ACCELERATING EV ADOPTION
WITHOUT BREAKING THE BANK

ENERGEIA

ACCELERATING ELECTRIC VEHICLE ADOPTION WITHOUT BREAKING THE BANK: READING THE SIGNS

Energeia has recently completed three major electric vehicle consulting projects for clients in the US and Australia, covering uptake patterns, charging patterns, impacts on network infrastructure and system resourcing, infrastructure and business positioning strategy.

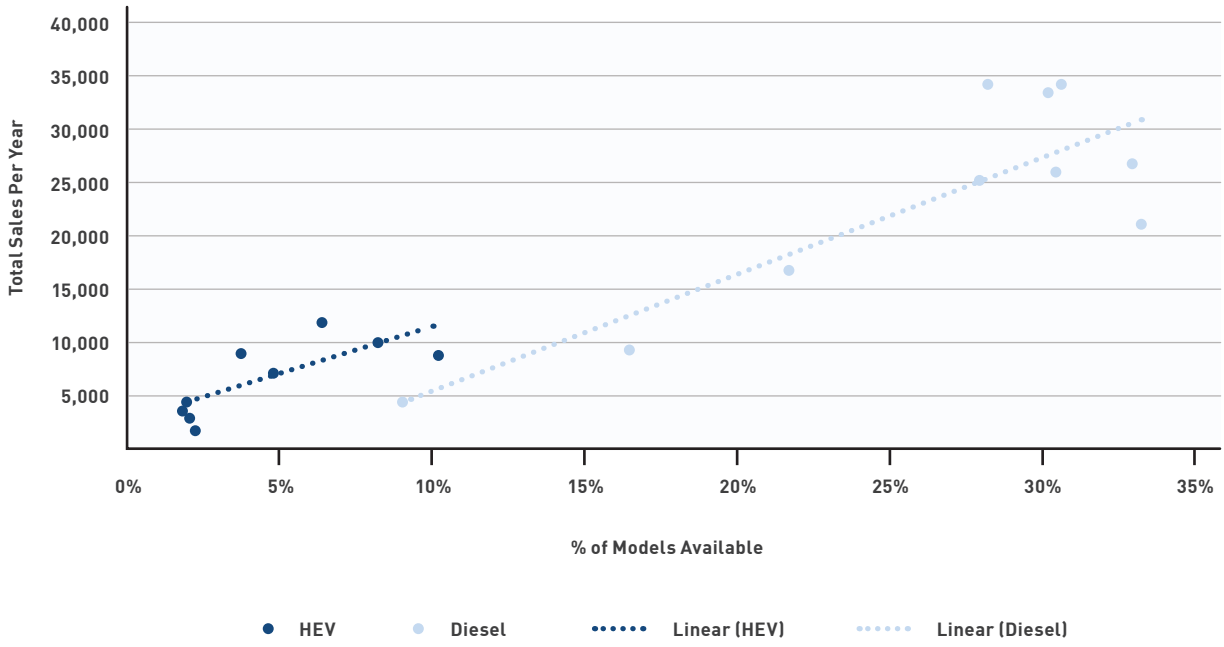
Based on our in-depth analysis of real-world uptake rates, travel statistics, charging behavior, hourly load profiles and infrastructure costs, we have identified three key issues in the electric vehicle market that are currently holding back widespread uptake of the technology.

1. Offer What the Customer Wants

Our first insight comes from analyzing customer uptake of new vehicle technology over the 1990s, when diesel engines first became a real competitor to gasoline, promising greater energy efficiency to policymakers and lower operating costs to customers, but at a higher purchase premium.

Energeia's analysis (Figure 1) identified that vehicle availability was a key driver of customer adoption of diesel and later Hybrid Electric Vehicle (HEV) technology. In other words, customers tended to make more economically rational investment decisions where diesel was offered in the model they liked to drive in the first place.

Figure 1 – Relationship between EV Uptake and Model Availability



Source: VFacts data, Energeia modeling

Energeia has used this insight to develop highly accurate, two-factor uptake models, which can explain 98% of actual sales, much more than models using economic drivers alone.

The key issue for electric vehicles to date, then, is that the models offered by Original Equipment Manufacturers (OEMs) are not top selling vehicles. There are no all electric or plug-in hybrid versions of top selling models such as the Honda Accord and Toyota Camry.

Our model predicts that if Australia's top 5 selling passenger vehicles were offered as Battery Electric Vehicles (BEV) or Plug-in Hybrid Electric Vehicles (PHEV), Australia would see a three-fold increase in EV sales per annum at current incentive levels.

2. Avoid Overloading the High Voltage Network

Electric vehicles are seeing their ranges extended with each new model iteration. For example, Tesla's Model S, Volkswagen's Golf and the BMW i3 have each seen range improvements of 50% in less than 3 years. Key new entrants to a category such as the Chevrolet Bolt or Tesla Model 3, have offered 100% greater ranges than the category average to date.

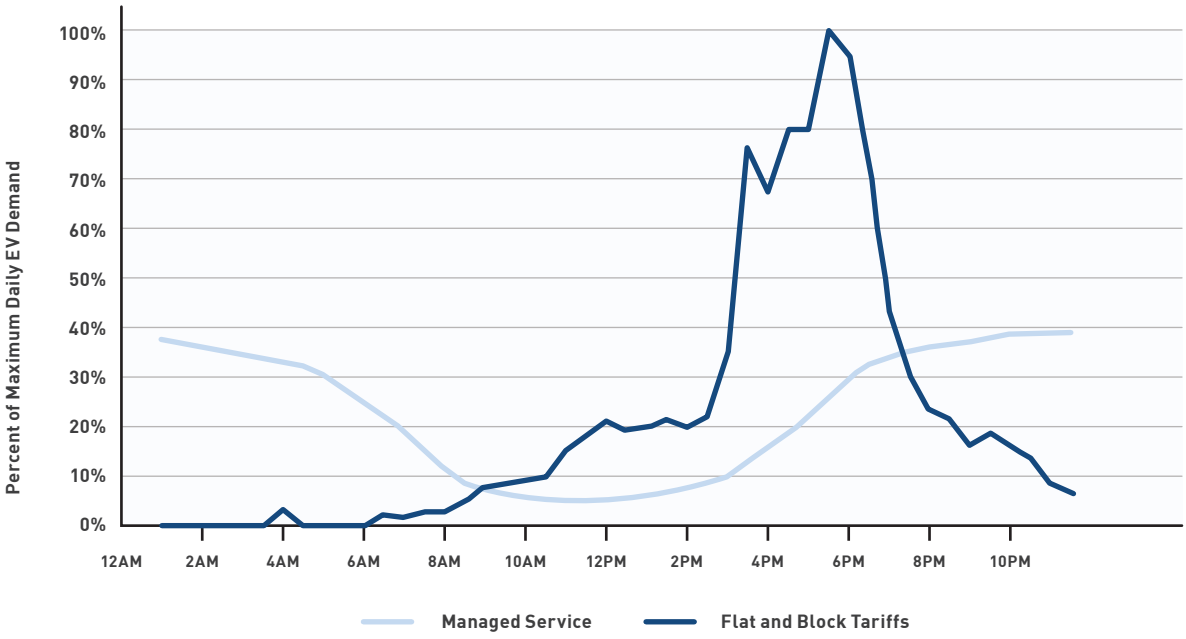
Although EV drivers are unlikely to drive significantly more due to a larger battery, they are more likely to charge less frequently. Model S drivers with an 85 kWh battery tend charge every few days compared to first generation Nissan Leaf drivers with a 30 kWh battery, who tend to charge every day, sometimes twice a day, depending on their driving needs.

With more capacity to charge, demand for higher charging rates is increasing. Most Model S drivers already have a 7.4 kW charger at their disposal, while the power of new chargers for other EV models is rapidly increasing from the original 2.4 kW level offered by first generation L2 chargers.

Based on current trends, Energeia anticipates mid-size BEVs to reach ICE driving ranges of 400 miles and charge rates comparable to today's Model S 7.2 kW charger within the next 3-5 years. This means that the electric vehicle will become the single largest load in a residential premise.

Energeia's modeling of vehicle charging patterns based on census data of customer commuting times by post code shows that current electricity tariffs are likely to lead to a significant increase in the peak demand on electricity distribution networks, as shown in Figure 2 below.

Figure 2 – Aggregated Electric Vehicle Charging Profiles at the Distribution Network Level



Source: US census travel data, Energeia modeling

Under flat tariffs, EV drivers are encouraged to charge their battery when they arrive at home or work, as this is the most convenient time to plug-in. This leads to a spike around 9am, when most cars have arrived to work, and a spike around 6pm, when most commuters have returned home.

Under Time-of-Use pricing, EV drivers are encouraged to schedule their charging during the off-peak period. This reduces what little diversity there is among commuters, and leads to an even larger demand increase, as all chargers turn on at exactly the same time, creating a new overnight peak.

Our modeling shows that either of the above approaches will lead to a substantial increase in peak demand across the high-voltage distribution network, which will cost billions of dollars to augment. Importantly, our modeling shows that EV driven peak demand is likely to begin occurring by 2020.

The solution, orchestrated managed charging, is well accepted among EV specialists. Solutions to other barriers, including technical, infrastructure and commercial, are less well progressed, however, California, led by the CEC, is gearing up to tackle these barriers.

3. Don't Miss the Most Obvious Place to Charge

Current thinking regarding public charging infrastructure is that it should:

- Extend EV range to enable EVs to be used for any type of trip,
- Encourage EV charging during hours of excess supply from solar PV, and
- Enable drivers without a garage to own an EV.

For the reasons explained below, Energeia's analysis has found the above policies are likely to lead to under-utilized charging infrastructure, inefficient investment, unviable charging business models, and unnecessary increases in electricity distribution costs.

Charging Needs Changing Rapidly, Increasingly Focused on Recharging Speed

As EV battery capacities rise to allow EVs to reach and exceed ICE ranges, Energeia sees the need for range extension reducing to only those drivers making long haul trips, which amount to 1.5% of daily trips.[1] Instead, we expect to see 1 MW public chargers to hit 5-minute gasoline refueling times.

Low Utilization and Peak Demand Impacts Undermine Workplace Charging

Workplace charging offers a charging solution to those with small batteries or those without their own private chargers. It is also seen as beneficial to the California energy system because commuter vehicles will be charging during the middle of the day when solar PV generation is at its maximum.

However, Energeia's modeling of locational EV charging patterns has found that un-orchestrated workplace charging is likely to increase high-voltage (HV) distribution network investment costs unless an offsetting amount of solar PV is connected on the same feeder.

The other major challenge for workplace and other destination charging is the business model and asset utilization. Demand for workplace and destination charging is limited to business or leisure hours, typically resulting in low levels of overall utilization, and therefore higher per charge costs.

A High-Cost Approach to Guaranteeing Charging for Those Without a Private Charger

Changes to building codes are enabling greater access to private EV charging if drivers have a dedicated parking spot. Other EV drivers must rely on public charging to refuel their vehicles, and are unlikely to buy an EV unless reasonable access to charging is ensured.

Delivering sufficient charging stations in the right parking locations – so that a driver without a private EV charger is confident of obtaining a charging spot – will require major investment in charging stations, many of which are likely to only be lightly utilized.

Gas Stations Have Already Solved the Refueling Problem

Due to the issues discussed above, Energeia sees the future of public charging infrastructure to be mainly based on today's gas station refueling model. This is because of the size, cost and complexity of high-power charging infrastructure needed to meet driver needs in the medium to longer-term.

The gas station recharging model solves the problem of convenient, reasonably assured access to recharging for drivers in a familiar and easy to accept way, while also solving the problem of charger utilization faced by workplace and other destination charging models.

Energeia's analysis of L2 public chargers at work and destinations compared to a gas station based charging model has found that a L2 based public charging infrastructure would cost at least 42% more than a gas station based model, assuming the L2 chargers were located as efficiently as gas stations. In reality, L2 costs are likely to be even higher due to the optimization challenges involved.

Figure 3 – Comparing High Power Gas Station to Low Power Based Public Charging

	Public Workspace (Parking Lot)	Public Destination (Parking Lot)	Public Transport (Gas Station)
Equipment Capex	$2,000	$2,000	$20,000
Electricity Connection Capex			$50,000
Electricity ($/kWh)	$0.15	$0.15	$0.10
Daily Fixed Cost	$1	$1	$25
Per 100 kWh Charge Cost	$16	$17	$11
Power (kW)	9.6	9.6	1,000
Usage Profile	Weekdays	Weekends	7 Days
Charges per day (Wkly Avg)	1.4	0.6	25.2
Mins per Charge	240	240	5
Total kWh / Day / Charger	55	22	2,099

Source: Energeia estimate

The sooner high powered public EV chargers are collocated at gasoline stations across California, the sooner we will see drivers (including self-driving cars) without a dedicated parking space transitioning to electrified transportation options, and a viable charging business model.

[1] Source: Assessment of Electric Cars' Range Requirements and Usage Patterns based on Driving Behavior recorded in the National Household Travel Survey of 2009 http://www.solarjourneyusa.com/HowFarWeDrive_v1.3.pdf

ABOUT ENERGEIA

Energeia is a global leader in the economics, system impacts and business opportunities of electric vehicles. Established in 2009 in Sydney, Australia, the company opened its first US office in 2015 in California, another world leader in distributed energy technology adoption. For more information about how to best integrate distributed energy technology into your energy system, network, business model, or operations, please contact us at one of our offices listed below.

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