

Towards an Electric Vehicle Future?

An Analysis of the State of EVs in Lima, Peru

I. Introduction

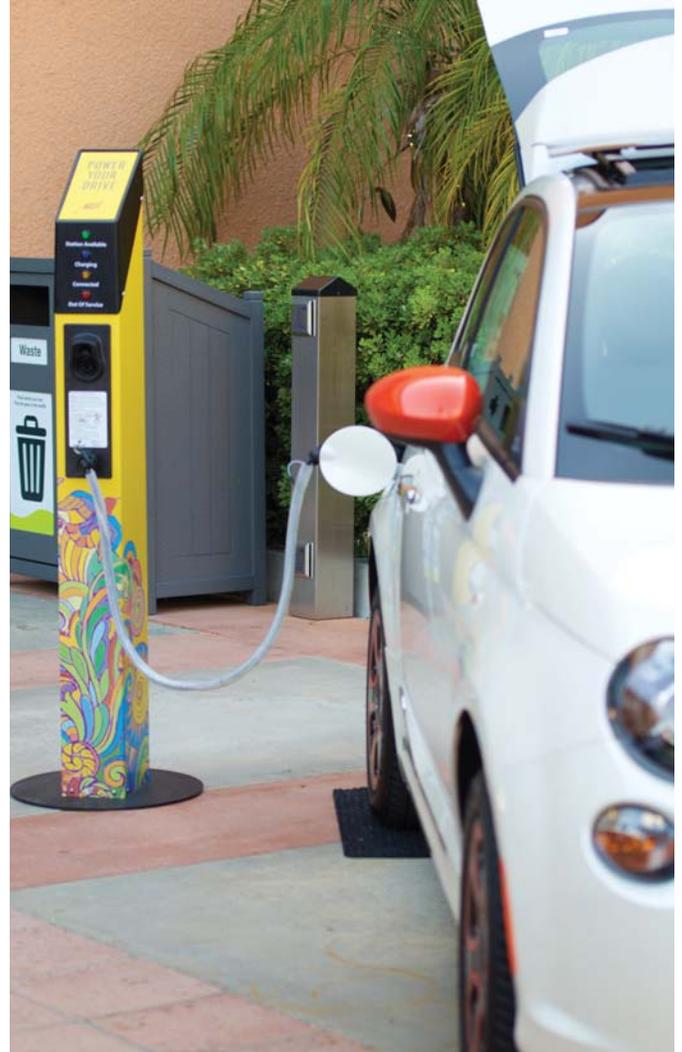
Electrifying a transport sector to any extent is an endeavor that requires significant evaluation, planning, resource adequacy and proactive charging infrastructure deployment. Given the barriers to electric transport and the need for coordinated policy action, the role of policymakers cannot be understated in advocating for electro-mobility and working on its behalf. These challenges could be magnified when discussing electrifying the transport sector in a city like Lima, Peru. At the same time, such a scenario provides a clean slate with which to begin, and the chance to survey the policy landscape to target opportunities.

Lima presents an interesting case for the future of electric transport as it has an abundance of reserve electricity capacity to utilize which is relatively cheap, and could benefit immensely from reduced urban air pollution. EVs then are decently placed to deliver multiple services to the transport and health sectors. However, there are still a significant number of barriers preventing EVs from being adopted en masse, not least of which are availability and price.

This report aims to give policymakers and stakeholders in Peru expert analysis and an advocacy tool to aid in the initial transition to electrifying light-duty transportation. To complete our analysis and review of the landscape for possible EV deployment in Lima and Peru more broadly, we gathered data from interviews with several experts in Lima representing the Ministry of Energy and Mines, the System Operator (COES), industry stakeholders, as well as engineers from universities in Lima. These interviews show a range of opinions on the topic of electric vehicle deployment in Lima and provide a balanced glimpse of plausible next steps and policy options in the realm of electro-mobility for a country with an overabundance of electricity generation and some of the poorest urban air quality in South America.

II. Research Methodology

We conducted interviews with 12 experts in the fields of energy and transport in Lima over the course of several months. In designing our survey, we used the International Energy Agency's (IEA) 2-degree scenario to forecast the deployment of EVs worldwide as a benchmark for the experts to base their judgements on. We also used the EV prices for Peru produced by the Inter-American Development Bank (IDB) to estimate the cost reductions necessary for financial incentives to make EVs cost competitive.



Our questionnaire asked experts a range of questions on the Peruvian electricity market, regulatory frameworks in the transport sector, grid infrastructure, plausible incentives, predictions of the amount of public and private electric vehicles operating in Lima in the future, and consumer preferences in regards EVs. To elicit responses, we developed a protocol based on expert elicitation which is used to extract judgments about a topic from people who are well versed in it. The result is a distribution of answers that provides a median, or best estimate of the uncertain event in question.

Overconfidence in an individual's judgement is a common bias in respondents that can skew the results. In order to limit the natural inclination to be overconfident when providing

judgments for uncertain outcomes, we asked respondents to provide an upper and lower bound for a scenario such as the number of EVs operating in Lima by the year 2030, and then to provide a best estimate. The bounds should act as most optimistic and worst case scenarios, while the best estimate is the expert's most accurate judgement. This provides a buffer to overconfidence in answering probabilistic questions.

III. Background

By some estimates, Lima is home to ten electric vehicles (EVs), all of which are supported by residential charging and owned by early adopters keen on new technologies. These EVs are operating in a city of 2.6 million vehicles, which the WHO ranked as the worst city in South America for urban air quality in 2014 and which incurs \$2.6 billion a year in health-related costs associated with poor air quality. The cause of Lima's poor air quality can be traced to the aging fleet of petrol and diesel vehicles that fail to meet emissions standards. In our research, experts graded the enforcement of existing air quality regulations as a 3/10 on average, and were equally pessimistic about the ability of emissions regulations to be enforced effectively by 2030. Given Lima's flawed enforcement of air quality regulations and doubts that regulatory agencies will improve their performance, improving air quality in Lima requires a more dramatic shift to alternative fuel vehicles.

The government has successfully implemented programs to mitigate emissions by converting cars to run on natural gas. Currently, about half of taxis in Lima are natural gas vehicles supported by 150 fueling stations, and utilizing a resource that advocates say is in abundant supply and could be the future of the Peruvian transport sector. But others are less bullish on the future of natural gas in Peru, and advocates of electrifying the transport sector point to the over-generation of electricity and its relatively low cost as reasons to push for government support for electric vehicles. The experts we interviewed estimate on average that Peru's current generation capacity could handle a 50% increase in demand for electricity, more than enough to accommodate a budding EV fleet.

Those we interviewed recommended a range of proposals for government intervention to curb emissions in Lima. The most common responses detailed government support for alternative fuel sources such as natural gas or electricity, and stricter yearly technical revisions for polluting vehicles. The incentives to transform taxis to run on natural gas have been successful with the help of CAF – Development Bank of Latin

America but questions remain about a similar program to electrify public transport to further reduce urban air pollution and aid the transition to an electrified transport sector.

To facilitate that transition, the electricity market should be flexible enough to incorporate the mass deployment of EVs and accommodate their charging needs. Creating a pricing structure and implementing policies to support EVs will be crucial going forward. The experts we surveyed graded the flexibility of the electricity market as a 6.3 on average. Reasons for poor grades ranged from the bureaucratic sluggishness of Peruvian regulators, the disparate policy-makers involved in making changes, and the lobbying power of the natural gas industry opposed to EVs. Experts offering more favorable assessments of the sector cited the relatively low technical losses in the transmission and distribution systems and the off-peak charging behaviors of most EV owners: nighttime charging would present no additional stress to Peru's load.

Lastly, in 2015 Peru imported \$3.68 billion worth of petroleum products. Initial deployment of EVs may be in the public transport sector, namely replacing natural gas-fueled taxis, which would mean that EVs would eat into domestically produced natural gas instead of petroleum imports, but experts we interviewed estimated that a 1% penetration of EVs in Lima could reduce petroleum imports by around 0.6%.

IV. Results

a. Financial Incentives

The coalition support key to pushing EVs into the Peruvian market will likely require both financial and non-financial incentives to encourage consumers to purchase EVs, which have been key to their success in other parts of the world. In the U.S. for example, low-emission vehicles gain access to high occupancy vehicle (HOV) lanes and benefit from financial incentives from federal and state governments as well as from the electric utilities. Our interviews suggest that the high upfront cost is the greatest barrier to owning an EV in Peru. We asked these experts which of several financial and non-financial incentive schemes would be most practical for use in Lima; the results are detailed in Figure 1.

In general, an incentive spread out over a period of time is considered least attractive, since consumers tend to be disinclined to pay now and wait for the incentive to come

later. The experts we interviewed seem to confirm this as the case in Peru, rating the option of a tax incentive spread over 3 years as the least attractive. Tax incentives overall were rated less favorably than a rebate issued at the time of purchase, which was considered the best option by most respondents.

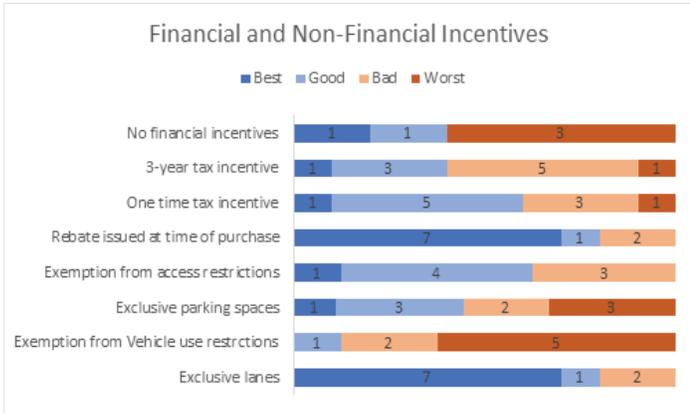


Figure 1: Potential incentives to spur EV adoption. According to experts we interviewed, granting owners access to exclusive lanes and issuing a rebate at the time of purchase were most attractive.

b. Non-Financial Incentives

The majority of respondents also chose exclusive lanes as the most attractive non-financial option to implement in Lima. Currently, Lima has no access or license plate use restrictions of the type seen in cities like London or São Paulo. One caveat to implementing any type of non-financial incentive, as pointed out by one of our respondents, is the added inequality perceived by those who do not receive it, which is particularly important given the perception of EVs as a high-cost luxury good and could fuel opposition and potentially fuel social unrest.

V. Predictions

Our interviews and assessments find that experts have a range of opinions on the potential for the deployment of EVs in Lima. As illustrated in Figure 3, experts rank price as the greatest barrier a Peruvian would face when buying an EV, followed by current model availability and a lack of public charging infrastructure. The complications around the implementation and costs of public charging were also cited as reasons why EVs would not do well in Lima. Likewise, given the role of natural gas in Peruvian transportation, those predictions that were low are not all that surprising: EVs have an

uphill battle if they hope to create a foothold in the Peruvian market. These factors combined led some respondents to estimate that deployment by 2030 will not pass 500 vehicles.

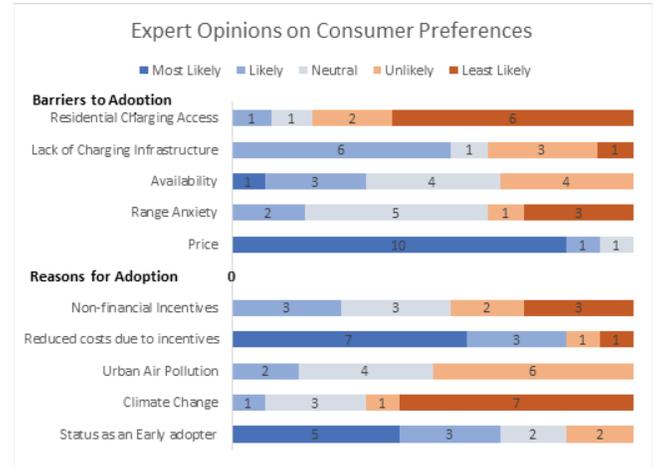


Figure 2: Price appears to be the ultimate barrier to owning an EV in Peru followed by a lack of public charging infrastructure and current availability. Unsurprisingly then, reduced costs from robust financial incentives would be the most likely reason a Peruvian would choose to buy an EV, followed by their penchant for new technologies and status as an early adopter.

Higher predictions cite the current global EV trajectory as a portent for what’s to come in Lima. Falling battery prices, which currently make up roughly a third of the price of an EV but are predicted to drop to under 20% of overall costs, mean reduced upfront vehicle purchase costs. Additionally, Peru’s recent push to improve its transport sector detailed in its Nationally Appropriate Mitigation Actions (NAMA) focus on better infrastructure and more efficient vehicles, which are cause for optimism for the future of EVs. The current success of natural gas, initiated by the Peruvian government, is also a sign that technological change is not just possible but can take root and succeed with the proper coalition support, and signals to supporters that EVs can also succeed if given a push.

As mentioned above, taxes on vehicles in Peru are high and some type of incentive will be necessary if the government hopes to encourage EV purchases and utilize the positive external benefits they provide. When we asked our experts to estimate the threshold amount to shift consumers’ vehicle purchase decisions for three types financial incentives, we received varied answers.

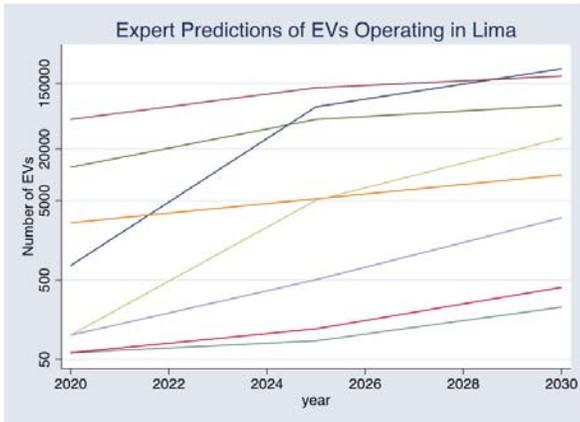


Figure 3: Each line represents an expert prediction on the potential future of EVs in Lima. The highest estimates range up to about 150,000 by 2030, that’s roughly 6% of the current vehicles operating there.

Figure 4 details the range of responses received. The median amount for a rebate issued at the time of purchase was \$12,500 and \$10,000 for a tax incentive. A tax incentive spread over three years was valued at about \$4,800 per year.

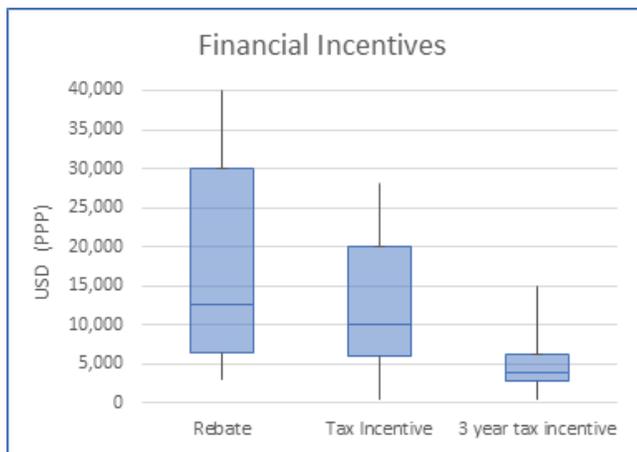


Figure 4: The range of values for financial incentives elicited from the experts we surveyed is broad, with the median values of a rebate and a tax incentive at \$12,500 and \$10,000, respectively. an early adopter.

The IDB estimates that a Nissan LEAF would cost roughly \$60,000 in purchasing power parity (PPP) terms in Peru, including all taxes. That comes out to about \$36,000 in real terms. This is prohibitively expensive for the vast majority of Peruvians, who buy a car for \$15,000 or less. In early March of this year that the government will begin

offering financial incentives to EV buyers starting in July. The amount was not given, although the Vice-Minister of Energy, Raul Garcia Carpio, cited a \$3,000-\$5,000 range.

This amount may be enough to incentivize upper class Peruvians to purchase an EV, but does not reduce costs enough today to make EVs attractive for the median Peruvian according to Figure 4. Nor does the proposed incentive detail how EVs will be supported.

Lastly, vital to curb the congestion on the streets of Lima and in line with Peru’s NAMA transport initiatives is electrifying public transport and improving its infrastructure development. The experts we interviewed estimated that by 2025 5% of the public transport, mostly larger city buses, could be electrified, and that by 2030, this number could increase to 12% of all city busses. Improving public transportation options will be crucial for a city as congested as Lima, and one drawback to EV incentives is that they add to the number of cars on the road, albeit at the same time reducing net emissions from moving sources.

VI. Discussion and Recommendations

The future of EVs in Lima is not without obstacles, but opportunities exist to develop policies and mechanisms to aid their deployment. Based upon the information and expertise we gathered and our analysis of the results of our interviews, there are several potential next steps for policy makers in the Peruvian government, and in society more broadly, to consider.

1) Low interest financing

Price is the main deterrent to EV ownership, and vehicle loans are prohibitively expensive for many Peruvians. Providing low interest loans exclusively for electric vehicles could not only provide access to those consumers who would buy electric vehicles but cannot afford them yet, but also raise awareness of their availability through advertising campaigns.

2) Pilot program with taxis

The program to convert taxis to natural gas vehicles was a successful joint venture between CAF and the Peruvian

government. Using this as a framework the government should explore creative avenues to use taxis to lead the push into the electro-mobility space. Utilizing ride share apps like Uber and targeting vehicle owners with low credit risk is a creative way to offer low-interest payment programs, create jobs and promote the use of electric vehicles.

3) Focus on public mass transportation

Currently Lima fails to enforce emissions regulations for many gasoline and diesel-fueled buses. Focusing on electrifying public transportation is a high-impact opportunity to improve local air quality and grow the overall electric transportation sector. Current electric busses are expensive and their range is limited to around 300 km, but incorporating a support system for charging infrastructure now will help initiate them into Lima's transport sector in the future.

4) Begin investing in public charging infrastructure with Public-Private Partnerships

The stakeholders in the private sector we interviewed were keenly interested in understanding and promoting the future of electric vehicles in Peru. With the right incentives, Peru could signal to investors that they are confident in the future of electro-mobility and want to support its long-term success. Additionally, Peru is no stranger to incorporating public-private partnerships in its energy sector: much of its electric transmission system was built using such partnerships

5) Create pricing structure for public charging

Considering the recent announcement by the Peruvian government that it will offer financial incentives to purchasers of EVs, the next step is to create a pricing system that is sustainable and attractive to consumers, especially considering Peru has some of the lowest electricity prices and highest demand charges in the region. An EV charging price scheme is balancing act between attracting customers and financing infrastructure via demand charges, and consideration should begin now to establish a reasonable price scheme. Getting a start on this now will significantly help the increase in EV sales in the future.

Starting from scratch in Lima is a challenging proposition for EVs; the transportation sector there is not without issues. In their annual Driver Satisfaction Index, Waze, the company responsible for the popular navigation app of the same name, ranked Lima 169th out of 181 cities worldwide. That's the worst capital city in South America. EVs will not solve all the transportation issues there, but electrifying transport can improve air quality and provide additional demand for the over-generation in Peru. Clearly, with the announcement earlier this year that incentives will soon be offered, policymakers understand the benefits EVs can provide and are looking towards the future.

The authors would like to thank **Ahmed Abdulla for his gracious guidance in constructing and executing this project.*

i "Global EV Outlook 2017". The International Energy Agency. 2017

<https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf>

ii Gelvez et al. "The incorporation of Electric Cars in Latin America." The Inter-American Development Bank. September 2016.

<https://publications.iadb.org/handle/11319/7854>

iii Morgan, Granger M. "Use (and abuse) of expert elicitation in support of decision making for public policy." PNAS. May 20th, 2014

iv Abdulla, Ahmed et al. "Expert assessments of the cost of light water small modular reactors." PNAS. April 2013.

v "World Health Organization says Lima has worst air pollution in LatAm." Peruvian Times. May 8th, 2014.

<https://www.peruviantimes.com/08/world-health-organization-says-lima-has-worst-air-pollution-in-latam/22119/>

vi Curry, Claire. "Lithium-ion battery costs and market" Bloomberg New Energy Finance. July 5th, 2017.

<https://data.bloomberglp.com/bnef/sites/14/2017/07/B-NEF-Lithium-ion-battery-costs-and-market.pdf>

vii Garcia, Eduardo. "Bonos para Vehículos Eléctricos." El Peruano. March 3rd, 2018

<http://elperuano.pe/noticia-bonos-para-vehiculos-electricos-64483.aspx>

viii "Driver Satisfaction Index 2016. Waze. 2016

<https://inbox-static.waze.com/driverindex.pdf>

The Institute of the Americas' Energy & Sustainability Program works to foster a deeper understanding of the Western Hemisphere's most critical energy and sustainability issues. For more information and upcoming events, follow us on Twitter @IOA_Energy or visit: www.iamericas.org/energy