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German and Israeli Cities at the Intersection of Tech Innovation and Decarbonization: Trends and Challenges

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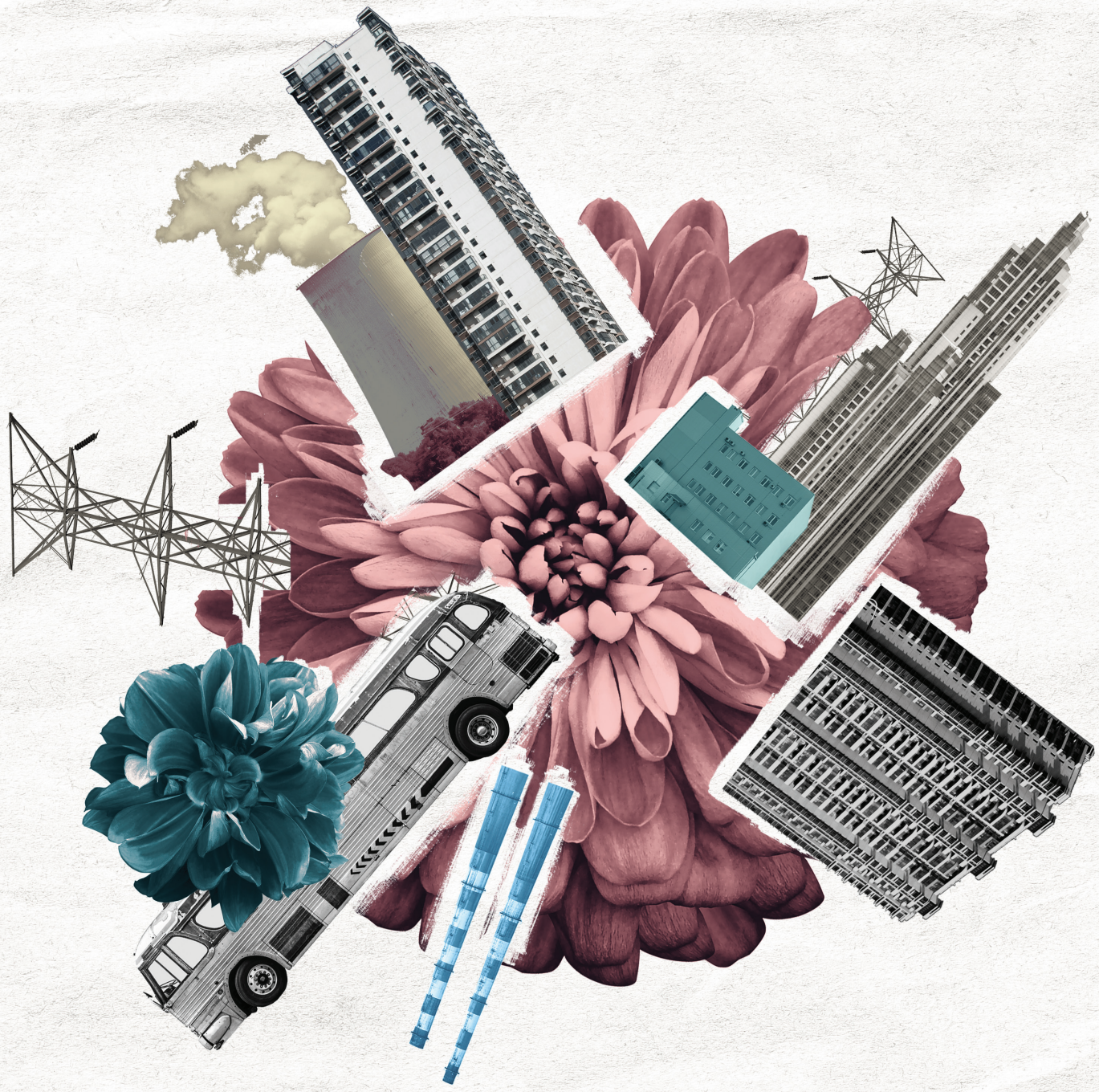

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About the Author

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About the Program

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Against the backdrop of the Paris Agreement, the program invited policy professionals from Germany and Israel to explore issues relating to the transition to low-carbon economies, with the aim of fostering increased cooperation and exchange of ideas and knowledge between relevant stakeholders from academia, civil society and the governments of both countries. The opinions expressed in this policy brief are solely that of the author and do not necessarily reflect the views of any of the program partners.

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1. Executive Summary

One of the main challenges of the 21st century is to remove fossil fuels from our energy and socio-economic systems. This transformation to zero-carbon economies – termed decarbonization – calls for simultaneous transformations and an integrated approach to address carbon-intensive behavior.[1]

Germany and Israel represent two different stages of decarbonization, as well as different stages in the use of innovative tech solutions to drive their respective decarbonization processes. Germany has launched a massive energy transition process (Energiewende), which aims to dramatically reduce the country's reliance on fossil and nuclear energies. Among others, German policymakers are faced with the challenge of securing enough renewable energy sources to support industrial and residential needs and reducing carbon emissions from the transportation and agriculture sectors.[2] The energy transition in Germany is taking place in a federal system with a decentralized energy market that affords cities leeway to develop and implement their own policies and practices. In addition, Germany is now taking steps to develop its tech and start-up industries amid global demands and competition.[3] These efforts are also being incorporated into the energy transition.[4]

Israel's decarbonization challenges are different. They include, among others, the task of reducing carbon emissions from the transportation sector and the built environment and increasing the share of renewable energies to 30% by 2030 (compared to 5% today).[5] Following the discovery of large natural gas

reserves off its coast in the late 1990s, the country is now shifting to a natural-gas-based economy, which is portrayed as a step towards emissions reduction.[6] Israel has a strong and innovative tech industry, but it has only recently begun to harness these capacities to reduce carbon emissions.[7] This is happening in a centralist political system, very different from the German situation. Many municipalities in Israel are dependent on central government and party affiliation to manage their resources and provide services. At the same time, many of them enjoy de facto autonomy in the management of resources and services such as urban planning and some aspects of transportation.[8]

Municipalities in both Germany and Israel have launched various initiatives to support decarbonization processes in their jurisdictions, while integrating technological tools and stressing the importance of harnessing innovation, albeit different in form and scale.

This policy brief focuses on the nexus between decarbonization and tech innovation on the municipal level in Germany and Israel. It asks how decarbonization and innovation are coupled in cities in both countries, and what this nexus brings with it. To answer these questions, the following text provides a qualitative analysis of two German and two Israeli forerunner cities that are involved in efforts and practices of urban decarbonization and innovation.

Key Findings

The policy brief identifies three key challenges at the nexus between decarbonization and tech innovation:

1. In the Israeli cities and, to a lesser extent, in the German ones, there is a growing emphasis on tech innovation as an approach to decarbonization: The cities focus on IT/ICT solutions that allow urban resources to be used and managed more efficiently, and also provide space for niche experimentation. While innovation is hailed as the harbinger of a greener future, in practice the technological tools and their benefits remain questionable when viewed in the context of the cities' decarbonization and development challenges. One major reason for this push for innovation is pressure from the central government.
2. Within the range of tech solutions, electric private mobility is prioritized: Three out of four cities prioritize innovation through the promotion of e-vehicles and shared e-mobility. To some extent, this perpetuates a reliance on private cars. Steps to dramatically reduce private mobility are few and not systematic.
3. Political gaps between central government and local authorities may slow decarbonization efforts: Despite their different political systems, decarbonization processes at the national-level and related tech innovation policies in both Israel and Germany are confined to a relatively limited group of stakeholders. For example, city-level officials and urban development experts seem to be insufficiently integrated into

decision-making processes in this area. This pattern of exclusion may slow cities' efforts to promote their decarbonization efforts.

Recommendations

The following recommendations are geared towards addressing problems at the nexus between decarbonization and tech innovation on the municipal level:

1. Instead of focusing primarily on tech innovation as a silver bullet in driving forward their decarbonization processes, cities should utilize their power to push for deeper decarbonization measures in energy and green building, among others. This is especially relevant in the case of Israeli cities, but could also benefit German cities.
2. When adopting tech solutions, cities could benefit from a more diverse allocation of resources rather than concentrating their efforts on private e-mobility.
3. A more collaborative and inclusive approach to national strategic planning, which integrates the perspectives of city officials, citizens and civil society, may enhance the urban decarbonization process.

2. Research Rationale

The role of cities in shaping and driving the decarbonization process is growing, as municipalities are increasingly implementing policies and technologies that support the transition to a low-carbon economy.[9] Cities are leading the shift to sustainable energy consumption and production,[10] reducing emissions from urban and national transportation fleets,[11] and adopting "smart" technologies and other innovative measures to efficiently use and manage resources.[12] Forerunner cities deserve special attention in this regard, as they may shed light on the capabilities and limitations of cities in a given political system.[13]

There is a wealth of research on urban low-carbon transitions and innovation[14] and critical assessments of the role of tech innovation and sustainability efforts in cities.[15] However, the links between decarbonization and innovation measures, especially tech innovation at the municipal level, and their implications for cities are under-researched.[16] This research gap holds true also for cities in Germany and Israel. German cities are an integral part of the Energiewende,[17] and play a key role in enhancing energy efficiency and promoting public transportation and green building standards. Moreover, German cities benefit from the low-carbon policies and measures promoted by the European Union (EU).[18] Also in Israel, although cities receive less encouragement to reduce their carbon emissions from higher levels of government than in Germany,[19] many of them try to take climate action on their own initiative.[20] However, a more detailed account of recent developments regarding initiatives that set out to

promote decarbonization processes via the integration of new technologies, as well as the links between the parallel efforts to make cities “smart” and “green”, is lacking at the municipal level in both countries. This is especially true for policy-oriented studies. The goal of this analysis is to enhance the understanding of these links and their implications.

3. Methodology

To provide an account of developments in decarbonization and innovation measures in German and Israeli cities, the following text examines what cities are "doing". It identifies weak points with regard to the goal of decarbonization and, in some cases, suggests alternatives.

The study focuses on four cities: Tel Aviv-Yafo and Eilat in Israel, and Berlin and Freiburg in Germany (see Table 1). All four cities are leaders in their countries in terms of implementing decarbonization and/or innovation measures. These measures are aligned to some extent with tech innovation, such as the smart management of resources, information and services. The decision to focus on forerunner cities may draw criticism for not being representative.[21] However, forerunner cities provide insights into trends in cutting-edge decarbonization efforts at the city level and their consequences, which other cities cannot do to the same extent.

The Israeli cities' high ranking in the smart and sustainable cities index[22] is confirmed by other studies and reports.[23] Eilat was incorporated into this study based on the author's ongoing research project; its decarbonization and innovation practices have only recently become the focus of research. The German cities were also chosen based on the author's ongoing research project,[24] and their relevance for the paper was examined against other studies.[25]

The choice of the four cities is based on the following considerations:

- Being known for decarbonization and innovation efforts;[26]
- Different geographical scales and political weight;
- Domestic political and/or institutional context.[27]

The analysis is based on semi-structured interviews and formal and informal conversations with German and Israeli stakeholders engaged in the design of decarbonization and innovation measures at the municipal and national levels; and a review of the research literature and other relevant sources on urban sustainability, low-carbon transitions and technology. Some of the data and conversations were drawn from the author's ongoing (separate) research projects.[28]

Table 1. Cities' Characteristics

City	Size	Population	Type	Main Sources of Income	Initiating Decarbonization	Focusing on Tech Innovation Since:	Further Notes
Berlin (GR)	892 km^2	3.77 million	Centre (Capital)	Tourism, services, government, hi-tech	Early 2000s	2010s	Site for experimentation
Freiburg (GR)	153 km^2	230,000	Periphery	Tourism, services	Late 1970s	Late 2010s	Model city of urban sustainability
Tel Aviv-Yafo (IL)	52 km^2	451,500	Centre	Tourism, services, hi-tech	Late 2000s	2010s	"Smart City" and sustainability pioneer
Eilat (IL)	85 Km^2	52,000	Periphery	Tourism	Early 2010s	Late 2010s	Renewable energy pioneer

Source: Author

4. Findings

4.1. Prioritization of Tech Innovation

Finding 1: In the Israeli cities and, to a lesser extent, in Berlin and Freiburg, tech innovation is celebrated as the key to drive the decarbonization process

All four cities exemplify the coupling of decarbonization and tech innovation by various means. However, in the Israeli cities tech innovation seems to have taken the lead as the main pathway to promote decarbonization efforts, with tech solutions being treated de facto as decarbonization measures (see Table 2). While this approach also exists in the German cities, it is less prominent. The following section maps these trends and goes on to question the usefulness of these preferences in view of the development challenges the cities are facing. The section ends by pointing to one major driver of the preferences of all four cities, namely the central government.

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4.1.1. Decarbonization Measures and Tech Innovation in the Different Cities

Tel Aviv-Yafo: Tel Aviv-Yafo is Israel's economic center and the capital of the country's largest metropolitan area. The city tops Israel's smart cities index[29] and is leading municipal efforts to reduce carbon emissions. For example, the city is engaged in planning efficient small-scale energy production in new neighborhoods, experimenting with green renovation in Bauhaus buildings, providing information to residents who wish to install photovoltaic (PV) panels in their homes

and securing green standards and PV instalments in new municipal public buildings.[30]

With regard to emissions reductions from transportation, Tel Aviv-Yafo has pioneered smart mobility solutions, including a car-sharing initiative called AutoTel,[31] a bicycle-sharing service, and, more recently, an experimental public ride-sharing service ("Bubble").[32] The city's strategic plan connects these initiatives to the use of tech solutions to improve the urban environment and urban services, while also addressing climate change.[33]

Eilat: Israel's southernmost peripheral city. It is streets ahead of other Israeli cities in terms of its use of renewables: About 70% of Eilat's daytime electricity comes from renewable energies provided by Eilat-Eilot, a public-benefit corporation.[34] The city has positioned itself as a smart-energy city: It has completed an EU Pilot on the smart management of energy and resources at the neighborhood scale,[35] and it is collaborating with private corporations to encourage private households to install solar panels by providing residents with relevant data.[36] Smart solutions are also envisaged to reduce emissions from transportation by enhancing mobility management and integrating e-vehicles into the municipal public transport fleet and taxis.[37]

Tel Aviv-Yafo and Eilat apply tech solutions such as smart energy and mobility management to the problem of urban emissions. While this approach has the potential to reduce emissions, it also perpetuates carbon-intensive patterns of urban planning, which are not conducive to green building on a large scale or a shift away from private mobility.

Berlin: Berlin has been making efforts to reduce its carbon emissions from energy since the early 2000s.[38] It positioned itself as an innovative and forerunner city by developing and encouraging knowledge production and experimentation in the area of climate and sustainability,[39] especially in (sustainable) energy management and, increasingly, in green building and transportation.[40] Two major advancements are the 2016 Berlin Energy Turnaround Act[41] and the 2018 Berlin Mobility Act,[42] in which Berlin sets out to dramatically reduce its emissions from energy, building and transportation over the next two decades. Among other things, the new laws provide for vast investments in the city's public transportation system and attempts to reduce its dependency on fossil fuels.

In parallel, Berlin is emerging as Germany's start-up and entrepreneur city. The city aspires to be a leading "Smart City" by integrating smart solutions to increase resource efficiency and improve services such as data collection and dissemination. Smart solutions are promoted as a way of improving the energy efficiency of infrastructures and buildings, increasing the uptake of renewable energy, and supporting better and more sustainable urban planning.[43] They are also seen as vital to managing transportation in the city.[44] But despite these good intentions, Berlin is still seen as lagging behind in terms of coupling smart solutions with urban environmental problems.[45]

Freiburg: Freiburg has more experience with systematic decarbonization policies and practices than the other cities considered in this study. It can look back on decades of trial

and error in implementing various measures to drive urban sustainability, as well as long-standing efforts to serve as a model city.[46] Yet the city has not been as advanced when it comes to tech innovation:[47] Rather than hi-tech solutions, it has tended to focus on novel building and planning approaches. However, it is now trying to make up for lost time by putting more emphasis on smart solutions with respect to energy and transportation challenges.[48]

Harnessing tech solutions to drive forward urban sustainability and decarbonization, Berlin and Freiburg, unlike their Israeli counterparts, seem not to view these as the primary solution. Rather, the two German cities employ a more heterogeneous mix of instruments and provide space for decarbonization efforts that do not focus mainly on technology.

4.1.2. The Challenge Ahead: Urban Development

The increasing preference of tech solutions should also be seen in the context of different urban development prospects. For example, Tel Aviv-Yafo plans new neighborhoods with an estimated total of more than 50,000 residents. Berlin's population is expected to grow by 500,000 by 2035, thus passing the four million mark.[49] Eilat and Freiburg are also set to grow, albeit on a smaller scale. In addition to the construction of new residential and commercial buildings, urban growth calls for additional infrastructure, roads and resources (water, energy, land). These elements should be considered when considering potential decarbonization pathways.

Green building has been slow to take off in Israel,[50] and the planning of new neighborhoods is still based largely on traditional, unsustainable models.[51] Yet in an important new development, Israel's Central Planning Authority has stipulated that all new buildings are to implement the Israeli Green Building Standards from 2021 on.[52] However, the new requirement has its shortcomings: For example, certain types of public, private and commercial buildings are exempted.[53] It is too early at this stage to assess how this requirement will affect the decarbonization process in Israel's cities.

Similar contradictions are also found in Berlin. Reducing Berlin's reliance on a fossil-based energy supply remains a major challenge, as are its large energy-inefficient building stocks.[54] Moreover, energy experimentation in Berlin has not always translated into large-scale projects.

Freiburg, on the other hand, may be in a better position to cope with its urban development demands, thanks to its longer and successful experience of urban sustainable transportation and building. The fact that it was late to jump on the tech innovation bandwagon may stand in its favor, ensuring that the city can take a more critical stance as it attempts to incorporate tech solutions into its decarbonization efforts, while also tackling development challenges.

Table 2. Cities' Main Decarbonization Efforts and Tech Innovation Measures

	Tel Aviv-Yafo	Eilat	Berlin	Freiburg
Decarbonization Measures	**Energy** Green retrofit (Bauhaus buildings; experimentation); Green building standards & renewable energy (PV) in new public buildings; Neighborhood cogeneration (CCHP; in planning); Providing residents with data **Transportation** Bicycle & scooter sharing; Car-sharing (AutoTel); New bicycle lanes	**Energy** Renewable energy; Energy efficiency (public buildings, neighborhood scale) **Transportation** E-mobility (shared cars/taxis; planning)	**Energy** Renewable energy; Energy efficiency; Experimentation sites **Transportation** Large investments in public transportation and bicycle use; Alternative public transportation (Berlkönig); Car-, scooter- & bike-sharing; E-vehicles & e-public transportation; Bicycle lanes	**Energy** Renewable energy; Energy efficiency; Green building; Sustainable urban planning (district scale) **Transportation** Public transportation; Bicycle lanes; Car-sharing
Tech Innovation Measures	Car-sharing (AutoTel), bike & scooter sharing Information services ("Digitel") Smart mobility (public transportation – "Bubble" project, information services)	Energy efficiency (smart management) Smart & sustainable neighborhood (experimentation) Information services (energy)	Smart public and private mobility management Information services Energy management (experimentation)	Car-sharing Smart energy management

Source: Author

4.1.3. Drivers of Tech Innovation: Central Government

One major reason for incorporating tech solutions into decarbonization measures is the national political climate that encourages and supports tech industries and the solutions they provide.

The current political leadership in both Germany and Israel views tech innovation as key to their countries' economic development and international status.[55] Both countries see hi-tech and research and development in IT/ICT as more important engine of economic growth than traditional manufacturing industries. This is evident, for example, in Germany's attempts to turn coal-based industrial zones into cleantech areas.[56]

In terms of investment, both countries are allocating substantial financial resources to promote tech innovation. Israel invests about 400 million euros annually in the tech industry,[57] and is planning to establish a sustainability-focused innovation lab with funding of approximately 3.5 million euros in total.[58] In Germany, the federal and state levels are undertaking large-scale efforts to align the German market with global tech development and commerce trends. Public and private spending on hi-tech exceeded 92 billion euros in 2016,[59] while hundreds of millions of euros were invested in green tech (energy efficiency, renewable energy and transportation, among others).[60] Tech solutions are also an integral part of the Energiewende.[61]

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and social legitimacy of the tech industry. Cities benefit from this trend in terms of capital, increased national and international prestige, and are becoming a favored location for educated and wealthy populations.[62] Indeed, cities encourage it[63] and respond to global calls for urban innovation.[64] Yet, this kind of attitude may put cities in "permanent experimentation" mode[65] rather than speeding up deep decarbonization processes.

In addition, regardless of the political context, the four cities are bound by national policies and regulations, especially in major carbon-intensive fields like building, transportation and energy, all the while having limited resources. This means that it may be simpler for cities to adopt and implement tech solutions that are supported by national policies and allow for modest emissions reductions, rather than get to the root of the municipality's problems concerning carbon emissions. This preference may make it difficult for these cities to continue to serve as decarbonization forerunners.[66]

4.2. Emphasis on Electric Mobility

Finding 2: Municipal investment in tech-innovation prioritizes private e-mobility

Transportation is a major source of greenhouse gas (GHG) emissions in cities. All four cities in this study are officially committed to addressing the problem of emissions from transportation and, especially, from private mobility. The cities have been actively seeking innovative policies and technologies to make urban transportation – private and public – "smarter" (i.e. more efficient). The "forerunner" element here is the cities' role as a testing ground and enabler of smart mobility.

All four cities in this study are officially committed to addressing the problem of emissions from transportation and, especially, from private mobility.

Tel Aviv-Yafo allocated about 25 million euros to a ten-year car-sharing project (AutoTel).[67] In contrast, it invested about 12,000 euros (in total) to encourage residents to install PVs on rooftops.[68] The city is also experimenting with the infrastructure for e-vehicles and shared bikes and scooters.[69] Eilat has followed suit, experimenting with e-vehicles as part of its overall (intended) shift to "clean" electricity in the transportation sector.[70]

Berlin has become a testing ground for numerous experiments with the ongoing commercial use of shared vehicles and, more recently, e-mobility (cars, bicycles and scooters) such as the Berliner Agentur für Elektromobilität initiative.[71] In parallel, the city is replacing its bus fleet with electric buses at a rate of about ten buses per year.[72] These measures are part of the city's efforts to reduce the use of private cars in order to lower its GHG emissions and air pollution.[73] Despite its advanced public transportation system, Freiburg, too, encourages car-sharing within its boundaries, and is keen to establish e-vehicle projects – but it has been slower than Berlin in this regard.[74]

These initiatives are clearly a reaction to national policies and strategies that support the shift to e-mobility and, especially, private e-vehicles with a view to reducing GHG emissions from the transportation sector – in both Germany[75] and Israel.[76] By and large, German and Israeli national strategies aim to encourage a switch to more sustainable energy in private mobility and improve energy management rather than tackling people's (and the economy's) dependency on this kind of mobility. This approach owes a lot to the high dependency of both the German and Israeli economies on private mobility in a complex, structured web of economic and political interests

that go beyond the scope of this study. German and Israeli cities are bound by this complexity.

Reducing emissions from the transportation sector has its challenges,[77] including the need for increased electricity production to charge vehicles.[78] While e-vehicles contribute to reducing direct emissions from engines, the indirect emissions that result from supplying them with energy can be more difficult to reduce. In Israel, e-vehicles will rely mainly on natural gas to supply their electricity,[79] while in Germany the use of e-vehicles on a large scale requires a secure and stable energy supply that will continue to rely, partly, on fossil fuels such as natural gas and, later on, hydrogen.[80]

There are, moreover, estimations that show that shifting to private e-vehicles would not result in a substantial reduction in the number of cars,[81] and hence will not solve the problem of traffic congestion in cities. This is especially true for Berlin and Tel Aviv-Yafo, which are both anticipating steady urban growth in the years to come. Given the predictions for the four cities' future development, a continued reliance on private e-vehicles will perpetuate existing patterns of urban planning (especially, but not only, for Israeli cities). Shifting to private e-vehicles also brings the challenge of new infrastructures. If the cities continue to follow the prevailing national policies, they are unlikely to depart from car-dependent models in the planning of new neighborhoods and infrastructure.[82]

Furthermore, although car-sharing schemes are gaining momentum in Tel Aviv-Yafo, Berlin and Freiburg, the number of shared vehicles is marginal compared to the quantity of

private vehicles in these cities. For example, Berlin had approximately 3,000 shared cars in 2016, compared to its 1.2 million private cars.[83] And Tel Aviv-Yafo had approximately 100 shared cars compared to the 230,000 private cars in the city (excluding commuters). Additionally, most car-sharing services in Israel and Germany to date do not provide e-vehicles,[84] which would have the added value of emissions reductions.

Lastly, all four cities encourage the use of – and are experimentation sites for – shared e-bicycles and e-scooters. This, however, may have little impact in terms of reducing congestion and GHG emissions. E-scooters, for example, were found to generate more carbon emissions across their lifecycle than the emissions saved from using them.[85] Moreover, it is not clear whether they substantially reduce the reliance on private mobility.

4.3. Political Gaps Between Central and Municipal Levels

Finding 3: Lack of coordination between central and local government

In the federal system, German cities have high degree of autonomy in planning and implementing policies in transportation and energy. In practice, they are primarily oriented towards their respective federal states and horizontal networks of European stakeholders.[86] Israeli cities are bound much more to central policies and have comparatively little official authority.

However, the central levels in both Germany and Israel seem to give little thought to the particular needs of cities when developing their decarbonization strategies.[87] For example, a conversation at the Federal Ministry for Economic Affairs and Energy (BMWi) revealed that in the process of revising its Energiewende policy and drafting Germany's new climate law, the ministry did not consider how cities could respond to these changes.

The central levels in both Germany and Israel seem to give little thought to the particular needs of cities when developing their decarbonization strategies.

In addition, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has its own plans for reducing mobility emissions: a) reducing commuting, b) reducing the use of private cars, and c) enhancing the use of bicycles, public transport and shared mobility.[88] These objectives are largely dependent on local-level policies and the capacity of cities to implement these kinds of strategies: cities can encourage or restrain shared mobility; they have the power to design and allocate spaces for commercial sites; and they are directly responsible for bicycle lanes and public transportation within their jurisdictions.[89] However, it seems that rather than including cities in the planning process, the BMU simply leaves it to them to apply these strategies on the ground.

Berlin and Freiburg have formulated their own policies and strategies to tackle climate change which are more ambitious than their federal-level equivalents.[90] But they still need to deal with the implications of national strategies, despite being excluded from the formulation of these strategies.

The situation in Israel is similar: the central government often promotes policies detached from the needs of municipalities.

This situation leads cities either to initiate policies that are not coordinated with national efforts – and therefore difficult to implement – or small in scale. Their only other option is to follow the steps dictated by the national level, which may not support decarbonization processes. We can see this in the case of the Israel Innovation Authority (IIA), which does not include cities in its policy design process.[91]

Similar to the German cities examined in this paper, also Tel Aviv-Yafo and Eilat are more ambitious than the central government in their climate protection strategies, but they still need to adhere to national policies – e.g. with regard to e-mobility – and have limited influence on energy policies.

5. Policy Recommendations

1. *To drive forward the decarbonization process, cities should take the initiative and capitalize on their full potential by exercising the powers at their disposal*

Previous research shows that cities can bypass or, at least, find alternative paths to national-level policies.[92] The four cities have already proven their ability to take steps toward decarbonization ahead of – or parallel to – central government, without having to undergo changes in their governance structures and ways they operate. In cooperation with the central government, Tel Aviv-Yafo is now planning trigeneration energy facilities (combined cooling, heat and power) in new neighborhoods. It has also been a trailblazer with its infrastructure for bicycles and bicycle-sharing. With little intervention from central government, Eilat has teamed up with private corporations and the EU to use renewable energy and enhance energy efficiency at the neighborhood scale.[93] Freiburg is planning an entire new district that incorporates renewable energy, public transportation and high resource efficiency. And Berlin took the initiative with its legally binding commitment to become carbon neutral by 2050, ahead of the federal government.[94] These are but a few examples for the possibilities open to cities in making a significant contribution to tackle their carbon emissions problem, using the authority they already have.

The four cities have already proven their ability to take steps toward decarbonization ahead of – or parallel to – central government, without having to undergo changes in their governance structures and ways they operate.

Second, as decarbonization and tech innovation are subject to national contexts and markets, cities will have a hard time sounding their voice if they do not join forces. Teaming up with

other cities (like Tel Aviv-Yafo, Berlin and Freiburg), diversifying their funding sources – as seen in the case of Eilat – and forming local and international coalitions may strengthen cities' political status and help them to overcome potential barriers down the road.

2. *When supporting tech innovation, cities need to diversify their resources allocation*

The appeal of smart solutions in the use and management of private and public mobility and e-mobility is growing. However, cities should expand their focus beyond mobility and diversify their funding schemes to also promote tech solutions that support the decarbonization process of other sectors as well. Thus, smart mobility should be just one of several pathways taken. Tel Aviv-Yafo is a prime example: the city has invested millions in shared mobility but has allocated relatively negligible resources to promote renewable energies. Spreading these funds more evenly could support further decarbonization efforts beyond the mobility sector. In other words, cities should apply smart solutions in response to other acute needs, including green building and energy efficiency in new districts, renewable energies and instruments to enhance sustainable planning and public participation in it.

Cities should expand their focus beyond mobility and diversify their funding schemes to also promote tech solutions that support the decarbonization process of other sectors as well.

3. *Establish collaborative processes between city and national level officials*

By ignoring municipalities as a vital sphere for the implementation of decarbonization policies, strategic plans at the central level stand in the way of their own success. Cities in both Germany and Israel have the capacity to reduce transportation loads, increase renewable energy use and

improve planning. A failure to take municipalities' capacity into consideration in the framework of national strategic planning not only miss out on potential synergies, but may also hinder decarbonization efforts at the municipal level.

Mechanisms and platforms for collaboration between local- and national-level stakeholders exist in both Germany and Israel. Research has shown that local-level initiatives can be scaled up to the national level in Israel[95] and in Germany.[96] So it is possible to incorporate cities' needs and their solutions to carbon emissions into strategic planning at the national level. This can be achieved by forming bottom-up coalitions of cities, environmental NGOs and businesses (in Israel), and involving more city officials in national planning processes (in Germany). This is already happening to some extent in both countries, but it is still the exception rather than the norm.

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6. Conclusions

This policy brief highlights key points in the nexus of tech innovation and decarbonization in German and Israeli cities, and lays the ground for further research on these and other cities.[97]

Regardless of their political context, geographical position and experience, cities can launch their own decarbonization policies and practices as well as tech-innovation schemes. However, in terms of driving forward an effective decarbonization process, the employment of tech innovation should be considered not as a standalone silver bullet, but as part of a holistic effort that integrates technological solutions into broader and more diverse schemes. Given the acute impacts of existing practices and dynamics in cities in Germany and Israel, and the challenges they are facing, more radical steps should be considered: for instance, the planned bans on private cars in the city centers of Paris and Oslo. This proposal is especially relevant to the Israeli cities in this study but would also help Berlin in its efforts to reach climate neutrality within two decades. Freiburg may already exemplify this alternative path: as the city increasingly turns to tech innovation, its rich experience with the practices, legislation and politics of low-carbon measures gives it an edge when it comes to achieving deeper decarbonization.

Given the acute impacts of existing practices and dynamics in cities in Germany and Israel, and the challenges they are facing, more radical steps should be considered.

Focusing less on tech innovation and more on political/legal means is surely challenging, but all of the cities examined in this study have the necessary political and/or economic capacities to achieve their decarbonization goals. As forerunner cities, their successes in this area could signal to other cities

and stakeholders that advancing the decarbonization process at the municipal level is desirable and possible through existing frameworks.

Second, cities and national governments alike should take a more critical stance on private e-mobility. While they contribute to reducing GHG emissions from transportation, the transition to e-vehicles may not tackle the root cause of carbon-intensive practices: our dependency on private mobility and how it dictates policies and planning. While this is not a call to ban private e-vehicles in cities, a more cautious approach to this trend and a more thorough understanding of its consequences may help to avoid the problematic aspects of e-mobility as a means of reaching decarbonization goals.

Third, decarbonization and tech innovation measures in German and Israeli cities benefit from national support. However, there is a need for a more inclusive approach that takes into consideration how cities might react to national strategies and whether it will still be possible for them to implement their decarbonization policies and join the tech-innovation bandwagon. A national push for smart solutions at subnational levels that neglects their implications for such actors may unwittingly create more obstacles to drive forward national decarbonization efforts. Learning at the national level from the situation in forerunner cities – what they do, how and why – may facilitate a more effective decarbonization process in Israel, Germany and beyond.

There is a need for a more inclusive approach that takes into consideration how cities might react to national strategies and whether it will still be possible for them to implement their decarbonization policies and join the tech-innovation bandwagon.

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97. For example, quantitative analysis could be beneficial to strengthening or refuting some of the findings of this paper.

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The Israel Public Policy Institute (IPPI) is an independent non-profit policy think-tank and a multi-stakeholder dialog platform. Through its research activities and programs, IPPI contributes to the ideational renewal of public policy, developing new ways to address the transformation processes and challenges that are shaping the face of our societies in the 21st century. Based in Tel Aviv with representations in Berlin and New York, IPPI works with a global network of actors from government, academia, civil society, and the private sector to foster international, multi-sector, and interdisciplinary cross-pollination of ideas and experiences.

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