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Early Plug-in Electric Vehicle Sales: Trends, Forecasts, and Determinants

Prepared for the Southern California Association of Governments

Deliverable 4

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Early Plug-in Electric Vehicle Sales: Trends, Forecasts, and Determinants

About the Report

This report was prepared for the Southern California Association of Governments (SCAG) by Brett Williams, PhD, J.R. DeShazo, PhD, and Ayala Ben-Yehuda of the UCLA Luskin Center for Innovation. It constitutes Deliverable 4 of SCAG contract 12-021-C1 to support regional planning for plug-in electric vehicle (PEV) adoption. SCAG is coordinating a multi-stakeholder group of government agencies, utilities, and university researchers to prepare multi-faceted and interdisciplinary regional PEV readiness plans. Among other purposes, these plans will help illuminate and guide strategic infrastructure investment, PEV-related economic development, and supportive policy design in Southern California.

Disclaimer

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Contents

1 Report Structure and Summary

Plug-in electric vehicles (PEVs[1]) will be sold by all major automakers in California in the 2010–2014 timeframe. Plug-in electric vehicles include plug-in hybrid electric vehicles (PHEVs) and all-battery electric vehicles (BEVs). Policymakers would like to know how many and what type of PEVs will be sold in Southern California over the coming decade so that PEV readiness efforts by local governments can be synchronized with regional market growth. One concern is whether consumer demand for PEVs will be constrained by automaker supply of these vehicles. The basis for this concern has been the slow and delayed arrivals of PEV models to market, as well as the perception that announcements of vehicle production targets are frequently over-optimistic.

While predicting with confidence how many and what type of PEVs automakers will produce is problematic, in this report we examine PEV supply by presenting and evaluating a wide range of evidence. Section 2 characterizes recent PEV market sales in the U.S. by model and product type. It shows cumulative U.S. sales as of June 2012 at over 36,000 vehicles for 12 PEV models. The Volt, Leaf, and Prius Plug-in are currently leading in market volume, and plug-in hybrids are emerging as the dominant product type. With respect to trends in the rate of sales, Section 2 also compares PEV sales to historical sales of gasoline hybrids. Sales of certain PEV models have been compared unfavorably to those of early hybrids, but a closer look at the adoption of individual models reveals a more nuanced picture. Based on some metrics of comparison, individual PEV model adoption rates do tend to lag the early adoption rates of the most successful gasoline hybrid models. Taken as an overall product class, however, PEV adoption over the last three years has been outpacing early hybrid introduction.

Section 3 evaluates expectations about PEV supply from two perspectives: i) announcements about national vehicle releases and sales goals, and ii) low-cost compliance with California's Zero Emission Vehicle (ZEV) regulations. Section 3.1 shows that announced release dates and sales expectations tend to be overly optimistic. Nonetheless, the number of PEV models sold will likely more than double by late 2013.

Expected ZEV compliance estimates described in Section 3.2 suggest PEV sales in California could exceed 50,000 per year by 2019 and 150,000 in ten years (by 2022). Cumulatively, PEVs would exceed 100,000 by 2019, 300,000 by 2021, and approach 500,000 by 2022 if automakers meet current ZEV requirements.

Section 4 examines U.S. and California forecasts published by academics, consultants, and market researchers. Few of them explicitly focus on potential supply constraint scenarios by auto manufacturers. Most forecasts have been based on macroeconomic factors (such as gasoline prices) as well as the persistence of existing policy incentives at the state and federal level. Some forecasts are

[1] To avoid ambiguity, we use the term plug-in electric vehicles (PEVs, synonymous with "plug-in vehicles" or "plug-ins"). Technically speaking, the term electric vehicle (EV) may properly refer to either electric-drive vehicles (including all-gasoline hybrids and fuel-cell electric vehicles without grid charging capability) or electric-fuel vehicles (which generally implies charging from the grid). Historically EV has been used synonymously with all-battery EV when that was the sole, or at least primary, type of EV in major development.

based on models developed by researchers that predict the diffusion of innovative technologies using certain market and demographic assumptions (including historic sales of hybrid vehicles). Other estimates are based on software simulations that compute variables such as vehicle price, fuel price and availability, consumer preferences, and a variety of subsidy and policy scenarios. Still other forecasts are prepared according to industry disclosures and surveys, market research, literature reviews and emissions compliance targets. Projections indicate the California PEV population could approach 100,000 by 2014–2015, 300,000 by 2015–2019, and 500,000 by 2018–2020.

Section 5 synthesizes the evidence reviewed to date, focusing on sales factors in the context of California. PEV models are expected to proliferate rapidly between 2010 and 2014. While some models appear to be low-volume, development and/or regulation-compliance platforms, others appear targeted at widespread consumer acceptance. As with all new car models, we should expect that some of these new models will sell poorly and eventually be discontinued. However, some models will "take off," and a very few may even become PEV "classics."

Fundamentally, we expect that PEV sales volumes will be determined largely by a few factors. Foremost among these is the price of the vehicle, which should fall as battery costs continue to decline. A second and related factor is the persistence of federal and state policy incentives, which in California can provide up to a $10,000 reduction in the effective price of a PEV, without counting local incentives (see Appendix A). These incentives provide critical momentum to PEV sales. Until PEV prices fall significantly, continued provision of these policy incentives may be a greater source of uncertainty for PEV sales than other constraints on PEV production. A third critical factor is currently the very low consumer awareness of the value proposition embodied in the adoption and use of PEVs. The "message" explaining the value of PEVs and addressing widespread misconceptions associated with them is simply not being adequately conveyed on a scale that will lead to rapid increases in demand for this technology. A fourth factor that will influence PEV sales is the availability of charging infrastructure. This demand driver is examined in depth in Deliverable 2.

Consumer uptake remains the critical uncertainty. However, less doubt remains about the automotive industry's fundamental ability to supply a number of vehicles equal to or greater than what is necessary for ZEV program compliance, should sufficient demand exist. Based on current vehicle pricing, production, and sales trends, consumer demand is unlikely to critically outstrip available supply for most PEV models in the California market.

2 Existing PEVs: U.S. Light-Duty PEV Sales to Date

This section characterizes current PEV supply and early market dynamics in the U.S., including an examination of PEV sales (subsections 2-1 through 2-3) and a comparison to early hybrid sales (subsections 2-4 through 2-5).

2.1 Current PEV model and sales summary

Table 2-1 summarizes U.S. light-duty PEV "sales" through June 2012. Sales are defined to include all financing arrangements, including leasing without an option to buy. Table 2-1 describes twelve PEV models released in the U.S. by American, Japanese, and European automakers—nine BEVs and three PHEVs. They range in price from $29,000 to $109,000. The vehicles' EPA-rated electric-drive capabilities range from 11 to 38 miles (mi) for PHEVs and 62 to 265 mi for BEVs. This is provided by batteries rated from 4.4 to 20 kilowatt hours (kWh) for PHEVs and from 16 to 83 kWh for BEVs.

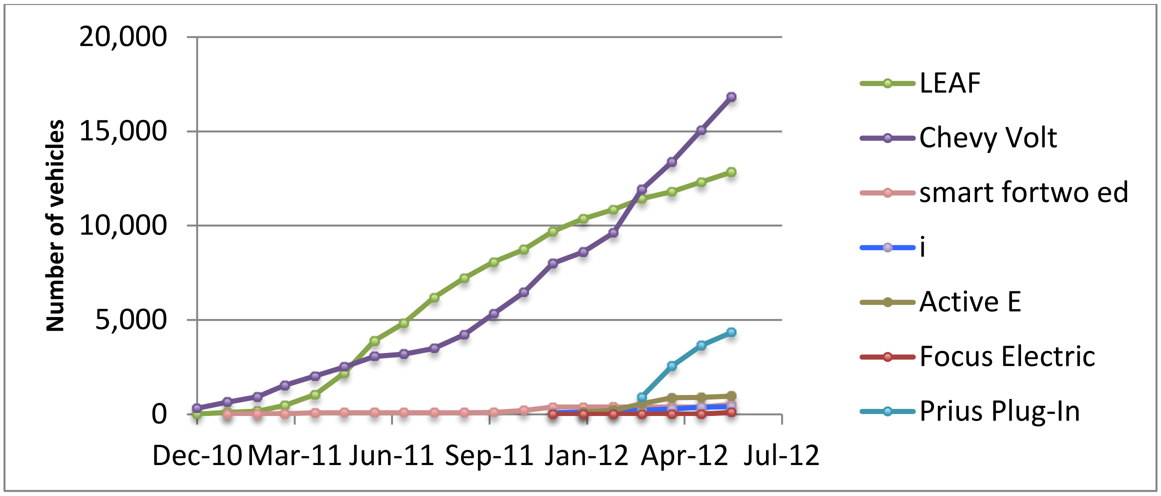
Table 2-1: U.S. light-duty PEV model characteristics and sales through June 2012[a]

Model	Make	U.S. sales start	Battery (rated kWh)	CS fuel economy (mi/gal)	CD fuel economy (mpge)	Electric range - EPA (mi)	Range, total (mi)	Base MSRP	Cumulative U.S. sales
Roadster	Tesla	Feb-08	53	-	119	245	245	Discontinued. ($109,000)	<2,500[b]
Cooper MINI-E	BMW	Jun-09	35	-	98	100	100	Discontinued. ($600/month for 12 mo.)	450[c]
LEAF	Nissan	11-Dec-10	24	-	99	73	73	$35,200	12,841
Chevy Volt	GM	15-Dec-10	16.5	37	98	38	382	$39,145	16,814
smart fortwo ed	Daimler	Jan-11	16.5	-	87	63	63	$599/mo for 48 mo. + $2,500	≥518
Karma	Fisker	18-Oct-11	20.1	20	52	32	232	$102,000	<1,000[d]
i	Mitsubishi	13-Dec-11	16	-	112	62	62	$29,125	409
Active E	BMW	22-Dec-11	32	-	102	94	94	$499/mo. for 24 mo. + $2,250	≥673, ≤969[e,f]
Focus Electric	Ford	Dec-11	23	-	105	76	76	$39,200	105
Prius Plug-in	Toyota	Mar-12	4.4	50	95	11	540	$32,000	≥4,333 ≤4,346[f]
Sedan	Coda	16-Mar-12	31	-	73	88	88	$37,250	≥3
Model S	Tesla	22-Jun-12	83	-	89	265	265	$97,900	≥5

[a] Excludes bankrupt companies (e.g., ~250 Th!ink City vehicles, etc.) [b] Contracted for 2,500 Lotus Elise gliders total for global sales. [c] Limited-production program. [d] Approximately 1,000 global sales. [e] U.S. allotment for limited-production program possibly limited to 700. [f] Conflicting 2012 YTD sales figures available at hybridcars.com

Of the twelve models described above, publicly available per-month sales data can be compiled for seven from hybridcars.com. Figure 2-1 depicts cumulative U.S. sales by PEV model for these seven PEVs, listed in the figure key in order of U.S. release. Sales have been dominated by the LEAF and Volt (each with well over 10,000 vehicles on the road), with additional significant influence seen as of March 2012 from the Prius Plug-in (approaching 5,000 in its first few months).

Figure 2-1: Cumulative U.S. light-duty PEV sales through June 2012 by model



Reliable estimates for California sales are not publicly available for all PEVs models. Assuming California's share of national PEV sales turns out to be the roughly 25% characterized in a KEMA projection discussed in Section 4 [1, p. AP-8], an estimated 9,000 vehicles have been sold in California. However, because most PEVs are initially released in California, and sometimes only in California, the state's share may be even higher in the near term as releases expand to additional markets.

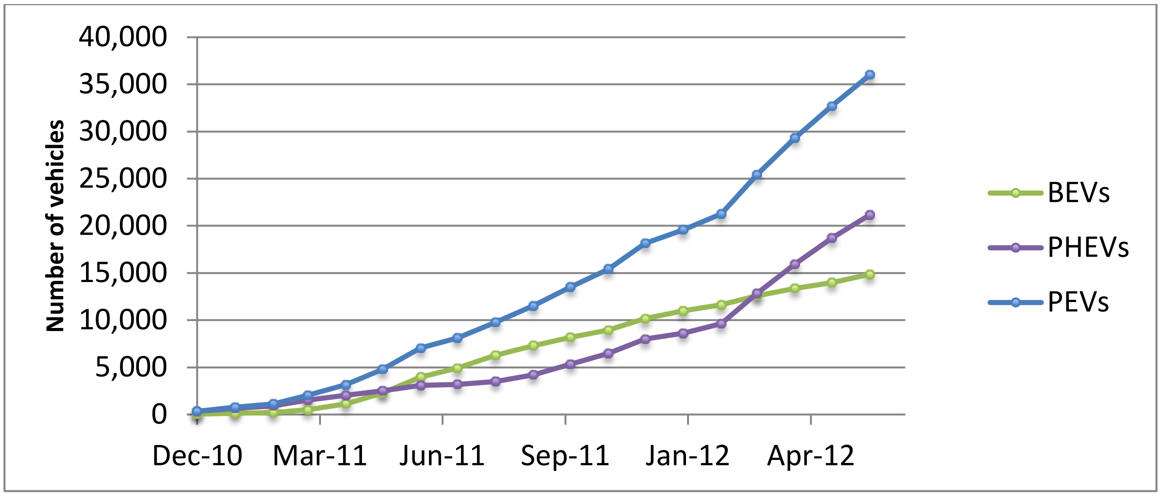
2.2 PEV sales by product type: BEVs and PHEVs

An often-neglected uncertainty in planning for PEV market penetration is the relative level of adoption of BEVs and PHEVs. Each has significantly different implications for consumer behavior, infrastructure requirements, grid impacts, adoption dynamics, and policy design and effect. Though both BEVs and PHEVs will play an important role in helping California meet its transportation and energy goals, an increased understanding of and differentiation between the two vehicle product types is necessary.

As seen in Figure 2-1, Volt cumulative U.S. sales overtook the LEAF in March 2012. Similarly, in March 2012 cumulative sales aggregated over all PHEV models surpassed cumulative BEV sales, as seen in Figure 2-2. This trend was reinforced by strong early Prius Plug-in sales, which helped to propel PHEVs to over 21,000 vehicles by the end of June 2012, while BEV sales of the models examined remained below 15,000.

One BEV model—the LEAF—is becoming more available but possibly experiencing slowing adoption (though only half of 2012 sales have been reported). Four BEV models—the smart, i, Active-E and Focus—are experiencing lower volumes, some of which are arguably due to an approach more focused on development and regulation compliance.

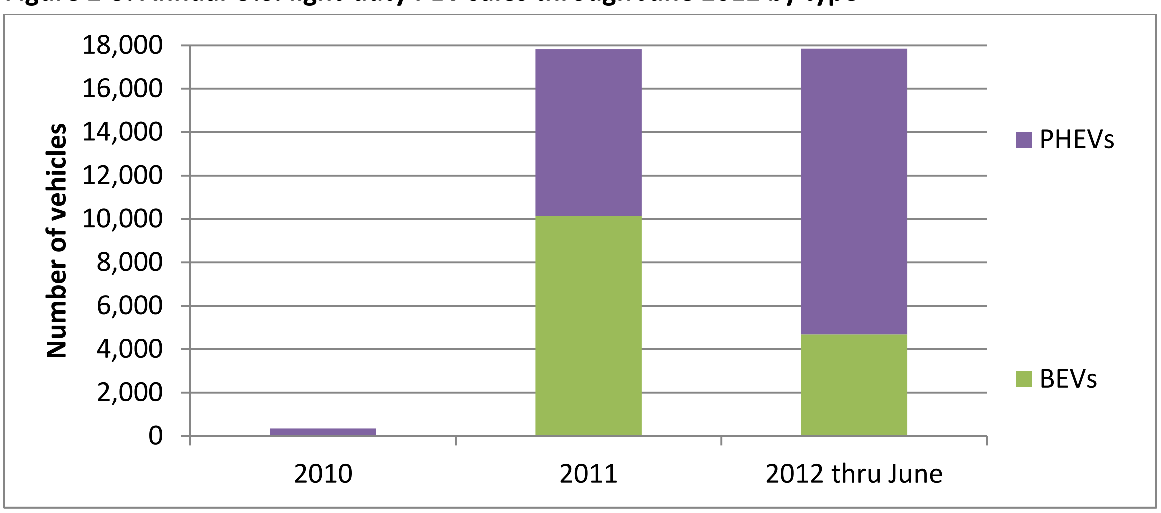
Figure 2-2: Cumulative U.S. light-duty PEV sales through June 2012 by type*



*aggregating the 7 models listed in Figure 2-1.

Examining this trend on an annual basis, Figure 2-3 shows that after BEVs dominated PHEVs in the market in 2011, the reverse is expected to be true in 2012. This is based on the first half of the year, which closely matches 2011 in total PEV sales (~18,000 vehicles) but differs significantly in BEV/PHEV share. Thus far in 2012, only one-fourth of PEVs sold were BEVs, compared to over half in 2011. If this trend continues, the world of commercial "EVs" will be dominated by a new product type with use, impact, policy, and planning implications considerably different than those that have come before.

Figure 2-3: Annual U.S. light-duty PEV sales through June 2012 by type



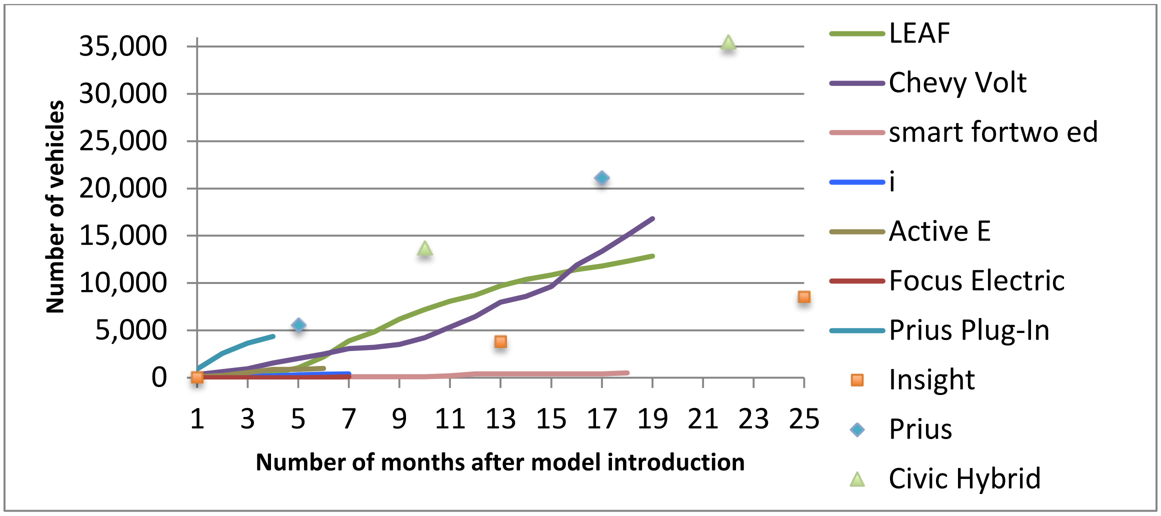
2.3 Sales comparison: PEVs and early hybrids

How do early PEV sales compare to sales of early gasoline-only hybrid electric vehicles (HEVs)? Before examining the evidence, it is important to recognize the dramatic differences in both market structure and adaptive behavioral processes needed for PEV as compared to HEVs. The number of PEV models in the early market is much greater than the three models in the first five years of the HEV market. Early PEV consumers will have a greater array of brands and vehicle types which should facilitate matching consumer needs with vehicle characteristics. While this vehicle variety should speed aggregate rates of PEV adoption, working against this are several factors. These include the fact that PEVs, in particular BEVs, entail vehicular and infrastructure financial costs, adoption complexity, and behavioral change not required of early hybrid adopters. Further, the diversity of product types and associated required adaptations are difficult for consumers to understand when considering the vehicle purchase. It would stand to reason that these financial, learning, and adaptive costs act to slow PEV adoption relative to HEV introduction, which entailed incremental cost and uncertainty about new technology, but required no behavioral change.

Figure 2-4 plots sales for individual PEV and HEV models against the number of months after model introduction, based on annual data for HEVs available at afdc.energy.gov about hybrids. With one exception, PEV model sales accumulated more slowly than the original Prius in its initial months of commercialization starting in August 2000. The PEV exception is the Prius Plug-in. Both the fact that it is built upon the successful Prius platform and its small-battery PHEV architecture tend to minimize many of the real and perceived PEV adoption hurdles described above.

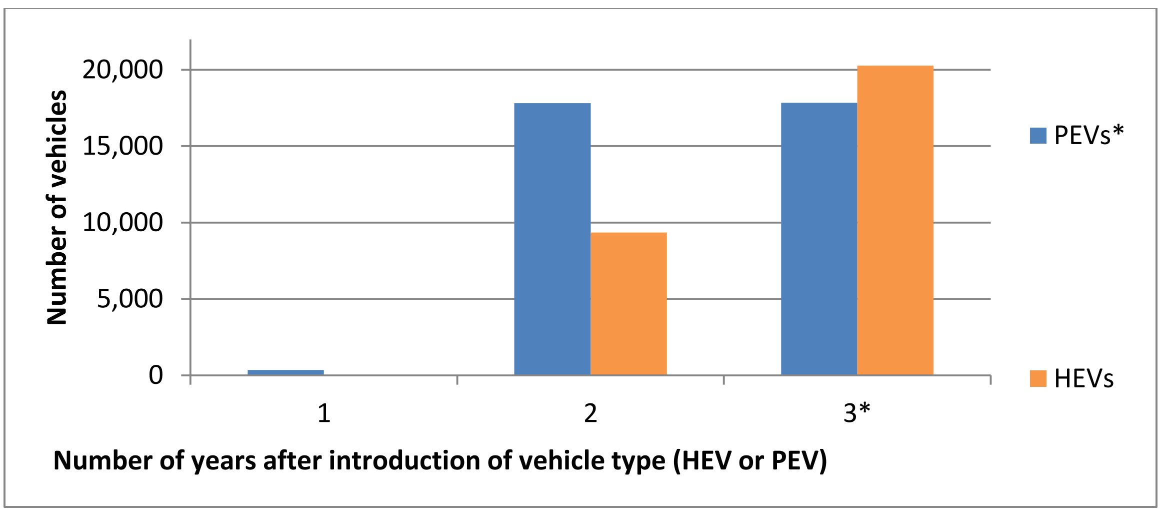
The Honda Civic Hybrid accumulated sales in the U.S. even more rapidly than the Prius. In contrast, the first U.S. hybrid, the Honda Insight, was a two-seater coupe and had much more limited success. It was adopted at lower rates than seen thus far for the LEAF, Volt, and Prius Plug-in.

Figure 2-4: Cumulative U.S. light-duty sales by month after introduction of model



A comparison of the adoption of *individual models* of PEVs and hybrids is thus complex. On the other hand, comparing PEV and hybrid adoption *overall* presents a simpler and perhaps more surprising picture. Despite the barriers to PEV adoption, Figure 2-5 shows that PEVs as a whole (in blue) outpaced hybrids (in orange) in the first two years of introduction. With only six months of sales reported so far in 2012, PEVs—propelled by two PHEV models, the Volt and the Prius Plug-in—are well-positioned to continue this trend by the end of their third year on the market.

Figure 2-5: U.S. light-duty sales by calendar year after introduction by EV type (HEV or PEV)



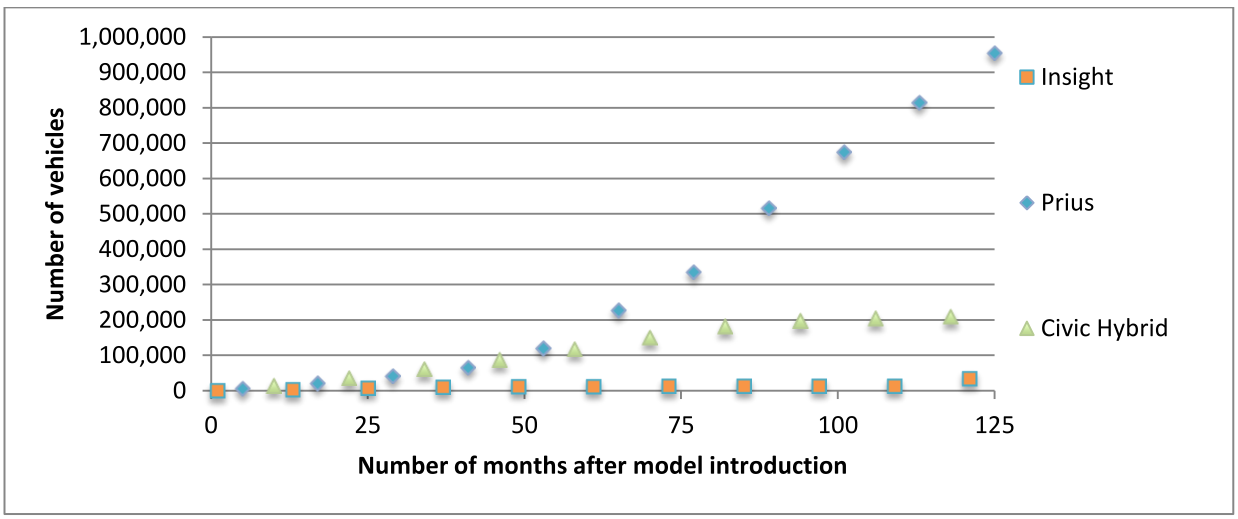
* PEV sales in year 3 (2012) are only through June. HEV sales in year 3 (2001) are for the entire year.

2.4 Later hybrid adoption trends and lesson for PEVs

Figure 2-6 tells more of the hybrid adoption story by illustrating the first ten years of sales for the first three mainstream hybrids: the Honda Insight (starting in 1999), the Toyota Prius (2000), and the Honda Civic Hybrid (2002). In their first two years, each vehicle experienced relatively comparable low-volume sales. In its third year the Honda Insight did not see the increases the other vehicles saw in their third years. The Insight was presumably constrained by its two-seater, CR-X-based body, and possibly its overly futuristic styling. After five years on the market, Prius sales begin to differ from the Civic Hybrid's fifth-year sales to emerge as the clear winner. For the Prius, this corresponded both with its establishment as the clear fuel-efficiency leader as well as its 2004 redesign into the iconic, distinct, but not-quite-as-futuristic form that persists today. The vehicle left behind its "economy/compact sedan" Echo platform roots and increased in size to a unique platform between the Corolla and Camry. Simultaneously it increased in performance and fuel economy, winning it the Motor Trend Car of the Year award.

It took roughly eight years of commercialization to accumulate over 500,000 hybrids. The Prius would go on to sell roughly a million units in the U.S. in ten years, whereas Honda would struggle to sell a fifth that amount between two models, at least up until the Insight was recently redesigned as a four-door sedan.

Figure 2-6: Cumulative U.S. light-duty sales by month after introduction: hybrids



In the sixth year of HEV commercialization (2004), the Prius sold over 50,000 units, followed by two doublings over the next three years. It does not seem unreasonable that after another three and one-half years, a PEV model would approach 50,000 units per year. This is roughly the scale that the Volt was meant to achieve relatively early in its commercialization (45,000/year), according to early announcements. Whether PEVs can achieve the subsequent doubling of sales year over year remains to be seen. However, several market forecasters have been willing to predict as much, as discussed in Section 4.

2.5 Why is the PEV market different from the HEV market?

It would not be unexpected for PEVs to significantly lag HEVs in overall adoption trends. PEVs require complex purchase decisions based on poor and poorly understood information about PEVs, full costs of adoption, behavioral changes, and so forth. They depend on a nascent and rapidly evolving charging infrastructure. Fuel and maintenance cost savings calculations are difficult for the typical consumer because of hard-to-read utility bills, complex rate structures, future fuel choices, and as-yet unproven maintenance expectations. Clearly, the differences between gasoline hybrids and vehicles with electric fuel capabilities are even more fundamental than those highlighted above between PHEVs and BEVs.

As unsettling as hybrid commercialization was at the time, the difference between PEVs and hybrids is the difference between uniformly disruptive innovation and relatively straightforward product development. To the extent historical examples can act as guides (e.g., the personal computer and home electricity [2]), disruptive innovations can be expected to take multiple decades to succeed, not the one required by the Prius to reach one million sales.

3 Expected PEVs: Announced Vehicles and Regulation Compliance

Fears of supply constraints will be heightened if only a limited number of PEV suppliers and vehicles are expected. To the contrary, Section 3.1 presents evidence that the majority of the automakers operating in the California market have discussed their intention to supply at least one PEV model within the next two years, increasing the available options by roughly two dozen models. However, these informal “announcements” and their coverage in the media have a reputation for being inaccurate. Release dates may be delayed or canceled. Production or sales volumes could be markedly lower than planned. Section 3.1 discusses the many caveats applied to interpretation and use of this data. It also compares the announcements with actual data for existing PEVs to ascertain how accurate these data may be. We conclude that while the average announcement tends to be inaccurate, the sheer quantity of anticipated PEVs releases suggests that consumers will have many possible PEV choices.

Section 3.2 explores the expected level of overall PEV supply from the perspective of compliance with California ZEV regulations. Though riddled with a complex past, these regulations provide an indication of the PEV supply that must be brought for sale in California over time for automakers to be seen in the positive light of compliance. Recent indications, including the development of the many vehicles described herein and the first increases to the national Corporate Average Fuel Economy standards in decades, point toward an unprecedented ability and willingness to supply the vehicles necessary. Regardless, compliance estimates provide important context for both the “minimum” (if mutable) supply the state is aiming for, as well as the “maximum” levels automakers might be willing to supply in absence of clear demand. Thus they also ground the demand-based penetration projections summarized in Section 4.

3.1 Expected PEV models and a comparison of announced vs. actual sales volumes

Table 3-1 summarizes announcements compiled from a variety of media, online, and conference sources about planned U.S. PEV releases into 2014. These data show that over two dozen new models have planned release dates, roughly half in 2012 and the other half slated for 2013–2014.

These PEVs announcements and their coverage in the media are inherently uncertain, ambiguous, and often inaccurate. In addition to the vagaries of product planning, automakers publicly provide information on future products using a variety of approaches that differ both across and within organizations. Details, where available, must also be viewed in the context of such altering forces as ongoing development, strategic positioning, fundraising (particularly for certain start-ups), and so forth. For example, claims about BEV electric range in particular have almost always been presented in ways that allow use of a figure equal to or greater than 100 miles, even long after the EPA ratings (which, as seen in Section 2, rarely exceed 100 miles) have been determined and provide a standard frame of reference (if an imperfect one from certain perspectives).

Table 3-1: PEVs slated for U.S. release (as of May 2012)

Model	Make	U.S. sales start*	Battery rated kWh	Electric range** ("mi")	Range, total ("mi")	Price indications
Model S variations	Tesla	2012	42	160+***	160+	$57,400+
2012 smart fortwo ed	Daimler	2012	17.6	86	86	$599/mo. lease only + $2,500 at signing
e6	BYD	2012	60	150	150	$35k, on sale in China for $47.2k
Chevy Spark	GM	2012	20	100	100	?
Scion iQ	Toyota	2012	13?	50	50	?
RAV4EV	Toyota	2012	41.8	100	100	$49,800 MSRP
C-Max Energi	Ford	Sep-12	10?	17	>500	?
Fusion Energi	Ford	Sep-12	8?	17	>500	?
Fit EV	Honda	2012	20	?	?	$399/mo. lease only (based on $36,625)
GCE	Amp	2012	37.6	80	80	$57,400
Mle	Amp	2012	40	100	100	$79,500
Accord PHV	Honda	2012	6.0	15	>400	?
F3DM	BYD	2012	13.2	60	>300	$28,800
F6DM	BYD	2012	20	60	>300	~$22k in China
500 Elettrica	Chrysler-Fiat	2012	22?	90	90	$45,000
i3	BMW	Sep-13	22	75	75	$35,000
Cadillac ELR	GM	2013	16.5?	38?	>300	~$50-57k
Golf twinDRIVE	VW	2013	13.2	35	558	?
Sonata Plug-in Hybrid	Hyundai	2013	?	?	>300	?
Outlander Sport PHV	Mitsubishi	2013	?	?	>200	?
A-class E-Cell	Daimler	2013	?	?	?	?
PX-MiEV	Mitsubishi	31-Dec-13	12	30	>500	?
Model X	Tesla	2013	60	160+?	160+?	?
E-Golf	VW	2013	?	35	35	?
i8	BMW	2014	?	20	>200	$132,600
Atlantic	Fisker	2014	?	50?	282?	~$45-$60k
A4 e-quattro	Audi	2014	?	37	>300	?
Infinity LE	Nissan	2014	24	100	100	?
A3 e-tron	Audi	2014	12	31?	>200	?

*Some announced start years may actually be model, not calendar years. Thus some "2014" vehicles may be released in 2013.
** Based on claims, press coverage, simple calculations, etc. All range estimates are rough approximations and highly subject to differences in driving and testing conditions.
*** Base model (offering "160, 230, or 300 mile range pack," though the largest current EPA rating is 265 miles)

Figures 3-1 and 3-2 illustrate the difference between announced volumes and actual sales for models considered "high volume" and "low volume," respectively. Each vehicle is represented by one color. Actual sales for each vehicle are marked by triangles. 2012 sales are through June only, and thus are connected to 2011 sales by dotted lines to represent the fact that 2012 triangles will move significantly up the vertical axis by year's end. Announced volumes for each model are marked by squares and represent highly uncertain numbers that were at some point in the past discussed in the media, presumably based on conversations with automakers, but subject to the significant uncertainty and error described above. Thus these and similar figures should be considered illustrative only.

Nevertheless, several findings are of interest. In all cases but two, actual sales either did fall or look to fall significantly short of announcements. Notable differences can be seen in the 2012 numbers so far for the Coda Sedan, LEAF, Volt, Focus Electric, and i—four out of five of which are BEVs. Start-up firms Coda and Fisker (for which sales figures are unavailable but likely fall far short of volume announcements exceeding 10,000) also notably fall short of expectations, though arguably not surprisingly for firms trying to raise capital. On the other hand, expectations about the Active-E developmental release have been better managed, and the Prius Plug-in could still arguably achieve 2012 sales on par with known announcements.

Figure 3-1: Announced volumes and actual sales, "high volume" PEV models

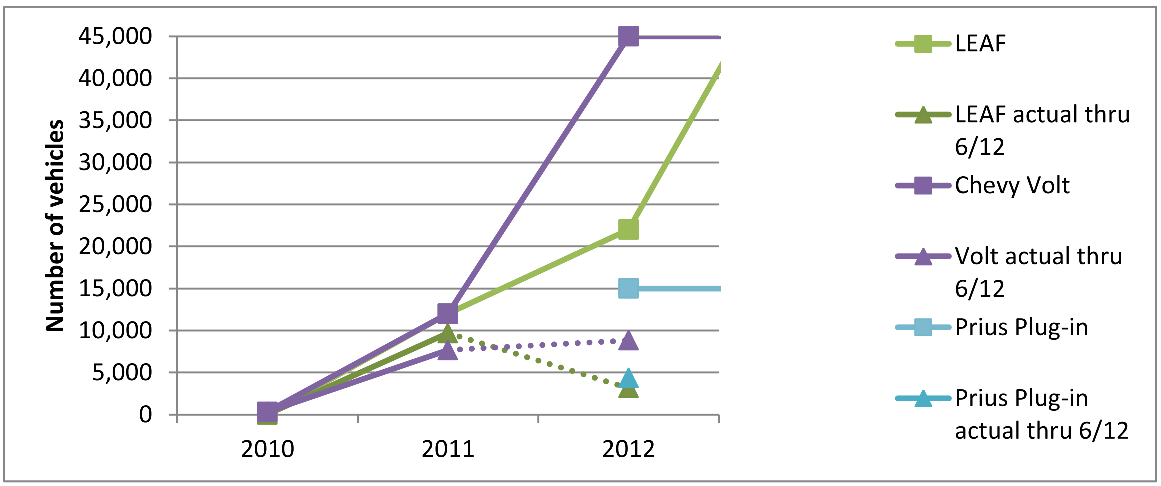
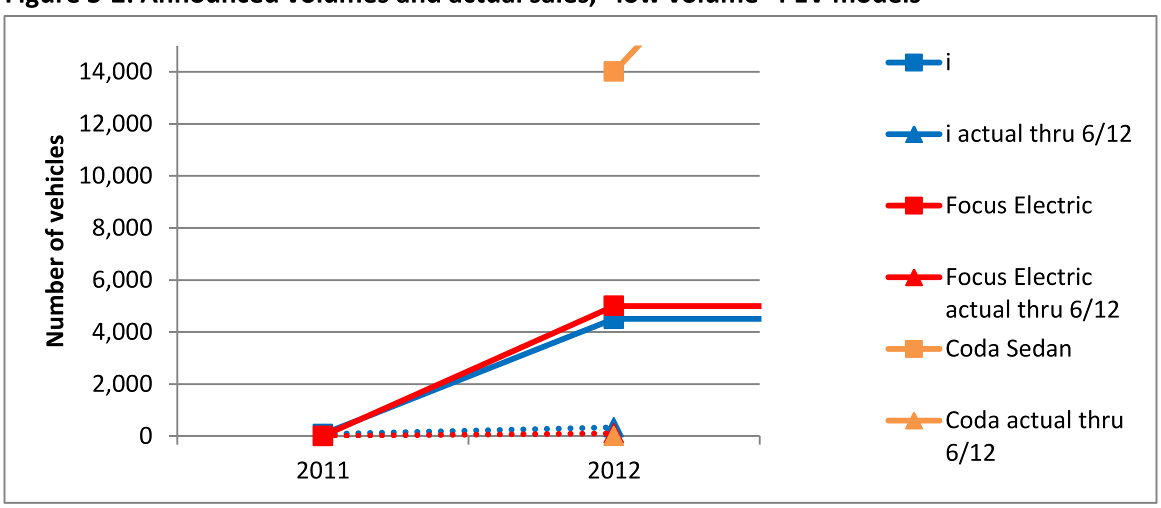


Figure 3-2: Announced volumes and actual sales, "low volume" PEV models



Announced PEV volumes have thus been a relatively poor indicator of actual sales, and several BEV models and start-up firms stand as notable examples. A developmental BEV and a PHEV built on the most successful hybrid EV platform to date provide exceptions to the rule. In contrast, however, it might be argued by some that absolute actual sales levels are not surprising (e.g., they should be expected to be lower than initial hybrid sales, which did not depend on complex charging and behavioral changes). This shifts the emphasis from sales to announcements. This is consistent with the difficulties of *managing expectations* described in the innovation and management literature (e.g.,[3]), and will likely remain problematic throughout early PEV commercialization.

3.2 Regulation-induced supply of PEVs: CARB ZEV regulation

The California Air Resources Board ZEV regulations, now integrated into the Advanced Clean Cars Program [4], requires a specified percentage[2] of the passenger vehicles brought for sale in California by each major automaker be ZEVs (i.e., PEVs and FCEVs). Automakers have generally preferred not to be seen in the negative light of non-compliance. Thus, to the extent the program remains unchanged and effective (discussed below), its requirements do present a reasonable if imperfect indication of the aggregate supply that might be expected in California over the mid term. This provides a roughly sketched and possibly mutable supply "floor" propped up by regulation in hopes that demand will be stimulated to encourage PEV penetration at even higher levels. Further, for automakers to be willing to supply PEVs at aggregate levels in excess of compliance estimates, clear indications of demand must be present. Compliance estimates thus also provide an important reality check on penetration projections predicting significantly more rapid adoption, such as those summarized in Section 4.

Expectations about the program should be viewed in the context of a history of delays and reductions in requirements based on complex considerations, pressures, and evolving knowledge. Nevertheless, in recent years much has changed, including:

- the development and adoption of relatively lightweight, high-performance lithium-ion batteries at costs that are decreasing and "in the ballpark" required for successful commercial sales;
- widespread development of PEV platforms and components by all of the world's major automakers; and
- a relatively recent and unprecedented acquiescence by automakers to several major programs at the national and state level (e.g., in exchange for bailout loans and regulation harmonization) that has allowed, for example, CAFE to be increased for the first time in several decades.

With the arrival in the marketplace of several relatively high-volume PEV models, hypothetical uncertainties and theoretical possibilities are giving way to real investments and concrete product-development challenges. Consumer uptake remains the critical uncertainty, but less doubt remains

[2] Each vehicle brought for sale earns a certain number of ZEV credits based on a variety of emissions-related performance characteristics. The actual percentage and number of vehicles required for compliance thus depends on a variety of credit multipliers. Further, credits can be banked and traded.

about the automotive industry's fundamental ability to supply the vehicles necessary for ZEV program compliance, should sufficient demand exist.

Even taking compliance as a given, precisely defining the associated number of PEVs on the road in California requires a complex calculus of ZEV credit multipliers, banked and sold credits, projected overall vehicle sales volumes, and the ratio of ZEVs (BEVs and FCEVs) expected. Figures 3-3 and 3-4 illustrate expected compliance-based PEV supply levels constructed on data from the CARB ZEV calculator tool [5]. The data selected for Figures 3-3 and 3-4 are meant to represent the lowest-cost compliance pathways. They thus utilize scenarios whereby automakers earn as many credits as allowed with "TZEVs" (i.e., PHEVs), thereby minimizing the number of truly zero-tailpipe-emission vehicles (ZEVs) required. Further, the scenarios selected for Figures 3-3 and 3-4 are somewhat more modest than some compliance pathways published by CARB (e.g., in its summary of the Advanced Clean Cars program [4]) because they take into account GHG over-compliance provisions that would reduce the number of required vehicles, as well as historical credits. In all cases, the proportion of BEVs vs. FCEVs was left at default CARB assumptions (ranging from 50% to 83% BEVs, depending on the year). Thus, should FCEVs become commercially successful and the preferred method of ZEV program compliance, the expected supply of BEVs illustrated in Figures 3-3 and 3-4 could drop towards zero, though this is unlikely in the near term.

Expected ZEV compliance estimates suggest PEV sales in California could exceed 50,000 per year by 2019, and 150,000 in ten years (by 2022). Cumulatively PEVs would exceed 100,000 by 2019 and approach 500,000 by 2022.

Figure 3-3: Expected annual PEVs: low-cost ZEV program compliance

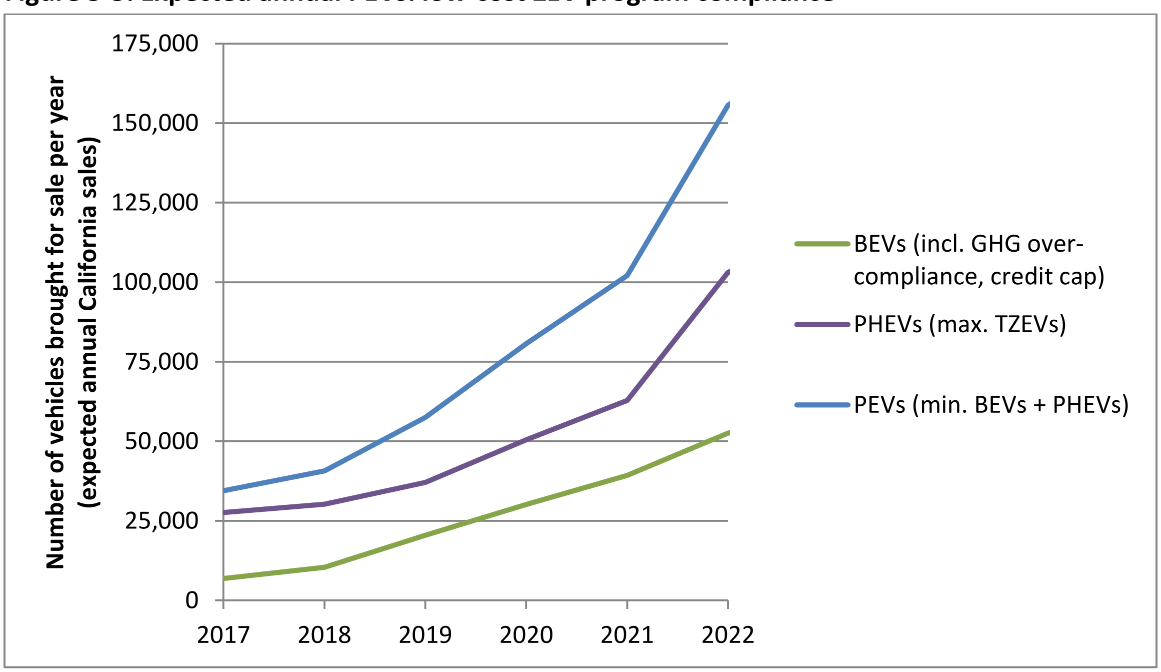
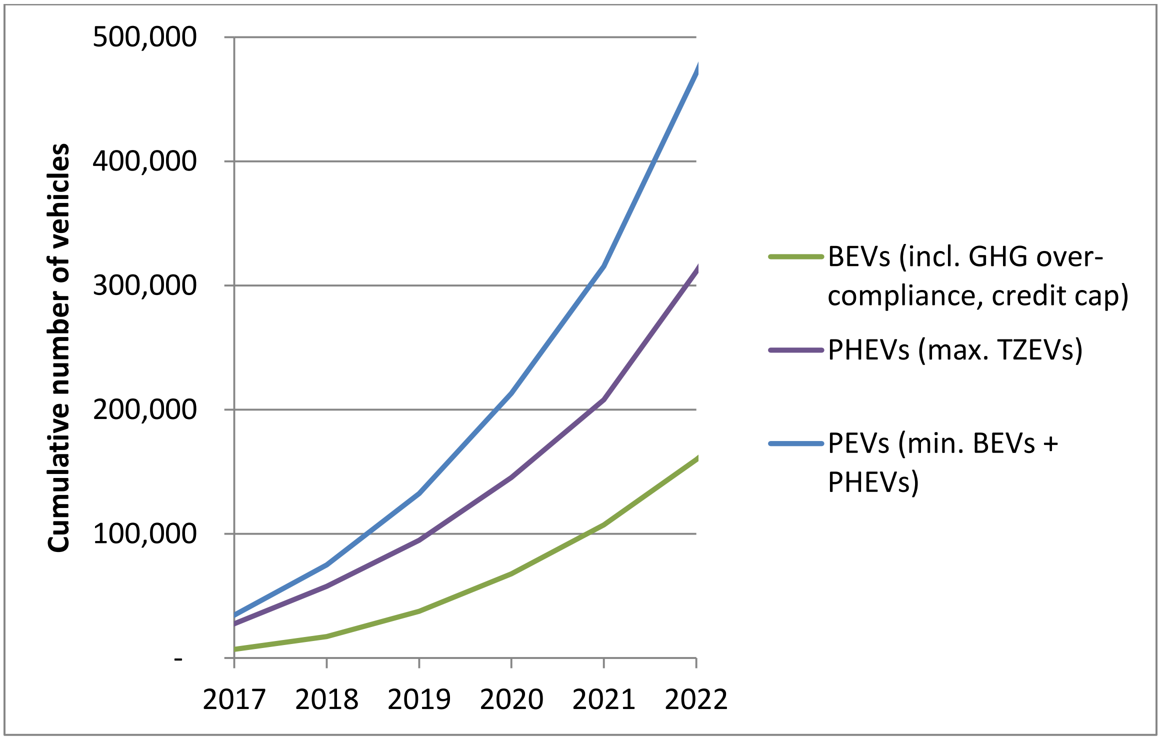


Figure 3-4: Expected cumulative PEVs: low-cost ZEV program compliance supply



4 Projected PEVs: Market Forecasts

Previous sections described PEV supply in terms of *existing* supply (i.e., historical sales, Section 2) and *expected* supply (based on production announcements and regulation compliance, Section 3). This section briefly discusses *projected* penetration of PEVs, expanding the analysis explicitly into the realm of demand and setting the stage for discussions of demand projection in Deliverables 2 and 3.

Several efforts have been made in recent years to predict the future market penetration of PEVs. Some forecasts are based on models developed by researchers that predict the diffusion of innovative technologies using certain market and demographic assumptions (including historic sales of hybrid vehicles). Other estimates are based on software simulations utilizing parameters such as vehicle price, fuel price and availability, consumer preferences, and a variety of subsidy and policy scenarios. Still other forecasts are prepared according to industry disclosures and surveys, market research, literature reviews, and emissions compliance targets. The quality of data and methods in some reports, prepared mainly by consultants for industry and investor clients, are difficult to evaluate at low cost.

Fundamentally, we expect that PEV sales volumes will be determined largely by a few factors that introduce substantial uncertainty into any projection. The most commonly cited factors driving the market penetration predictions reviewed here are vehicle price (of which the cost of battery technology is a major driver), gas prices, government incentives, and emissions regulations. The factors that are likely to introduce the most variability into the projections are discussed below.

Vehicle prices

Vehicle price is clearly one of the most important factors affecting PEV purchases. A variety of purchase incentives—such as a federal tax credit, California's Clean Vehicle Rebate Program, and various local incentives—have been designed to reduce the upfront cost of a PEV to the consumer (please see Appendix A). In California, these amount to as much as $10,000 per vehicle, not including local incentives or non-monetized perks (e.g., carpool lane access, parking benefits, etc.) However, the extension of incentives beyond their current allotments and available funding is uncertain and the effect of incentive phase-outs difficult to predict.

Battery costs

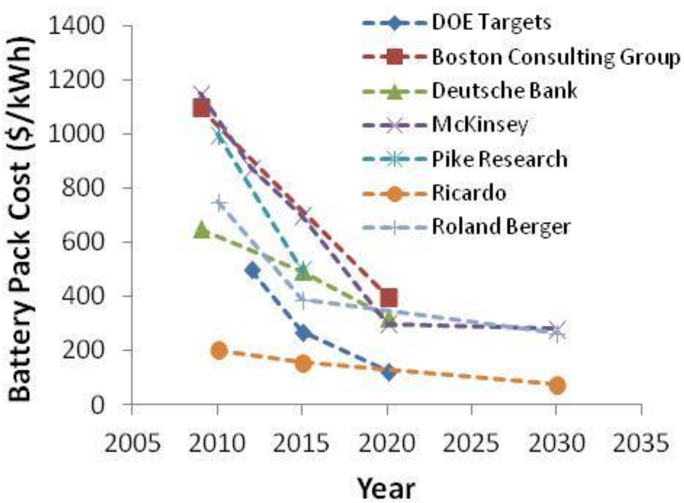
With significant lithium-ion battery production capacity online and coming online both nationally and globally in the next few years, indications are that lithium-ion batteries, taken as a category, might actually be in oversupply in the near term[3] and that battery manufacturers are seeking supplemental stationary and other markets for their products. However, automaker *willingness* to tool up to supply a given volume of PEVs does depend critically on a perception of sufficient demand at a price that is compatible with their cost structure at that volume. As the single-largest and perhaps least-certain

[3] However, a more detailed, model-specific, and expected-sales-weighted examination might show deficiencies in the expected availability of one or more of the many chemistries of lithium-ion batteries or in other model-specific components.

major component of that vehicle cost structure, battery pack cost (as a function of volume and time) remains a critical relationship underlying and complicating the interpretation of PEV penetration projections.

Significant cost reductions in lithium-ion battery packs have been achieved in the last few years. A reasonable rule-of-thumb might be that, immediately prior to the release of PEVs in the U.S. in December 2010, lithium-ion batteries cost roughly one thousand dollars per kWh. This includes battery management systems that roughly doubled cell-related costs at the time. Now, in mid-2012, battery systems cost roughly $600–700 per kWh [6]. Expectations are that battery costs will continue to fall, but significant uncertainty remains. This is illustrated in the wide variety of battery cost projections in Figure 4-1 (from Neubauer, Williams, et al. 2012 [7, p.3]).

Figure 4-1: Battery pack cost projections by year and by report [7, p.3]



A more recent McKinsey analysis uses a bottom-up analysis of what the components of complete PEV battery systems “should” cost to argue that aggressive reductions from that $600–700/kWh baseline are possible by 2020 and 2025 [6, p. 2], aligned with the more optimistic estimates in Figure 4-1. Of the total reduction potential, they estimate that roughly one-third would come from increased scale of production, 25% from lower component prices, and 40–45% from technological advances in capacity.

Gasoline prices

Many PEV purchase projections are modeled on the price of gasoline, as it is assumed that higher prices will significantly encourage vehicle electrification. Because the future price of gasoline per gallon or the future price of oil per barrel is difficult to predict, some studies project PEV market penetration based on a range of estimated prices. Others model the effect of specific increases in the current federal gasoline tax, which could simultaneously discourage gas consumption and be used to fund PEV purchase incentives.

Charging infrastructure availability

While a dearth of charging infrastructure is often cited as a barrier to wider adoption of PEVs, most of the forecasts reviewed here do not explicitly model the effect of charging infrastructure availability on market growth. Sentech Inc. [8, p.32] is the exception, demonstrating that financial incentives for increased charging infrastructure are expected to have only a moderate effect on cumulative PHEV adoption to 2020.

Vehicle supply constraints

Only two studies reviewed in Section 4.2 explicitly consider the question of whether vehicle supply constraints will significantly impact PEV market penetration, and neither address California specifically. Balducci [9] considers a scenario in which manufacturers are not able to meet PHEV demand due to: limited engineering capabilities, the need to build new manufacturing facilities, limited access to raw materials, and other constraints. This supply-constrained scenario, which projects PHEVs will make up 15% of annual light-duty vehicle sales in 2020 [9, p.15], is far more optimistic than other annual projections reviewed here.

A simulation model by Karplus et. al. controls market penetration of PHEVs by a fixed factor that represents limited initial supply [10, p.626–627]. Under every scenario, PHEVs in Karplus' simulation make up less than 5% of the vehicle fleet by 2020, a projection that is more in line with other forecasts than Balducci's. A fixed-factor or similar approach may be a useful construct to constrain near-term supply of new PEV models that are: development platforms, models targeted mainly for regulation compliance, and/or are new and have not been on the market for very long or widely released outside of select markets. In the aggregate and longer term, and based on a reasonable selection of PEV models in California, these effects will be less important.

Due to variation in methods and the challenge of predicting market conditions in out-years, the forecasts summarized below diverge significantly after 2015. Where possible, forecasts are summarized from lowest to highest and from nearer- to longer-term. Predictions for California are presented first, followed by predictions for the U.S. as a whole.

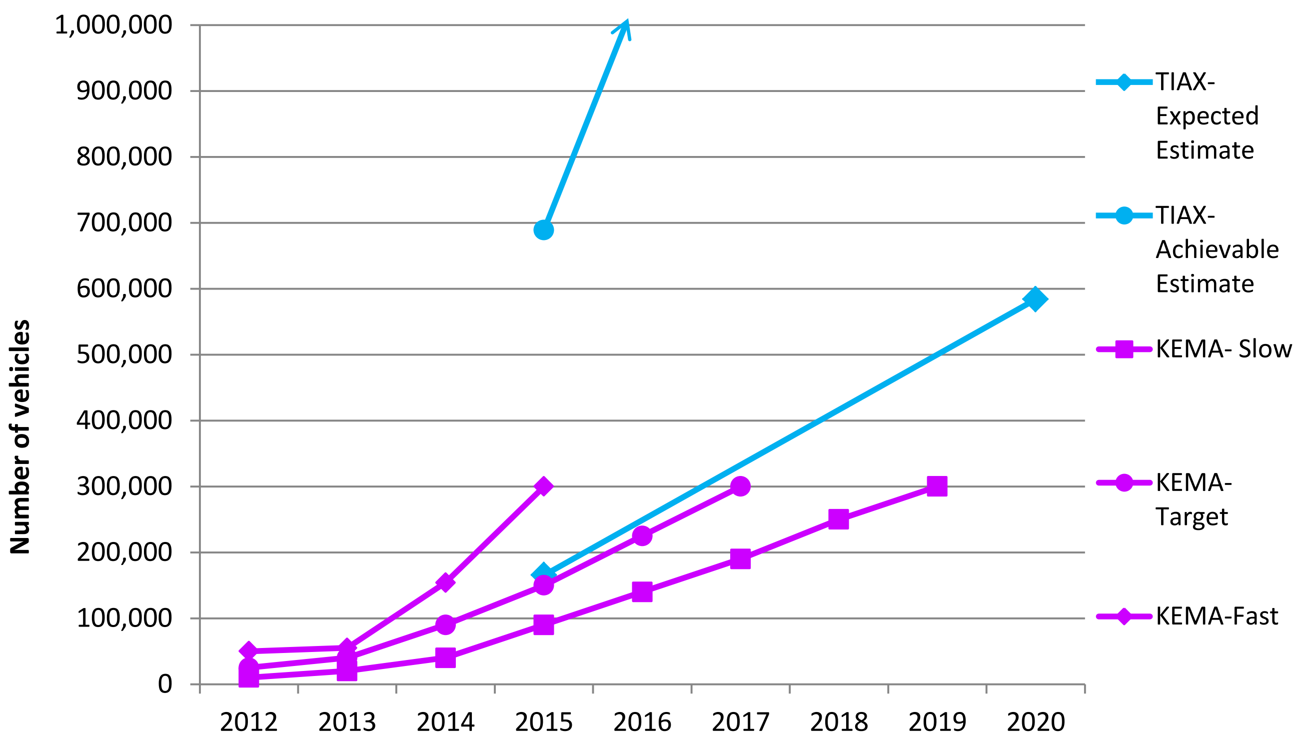
4.1 California-Specific PEV Forecasts

A comparison of forecasts for California and the U.S. shows that the state could make up a significant portion of total PEVs on U.S. roads in the next decade. Illustrating how quickly the state might reach 300,000 PEVs, KEMA, Inc. predicts California's PEV population will range from just under 100,000 to 300,000 by 2015, less than 200,000–300,000 by 2017, and 300,000 by 2019 under its "fast," "target," and "slow" scenarios [1, p. AP-3–AP-4].

In a report to the California Electric Transportation Coalition, TIAX projects California's total BEV and PHEV population for 2015 and 2020 based on "expected" and "achievable" scenarios [11]. These take into account existing and expected state and federal emissions regulations and funding for programs to meet GHG reduction targets. By 2015, TIAX estimates a total California BEV population of 22,000–209,000 and a PHEV population of 138,000–480,000. By 2020, the estimates rise to 28,000–455,000 BEVs and 548,000–2,112,000 PHEVs [11, p.3-2 and 4-7].

Figure 4-2 summarizes the KEMA and TIAX cumulative projections for California. Projections indicate the California PEV population could approach 100,000 by 2014–2015, 300,000 by 2015–2019, and 500,000 by 2018–2020.

Figure 4-2: Cumulative PEV forecasts for California [1, 11]



4.2 U.S. PEV Forecasts

This section presents U.S. PEV sales forecasts. These are characterized by timeframe, which, for the purposes of this planning project are defined as : i) "near-term" (2012–2014), ii) "mid-term" (2015–2017), and iii) "long-term" (2018–2022). The near-term was discussed in Sections 2 and 3 in the context of current sales and announced models. Projections for the mid- and long-term are discussed next.

Mid-term predictions

A DOE-sponsored literature review and expert survey by Balducci estimates PHEVs will make up 0.9–4.6% of annual light-duty car sales by 2015 [9, p.15]. Balducci's market penetration scenarios depend on the advancement of hybrid technology, achievement of research and development goals, and a potential constraint on the supply of PHEVs. Balducci places annual PHEV market penetration at 1.4%–5.9% in 2016, climbing to 4.5%–12.1% by 2019 [9, p.15].

Sullivan et. al. use a software simulation incorporating such factors as vehicle attributes and household income to predict 0.7–2.9% annual sales and 0.3–1.2% cumulative PHEV market penetration by 2015 with gasoline priced at $4 per gallon [12, p.37]. The simulation does not incorporate manufacturer supply constraints, pointing to manufacturer subsidies and sales tax exemptions as a primary driver of consumer choice.

A diffusion model developed by McManus & Senter demonstrated the sensitivity of PHEV purchases to price premiums over conventional vehicles [13]. Taking into account consumer choice, vehicle stock, and turnover, the model put 2015 annual sales as low as 4,726 (with a $10,000 price premium) and as high as 118,793 (with a $2,500 premium) [13, p.25].

KEMA, Inc. used the Obama administration's goal of 1 million PEVs by 2015 as well as vehicle manufacturers' production plans and historic rates of Prius adoption to project between about 300,000 and 1,000,000 PEVs on the road by 2015 [1, p.24]. These include PHEVs and BEVs purchased under "slow," "target," and "fast" growth scenarios. KEMA Inc. predicts cumulative PEV sales (including PHEVs and BEVs) to have reached 500,000–1,500,000 by 2016 and 1,000,000–2,400,000 by 2019 [1, p.24]. These numbers reflect a market that will begin to move beyond early adopters, as well as see decreasing battery costs, product evolution, and continued (but declining) government incentives.

Sentech, Inc.'s simulation predicts a base case of about 1,000,000 cumulative PHEVs by 2015 [8, p.59]. Sentech's simulation does not take into account supply constraints and assumes continuation of current federal tax credits for vehicle purchase, battery manufacturing grants, and PEV demonstration projects. More aggressive PHEV subsidies would push the number higher, with a state sales-tax exemption more than doubling the projection.

Longer-term predictions

With gasoline priced at $4 per gallon, Sullivan et. al. predict 0.7–3.7% annual sales and 0.5–2.2% cumulative PHEV market penetration by 2020, with the outcomes dependent on subsidies to manufacturers and consumer tax incentives [12, p.37].

Deloitte Consulting's industry interviews and survey of 2,000 vehicle owners projects annual sales of PHEVs and BEVs will account for 1.9–5.6% of sales in 2020, or a volume of 285,000 to 840,000 [14, p.16–17]. Scenarios cover ranges of purchase price ($25,000–$45,000), electric range (100–350 miles) and gas price ($3–$4.50 per gallon).

Karplus et. al. estimate PHEV market penetration using the MIT Emissions Prediction & Policy Analysis model [15]. The model considers energy inputs, services and vehicle markup within different biofuel availability, electric range, and carbon policy constraint scenarios. In all cases, PHEVs make up less than 5% of the vehicle fleet by 2020 [10, p.629–632].

Boston Consulting Group developed market penetration scenarios based on oil prices of $60, $150 and $300 per barrel [16, p.7]. In North America, BEVs and PHEVs were expected to make up 2% and 3% of annual vehicle sales by 2020 in the $150 scenario and 5% each under the $300 scenario.

PHEVs will make up 7% and BEVs 4% of annual vehicle sales by 2020, according to Deutsche Bank [17, p.15].

J.D. Power and Associates project particularly slow adoption of BEVs in the U.S., with less than 110,000 BEVs, or less than 1% of passenger vehicle sales, in 2020 [18, p.20].

Sentech Inc. predicts about 2.5 million cumulative PHEV adoptions by 2020, but the forecast rises by an additional 1.5 million given an aggressive feebate program [8, p.59].

Consumers' willingness to pay a premium for PHEVs is illustrated by McManus & Senter's consideration-purchase model. Annual sales estimates range from 84,341 at a $10,000 price premium over conventional vehicles to 1,891,576 at a $2,500 price premium by 2025 [13, p.25].

Figures 4-3 and 4-4 summarize the U.S. projections for percentages of annual sales and cumulative PEV populations, respectively.

Figure 4-3: Annual U.S. PEV sales forecasts (percentage)

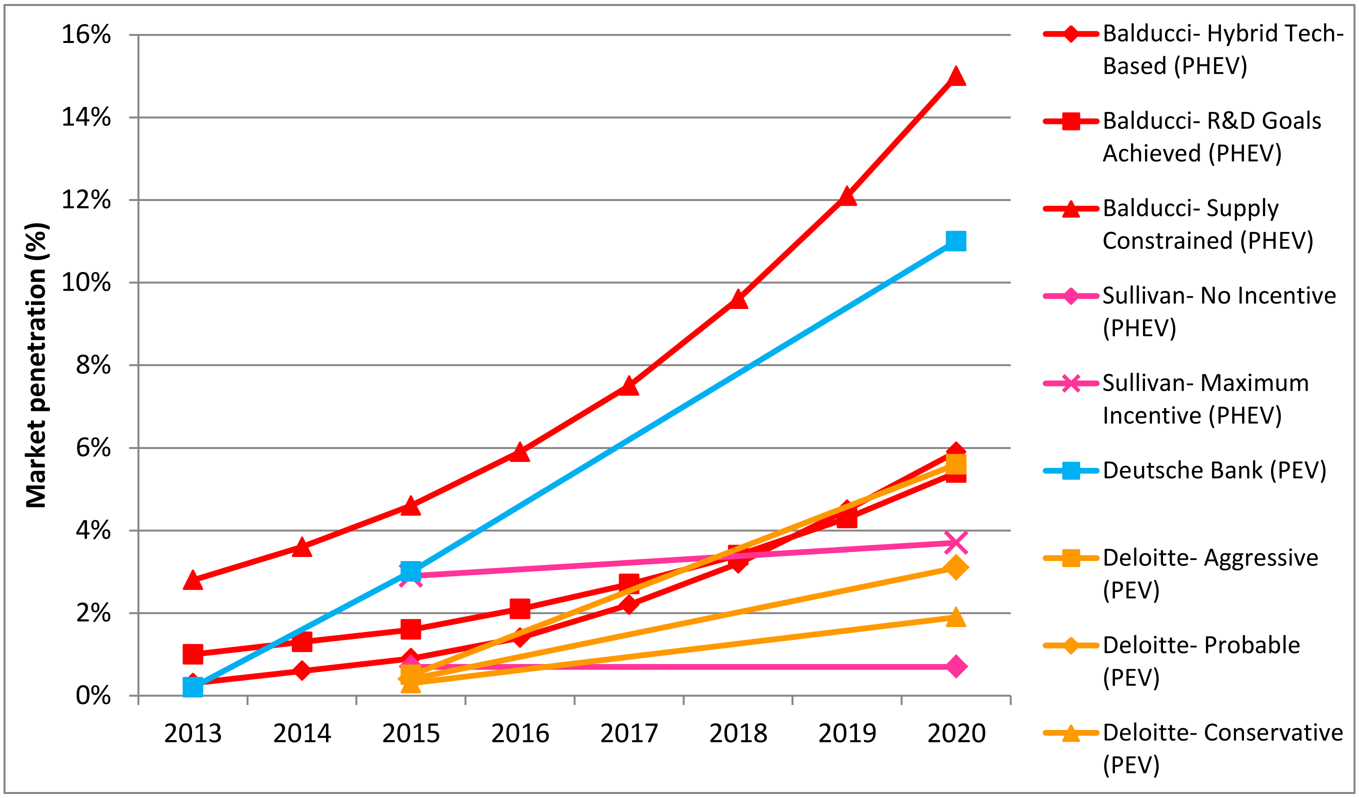
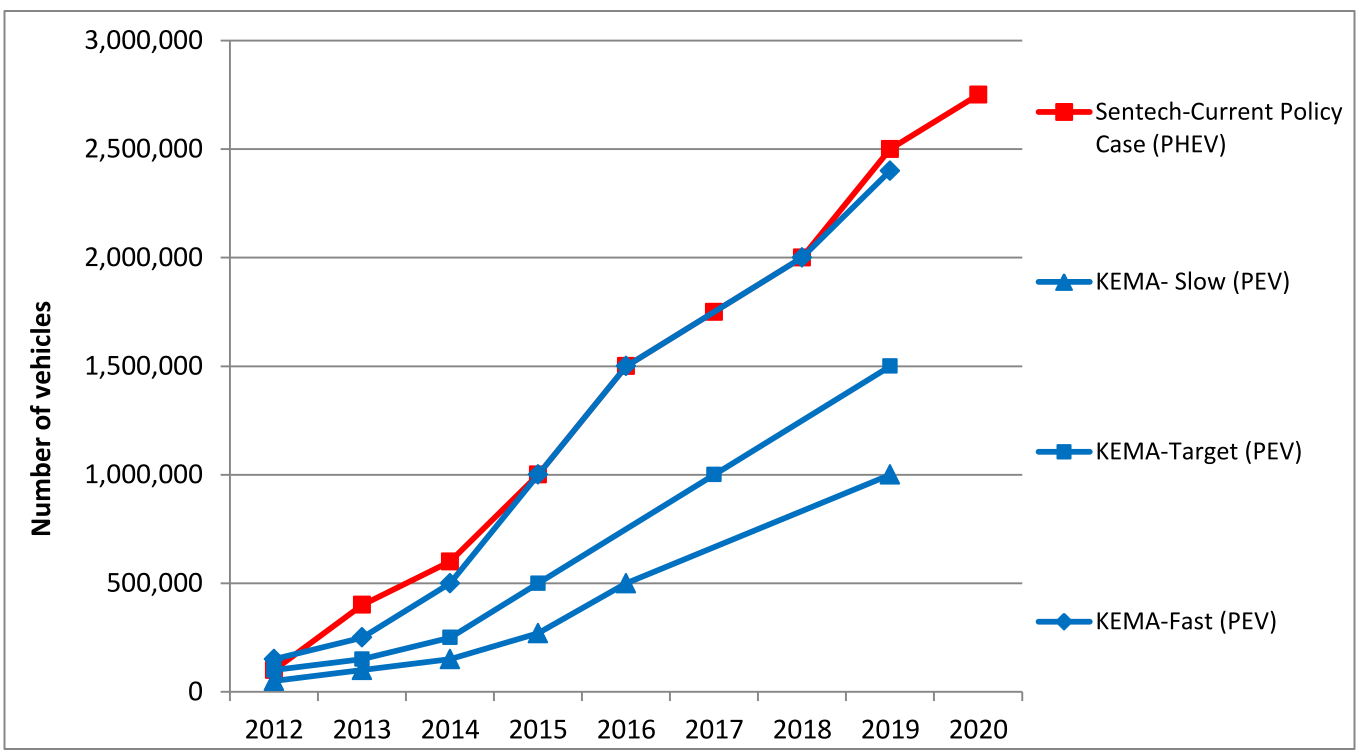


Figure 4-4: Cumulative U.S. PEV sales forecasts (number of vehicles)



5 Conclusions

Based on current vehicle pricing, production, and sales trends, we do not foresee consumer demand outstripping available aggregated PEV supply in the California market. Cumulative sales of seven out of the twelve PEV models sold in the U.S.to date amount to over 36,000 vehicles. PHEVs have overtaken BEVs in monthly and cumulative sales metrics, a trend with potentially important policy and planning implications. Our review of the evidence finds a rapid proliferation of PEV models, with over two dozen new models expected by 2014—slightly more than half PHEVs and the rest BEVs. While some of the models are product-development platforms and/or “compliance cars” (targeted primarily for compliance with California ZEV regulations), other models are priced and built with the hope of widespread consumer acceptance. As with all new car models, we should expect that some of these new models will sell poorly and eventually be discontinued. However, some models will “take off,” and a very few may even become PEV “classics.”

PEV adoption could be expected to lag historic hybrid adoption due to additional cost, complexity, and behavioral adaptation. Nevertheless, PEV models are being adopted at a rate in-between the most and least successful hybrids, and PEV adoption as a whole is outpacing hybrid adoption as a whole based on some metrics.

Building up from the base of existing PEVs, expected ZEV-regulation compliance estimates provide a frame of reference, albeit an imperfect one, for both the minimum supply the state is aiming for and the maximum supply automakers might be willing to provide in absence of clear indications of consumer demand. A low-cost compliance pathway suggests California cumulative PEV populations could approach 300,000 by 2021 and 500,000 by 2022. The wide variety of penetration projections discussed in Section 4 indicate the California PEV population could approach 100,000 by 2014–2015, 300,000 by 2015–2019, and 500,000 by 2018–2020.

Fundamentally, we expect that PEV sales volumes will be determined largely by a few factors, including vehicle price, which should fall as battery costs continue to decline, and the persistence of federal and state policy incentives. Until PEV prices fall significantly, continued provision of these policy incentives may be a greater source of uncertainty for PEV sales than other constraints on PEV production. A third critical factor is currently the low consumer awareness of the value proposition embodied in the adoption and use of PEVs.

Consumer uptake remains the critical uncertainty. However, less doubt remains about the automotive industry’s fundamental ability to supply a number of vehicles equal to or greater than what is necessary for ZEV program compliance, should sufficient demand exist.

Acronyms

CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CEC	California Energy Commission
BEV	battery electric vehicle (aka all-electric vehicle)
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency, either federal (if unqualified) or state
EV	electric vehicle (aka electric-drive vehicle) = HEV, PHEV, BEV, or FCEV
FCEV	fuel-cell electric vehicle (aka fuel-cell vehicle)
HEV	hybrid electric vehicle (aka hybrid)
k	kilo- (one thousand)
kWh	kilowatt-hour(s)
mi	mile(s)
PEV	plug-in-electric vehicle (aka plug-in vehicle, plug-in) = PHEV and BEV
PHEV	plug-in hybrid electric vehicle (aka plug-in hybrid)
SCAG	Southern California Association of Governments
SoCal PEVCC	Southern California Plug-in Electric Vehicle Coordinating Council
TZEV	transitional zero-tailpipe-emission vehicle
UCLA	University of California, Los Angeles
U.S.	United States
ZEV	zero-tailpipe-emission vehicle

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6 Appendix: Financial Incentives for PEVs in Southern California

This summary, by Jon Overman, provides information on financial incentives available in Southern California for four different types of PEVs: BEVs, PHEVs, neighborhood electric vehicles (NEVs), and zero emission motorcycles (ZEM).

Vehicle Incentive Programs

1. **Federal Tax Credits**

The Internal Revenue Code Sections 30 and 30D offer tax credits for qualified plug in electric vehicles.[i] This code was updated with the passage of the American Recovery and Reinvestment Act (ARRA) of 2009.[ii]

Section 30D - Qualified Plug-in Electric Drive Motor Vehicles[iii]

IRC Section 30D is intended for electric passenger vehicles and light duty trucks. The tax credit is a minimum of $2,500 and up to $7,500. Most of the available passenger BEVs on the market today receive the maximum amount of $7,500.[iv] Purchases after December 31, 2009 are eligible for the credit; however, the credit will begin to be phased out when a manufacturer has sold 200,000 qualifying vehicles in the United States. Individuals wishing to claim the tax credit should use IRS Form 8936.[v]

Section 30 – Plug-in Electric Vehicles[vi]

IRC Section 30 provided tax credits on purchases low-speed and two- or three-wheeled plug-in electric vehicles. Qualifying vehicles receive a tax credit of roughly 10% of the cost of the vehicle, not to exceed $2,500. Vehicles had to have been purchased between February 17, 2009 and before January 1, 2012 to be eligible.

2. **State Incentives - California**

Clean Vehicle Rebate Program (CVRP)[vii]

The CVRP is administered and implemented through a partnership between the Air Resources Board (ARB) and the California Center for Sustainable Energy (CCSE). ARB determines annual funding amounts for CVRP through the AB 118 Air Quality Improvement Program.[viii] The CVRP is expected to be effective through 2015.

Eligible for Rebates

- Light duty zero emission vehicles (BEVs) - $2,000 to $2,500
- Light duty PHEVs - $1,500
- NEVs and ZEMs - $900

Program funding as of June 25, 2012:

CVRP Remaining Funds	$ 2,365,063
CVRP Currently Pending	$ 48,000
CVRP Currently Reserved	$ 1,160,600
CVRP Rebates Issued	$ 22,244,604

High Occupancy Vehicle (HOV) Lane Exemption

Qualifying electric and plug-in hybrid electric vehicles (PHEVs) meeting specified California and federal emissions standards are eligible for High Occupancy Vehicle (HOV) Lane Exemption.[ix] Those vehicles with the Clean Air Vehicle sticker may use HOV lanes regardless of the number of occupants in the vehicle.

White Clean Air Vehicle Stickers, expiring January 1, 2015, are available to an unlimited number of qualifying fully electric vehicles. Green Stickers are available for the first 40,000 qualified PHEVs. As of June 1, 2012, 1,400 green stickers have been issued; green stickers are valid through January 1, 2015.

3. Local Incentives – Southern California

City of Corona - Alternative Fuel Vehicle Rebate Program

The City of Corona offers rebates for City residents who purchase a new or used "alternative fuel vehicles", including BEVs. The rebate amounts are $2,000 for new vehicles and $1,000 for used vehicles. The program was renewed July 1, 2012 and is partially funded by the South Coast Air Quality Management District.[x]

City of Riverside - Alternative Fuel Vehicle Rebate Program

As of July 1, 2012, the City of Riverside is offering a $2,500 rebate from the Department of Public Works to any resident of the City who purchases a qualified vehicle from an authorized dealer within the City.[xi]

Other EV Incentives

4. Charging Infrastructure Incentives

ChargePoint America

ChargePoint America is a program sponsored by Coulomb Technologies with funding from the DOE through ARRA. The program provides free electric chargers to electric vehicle owners in 10 selected regions in the United States, including Los Angeles. The program offers free Level II Coulomb chargers to residents who purchase a qualified electric vehicle – though owner must pay for the installation. Qualified vehicles include: Chevrolet Volt, Ford Transit Connect, Ford Focus Electric, BMW ActiveE, Nissan LEAF, Fisker Karma, Tesla, Navistar eStar Electric Truck, and the Smart fortwo Electric Drive car. As of April 10th, 2012, ChargePoint had shipped 2,400 out of the roughly 4,500 chargers they plan to distribute.[xii]

The EV Project

The EV Project is administered by ECOtality and is funded in large part by the US DOE.[xiii] The Project was officially launched on October 1, 2009 and offers Level II chargers at no cost to qualified Nissan LEAF and Chevrolet Volt customers in the Los Angeles and San Diego metropolitan areas. The EV Project incentive program offers the charger for free and will also cover most, if not all, of the costs of EVSE installation. All participants in the EV Project incentive program must agree to anonymous data collection after installation.[xiv]

City of Los Angeles Department of Water and Power - Charge Up LA!

The Los Angeles Department of Water and Power (LADWP) provides rebates of up to $2,000 to residential customers who purchase or lease a new electric vehicle and install Level 2 EVSE with a separate time-of-use meter at their home.[xv] The rebate is available to the first 1,000 customers that submit a completed application. The program will expire on June 30, 2013, when the program goals are met, or when the funds are exhausted, whichever occurs first.

Alternative Fuel Vehicle Refueling Property Credit

Owners who installed electric vehicle charging equipment in 2011 or before are eligible for a federal tax credit under IRC Section 30C. [xvi] The Alternative Fuel Vehicle Refueling Property Credit was enacted under EPACT 2005 and expanded under ARRA 2009. The credit is the lesser of these two options: 30% of the installation cost or $30,000 for businesses and $1,000 for personal expenses. [xvii] Currently, the tax credit has not been extended but is still available for hydrogen fueling stations through 2014. Individuals should use IRS Form 8911 to claim the tax credit.[xviii]

5. Utility Rate Discounts

Southern California Edison (SCE)

SCE offers a discounted rate to residential customers for electricity used to charge plug-in electric vehicles. Two rate schedules are available for PEV charging during on- and off-peak hours: TOU-D-TEV[xix] for residential customers who do not have a separate meter and TOU-EV-1[xx] for customers who have a separate meter.[xxi] The cost savings per kWh compared to non-EV rates vary depending on the time and current electricity usage; however; the electric vehicle rates are on average $0.03 per kWh less than equivalent non-PEV rates: the time of use TOU-D-T[xxii] and the standard tiered residential Schedule D[xxiii].

Los Angeles Department of Water and Power (LADWP)

The LADWP offers a $0.025-per-kilowatt discount for electricity used to charge PEVs during off-peak times. Proof of vehicle registration is required.[xxiv]

6. Auto Insurance Discounts

Farmers Insurance

Farmers Insurance provides a discount of up to 10% on all major insurance coverage for PEVs. [xxv]

GEICO

Hybrid vehicles, including PEVs, insured in California are now eligible to receive a 5% discount on certain coverages.[xxvi]

Travelers Insurance

Travelers Insurance offers up to a 10% discount on most major coverages for those who drive hybrid vehicles.[xxvii]

AAA

AAA offers up to a 5% discount on auto insurance policies for drivers of qualified hybrid and electric vehicles.[xxviii]

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[i] Internal Revenue Service: http://www.irs.gov/businesses/article/0,,id=214841,00.html

[ii] IRS – ARRA: http://www.irs.gov/newsroom/article/0,,id=206871,00.html/
[iii] IRS – IRC Section 30D: http://www.irs.gov/irb/2009-48_IRB/ar09.html
[iv] Fueleconomy.gov: http://www.fueleconomy.gov/feg/taxevb.shtml
[v] IRS Form 8936: http://www.irs.gov/pub/irs-pdf/f8936.pdf
[vi] IRS – IRC Section 30: http://www.irs.gov/irb/2009-30_IRB/ar07.html
[vii] California Center for Sustainable Energy – CVRP: http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project
[viii] ARB Air Quality Improvement Program: http://www.arb.ca.gov/msprog/aqip/meetings/AQIPdiscussion-final4-10-12.pdf
[ix] CA EPA – Air Resources Board http://www.arb.ca.gov/msprog/carpool/carpool.htm
[x] City of Corona – AFVRP: http://www.discovercorona.com/City-Departments/Public-Works/Public-Services-and-Information/Alternative-Fuel-Vehicle-Rebate-Program.aspx
[xi] City of Riverside: http://www.riversideca.gov/air/alternativefuel.asp
[xii] ChargePoint America - Press Release: http://chargepointamerica.com/pr/pr-20120410.php
[xiii] The EV Project: http://www.theevproject.com/overview.php
[xiv] The EV Project: http://www.theevproject.com/overview.php
[xv] LADWP: https://www.ladwp.com/ladwp/faces/wcnav_externalId/r-gg-EVincentives?_adf.ctrl-state=11zbqfhe3k_21&_afrLoop=196770275391114
[xvi] IRS Alternative Fuel Vehicle Refueling Credit: http://www.irs.gov/formspubs/article/0,,id=243101,00.html
[xvii] IRS Form 8911: http://www.irs.gov/pub/irs-pdf/f8911.pdf
[xviii] IRS Form 8911: http://www.irs.gov/pub/irs-pdf/f8911.pdf
[xix] SCE TOU-D-TEV: http://www.sce.com/NR/sc3/tm2/pdf/CE324.pdf
[xx] SCE TOU-EV-1: http://www.sce.com/NR/sc3/tm2/pdf/ce114-12.pdf
[xxi] SCE: http://www.sce.com/info/electric-car/residential/rate-plans.htm
[xxii] SCE: http://www.sce.com/residential/rates/special-time-of-use.htm
[xxiii] SCE: http://www.sce.com/residential/rates/standard-rates.htm
[xxiv] LADWP: https://www.ladwp.com/ladwp/faces/wcnav_externalId/r-gg-EVincentives?_adf.ctrl-state=11zbqfhe3k_21&_afrLoop=196418744466114
[xxv] Farmers Insurance: http://www.farmers.com/california_insurance_discounts.html
[xxvi] GEICO: http://www.geico.com/information/states/ca/
[xxvii] Travelers Insurance: https://www.travelers.com/personal-insurance/auto-insurance/hybrid-car-insurance-coverage.aspx
[xxviii] AAA: http://www.csaa.com/about-aaa/community-advocacy/saving-green-how-aaa-members-benefit