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Conference Paper · June 2025

DOI: 10.3390/engproc2025097017

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engineering proceedings

MDPI

Proceeding Paper

Social Assessment of Alternative Urban Buses †

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† Presented at the 1st International Conference on Smart Management in Industrial and Logistics Engineering (SMILE 2025), 16–19 April 2025, Casablanca, Morocco.

Abstract: Public transportation in cities is negatively affected by reliance on petroleum-based fuels, leading to emissions and poor air quality. Although the environmental evaluation of alternative buses in terms of sustainability has been extensively studied, the social dimensions have not received as much attention. In this regard, this research examines the social implications of alternative urban buses through life cycle impact assessment (LCIA) methods, including Eco-Indicator 99, Impact 2002+, and ReCiPe Endpoint. The results indicate that diesel buses significantly impact health, while hybrid, fuel cell, and electric buses can decrease emissions by 50%. These results underscore the necessity of zero-emission technologies to enhance urban air quality and promote better public health.

Keywords: urban buses; alternative fuels; human health; LCIA; social sustainability

Academic Editors: Mustapha Hlyal, Abdessamad Ait El-Cadi, Kaoutar Kouzmi, Mariam Atwani and Kenza Izikki

Published: 10 June 2025

Citation: Jelti, F.; Cheikhrouhou, N. Social Assessment of Alternative Urban Buses. *Eng. Proc.* **2025**, *97*, 17. https://doi.org/10.3390/engproc2025097017

1. Introduction

Urban mass transit fosters social inclusion by connecting people to employment, education, and essential services [1]. To this end, alternative city buses invigorate urban life by offering affordable and reliable mobility solutions that counteract social inequality and enhance community connectivity [2]. Consequently, cities around the globe are moving away from diesel-powered transportation to tackle environmental and public health issues. Additionally, these progressive solutions advance social equity by ensuring that all residents, particularly those in marginalized neighborhoods, can access modern, eco-friendly transit alternatives [3].

Given their significance, urban bus networks play a crucial role in shaping the social landscape of cities. Specifically, they affect public health, social equity, and job availability. Therefore, developing effective assessment methods to gauge their societal effects is essential. In this context, this section examines two main elements: the social consequences of urban buses and ways to evaluate their influence.

1.1. Social Implications of Urban Buses

Public transportation impacts human health by affecting air quality and the well-being of commuters and increasing exposure to infectious diseases. Conventional diesel buses are major contributors to air pollution, releasing nitrogen oxides (NO_x) and particulate matter (PM), which have been associated with respiratory and cardiovascular conditions [4]. It is possible to minimize such health hazards to humans by adopting cleaner alternatives such as electric and hydrogen buses. In addition, city buses are potential vectors of airborne infection, mainly when operating in enclosed spaces with minimal ventilation [5]. The COVID-19 pandemic demonstrated the spread of disease through buses and brought about a reduced usage of public transportation in most cities [6].

In addition to health issues, urban buses are crucial for fostering equity by facilitating mobility for underprivileged communities. Nevertheless, variations in service quality often lead to decreased accessibility for low-income individuals. Studies conducted in cities like Shenyang and Perth have shown that lower-income residents face longer travel durations and inferior service quality, restricting their access to jobs, educational opportunities, and healthcare [7,8]. Policy measures such as fare subsidies and enhanced route planning are essential to tackle these disparities.

Urban buses also play a role in job creation by providing operations, maintenance, and administration positions. However, transitioning to cleaner bus technologies changes job structures and necessitates new skill requirements for transit employees [9]. While better transit accessibility boosts employment prospects, automation presents a potential risk to conventional transit jobs, particularly for bus operators [10]. Despite worries about job losses, new opportunities are arising in data analytics and transit management.

1.2. Assessment Methods for the Societal Impact of Urban Buses

A comprehensive assessment of urban buses' social impact should combine quantitative and qualitative methods. Quantitative methods, such as life cycle assessment (LCA) and cost–benefit analysis (CBA), provide measurable data on emissions-related health effects, jobs, and economic accessibility [11,12]. Conversely, qualitative methods such as stakeholder interviews, surveys, and social impact assessments (SIAs) help to capture societal issues such as equity in access to transport and public attitudes [13]. By integrating these methods, a comprehensive assessment can be carried out to better understand the broader implications of urban bus systems on people's health, employment opportunities, and social inclusion.

Air quality poses a significant challenge for urban buses. The computational fluid dynamics study in [5] explores the risks of airborne transmission within buses, emphasizing the role of heating, ventilation, and air conditioning (HVAC) systems in mingling infectious particles. This research is best suited to assessing pandemic-related health risks in public transport environments.

Public transport equity is generally quantified by spatial accessibility analyses using Geographic Information Systems (GISs) and time-dependent models. These analyses have indicated that rich and poor groups have significant disparities in accessibility [14]. Structural equation modeling (SEM) additionally aids in elucidating the connection between transit access and socioeconomic factors, providing substantial insights for decision-makers [7].

Assessments of employment impacts employ labor market models and econometric analyses to determine job creation within the transit sector. Research has shown that enhanced transit accessibility notably boosts employment rates, particularly among low-income groups [15].

1.3. Novelty and Objectives of This Study

While alternative fuel buses are favored for reducing emissions, their health implications over the long term have not been investigated well. While most research is aimed towards air quality improvement, there is limited in-depth research on how hybrid, electric, and fuel cell buses affect human health compared to diesel buses. Transit equity research also neglects the role digitalization plays in increasing accessibility, and job employment studies say little about automation and policy impacts on transit workforce growth. A holistic, multi-disciplinary strategy is essential to bridge these deficits for sustainable and inclusive cities.

This paper formulates the information on the social impact of alternative fuel city buses, with a particular emphasis on human health, as research in other areas of society has only been limited to the study area. It particularly evaluates the health effects of hybrid (diesel-electric), electric, and fuel cell buses compared to conventional diesel buses. To ensure a comprehensive assessment, the study applies Life Cycle Impact Assessment (LCIA) methodologies—Eco-Indicator 99, Impact 2002+, and ReCiPe End-point—to quantify their human health implications.

The rest of the paper is structured as follows: first, it examines the social and health effects of alternative fuel buses using LCIA methods; second, it analyzes and compares the results to offer a clearer understanding of their health impacts; and finally, it provides recommendations for enhancing social sustainability in urban transport systems.

2. Materials and Methods

In this study, two well-documented approaches—systematic literature review (SLR) and life cycle impact assessment (LCIA)—are merged to evaluate the social effects of alternative urban buses from the perspective of human health. This research offers a valuable overview of sustainable urban transport by combining qualitative evidence from a broad literature survey with quantitative indicators using life cycle impact tools. This dual approach enables a clearer understanding of the pros and cons of transitioning towards cleaner bus technologies.

The review includes papers published between 2014 and 2024 and extensively analyzes prominent trends and emerging themes in the social impacts of the transition to new technologies for city buses. To ensure a reliable selection process was carried out, papers were retrieved from reputable academic databases such as Scopus and Web of Science. The review concentrates on studies on the social components of adopting these technologies.

The LCIA approach plays a valuable role in the life cycle assessment (LCA) framework as a whole as it can measure transport systems' social and environmental footprint [16]. While environmental LCA is well grounded in urban transport research, social LCA is emerging as an essential tool for evaluating broader societal impacts, particularly for public transit [17–19]. Urban buses have considerable implications for human health, social equity, and community well-being, and therefore, they are a suitable subject for social impact assessment. To analyze such dimensions, in this research, LCIA methods such as Eco-indicator 99, Impact 2002+, and ReCiPe Endpoint are used [20]:

- **Eco-indicator 99** analyzes human health, ecosystem quality, and depletion of resources. Although it supplies very little detail regarding social effects, it supports an analysis of the general impacts of health issues caused by pollution.
- **Impact 2002+** combines environmental and social impacts into endpoint indicators, focusing on social vulnerabilities such as the effect of resource depletion on poor individuals. Its primary focus remains on environmental outcomes.
- **ReCiPe Endpoint** comprehensively evaluates environmental and social impacts with factors on health, availability of resources, and displacement. Although it considers a broad range of social impacts, its primary concern remains indirect effects, with less consideration of equity and labor rights.

The LCIA method quantifies urban transport systems' social and environmental impacts in monetary units with the assistance of the OPENLCA software developed by GreenDelta in conjunction with the LCIA version 2.0.2 [18].

This study involves a cast study of Oujda (Morocco) to put the results into perspective. It examines the social impacts of transitioning from conventional fossil fuel-based buses to alternative urban buses (hybrid, electric, and hydrogen). Exploring this real case helps to describe Morocco's situation and highlights challenges in adopting alternative urban transport, offering a local perspective of the broader implications of such changes in a developing country.

To estimate the potential social impacts of alternative urban buses in Morocco and their contribution to improving human health, the following inputs and assumptions have been considered:

- The LCIA model's assumptions and sources of data are based on a study [19] of the average coverage of the public transport operator's bus fleet, daily bus operating hours, and the Moroccan electricity generation mix for electric buses.
- Table 1 indicates the weighting applied to each of the pollutants emitted. It presents a comparative analysis of the social impacts, in terms of human health, of alternative urban buses using three LCIA methods: Eco-indicator 99, ReCiPe Endpoint, and Impact 2002+ (Endpoint). The table shows the effect of various emissions (such as CO_2, CH_4, N_2O, VOC, NO_x, PM_{10}, $PM_{2.5}$, and SO_2) on some of the major health-related categories that include climate change, respiratory effects (both inorganic and organic), particulate matter formation, and photochemical oxidant formation. The impact of each emission is shown in Disability-Adjusted Life Years (DALY) per kilogram. It is expressed in terms of equivalence units (e.g., kg $CO_{2\ eq}$, kg $C_2H_{4\ eq}$, kg $PM_{2.5\ eq}$) to depict its contribution to specific health burdens. In so doing, this table provides a clear basis for a comparison of the human health impacts of various bus technologies by linking pollutant emissions to their overall social and health effects.

Table 1. The weighting of the different air pollutant emissions.

	Eco-Indicator 99 (E,E)			ReCiPe Endpoint (E,A)			Impact 2002+ (Endpoint)					
LCIA 2.0.2	**Climate Change**	**Respiratory Inaorganic**	**Respiratory Organic**	**Climate Change**	**Particulate Matter Formation**	**Photochemical Oxidant Formation**	**Climate Change**		**Respiratory Inaorganic**		**Respiratory Organic**	
CO_2 (DALY/kg)	2.10×10^{-7}			3.51×10^{-6}			**CO_2 (kg CO_2 eq/kg)**	1.00				
CH_4 (DALY/kg)	4.40×10^{-6}		1.28×10^{-8}	2.67×10^{-5}		3.94×10^{-10}	**CH_4 (kg CO_2 eq/kg)**	10.35			**CH_4 (kg C_2H_4 eq/kg)**	6.01×10^{-3}
N_2O (DALY/kg)	6.90×10^{-5}			5.37×10^{-4}			**N_2O (kg CO_2 eq/kg)**	156.00				
VOC (DALY/kg)			6.46×10^{-7}			3.90×10^{-8}					**VOC (kg C_2H_4 eq/kg)**	3.03×10^{-1}
CO (DALY/kg)	3.22×10^{-7}	7.31×10^{-7}				1.78×10^{-9}	**CO (kg CO_2 eq/kg)**	1.57	**CO (kg $PM_{2.5}$ eq/kg)**	1.04×10^{-3}		
NO_x (DALY/kg)		8.91×10^{-5}			5.72×10^{-5}	3.90×10^{-8}			**NO_x (kg $PM_{2.5}$ eq/kg)**	1.27×10^{-1}		
PM_{10} (DALY/kg)		3.75×10^{-4}			2.60×10^{-4}				**PM_{10} (kg $PM_{2.5}$ eq/kg)**	5.36×10^{-1}		
$PM_{2.5}$ (DALY/kg)		7.00×10^{-4}			2.60×10^{-4}				**$PM_{2.5}$ (kg $PM_{2.5}$ eq/kg)**	1.00		
SO_x (DALY/kg)		5.46×10^{-5}			5.20×10^{-5}	3.16×10^{-9}			**SO_x (kg $PM_{2.5}$ eq/kg)**	7.80×10^{-2}		

3. Results and Discussion

3.1. Analysis of the Results

The analysis provides relevant information on the impact of alternative urban buses on human health through three channels. The comparison provides an insight into the compromises in adopting sustainable transport modes and their impacts on human health, particularly climate change and respiratory diseases.

3.1.1. Eco-Indicator 99: Human Health Damage Assessment

The assessment using Eco-Indicator 99 highlights the health effects associated with urban buses, especially regarding climate change and inorganic respiratory pollutants, as illustrated in Figure 1. Concerning climate change, diesel buses are the most detrimental, resulting in about 2.0 DALYs (Disability-Adjusted Life Years) due to elevated CO_2 emissions. Although hybrid buses save fuel and lower the impact to approximately 1.5 DALYs, they are also diesel powered. On the other hand, electric buses reduce the burden to about 1.0 DALYs, while their sustainability depends on the local energy composition. It is noteworthy that hydrogen fuel cell buses have the least negligible effect at about 0.5 DALYs, making them a candidate for the cleanest option. Similarly, in the category of inorganic respiratory pollutants primarily driven by substances like sulfur oxides (SO_x), NO_x, PM_{10}, and $PM_{2.5}$, diesel buses have the most significant effect at roughly 0.6 DALYs. While hybrid buses reduce this figure to 0.4 DALYs and electric buses further cut it down to 0.3 DALYs, hydrogen fuel cell buses almost eliminate this impact, with a DALY approaching zero, underscoring their benefit of zero tailpipe emissions.

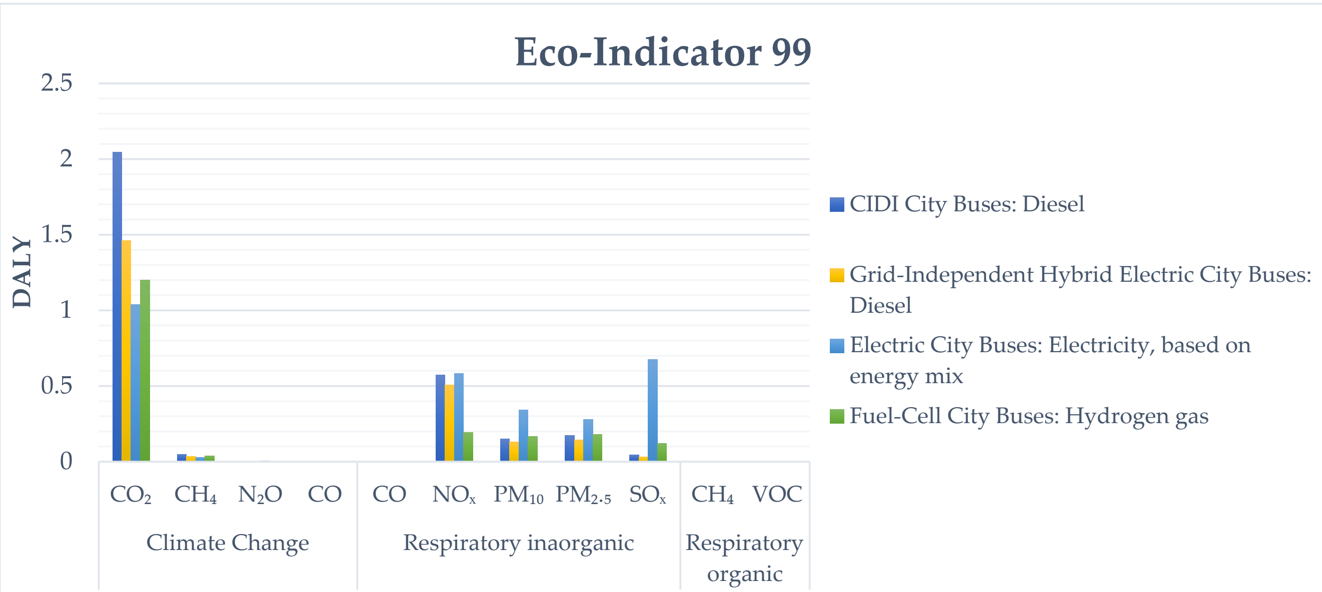

Figure 1. Impact assessment using the Eco-indicator 99 method for each bus technology in the investigated case.

3.1.2. ReCiPe Endpoint: Comprehensive Human Health Impacts

The ReCiPe endpoint assessment continues the analysis by decomposing impacts into climate change, particulate matter formation, and photochemical oxidant formation, as shown in Figure 2. Diesel buses contribute the most to climate change, at around 34 DALYs due to CO_2 emissions. Hybrid buses reduce this to 25 DALYs, and electric buses reduce further to 20 DALYs, depending on the energy mix. Hydrogen fuel cell buses contribute the least, at approximately 12 DALYs, since they refer to their potential sustainability. Even the formation of particulate matter, which is caused mainly by PM_{10} and $PM_{2.5}$ emissions, highlights the benefits of cleaner city bus alternatives, where diesel buses contribute 1.5 DALYs and hybrid (1.0), electric (0.7), and hydrogen buses contribute under 0.5. Similarly, for the production of photochemical oxidants at the behest of volatile organic compounds (VOCs), nitrogen oxides (NO_x), and carbon monoxide (CO) emissions, diesel buses again have the highest contribution with 1.2 DALYs. Hybrid (0.8), electric (0.6), and hydrogen buses (0.3), on the other hand, register declining figures. Thus, hydrogen fuel cell buses consistently have the lowest health effects again, reaffirming their position as a viable alternative for sustainable urban transport.

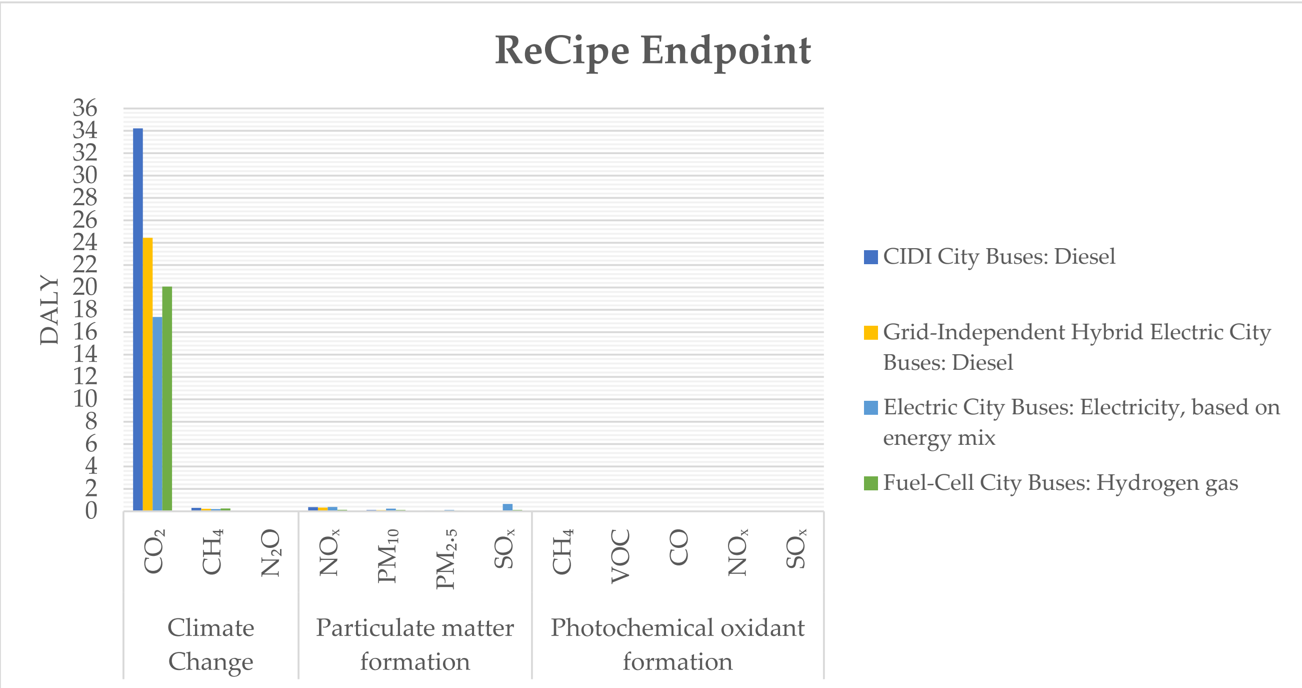

Figure 2. Impact assessment using the ReCiPe endpoint method for each bus technology in the investigated case.

3.1.3. Impact 2002+ Endpoint: Comprehensive Human Health Impacts

The Impact 2002+ Endpoint analysis identifies the health impacts of urban buses, primarily climate change, respiratory organic, and respiratory inorganic effects, as shown in Figure 3. The climate change impacts, in terms of kg $CO_{2\,eq}$, are scattered across the four bus technologies. Diesel buses emit the most significant amounts, over 10 million kg $CO_{2\,eq}$, since they solely rely on fossil fuels. Though still diesel-powered, hybrid buses are slightly better with less than 8 million kg $CO_{2\,eq}$ emissions. Electric buses reduce the emissions to only just over 6 million kg $CO_{2\,eq}$, depending on Morocco's energy structure, i.e., fossil fuel-based inputs. Unlike fuel cell buses, these possess the lowest emissions, less than 6 million kg $CO_{2\,eq}$, and hence are the most sustainable solution for the case presented here.

For inorganic respiratory emissions, the most significant contribution comes from diesel buses with NO_x and SO_x emissions exceeding 900 and 1000 kg $PM_{2.5\,eq}$, respectively. Hybrid buses offer a slight reduction, with NO_x emissions of around 800 kg $PM_{2.5\,eq}$. Electric buses reduce NO_x and PM emissions but suffer from high SO_x emissions of around 1000 kg $PM_{2.5\,eq}$ due to the generation of electricity requiring fossil fuels. Fuel cell buses have the lowest effect, with NO_x and PM below 200 kg $PM_{2.5\,eq}$ and no SO_x emissions, and are the unambiguous winners in terms of air quality.

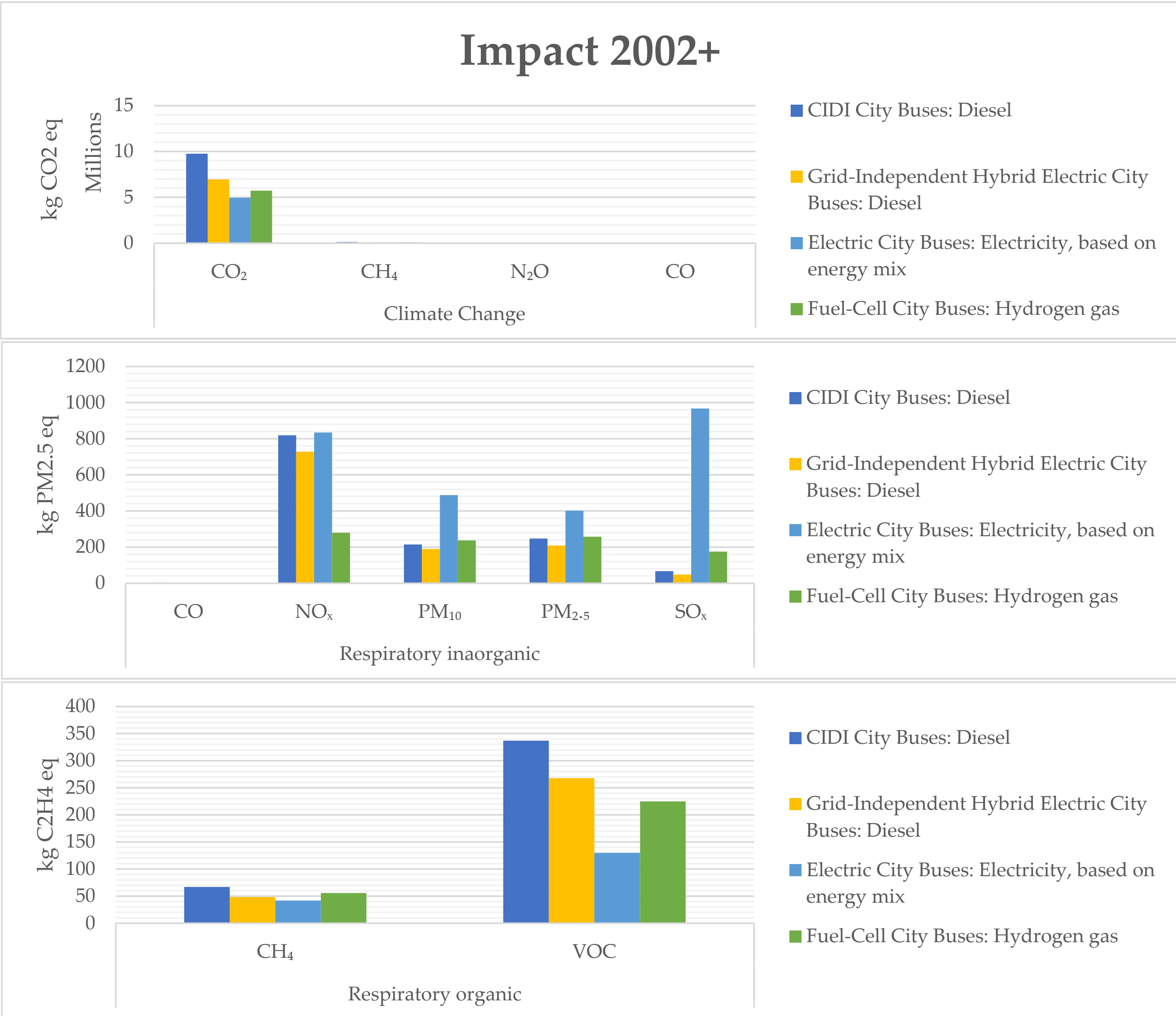

Figure 3. Impact assessment using the IMPACT 2002+ method for each bus technology in the investigated case.

Regarding respiratory organic emissions, diesel buses are the most significant emitters, with emissions of VOCs of over 350 kg $C_2H_{4\,eq}$. Hybrid buses experience a moderate reduction, but their VOC emissions are over 300 kg $C_2H_{4\,eq}$. Electric buses perform better, with VOC emissions at about 150 kg $C_2H_{4\,eq}$, although there are upstream emissions when electricity is generated. Fuel cell buses are optimal with VOC emissions of less than 200 kg $C_2H_{4\,eq}$ and low methane (CH_4) emissions, making them the cleanest option on the market to reduce respiratory health risks.

3.2. Discussion of the Results

The comparative analysis of Eco-Indicator 99, ReCiPe Endpoint, and Impact 2002+ reveals significant discrepancies in assessing the human health impact of alternative city buses. Although each method recognizes the benefits of avoiding conventional diesel buses, they differ in quantifying and describing these benefits, influencing urban transport planning choices. Eco-Indicator 99, for example, focuses on damage-based indicators like DALYs to quantify climate change and the health effects of inorganic respiratory emissions.

According to its findings, diesel buses show the highest adverse health effects, while hydrogen fuel cell buses, with zero tailpipe emissions, show the lowest health burden across the board.

On the other hand, the scope of ReCiPe Endpoint is more broad by integrating various environmental effects, such as climate change, particulate matter formation, and photochemical oxidant formation. This broader scope provides the opportunity to have a better view of the health-related consequences. While the results from ReCiPe Endpoint agree with Eco-Indicator 99 that hydrogen buses are the least harmful, they also indicate other health problems, particularly due to the role of VOCs in photochemical smog formation.

Furthermore, Impact 2002+ also refines the analysis by separating respiratory effects into inorganic and organic emissions and adding climate change impacts. It also provides a more explicit assessment of pollutants, further specifying the air quality-related health impacts. The results confirm the trends from the other methods, emphasizing that fuel cell buses are most preferable in minimizing GHG emissions and pollutant exposure. However, Impact 2002+ also stresses that the benefit of electric buses is closely proportional to the local energy mix, implying that their benefits would be maximized under a transition to renewable energies. Generally, although all approaches highlight the merits of alternative city buses, differences in detail and magnitude exist.

Eco-Indicator 99 gives a simplified health damage calculation, ReCiPe Endpoint gives a more comprehensive environmental damage calculation, and Impact 2002+ gives a more detailed emissions split. The choice of methodology should therefore be calibrated to urban transport authorities' specific interests, finding a balance between simplicity, completeness, and pollutant-specific information to inform sustainable mobility policies.

3.3. Social Aspects of Sustainable Urban Buses: Policies, Feasibility, and Challenges in the Case of Oujda

In Oujda, therefore, replacing diesel buses with buses that use alternative fuels needs to be addressed through an integrative policy intervention that balances regulatory action and economic incentives. Specific measures involve stricter emission regulations while offering subsidies to promote the purchase of hybrid, electric, and hydrogen fuel cell buses [19]. Effective policy-making requires collaboration between the local government, transport agencies, and civic organizations to ensure a balanced transition that is appropriate for the region's socio-economic context [21,22]. Therefore, this multi-faceted strategy—from regulatory harmonization to financing and stakeholder participation—is the solution to making alternative fuel buses successful and achieving environmental goals in Oujda's public transport.

The feasibility of the transition to alternative fuel buses in Oujda City is critical, requiring significant infrastructure investments such as charging stations for electric buses and refueling points for hydrogen fuel cell buses. While they cost more to buy up front than traditional diesel buses, they have a significant long-term economic advantage [19]. In addition to reducing operating expenses, they also save on public health costs by reducing harmful emissions, which is a benefit in urban areas. A detailed cost–benefit analysis is necessary to assess their economic viability, comparing the significant up-front cost with the ultimate benefits to public transit and society as a whole [23]. By carefully balancing these considerations, transit authorities and city planners can make wise choices that trade off near-term costs and long-term payoffs to Oujda's transportation network and its people.

The transition to cleaner modes of transport is bringing significant challenges, demanding careful thought and foresightful action. They include the need for labor and skills training for retraining technicians, drivers, and maintenance staff in working with new vehicle technology and potential socioeconomic dislocation in industries dependent upon diesel technology [24]. Addressing these issues, organizing retraining courses, and providing job displacement aid are imperative [24]. In addition, securing community acceptance and transport equity is critical, particularly among low-income communities that depend predominantly on public transport [25]. Public campaigns and policies catering to the needs of vulnerable communities are crucial towards building widespread social support for this critical transition towards cleaner transport means [25]. By confronting these challenges ahead of time, cleaner transportation can be made both more sustainable and equitable, leading to lower emissions and better public health.

4. Conclusions

Alternative urban buses have far-reaching social implications, particularly to human health, as identified by Eco-indicator 99, ReCiPe Endpoint, and Impact 2002+. These methods of assessments highlight the importance of a reduction in harmful pollutants such as $PM_{2.5}$, VOCs, and NO_x, which are causal factors for respiratory and cardiovascular diseases that heavily burden poor urban societies. Additionally, green city buses play a key role in minimizing climate-related health hazards by eliminating emissions that create global warming and ozone production, both of which exacerbate respiratory diseases. Green city buses promote city-wide sustainability and social justice by removing air pollution and minimizing health hazards.

Future research needs to quantify alternative urban buses' direct and indirect effects on health in the long run, particularly in reducing hospitalization and healthcare costs for air pollution-related diseases. The research also needs to address the social consequences of this transition, including perceptions, behavioral adjustments in transportation, and fairness of access to clean transport by different demographic groups. Examining the intersection of mental health and sustainable transport policy, for instance, stress reduction via improved air quality and reduced noise pollution, can have valuable implications for general well-being. Finally, inter-disciplinary solutions combining urban planning, human health, and environmental justice perspectives will ensure that future transportation policies are socially equitable and efficacious.

Author Contributions: Conceptualization, F.J.; methodology, F.J.; writing—original draft preparation, F.J.; writing—review and editing, N.C.; supervision, N.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Ribeiro, P.; Dias, G.; Pereira, P. Transport Systems and Mobility for Smart Cities. *Appl. Syst. Innov.* **2021**, *4*, 61. [CrossRef]
2. Ceder, A. Urban Mobility and Public Transport: Future Perspectives and Review. *Int. J. Urban Sci.* **2021**, *25*, 455–479. [CrossRef]
3. Jelti, F.; Allouhi, A.; Büker, M.S.; Saadani, R.; Jamil, A. Renewable Power Generation: A Supply Chain Perspective. *Sustainability* **2021**, *13*, 1271. [CrossRef]
4. Nogueira, T.; Dominutti, P.A.; Vieira-Filho, M.; Fornaro, A.; Andrade, M.d.F. Evaluating Atmospheric Pollutants from Urban Buses under Real-World Conditions: Implications of the Main Public Transport Mode in São Paulo, Brazil. *Atmosphere* **2019**, *10*, 108. [CrossRef]
5. Ramajo, D.E.; Corzo, S. Airborne Transmission Risk in Urban Buses: A Computational Fluid Dynamics Study. *Aerosol Air Qual. Res.* **2022**, *22*, 210334. [CrossRef]
6. Przybylowski, A.; Stelmak, S.; Suchanek, M. Mobility Behaviour in View of the Impact of the COVID-19 Pandemic—Public Transport Users in Gdansk Case Study. *Sustainability* **2021**, *13*, 364. [CrossRef]

7. Wang, Y.; Cao, M.; Liu, Y.; Ye, R.; Gao, X.; Ma, L. Public Transport Equity in Shenyang: Using Structural Equation Modelling. *Res. Transp. Bus. Manag.* **2022**, *42*, 100555. [CrossRef]
8. Ricciardi, A.M.; Xia, J.; Currie, G. Exploring Public Transport Equity between Separate Disadvantaged Cohorts: A Case Study in Perth, Australia. *J. Transp. Geogr.* **2015**, *43*, 111–122. [CrossRef]
9. Muñoz, P.; Franceschini, E.A.; Levitan, D.; Rodriguez, C.R.; Humana, T.; Perelmuter, G.C. Comparative Analysis of Cost, Emissions and Fuel Consumption of Diesel, Natural Gas, Electric and Hydrogen Urban Buses. *Energy Convers. Manag.* **2022**, *257*, 115412. [CrossRef]
10. Frey, C.B.; Osborne, M.A. The Future of Employment: How Susceptible Are Jobs to Computerisation? *Technol. Forecast. Soc. Change* **2017**, *114*, 254–280. [CrossRef]
11. Gompf, K.; Traverso, M.; Hetterich, J. Towards Social Life Cycle Assessment of Mobility Services: Systematic Literature Review and the Way Forward. *Int. J. Life Cycle Assess.* **2020**, *25*, 1883–1909. [CrossRef]
12. Lucas, K.; Philips, I.; Verlinghieri, E. A Mixed Methods Approach to the Social Assessment of Transport Infrastructure Projects. *Transportation* **2022**, *49*, 271–291. [CrossRef]
13. Coakes, S.; Anagnostaras, J. Chapter 29: Social research methods for project social impact assessment. In *Handbook of Social Impact Assessment and Management*; Edward Elgar Publishing: Cheltenham, UK, 2024; pp. 460–474. [CrossRef]
14. Raza, A.; Zhong, M.; Akuh, R.; Safdar, M. Public Transport Equity with the Concept of Time-Dependent Accessibility Using Geostatistics Methods, Lorenz Curves, and Gini Coefficients. *Case Stud. Transp. Policy* **2023**, *11*, 100956. [CrossRef]
15. Bastiaanssen, J.; Johnson, D.; Lucas, K. Does Better Job Accessibility Help People Gain Employment? The Role of Public Transport in Great Britain. *Urban Stud.* **2022**, *59*, 301–322. [CrossRef]
16. Guinée, J.B.; Heijungs, R.; Huppes, G.; Zamagni, A.; Masoni, P.; Buonamici, R.; Ekvall, T.; Rydberg, T. Life Cycle Assessment: Past, Present, and Future. *Environ. Sci. Technol.* **2011**, *45*, 90–96. [CrossRef]
17. Hawkins, T.R.; Singh, B.; Majeau-Bettez, G.; Strømman, A.H. Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles. *J. Ind. Ecol.* **2013**, *17*, 53–64. [CrossRef]
18. Huertas-Valdivia, I.; Ferrari, A.M.; Settembre-Blundo, D.; García-Muiña, F.E. Social Life-Cycle Assessment: A Review by Bibliometric Analysis. *Sustainability* **2020**, *12*, 6211. [CrossRef]
19. Jelti, F.; Allouhi, A.; Al-Ghamdi, S.G.; Saadani, R.; Jamil, A.; Rahmoune, M. Environmental Life Cycle Assessment of Alternative Fuels for City Buses: A Case Study in Oujda City, Morocco. *Int. J. Hydrogen Energy* **2021**, *46*, 25308–25319. [CrossRef]
20. Rybaczewska-Błażejowska, M.; Jezierski, D. Comparison of ReCiPe 2016, ILCD 2011, CML-IA Baseline and IMPACT 2002+ LCIA Methods: A Case Study Based on the Electricity Consumption Mix in Europe. *Int. J. Life Cycle Assess.* **2024**, *29*, 1799–1817. [CrossRef]
21. Shahpar, A.; Faghri, A.; Li, M. Emission and Life-Cycle Assessment of Alternative-Fuel Buses: A Case Study of the Delaware Authority of Regional Transit. *Int. J. Sustain. Dev. World Ecol.* **2018**, *25*, 290–302. [CrossRef]
22. Patil, A.; Herder, P.; Brown, K. Investment Decision Making for Alternative Fuel Public Transport Buses: The Case of Brisbane Transport. *J. Public Transp.* **2010**, *13*, 115–133. [CrossRef]
23. El Hafdaoui, H.; Jelti, F.; Khallaayoun, A.; Ouazzani, K. Energy and Environmental National Assessment of Alternative Fuel Buses in Morocco. *World Electr. Veh. J.* **2023**, *14*, 105. [CrossRef]
24. Fakhreddine, O.; Gharbia, Y.; Derakhshandeh, J.F.; Amer, A.M. Challenges and Solutions of Hydrogen Fuel Cells in Transportation Systems: A Review and Prospects. *World Electr. Veh. J.* **2023**, *14*, 156. [CrossRef]
25. Joseph, Z.S.; Anosike, A.C.; Adegboyega, B. Abdulquadri Optimizing Sustainable Urban Mobility: Integration of Electric Vehicle Charging Infrastructure Into Smart Buildings. *IOSRJMCE* **2024**, *21*, 38–44. [CrossRef]