Israel Public Policy Institute

HEINRICH BÖLL STIFTUNG
TEL AVIV

Policy Paper | February 2021

Making Smart Mobility Sustainable

How to Leverage the Potential of Smart and Shared Mobility to Mitigate Climate Change

Felix Creutzig

Beyond Carbon: Shaping the Transition to a Low-Carbon Economy Perspectives from Israel and Germany

Paper Series by the Israel Public Policy Institute and the Heinrich Böll Foundation Tel Aviv

In Cooperation with:

Embassy
of the Federal Republic of Germany
Tel Aviv

MCC
Mercator Research Institute on
Global Commons and Climate Change

Making Smart Mobility Sustainable

How to Leverage the Potential of Smart and Shared Mobility to Mitigate Climate Change

Author

Dr. Felix Creutzig

Project Lead

Oz Aruch
Heinrich Böll Foundation Tel Aviv
→ oz.aruch@il.boell.org

Polina Garaev
Israel Public Policy Institute (IPPI)
→ polina@ippi.org.il

Please cite as follows:

Creutzig, F. (2021). Making Smart Mobility Sustainable: How to Leverage the Potential of Smart and Shared Mobility to Mitigate Climate Change. Policy Paper Series: Shaping the Transition to a Low-Carbon Economy – Perspectives from Israel and Germany. Israel Public Policy Institute and Heinrich Böll Foundation Tel Aviv

About the Project

This policy paper was written in the framework of the project "Beyond Carbon: Shaping the Transition to a Low-Carbon Economy - Perspectives from Israel and Germany" and presented in an experts' workshop in December 2020.

The project, which includes the publication of a series of policy analyses and execution of experts' workshops, sets out to promote dialog and exchange of knowledge between experts from Germany and Israel regarding the transition to a low emissions society.

The project was conceptualized and executed by the Israel Public Policy Institute (IPPI) and the Heinrich Böll Foundation Tel Aviv with generous support by the Climate Fund of the German Federal Foreign Office, represented by the German Embassy in Tel Aviv.

We would like to thank the Mercator Research Institute on Global Commons and Climate Change (MCC) for their expertise, insights and excellent cooperation in the framework of this project.

Israel Public Policy Institute (IPPI)

The Israel Public Policy Institute (IPPI) is an independent policy think-and-do-tank and a multi-stakeholder dialog platform at the intersection of society, technology and the environment. Through its research activities, knowledge sharing, networking and public outreach, IPPI contributes to the innovation of public policy with the goal of understanding, guiding, and advancing the transformation process of our societies towards a sustainable and democratic future. IPPI works with a global network of actors from government, academia, civil society, and the private sector to foster international and interdisciplinary cross-pollination of ideas and experiences.

Heinrich Böll Foundation Tel Aviv

The Heinrich Böll Foundation is an independent global think-and-do-tank for green visions. With its international network of 33 international offices, the foundation works with well over 100 project partners in more than 60 countries. The foundation's work in Israel focuses on fostering democracy, promoting environmental sustainability, advancing gender equality, and promoting dialog and exchange of knowledge between public policy experts and institutions from Israel and Germany.

German-Israeli Dialog Program of the Heinrich Böll Foundation

The German-Israeli Dialog Program of the Heinrich Böll Foundation was established to foster cooperation and exchange of knowledge between public policy communities from Germany and Israel with the aim of generating new actionable insights in support of democratic values and sustainable development. The program is home for a range of projects and activities that provide unique collaborative spaces for researchers and practitioners from government, academia, tech and civil society to meet, debate and formulate innovative policy-oriented solutions to societal questions and challenges shared by both countries.

Contents

Executive Summary

With a growing number of smart mobility start-ups, tech evangelists often boast about the numerous gains that smart and shared mobility holds, from decreasing carbon emissions and urban congestion to reducing the number of accidents. However, while supporters of these new technologies present them as a seamless alignment of environmental activism, convenient mobility and economic promise, skeptical voices increasingly claim that smart mobility solutions, in their current design and deployment, are hardly sustainable as they do not necessarily help in decreasing GHG emissions in the transport sector, and, at times, even generate additional demand for vehicles.

Against this backdrop, the following analysis provides a comprehensive assessment of the environmental effects of different shared mobility options by estimating their marginal CO_2 emissions and considering the factors that account for the wide range in their respective emissions.

> **High systemic energy efficiency in the form of proper and proportional use of all transportation modalities, in combination with high vehicle occupancy in usage are key determinants of making urban transport low-carbon.**

Findings reveal that high systemic energy efficiency in the form of proper and proportional use of all transportation modalities, in combination with high vehicle occupancy in usage are key determinants of making urban transport low-carbon. Moreover, the consideration of wider systemic effects, presented in this paper, proved to be crucial to identifying the overall climate change mitigation contributions (or potential damage).

Only if shared mobility is effectively designed and focused on replacing private car trips and complementing rather than substituting public transport, can it contribute to achieving low-carbon mobility.

> **Only if shared mobility is effectively designed and focused on replacing private car trips and complementing rather than substituting public transport, can it contribute to achieving low-carbon mobility.**

When combining these footprint investigations with an economic perspective, including profitability challenges faced by shared mobility companies, the findings indicate that the evaluated shared mobility models have little future in providing low-carbon sustainable mobility in the current array. Nevertheless, reason for optimism remains when focusing on traditional stationary carsharing and incorporating improved conditions and regulations. Results indicate that by these means, private car traffic and emissions can be reduced dramatically while also yielding positive side benefits such as more space for urban life.

A combination of private bicycle use and shared pooled mobility can make urban transport low-carbon. Nevertheless, effective implementation depends on regulatory agencies creating further incentives for both mobility participants and service providers, and taking bold measures to institute new norms and regulations for use of street space, with the ultimate aim of banning cars entirely from city centers.

1. Introduction

As climate change mandates drastic changes to the way our economies function, and as congestion and crowded parking continue to be major issues for quality of life, new emerging mobility options such as smart and shared mobility enter the scene, promising to align green consciousness with convenient mobility and new business opportunity. As the organizers of Israel's Smart Mobility Summit 2019 framed it: "*The time is ripe for a revolution in transportation, for a world free of oil, populated by clean, accessible and efficient means of transportation.*"[1] And it's true: fossil-fuel-based transport is rapidly becoming history, and new digital technologies make novel mobility modes and usage frictionless and attractive. In particular, countries like Israel, not hampered by a domestic car industry, but motivated by having the most congested streets of all OECD countries, would profit from redesigning their mobility systems.

Yet, the digitalization of urban transport does not automatically translate into social and environmental sustainability.[2] Pedestrians complain about e-scooters on sidewalks. Uber services present unwelcome competition for taxi drivers. And though shared mobility options are increasingly entering into service, streets remain crowded as ever. Nor is there a sign that GHG emissions in the transport sector are declining. It is thus time to revisit the promise of smart and shared mobility and investigate how it can be steered in order to realize its potential.

The unfortunate starting point of this policy paper is a confusion of meaning – too often smart mobility is equated with sustainable mobility. A survey among Israel-based stakeholders reveals that smart mobility entrepreneurs are mostly concerned about commercial opportunities and lack a deeper understanding of what is necessary to transition to sustainable mobility.[3] Noy and Givoni state that "the belief amongst those entrepreneurs, it emerges, is that technological developments alone, specifically with respect to autonomous and connected vehicles, can lead to sustainable transport. This should be a real concern if those same actors are the ones who lead and pave the way forward for transport planning."[4] Hence, it's time to address this confusion and work out which smart or shared mobility options contribute to climate change mitigation and sustainable development.

A survey among Israel-based stakeholders reveals that smart mobility entrepreneurs are mostly concerned about commercial opportunities and lack a deeper understanding of what is necessary to transition to sustainable mobility.

This policy paper converses with an earlier policy paper by this author, on the feasibility and rationale of an integrated data platform to manage smart and shared mobility.[5] It first identifies the specific CO_2 emissions of different shared mobility options, demonstrating a wide range of emissions between respective venues. Second, it highlights the specific role of vehicle occupancy as key variable. Third, it calculates larger system-wide effects, and fourth, it projects the economics of shared mobility. Armed with this information, this paper will conclude with policy recommendations.

2. Assessing Marginal CO_2 Emissions of Shared Mobility Modes

There are four different modes of carsharing:[6]

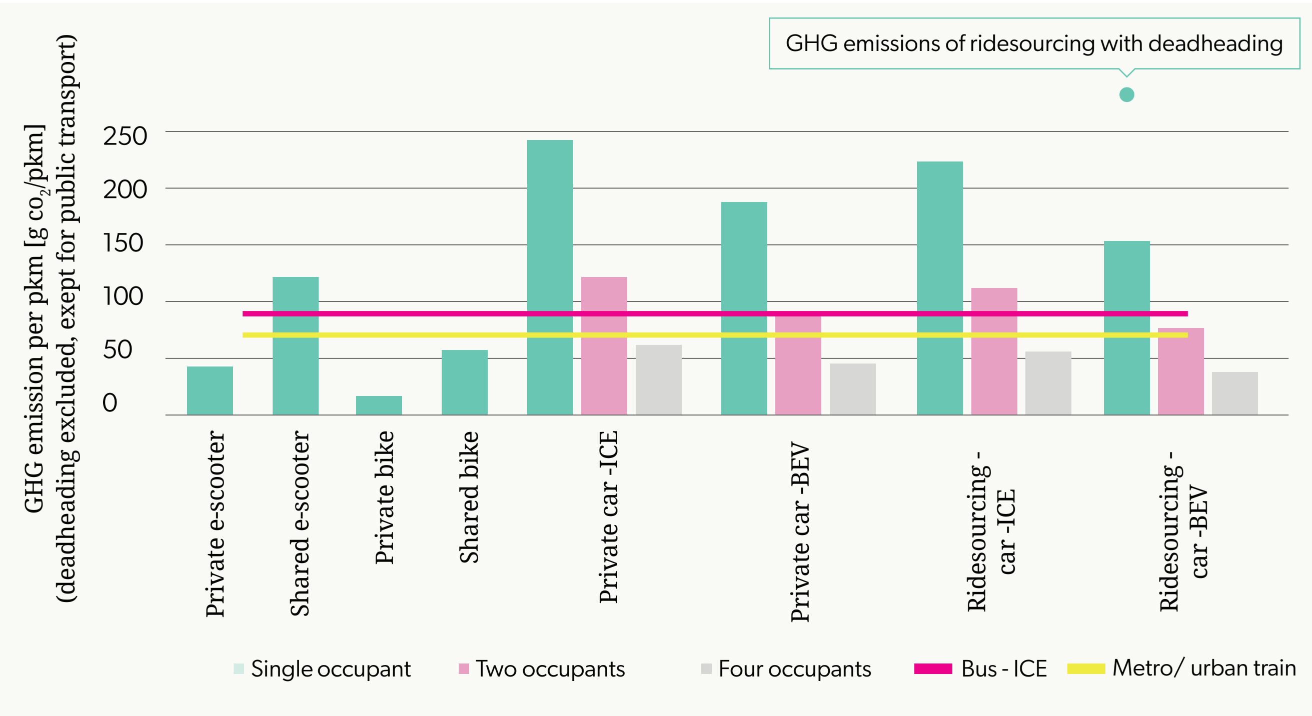
- **Micromobility** involves bike sharing and e-scooter platforms, like Tier and Lime, and similar modes. They are commonly used in cities and for shorter distances.
- **Carsharing** involves regular car driving but with cars that can be accessed by a common customer base. Carsharing refers both to stationary format with fixed pick-up and return points, and free-floating versions that allow for more flexibility, but usually at higher costs.
- **Ridesourcing services** like Uber and Lyft, are essentially unregulated taxi services (that are now becoming increasingly regulated).
- **Shared pooled mobility,** like Bubble (ViaVan), which picks up and delivers several passengers along flexible routes.

We will evaluate these modes in turn, but leave out carsharing for the moment, as marginal emissions are essentially the same as for normal car driving. Shared mobility's essential promise is that it promotes sustainability by changing consumer behavior in the long run and "by shifting personal transportation choices from ownership to demand-fulfilment."[7] In the following pages, we will explore the environmental effects of shared mobility and whether it delivers on its promise.

A first step towards evaluating the climate effects of different shared mobility modes is to calculate marginal CO_2 emissions for each kilometer a person travels. This can be done by attributional life cycle analysis (ALCA), commonly performed in academic studies. The International Transport Forum (ITF)

Figure 1.

Comparison of Attributional Life-Cycle Emissions of Different Shared and Non-Shared Modes[9]



ICE is referring to internal combustion engine and BEV is an abbreviation of battery electric vehicle. If deadheading (cruising without passengers) is included (see top right side of the figure), ridesourcing becomes more CO_2-intensive than using a private car.

released a complete data set of LCA values for a range of modes, and ran data through them for different assumption sets.[8] Figure 1 presents a selection of modes as reported by the ITF. The modes portrayed in the figure are micromobility (bike sharing and e-scooters) and ridesourcing.

The data reveals the following key insights:

→ **Two wheelers are more climate friendly than four wheelers.** Both e-scooters and bikes considerably outperform any sort of car transport. For example, a private bicycle is 15 times more CO_2-efficient than an average car with an internal combustion engine. The main reason is that two wheelers are much lighter than cars, and thus total energy expended required for travel, proportional to mass, is concurrently lower. Less dominant but also relevant: lifecycle emissions of vehicle production are also much lower for the smaller vehicles.

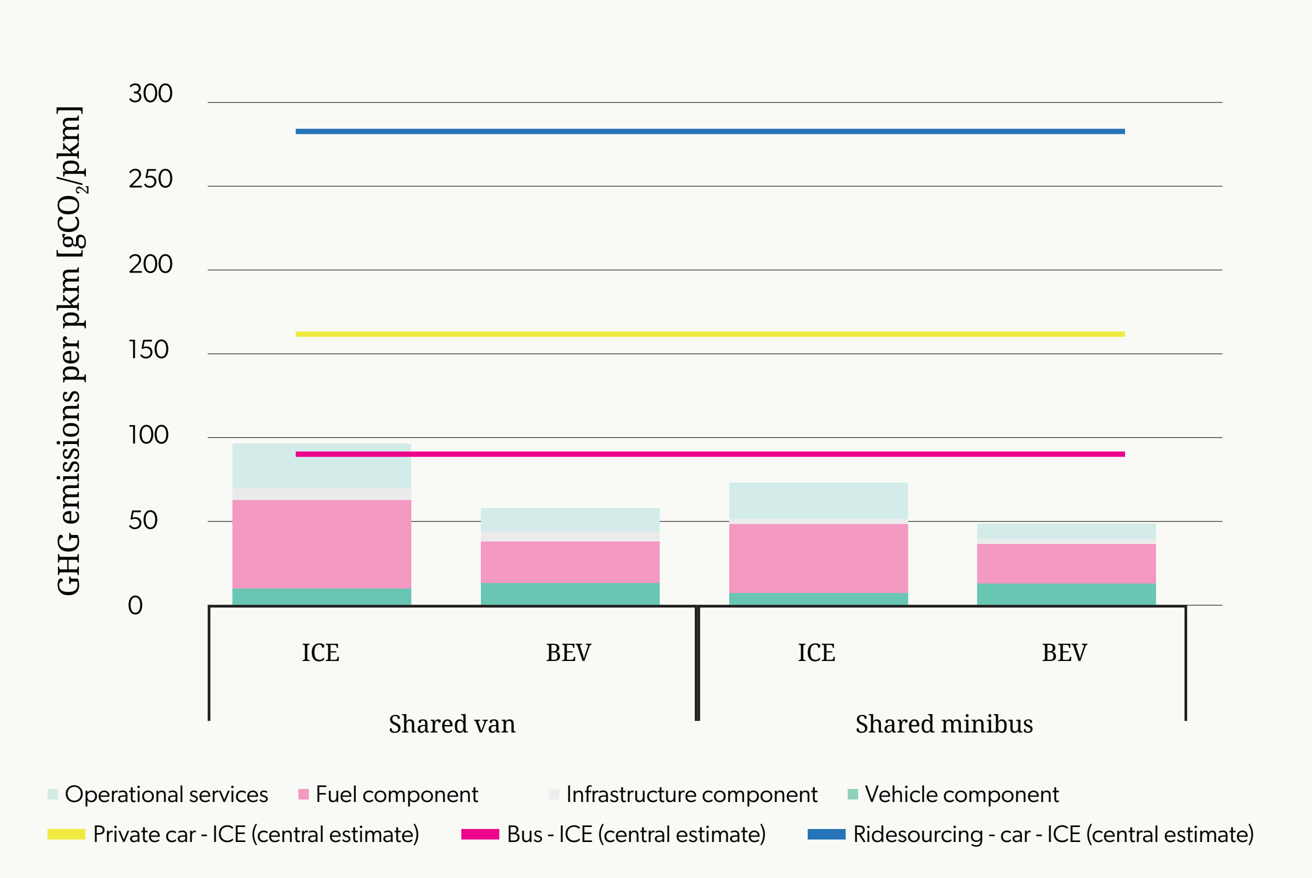
→ **There is a clear technological hierarchy.** Non-motorized means of transport (bikes) are most CO_2-efficient, followed by electric mobility (e-scooters and battery electric vehicles). Conventional fossil fuel cars perform worst. Importantly, electric vehicles are powered by electricity that is partially sourced from coal or gas power plants, and hence are not carbon neutral. Nonetheless, from a climate perspective, electric mobility clearly is an improvement compared to combustion engines.

→ **Occupancy makes all the difference for car use.** While cars with a single driver perform considerably worse than conventional public transit, marginal passenger-km CO_2-efficiency increases with every passenger, and with four passengers, cars perform similar to e-scooters and shared bikes. Occupancy is in fact the major factor driving efficient mobility. A recent study finds that occupancy accounts for about 70-90% of observed GHG emission intensities, while only the remaining 10-30% is explained by differences in trip distances, technology and operating conditions.[10]

> Occupancy makes all the difference for car use. While cars with a single driver perform considerably worse than conventional public transit, marginal passenger-km CO_2-efficiency increases with every passenger, and with four passengers, cars perform similar to e-scooters and shared bikes.

→ **"Deadheading" is key.** Deadheading refers to empty trips traveled by public or shared mobility vehicles. Commonly, buses drive empty for 1-25% of their travel time. Cities and countries with high modal split in bus transit (e.g. Bangalore, India) have usually little deadheading, while cities and countries with low modal split in public transport (e.g. Brisbane, Australia) have high deadheading shares. Ridesourcing is a mode with high deadheading shares, typically with deadheading shares of 42-81%.[11] These are high values and must be considered in calculating the marginal emissions per passenger-km. When passenger-km emissions are taken into account, ridesourcing's GHG emissions are considerably higher than that of private vehicles (Figure 1).

Figure 2.
Comparison of Different Shared Pooled Mobility Modes with Bus, Private Vehicle and Ridesourcing (with Deadheading)[12]



Vans are assumed to have eight seats, with a utilization rate of 70% as observed for New York City (4.5 seats occupied in average), and deadheading of 150%. Minibuses have a 20-seat capacity and average occupancy of 10 seats.

Next, let us consider shared pooled mobility. Our occupancy analysis above suggests that shared pooled mobility has an advantage, because it transports more passengers per vehicle-kilometer travelled. Indeed, attributional lifecycle analysis reveals that shared pooled mobility outperforms not only ridesourcing and conventional ICEs but also bus transport in terms of marginal CO_2 emissions (Figure 2). This is an impressive feat and should draw our attention, as it implies that there is a win-win situation in the dimensions of convenience and CO_2-efficiency when switching from bus to shared pooled mobility (though the latter is usually more expensive). When combined with electric propulsion, shared pooled mobility becomes similarly efficient to e-scooters.

As an intermediate summary, we can hence observe that micromobility services and shared pooled mobility with high occupancy make a difference from the perspective of climate change mitigation, but ridesourcing does not.

> **When combined with electric propulsion, shared pooled mobility becomes similarly efficient to e-scooters.**

3. Systematic Effects: A Clouded Landscape

Until now, we have discussed marginal GHG emissions of shared mobility modes. However, as is commonly known in sustainability science, the choice of boundaries of analysis is crucial.[13] Specifically, it is important to also consider wider system effects. The most important such effect is the question of which transport mode is replaced by novel shared mobility options. If they replace cycling or walking, overall GHG emissions will rise. If some of the better options replace private vehicles, systemic effects will be beneficial.

According to the ITF study, ridesourcing outfits such as Uber, already implicated with the worst CO_2 footprint of all modes, replace public transport in a third of trips.

- **Ridesourcing:** While there are some examples of marginal positive effect, in most cases, ridesourcing has been shown to increase the overall GHG emissions, as it often replaces less CO_2-intensive means of transport. One example of its positive effect is a study of Didi, the main Chinese ridesourcing service, which revealed that ridesourcing is more CO_2 efficient than taxis, because Didi drivers wait at the drop-off location for new passengers rather than returning to fixed stations.[14] However, the more comprehensive ITF study on observed replacement effects points to a largely negative effect: It finds that ridesourcing outfits such as Uber, already implicated with the worst CO_2 footprint of all modes, replace public transport in a third of trips.[15] Also the replacement of car and taxi travel in about 40% of all ridesourcing trips, otherwise plausibly beneficial, actually increased GHG emissions, according to the study. Finally, the convenience of ridesourcing gives rise to an effect known as "induced travel," whereby in 8% of ridesourcing trips patrons would have stayed home otherwise.[16] This mode of transport therefore leads to the most overall additional GHG emissions per trip.

- **Carsharing:** So far not considered, carsharing has small beneficial effects. It replaces, in some cases, private car ownership, which reduces the number of overall car trips, essentially cancelling out unnecessary travel, thus reducing GHG emissions. For example, an early study of San Francisco carsharing demonstrated a saving of nearly half a ton of CO_2 per carsharing user due to replacement of private car usage, corresponding to about 16-18% of previous GHG emissions.[17] Similar effects were also observed in the Netherlands and in Calgary, but at a somewhat lower magnitude.[18]

- **Micromobility:** This mode of shared mobility has ambiguous effects. It replaces some car trips (in about 5-15% of trips), which reduces overall GHG emissions. However, it also replaces numerous walking and cycling trips – nearly half of all trips with e-scooters would have been walked otherwise. This induced motorized travel increases GHG emissions. However, the example of dockless bikesharing in Shanghai demonstrates that bike sharing replaces a high number of car trips, especially during the evening peak hour and in the inner city, and reduces CO_2 emissions by more than 25,000 tons.[19] A case study of motorcycle sharing in Jakarta demonstrates that beneficial effects of car substitutions are canceled out by public transit replacement and deadheading, thus improving mobility but not sustainability.[20]

In summary, substitution assessment and case study observation demonstrate that the evaluation of systemic effects in shared mobility is crucial for identifying the overall climate change mitigation contribution (or additional damage). If shared mobility is efficiently designed and replaces private car trips, it can contribute to marginally reducing GHG emissions.

Table 1.

Systemic Modal Substitution Effects of Shared Mobility[21]

Mode	Country	Modal Substitution Effect					
		Taxi	Public Transport	Cars	Walking	Cycling	Induced Travel
Ridesourcing	United States	-39%	-33%	-6%			8%
	France	-27% to -32%	-38% to -45%	-5%			9%
Carsharing	United States		Slight reduction	-10%			-10%
	France		Slight increase	-10%			-10%
Micromobility	United States	-15%	-10%	-15%	-37%	-9%	8%
	France	-4% to -5%	-29%	-4% to -5%	-47%	-12%	3%
	Brazil	-26%	-20%	-14%	-52%		

4. The Economics of Shared Mobility

While some shared mobility modes entered urban markets only recently, carsharing is a much older concept. It is therefore important to take stock of the decades-old development. The insight is clear: while carsharing has been established in niche markets, it has not made a dent in overall rates of car ownership and has failed to change mobility patterns in cities. A study from 2019 demonstrates that new free-floating carsharing models, marketed aggressively, have also failed to make a difference.[22] It is true that companies like ShareNow (formerly Car2Go and DriveNow) are popular and brought in a reasonable customer base. However, the numbers remain too low to change overall car ownership and mobility in cities. Carsharing and similar offers are chosen for convenience and their economics complement rather than substitute the use of private cars, at least at aggregate scale.

> While carsharing has been established in niche markets, it has not made a dent in overall rates of car ownership and has failed to change mobility patterns in cities.

A key additional challenge is the economics of density. Economics of density here means that shared mobility companies require sufficient ridership and sufficiently frequent use of their vehicle stock to remain economically viable. Shared mobility modes are economically competitive where populations are concentrated, i.e. in dense cities. One report, considering the German case, suggests that only the areas with the highest population density in Germany, which account for only 5% of the population, are attractive for carsharing companies.[23] This needs to be contrasted with the observations that urbanites in city centers are the people least dependent on cars to start with. Areas with low-to-medium population density including suburbs, where there is most potential for transitioning from individual to pooled car use, are meanwhile not targeted by private companies fearing insufficient revenues to cover operation costs. This analysis, together with the footprint investigations of the first part of this paper, suggest that shared mobility has little future in providing low-carbon sustainable mobility in the current market system.

However, there are two rays of light. First, the above analysis was focused on free-floating shared mobility, while traditional stationary carsharing (i.e. car rental) does effectively reduce emissions, since it is more often used for longer trips outside the city and is more strongly related to replacement of private car ownership and overall mileage.[24]

Second, modeling studies by the ITF suggest that under different conditions and regulation, shared mobility could make a difference. The ITF modeled shared mobility potentials for Dublin, Lisbon and Helsinki,[25] and their results demonstrate that replacing private car traffic with pooled van and minibus services in urban areas dramatically reduces the number of vehicles required, lower GHG emissions, and makes current parking space available for urban life – while maintaining door-to-door accessibility for all inhabitants. Thus with minibuses, today's automobile traffic in Helsinki could be replaced by just 4% of the current number of private vehicles, realizing the following benefits:

- → GHG emissions from cars would fall by a third;
- → Congestion would be reduced by more than a third;
- → Parking spaces could be freed for public life;
- → Fewer transfers, less waiting, and shorter travel times would provide an advantage over traditional public transport.

Given these benefits, even current habitual car users may be convinced to use this new form of transport instead of their own cars. This leaves the question of what kind of steps could be taken to realize these fantastic benefits.

> **Modeling studies by the International Transport Forum suggest that under different conditions and regulation, shared mobility could make a significant contribution to the reduction of GHG emissions.**

5. Policy Recommendations

Our analysis suggests that smart and shared mobility can indeed contribute to GHG emissions reduction in the transport sector and sustainable development, e.g., by reducing congestion and pollution. However, the analysis also reveals that in its current design and deployment, with a strong focus on ridesourcing and micromobility, shared mobility not only contributes little to climate change mitigation, but also produces undesirable effects, such as partially increasing GHG emissions and reducing active mobility by providing a convenient motorized option that leads people to forego the effort of walking or biking. A central question hence concerns the choice of policy instruments that can help shared mobility realize its potential.

> The key policy recommendations presented in this paper are motivated by the observation that occupancy is what makes shared mobility CO_2-efficient.

The key policy recommendations presented in this paper are motivated by the observation that occupancy is a key factor in making shared mobility CO_2 efficient. Thus, higher occupancy shared taxis, minivans or minibuses should be strategically incentivized.

- **Reserve designated boarding spaces for shared pooled mobility in central locations:** A good starting point would be to reserve designated boarding spaces in attractive locations, e.g., in front of office complexes, opera houses, and football stadiums, for shared pooled mobility but excluding ridesourcing and taxi services. In addition, urban parking spaces can be discounted for shared mobility modes.

- **Exclusion of private cars from city centers:** A more radical approach calls for the exclusion of private cars from city centers altogether. This approach is justified by the understanding that private car use is a “tragedy of the commons,” where individual benefit – the convenience of having one’s own mode of transport always accessible – deteriorates quality of life for everyone else (public space occupation, congestion, air pollution, climate change, resource depletion, etc.). In fact, the benefits lost as a result of banning private cars from urban centers would be mostly offset by gains such as reduced congestion, shortened duration of rides, as well as alleviating the stress of travel. Freeing up parking spaces as a result of banning cars from urban centers would also contribute to a fairer allocation of street space:[26] From a space distribution perspective, the use of space for non-moving vehicles is much more problematic than the use of streets for moving cars. Shared mobility optimizes this situation by having fewer cars, which move more.

- **Incentives for shared mobility providers:** Municipal governments should proactively engage with shared mobility providers and offer lenient regulation, which could be leveraged as an incentive in exchange for data sharing and trusted urban data governance.[27] Preferential regulation should inter alia allow for free parking, especially in areas insufficiently covered by public transit, thus increasing the likelihood of complementing rather than substituting for public transit use.

- **Create reporting standards for shared mobility providers:** Reporting standards for shared mobility providers should be created, especially with regard to environmental and CO_2-footprint data. Measuring total lifecycle GHG emissions of shared mobility vehicles provides not only transparency but also changes the mindset of providers to actively consider opportunities to make mode use more efficient and thus reduce overall GHG emissions. A crucial dimension is the lifetime of vehicles, also to be reported, which can be improved by corporate policies, probably without increasing costs. Federal jurisdictions and cities can make licensing subject to reporting and minimum CO_2-footprint standards.

→ **Facilitate better understanding of the "Bigger Picture":** A last policy recommendation relates to the lack of incentive for mobility service providers to consider actual GHG emission reductions as part of their business plans. This begins with an understanding that shared mobility is embedded into an overarching economy-wide strategy to reduce GHG emissions, complying with the goals of the Paris Agreement, and supporting the transition to a low-carbon economy. Such an orientation would give rise to policies such as economy-wide carbon pricing that puts a price on pollution, from GHG emissions not only due to vehicle use, but also from vehicle construction. This would trickle down to mobility service providers, who would then be motivated to comply with the wider environmental and planetary interest.

Endnotes

1 Israel Ministry of Foreign Affairs, n.d. Smart Mobility 2019. https://mfa.gov.il/MFA/InnovativeIsrael/Conferences/Pages/Smart-Mobility-2019.aspx (accessed 11.23.20).

2 Creutzig, F., Franzen, M., Moeckel, R., Heinrichs, D., Nagel, K., Nieland, S., Weisz, H., 2019. Leveraging Digitalization for Sustainability in Urban Transport. Glob. Sustain. https://www.cambridge.org/core/journals/global-sustainability/article/leveraging-digitalization-for-sustainability-in-urban-transport/9322C52E379793B7C4A41682EC99DB6A.

3 Noy, K., Givoni, M., 2018. Is 'Smart Mobility' Sustainable? Examining the Views and Beliefs of Transport's Technological Entrepreneurs. Sustainability 10, 422. https://doi.org/10.3390/su10020422.

4 Ibid.

5 Creutzig, F., 2020. Leveraging the Benefits of Smart Mobility via an Integrated Data Platform. Policy Paper Series "Decarbonization Strategies in Germany and Israel". Potsdam/Tel Aviv: Institute for Advanced Sustainability Studies (IASS), Israel Public Policy Institute (IPPI), Heinrich-Böll-Stiftung Tel Aviv.

6 Shaheen, S., Cohen, A., 2019. Shared ride services in North America: definitions, impacts, and the future of pooling. Transp. Rev. 39, 427–442. https://doi.org/10.1080/01441647.2018.1497728.

7 Mi, Z., Coffman, D.M., 2019. The sharing economy promotes sustainable societies. Nat. Commun. 10, 5–7. https://doi.org/10.1038/s41467-019-09260-4.

8 International Transport Forum, 2020. Good to Go? Assessing the Environmental Performance of New Mobility. https://www.itf-oecd.org/sites/default/files/docs/environmental-performance-new-mobility.pdf.

[9] Data source: International Transport Forum, 2020.

[10] Schäfer, A.W., Yeh, S., 2020. A holistic analysis of passenger travel energy and greenhouse gas intensities. Nat. Sustain. 3, 459–462. https://doi.org/10.1038/s41893-020-0514-9.

[11] Henao, A., Marshall, W.E., 2019. The impact of ride-hailing on vehicle miles traveled. Transportation 46, 2173–2194. https://doi.org/10.1007/s11116-018-9923-2;

Henao, A., Marshall, W.E., Janson, B.N., 2019. Impacts of Ridesourcing on VMT, Parking Demand, Transportation Equity, and Travel Behavior. Mountain Plains Consortium.

[12] Data source: International Transport Forum, 2020.

[13] Socolow, R.H., 1976. Failures of discourse. Bull. Am. Acad. Arts Sci. 11–32.

[14] Sui, Y., Zhang, H., Song, X., Shao, F., Yu, X., Shibasaki, R., Sun, R., Yuan, M., Wang, C., Li, S., Li, Y., 2019. GPS data in urban online ride-hailing: A comparative analysis on fuel consumption and emissions. J. Clean. Prod. 227, 495–505. https://doi.org/10.1016/j.jclepro.2019.04.159.

[15] International Transport Forum, 2020.

[16] Ibid.

[17] Cervero, R., Tsai, Y., 2004. City CarShare in San Francisco, California: second-year travel demand and car ownership impacts. Transp. Res. Rec. 1887, 117–127.

[18] Amatuni, L., Ottelin, J., Steubing, B., Mogollon, J., 2020. Does car sharing reduce greenhouse gas emissions? Assessing the modal shift and lifetime shift rebound effects from a life cycle perspective. J. Clean. Prod. 121869.

[19] Zhang, Y., Mi, Z., 2018. Environmental benefits of bike sharing: A big data-based analysis. Appl. Energy 220, 296–301. https://doi.org/10.1016/j.apenergy.2018.03.101.

[20] Suatmadi, A.Y., Creutzig, F., Otto, I.M., 2019. On-demand motorcycle taxis improve mobility, not sustainability. Case Stud. Transp. Policy 7, 218–229.

[21] Data source: International Transport Forum, 2020.

[22] ATKearney, 2019. The demystification of car sharing. https://www.de.kearney.com/documents/1117166/0/Car+Sharing.pdf/3bff4a9a-1279-b26f-3b23-8183f14979ce?t=1565336041050.

[23] Ibid.

[24] For Germany but also California, see Cervero and Tsai, 2004.

[25] International Transport Forum, 2017. Shared Mobility Simulations for Helsinki. https://www.itf-oecd.org/sites/default/files/docs/shared-mobility-simulations-helsinki.pdf.

[26] Creutzig, F., Javaid, A., Soomauroo, Z., Lohrey, S., Milojevic-Dupont, N., Ramakrishnan, A., Sethi, M., Liu, L., Niamir, L., Bren d'Amour, C., 2020. Fair street space allocation: ethical principles and empirical insights. Transp. Rev. 1–23.

[27] For further information, see Creutzig, 2020.

About the Author

Dr. Felix Creutzig is head of the working group Land Use, Infrastructures and Transport at the Mercator Research Institute on Global Commons and Climate Change (MCC), Chair of Sustainability Economics at Technische Universität Berlin and a Research Fellow at the Israel Public Policy Institute (IPPI). He is the Coordinating Lead Author of the IPCC's Sixth Assessment Report, and was the lead author of the IPCC's Fifth Assessment Report as well as lead analyst of the Global Energy Assessment.

Felix holds a PhD in computational neuroscience from the Humboldt University of Berlin. He was a postdoctoral fellow at the University of California at Berkeley, where he researched climate change mitigation in the transportation sector and, and a visiting fellow for the Energy Foundation China, where he analyzed the effects of an inner city toll in Beijing. As president of Netzwerk Europa, the alumni association of the Studienkolleg zu Berlin, he has been dedicated to building a common Europe.

Israel Public Policy Institute

→ office.israel@ippi.org.il
→ www.ippi.org.il

Heinrich Böll Foundation Tel-Aviv

→ info@il.boell.org
→ www.il.boell.org

Release date: February 2021

Design: www.tinker.co.il
Cover: www.danielgoldfarbart.com

Israel
Public Policy
Institute

HEINRICH BÖLL STIFTUNG
TEL AVIV