped fluid[7].

A recent analysis of the DJ Basin reinforces this observation, showing that production exhibits different sensitivity to well density and frac size. The study found that production per acre follows a near-linear trend with respect to the number of wells per section (WPS), whereas the response to frac volume exhibits a power law exponent of 0.82, indicating diminishing returns. Notably, comparing scenarios of moderate well spacing with large fracs (8 WPS, 100 bbl/ft) and high well density with small fracs (28 WPS, 20 bbl/ft) highlights that additional wells with moderate frac sizes may provide a more efficient strategy for enhancing oil recovery in this region. However, the optimal development strategy must also consider economic factors, including drilling and fracturing costs, as well as revenue potential. While this analysis serves as a valuable scoping tool for optimizing production strategies, further economic evaluations are necessary to determine the most cost-effective approach for maximizing output in specific shale basins.

Market and Economic Impacts of the Shale Revolution

The global energy market has historically maintained a close correlation between the price of natural gas and crude oil due to their interchangeable use in heating and electricity generation. This linkage is based on energy equivalence, where a barrel of crude oil contains approximately 5.8 million British thermal units (MMBtu), while natural gas holds about 1 MMBtu per thousand standard cubic feet (Mscf). In theory, six Mscf of natural gas should be priced similarly to one barrel of crude oil, provided no significant supply disruptions occur. However, this relationship has been fundamentally altered in the United States due to the Shale Revolution. The rapid expansion of domestic shale gas production since 2005 has led to an oversupply of natural gas, severing its traditional price link to oil. Unlike crude oil, which is easily transported globally, natural gas often becomes stranded in regions lacking sufficient pipeline or liquefied natural gas (LNG) export infrastructure, contributing to its significantly lower price.

This price decoupling has resulted in a stark divergence in energy costs, with natural gas-fueled energy now being approximately five times cheaper than crude oil-derived energy in the U.S. The economic implications of this shift have been profound, particularly for American consumers and industries. Lower energy costs have driven a resurgence in domestic manufacturing, attracting international companies to the U.S. in search of inexpensive energy and affordable petrochemical feedstocks. This dynamic has fueled a wave of industrial growth and job creation, reinforcing the country's competitive advantage in global markets. In contrast, nations like Germany, which have pursued aggressive renewable energy transitions, struggle to maintain manufacturing competitiveness against the U.S. energy landscape. As the political discourse evolves, the success of U.S. energy policy in fostering economic growth and industrial revitalization serves as a critical consideration for policymakers and stakeholders navigating the future of energy development (**Figure 2**).

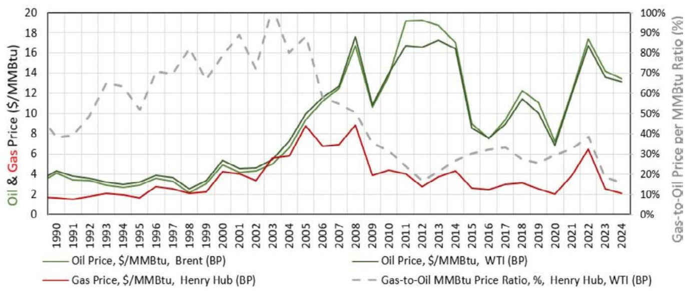

Figure 2: Oil & Gas Prices wrt BTUs[8].

Policy, Regulation and Energy Supply Constraints

The "Just Stop Oil" movement, alongside policy measures enacted by several Western governments and the geopolitical maneuvers of Russia, has contributed to significant constraints on global oil supply. While the overall availability of hydrocarbons has managed to grow despite these pressures, new production in many European nations has largely ceased and regulatory challenges have made drilling and hydraulic fracturing on federal lands in the United States increasingly difficult. However, the fundamental principles of supply and demand dictate that restricting the availability of a highly valued commodity, such as oil, inevitably leads to price increases. The global economy's dependence on oil as an essential energy source makes it resistant to abrupt reductions in demand, ensuring that any disruption in supply results in higher market prices-an economic principle that has been clearly demonstrated in recent years (**Figure 3**).

The evolution of oil prices over the past decade has highlighted the interplay between production costs and market revenues. The U.S. Shale Revolution significantly lowered the cost of drilling and hydraulic fracturing, as evidenced by declining drilling and completion (D&C) costs per foot of horizontal lateral. A comparison of cost trends with oil production revenues per foot reveals that between 2015 and 2016, low oil prices, driven by Saudi Arabia's market strategy, coincided with relatively high D&C costs, allowing consumers to benefit from inexpensive energy. However, since the increased opposition to oil development in 2021, crude oil prices have remained elevated, even as D&C costs have reached historic lows. This constrained supply environment has ultimately led to higher fuel costs for consumers while simultaneously generating substantial financial returns for oil and gas companies and their shareholders. Thus, the policies intended to suppress fossil fuel production have, paradoxically, reinforced the profitability of the very industry they sought to weaken.

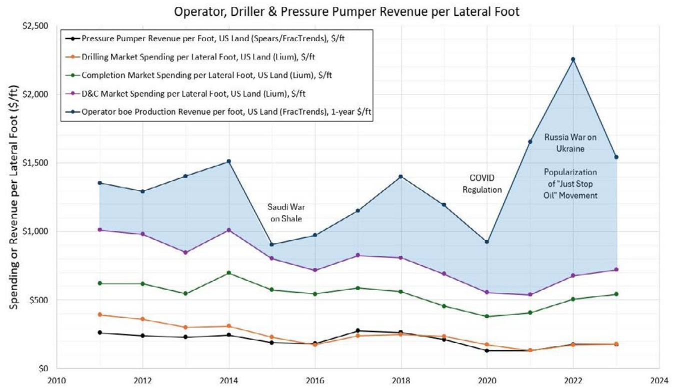

Figure 3: Operator and Service Companies Revenue[9].

The demand for reliable and domestically sourced energy necessitates the continued expansion of natural gas and coal-fired power plants to ensure grid stability across North America. These energy sources provide a dependable baseline supply, mitigating the intermittency issues inherent in wind and solar power. Additionally, increasing crude oil production remains essential for off-grid applications, where alternative energy sources remain impractical or insufficient. Beyond terrestrial needs, advancing space exploration requires greater investment in rocket fuel and spacecraft technology, aligning with humanity's natural inclination toward discovery and expansion. While renewable energy sources such as wind and solar are often presented as viable replacements for fossil fuels, their reliance on hydrocarbons for manufacturing, transportation and grid integration underscores their limitations. A pragmatic energy strategy must acknowledge these dependencies and prioritize the development of energy sources that can sustain economic growth, technological progress and national security.

Energy and Human Well-Being

Bjorn Lomborg's recent work, Best Things First[10], presents a Benefit-to-Cost Ratio (BCR) analysis to assess trade-offs among various United Nations Sustainable Development Goals (SDGs), ultimately identifying 12 priorities that can most effectively enhance human well-being. One area that merits inclusion in this framework is the role of clean cooking fuels, particularly propane, in addressing critical environmental and public health challenges. The widespread reliance on firewood for cooking in many developing regions imposes significant burdens, particularly on women and children, who are often responsible for wood collection. Furthermore, indoor air pollution from biomass combustion is a major health hazard, with particulate matter (PM2.5) exposure contributing to approximately 2.3 million premature deaths annually. The transition to propane can mitigate these adverse effects by reducing deforestation, alleviating the time burden associated with fuel collection and eliminating exposure to harmful pollutants.

Despite its evident benefits, clean cooking fuel access is not among the 12 goals prioritized in Lomborg's analysis. A preliminary BCR assessment suggests its inclusion is warranted, given the substantial economic and health advantages. Providing universal access to propane could prevent approximately 500,000 infant deaths annually, extending the lives of millions more and translating into an estimated 50 million life-years gained per year. Based on the International Monetary Fund's valuation of a statistical life-year at $4,300, this intervention would yield an economic benefit of approximately $200 billion annually. Additionally, the World Bank estimates that reducing firewood dependence could recover 170 million lost productivity life-years, representing an additional $700 billion in economic gains. Organizations such as the Bettering Human Lives Foundation (BHLF) have developed financial models to facilitate the adoption of clean cooking fuels, offering low-interest loans for propane stoves to overcome initial cost barriers. Given its potential to address multiple SDGs simultaneously, the inclusion of clean cooking fuels within Lomborg's prioritization framework would provide a high-return investment in global development and public health.

The historical trajectory of energy consumption in the United States provides valuable insights into the relationship between energy access and human development. Over the past several centuries, the United States has experienced a dramatic increase in energy consumption, which has been closely linked to economic growth, technological innovation and improved living standards. However, this rapid energy transition has also come with significant environmental and social costs (**Figure 4**).

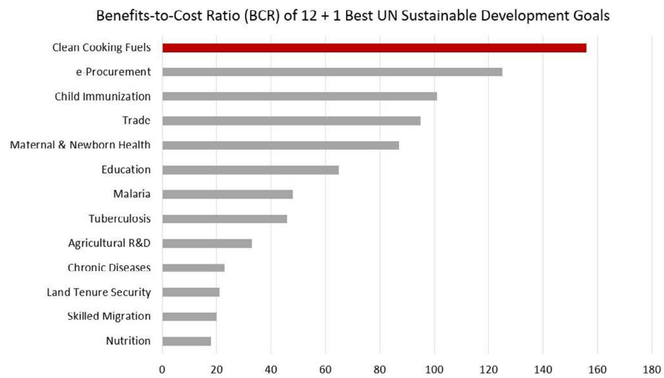

Figure 4: Benefits to Cost Ratio Chart[11].

Climate and Temperature Extremes: A Data-Driven Perspective

The global land surface temperature averages approximately 14.8°C (58.7°F), which, in many regions, is lower than what is considered thermally comfortable for humans. To evaluate how this compares to actual temperature conditions in the world's largest cities, an analysis was conducted using year-round averages of daily minimum and maximum temperatures from the World Meteorological Organization (WMO). Given that human thermal comfort typically falls within a narrow range of 20–25°C (68–77°F), temperature distributions were assessed to determine the extent to which these urban centers experience conditions that are either too cold or too hot relative to this benchmark.

Results indicate that even among the 20 most populous cities-many of which are situated in relatively warm climate zones-temperature conditions tend to be colder than the comfort threshold for most of the year. Specifically, the majority of these cities experience temperatures below the ideal range more frequently than above it. Only seven of the twenty cities analyzed exhibit conditions that are predominantly too hot, whereas the remaining thirteen require more heating than cooling over the course of a year. These findings reinforce broader climatic trends, suggesting that despite concerns over rising global temperatures, climate change is gradually shifting conditions away from extreme cold toward a thermal range that is more conducive to human habitation (**Figure 5**).

Approx. Latitude	City	Country	Mean Daily Minimum Temperature (°C)	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°F)	Mean Daily Maximum Temperature (°F)	Too Cold (<20°C or <68°F) (%)	Just Right (20-25°C or 68-77°F) (%)	Too Hot (>25°C or >77°F) (%)
40	New York	USA	8.8	16.6	47.9	61.9	72%	20%	8%
40	Istanbul	Turkey	10.3	18.4	50.6	65.2	75%	18%	7%
40	Beijing	China	6.5	17.7	43.7	63.8	68%	17%	14%
35	Tokyo	Japan	12.9	20.0	55.3	67.9	62%	21%	17%
35	Osaka	Japan	13.3	21.1	55.9	70.0	59%	17%	24%
35	Tehran	Iran	11.7	22.5	53.0	72.6	57%	16%	27%
30	Shanghai	China	12.5	19.9	54.4	67.7	60%	18%	21%
30	Chongquin	China	15.3	21.1	59.5	70.0	55%	22%	23%
30	Delhi	India	19.0	31.3	66.2	88.4	28%	15%	57%
30	Cairo	Egypt	16.7	27.9	62.0	82.2	39%	25%	36%
25	Kolkata	India	22.0	31.4	71.6	88.5	11%	18%	71%
25	Dhaka	Bangladesh	21.5	30.6	70.8	87.1	12%	20%	67%
25	Karachi	Pakistan	21.1	32.3	70.0	90.1	15%	17%	68%
20	Mumbai	India	22.4	31.8	72.2	89.2	4%	19%	77%
20	Mexico City	Mexico	9.6	23.4	49.4	74.1	75%	23%	2%
15	Manila	Phillipines	24.5	30.4	76.1	86.7	0%	17%	83%
5	Lagos	Nigeria	22.7	30.7	72.8	87.3	0%	31%	69%
-20	Rio de Janeiro	Brazil	21.0	27.2	69.7	80.9	6%	59%	35%
-20	Sao Paulo	Brazil	15.5	24.9	59.9	76.8	47%	44%	9%
-35	Buenos Aires	Argentina	13.6	22.7	56.6	72.9	61%	27%	13%

Figure 5: Average Temperature of various cities[12].

Global temperature trends have significant implications for human health and comfort. On average, the Earth's climate is colder than what is considered optimal for human well-being. Empirical evidence suggests that cold-related mortality far exceeds heat-related mortality. According to a study published in The Lancet, excess deaths due to cold exposure are particularly prevalent in Sub-Saharan Africa, a region where such outcomes might be unexpected given its geographical location (**Figure 6**).

Humans thrive within a relatively narrow temperature range, typically between 20–25°C (68–77°F), as indicated by standard indoor climate control settings. While clothing provides some adaptation to external conditions, energy access remains a crucial determinant of survival, particularly in colder environments. Data from Our World in Data and Berkeley Earth indicate that global land temperatures have risen by approximately 1.1°C over the past seven decades. This warming has had a net positive impact on global temperature-related mortality, preventing an estimated 167,000 deaths per year—reducing cold-related fatalities by 283,000 annually while increasing heat-related deaths by 116,000. Given that a significant portion of the global population still experiences temperatures below the optimal range, further warming could potentially reduce overall temperature-related mortality. These findings raise an important question: if moderate warming has thus far provided net benefits to human health, why is it widely regarded as a catastrophe?

Conclusion

The prevailing discourse surrounding global warming often emphasizes its potential negative consequences; however, empirical data suggest that moderate increases in temperature may provide significant benefits, particularly in reducing cold-related mortality. Cold exposure remains a leading cause of excess deaths, disproportionately affecting populations with limited access to energy resources. Over the past two decades, rising global temperatures have contributed to a net decrease in temperature-related mortality, preventing an estimated 167,000 deaths annually. These findings underscore the importance of a balanced perspective on climate change, recognizing both the risks and benefits associated with warming trends. Future discussions on climate policy should consider the complex interplay between temperature variations, energy access and human health, ensuring that mitigation strategies align with broader efforts to improve global living conditions.

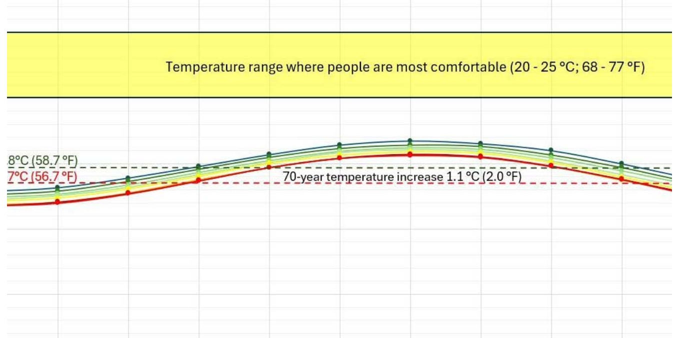

Figure 6: World Average Surface Temperature[13].

References

1. Alagoz E and Alghawi Y. The Energy Transition: Navigating the Shift towards Renewables in the Oil and Gas Industry. J Energy and Natural Res 2023;12(2):21-24.

2. Alagoz E, Alghawi Y and Ergul MS. Innovation in Exploration and Production: How Technology Is Changing the Oil and Gas Landscape. J Energy and Natural Res 2023;12(3):25-29.

3. Alagoz E. Sustainable Development in the Oil and Gas Sector: Considering Economic, Environmental and Social Aspects. Int J Earth Sci Knowledge and Applications 2023;5(2):303-308.

4. Alagoz E. "Electrifying the Transportation Sector: Implications for the Oil and Gas Industry", IJESG 2023;8(1):25-35.

5. Alagoz E, Alghawi Y. The Future of Fossil Fuels: Challenges and Opportunities in a Low-Carbon World. Int J Earth Sciences Knowledge and Applications 2023;5(3):381-388.

6. Alagoz E and Al Krmagi M. Rethinking Green Energy: Navigating the Complexities of Sustainability, Innovation and Energy Choices. Progresses in Petrochemical Science 2025.

7. https://www.linkedin.com/feed/update/urn:li:activity:7246639924873986049?updateEntityUrn=urn%3Ali%3Afs_updateV2%3A%28urn%3Ali%3Aactivity%3A7246639924873986049%2CFEED_DETAIL%2CEMPTY%2CDEFAULT%2Cfalse%29

8. https://www.linkedin.com/feed/update/urn:li:activity:7233103604297916416/?updateEntityUrn=urn%3Ali%3Afs_updateV2%3A%28urn%3Ali%3Aactivity%3A7233103604297916416%2CFEED_DETAIL%2CEMPTY%2CDEFAULT%2Cfalse%29

9. https://www.linkedin.com/feed/update/urn:li:activity:7244743331467984896?updateEntityUrn=urn%3Ali%3Afs_updateV2%3A%28urn%3Ali%3Aactivity%3A7244743331467984896%2CFEED_DETAIL%2CEMPTY%2CDEFAULT%2Cfalse%29

10. Lomborg B. Best Things First, Cambridge University Press 2023.

11. https://www.linkedin.com/feed/update/urn:li:activity:7248010175305957380?updateEntityUrn=urn%3Ali%3Afs_updateV2%3A%28urn%3Ali%3Aactivity%3A7248010175305957380%2CFEED_DETAIL%2CEMPTY%2CDEFAULT%2Cfalse%29

12. https://www.linkedin.com/feed/update/urn:li:activity:7242654546932482049?updateEntityUrn=urn%3Ali%3Afs_updateV2%3A%28urn%3Ali%3Aactivity%3A7242654546932482049%2CFEED_DETAIL%2CEMPTY%2CDEFAULT%2Cfalse%29

13. https://media.licdn.com/dms/image/v2/D5622AQHbxG8306ZwvQ/feedshare-shrink_2048_1536/feedshare-shrink_2048_1536/0/1724261725091?e=1733356800&v=beta&t=rAs0K3oi1z2yIgjuDKRXxtQAVwUVXD7zKetP6VzH_Z4