Exploring the adoption of EVs in the US, Europe and China; charging scenarios and infrastructure

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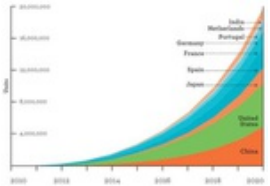

Aspirational targets among seven countries participating in the Electric Vehicle Initiative would see growth from just under 2 million EV and PHEVs to just under 20 million by 2020. Source: "Electric Vehicle Grid Integration". Click to enlarge.

A recently published paper by M.J. Bradley & Associates, commissioned by the Regulatory Assistance Project (RAP) and the International Council on Clean Transportation (ICCT), examines key drivers of EV adoption in the US, Europe and China, with an emphasis on vehicle charging scenarios and infrastructure.

This report examines hurdles to EV adoption in these regions, and identifies critical success factors that should guide policymakers in the transportation and electric sectors. Accelerating the pace of EV market growth requires a coordinated evolution in both sectors, the report argues, from the power plant to the charging station to the vehicle. Supportive policies should work to ensure that EV owners are able to capture the full economic value of their decision to fuel switch from electricity to gasoline, including any benefits to the grid operator, and any emission reduction benefits, in addition to realizing the savings from replacing gasoline or diesel fuel with electricity.

The report identifies insights about the choice of charging infrastructure in each region that will both maximize benefits to consumers (thus helping to drive EV adoption) and maximize benefits to the grid from greater EV use. The report examines how these optimal scenarios differ by region, and makes recommendations for policies and electricity regulations that will make realization of grid benefits from EVs more likely.

> "The economic and policy landscape is ever-changing, and convergent factors have the potential to drive a better business case for EV, for vehicle owners as well as state and national governments."

Although the report is addressing adoption in the three major regional markets, the authors chose to highlight a series of sub-regions due to the large amount of economic and demographic variation within the focus regions, with particular attention to near-term EV

market growth potential.

Within the US, it examines California, Massachusetts, and Michigan—states covering a range of differences in electric power generation and power market structures. Within the EU, it cites examples from France, Germany, Spain, the United Kingdom, and Denmark. In addition to providing a snapshot of Western Europe, these countries have each implemented EV policies and have collected and published relevant data that are useful for the analysis. Within China, information comes from Beijing, Hong Kong, Guangzhou, and Shenzhen, which are significant economic centers with demonstrated long-term EV policy planning.

> *All three regions have established targets for EV registrations. In 2012 the German government declared a goal of having one million EVs registered by 2020. Spain has set a goal of 250,000 electric vehicles on the road by 2014. The French government has set a goal of two million EVs by 2020, and has dedicated €50 million in funding to promoting adoption of electric vehicles. Denmark has a goal of 200,000 EVs by 2020, recently reduced from 400,000.*
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> *In the US, President Obama declared an American goal of putting one million EVs on the road by 2015. The number of registered EVs surpassed 100,000 in May 2013, leaving much ground to be covered before the target is met. Massachusetts and California state governments have taken meaningful steps to promote EV ownership, since they believe that the transportation sector will play a crucial role in helping achieve their respective GHG reduction targets.*
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> *China has taken numerous steps to drive EV adoption amidst the ongoing growth of the passenger vehicle market. In 2011, the Ministry of Science and Technology announced a goal of one million EVs by 2015 and 10 million by 2020, but these targets were later cut in half. Between 2009 and 2011, Chinese buyers purchased 13,000 EVs and PHEVs—more than U.S. sales but well below the run-rate needed to reach the 2015 target.*
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> *National targets are aspirational and provide a rallying cry for subsequent policy initiatives, but alone they are unenforceable. Enthusiasm in some areas has been tempered by slow EV uptake. In Germany, for example, consumers bought 2,100 EVs in 2012—less than 0.1 percent of total car sales. The automobile industry has said that without additional government subsidies they can only sell 600,000 electric cars by 2020 at best. In China, 20,000 EVs and HEVs were sold in 2011 and 2012, amounting to only four percent of the 2015 target.*
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> —"Electric Vehicle Grid Integration"

The report notes that with current technology, the costs and operating limitations of EVs inhibit market growth in all but a small segment of the potential buyer base, with adoption thus falling short of initial goals in all regions.

Among the regional observations the report makes are:

- Key differences exist among electric sector regulatory regimes within the three regions. Furthest along with electricity market deregulation, the US can serve as a model for how to design market rules to reduce the cost of integrating EVs on the grid. Because the basic principles of electricity dispatch hold true across the regions, research conducted in the US on the impacts of EV integration holds lessons for ways to understand and minimize the impacts in all regions.

  Another observation from the US market is that the diverse fuel mixes of regional electricity generation fleets, along with intraday variations in system load, cause frequent fluctuations in the emissions from electricity used to charge an EV. Across the board, better alignment of electricity and transportation planning processes will be essential to optimize grid integration of EVs, not only mitigating the downside risks but also capturing as much value as possible for system operators.

- European regulators are unbundling generation and transmission, and creating trans-national electricity markets. Trends toward deregulation of the electric sector in all regions will facilitate greater market-based procurement of decentralized generating capacity and load management resources. This could mean greater opportunities for EVs to provide valuable services to the electric grid.

- Vehicle ownership rates are increasing in densely populated urban areas of China—and unprecedented air pollution is becoming a major issue. EVs offer the potential to limit urban mobile source air emissions by pushing them upstream into the electric grid, where successful control can be achieved through limits on far fewer sources.

- Electric sector environmental regulations in the United States, coupled with low natural gas prices, have helped reduce emissions from power generation, improving the operating footprint of EVs and increasing their comparative advantage over gasoline-powered vehicles. Electric sector regulations in the US, along with decarbonization goals being implemented in the EU, will continue to reduce GHG intensity and conventional air emissions from electricity generation.

- Fleet-wide average fuel economy standards in all regions are driving demand for more efficient vehicle technologies. These standards could help or hurt EVs, depending on the degree to which they stimulate a market for other advanced vehicle technologies and drive efficiency gains in ICE vehicles. Whether automakers increase production of EVs to help meet average fuel economy standards will depend on the commercial prospects of EVs. Policies will play a key role here, the report notes.

- Larger shares of grid-connected intermittent renewable energy resources, such as wind and solar power, have been driven by electric sector renewable energy policies and the falling costs of generating technology. The integration of these resources requires greater attention to electric system load management, which could drive demand for the types of grid services EVs are capable of providing.

The report makes the case for four broad policy objectives:

1. Limit negative grid impacts, to avoid creating new barriers and costs due to integrating larger numbers of EVs into the grid.

2. Realize full potential of grid benefits, to help lower ownership costs for drivers, and ensure that electricity customers benefit from grid-connected EVs as much as is technically possible.

3. Expand economic incentives for drivers, through sound, cost-effective policies that assign value to the benefits from EV use, and enable drivers to capture those benefits.

4. Avoid creating stranded assets through subsidies, by limiting public investment in high capital cost electric vehicle supply equipment (EVSE) that is at risk of being underutilized.

In support of those objectives, the report makes a series of primary policy recommendations:

- Create or amend electricity sector rules to foster participation by non-generators in electricity markets. This includes unbundling of electricity services, creating open and transparent electricity markets, enabling aggregators to participate in ancillary services markets, and reducing regulatory barriers.

- Encourage time-of-use (TOU) and/or real-time electricity pricing tariffs. To minimize emissions impacts from charging, price signals should reflect the environmental costs of generation, thereby creating an incentive for charging behavior that minimizes the emissions due to vehicle charging. This is especially important in regions where marginal generation has a high emissions profile.

- Allow prudent cost recovery of capital and operating costs by electricity distribution companies to foster EV ownership.

- Adopt policies to control GHG emissions. Decarbonization policies place an economic value on GHG reductions, increasing the size of the potential incentive pool for EV owners. Charging an EV produces varying amounts of GHG emissions, ranging down to zero GHGs from renewable electricity, giving them an inherent advantage over ICE vehicles. Stricter policies to control GHGs can increase the value of environmental benefits from EVs, and increase operating cost savings, but careful policy design is needed to avoid creating new barriers to EV adoption.

- It is important to ensure that energy resource planning, procurement, and investment are compatible with public policies that address system reliability, affordability, air quality, and GHG reduction, and do not provide unfair advantage to incumbent sources of generation.

- Promote lower energy use, and rates, through decoupling. Regulated entities that earn profits on energy sales have an incentive to sell more electricity, which can drive up energy costs for EV owners and reduce the cost savings

vs. ICE vehicles. Policies to separate utility earnings from energy sales, and reward energy and cost efficiencies, can reverse this incentive.

- Establish a long-term strategy to integrate EVs into road user fees. In the short run, preserve the implicit road tax exemption for EV owners by minimizing road use EV surcharges. Meanwhile, launch an effort to identify the best approach to integrating EV use into tax policy in a way that recognizes the societal benefits of EVs as well as the costs of road use, to level the playing field with ICE vehicles.

Secondary policy recommendations include:

- Stimulate prudent research and development activity. The greatest key to EV penetration is vehicle cost reduction and range extension. Longer-range, cheaper vehicles would meet the daily driving needs of more drivers. Avoid preferential/protectionist funding, which can lead to less efficient use of subsidy funds.

- Harmonize EVSE and EV standards; include advanced communication capability.

- Consider EV charging incentives "elsewhere" on the bill. Beyond time-of-use (TOU) pricing, specific reductions to transmission costs, capacity charges, environmental surcharges, and/or electricity taxes could be used to promote off-peak charging and recognize the specific locational benefits of individual off-peak electricity use, compared to on-peak.

- Establish customer relationship guidelines, or amend existing ones, to address issues raised by EV ownership.

- Promote alternatives to high capacity public DC charging. As a matter of policy, promoting a dominant charging strategy of high capacity EVSE conflicts with the objective to limit negative grid impacts and realize the potential grid benefits. Lower capacity, off-peak charging offers lower charging costs to consumers and reduces peak load, and because of the longer charge times, provides greater opportunity for vehicles to provide grid services.

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts focused on the long-term economic and environmental sustainability of the power and natural gas sectors. The International Council on Clean Transportation (ICCT) is an independent nonprofit organization founded to provide unbiased research and technical analysis to environmental regulators.

Resources

- Electric Vehicle Grid Integration in the US, Europe, and China: Challenges and Choices for Electricity and Transportation Policy

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