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new demand, new challenges, and new opportunities

making EVs and the grid work together

ELECTRIC VEHICLES (EVS) ARE not hype. They are here to stay as a critical component in the decarbonization of our transport. According to the International Energy Agency, from 2017 to 2022 alone, EV sales (battery and plug-in hybrids) went from 1 million to more than 10 million. In 2022, 14% of all new cars sold globally were electric. In China, where half of the world's EVs reside, the share of EVs in total car sales reached 29% in 2022. In Europe, the second largest market, more than one in every five cars sold was electric. In the United States, the share of EVs in total car sales reached almost 8%. With more EVs, of course, comes more electricity demand. This means we also need to ensure that EVs and the grid, particularly the distribution grid, can work together.

Understanding how this new demand looks is the first step for distribution companies (the companies managing the poles and wires connecting our homes and businesses) to make informed planning and operational decisions around EV infrastructure. For instance, in certain parts of the world, where the distribution grid is designed considering houses with air conditioning and/or electric heating, the additional demand from EVs might not initially cause much concern. For other parts of the world, though, even modest EV uptakes can quickly bring challenges. There is also the aspect of diversity. We often, and mistakenly, assume that people will charge their EVs at home, immediately after arriving from work—everyone, almost at the same time, significantly increasing the traditional peak demand in the evening. In practice, there is much more diversity, which is, of course, good news for the grid.

Furthermore, we cannot forget that this new demand is different and super techy, and therefore, capable of bringing with it new opportunities. In fact, there is flexibility to be exploited. Not only EVs can be scheduled to charge at desired times; modern EV chargers can also receive external signals to limit the power supply if needed (also known as *EV management* or *flexible/smart charging*). This means that distribution companies can, for instance, use tariffs to incentivize charging at certain times or offer special connection agreements when installing EV chargers. The opportunities do not end up there as that very flexibility, when combined with the ability of some EVs to do vehicle-to-grid (V2G) (discharging their batteries and injecting power to the grid), can also be used to provide grid services when managed by third parties such as aggregators.

To understand how EV demand looks and how we can realize potential opportunities, we need to test the technologies involved, develop standards, come up with new platforms, carry out different types of studies, etc. Further, from a planning perspective, we also need to estimate the future EV uptake and which opportunities might be unlocked so that the corresponding investments can be determined in a timely manner. As seen here, there is a lot of work to do, and this work has already started in many countries around the world.

In this month's issue of *IEEE Power & Energy Magazine,* we aim to provide you with a glimpse of the many exciting activities and advances around EVs that are taking place internationally, from understanding EV demand to their charging infrastructure, management, and innovative approaches that can help improve our planning studies. The authors have not only shared their technical knowledge about the different opportunities and challenges but also the advances that come from actual implementation. We are just scratching the surface of EV adoption around the world and, in general, the electrification of transport. We trust that these articles will give the power and energy community a good overview of the most relevant aspects concerning EVs and the distribution grid.

In This Issue

The articles in this issue come from different corners of the world: Costa Rica, Ireland, New Zealand, Norway, Scotland, South Korea, and the United States.

"Learning From the Norwegian Electric Vehicle Success," written by Magnus Korpås, Aurora F. Flataker, Hanne Sæle, Bendik Nybakk Torsæter, Karen B. Lindberg, Shanshan Jiang, Åse L. Sørensen, and Audun Botterud [A1], gives us a great overview of why Norway

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is at the forefront of the electrification of transport. You will not only learn about the range of incentives put in place by the Norwegian government but also the many efforts in various communities, the barriers that can be faced around EV management, and that EVs are just the beginning. This is a great starting article for this issue.

"A Grid-Friendly Electric Vehicle Infrastructure: The Korean Approach," written by Kijun Park, Dongsik Jang, Sangok Kim, Youseok Lim, and Jungho Lee [A2], takes us to Korea, where we learn about their EV success and the brilliant work done behind ultrafast charging infrastructure and payment systems needed to make the EV user experience flawless. This article, from Korea Electric Power Corporation (KEPCO), the vertically integrated utility in Korea, also takes us deeper into V2G technology and the exciting opportunities ahead.

"Customer-Centric Electric Vehicle Orchestration in New Zealand," written by Steve Heinen, Andre Botha, Duncan Head, Rafferty Parker, and Pieter Richards [A3], provides us with the perspective and experiences of Vector, the largest distribution company in New Zealand, on EV demand and what it means to the planning engineers. The insights from their recent trial involving smart charging and time-of-use (TOU) tariffs are great, highlighting the benefits and challenges of those approaches from the perspectives of the distribution company but also customers.

"Utility Planning for Distribution-Optimized Electric Vehicle Charging," written by Matthew Mills, Manasseh Obi, Kendall Cody, Kyle Garton, Amanda Myers Wisser, and Sammy Nabahani [A4], brings the perspective of another distribution company, Portland General Electric (PGE), in the United States. In this article, you will learn about how they are preparing for EVs and the necessary studies to do detailed forecasting of EV demand, the considerations of EV management and TOU tariffs, and how all this needs to be incorporated into the planning of the distribution grid.

"Open Data to Accelerate the Electric Mobility Revolution," written by Lewis Hunter, Ryan Sims, and Stuart Galloway [A5], brings another perspective: that of local governments and the challenges they face when planning EV infrastructure. This article will show you that it is possible to produce tools based on publicly available data in the United Kingdom that allow local or regional governments to carry out techno-economic studies to decide where to best place the EV charging infrastructure. This is important because to accelerate the uptake of EVs, we need infrastructure projects to be assessed much faster and without the delays associated with formal electrical connection requests.

"Grid Planning for Electrification Using Highly Granular Analytics," written by Robert A. F. Currie, Teddy Ward, James L. Carney, Greg Mandelman, Margot C. Everett, Aram Shumavon, Nathan Phelps, Lindsay Griffin, and Stephan Roundtree [A6], also demonstrates the importance of publicly available data in the United States and how it can significantly help distribution companies make extremely granular forecasts of EV demand. In turn, this brings much better and faster insights for distribution planning engineers. The different types of publicly available data in the United States are impressive. Of course, the trick is to put the data all together for accurate planning studies.

"The Bigger Picture: Robust Decarbonization of the Transport Sector in Costa Rica," written by Jairo Quirós-Tortós and Luis Victor-Gallardo [A7], reminds us that the electrification of transport is something that governments need to plan carefully. For developing nations, there is still an opportunity to get it right, given that EVs are not common yet. This article shows how it was possible for Costa Rica to take a holistic approach when assessing the costs and benefits of electrifying transport while considering relevant stakeholders.

Finally, the "In My View" column, by Andy Keane [A8] (Ireland), provides an expert summary of the different challenges and opportunities around the electrification of transport. Andy reflects on the importance of educating the public, the role of governments, and the different planning and EV management opportunities that we can have when involving more data, along with the interdisciplinarity nature of making the electrification of transport a reality. This is a brilliant column that wraps up this *IEEE Power & Energy Magazine* issue.

Special Thanks

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Power & Energy Magazine and his team, who provided us with the opportunity to serve as the guest editors of this issue and kindly helped us through every step of the process, including providing such insightful feedback.

Appendix: Related Articles

[A1] M. Korpås et al., "Learning from the Norwegian electric vehicle success: An overview," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 18–27, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308246.

[A2] K. Park, D. Jang, S. Kim, Y. Lim, and J. Lee, "A grid-friendly electric vehicle infrastructure: The Korean approach," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 28–37, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308232.

[A3] S. Heinen, A. Botha, D. Head, R. Parker, and P. Richard, "Customer-centric electric vehicle orchestration in New Zealand: How residential smart charging can deliver affordability and customer satisfaction," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 38–47, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308250.

[A4] M. Mills, M. Obi, K. Cody, K. Garton, A. M. Wisser, and S. Nabahani, "Utility planning for distribution-optimized electric vehicle charging: A case study in the United States Pacific Northwest," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 48–55, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308243.

[A5] L. Hunter, R. Sims, and S. Galloway, "Open data to accelerate the electric mobility revolution: Deploying journey electric vehicle chargers in rural Scotland," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 56–67, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308221.

[A6] R. A. F. Currie et al., "Grid planning for electrification using highly granular analytics: Insights into the transportation distribution infrastructure," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 68–76, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308237.

[A7] J. Quirós-Tortós and L. Victor-Gallardo, "The bigger picture: Robust decarbonization of the transport sector in Costa Rica," *IEEE Power Energy Mag.*, vol. 21, no. 6, pp. 77–90, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308234.

[A8] A. Keane, "Buckle up: Electrification of transport is happening [In My View]," *IEEE Power Energy Mag.*, vol. 21, no. 6, p. 114, Nov./Dec. 2023, doi: 10.1109/MPE.2023.3308249.