An Analysis of Electric Vehicles in the Portland Market

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Abstract

The objective of this paper is to compare consumer expectations and current market offerings concerning the plug-in electric vehicle (PEV). Consumer expectations in regards to vehicles are derived from existing studies and organized into seven categories. For each of these categories, an evaluation of whether the current PEV offerings from both industry and all levels of government are met is conducted. In particular, a special focus is put on marketing strategies in the city of Portland, Oregon as a vanguard of the propagation of large-scale PEV adoption.

1 Introduction

With the overwhelming amount of federal, state, and local support for the national transition to PEV use, combined with the strong collaboration between policy-makers and industry, one would assume that the transition to electric vehicles would occur very rapidly. However, it is not. In the United States, 12% of the population see themselves as a potential first mover (first time buyer) concerning PEVs and 42% have previously identified themselves as a first time mover. By contrast, 46% are not likely to consider being a first mover. The number of potential first movers and people who might be willing to buy a PEV within the United States is relatively low compared to other countries. As a technology manager, it is important to ensure that one's products appeal to the correct customer base, especially where an emerging technology is concerned. PEV developers are not exempt from this. A typical first time buyer generally possesses a higher education, pertains to the upper or middle class, and tends to live in urban or suburban areas. Moreover, they tend to see themselves as "conscious of the environment, tech-savvy, trend-setting and politically active". Potential first movers are especially interested in receiving incentives from the government [1].

In 2010, the mayor of Portland, Oregon made public a plan called "Electric Vehicles: the Portland Way," which listed policies and incentives that would be put in place that would make the city the leading PEV market in the United States. [2] In order to thoroughly evaluate the PEV market in Portland it is necessary to analyze the attributes consumers address when considering purchasing a vehicle. Attributes from existing PEV studies will be collected, categorized, and addressed in the following chapters. The current PEV market shares in Portland will then be compared to the national average so that the relative success or failure can be extrapolated.

2 Relevant Attributes to PEV studies and Deduced Categories

The earliest PEV studies started shortly after the 1970s oil crisis, and were conducted on multi-car households [3], [4]. Both used survey data to provide a sample distribution of consumer preferences for vehicle attributes. The primary conclusion of these studies was that there was a low general market potential for PEVs due to consumers' concerns about their drive-range potential. Additionally, both found significant heterogeneity in customers' needs and/or desires in regards to vehicle attributes.

In the early 1990s California announced a zero emission vehicle mandate, which caused catalyzed research into PEV markets. The main focus of these studies was to estimate the potential market for PEVs in California [5], [6], [7], [8]. At that time however, a series of studies was conducted elsewhere [9], [10], [11], [12]. The studies conducted outside of California differ because they targeted the entire nation, and did not focus on only multi-car households. The conclusion that most groups came to was that the probability of PEVs having a high market share was low. Factors leading to this were identified as a relatively high purchase price, limited driving range, and a long charging time. Nonetheless, they also found that people were willing to pay significantly more money for a PEV to save on gas, thus reducing emission [1], [5], [9], [10], [12].

In this paper it will not only be examined if the important attributes of a PEV are addressed by the industry and the government, but also analyzed if gaps exist. Thus, a cohesive list of attributes is a prerequisite. Table 1 gives a summary of the relevant attributes used by the mentioned studies.

Table 1 Summary of past PEV studies

Study	Attributes used
Beggs *et al.* (1981) [3]	Price, fuel cost, range, top speed, number of seats, warranty, acceleration
Calfee (1985) [4]	Price, operating cost, range, top speed, number of seats
Bunch *et al.* (1993) [5]	Price, fuel cost, range, acceleration, fuel availability, emission reduction
Brownstone and Train (1999) [7]	Price, range, home refueling time, home refueling cost, service station refueling time, service station availability
Brownstone *et al.* (2000) [8]	Refueling cost, service station availability, acceleration, top speed, tailpipe emission, vehicle size, body type, luggage space
Ewing and Sarigollu (1998, 2000) [10], [13]	Price, fuel cost, repair and maintenance cost, commuting time, acceleration, range, charging time
Dagsvik *et al.* (2002) [9]	Price, fuel cost, range, top speed
Hidrue *et al.* (2010) [11]	Price, range, charging time, acceleration, fuel costs, tailpipe emission
Deloitte (2011) [1]	Range, charge time, price, fuel cost, fuel efficiency

The attributes listed above can be classified into six distinct categories: Technology, vehicle architecture, Energy source, Charging infrastructure, Financial aspects, and what will be referred to herein as the "Good

Feeling". Additionally, it has to be considered that potential customers of PEVs are also affected by incentives provided by the government [1], a seventh category on Government Incentives therefore is added. It is important to mention that the reasonable assumption is made that some peculiarities of the attributes do not differ between Portland and the United States in general. E.g. the consumer's expectation of the acceleration should not differ distinctly. However, e.g. the provided and expected charging infrastructure is very different. Figure 1 gives an overview of assorted attributes considered in PEV studies, and the corresponding categories.

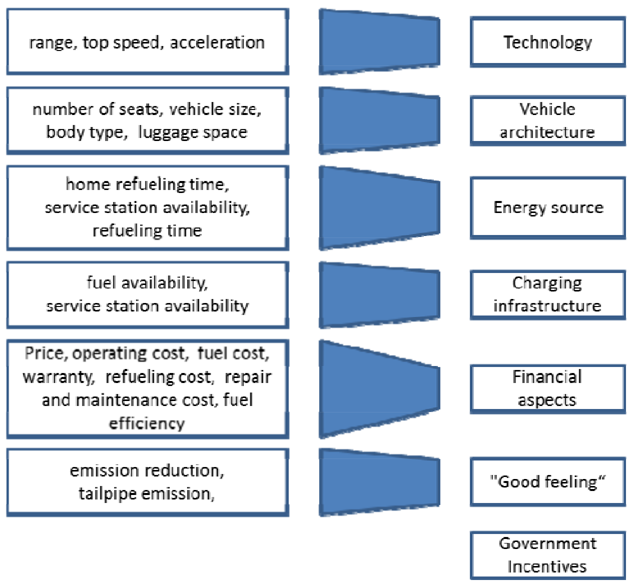

Figure 1 Derivation of PEV appropriate categories

3.1 Technology

Consumers demand new vehicles whose attributes are superior to those of currently in the market; they do not actively seek inferior alternatives [14]. Although PEVs have been around for decades, they were not able to meet consumer demands in terms of price range, charging time, *etc.* until recently.

<u>Range</u>

According to Hidrue [12], "range anxiety" is the primary concern of a potential PEV consumer. Despite the fact that 78% of consumers do not exceed 50 miles per day, they demand range capacities that compare to that of a conventional internal combustion engine (ICE) vehicle [1]. The expectation is that a PEV charge should last approximately 300 miles [1], yet the current technology allows for an average of 100 miles per charge [15]. The only PEV that approaches consumer demands in terms of range is the Tesla S, which has a range capacity of 265 miles [16]. The average technology does not live up to consumer demand in terms of drivable range between charges currently.

Top Speed and Acceleration

Compact and intermediate ICE vehicles such as Toyota Corolla and Ford Focus are rated at 132 [17] and 160 [18] horsepower, respectively. PEVs must approach this average power demand in order to meet current standards. The Nissan Leaf is rated up to 90 kW of power, which is roughly equivalent to 120 horsepower. The Tesla S can produce up to 416 horsepower, far exceeding the average ICE, and reach speeds as high as 130 mph [16]. A PEV generally is not capable of exceeding 130 mph because the power output drops dramatically at high speeds.

3.2 Vehicle Architecture

According to the Deloitte survey, globally, car design is important to consumers when choosing a vehicle. Vehicle design varies from roomy sports utility vehicles (SUVs) to simple compact cars or sedans. The need for different styles of cars stems from different preferences for amount of luggage space, number of seats, *etc*. In general, consumers predominantly demand mid- and small-sized sedans. Focussing on the United States, 32% of consumers prefer mid-size sedans, and 23% would opt for a SUV/crossover. Furthermore, only 15% of the United States population prefers a small-size sedan [1].

Manufacturers in the United States seem to have responded to the demand for the variance in vehicle architecture demands. The three highest selling PEVs are currently the Chevrolet Volt, the Tesla Model S and the Nissan Leaf. The former two are considered mid-sized sedans, while the latter is a hatchback/crossover. The Toyota Rav4, a PE-SUV, shows that the current PEV technologies have evolved to satisfy SUV user demands [19].

3.3 Energy Source

PEVs run on electricity stored in electrochemical batteries, as compared to energy being stored in hydrocarbons in ICE vehicles. The charge-producing reactions that take place in commonly used lithium-ion batteries occur slowly, which corresponds to a slow charge and discharge. Stations providing quick and efficient charging to consumers are costly and damaging to these batteries, which are expensive to replace. For this reason, manufacturers have begun to look for effective solutions to this dilemma.

Charging time

The 2011 PEV market study conducted by Deloitte states that the majority of consumers expects a PEV charge time of under two hours [1]. However, PEV technology does not meet this expectation. For example, in order to fully charge a 265 mile capacity Tesla Model S it takes 10-88 hours [20], while the 73 mile capacity Nissan Leaf only takes 3.1 to 6.3 hours [21], depending on the service level. The charging times for the Tesla Model S and Nissan Leaf are more than 5 and 1.5 times larger than the consumer expectation, respectively, and represent the average PEV. These charging times equate to a mile range per minute of charging rate of 0.05-0.5, and 0.19-0.38 miles per minute for the Model S and Leaf, respectively. The average refuel time of an ICE is between five and seven minutes [22], which equals an average refuel rate of 50-80 miles per minute. There is clearly a gap between what the market has to offer and what the customer wants. In order to meet the less than two hours charging consumer expectation, the Tesla would require a 2.2 mile per minute recharge rate and the Nissan leaf would require a 0.68 mile per minute rate.

To address this gap, manufacturers are developing DC fast-charging stations, which have the ability to charge a PEV battery to 80% capacity in 30 minutes. However, this technology is expensive, potentially damaging to the car battery, and dangerous due to the high voltage requirement (3 phase +400V) [1]. As a result, these charging stations have a low adoption rate.

Table 2 Overview of charging times and miles per hour of charge

	Charing capacity (kWatts)				
Service type	1.4	3.3	5.8	6.6	10
Level I	3	5			
Level II		11.5	17	23	29
Level III		168			
	Miles per hour of charge				

<u>Battery "swap"</u>

A shortened battery lifetime is a trade off for quick charging. Using fast-charge stations can diminish the performance of a battery by 10% over 10 years, which is in addition to the existing degradation from charge cycles. One potential solution to the critical issue of charge time is battery replacement, or "battery swap", which means that consumers would be able to trade a discharged or low battery for a fully charged one. Initially manufacturers in the United States were hesitant to approach a battery swap model due to the lack of a solid business case and negative customer sentiment [23]. The investment requires support for the development of infrastructure with the capability of replacing batteries and maintaining an inventory of batteries for more than 100,000 PEVs, which would cost more than $1.2 billion. Battery costs dropped from $1,000 per kWh in 2008 to $485 per kWh in 2012 [24]. As battery costs continue to drop, it is reasonable to assume a valid business case will emerge. If battery costs were to drop significantly as to enable a realistic battery swap business model, the consumer charging concern could be addressed.

There is currently no infrastructure for battery replacement in the United States, however Tesla and Nissan have recently announced a battery swap plan in to address battery-related consumer anxiety [22] [25]. Tesla demonstrated an automated battery "loan program" with their Model S, which takes less than 90 seconds [22]. The customer can get their empty battery replaced by a fully charged one. The Level III charging station service, for which they will charge $60-80, will provide the convenience of 100% battery charge in less time than it takes to fill a gas tank, for approximately the same cost.

3.4 Charging Infrastructure

Charging stations and equipment are commonly referred to as EVSE (electrical vehicle service equipment), and falls into two categories: slow charge and fast charge. The slow charge EVSE can be broken further into two sub categories: Level I, a domestic ~110V AC outlet, and Level II, a domestic or commercial ~240V AC outlet. The fast charge EVSEs are classified as Level III, 480V DC 3-phase, outlets. Studies conducted in 2013 illustrate that the availability and distribution of refueling stations, or "ease of recharging", is the second biggest purchase criteria, and therefore a major consumer concern [21], [26].

<u>Installation and costs</u>

The installation of an EVSE service station is an added cost to the PEV owner or the business providing the service. A Level I EVSE may cost between $500 and $1500 without a service panel upgrade, and up to $2500 with a service panel upgrade [27]. A service panel upgrade is a process that involves increasing or upgrading the electrical service to a business or residence. In addition, EVSE cables and accessories can cost from $200 to $1000, and additional insurance may be required for homeowners and businesses. Level II services are the most common public charging station, each of them costs between $16,000 and $25,000 [28]. Level III services, are the least common charging station due to a cost of up to $80,000 to $110,000 [28].

<u>Infrastructure support/funding</u>

Three examples of public charging support in Oregon at a state, city and organizational level exist. (1) ECOtality received a DoE grant for $230million to deploy residential and public charging infrastructure starting in 2009. ECOtality also offers free ESVE installing to purchasers of PEVs in Portland, Eugene, Salem, and Corvallis metropolitan areas. (2) The West Coast Electric Highway partnered with ODOT to install 20 level III fast charging stations along the I5 route every 20 to 60 miles. (3) PSU partnered with PGE and the city of Portland to install 5 level II and 2 level III charge stations on campus [28].

<u>Consumer expectation</u>

It is difficult to numerically determine consumers' expectation for charging stations. A federal national travel survey in 2009 found that the average distance traveled per person per day in the United States is 36.13miles total [1], [29]. It has been established that consumers expect a range close to that of an ICE. Therefore, a very close-knit network of charging stations would have to be provided.

Availability of infrastructure

In the United States there are a total of 8,319 alternative fuel stations for PEVs, of which 6,686 are available to the public. According to the United States DoE, Oregon has 373 (private and public) PEV fueling stations [30]. Oregon currently leads the nation in charging stations per capita with 11.0 charging stations per 100,000 people [31].

These numbers show that there may not always be a charging plug available at the nearest charging station when you arrive. To address this perceived availability issue and improve visibility of charging stations, companies such as Blink and ChargePass [32] have created online Apps that consumers can use to view their local charge stations to determine whether they are free or occupied, and for how long.

3.5 Financial Aspects

There are two key financial drivers for consumers when considering an electric vehicle: current gas prices and the fear of America's ability to control foreign oil prices. In 2008, America experienced its worst gas crisis in history [33]. The price per gallon reached a national average of $4.00 a gallon which added additional strain to an already hurting economy. The resulting PEV market share for the four month crisis only increased by one percent and as soon as gas prices stabilized the demand weakened [34]. Analysts at Edmunds have shown that gas prices will need to reach at least $8 to $10 per gallon before fuel economy becomes a top factor in automobile purchases [35].

The U.S. Department of Energy's (DOE) Alternative Fuels Data Center has a tool on its websites for comparing the total cost of ownership of vehicles in the United States. For the purposes of this financial analysis, the Nissan Leaf, America's top selling electric vehicle of all time [36], is analyzed. The total fuel cost for a Nissan Leaf is $0.20 cents per mile, which translates to an annualized operating cost of $2,483.

In addition to the fuel costs, the DOE’s tool also accounts for purchase price, general financing terms, registration costs, insurance, and maintenance. When all of these variables are considered, users of the tool are able to adjust the price per gallon of gasoline to better understand the cost and benefit of making the initial investment of an electric vehicle. The Leaf, for example, finally makes up for its higher upfront cost in year 12 assuming gas prices are $4.00 per gallon. This is a financial deal breaker for consumers who typically hold onto their vehicle for five or less years [36].

Government forecasts of gas prices suggest a slow and steady growth pattern. In addition, the world’s supply of oil continues to grow as other non-Middle Eastern sources are discovered [37]. As the oil supply increases, the price paid at the pump decreases, which might result in a decrease in demand for electric vehicles based on financial considerations. Until car manufacturers are able to lower the initial price of their electric vehicles, likely through economies of scale and/or technology innovation, the math simply does not work out in the PEV’s favor. Different possible analyses are shown in Figures 2 to 4.

Assumptions: Gas Price: $3.50/gal
Driving Distance: 12,500 /year
Energy Prices: No change

	Annual Fuel Costs	Annual Operating Costs
Nissan Leaf	$355	$2,483
Chevy Volt	$597	$2,885
Nissan Versa	$1,466	$3,755
Chevy Cruze	$1,417	$3,706

Payback Period: **14 years**

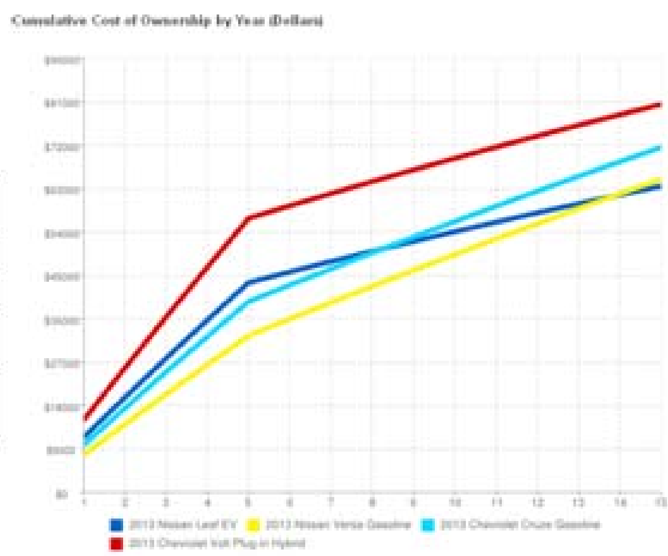

Figure 2 Financial analysis of scenario 1

Assumptions: Gas Price: $4.00/gal
Driving Distance: 12,500 /year
Energy Prices: No change

	Annual Fuel Costs	Annual Operating Costs
Nissan Leaf	$355	$2,483
Chevy Volt	$637	$2,925
Nissan Versa	$1,676	$3,964
Chevy Cruze	$1,619	$3,908

Payback Period: **12 years**

Figure 3 Financial analysis of scenario 2

Assumptions: Gas Price: $5.00/gal
Driving Distance: 12,500 /year
Energy Prices: No change

	Annual Fuel Costs	Annual Operating Costs
Nissan Leaf	$355	$2,483
Chevy Volt	$717	$3,006
Nissan Versa	$2,095	$4,383
Chevy Cruze	$2,024	$4,313

Payback Period: **9 years**

Figure 4 Financial analysis of scenario 3

3.6 Government Incentives

Producers of PEVs are not the only entities pushing for the widespread adoption of an alternative to ICE vehicles. Outside of the associated technological advances designed in order to meet consumer needs and desires lie the incentives offered by federal, state, and city governments in support of the switch.

In an attempt to address the goals set forth by the Energy Improvement and Extension Act of 2008, which provided individuals and businesses tax credits for implementing and/or developing "clean" or "renewable" energy technologies [38], the federal government developed a tax credit entitled the Plug-in Electric Drive Vehicle Credit (IRC 30D). Put into effect on January 1, 2010, the IRC 30D offers up to a $7,500 tax credit to customers for purchasing qualified electric vehicles. As specified by the IRC 30D, the phase-out process for a specific vehicle occurs when a given company has sold 200,000 cars within the United States [39]. According to the United States DOE, none of the 21 qualifying vehicles have reached the phase-out point as of 2013 [40]. The federal government also offers up to a 30% reimbursement, up to $1000 for consumers and up to $30,000 for businesses, for the installation of a charging station [41].

Oregon has taken to furthering the federal initiative by offering its own incentives at the state level. Residents of the state of Oregon who install electric vehicle charging stations can apply for state tax credits in order to offset the price of the required equipment beyond what is offered at the federal level. This credit covers an additional 25%, up to $750, of the price of the charging equipment [42]. Businesses undertaking similar projects can qualify for a tax credit that equals up to 35% of the installation costs [43].

In July of 2010, the city of Portland announced the start of its efforts towards becoming the "leading electric vehicle city in the United States" [44]. This push is a result of the local government's desire to promote sustainable energy use and reduce vehicle-related greenhouse gas emissions. As a part of this effort, the city teamed up with The EV Project, a group that was to install up to 1,000 public and 900 residential charging stations at little to no cost to the owner [44]. This partnership was the beginning of Portland's attempt to condense the charging station permitting process, which is currently completely electronic, and make the city-wide conversion to electric vehicles easier for consumers.

This partnership was only a small factor in the multi-dimensional report called "Electric Vehicles: The Portland Way", which describes the city's electric vehicle transition strategy. The bulk of the report outlines Portland's plan to target ease-of-use and non-monetary incentives for citizens of the city to drive PEVs. Amongst these incentives is the allocation of right-of-way parking spaces for electric vehicle charging stations across the city. This, along with the city's partnership with Zipcar, will ensure that drivers have access to charging stations throughout the day at their leisure. Furthermore, the city is working to promote the 40 electric-vehicle related technology companies, stimulating economic growth for the industry within the metro area [2].

3.7 "Good feeling"

A customer can take many things into consideration when he or she decides to buy a PEV. The possibility to save on gas, for example, has been previously discussed in section 3.5. Another major reason for the purchase of an electric vehicle is the perceived positive impact on the environment [45]. While it is evident that PEVs produce lower CO_2 emissions than ICEs during use, in that they don't, different opinions exist regarding whether or not the CO_2 emissions of a PEV are lower than those of a combustion engine over the entire life cycle, which include production and electricity generation [46], [47]. The decision to buy a PEV or not is highly subjective, however. It becomes obvious that the purchasers of a PEV do get a "good feeling" because they *feel* like they are doing something positive for the environment. This is underlined by the way companies advertise their EVs, playing up environmental advantages.

Toyota, for example, claims that their PEVs will "make the world a better place to live in" [48]. Tesla emphasizes the environmental advantages of their PEV, by saying that their Model S is "a car that may lead other cars in no longer taking from the earth, but accepting from the sun" [49]. By saying this, they emphasize that their car relies on renewable solar energy rather than fossil fuel energy. Furthermore, Nissan paints a very harmonic picture with their commercial, including the promise “we make them [PEVs] better to make your life better” [50].

The ways companies advertise their PEVs shows that they put great emphasis on giving their potential customers a positive feeling. All commercials include harmonic background music and pictures of an untouched, unpolluted environment. Psychology literature finds advertising to be a very efficient way to manipulate the way customers feel about a product [51]. While it cannot be judged whether or not companies succeed at giving their customers a good feeling for buying a PEV because they focus on environmental sustainability, it is very clear that these companies believe that this will be an efficient way to reach customers. A study on the willingness of people to buy a PEV shows that a number of positive characteristics are typically attributed to PEVs, like convenience, stylishness, and good environmental value [1]. Hence, a positive image of PEVs in general exists and is furthermore emphasized by companies.

4 Marketing Strategy for the Portland Market

Manufacturers of PEVs approach the Portland market and the way that they market to consumers in that market a little differently from the norm. In many respects, Portland is an ideal market for companies trying to sell PEVs. In 2012, Oregonians purchased 1.9% of all hybrid vehicles purchased in the US, but only were responsible for 0.9% of all vehicles [52]. These results are reflected in actual PEV sales as well. Early figures from 2013 indicate that Oregonians purchased 1.8% of electric vehicles, meaning that PEVs have almost exactly twice the market share in Oregon as they do nationwide. Furthermore the market share in Portland was 1.12% in comparison to 0.58% nationwide [53]. It is clear that Portland is a receptive market for sellers of electric vehicles.

That said, there have been marketing tactics that have worked, and those that have not. Nissan has engaged in tactics that have clearly been successful. The Nissan Leaf has been the best selling Nissan model in Portland every month since March of 2013 [54], [55]. In fact, 10% of all Leaf sales in the US outside of California were made in Oregon [56]. By any metric, the Nissan-Renault Alliance has been enormously successful in the

Portland market selling their Leaf. The Alliance has not published anything that has explicitly described the marketing strategy for Portland, but one of the most telling signs of their strategy is the fact that the Nissan-Renault Alliance has targeted a partnership with Portland General Electric (PGE) to build charging station infrastructure in the metro area. In return, PGE mentions the Nissan Leaf in much of the PEV and charging station literature that they produce [57].

The Nissan-Renault Alliance has taken this tactic in other strategic markets in and out of the US: France's Vendee Region, Switzerland, Israel, Denmark, Sonoma County in California, Austin, and San Diego [58], [59], [60]. Likewise, Tesla has more quietly helped build infrastructure in the region [61], and opened a PEV-only showroom in the Washington Square Mall in early 2012. Tesla does not publish sales data by region, but Tesla opened a service center in Portland in March 2013, and at the time Portland was one of the top 3 smallest metro areas to merit a service center. This serves as an indication that Portland's Tesla sales were high enough to warrant a service center, beating out metropolitan areas such as Philadelphia, Montreal, New York and Dallas [62].

There have also been tactics that have not worked in Portland. For instance, Toyota seems to be relying on its status as the incumbent champion of alternative power drive vehicles, and is consistently losing market share. The Toyota Prius plug-in stands to be the first electric vehicle sold in the US that sold fewer cars in its second year than its first year. Moreover, Toyota Prius plug-in has no more market share in Portland than it does in the US as a whole [52]. Given PEVs' relative strength in Portland overall, this suggests that Toyota is falling short in Portland. Some experts attribute this to Toyota not marketing their Prius plug-in separately from the rest of their Prius line [63]. The same truth also applies to Chevrolet and their Volt: Volt sales in Portland are no better than nationwide sales. However, Volt sales in Portland and the US overall are growing, so Chevrolet's situation is not as dire [63].

5 Conclusion and Discussion

There is a clear gap between the needs and the requirements of the potential PEV consumer. Of the seven categories of PEV attributes identified in figure 1, the technological relationship between three of these, namely range, infrastructure and charging combine to create the largest gap between the consumer requirement and customer expectation for the PEV and this is at the heart of the challenge for PEV manufacturers. The ICE has been an incumbent for so long that the performance characteristics of fossil fuel engines are now considered prerequisites for any challenger or successor to the personal vehicle throne regardless of the actual need. The current PEV offerings (ranges from 70-100miles) supply adequate performance to meet the *need* of the average customer, not to mention the average metro area or urban consumer. This fact coupled with fact that the majority of the time a vehicle is parked at the workplace or the home, which is sufficient time to fully charge a PEV to achieve 40-60 miles per day with the current level II charging technology. The perception of inadequate charging times has lead to an inflated requirement for infrastructure which compounds the challenge.

Regarding financial aspects, some further gaps can also be identified. PEV manufactures can only control half of this attribute, the half which is their own technology and technology roadmaps. The operating cost benefit of PEV *versus* ICE is largely dependent on oil prices and supplies. The recent discovery of new oil reserves in Australia shows how the projected oil prices may not be realistic. The ICE is a commodity and therefore has lower manufacturing costs. The PEV is a long way from this stage of manufacturing and commercialization, and therefore will have to battle against the lower cost incumbent until either the cost to manufacture a PEV or PEV battery drops significantly or oil prices rise to “fear mongering” levels. Put simply, the PEV payback period for most personal vehicle owners is not attractive enough to close this gap yet.

The attribute that might have the potential to close this requirement *versus* expectation gap is the “good feeling” attribute. The implementation of successful advertising and marketing campaigns has convinced the consumer to focus first at vehicle level CO_2 emissions *versus* the ICE, rather than the total “well to wheel” carbon footprint. This has lead to the common conception that PEVs are always cleaner than ICEs, if the “well” energy source is a renewable one. However if fossil fuels are used to generate the electricity, the total carbon footprint metric is pushed aside in favor of a “miles per gallon” or “zero emissions” comparison to the ICE.

Customer education and advertising are critical issues in addressing and overcoming the gaps identified. Finding the right balance for a given market is a key factor in winning a market. In the right situation or market, some attributes can be used to outweigh or overshadow others. Tesla has successfully marketed to the United States and Portland market targeting the luxury market providing a balance that emphasizes high performance. Nissan has chosen to partner with the local energy supplier to help educate and motivate the market. These two PEV manufacturing companies have clearly taken the lead on addressing and marketing to the PEV market in Portland, both Nissan and Tesla have unique approaches that are distinguishing them from their competition.

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