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Unplugged:
Electric vehicle realities versus consumer expectations

Contents

Executive summary

Electric vehicles (EVs) have been around since the earliest days of the automotive industry. In recent years, however, as the price of oil has risen steadily and concerns about the environment have increased, interest in EVs has intensified.

This interest is coming from a number of sources, including government and industry. Policymakers, automotive executives, and electric utility industry executives are each, in their own way, trying to understand when and where consumers are most likely to adopt EVs and exactly how many may be on the road next year, five years from now, or 10 years or longer from now. As they work together, and apart, in this complicated dance toward the next generation of personal mobility, with profound implications for all parties, it still comes down to the consumer. It is the consumer, looking for a less-expensive, greener transportation alternative with all the performance qualities of a traditional car, whose interest is the most intriguing and perhaps the most complicated. It is the consumer, after all, who will tell manufacturers how close they are to creating a vehicle that has a chance to achieve mass popularity in the marketplace.

With that in mind, Deloitte Touche Tohmatsu Limited's (DTTL) Global Manufacturing Industry group undertook an extensive global study designed to gauge consumer attitudes toward pure EVs. While the broad category of EVs available today include a variety of hybrid vehicles using some form of both electric motor propulsion and internal combustion engines, this study focused exclusively on the pure electric vehicle. In this way, the study serves to anchor the far end of today's automotive product offerings and create clarity for all those either participating in the study or interested in the findings. The study was based on a survey of over 13,000 individuals in 17 countries and, in addition to inquiring into willingness and intent to purchase, asked respondents a variety of questions related to the car's major selling points, including price, range, and charge time.

The survey, conducted between November 2010 and May 2011, revealed that the majority of consumers are either willing to consider the purchase of an electric vehicle or see themselves as potential first movers when it comes to electric vehicle adoption. Potential first movers were those respondents who indicated they were very interested in purchasing an electric vehicle and were likely to purchase or lease a new vehicle of some kind within the next 12 months.

However, deeper questioning revealed a significant gap between consumer expectations of electric vehicle capabilities and what an electric vehicle can deliver today. Consumers generally felt that EVs should be able to go farther, on less charge time, for a cheaper price than automakers are currently able to offer.

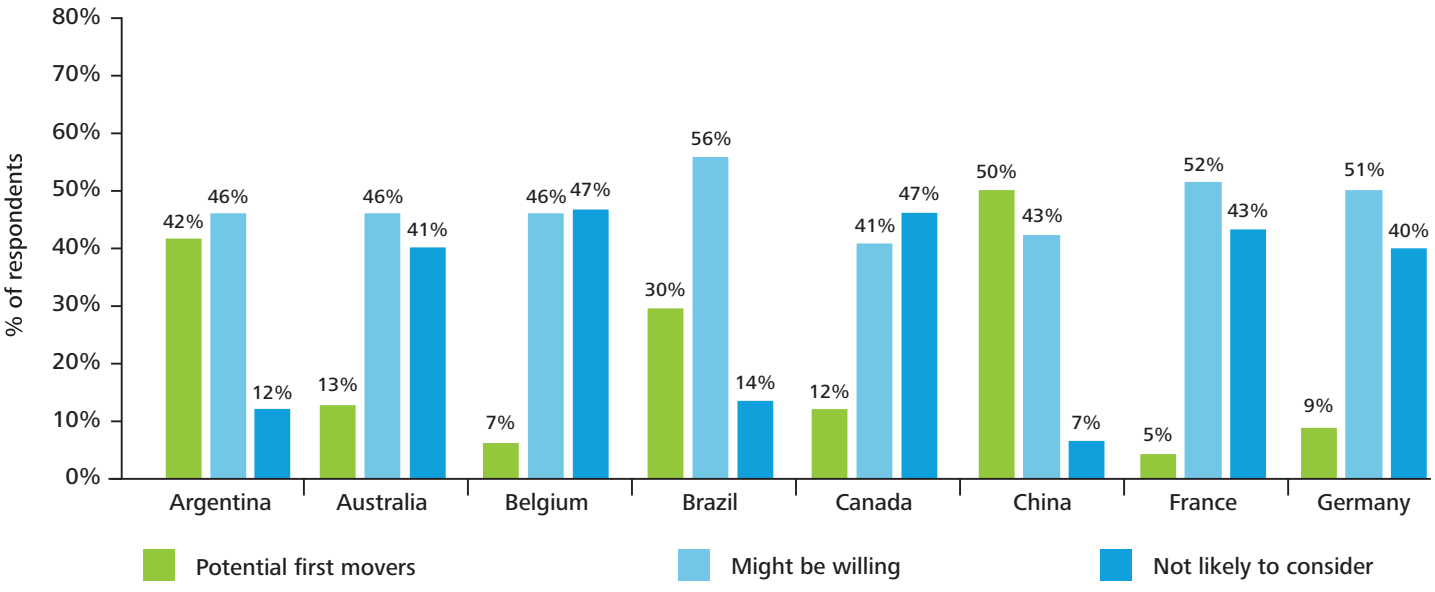
This gap—and where it manifests itself most dramatically and where it might be most easily closed—will be of special interest to automakers operating in the electric vehicle space.

This report looks closely at the results of the survey, with special attention to geographical differences and similarities in consumers' responses. It also provides critical context by contrasting consumer perceptions and expectations with the current realities of electric vehicle technology.

Consumer interest

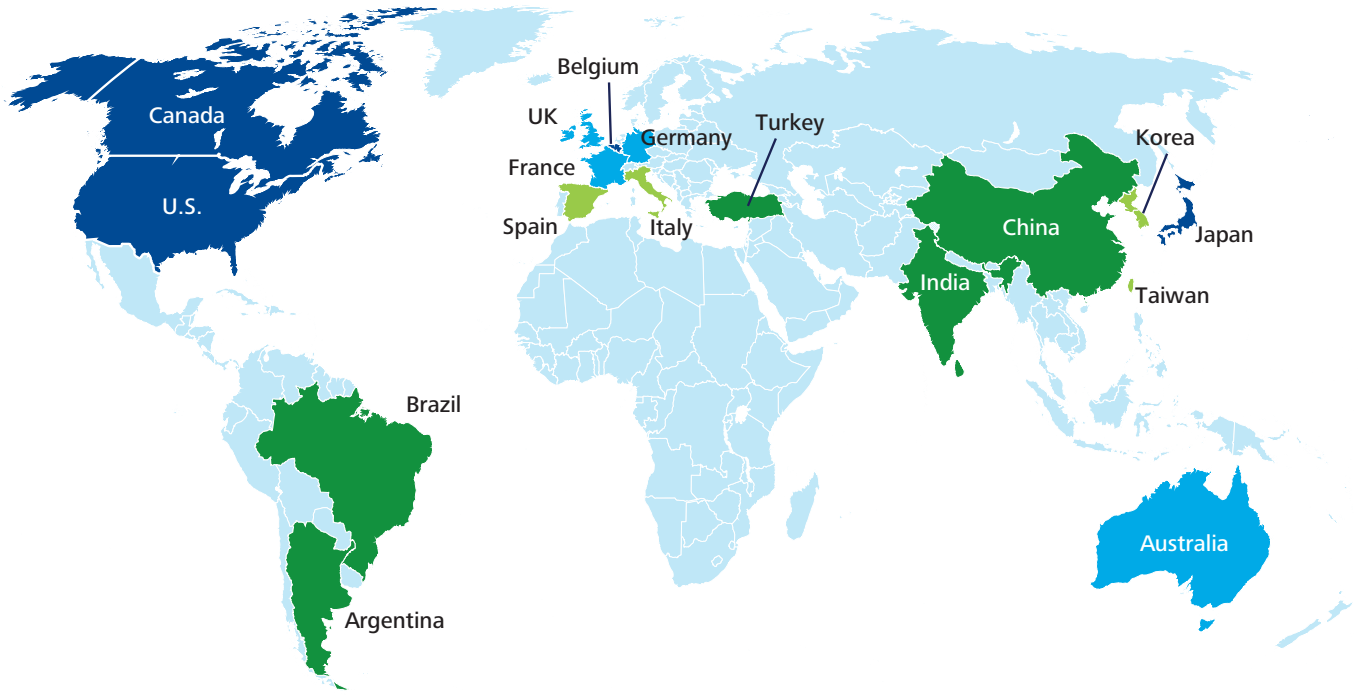
In each of the countries surveyed[i], a significant portion of consumers said that they would either be a first mover in the adoption of an electric vehicle or at least might be willing to consider purchasing an electric vehicle. China and India led the world with those considering themselves potential first movers at 50 percent and 59 percent respectively. This was a dramatic contrast to the potential first movers in Japan (4 percent), France (5 percent), Belgium (7 percent), and Germany (9 percent). But when potential first movers are combined with those that might be willing to consider the purchase of an electric vehicle, respondents around the world begin to look more similar than different showing a collective high degree of interest in electric vehicles. Only Japan had the majority of respondents (52 percent) indicate they are not likely to consider an electric vehicle. Europe seems divided, with more reluctance to consider an electric vehicle in Belgium, France, Germany, and the UK and greater receptivity in Spain, Italy, and Turkey. The U.S. and Canada have very similar profiles with a near split between those willing to consider and potential first movers versus those not likely to consider an electric vehicle. Respondents in Brazil and Argentina are much more interested in electric vehicles than their counterparts in North America, while Australia's respondents tend to look very similar to those in North America. Finally, the Republic of Korea (Korea) and Taiwan have profiles similar to those of the respondents in southern Europe (see Figures 1 and 2).

Figure 1: Global consumer segmentation for EVs



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 2: Global consumer interest is high

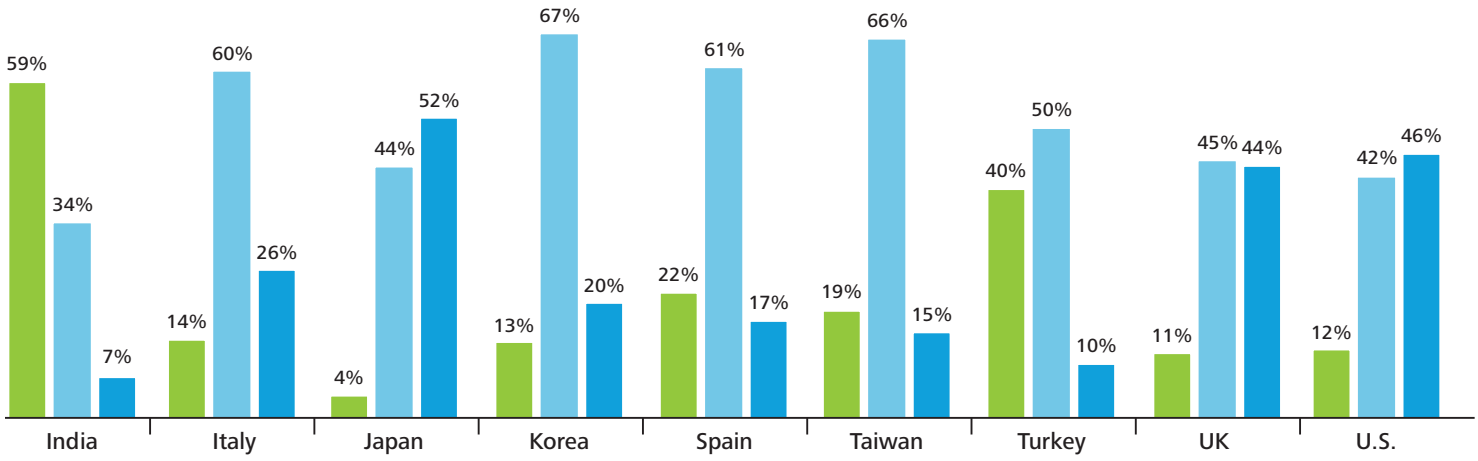


Consumer interest

- Greater than 85%
- 71% - 85%
- 55% - 70%
- Less than 55%
- Countries not surveyed

Percentages represent the summation of the "Potential first movers" and "Might be willing to consider" consumer segments

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group



Consumer profiles and preferences

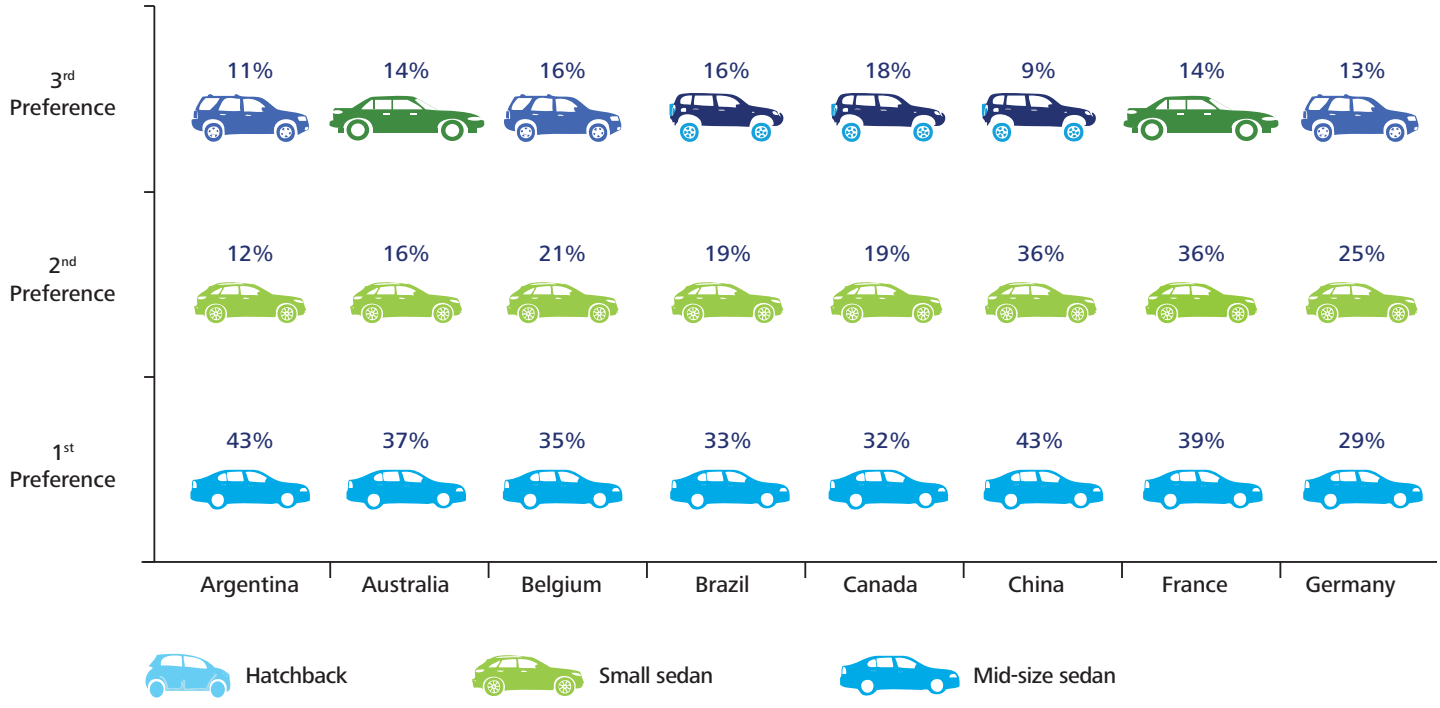
Who are the potential first movers most likely to buy an electric vehicle? They are generally well-educated, with a higher-than-average number holding post-secondary degrees. They claim to know much more about EVs than the might be willing consumers. They tend to live in urban areas, though suburbanites in the United States and Japan are also represented among the first movers. They are marginally more likely to be male than female and represent the middle or upper class. They tend to see themselves as environmentally conscious, tech savvy, trendsetting, and politically active. They claim to be more knowledgeable of EVs and attribute a number of positive characteristics to EVs: "coolness," convenience, safety, stylishness, and good value. On this latter point, potential first movers are also sensitive to government incentives, fuel efficiency, and the cost to charge a battery.

Among the potential first movers and might be willing is a subset, the early adopters, who will actually purchase an electric vehicle in the near future. The appeal of electric vehicles to those who indicated an interest is the perception that these vehicles are cleaner, more environmentally friendly, and more efficient than traditional internal combustion-driven vehicles. Despite their apparent eagerness to buy an electric vehicle, however, the final decision to purchase or not will be influenced by a number of factors, including how well current and future vehicles meet their needs.

The survey also asked consumers what style of vehicle they preferred. The first choice of many consumers, from 29 percent in Germany to 45 percent in Korea and Italy, is the mid-sized sedan. Interesting exceptions include Japan, where the greatest number said they would prefer a minivan, and the UK, where drivers selected hatchbacks as their vehicle of choice (see Figure 3). Overall, the survey found yet again that the automotive companies have potentially cultivated a global consumer, where the preferences across the globe for EVs seem to be mid-size and small size sedans.

Figure 3: Consumers want mid-size sedan EVs

Survey question: If you were considering buying or leasing an electric vehicle, which type of vehicle would you be most interested in?

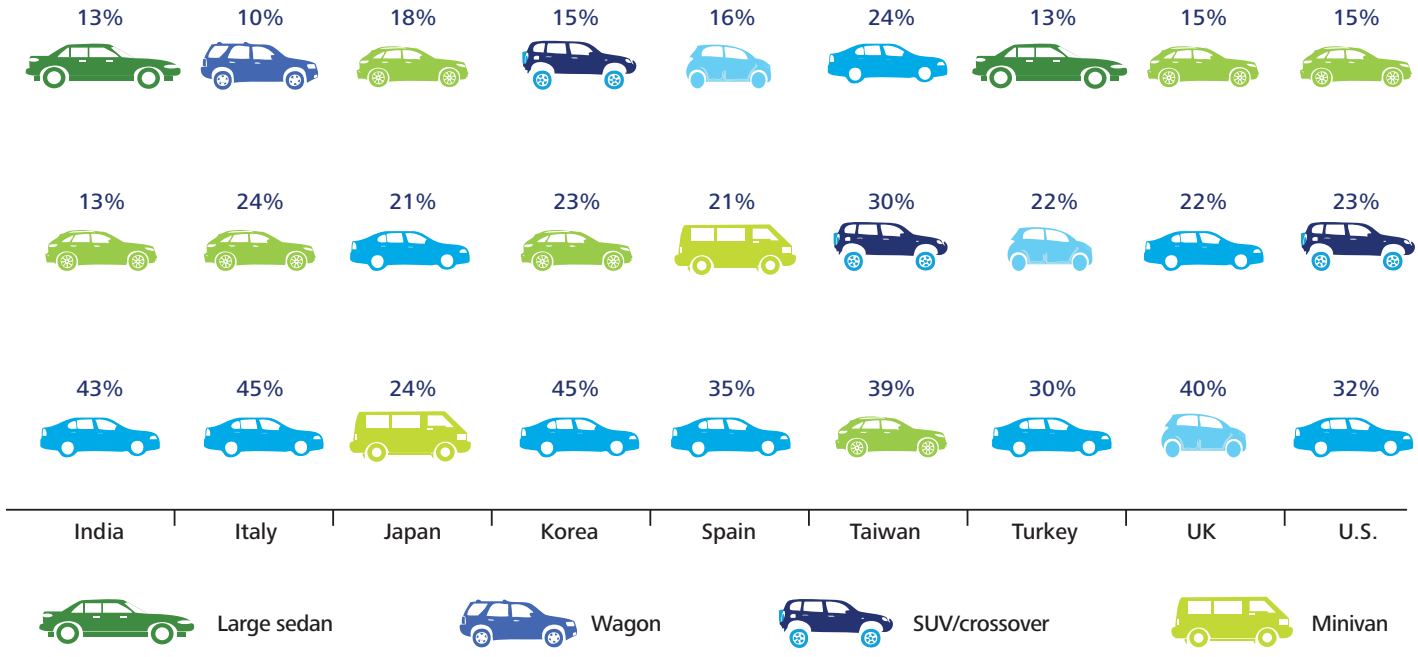


Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Defining the expectations and the limitations

Interest in electric vehicles is clearly growing. For more than 85 percent of the survey respondents, range, convenience to charge, and cost to charge were all "extremely important" or "very important" considerations for buying or leasing an electric vehicle. The survey found, however, that the expectations around these factors of potential electric vehicle consumers did not match the current market offerings.

In the following report, we dig deep into the six key considerations respondents felt were most important when evaluating electric vehicles – range, charge time, price premium, purchase price, fuel price, and fuel efficiency. For each, we outline consumer expectations based on survey responses and then provide current realities based on additional research conducted by DTTL's Global Manufacturing Industry group.



Range

The expectation:

Despite the relatively high willingness of consumers to consider an EV, many seem not willing to compromise in key criteria, such as range. While on average 80 percent of drivers surveyed typically drive less than 80 kilometers per day, consumers expect EVs to travel considerably farther. The U.S. and France seemed to have the highest sensitivity toward range, with only 63 percent and 67 percent, respectively, satisfied with a range of 480 kilometers. India, Taiwan and Brazil, however, seemed to have more realistic expectations, with nearly half of their populations satisfied with a range of up to 160 kilometers. In each country, the majority of drivers expect ranges much longer than their typical weekday driving distances and correlate much closer to ranges provided in conventional internal combustion engine (ICE) vehicles. In all regions, expectations far outpaced reality, typically by a factor of two to three times (see Figure 4).

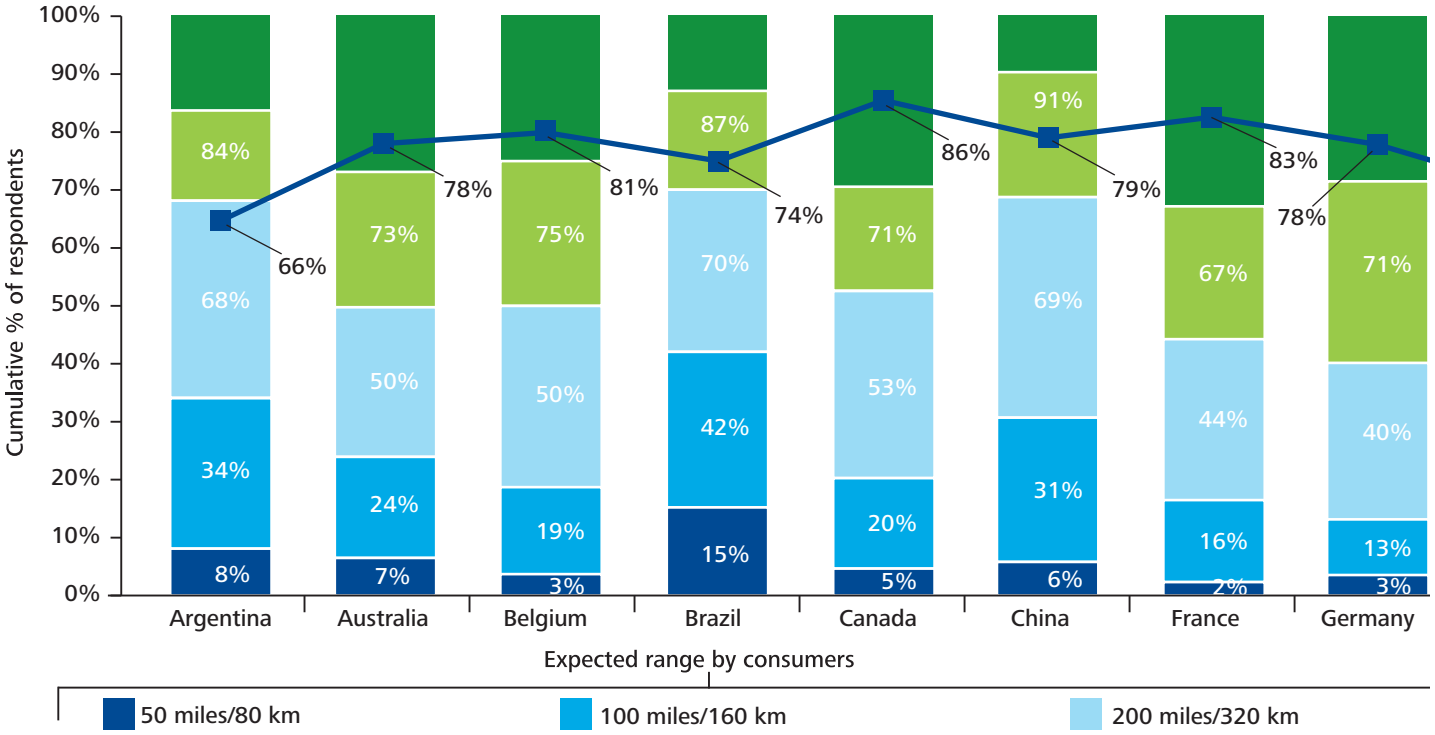
The reality:

Current technology permits most electric vehicles to cover an average of only 160 kilometers between charges. The main limiting factor for range is energy density. Energy density represents how much electrical energy the battery can store per unit mass. In recent years, lithium ion batteries (LiBs) have offered the highest energy density and power relative to their size and have a relatively long life cycle. Looking at automobiles already introduced and announced product introductions around the world through 2013, for most manufacturers, the driving range of their pure EVs still falls short of consumer expectations (see Figure 5). In fact, there is little or no increase in range beyond 160 kilometers over this time horizon based on announced vehicle introductions from most manufacturers.

But, manufacturers are working on the issue and expect energy density to improve over the remainder of the decade, reaching 200–250 Wh/kg[ii] by 2020 (see Figure 6) assuming government targets are hit. This will serve as one solution to help increase the overall driving range but assuming the battery size (i.e., mass) remains around the 150 kg weight that is commonly used today, it still equates to a driving range well short of current consumer expectations. Manufacturers will likely turn to the battery mass and operating efficiency (kilometers per kilowatt hour of energy), in addition to energy density, and vehicle weight reductions combined with advanced high-strength, light weight material compositions in order to increase driving ranges.

Figure 4: Range expectations exceed typical driving distance

Survey question: What is the minimum range that an electric vehicle would need before you would consider buying or leasing it? On average, approximately how many miles/kilometers do you drive each day during the week (Monday through Friday)?



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 5: Manufacturers electric vehicle launches trail range expectations

More electric vehicle models will be introduced in coming years to new markets, though most will offer similar driving ranges as today's products.

Note: Driving ranges depend on the calculation condition in each country.

[1] Increased range is primarily due to larger battery mass, nearly 450 kg versus the more standard 150kg

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis[iii]

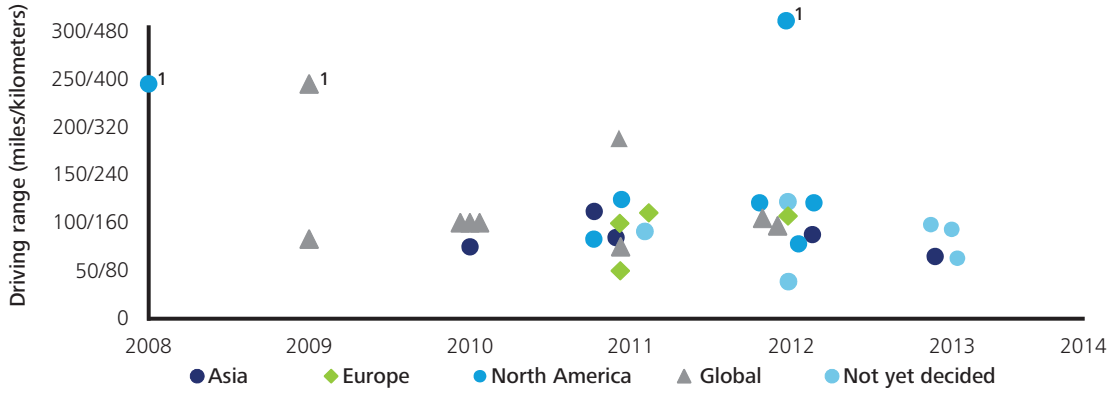
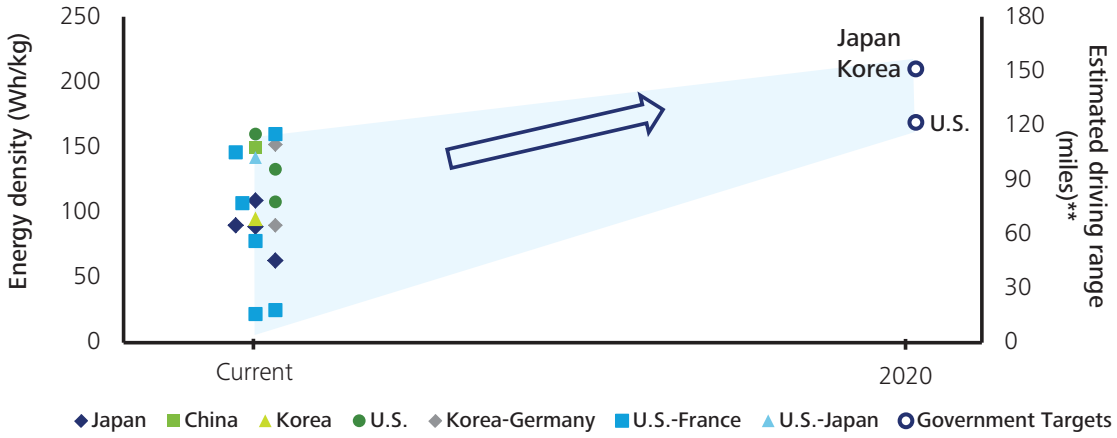


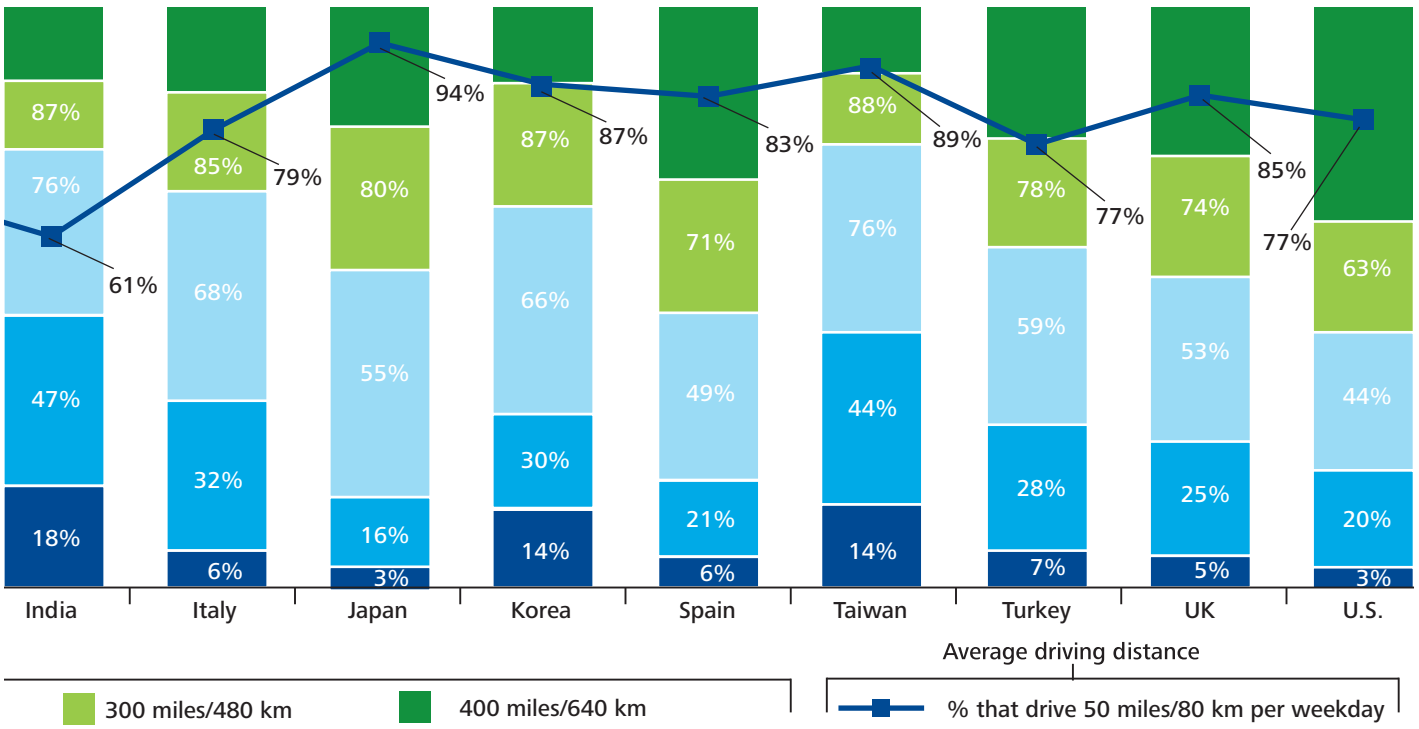
Figure 6: Energy density to improve over time

Energy density targeted to increase 20-50 percent by 2020.

**For estimation purposes, assumes battery weight to be 150 kg and averaging 4 miles per KWh of energy.

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis[iv]





Charge time

The expectation:

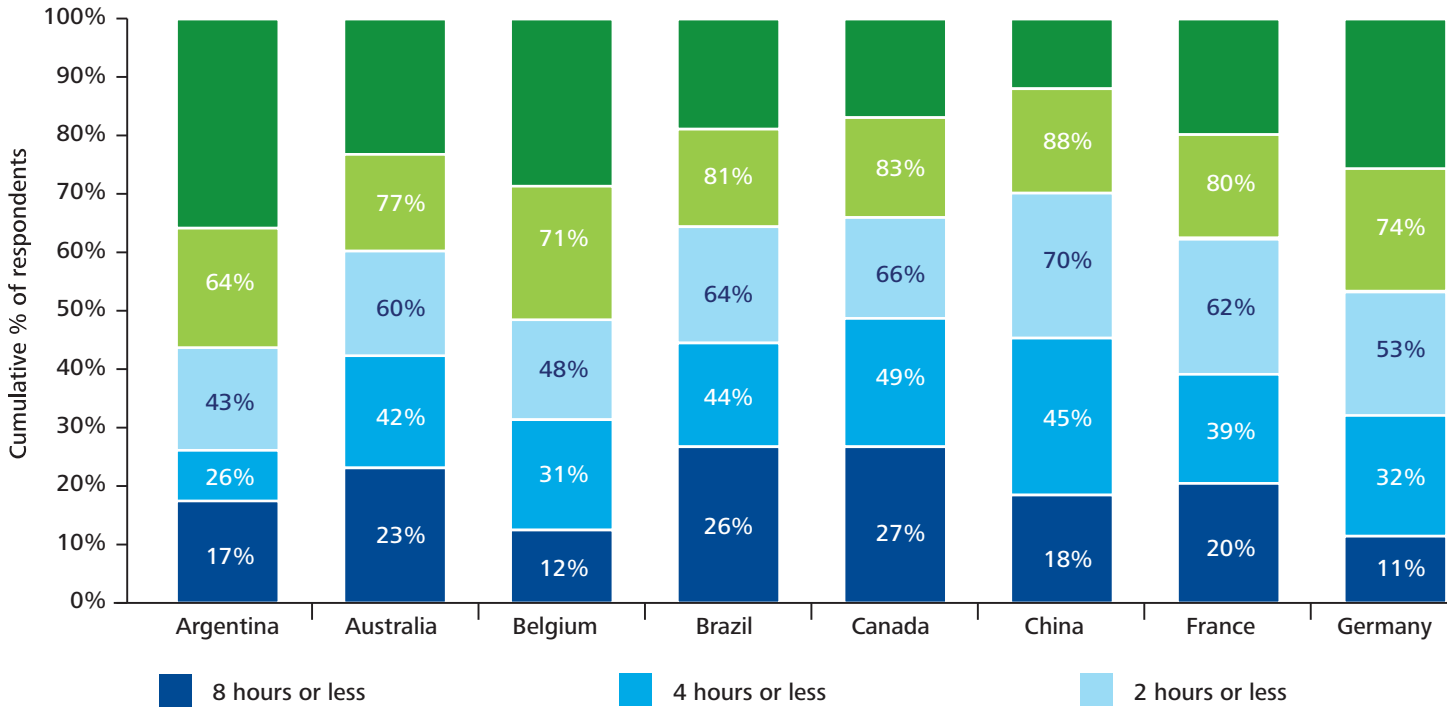
Most of the consumers surveyed expected an electric vehicle to recharge its battery in two hours or less. Many, especially in Japan, had even greater expectations: 37 percent cited 30 minutes as the longest acceptable charge time. In all countries, only a small majority viewed eight hours—the actual and longest time it can take to recharge the typical electric vehicle battery in vehicles today using a level 2 charger— as acceptable (see Figure 7).

The reality:

Based on survey results, consumer expectations appear to be inconsistent with current technology capabilities. Electric vehicle chargers are classified by the level of power they can provide to the battery pack. For example, level 1 being the lowest level of power and level 3 chargers supplying the highest level. With level 1 and 2 chargers, anywhere from three to 20 hours are required which means that the traditional model of periodic roadside filling stations will be challenging thereby leaving the charging limited to the home and possibly the workplace. To that end, building and installing a recharging infrastructure will need to be considered as part of the solution. Level 2 chargers are preferred as they optimize charge time and cost for use at home or at an external facility. Consumers would not only have to plug in their vehicles overnight, but also be able to recharge in public spaces such as parking lots at grocery stores or office buildings. Each of these infrastructure improvements brings its own issues. Expense—and who pays—is certainly primary among them. The technology would likely have to be standardized so that an electric vehicle can recharge at any dock, not just those specific to its make (see Figure 8).

Other alternatives include convenient battery swapping stations, where drivers could exchange a dead (or dying) battery for a freshly charged battery in less than two minutes without getting out of the car. This could reduce the cost of the battery and eliminate the concern over charge times. But it would add to the cost of infrastructure to build the stations and would likely cause significant challenges for electric vehicle automotive manufacturers. Wireless inductive charging is another possibility, and three

Figure 7: Majority of consumers expect electric vehicles to recharge in two hours or less
Survey question: Considering your expected vehicle use, what is the longest time to fully recharge the battery that you would consider acceptable when buying or leasing an electric vehicle?



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 8: Chargers vary in capabilities

Though a variety of chargers are available, most will use level 2 due to factors such as length of charge, price, and battery degradation.

	Normal chargers		Rapid chargers
	Level 1	Level 2	Level 3
Voltage	110-120	208-240	480
Charge power (kW)	1.8-1.9	<= 14.4	30-250
Estimated charge time	10-20 hours	3-8 hours	< 30 minutes
Estimated price	~ US$1,000	US$500-3,000	US$17,500-50,000
Comments	• Appropriate for small battery packs such as in partial hybrid electric vehicles	• Ideal and cost-effective for most EV charging applications	• Most expensive and most stressful for the grid • Shortens battery life

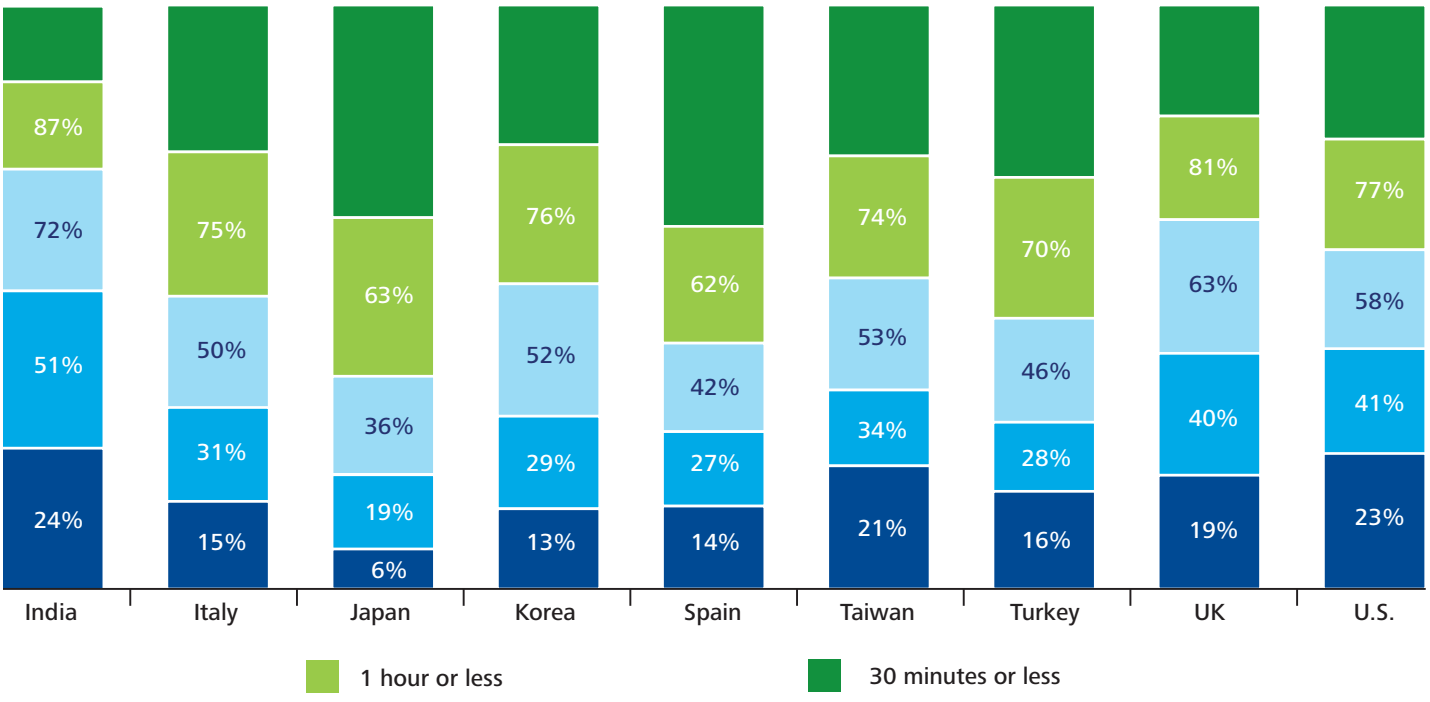
Note: Charge time = energy capacity/power

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis [v]

models are in development: electro-magnetic induction, magnetic resonance, and microwave.

Companies are also currently developing telematics to aid in the dissemination of information related to charging. By using a smartphone connected to the vehicle by telematics, customers could operate the vehicle's audio/video remotely and receive guidance on the real-time state of charge of its battery. There are other advantages to this solution. With a forecast of energy use, customers can see how far the vehicle can drive without stopping to charge, access a real-time map of charging stations, and monitor the performance of the battery and know when it is time to replace a deteriorating unit.

The exception to charging constraints described above are the level 3 rapid chargers. These high-voltage, high-amperage chargers could have the ability to return a battery to full power in under 30 minutes, eliminating all the complications of long charge times. However, there are serious issues with these rapid chargers, including the degradation of the battery life, safety concerns related to the high voltage used, the stress put on a region's power grid, and, at 10 times the cost of a level 2 battery, the expense.



Price premium

The expectation:

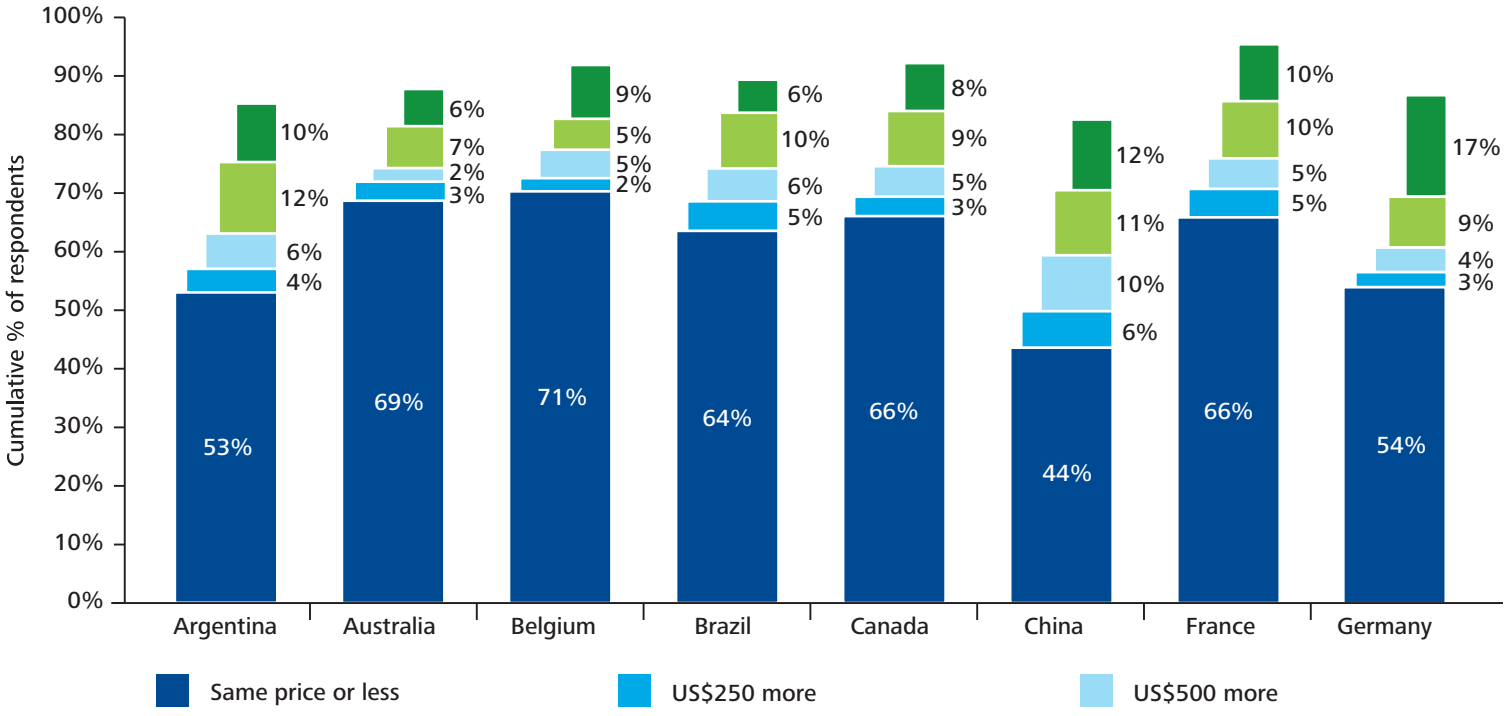
In almost every region the majority of survey respondents indicated they would not be willing to pay a premium for EVs over a vehicle with a gasoline engine (see Figure 9). Of those who suggested they would pay a premium, few consumers were willing to pay much more than they would for a traditional car. Belgium and the UK seemed to be the most price sensitive, both with 71 percent expecting to pay the same price or less for an electric vehicle. Respondents from China, Korea, and India seemed more receptive to potentially paying a price premium, as the majority of their respondents expected to pay some level of a premium. It is interesting to note though, that in countries such as China and India, where consumer interest in EVs was extremely high, they have a majority of respondents at least willing to pay some sort of a premium. And countries such as Argentina, China, France, Germany, India, Italy, Japan, Spain, and Turkey all have a fairly significant subset of the population, double-digit percentages, which would at least be willing to pay a modest US$2,000 premium for an electric vehicle.

The reality:

The current retail price for electric vehicles is largely due to the battery, which can represent up to 50 percent of the cost of the vehicle[vi]. It is estimated that a battery for an average electric vehicle currently can cost almost US$16,000 (see Figure 10). Although a portion of that cost is offset with the removal of the internal combustion engine, the battery for an electric vehicle is still a significant incremental cost when compared to traditional vehicles. Though the unit cost of batteries are expected to decline from US$600 to US$625 per kWh ($/kWh refers to U.S. dollars per kilowatt hour) to US$330 to US$400 per kWh by 2020, any overall cost reduction will likely be offset as battery suppliers look to achieve higher driving ranges by adding more energy storage. Therefore, a significant portion of the cost of the battery would likely need to be subsidized, potentially by industry or government, if EVs are to be cost competitive with traditional ICE vehicles.

Figure 9: Consumers are not willing to pay a price premium

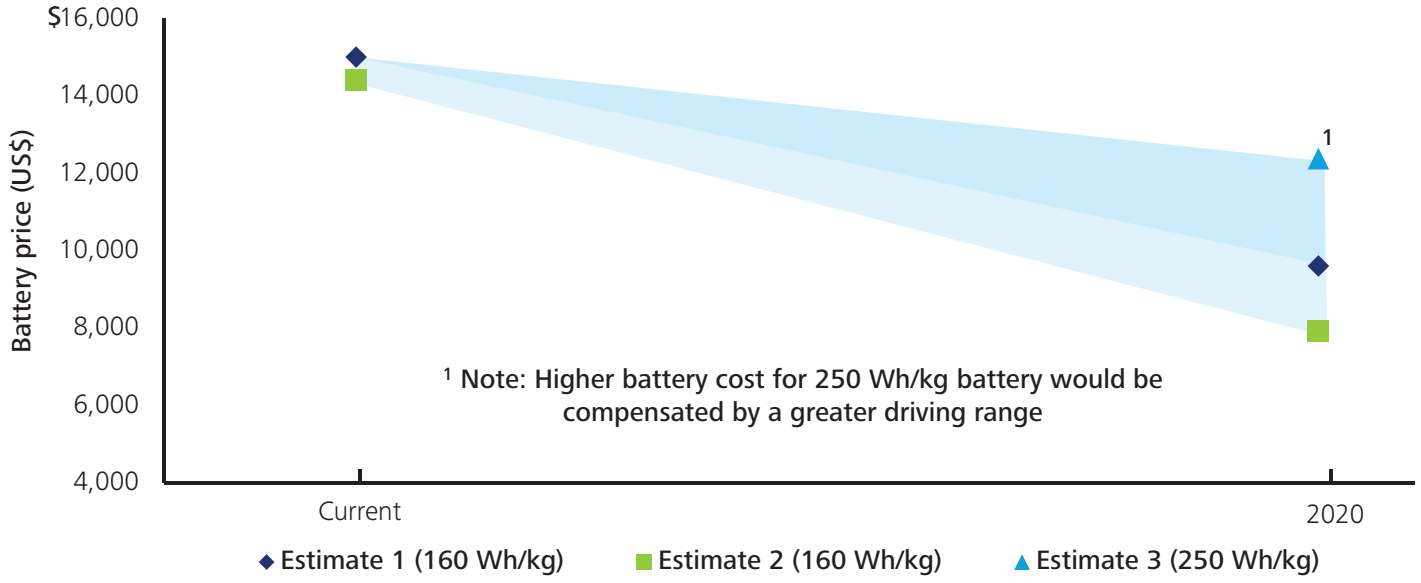
Survey question: How much more would you be willing to pay for an electric vehicle compared to a similar vehicle with a gasoline engine?



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

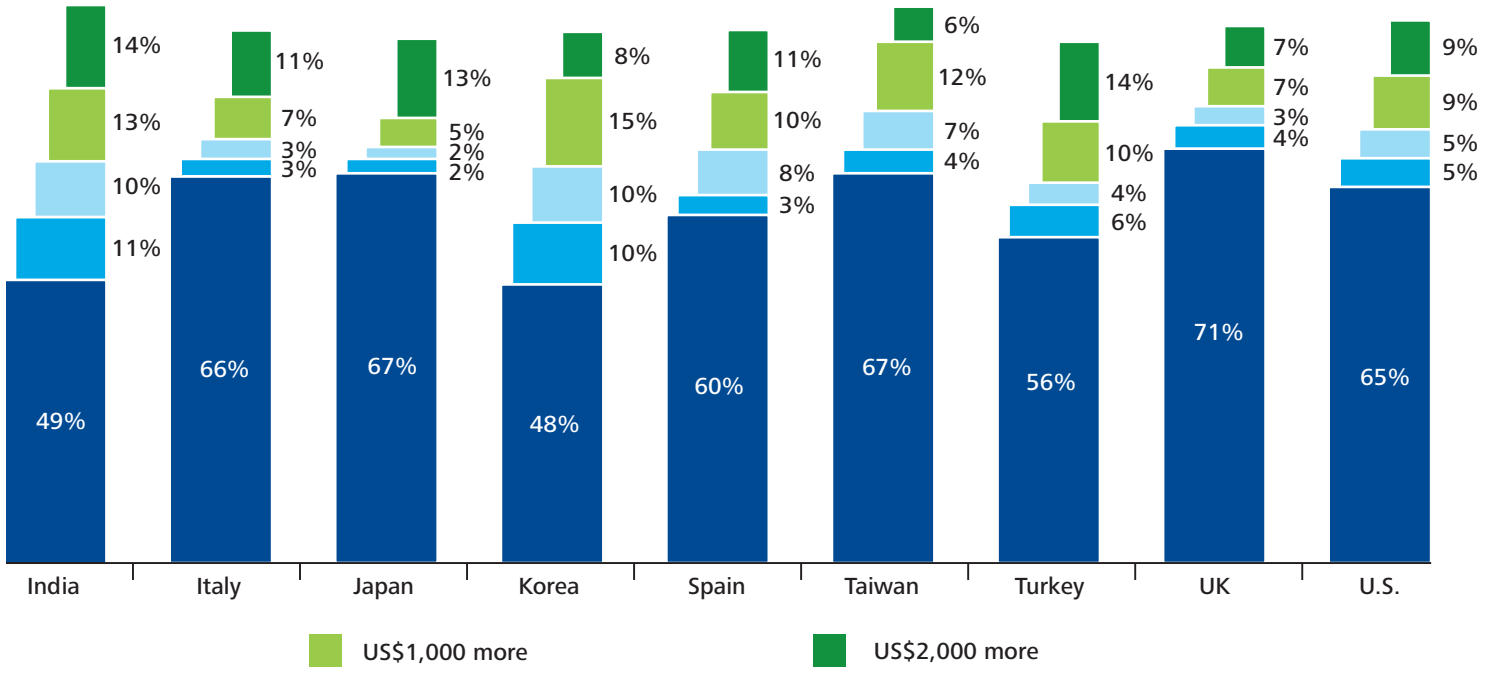
Figure 10: Battery prices set to fall, but by how much?

Though battery costs are expected to decline, the overall cost reduction will likely be offset to achieve higher driving ranges.



Note: Criteria considered in battery cost estimation: Scale of economies, Technology improvement and Re-use of battery
Current estimates: 600-625 US$/kWh; 2020 estimates: 330-400 US$/kWh

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis[vii]



Purchase price

The expectation:

Price expectations among consumers tend to be on the low end. Some 78 percent of Argentinean and 74 percent of Indian respondents surveyed expect EVs to be among the cheapest cars on the market. The U.S., Canada, and Japan seemed to be the least price sensitive with only 34 percent, 32 percent, and 41 percent respectively, looking to purchase an electric vehicle for the equivalent of US$20,000. The overwhelming majority of respondents across the globe expect to pay no more than US$30,000 for a new electric vehicle — anywhere from 69 percent in China to 94 percent in Turkey. And a significant number suggested they would not even pay more than US$20,000. And yet because of the cost of the battery, EVs are currently more expensive than their internal combustion counterparts and will be for the foreseeable future. Here again, most consumers show they are not willing to compromise on key decision criteria, such as the purchase price, when they look to buy an electric vehicle.

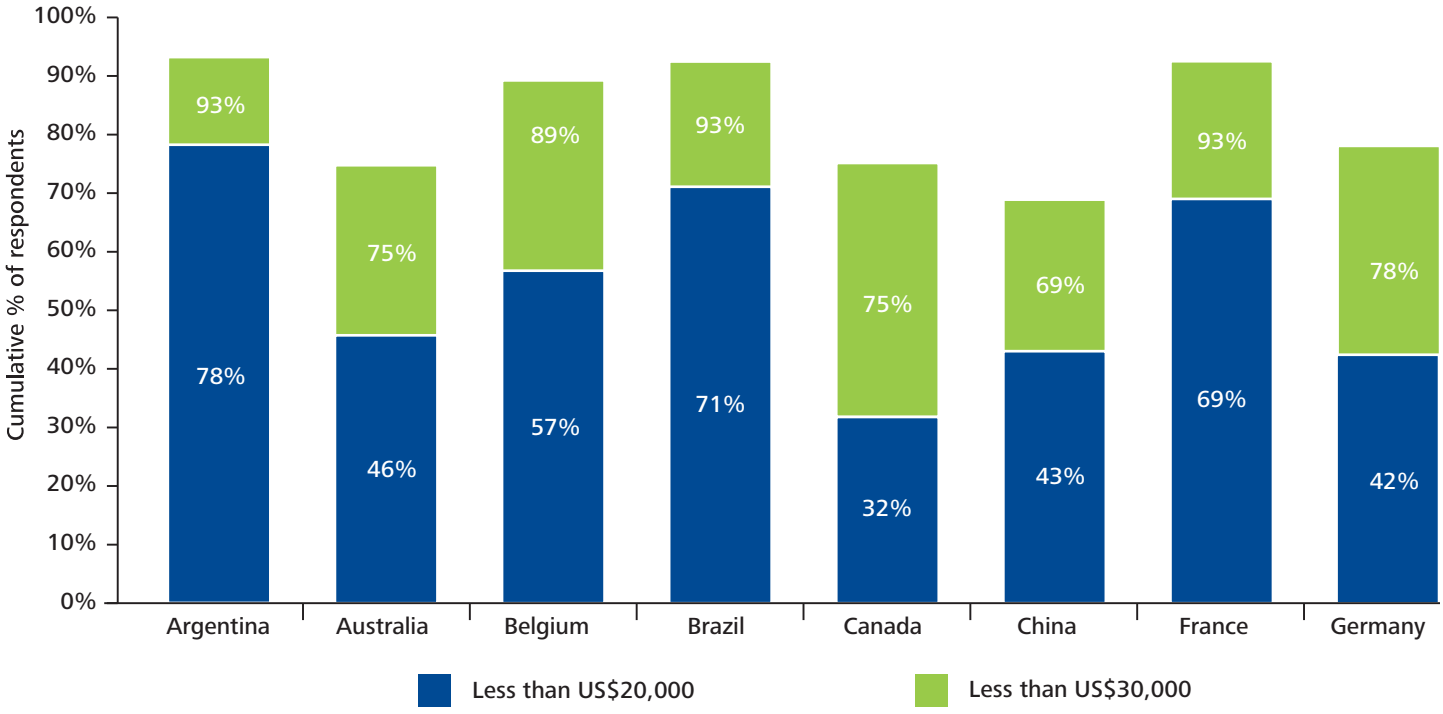
The reality:

With the expected increase in the popularity of EVs, battery makers are expected to expand their production from a 2010 level of 172,400 units to an estimated 1.51 million units in 2015, almost nine times greater than current levels[viii]. As production ramps up, savings realized through economies of scale should help to reduce the cost of batteries. When combined with technological improvements and increased reuse of existing batteries, the price is expected to decline from the current $600 to $625 per kWh to $330 to $400 per kWh (see Figure 11).

There is some compelling skepticism about these estimates, however. Any decline in battery price due to scale is likely to be countered by high direct labor costs (employees need to be highly skilled), commoditized parts whose prices are unlikely to drop (such as electronic sensors and controls), and inflationary pressures on key materials (nickel, manganese, cobalt, and other metals make up a significant percent of the cost of a lithium ion battery). With increased demand, the price of these materials may rise (see Figure 12). As previously mentioned, we may not see any overall cost reduction in battery prices as suppliers continue to target higher driving ranges by adding more energy storage.

Figure 11: Consumers expect to pay less than $30,000 for an EV

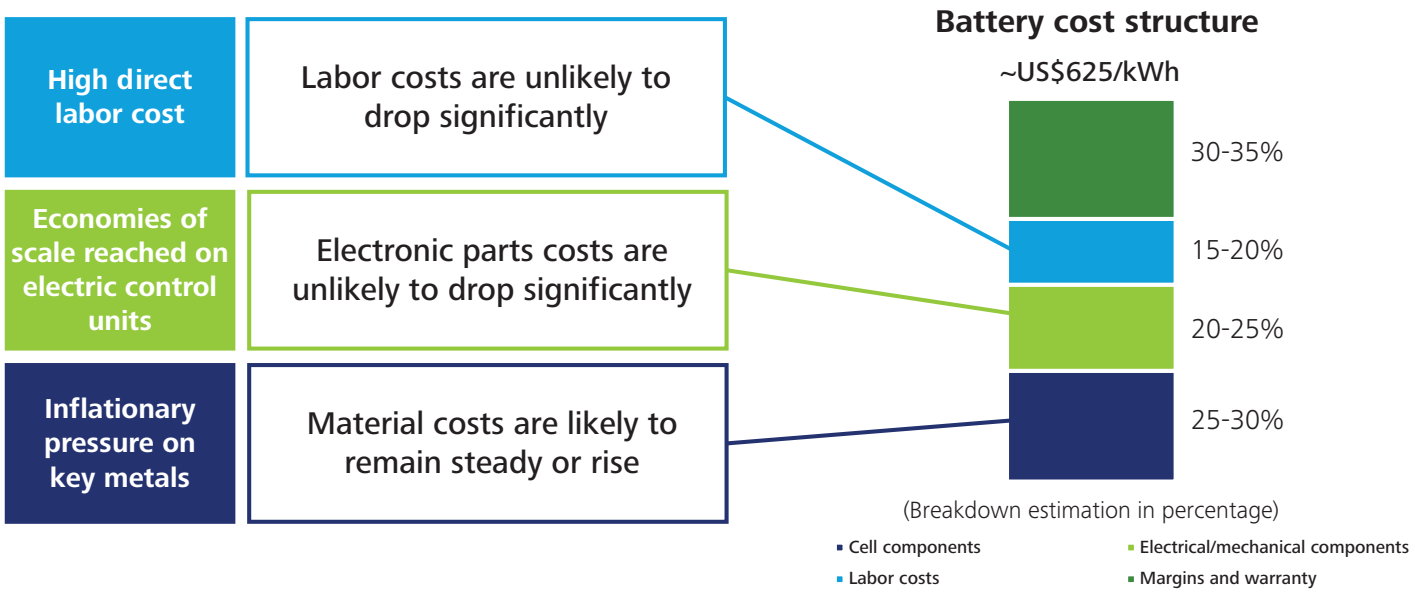
Survey question: If you were considering buying or leasing an electric vehicle, in which of the following price ranges would you be shopping?



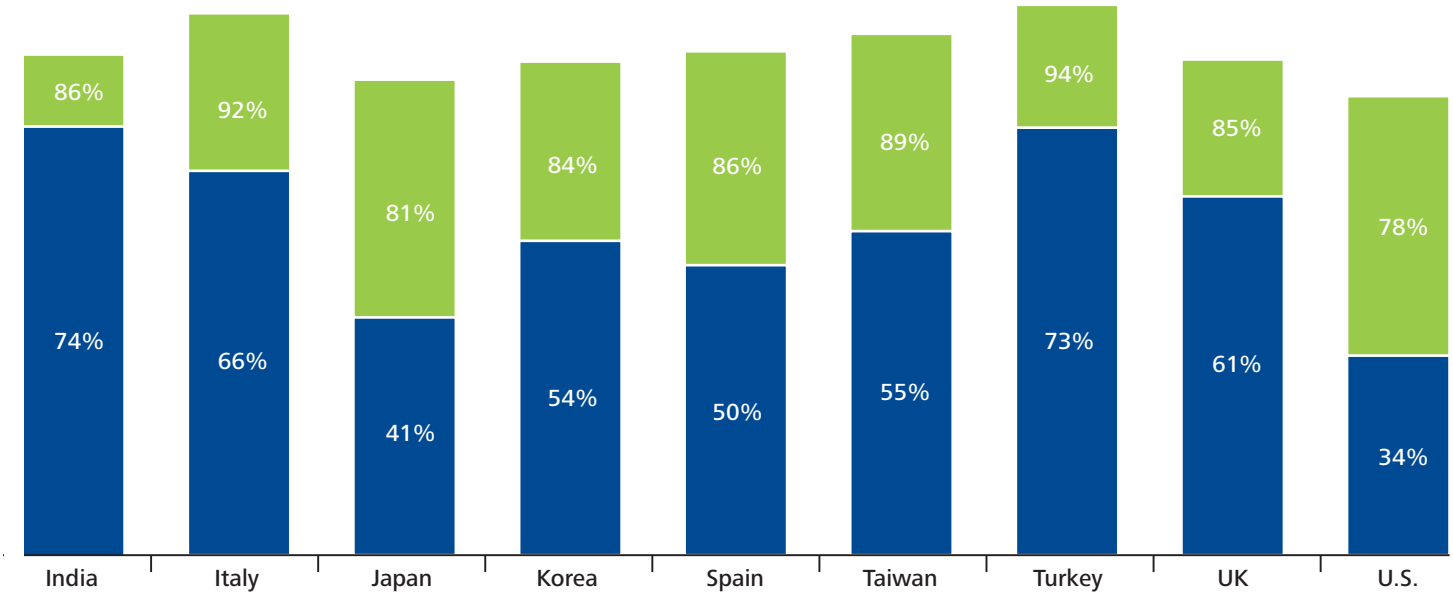
Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 12: Battery cost structure prevents significant decrease in EV price

High direct labor cost, electronic parts, and inflationary prices of key metals will likely prevent battery prices to drastically decrease.



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis [ix]

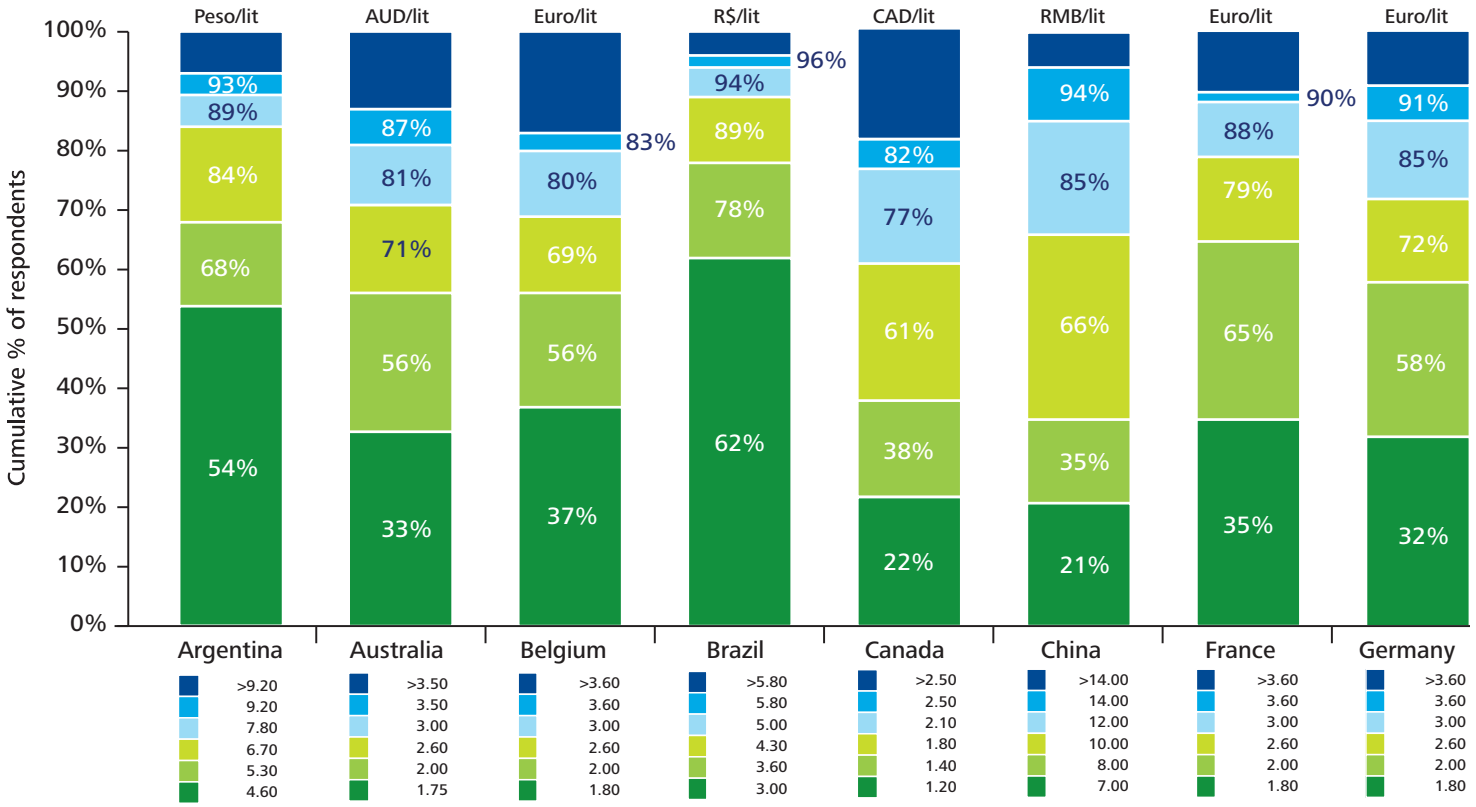


Fuel price

Another interesting component of the overall adoption rate of EVs is the price of oil, which, of course, has a significant impact on the cost of driving conventional ICE vehicles. Though fuel prices for consumers vary widely around the world and despite the actual current price at the pump, every country seems to have a tipping point. Consumers in all regions surveyed indicated that their interest in EVs would be stimulated by higher gas/petrol prices. If, for example, the price of a gallon of gas in the United States rose to US$5.00 (representing a hike of about 37 percent from the average price in the United States [see Figure 13]), the percentage of respondents who indicated they would be interested in EVs rises to 78 percent (see Figure 14). Countries such as Brazil seem to be very close to the edge of the tipping point, where fuel prices will push consumers more likely to consider an electric vehicle. Conversely, the fuel price in countries such as Spain, China, and Japan would need to significantly increase in order for consumers to become more interested in EVs. In these countries, it seems unlikely that they could experience an oil price shock substantial enough and quick enough to trigger even 50 percent of respondents to become more interested and even less likely to experience a shock large enough to trigger the 75 percent more interested level. The consequences for economies around the world and the potential global recession that would likely be triggered seem to suggest that the double-digit increase in current fuel prices for a significant majority of consumers to become more interested in EVs may not be likely to occur in the short term except for a few, select countries. One of these countries of exception may be the U.S. Notwithstanding Brazil, Turkey, and India, it appears that the U.S. market is closest to having oil/gasoline prices hit a level where consumers are much more likely to consider adopting EVs. A close eye should be kept on the U.S. market for this reason as well as their higher tolerance to high purchase prices for EVs, as noted previously.

Figure 13: Consumers are wary of fuel prices

Survey question: At what price for gasoline would you be much MORE likely to consider buying or leasing an electric vehicle (EV)?



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

Figure 14: Modest increase in fuel pump prices will be tipping point toward EV adoption

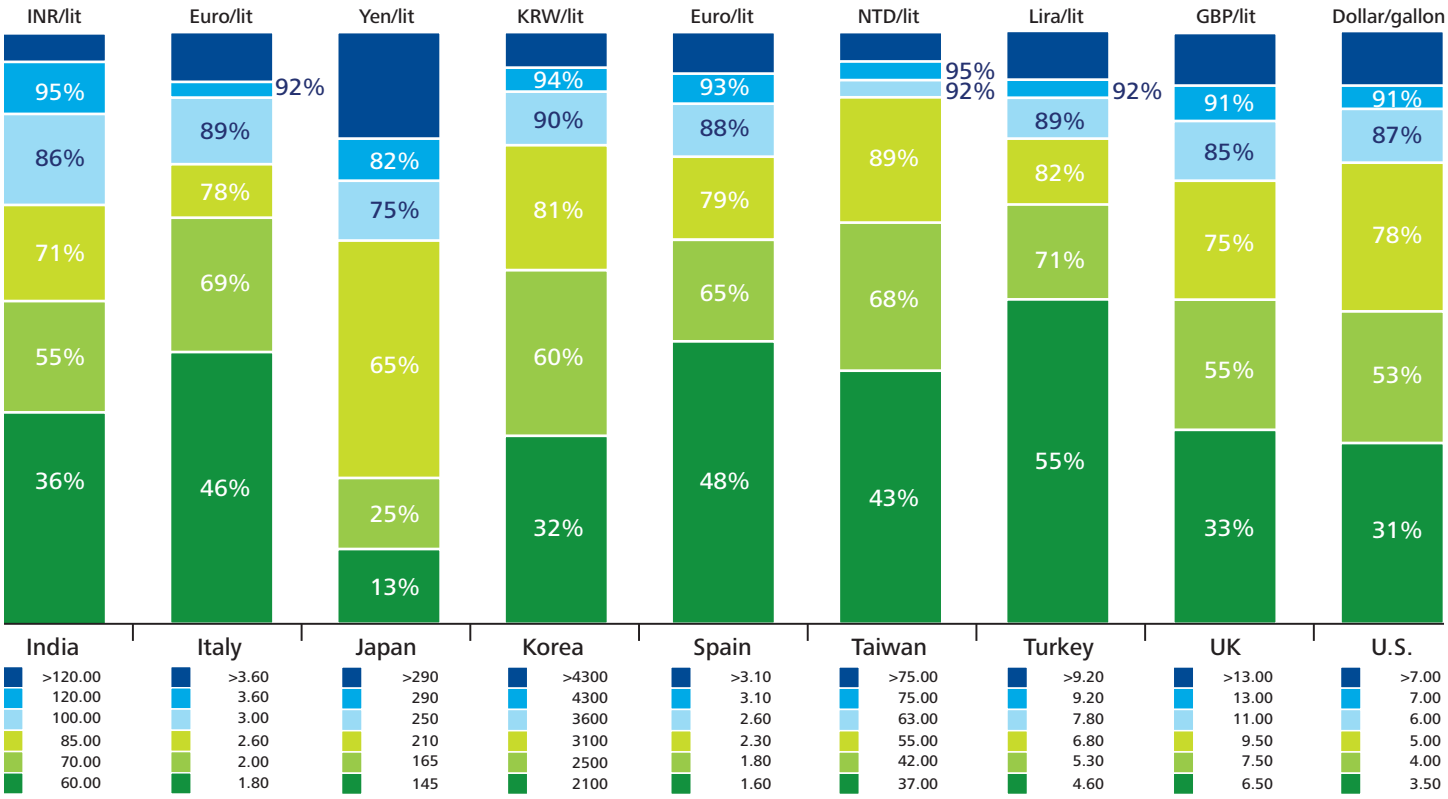
With rising fuel prices, consumers are likely to become more interested in EVs.

Country	Local currency/unit	Percent increase to appeal to at least 50%	Percent increase to appeal to at least 75%
Argentina	4.02 Peso/lit	14.5%	66.7%
Australia	1.42 AUD/lit	41.3%	112.0%
Belgium	1.54 Euro/lit	29.9%	94.8%
Brazil	2.91 R$/lit	3.1%	23.7%
Canada	1.28 CAD/lit	41.1%	64.6%
China	6.71 RMB/lit	49.0%	78.8%
France	1.57 Euro/lit	27.4%	65.6%
Germany	1.52 Euro/lit	32.0%	98.0%
India	63.70 INR/lit	9.9%	57.0%
Italy	1.57 Euro/lit	27.3%	65.5%
Japan	149.3 Yen/lit	40.7%	67.4%
Korea	1,939 KRW/lit	28.9%	59.9%
Spain	1.31 Euro/lit	37.1%	75.2%
Taiwan	31.5 NTD/lit	33.3%	74.6%
Turkey	4.33 Lira/lit	6.2%	57.0%
UK	1.34 GBP/lit	23.0%	55.8%
U.S.	3.65 Dollar/gallon	9.6%	37.0%

*The prices are not strictly comparable because:

- They cover a period covering at least the last five months (April - September 2011)
- Prices vary across different regions within a country

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis [x]

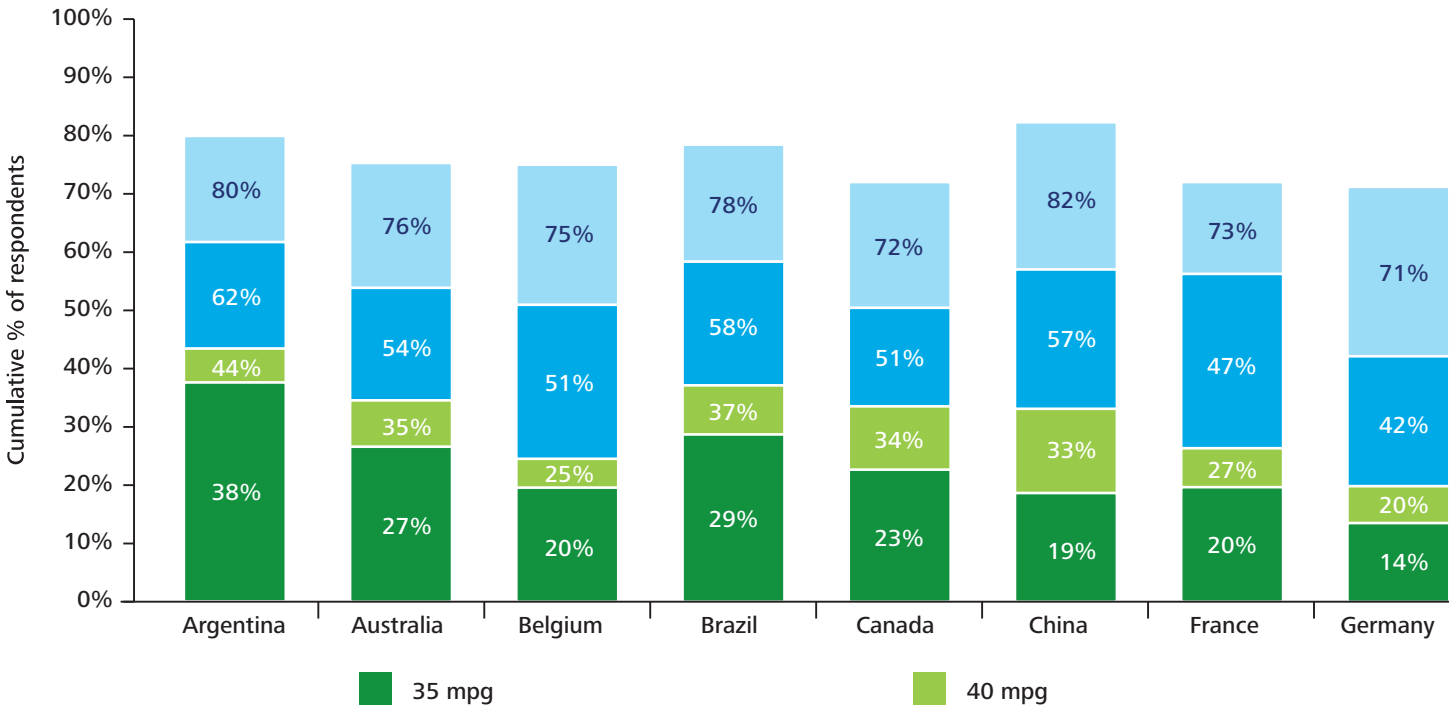


Fuel efficiency

As illustrated in Figure 16, governments around the world are mandating that vehicles become significantly more fuel efficient over the next several years. Technology improvements in gasoline and diesel engines, as well as start-stop idle technologies and reductions in vehicle weight, are pushing fuel efficiency very close to the 50 miles per gallon (mpg) mark. The study shows that a fuel efficiency of 50 mpg in large automotive markets, like China (57 percent) and the U.S. (68 percent), results in over half of the population surveyed becoming much less likely to consider an EV. Respondents in countries such as Taiwan and Argentina were also very sensitive to fuel efficiency, as 69 percent and 62 percent respectively, became less interested in EVs when ICEs hit 50 mpg. Within the European countries surveyed, an average of roughly half of the consumers would be much less likely to consider an EV and in Asia the average is closer to 55 percent when fuel efficiency reaches 50 mpg. Respondents in countries such as Japan and Germany seem to be less sensitive to fuel efficiency as it is less likely to affect their likelihood to buy or lease an EV, as only 39 percent and 42 percent would be less likely to consider purchasing an EV when ICE reaches 50 mpg. As fuel economy approaches the equivalent of 75 miles per gallon or 32 kilometers per liter, as shown in Figure 15, the vast majority of consumers would be much less likely to consider an EV. Though the tipping points may vary slightly from country to country, the study found that across the globe consumers will be less likely to consider purchasing an electric vehicle as the fuel efficiency of ICEs improves. As a result automotive manufacturers will need to carefully plan their investments to maximize sales of fuel efficient technologies consumers are willing to purchase.

Figure 15: Fuel efficiency trumps EVs

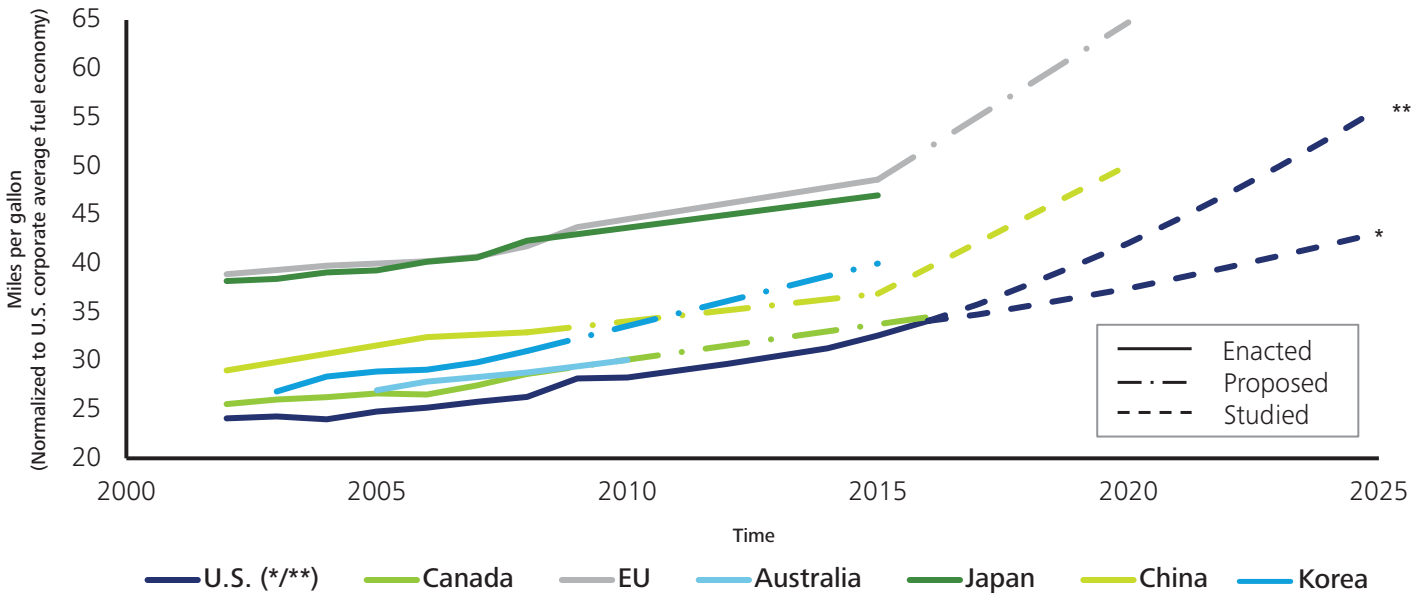
Survey question: If vehicles with gasoline engines of the size, performance, and other features you prefer were able to achieve the following fuel efficiency, at what point would it make you much LESS likely to consider buying or leasing an electric vehicle?



Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group

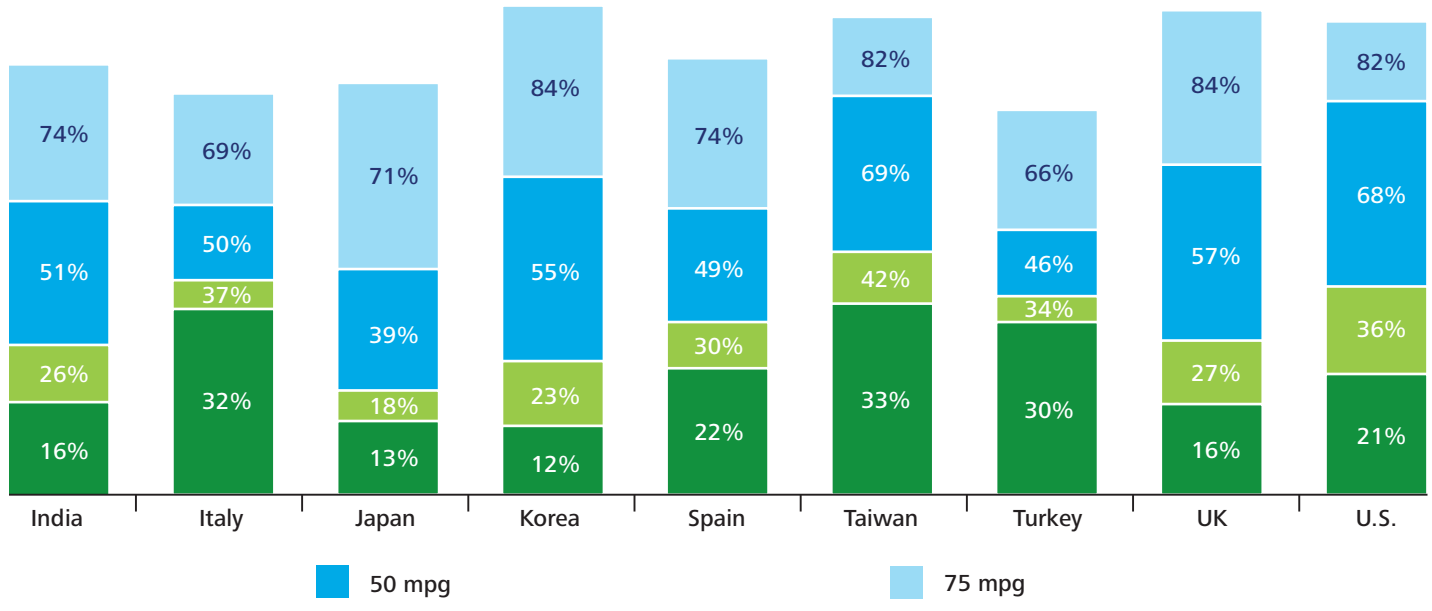
Figure 16: Current and proposed global fuel economy standards will negatively impact EV adoption

As traditional ICE vehicles become more efficient, consumers are less likely to consider EVs.



*Reflects pure efficiency improvement based on 3% annual fleet Green House Gas emissions reduction between 2017 and 2025
**Reflects pure efficiency improvement based on 6% annual fleet Green House Gas emissions reduction between 2017 and 2025

Source: Deloitte Touche Tohmatsu Limited Global Manufacturing Industry group analysis [xi]



The reality is that when consumers actual expectations for range, charge time, and purchase price (in every country around the world included in this study) are compared to the actual market offerings available today, no more than 2 to 4 percent of the population in any country would have their expectations met today based on a data analysis of all 13,000 individual responses to the survey.

Conclusion

To its great credit, the global automotive industry has generally succeeded in harmonizing consumer expectations for the vehicles it makes. One of the more remarkable findings of the survey is not so much the differences between consumers in different countries, but the similarities (which permits automakers to build cars that will appeal to consumers worldwide). Certainly, some drivers want size while others want fuel economy, but whether in Brazil, the United States, or China, those who want size expect similar size vehicles. Those who expect fuel economy will be satisfied with similar levels of fuel economy.

The global survey found that there is a common set of expectations consumers have regarding the range, charge time and purchase cost of an electric vehicle. Survey results also show very similar expectations for all segments of consumers. Regardless of whether they thought of themselves as potential first movers, might be willing to consider an electric vehicle, or even those that are not likely to consider an electric vehicle, their expectations for range, charge time and purchase price are extremely similar – and consistently and significantly different from what automobile manufacturers can offer today. The reality is that when consumers actual expectations for range, charge time, and purchase price are compared to the actual market offerings available today (in every country around the world included in this study), no more than 2 to 4 percent of the population in any country would have their expectations met today based on a data analysis of all 13,000 individual responses to the survey.

This presents a daunting challenge for both policymakers and automotive manufacturers should they like to encourage electric vehicle adoption.

As depicted in Figure 17, consumers have a hierarchy of considerations regarding EVs starting with range, followed by charge time and then purchase cost. While experience today is limited, we anticipate consumers will create new considerations and potentially new hurdles to adoption as their experience grows. New hurdles that may emerge will likely include operating costs (the cost of electricity to charge the vehicle and the cost to maintain and repair the new electric vehicle), and then ultimately culminate with total cost of ownership considerations. In this regard, residual value is expected to potentially become a significant issue, particularly for the early technologies being introduced into the market today. What happens to residual value of today's vehicles if the range of future vehicles doubles or triples? If that does not occur for another 10 to 20 years, perhaps it is not a significant issue. But if the technology is considerably closer to meeting today's consumer expectations in five years, then residual value will be a much larger issue. Lease rates will ultimately reflect this and used vehicle prices for EVs may potentially exhibit more opportunity as scrap, to recover the battery and other components, than as a functioning electric vehicle. As these issues emerge, total cost of ownership, rarely a top of mind consideration for consumers today, is likely to become the top consideration of tomorrow.

As important as the electric vehicle technology and pricing is in consumer adoption considerations, we believe there are three other items – government policies, electric utility infrastructure, and alternatives, which will also have a very strong influence on consumers' purchase decisions (see Figure 17).

It is clear from the survey that consumers' expectations for EVs are much higher than anything manufacturers can deliver today. But consumers are also notorious for being fickle and changing their mind; and doing so fairly quickly. Electric utility infrastructure can play a significant role in electric vehicle adoption. Plentiful electric power generated through stable, dependable, clean and cost-efficient sources (and delivered over smart grids with acceptable economics for consumers), coupled with easily accessible and economical charge stations can make consumer concerns about range and charge time dramatically less – even if EV technology does not demonstrate any significant improvements over the next decade. Higher oil prices (anywhere from a 40 to 70 percent increase) would also likely lessen the concerns consumers have today about electric vehicle range, charge time, and price.

But, these same fickle consumers are just as likely to abandon their interest in EVs if the fuel efficiency of ICEs continues to improve. Improved ICEs are the most affordable and promising alternative for most consumers today. In fact, dramatic improvements in ICE efficiency would likely reduce electric vehicle interest to an afterthought for most consumers based on their responses to the survey. When asked how much better ICEs had to improve to cause consumers to lose interest in EVs, surprisingly, the level of improvement seems to be within striking range for most global automotive companies today. Further, a similar level of improvement is being mandated in the future by countries with clearly defined and binding fuel economy standards. Even for the majority of the environmentally conscious consumers who participated in the survey, significantly improved fuel efficiency for ICEs trumped their interest in EVs. For these consumers, they have found their best alternative, and it is a more fuel efficient ICE.

So where does this leave us?

First, it seems to suggest that government policy will continue to play perhaps the most significant role in the adoption of EVs. Government policies can and do come in all shapes and forms. Energy policies impacting the generation and distribution of electricity as well as regulations concerning electric utility investment recovery and infrastructure build-out will play a key role. Likewise, government policies directly impacting the consumers in terms of incentives for the adoption of EVs and potential penalties for the continued use of ICEs could have a dramatic effect. Science and technology policies, research support, and innovation incentives can have a significant impact on technology advances. And fuel efficiency standards, attempting to influence automotive powertrain technologies being developed and deployed can, as we have seen, cut both ways. The complexity of the challenge for policymakers – attempting to reduce the consumption of oil while driving growing economies with meaningful job creation, in the face of widespread debt reduction efforts and coupled with demands for equitable policies impacting consumers – is immense. And yet, government policy is more so than any other aspect that will likely determine the adoption rate of EVs over the next decade and beyond.

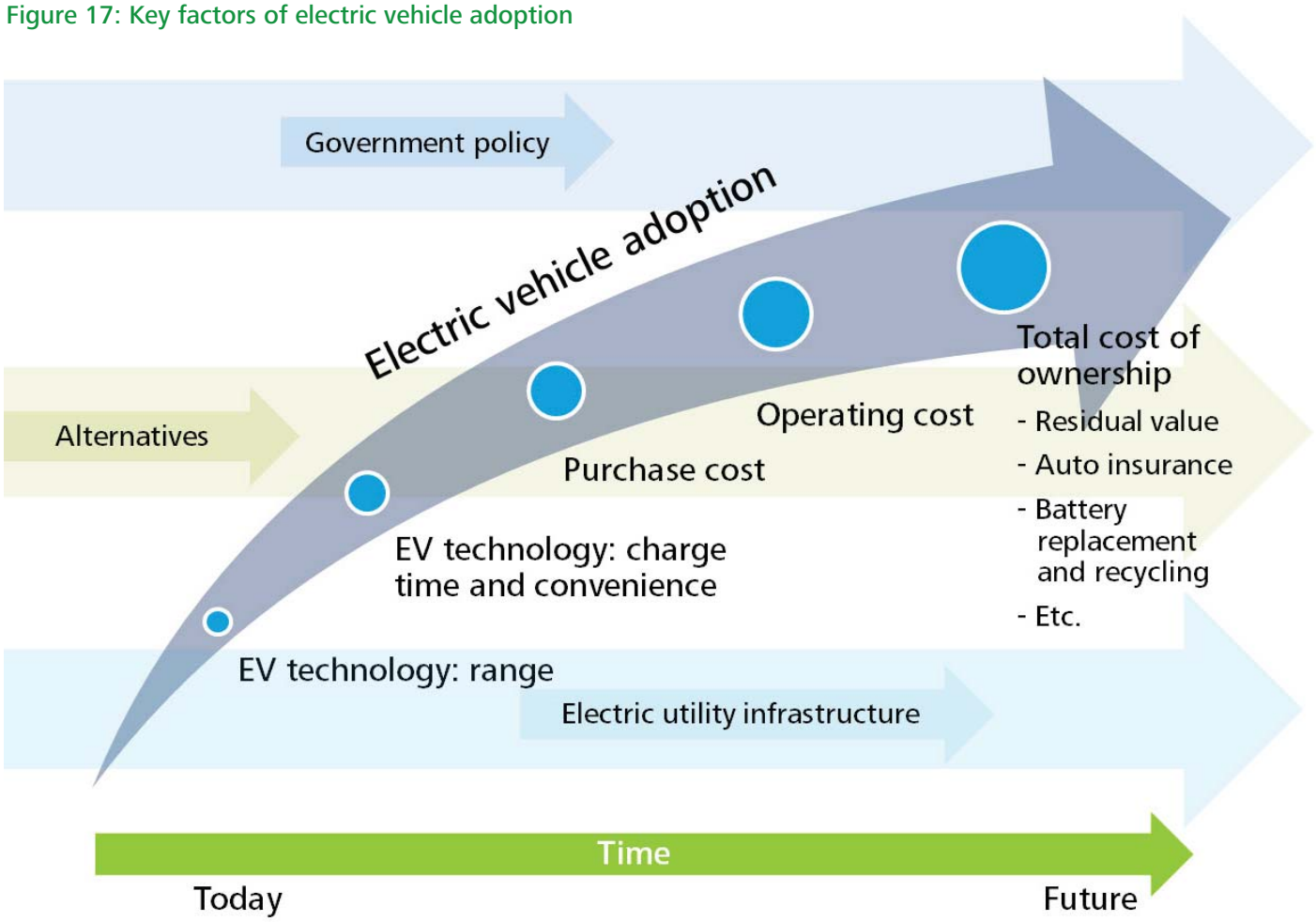
Finally, it suggests that while common consumer expectations have helped the automotive industry globalize, it also means that when it comes to alternative power train technology such as EVs, the globalized consumer will be less willing to deviate from their well-established expectations. What's more, with the rapid development of new markets for automobiles in Asia and the rest of the developing world, millions of new consumers are entering the market with the same set of well-established expectations. This helps explain why the survey found that consumer expectations regarding electric vehicles were so out of line with what can be offered by manufacturers today.

This is not to say that there will not be a market for EVs. On the contrary, conditions in certain markets – especially urban areas within the right climate – are such that EVs, even with their limitations, will be the logical choice for many. Depending on the direction governments take, the case for EVs could become very compelling.

Whether or not consumers around the world embrace electric vehicles will depend on a number of factors that have been discussed in this report. In the end however, the study suggests only a small niche of today's consumers would find current technology acceptable, and that small fraction of consumers will not result in mass adoption of pure electric vehicle technology over the next decade.

Looking out over a 10-year horizon, it seems much more likely that a broad array of alternatives to the pure ICE and the pure EV will continue to make incursions on the overall automobile market. The current collection of hybrids is better equipped to meld consumer expectations with environmental consciousness and government calls for cleaner forms of personal transportation. While manufactured costs of these dual powertrain hybrids will continue to be a significant challenge, it is expected hybrids will be much more readily adopted by consumers than pure EVs. Ultimately which technology enjoys the most success will depend on ever changing consumer expectations and preferences coupled with effective government policies. Meanwhile, automotive manufacturers will continue to develop their technologies with the aim of winning consumers around the world with whatever technology mix gives them the best advantage in the global market place.

Figure 17: Key factors of electric vehicle adoption



Source: Deloitte Touche Tohmatsu Limited (DTTL) Global Manufacturing Industry group

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Global electric vehicle research

DTTL's Global Manufacturing Industry group conducted a global survey to explore consumer adoption of electric vehicles (EVs). The online survey captures the views of more than 13,000 consumers across the Americas, Asia and Europe in 17 countries. To qualify for the survey, potential respondents had to be 18 years of age or older and to have a driver's license. The survey asked respondents, among other things, how likely they would be to consider buying or leasing an electric vehicle when they buy or lease their next vehicle (assuming that electric vehicles were readily available) and how likely they were to actually buy or lease an electric vehicle. The research analyzed the characteristics and opinions of three groups based on their purchase interest: Potential first movers are consumers who are most likely to buy or lease an EV; Might be willing to consider are consumers who are interested, but less likely to consider an EV; and Not likely to consider consumer who would not be interested in buying or leasing an EV. The margin of error for survey results about the total sample was 1.0 percent at the 95 percent confidence level. The margin of error was higher for survey results about sub-groups within the sample.

Endnotes

i. For the purposes of this study, DTTL's Global Manufacturing Industry group focused on the following countries: Argentina, Australia, Belgium, Brazil, Canada, China, France, Germany, India, Italy, Japan, Korea, Spain, Taiwan, Turkey, the United Kingdom, and the United States.

ii. Wh/kg (watt hours per kilogram) measures electricity capacity per kilogram of battery weight.

iii. DTTL analysis based on publically available information and automotive manufacturer websites

iv. DTTL analysis based on the Electrification Roadmap, published by the United States Electrification Coalition (http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf), November 2009; Technology Roadmap, published by the International Energy Agency, June 2011; NEDO Secondary battery technology development roadmap 2020, published by the New Energy and Industrial Technology Development Organization (NEDO), May 2010; and Integration roadmap for strengthening the competitiveness of the rechargeable batteries, published by Joint Ministries, July 2010

v. DTTL analysis based on the the United States Department of Energy website (http://www1.eere.energy.gov/vehiclesandfuels/avta/light_duty/fsev/fsev_battery_chargers.html), updated 12 April 2011; the Charged: EV Symposium, 2011 (http://chargedsv.org/); the Electrification Roadmap, published by the United States Electrification Coalition(http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf), November 2009; Installation Guide for Electric Vehicle Charging Equipment, published by The Massachusetts Division of Energy Resources (http://www.mass.gov/Eoca/docs/doer/charger1.pdf), September 2000; and Ford's Home EV Charging Station Stacks Up Against Competitors, published by Gizmag (http://www.gizmag.com/ford-home-focus-electric-charging-station/17601/), 16 January 2011.

vi. High Battery Cost Curbs Electric Cars, published by the Wall Street Journal (http://online.wsj.com/article/SB10001424052748703735804575536242934528502.html), 17 October 2010

vii. DTTL analysis based on the Electrification Roadmap, published by the United States Electrification Coalition (http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf), November 2009; Transitions to Alternative Transportation Technologies—Plug-In Hybrid Electric Vehicles, published by the National Research Council, 2010 (http://www.nap.edu/openbook.php?record_id=12826&page=12#p2001adff9960012001); and NEDO Secondary battery technology development roadmap 2020, published by the New Energy and Industrial Technology Development Organization (NEDO), May 2010

viii. Electric Cars: Plugged In 2, published by Deutsche Bank (http://www.fullermoney.com/content/2009-11-03/ElectricCarsPluggedIn2.pdf), 11 March 2009.

ix. DTTL analysis based on High Battery Cost Curbs Electric Cars, published by the Wall Street Journal (http://online.wsj.com/article/SB10001424052748703735804575536242934528502.html), 17 October 2010; and Electric Cars: Plugged In 2, published by Deutsche Bank (http://www.fullermoney.com/content/2009-11-03/ElectricCarsPluggedIn2.pdf), 11 March 2009

x. DTTL analysis based on publically available information

xi. DTTL analysis based on Global passenger vehicle standards, published by the International Council on Clean Transportation, 2011 update" (http://www.theicct.org/info/data/Global_PV_Std_May2011_datasheet_b.xlsx) and International Council on Clean Transportation website (http://www.theicct.org/passenger-vehicles/global-pv-standards-update/)

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