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Goldilocks and the Grid: Creating "No Regrets" State Policies and Regulations for Electric Vehicles

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Most public utility commissions (PUC) across the country have been faced with multiple utility and non-utility requests, applications, and proposals related to electric vehicles (EV) and EV charging infrastructure. As the pace and scope of these proposals intensify, it is essential for PUCs to develop their own policies for EVs that help avoid the risks of potentially stranded investment while not missing out on what EVs can offer. This paper proposes a step-by-step approach for commissions to develop and implement a "no regrets" EV policy of their own, regardless of whether they are just getting started or have been addressing EV policy issues and EV proceedings for years. These steps recognize the steep learning curve involved in understanding EVs, the technical and economic challenges of deployment, the most promising growth potential by customer class, and the decade-plus process ahead as EVs ramp from just 0.3% of all US vehicles today to substantial penetration levels in many regions across the United States.

In August 2017, *The Economist* featured on its cover a drawing of a beaten, deteriorated internal combustion engine under the bolded title "Roadkill." In 2018, Google data revealed Tesla was the most searched-for automaker in the United States[1] and that its CEO, Elon Musk, was second in searches only to Amazon's Jeff Bezos for the year.[2] Writing about the 2019 Geneva Motor Show, *Motor Trend* included several electric vehicles (EV) among the "best cars" of the show.[3]

It is safe to say that EVs have the world's attention. But how do we know that this time[4] is different? How do we know that this time the EV hype presages lasting and significant growth? After all, in the early 20th century, EVs constituted 28% of the car market and led Thomas Edison to exclaim, "In 15 years, more electricity will be sold for electric vehicles than for light."[5] Edison was one of many proven wrong as the advent of more plentiful and cheaper gasoline, charging challenges, and the emergence of the cost-effective Ford Model T laid waste to EV fervor by the end of World War I.[6]

This time around, environmental concerns, improvements in EV technology, and the ever-growing availability of cheap renewable electricity point to a much higher likelihood of EV success. Nevertheless, the stakes are high for state public utility commissions (PUCs) across the country. The increased electrification of the transportation

1 Michael Accardi, "American People Google Tesla the Most," *CarBuzz*, Oct. 15, 2018, available at: https://carbuzz.com/news/american-people-google-tesla-the-most.

2 Google Trends, available at: https://trends.google.com/trends/explore?date=2018-01-01%202018-12-31&geo=US&q=%2Fm%2F0dq_5.

3 MotorTrend, "Best Cars of the 2019 Geneva Motor Show: MotorTrend Favorites," Mar. 6, 2019, available at: https://www.motortrend.com/news/best-cars-of-the-2019-geneva-motor-show-motortrend-favorites/

4 An article in a 1911 edition of the *New York Times* stated, "The designers of electric passenger-carrying vehicles have made great advances in the past few years, and these machines have retained all their early popularity and are steadily growing in favor. . . . The enthusiastic interest recently shown by the electric power companies all over the country in furthering the cause of the electric passenger vehicle assures a still greater use of these machines…[I]t is possible for an owner of an electric to install his own charging plant in his stable, and the electric power companies are anxious to connect their feed wires to these individual charging plants." New York Times, "Electric Vehicles Attract Attention," Jan. 20, 1911.

5 Matt Novak, "The First Golden Age of Electric Car Advertising," *Pacific Standard*, Aug. 14, 2012, available at: https://psmag.com/environment/electric-cars-44397.

6 *Id.*

industry will have significant implications—many positive—for both utilities and their ratepayers. In an era of flat or declining electricity sales, for example, EVs would bring growth in load and electricity consumption. According to McKinsey & Company, EV penetration to just 25% of the stock of passenger vehicles in the United States could lead to a 30% increase in peak loads on residential feeder circuits.[7] EVs also expand the opportunity for electric utility profit growth, either through an expanded rate base or through pay-for-performance pricing, while providing another avenue to cut greenhouse gas emissions and other environmental externalities.[8] And, as a bonus, they could also have a significant impact on the scale and resilience of the electric grid.

All this explains why state PUCs across the United States are considering taking actions to address the potential EV revolution for the long term—indeed, most states have started doing so already.[9] But the risks are high: If they move too quickly, commissions could approve suboptimal investments that underperform and result in premature and potentially stranded costs; move too slowly, and the opportunities and benefits afforded by EVs could pass by unclaimed. Hence the need for "Goldilocks" policies, which recognize and balance risks against the potential benefits EVs can bring. Meanwhile, PUCs are inundated with utility and nonutility proposals alike to use ratepayer money to build out EV infrastructure and take other steps to prepare for—or help accelerate—substantial EV penetration.

Unlike in Edison's era, a number of factors suggest that this time, it really could be different for EVs. As we explain below, the EV market—though still in its infancy—is poised for rapid and accelerating growth, first through the push of public policy and eventually through superior economics. Additionally, this time EVs may offer the potential of economic integration to the grid by providing electric grid storage.

While the potential impacts of EVs on the electricity business are clear, we should not forget the broader context. The impact of EVs on the electricity business will depend entirely on their success in the transportation business. State PUCs will be dealing with a fundamental transformation of the transportation business, which means a whole new range of benefits and costs, often outside the electric sector, must be assessed. One example: displacement of internal combustion engine vehicles with EVs would have impacts on fuel taxes collected and disbursement of federal and state highway infrastructure dollars, which are based on gasoline and diesel consumption.[10]

Because this is a transformative change in the technology used in the transportation business, both requiring and potentially creating new electric grid services, the breadth and depth of the issues state PUCs will have to address is daunting. Nevertheless, "no regrets" policies on EVs can be achieved. Crucial to doing so requires addressing two central questions. First, what is the likely pace and nature of the EV revolution? Answering this question requires reviewing the current state of the EV market and developing some credible estimates of its scale and pace of change over time. Second, given the answer to the first question, what steps should PUCs take to develop no-regrets, long-term EV policies as the avalanche of EV-related requests, applications, and proposals come their way? In this article, we consider both of these questions.

7 McKinsey & Company, "The Potential Impact of Electric Vehicles on Global Energy Systems," August 2018, Exhibit 3, available at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-potential-impact-of-electric-vehicles-on-global-energy-systems.

8 In 2016, greenhouse gas emissions from the transportation sector surpassed electric power sector emissions for the first time since the late 1970s. The transportation sector continued as the largest contributing sector to carbon emissions in the whole United States during 2017 and 2018 (compared to the electric power, residential, commercial, industrial, agriculture, and manufacturing sectors). Rhodium Group, "Preliminary US Emissions Estimates for 2018," January 2019, https://rhg.com/research/preliminary-us-emissions-estimates-for-2018/.

9 At least 33 state PUCs have opened proceedings related to EVs. See North Carolina Clean Energy Technology Center, "The 50 States of Electric Vehicles: 32 States and DC Took Action on Electric Vehicles During Q3 2018," Nov. 7, 2018, available at: https://nccleantech.ncsu.edu/2018/11/07/the-50-states-of-electric-vehicles-32-states-and-dc-took-action-on-electric-vehicles-during-q3-2018/; and Justin Horwath, "Wisconsin Launches Study of EVs and the Power Sector," *S&P Global Market Intelligence*, Feb. 22, 2019.

10 Robert Kirk and William Mallett, "Funding and Financing Highways and Public Transportation," Congressional Research Service, pp. 11–12, available at: https://crsreports.congress.gov/product/pdf/R/R45350.

I. WHAT IS THE LIKELY PACE AND NATURE OF THE EV REVOLUTION?

In preparing for what some are calling "the inevitability of an EV world,"[11] timing matters. This is especially true for state PUCs, which seek to avoid premature and potentially stranded investment without missing opportunities created by the EV revolution.

I.A. Current state of the EV market

Insight on this topic begins with a look at the current state of the market for battery EVs and plug-in hybrid EVs (both referred to in this article as EVs), which, in our view, is best described as both nascent and global. Of the approximately 250 million cars and light duty vehicles on the road in the United States as of 2017,[12] just 0.3% of those—around 760,000—were EVs.[13] Even with the impressive growth experienced in 2018, the share of EVs reached only 0.4%—about 1.13 million.[14] Worldwide, the story is similar: of the 1.2 billion vehicles estimated to be on the road in 2017,[15] just 0.25%—or about 3.1 million—were EVs.[16]

It will be increasingly important for US states to be informed about developments outside the United States, because, like wind and solar, EVs are a global industry in which the next technological breakthrough—like cheaper batteries—may come from a country other than the United States. China, in particular, is of interest because it has significant incentives to promote EVs—incentives ranging from mitigating severe air pollution in its large cities to winning a large share of the global car business with its EVs.

The most recent data available on EVs' market share of new cars sold suggest that the EV industry is still in its infancy. The United States is one of the world's leading EV markets in terms of market share; nevertheless, EVs made up just 2.1% of all cars sold in the country in 2018.[17]

Small as EVs' market share may be today, there is evidence of rapid and accelerating growth, both domestically and across the world. In the United States, for example, since 2008, annual EV sales have increased from just a few thousand to over 360,000 in 2018, representing a compound annual growth rate of about 75% since 2011.[18] This growth in the US EV stock is shown in Figure 1 below.

11 BNY Mellon, "The Inevitability of an EV World," August 2017, available at: https://im.bynmellon.com/us/en/documents/manual/brochures/the_inevitability_of_an_ev_world.pdf.

12 US Bureau of Transportation Statistics, "Number of US Aircraft, Vehicles, Vessels, and Other Conveyances," available at: https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances. As of 2016, there were 247.6 million cars and light duty vehicles on the road in the U.S. This figure does not include motorcycles, heavy-duty trucks, or busses.

13 International Energy Agency, "Global EV Outlook 2018," Table A.1.

14 InsideEVs, "Monthly Plug-In EV Sales Scorecard: Historical Charts," available at: https://insideevs.com/monthly-plug-in-ev-sales-scorecard-historical-charts/.

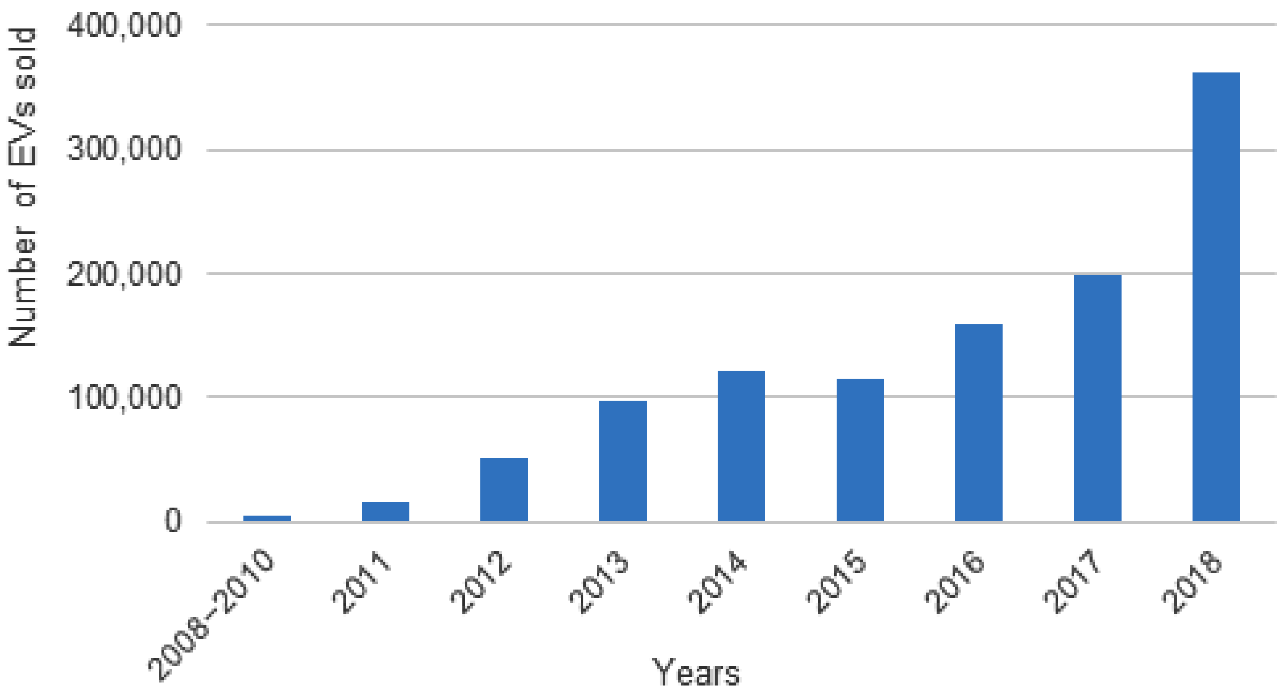
15 Navigant Research, "Transportation Forecast: Light Duty Vehicles," 2nd Quarter 2017, available at: https://www.navigantresearch.com/reports/transportation-forecast-light-duty-vehicles.

16 International Energy Agency, "Global EV Outlook 2018," p. 19.

17 361,307 EV sales divided by 17,270,000 total vehicle sales equals 2.1% in 2018. 2018 EV sales come from InsideEVs, available at: https://insideevs.com/monthly-plug-in-ev-sales-scorecard-historical-charts/. 2018 vehicle sales come from Tom Krisher, "US New-Vehicle Sales in 2018 Rise Slightly to 17.27 Million," Associated Press, Jan. 3, 2019, available at: https://www.apnews.com/ff3a9ade67be4be5b6181a016eb6f6d2

18 InsideEVs, "Monthly Plug-In EV Sales Scorecard: Historical Charts," available at: https://insideevs.com/monthly-plug-in-ev-sales-scorecard-historical-charts/.

Figure 1 – Annual EV sales in the United States (2008–2018)[19]



Globally, the stock of EVs has also been increasing at a rapid rate on a percentage basis. The stock of EVs exceeded 1 million for the first time in 2015; in 2016, EV stock grew by about 60% to 2.0 million and in 2017 by another 57%, to 3.1 million.[20] Figure 2 provides a breakdown, by country, of the 3.1 million stock of EVs in 2017; it also provides 2017 EV sales and market share. The figure demonstrates that, though dominated by China and the United States, EVs are spreading across many countries, including a particularly high market share in Norway. It is worth noting here that a country's EV market share is not evenly distributed across its footprint, but instead is more highly concentrated in urban areas, which can lead to more significant penetration of EVs in certain cities than the data in Figure 2 suggest. For example, in certain US cities (San Jose, San Francisco) and Chinese cities (Shanghai, Beijing, Tianjin, and others), EVs made up nearly 10% of all new vehicles in 2017, well above their respective national averages.[21]

[19] *Id.*

[20] International Energy Agency, Global EV 2018 Outlook, Table A.1.

[21] The International Council on Clean Transportation, "Electric Vehicle Capitals: Accelerating the Global Transition to Electric Drive," Oct. 30, 2018, Figure 2, available at: https://www.theicct.org/publications/ev-capitals-of-the-world-2018.

Figure 2 – EV stock, EV sales, and EV market share by country, 2017[22]

Country	2017 Stock (thousands)	2017 Sales (thousands)	2017 Market share (%)
China	1,227.8	579.0	2.20
United States	762.1	198.4	1.20
Japan	205.4	54.1	1.00
Norway	176.3	62.3	39.20
United Kingdom	133.7	47.3	1.70
Netherlands	119.3	11.1	2.70
France	118.8	34.8	1.70
Germany	109.6	54.6	1.60
Others	103.4	42.0	0.70
Sweden	49.7	20.4	6.30
Canada	46.0	16.7	1.10
Korea	25.9	14.7	1.30
Australia	7.3	2.3	0.10
India	6.8	2.0	0.06
Finland	6.3	3.1	2.60
New Zealand	5.9	3.5	1.10
Portugal	1.8	1.8	0.80
Mexico	0.9	0.3	0.02
South Africa	0.9	0.2	0.10
Brazil	0.7	0.4	0.02
Thailand	0.4	0.0	0.00
Chile	0.3	0.2	0.10
Total	3,109.1	1,148.7	

More evidence of growth comes from recent sales data in the United States. From 2010 to 2011, just three EV models reported sales in the country, with only two of those—the Nissan Leaf and the Chevrolet Volt—reporting significant sales, combining to sell about 17,000 units.[23] In 2018, however, there were 43 total models of EVs sold in the United States by 21 different manufacturers.[24] While Tesla has become a dominant supplier, new entry into the EV market has been substantial, with several manufacturers offering multiple EV models from which to choose (see Figure 3).

[22] Based on International Energy Agency data from the Global EV 2018 Outlook, Table A.7, www.iea.org/statistics. All rights reserved, as modified by Bates White LLC.

[23] *Id.*

[24] *Id.*

Figure 3 – 2018 US EV sales, by manufacturer[25]

EV manufacturer	2018 US EV sales (Units)	2018 US market share (%)	Number of models
Tesla	191,627	53.0	3
Chevrolet	36,325	10.1	2
Toyota	27,595	7.6	1
BMW	22,926	6.3	6
Honda	19,550	5.4	2
Nissan	14,715	4.1	1
Ford	9,216	2.6	3
Chrysler	7,062	2.0	1
Kia	5,488	1.5	3
Mitsubishi	4,166	1.2	1
Volvo	4,091	1.1	3
Mercedes	3,485	1.0	5
Porsche	3,058	0.8	2
Audi	2,597	0.7	1
Hyundai	2,395	0.7	3
Fiat	2,250	0.6	1
Mini	1,564	0.4	1
Volkswagen	1,354	0.4	1
Smart	1,219	0.3	1
Jaguar	393	0.1	1
Cadillac	231	0.1	1
Total	361,307	100.0	43

These data suggest that the EV industry, while just a small percentage of US auto sales, today is poised for substantial growth. Moreover, international demand is also growing substantially, which could have positive supply impacts for US consumers.

II. CONSIDERATIONS FOR THE LIKELY PACE AND NATURE OF THE EV MARKET OVER TIME

If EVs are just a tiny fraction of the existing stock but are growing rapidly, when might we expect significant market penetration? The two major drivers of the nature and pace of the EV revolution are likely to be economics and policy. To achieve substantial penetration of the overall auto market, EVs must become economically attractive to buyers. Today, for the vast majority of EV models available, this is not the case. In the meantime, public policy can serve to drive penetration through mandates and subsidies. We address these topics below.

[25] Data compiled from InsideEVs, "Monthly Plug-In EV Sales Scorecard: Historical Charts," available at: https://insideevs.com/monthly-plug-in-ev-sales-scorecard-historical-charts/.

II.A. EV economics: 2025–2030 timeframe

In 2015, 2016, and 2017, NREL conducted annual surveys in which respondents were asked to give the reason they would choose not to purchase an EV. The most cited answer—which was provided by more than half of the respondents in all three years—was not "range anxiety" or performance concerns, but rather that EVs were too expensive.[26] Interestingly, those same surveys found that the number-one reason the respondents would consider purchasing an EV was that it is "better for the environment."[27] How much might a typical US consumer be willing to spend to achieve the greater environmental benefits of an EV? In a recent study conducted by the Energy Policy Institute at the University of Chicago, 43% of Americans were unwilling to spend even one dollar per month to combat climate change.[28] This suggests that if EVs are more expensive than traditional vehicles, many US buyers may continue to choose the latter despite the environmental benefits of the former.

EVs remain more expensive than their internal combustion engine (ICE) counterparts. Estimates put the cost of an EV powertrain at around $10,000 more than that of an ICE.[29] Consider, too, sticker prices: the Ford Fusion ICE starts at $22,840;[30] the electric version starts at $36,595.[31] The Fiat 500's introductory manufacturer's suggested retail price is $16,245,[32] while the electric version is $33,210.[33]

But sticker price tells just part of the story. EV economics involve a "payback period," whereby fuel cost savings accrue until they offset the initial price premium paid for the EV. According to Goldman Sachs, once EVs achieve a three-year payback period, consumer adoption of EVs will become significant.[34] Today, however, the payback period for an EV is far longer. To take a simplified example, it would take almost 15 years to recover the additional sticker price cost of the all-electric 2019 Chevy Bolt, driven 12,000 miles/year, compared to a similar-size Chevy sedan, even when including the one-time $7,500 EV tax credit.[35] To get the payback period down to three years would require free electricity and $10/gallon gas.

When will the economics become favorable for EVs? Many analysts suggest somewhere between 2025 and 2030,[36] though estimated EV penetration rates vary from 2% to 20% by 2030.[37]

Most analysts expect that reductions in the cost of batteries—the largest cost driver of EVs—will be responsible for changing the economics of EVs. In 2009, EV battery costs were about $700/kWh; today, they are about

[26] Mark Singer, "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update," National Renewable Energy Laboratory Technical Report NREL/TP-5400-70371, November 2017, p. 17, available at: https://www.nrel.gov/docs/fy18osti/70371.pdf.

[27] *Id.*, p. 16.

[28] November 2018 Survey conducted by The Energy Policy Institute at the University of Chicago and the AP-NORC Center.

[29] Goldman Sachs Equity Research, "Electric Vehicle Boom: ICE-ing the Combustion Engine," Sept. 6, 2017, p. 13.

[30] Cars.com, "2019 Ford Fusion," available at: https://www.cars.com/research/ford-fusion/.

[31] Cars.com, "2019 Ford Fusion Energi," available at: https://www.cars.com/research/ford-fusion_energi/.

[32] Cars.com, "2019 Fiat 500," available at: https://www.cars.com/research/fiat-500/.

[33] Cars.com, "2019 Fiat 500e," available at: https://www.cars.com/research/fiat-500e/.

[34] Goldman Sachs Equity Research, "Electric Vehicle Boom: ICE-ing the Combustion Engine," Sept. 6, 2017, pp. 11–12. Goldman bases its assumption on the adoption profile of hybrid vehicles, which achieved substantial adoption levels upon reaching a three-year payback period. *Id.*, p. 12.

[35] Comparison assumes 12,000 miles/year (50% highway, 50% city), $3.24/gallon gas, 14.2 cents/kWh electricity, and no annual maintenance costs. The 2019 Chevy Bolt's assumed specifications: $37,495 price, $7,500 one-time tax credit, 238-mile battery range, 60 kWh battery charge. The 2019 Chevy Cruze-Eco's assumed specifications: $18,870 price, 38 miles/gallon highway, 28 miles/gallon city.

[36] See, for example, Nikolas Soulopolous, "When Will Electric Vehicles be Cheaper than Conventional Vehicles?" Bloomberg New Energy Finance, Apr. 12, 2017, p. 1; Goldman Sachs Equity Research, "Electric Vehicle Boom: ICE-ing the Combustion Engine," Sept. 6, 2017, p. 5; The Boston Consulting Group, "The Electric Car Tipping Point," January 2018, Exhibit 1.

[37] Michael Cembalest, "Eye on the Market: Annual Energy Paper," J.P. Morgan, April 2018, p. 10, citing estimates by IHF Automotive, Goldman Sachs, BP, Morgan Stanley, Wood Mackenzie, UN Paris Agreement, Bloomberg New Energy Finance, and the IEA.

$150–$175/kWh—or even as low as $120/kWh[38]—with many expecting costs to be below $100/kWh by 2030.[39] And while the prices for the raw materials essential to EV batteries, such as cobalt, can be volatile,[40] there are longer-term efforts under way to bring "solid-state" batteries into production—so called due to their use of a solid electrolyte instead of liquid—which offers hope of batteries that use no cobalt, are less prone to fire, reduce charging times, and increase performance and driving range.[41]

An additional driver of EV economics could be the trend toward car-sharing. Even without battery cost reductions, EV payback periods can be cut substantially by increasing the time an EV is on the road. The average US vehicle is on the road just 3.5% of the time; increasing that number to 24% (which equates to driving about 60,000 miles per year) would have dramatic effects on EV economics.[42] Recall that in taking the numbers of our example above comparing the Chevy Bolt to a similar-size Chevy ICE sedan, we needed free electricity and $10/gallon gas to achieve a three-year payback period; however, reverting to our original assumptions ($3.24/gallon gas and 14.2 cents/kWh electricity) and changing only the number of miles driven—from 12,000 miles/year (the national individual driver annual average) to 70,000 miles per year (the average annual mileage of a New York City taxicab[43])—cuts the payback period to a mere 2.4 years.

Moreover, *autonomous* (driverless) shared vehicles could further increase the time an EV is on the road—autonomous vehicles do not need lunch or bathroom breaks—thereby further reducing the payback period. For shared vehicle fleet operators, this payback period can be attractive and indeed has driven significant investment to date.[44] Individuals, meanwhile, might compare the cost of owning *any* car (electric or ICE) to relying on the shared fleet. If economically compelling, such shared fleets could also reduce the total number of cars on the road.

II.B. EV policy: Through 2025 and beyond

Until EVs' economics improve, adoption is likely to continue to be driven by public policy, including environmental mandates and subsidies. Indeed, in its *Global EV Outlook 2018*, the International Energy Agency (IEA) acknowledges that "[s]o far, EV deployment has been driven by policy"[45] rather than market forces. Policies in place in various jurisdictions worldwide include (a) public procurement and investment plans, (b) subsidies and other financial incentives, (c) fuel economy standards, and (d) mandates for zero-emission vehicles.[46]

Going forward, more policies spurring EVs—mostly through internalizing some of the negative externalities of ICE vehicles—could also be enacted in the United States and elsewhere. The IEA identifies several such policies: (a) phasing out subsidies to fossil fuels; (b) imposing a tax on carbon; (c) imposing taxes on local pollution; (d) implementing fuel quality standards to cut emissions; and (e) establishing vehicle maintenance requirements to cut emissions.[47]

38 Anthony Palazzo, Bloomberg, "Tesla's Cobalt-Light Batteries Seen Providing Cost Advantage," Sept. 4, 2018, available at: https://www.bloomberg.com/news/articles/2018-09-04/tesla-s-cobalt-light-batteries-give-e-car-pioneer-cost-advantage.

39 The Boston Consulting Group, "The Electric Car Tipping Point," January 2018, p. 6.

40 Goldman Sachs Equity Research, "Electric Vehicle Boom: ICE-ing The Combustion Engine," Sept. 6, 2017, Exhibit 61.

41 Goldman Sachs Equity Research, "Electric Vehicle Boom: ICE-ing The Combustion Engine," September 6, 2017, pp. 31–32.

42 Bates White, "Southwest Power Pool Annual Looking Forward Report," Apr. 18, 2017, p. 79, available at: https://www.bateswhite.com/media/publication/127_2017%20Looking%20Forward%20Report.pdf.

43 New York City Taxi & Limousine Commission, "2014 Taxicab Fact Book," 2014, p. 1.

44 Bates White, "Southwest Power Pool Annual Looking Forward Report," Apr. 18, 2017, pp. 86–89, available at: https://www.bateswhite.com/media/publication/127_2017%20Looking%20Forward%20Report.pdf.

45 International Energy Agency, "Global EV Outlook 2018," p. 10.

46 *Id.*, p. 95.

47 *Id.*, p. 96.

Such policy-driven growth can be substantial and can sustain an industry until it becomes economic. The tremendous growth of renewable energy over the past decade rode a wave of mandates (via state renewable portfolio standards) and subsidies (tax credits, net metering tariffs). Automotive manufacturers are already anticipating that EV policies and incentives will be implemented, which has already contributed to EV production expansion plans. For example, Chinese EV manufacturers have pledged to achieve 4.5 million annual sales by 2020.[48] Toyota has set up a new EV division and announced a target of 5.5 million annual sales by 2030,[49] as well as announcing development of a solid-state battery.[50] Other carmakers have also announced ambitious new EV model targets. Volvo has ambitions to offer a fully electrified model portfolio.[51] Hyundai has stated that it will offer 38 EV models by 2035;[52] Ford has announced 40 EV models by 2022;[53] GM plans to launch more than 20 new EV models by 2023;[54] and Volkswagen has plans to offer 50 EV models by 2025.[55]

II.C. EV markets: What types of EVs sell best?

Beyond economic developments and public policies, a more granular look at the EV market and its evolution is warranted to understand what types of vehicles could be economically electrified.

While the first commercially available EVs have been passenger cars, the US consumer increasingly favors pickup trucks and SUVs. In 2018, the three highest selling vehicles in the United States were pickup trucks, while the fourth, fifth, and sixth best sellers were sport utility vehicles (SUVs). Yet today there are no electric pickup trucks on the market. That will soon change, as startup companies like Rivian, Atlis, Bollinger, and Workhorse introduce electric models (Rivian expects to begin delivery of the R1T in late 2020[56]), as will Tesla and traditional automakers such as Ford and GM.[57,58,59] Beyond filling a market need, electric truck makers also promise performance beyond that of traditional pickup trucks. For example, Rivian claims its R1T will deliver around 800 horsepower[60] with 826 lb/feet of torque with the ability to accelerate from zero to sixty miles per hour in three seconds.[61] In contrast, the "Limited" version of the Ford F-150—the best-selling vehicle in the United States—has 450 horsepower, 510 lb-feet of torque, and accelerates from zero

48 Michael Cembalest, "Eye on the Market: Annual Energy Paper," *J.P. Morgan*, April 2018, p. 9.

49 *Id.*

50 Mark Kane, "Toyota Says Solid-State Batteries Still More than Decade Away," Inside EVs, May 27, 2018, available at: https://insideevs.com/toyota-says-solid-state-batteries-still-more-than-decade-away/.

51 Volvo, "The Future Is Electric," available at: https://group.volvocars.com/company/innovation/electrification.

52 Michael Cembalest, "Eye on the Market: Annual Energy Paper," J.P. Morgan, April 2018, p. 9.

53 *Id.*

54 General Motors, 10-K for Fiscal Year 2017, p. 4.

55 Steven Loveday, "VW to Spend $50 Billion in Push to Launch 50 Electric Cars By 2025," Inside EVs, Nov. 16, 2018, available at: https://insideevs.com/vw-spend-50-billion-50-bevs-2025/.

56 Jeff Plungis, "All-Electric Rivian Pickup and SUV Take Charge," *Consumer Reports*, Feb. 15, 2019, available at: https://www.consumerreports.org/hybrids-evs/all-electric-rivian-r1t-pickup-truck-and-r1s-suv-debut/.

57 EV Bite, "5 Upcoming Electric Trucks," Jan. 15, 2019, available at: https://evbite.com/5-upcoming-electric-trucks/.

58 Ian Thibodeau, "Ford Invests $500M in Rivian; Companies Plan Electric Vehicle," *Detroit News*, Apr. 24, 2019, available at: https://www.detroitnews.com/story/business/autos/ford/2019/04/24/ford-invests-500-rivan-companies-plan-electric-vehicle/3559658002/.

59 Nora Naughton, "GM Confirms Plan to Build Electric Pickup," *Detroit News*, Apr. 30, 2019, available at: https://www.detroitnews.com/story/business/autos/general-motors/2019/04/30/gm-confirms-plan-build-electric-pickup/3626575002/.

60 Nate Petroelje, "The 2020 Rivian R1T Electric Truck Does 0-60 in 3.0 Seconds with 400 Miles of Range," *Road and Track*, No. 26, 2018, available at: https://www.roadandtrack.com/new-cars/future-cars/a25303973/2020-rivian-r1t-electric-truck-photos-info-performance-specs-price/.

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to sixty in about five seconds.[62] SUV offerings are also beginning to appear in the US market. In addition to Tesla's Model X and recently announced Model Y, Jaguar and Hyundai have recently introduced fully electric SUVs; and Audi, Mercedes, Volkswagen, and Kia will add their own SUV offerings over the next two years.[63]

Tesla,[64] Nikola Motors,[65] and Volvo[66] have announced development of electric tractor-trailer truck models. Volvo has begun delivering its electric trucks to the European market, with expectations to deliver trucks to the United States in 2020,[67] while Tesla's electric semi could offer attractive economics compared with ICE semis, according to analysts at Piper Jaffray.[68] In a different market segment, Daimler is currently testing its medium duty trucks in partnership with Penske Truck Leasing in the United States.[69]

Electric buses, meanwhile, are the fastest growing segment of the EV market, enjoying a compound annual growth rate of over 100% since 2013.[70] In 2017, 90% of all new buses purchased in China were electric, with 87,000 electric buses now on the road in that country.[71] In Europe, it is expected that 75% of all bus sales will be electric by 2030.[72] In the United States, just 300 of the 65,000 buses on the road are electric;[73] however, the economics suggests that electric buses could already be economic.[74] While electric buses can be competitive with competing ICE models over time, due to lower fuel and maintenance costs, their higher initial cost has hampered their adoption. However, recent battery leasing approaches and other innovative financing offered by the largest electric bus manufacturer should over time eliminate the first-cost disadvantage of electric buses relative to diesel ones.[75] There are over 40 manufacturers of electrified passenger buses in the world today, not only in China but also in Europe and the United States. Between 2010 and 2019, Proterra, Inc., an American electric bus manufacturer based in Burlingame, CA, sold over 675 vehicles in North America and received a $155 million investment by Daimler.[76]

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71 *Id.*

72 *Id.*

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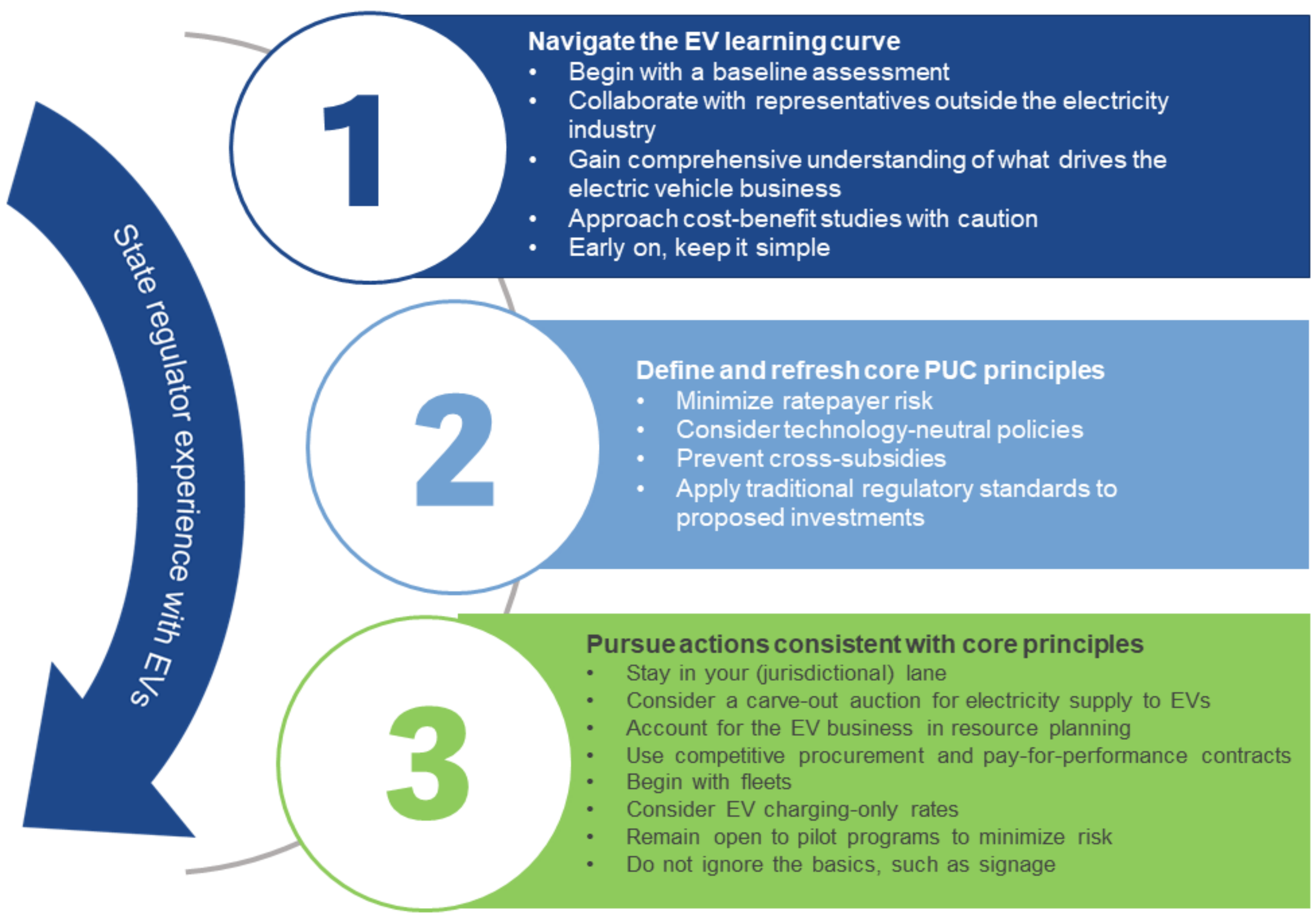
III. WHAT STEPS SHOULD PUCS TAKE TO DEVELOP NO REGRETS, LONG-TERM EV POLICIES?

Most PUCs across the country have already been inundated with utility and nonutility requests, applications, and proposals related to EVs. As the pace intensifies, it is essential for PUCs to develop their own policies for EVs that help avoid the risks of premature and potentially stranded investment while not missing out on what EVs can offer. These policies should be designed to minimize regrets and to serve the PUCs over the long haul as EVs transition from a tiny slice of today's market to substantial penetration levels over the next decade-plus.

Below, we provide examples of specific, actionable steps for PUCs to develop such policies. We have arranged these steps into three stages to reflect the fact that some PUCs are already well under way in addressing EVs. At a minimum, these steps encourage a proactive approach that will allow PUCs to address EV issues as they arise and evolve, while also providing potential areas for advocacy to push their states toward fostering economic EV adoption. Figure 4 summarizes the steps in each of the three stages discussed below.

Figure 4 – Stages in developing a no-regrets EV policy



Stage 1: Recognize the learning curve involved with EVs and take steps to deepen understanding. EVs represent a new frontier for PUCs and their staffs, since most PUCs have little or no jurisdiction over the transportation sector in their states. Moreover, EVs are a complex and dynamic topic, representing the intersection of physics, engineering, information technology, and economics and demanding unique expertise to address properly. And over time—especially a decade-plus time horizon—EVs could see fundamental technology and economic changes, such as the introduction of commercial-scale solid-state batteries. Recognizing the learning curve is essential to approaching EVs; we suggest the following steps:

- **Begin with a baseline assessment.** To properly frame the EV issues that need to be addressed in a state, the PUC and interested stakeholders will be well served to develop an initial baseline assessment that considers the state's unique geodemographics and frames the issues and the questions to be addressed. To be effective, credible, and authoritative, this baseline assessment ought to be prepared by an established, independent entity with sufficient expertise and no direct financial interest in or policy bias for EVs.

- **Collaborate with representatives outside the electricity industry.** Collaboration is crucial for PUCs to address the EV learning curve, to manage jurisdictional limitations, and to effectively consider all avenues available to fostering EVs. PUCs should open their doors to all interested stakeholders, not just those traditionally involved in the PUCs' electric dockets, and should seek out those that may not have a direct financial incentive to participate. Those stakeholders should include EV manufacturers, battery and charging equipment manufacturers, and engineers to help educate all stakeholders and to foster long-term continuing education on EV developments. Together, electric industry participants—such as the utilities themselves—and new stakeholders—such as manufacturers and installers of charging infrastructure—can combine forces to provide more credible answers to the PUCs' questions, such as, What is the difference between a 50-kilowatt charging station and a 350-kilowatt fast-charging station? How would such charging stations impact the grid and any distribution-level upgrades?

  Public agencies with which the PUC may not typically collaborate should also be involved. Federal, state, and municipal transportation authorities, state environmental agencies, state attorneys general, and state and local government officials can help the PUC stay within its jurisdictional bounds and explore the best options for fostering EV adoption. As noted above, displacement of ICE vehicles with EV vehicles could have significant impacts on gasoline tax receipts and highway infrastructure funding disbursements, which are based on gasoline and diesel consumption. Potential solutions to these and other EV-related consequences will require education and collaboration. PUCs can consider collaborating with PUCs in other states too, either to glean best practices and lessons learned or to collaborate on regional solutions.

- **Gain a comprehensive understanding of what drives the EV business.** PUCs must stay current on all the factors driving the EV business, ranging from the most recent data on EV technologies, battery prices, raw material supply and prices (e.g., lithium, cobalt, nickel), EV sales and market shares, to progress on broader, strategic factors such as progress in autonomous vehicles.

- **Approach cost-benefit studies with caution.** At some point, PUCs may conduct cost-benefit studies to look more deeply at their potential EV policies and investments, either to comply with legislation or as a further self-directed action. Cost-benefit studies can be helpful but can also cause controversies related to assumptions and methodologies. For example, EVs' purported benefits include an eventual cost advantage relative to ICE vehicles; however, this cost advantage is subject to uncertainties in the timing of reductions in battery costs and in gasoline price forecasts. These studies also hinge on benefits from reducing greenhouse gas emissions and other externalities. The uncertainties here are about how to value these reductions, with methodologies for doing so resulting in a wide range of estimated benefits.

In addition, some analysts argue that a market value should be used rather than a societal value; based on current auctions, market value tends to be much lower than societal value. Projected EV benefits also typically include lower electricity rates due to the fuller off-peak utilization of the electric system. The uncertainties here include a forecast of how much EV charging will be shifted to off-peak periods. Transparency in methodology and assumptions is key to conducting useful cost-benefit analyses.

- **Early on, keep it simple.** Just because the technical and jurisdictional challenges associated with EVs are complex, the PUCs' solutions do not have to be. Consider Tesla's October 2018 comments to the Illinois Commerce Commission in which it listed the three things it needs most from PUCs: (a) consumer education and awareness; (b) EV charging station development; and (c) electricity prices that lower the total cost of EVs.[77] Rather than focusing on complex rate-recovery mechanisms or EVs as distributed-energy resources, Tesla seeks simple steps such as consumer education and lower electricity prices.

Stage 2: Define—and refresh—the core principles for all PUC policies, including EVs. While EVs represent a new horizon for PUCs, the core principles by which PUCs exercise their authority should not change. In fact, it would be useful to refresh those core principles and tie them directly to potential actions the PUC may take.

- **Minimize ratepayer risk.** Even after the EV learning curve becomes clear, costs and benefits are estimated, and collaboration is well under way, risks and uncertainties associated with the emerging EV business will remain. In the face of those risks, PUCs, and other relevant agencies, should commit to defining risks and assigning them to those best able to mitigate them. That means, for example, protecting ratepayers from risk that should be shouldered by utility and nonutility developers of EV infrastructure and associated grid upgrades.
- **Consider technology-neutral policies.** To prevent the folly and inefficiencies of picking winners, PUCs should consider adopting technology-neutral stances. Technological and cost breakthroughs are subject to uncertainty; to avoid regrets, PUCs should let those advancements occur and thrive in their jurisdictions through flexible procurement mechanisms and technology-neutral policies.
- **Prevent cross-subsidies.** The price of electricity-related services to the EV business must cover the full cost of those services—no less and no more. EV rate design should avoid any intra-class and inter-class cross-subsidies.
- **Apply traditional regulatory standards to proposed investments.** Though transportation and the EV world of investments is new ground, PUCs should not abandon traditional standards in exercising their regulatory authority. PUCs should recognize petitioning parties' financial incentives and then apply traditional standards such as just and reasonable rates, used and useful investment, and prudence. In this way, PUCs can frame new proposals in a traditional light.

Stage 3: Pursue actions consistent with the core regulatory principles. Here, in particular, each state PUC may vary in its approach with EVs. Some may seek to do all they can to advocate for more EV investment and penetration, subject to traditional standards of prudence; others may take an agnostic view of the electrification of the transportation industry and instead focus on actions that allow the PUC not to be caught flat-footed as proposals roll in. Either way, actionable policies are possible.

- **Stay in your (jurisdictional) lane.** Electricity-related services are essential to the EV business, but those services are separate from the EV business. PUCs must be careful to avoid taking on expanded

[77] Francesca Wahl, Tesla, Response to Illinois Commerce Commission Notice of Inquiry Regrading Electric Vehicles. Oct. 23, 2018, p. 2.

responsibility for EVs. Instead, they should focus on collaboration with other agencies—including those with explicit jurisdiction over the transportation sector—through the long-term collaborative process outlined in Stage 1. Understanding where each agency's jurisdiction begins and ends will help define responsibilities and obligations.

- **Consider a carve-out auction for electricity supply to EVs.** To address the concern that EVs charged from the grid may not result in any meaningful environmental benefits, states may consider conducting separate, fixed-price auctions for renewable electricity supply to charging stations. This can be modeled after the full-requirements electricity supply auctions done in many retail choice states. This approach may require legislation in some jurisdictions but ultimately would fall under PUC jurisdiction. In considering this approach, PUCs should also assess the need for time-of-use metering in this context.

- **Account for the EV business in utility resource planning.** From the start, PUCs will have to be aware of the demands of the EV business on the electricity system. At some point, EVs could potentially become electricity storage suppliers, a possibility that should also be reflected in resource planning. PUCs should consider integrating EV planning with traditional electric utility resource planning in a way that allows for off-ramps in the planning process to minimize the potential for premature and potentially stranded costs.

- **Use competitive procurement and pay-for-performance contracts.** The American electricity business has been implementing competitive reform for electricity generation for forty years. State commissions should determine to what extent the risk (as well as the cost) of accommodating EVs can be minimized by allowing competitive development of charging stations and electricity supply to these stations. PUCs can also shift project development risk to suppliers through pay-for-performance contracts, while also considering any compelling reasons to use traditional, cost-plus ratemaking for some services.

- **Begin with fleets.** Fleets such as city buses, taxis, and delivery vehicles may be the first to shift from gasoline or diesel to electricity. These fleets can provide compelling economics and jump-start the private market. PUCs could seek to collaborate with state and municipal agencies to accommodate charging infrastructure for these fleets and should consider the experience of fleets' using compressed natural gas as a guide.

- **Evaluate EV charging-only rates.** At a minimum, utility rate design should not be an artificial hurdle to EV adoption. State PUCs, of course, retain jurisdiction over electricity rates and therefore can develop rate structures that avoid cross-subsidies and encourage efficient decisions by utility customers. One such ratemaking option is to consider rates applicable to EV charging only. Such rates may attempt to capture the environmental benefits associated with EVs, while requiring those EVs to be charged during off-peak hours, providing grid-wide benefits. Such an approach should also properly assign any needed grid upgrades to accommodate new EV customers, especially those creating significant new load.

- **Remain open to pilot programs to minimize risk.** Pilot programs can help mitigate the risks inherent in large-scale rollouts and investments. This is particularly true in the case of EVs, which also face a hurdle of public acceptance due to concerns about EV range and infrastructure. Introducing, for example, a small number of electric buses could demonstrate the reliability of those buses, which in turn could create momentum and public acceptance of expanded electric fleets. Other demonstration projects might include smart charging technology, range extenders, onsite generation and energy storage systems, and EV school buses. A PUC should feel free to participate in well-conceived pilot programs, but should be careful not to take them over.

- **Do not ignore the importance of basics, such as signage.** The vast majority of the US highway system—not to mention local roads—lacks any signage directing EV drivers to the nearest charging station. Introduction of nationally recognized signs indicating EV charging stations and other infrastructure is likely just a matter of time. PUCs can collaborate with relevant state and municipal agencies to ensure that signage is sufficient to minimize range anxiety.

IV. SUMMARY

Whether already immersed in all things EV or just beginning, PUCs across the United States can successfully design and implement their own "no regrets" policy. Doing this requires climbing the EV learning curve; staying updated on the evolution in transportation and its catalysts; staying true to core regulatory principles; and taking specific, proactive actions consistent with those principles. This way, PUCs can avoid regrets, whether Edison's predicted EV revolution arrives in the near future (albeit 100 years late) or whether it's further delayed by the Indian summer of fossil fuel-driven transportation.

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