HARMFUL EMISSIONS: HOW DIESEL FUELED SCHOOL BUSES ARE HARMING STUDENTS

A Research Paper submitted to the Department of Engineering and Society
Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

By

Joshua Robin

March 30, 2023

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISOR
Catherine D. Baritaud, Department of Engineering and Society

A RAPIDLY CHANGING SOCIETY

Dramatic change has been occurring in the transportation sector throughout the world. The introduction of the electric vehicle has allowed individuals to traverse long distances in an environmentally safe manner with specifications for these vehicles being similar, if not better, than traditional gas-powered vehicles. In recent years, the spotlight has been on larger vehicles to follow the same transition and school buses are no exception. Debates have risen whether these diesel-powered school buses do more harm than good (Skibell, 2021). On one hand, they're economically cheaper and allow school districts to employ more school buses which allow the opportunity for more students to ride the bus. However, many parents have been concerned about pollution levels outside and inside these buses.

One of the biggest issues these diesel school buses have contributed to has been air pollution and the disparity in air quality among different social groups. Between 2004-2016, communities of color and of lower income were found to have been consistently exposed to average $PM_{2.5}$ levels higher than areas predominantly white and of higher income levels (Jbaily et. al., 2022). Numerous discussions have been held regarding whose responsibility it is to redress this current disparity and about what can be done on a local level. As urbanization increases, so does the given pollution in a given community.

A local example of this is Crozet Elementary School which is constructing an additional academic wing in order to increase their capacity for an anticipated rise in student population. With this, there is expected to be an increase in vehicular presence on both the main road and on school premises. For the technical project, the focus was to redesign the site layout in order to improve traffic flow on site while adhering to a number of constraints laid out by board members of Albemarle County. This was to be accomplished by designing construction documents in

order to ensure feasibility of the proposed design on multiple fronts ranging from stormwater to grading. One of the objectives laid out by the county was to help mitigate air quality pollution on site. While vague, the goal was to reconfigure the site or place some form of control to the increased pollution on site due to the increased car presence.

Since site design and transportation policy are huge components of the issue at hand, both approaches will be investigated in the context of air quality issues in local communities. This will allow further analysis of how to achieve an economical and safe implementation of mass transportation regarding the educational sector and how to limit the harmful effects of increased urbanization. The following research revolved around the overarching question of how the government, engineers, and planners can improve the safety and quality of air in local communities. Rather than strictly focusing on the technical side of the issue at hand, this research will mainly focus on how these groups can push for certain policies within projects and local communities to ensure that negative effects are mitigated.

In order to sufficiently analyze the situation at hand through a socio-ethical lens, Actor Network Theory (ANT) will be applied to the current efforts at redressing the inequalities experienced regarding air pollution among different communities (Latour, 2005). By analyzing the relationships between the actors to the issue at hand, an enhanced understanding of a correct course of action will be able to be formulated that will help redress current inequalities with the energy poverty nexus as well as foreseeable complications in adhering to stricter regulations in air quality going forward. A major solution to the given problem at hand on a local level has been the call to transition towards electric school buses. While this research does not refute its importance, it does emphasize that it should not be the only solution being presented to the disparity in air quality among different communities. Engineers and planners have a huge

influence on the quality of life for many individuals on a local scale and their role is not to be diminished.

CURRENT SCHOOL TRANSPORTATION MEANS

Diesel powered school buses provide a multitude of benefits to counties all across the United States. Introduced in the mid-1900s, these school buses have allowed counties to feasibly transport a majority of their student population economically (Steinhilber, 2017). At the time, this technology was revolutionary for this and allowed students the ability to attend educational institutions that were once not feasible due to transportation issues. It still is affordable today but not a necessity as times have changed. The introduction of electrically powered vehicles has transformed the way individuals view transportation. What once was seen as a necessity in gas powered vehicles is no longer seen as that, and these diesel-powered school buses are no exception.

Diesel-powered school buses constitute roughly 90% of the current school bus population (Freehafer & Lazer, 2023). Diesel fuels are composed of very fine particles of carbon & a mixture of toxic gases that when released, expose harmful emissions to both the environment and student health. These harmful emissions are not constrained to the outside of the vehicle, but also inside. This can be seen in the law case of Reynolds v. Board of Education of Prince George's City. In this court case, Barbara A. Reynolds, a bus driver employed by Prince George's County, applied for accidental disability retirement benefits due to her prolonged exposure to diesel fuel and fumes (Reynolds v. BOARD OF EDUCATION OF PRINCE GEORGE'S CTY, 1999). A medical board established by the Board of Trustees of the Maryland State Retirement system ended up denying her claim due to her having a pre-existing asthmatic condition. This case study shows how the prolonged exposure of these fumes can have adverse long-term effects. This is

important considering students have lungs that are not fully developed which makes them susceptible to negative impacts on health later on in life.

Roughly 50% of the pre-high school population and 60% of low-income students ride the bus to and from school (Bureau of Transportation Statistics, 2021). With how much of the student population depends on these buses to get to and from school, many counties have focused on retrofitting their current school bus flight in order to mitigate exposure to the harmful pollutants of the diesel engines and help improve student performance. A specific case study on this would be in Georgia where between 2007 and 2015, roughly 2600 school busses were retrofitted and there was found to be positive links aerobic capacity and English and math test scores (Austin et. al., 2019). According to this analysis, it was found that retrofitting 10% of a districts fleet increased English end of grade scores by 0.009 standard deviation and increased math scores by 0.005 standard deviations. It was also correlated with a 0.18 $\frac{mL*kg}{min}$ increase in VO_2 max for aerobic capacity. This shows that these school busses impact much more than just the environment and quality of air in local communities.

Initiatives have been taken by the federal government to move away from these traditional diesel-powered school buses. Most recently, the Bidirectional Act was introduced to the US Senate in 2022 (Johnson, 2022). This act would create a program dedicated to deploying electric school buses with Vehicle to Grid capabilities which would consequently help counties struggling with meeting the financial burdens currently associated with electrically powered school buses. This would be accomplished through electrically powered school buses acting as batteries when not in use specifically to the electrical grid. Despite this act, there are issues systematically that are not considered as most programs seem to only focus on the actual direct costs associated with the transition. There are also issues regarding differences in opinion about

whose responsibility it is to address these issues as well as just how much funding should be allocated for this.

WHERE WILL FUNDING COME FROM?

Lack of sufficient funding and negligence by counties have been the biggest barrier to the transition towards a more sustainable means of mass transportation and redressing issues with air quality. The insufficient funding at addressing systemic issues and social issues caused by these diesel-powered school buses have caused counties to inadvertently settle for the minimum to meet regulations. As there is minimal pressure from the government to enforce this transition, counties are given the option to either pursue an electric or low emission form of school bus transportation. This can be seen in Anne Arundel County in Maryland where the federal government gave the Maryland Transit Administration roughly $1,890,000 in helping transition to low or no emission school buses (Raskin, 2022). As the grant was vague and the county does not own the buses it deploys but rather a third party, hybrid electric and diesel buses were purchased. This shows an ongoing issue of counties settling for the minimum in order to meet the regulations set out by the federal government due to insufficient funding.

Financially, electric-powered school buses are expensive. A single electric bus can range from $200,000 to $400,000 (Casale et. al., 2022). These high upfront costs have proven to be a detriment to counties looking to pursue electric vehicles and as a result, most counties are inadvertently settling for the minimum to meet standards rather than going all in. The savings associated with pursuing electrically powered school buses are spread out throughout the life cycle of the bus itself. The average total lifetime fuel/maintenance savings of one electric powered bus is roughly $192,000 which is spread along the average lifespan of these buses at around 16 years (Evans et al., 2021). These hybrid buses which most counties are pursuing emit

roughly 1.06 grams of NO_X per mile (Ranganathan, n.d.). Albeit they are lower, this still poses a threat to student health and wellbeing of the community overall. While this is a step in the right direction, the issue has not been erased but rather reduced. Despite this, some counties simply cannot afford to wait for the savings due to financial instability and the social issues neglected by these grants such as existing increased pollution in lower income counties.

WHAT CAN BE DONE?

In light of this, this research aims to analyze how the government, engineers, and planners can improve the safety and quality of air in local communities. In doing so, it analyzes the ethical and social issues in communities of lower income and/or of color regarding air quality. Historically speaking, racial/ethical minorities and lower-income groups in the USA are at a higher risk of death from the exposure of particulate matter (Jhaily et. al. 2022). Particulate matter is a common byproduct of diesel fuels and consequently, the schools with the highest number of operating buses tend to exhibit the highest average concentration of $PM_{2.5}$ (Grinshpun et. al., 2015). Consequently, it is important for engineers and planners to understand how they can mitigate the negative effects associated with diesel powered school buses. This research will not focus on the technicality of electric school buses, but more so on the policies within projects and communities that can be pursued to ensure that these effects of poor air quality are mitigated as much as possible.

PURSUING MORE ECO-FRIENDLY INFRASTRUCTURE, TRANSPORTATION, AND MATERIALS

In order to understand the issue at hand, this research will analyze it using Actor Network Theory in order to sufficiently understand what can be done to help mitigate the current systemic

issues while also addressing the changes that need to be made. Common consensus is that the government should be the catalyst for changes regarding the environmental sector due to their influence and power. While this research does not refute this claim, it emphasizes that engineers and planners can have a significant impact in helping solve some of the air quality issues experienced in local communities. As shown in Figure 1, the main actor's this research revolves around are the government, engineers, and planners. There are a multitude of overlaps when it comes to responsibilities among the three actors, but engineers and planners typically work on a smaller scale (i.e., local counties).

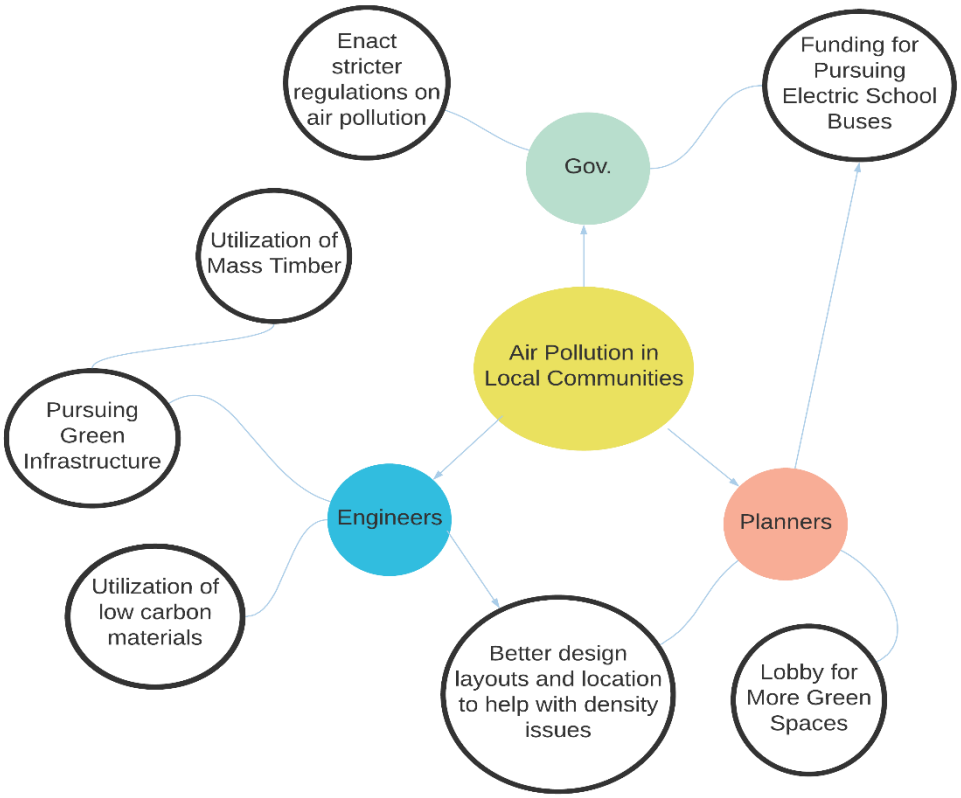

Figure 1: Actor Network Theory Map. This map visualizes the overlap of responsibilities among engineers, planners, and the government in regard to air quality in local communities. (Robin, 2023)

The Government's Role

Without a doubt the most important thing that the government can do in regard to addressing air pollution in local communities is providing substantial funding. This funding needs to consider not just the technologies themselves, but also the research, the development, and the systemic changes needed to ensure feasibility of cleaner air. Recent initiatives have focused on the technical aspect of cleaner modes of transportation. While a great starting point, the neglection of redressing the existing systemic and societal ethical injustices that are already in place are starting to get the attention of the public. Miller and his colleagues (2022) stated, "We propose, therefore, that those leading energy transitions have an ethical obligation to redress these existing inequalities and injustices, in addition to proactively addressing any potential additional harms created by the transition process, thus contributing to more just, equitable, and fair societies and markets" (p.3). As the government employs policies regarding the issues of air quality, it is vital that they do proactively look to combat the existing systemic obstacles in place preventing lower income communities from progressing forward.

As noted before, a commonly neglected aspect of the issue with communities being able to transition towards sustainability is the energy poverty nexus. Miller and his colleagues (2022) define it as, "an ensemble of complex, negative feedbacks in socio-energy systems that, over time, reinforce and exacerbate poverty and make conditions worse off for individuals, households, or communities" (p.4). The main issue at the federal level is the reluctancy to differentiate energy poverty from general poverty. As noted, the burden falls onto the state to try to figure out how to assist these communities; "51% of all funding to address high energy burdens is from utility ratepayer funded bill and energy efficiency assistance" (Bednar & Reames, 2020, p.1). With this comes struggles to pass policies that address the issue entirely.

The federal government needs to understand that if not funded immediately, many of these communities will only find themselves in bigger holes as they try to adhere to the stricter regulations that will be enacted in the future.

The Engineer's Role

As engineers, our relative influence only extends so far; rather than trying to tackle the problem on a national scale or state scale, engineers should focus on addressing the issue on a local scale. A major action that can be taken during planning of a project is advocating for low-carbon materials to be utilized during construction. The construction industry alone is responsible for roughly 40% of CO_2 emissions across the globe with roughly 11% of that coming from manufacturing and producing building materials, such as steel and cement (Abergel et. al., 2019). One of the most prominent emerging materials within the last 5 years has been mass timber, which is, "a building system that uses wood bonded together in layers to create strong and sustainable planks, posts, beams and other structural elements. Mass timber materials are designed to achieve the same strength ratings as non-wood materials like concrete and steel while maintaining a much lighter weight" (BigRentz, 2021). There are a multitude of benefits coming from this new material, but the main is that it is 100% renewable, thus significantly reduces emissions coming from construction projects by 15% to 20% (Think Wood, 2022). While this material will not be viable for every project, it can provide an option for smaller scale buildings that will meet requirements while also helping to meet regulations set by counties, such as LEED requirements.

The influence engineers have in a construction project is not to be disregarded. As shown in Figure 2, they are the gateway between the different disciplines working together on a project from the designer to the owner to the subcontractors. With this, they can influence decisions

regarding air pollution, environmental protection, and renewable alternatives that may have been overshadowed. They can also advocate for recycling and reusing materials to help alleviate environmental footprints. In general, construction and demolition waste amounts to roughly 25% of the total waste generated in the world (Malia et. al., 2013). By advocating for ways to mitigate waste before and after construction, engineers can significantly reduce this number. Through devising ways to recycle and reuse materials on site, engineers can alleviate the impact of their construction projects in regard to environmental protection.

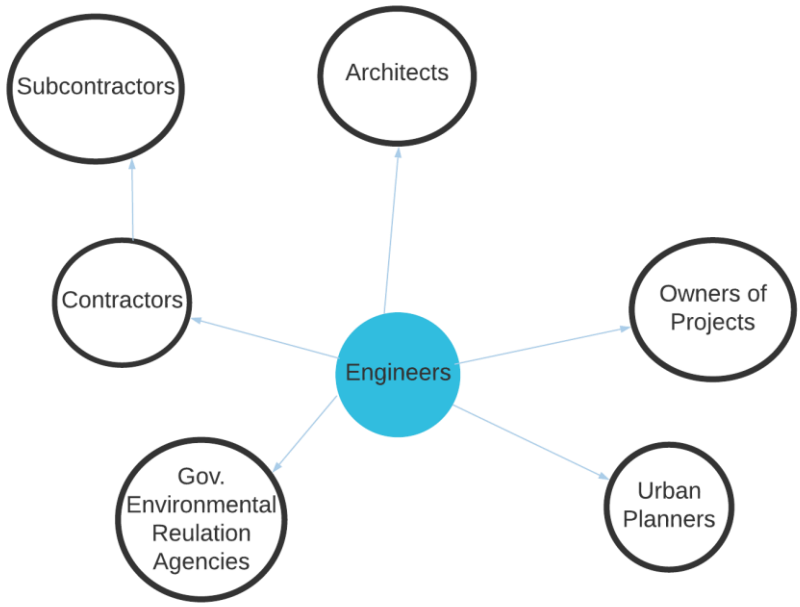

Figure 2: Social Construction Diagram of Engineers. A map depicting the different professions engineers interact with & the substantial influence they have. (Robin, 2023)

In regard to design, construction projects should typically be located away from external sources of pollution if possible at all. If not possible at all, extensive standards and requirements should be put in place by the builder to ensure that both the health and safety of the laborer and environment are not endangered. In Rostov-on-Don, a city in Russia, two similar 20+ stories buildings were evaluated for the concentration of particulate matter. Building 1 was constructed

along a busy highway while building 2 was constructed in a residential area. Building 1 was found to be higher than building 2 given that it was managing internal pollution as well as external pollution (Azarov, et. al., 2022). With this in mind, engineers should be mindful of ensuring more mitigation measures depending on where their construction sites are located.

The Planner's Role

Much of what planners can do to help with air quality is intertwined with the responsibility of engineers but because their influence extends far beyond a single project, they have more responsibility when it comes to advocating and lobbying. This can be accomplished through extensive communication with local officials to help certain policies be pursued. Planners should advocate for cities to implement more air pollution monitoring. Roughly 50% of all cities monitoring air pollution in high-income countries between 2008 and 2013 have reduced air pollution by 5% (Neira, 2018). This shows the effectiveness of lobbying for stricter measures when it comes to controlling and regulating the amount of air pollution emitted in given cities.

Another key initiative that can be taken by planners is implementing more green infrastructure and green spaces within communities. By increasing the amount of green space within a community, planners can help not only tackle air pollution issues, but overall environmental issues experienced. Green infrastructure has been shown to help support human health through "urban temperature mitigation, decrease of pollutants and air quality improvements, aesthetic and psychological benefits, provisions of spaces for social interaction and social activity" (Santamouris & Osmond, 2020). In regard to green spaces, these do not have to be massive sites implemented within communities; instead, they can be plots of land here and there set out for these spaces. Research has shown that urban trees are a significant element to reduce air pollution through reduction of $PM_{10coarse}$ which are particulate matter with a diameter

of 10 microns or less; in Strasbourg, France, public trees reduce roughly 7% of the emitted $PM_{10coarse}$ (Selmi et. al., 2016). This further enforces the need for both green infrastructure and green spaces regardless of the size of them.

WHERE DO WE GO NOW?

The global human population is expected to reach roughly 10 billion within the next 30 years (Lutz & KC, 2010). With this expected increase comes the need to extensively mitigate the damages environmentally and systematically to ensure a sustainable life for future generations. The current efforts on transition towards sustainability should be equally focused on redressing the existing energy poverty nexus to ensure that lower income communities are not at a disadvantage trying to meet the stricter regulations and standards being proposed by the government as well as ensuring a leveled playing field for all people.

The government, engineers, and planners have massive roles when it comes to mitigating the issues seen with air quality and the disparity among different communities. The government should focus on ensuring proper funding be allocated not just towards the technologies themselves, but also to the research, the development, and the systemic changes needed in regard to cleaner air. The engineer should advocate for low-carbon materials to be utilized during construction as well as ensuring accountability when it comes to mitigating waste before and after construction. Finally, the planner should pursue more green spaces and green infrastructure in local communities through their collaboration with local officials. The responsibility of improving air quality should not be looked at as belonging to a single sector, but rather as a collaboration among different professionals. In doing so, many of the ethical injustices on lower income communities can be improved and fixed.

REFERENCES

Abergel, T., Dulac, J., Hamilton, I., Jordan, M., & Pradeep, A. (2019). *Global Status Report for Buildings and Construction 2019*. IEA. https://iea.blob.core.windows.net/assets/3da9daf9-ef75-4a37-b3da-a09224e299dc/2019_Global_Status_Report_for_Buildings_and_Construction.pdf

Austin, W., Heutel, G., & Kreisman, D. (2019, March 15*). School Bus Emissions, Student Health and Academic Performance*. Economics of Education Review. https://www.sciencedirect.com/science/article/pii/S0272775719301530

Azarov, V., Manzhilevskaya, S., & Petrenko, L. (2018). The Pollution Prevention during the Civil Construction. *MATEC Web of Conferences*, *196* (4073), 4-6. https://doi.org/10.1051/matecconf/201819604073

Bednar, D. J., & Reames, T. G. (2020). Recognition of and Response to Energy Poverty in the United States. *Nature Energy*, *5*(6), 432–439. https://doi.org/10.1038/s41560-020-0582-0

Big Rentz. (2021, November 23). Mass Timber: The Future of Sustainable Construction https://www.bigrentz.com/blog/mass-timber

Bureau of Transportation Statistics. (2021, January 12). The Longer Route to School. https://www.bts.gov/topics/passenger-travel/back-school-2019

Casale, M., Horrax, J., & Nick, S. (2022). *Electric School Buses and the Grid*. Environment America. https://publicinterestnetwork.org/wp-content/uploads/2022/07/PA_V2G20202220print.pdf

Callon, M. (1999). Actor-Network Theory --- The Market Test. *The Sociological Review*, *47*(1), 181-185. https://doi.org/10.1111/j.1467-954X.1999.tb03488.x

Dean v. Utica Community Schools, 345 F. Supp. 2d 799 (E.D. Mich. 2004).

Evans, E., & Fogler, M. (2021). *Accelerating the Transition to Electric School Buses*. Environment America. https://environmentamerica.org/center/wp-content/uploads/2021/02/US_EL-buses-2021-Final.pdf

Freehafer, L., & Lazer, L. (2023, February 13). *The State of Electric School Bus Adoption in the US*. World Resources Institute. https://www.wri.org/insights/where-electric-school-buses-us#:~:text=Why%20Are%20Electric%20School%20Buses

Grinshpun, S.A., Hotchstetler, H.A., Reponen, T., Ryan, P.H., & Yermakov, M. (2010, December 13). Aerosol Particles Generated by Diesel-Powered School Buses at Urban Schools as a Source of Children's Exposure. *Atmospheric Environment*, *45*(7), 1444–1453. https://doi.org/10.1016/j.atmosenv.2010.12.018

Jacobson, M. Z. (2002, October 15). Control of Fossil-Fuel Particulate Black Carbon and Organic Matter, Possibly the Most Effective Method of Slowing Global

Warming. Journal of Geophysical Research: Atmospheres, 107 (D19), ACH 16.1-ACH 16.22. https://doi.org/10.1029/2001JD001376

Jbaily, A., Zhou, X., Liu, J., Lee, T.-H., Kamareddine, L., Verguet, S., & Dominici, F. (2022). Air pollution Exposure Disparities Across US Population and Income Groups. *Nature, 601*(7892), 228–233. https://doi.org/10.1038/s41586-021-04190-y

Johnson, P. (2022, September 30). *Bidirectional Act introduced in US Senate to Promote Electric School Buses Feeding Grid*. Electrek. https://electrek.co/2022/09/30/bidirectional-act-promotes-electric-school-buses-with-v2g/

Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press.

Lutz, W., & KC, S. (2010, September 27). Dimensions of Global Population Projections: What do we know about Future Population Trends and Structures? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2779–2791. https://doi.org/10.1098/rstb.2010.0133

Mália, M., De Brito, J., Pinheiro, M. D., & Bravo, M. (2013, January 11). Construction and Demolition Waste Indicators. *Waste Management & Research, 31*(3), 241-255. https://doi.org/10.1177/0734242X12471707

Miller, C.A., Biswas, S., Echevarria, A., Irshad, N., Rivera-Matos, Y., Richter, J., Chhetri, N., & Parmentier, M.J. (2022, August 10). Ending the Energy-Poverty Nexus: An Ethical Imperative for Just Transitions. *Science and Engineering Ethics*, *28*(36). https://doi.org/10.1007/s11948-022-00383-4

Neira, M. (2018, March 21). *Health Must be the Number One Priority for Urban Planners*. World Health Organization. https://www.who.int/news-room/commentaries/detail/health-must-be-the-number-one-priority-for-urban-planners

Ranganathan, S. (n.d.). *Hybrid Buses Costs and Benefits*. Environmental and Energy Study Institute. https://www.eesi.org/files/eesi_hybrid_bus_032007.pdf

Raskin, J. (2022, August 22). *Maryland Delegation Announces Nearly $42 Million for Eco-Friendly Upgrades to Regional Bus Systems in Prince George's, Anne Arundel, and Montgomery Counties*. Congressman Jamie Raskin. https://raskin.house.gov/2022/8/maryland-delegation-announces-nearly-42-million-for-eco-friendly-upgrades-to-regional-bus-systems-in-prince-george-s-anne-arundel-and-montgomery-counties

Requia, W. J., Adams, M. D., Arain, A., Papatheodorou, S., Koutrakis, P., & Mahmoud, M. (2018). Global Association of Air Pollution and Cardiorespiratory Diseases: A Systematic Review, Meta-Analysis, and Investigation of Modifier Variables. *American Journal of Public Health, 108*(S2), S123-S130. https://doi.org/10.2105/AJPH.2017.303839

Reynolds v. BOARD OF EDUCATION OF PRINCE GEORGE'S CTY, 736 A.2d 391, 127 Md. App. 648 (Ct. Spec. App. 1999).

Robin, J. (2023). *Actor Network Theory Map.* [Figure 1]. *STS Research Paper:* Harmful Emissions: How Diesel Fueled School Buses are Harming Students. (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Robin, J. (2023). *Social Construction Diagram of Engineers.* [Figure 2]. *STS Research Paper:* Harmful Emissions: How Diesel Fueled School Buses are Harming Students. (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Santamouris, M., & Osmond, P. (2020, December 7). Increasing Green Infrastructure in Cities: Impact on Ambient Temperature, Air Quality and Heat-Related Mortality and Morbidity. *Buildings, 10*(12), 233. https://doi.org/10.3390/buildings10120233

Sechel, I. C., & Mariasiu, F. (2021). Efficiency of Governmental Policy and Programs to Stimulate the Use of Low-Emission and Electric Vehicles: The Case of Romania. Sustainability, 14(1), 45. https://doi.org/10.3390/su14010045

Selmi, W., Weber, C., Rivière, E., Blond, N., Mehdi, L., & Nowak, D. (2016, June 1). Air Pollution Removal by Trees in Public Green Spaces in Strasbourg city, France. Urban Forestry & Urban Greening, 17, 192-201. https://doi.org/10.1016/j.ufug.2016.04.010

Skibell, A. (2021, July 30). *Electric School Buses Reduce Pollution, but New Infrastructure Deal Slashed Funding*. Scientific American. https://www.scientificamerican.com/article/electric-school-buses-reduce-pollution-but-new-infrastructure-deal-slashed-funding/

Steinhilber, C. (2017, August 22). *The Evolution of the Diesel Engine*. Thomas Built Buses. https://thomasbuiltbuses.com/resources/articles/diesel-is-innovative/

Think Wood. (2022, September 27). *4 Things to Know about Mass Timber*. https://www.thinkwood.com/blog/4-things-to-know-about-mass-timber

Trone, D. (2022, August 24). *Maryland Delegation Announces Nearly $43 Million for Eco-Friendly Upgrades to Regional Bus Systems in Prince George's, Anne Arundel and Montgomery Counties*. Congressman David Trone. https://trone.house.gov/2022/08/24/maryland-delegation-announces-nearly-43-million-for-eco-friendly-upgrades-to-regional-bus-systems-in-prince-georges-anne-arundel-and-montgomery-counties/