

# THREE SURPRISING RESOURCE IMPLICATIONS FROM THE RISE OF ELECTRIC VEHICLES

The economic consequences for energy, raw materials, and land may not be what you'd expect.

*by Russell Hensley, Stefan Knupfer, and Dickon Pinner*

Demand for electric vehicles (EVs) is primed for the passing lane. While EVs accounted for only about 1 percent of global annual vehicle sales in 2016 and just 0.2 percent of vehicles on the road, McKinsey estimates that by 2030 EVs (including battery electric vehicles and plug-in hybrids) could rise to almost 20 percent of annual global sales (and almost 35 percent of sales in Europe). These rates could rise even faster under aggressive scenarios. Already, demography is proving to be destiny. Recent surveys suggest that 30 percent of car-buying individuals and nearly 50 percent of millennials will consider purchasing an EV for their next car instead of one powered by a traditional internal-combustion engine (ICE).<sup>1</sup>

Increased EV adoption will affect more and different natural resources, as well as multiple industries, different geographies, and levels of carbon emissions. Indeed, ecological concerns figure strongly in most consumers' decisions to purchase an EV. Wanting to help the environment was the number-one given reason (by a substantial margin) that American buyers chose an EV in a 2017 CarMax survey.<sup>2</sup> A study by AAA that same year also

found environmental concerns to be EV purchasers' leading consideration—at a staggering 87 percent rate.<sup>3</sup> Yet our research reveals that several common assumptions about EVs and the Earth's resources are misplaced. And in some cases, the common wisdom is almost entirely wrong.

## Fossil fuels: EVs do not spell peak oil

Start with crude oil. More EVs will dramatically depress oil demand—right? Actually, no; having more electric and hybrid vehicles on the road is expected to reduce oil demand only modestly over the next 10 to 15 years. To the extent that there is downward pressure on oil demand, it will come in large measure from improvements in ICE efficiency and from making vehicles more lightweight. Those efficiencies have already increased at about 2 percent per annum since 2005 (raising miles per gallon for an average ICE vehicle in the United States from 26 in 2005 to 32 today). We anticipate they will continue to rise at more than 2.5 percent a year through 2025.

Yet even as internal-combustion-powered vehicles become more efficient and less predominant, global crude-oil

demand will continue to grow, all while EVs experience a significant increase as a proportion of vehicles on the road. Increased oil demand will come from a variety of sources, including industries such as chemicals and aviation; growing regions, notably China and other emerging markets; and the sale of more automobiles globally, including more ICE-powered automobiles, and hence more vehicle miles traveled worldwide.

EV adoption will, however, significantly affect demand for a different fossil fuel: natural gas. More EVs mean that more electricity will have to be produced. While coal will be part of the equation, approximately 80 percent of the forecast growth in US electricity demand is expected to be met with natural gas. If half of the automobiles on American roads were EVs, daily US natural-gas demand would be expected to increase by more than 20 percent.

### **Land: An unexpected squeeze?**

There are currently more than 400,000 public charging points that support the more than three million EVs now in use globally. This number will have to rise significantly to meet the global EV-adoption increases forecast by 2030 (Exhibit 1). Simply replacing gas stations with charging points or adding more charging points that are the size of gas stations won't be sufficient to service the expected number of EVs. It will take multiple rapid 120-kilowatt charging stations with eight outlets to dispense a similar amount of range per hour as the standard-size gas station of today.

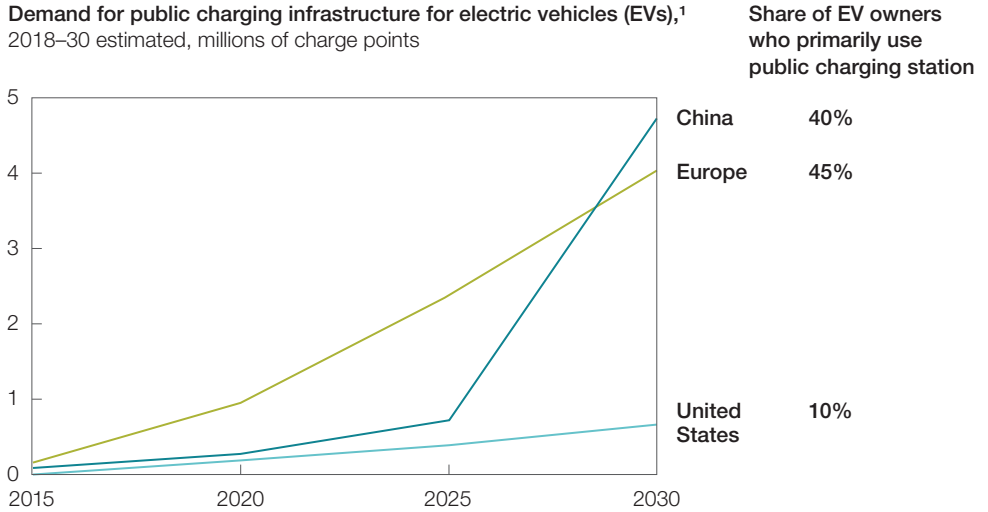
The possibility of a land squeeze will be much greater in Europe and China than

in the United States. Only 40 percent of European and 30 percent of Chinese EV owners have access to private parking and wall charging, versus 75 percent of US EV owners. Nor is the challenge merely a question of where to plug in or power up; generation and distribution are also factors. Today's power facilities can accommodate tomorrow's significant rise in the number of EVs, as long as the vehicles are charged off peak. Faster charging during peak demand, however, will indeed have an impact. In fact, peak demand from a single EV using a top-of-the-range fast charger is 80 times higher than the expected peak demand of a single typical household.

These potential constraints will likely have to be addressed through a variety of approaches, from innovation to top-down mandates. China has set a target of 4.8 million charging stations by 2020; McKinsey expects that the country's governmental record of centralized policies and compulsory implementation will ensure the country meets its mark. Funding outside of China, however, will be more challenging. California utilities, for example, look to increase publicly funded investments, with regulated returns. Private funding, on the other hand, could come from companies such as retailers. Several retail leaders are already beginning to consider how to turn the charging experience to their advantage by giving customers the opportunity to purchase while powering up. Just as shopping malls have long conjured images of leading retailers anchoring the buying experience, large retail-driven charging stations may come to mark the commercial landscape.

Exhibit 1

As electric-vehicle adoption increases, the demand for public charging stations will skyrocket.



<sup>1</sup> Assumes people who have access to charging their vehicles either at home or at work use public stations once a month, those with no private access use public stations 10 times a month, and those with access at both home and work do not use public stations at all (ie, 5% of EV owners in each country).

**Ores and metals: Between a cliff and a hard place**

It's not surprising that more EVs on the road will result in greater price pressure for their constituent parts. The cost of an EV can be broken down largely into the cost of its battery (40 to 50 percent), electric power train (about 20 percent), and other elements of the vehicle itself (30 to 40 percent). Of these, battery costs will be the most important in the medium term. And pricing dynamics will reflect more than just demand. Currently, battery costs are about \$200 to \$225 per kilowatt hour. We estimate that a battery cost of \$100 per kilowatt hour will be required to achieve cost parity with ICE vehicles for most C-segment and D-segment vehicles<sup>4</sup> and \$75 per kilowatt hour for larger ones, unless government subsidies

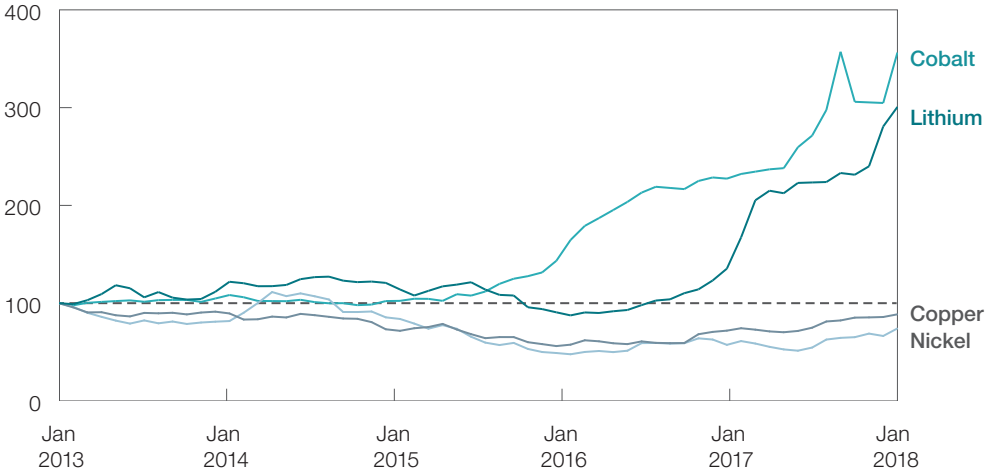
are continued—an unlikely proposition, as subsidies worldwide are already being phased out. If EV sales are to meet forecast levels, battery-manufacturing capacity will need to increase too—by our analyses, threefold by 2020. Technological improvements must also continue apace.

Higher EV sales will help reduce battery costs, with major battery manufacturers racing to expand capacity. At the same time, EV growth will put pressure on the costs of crucial battery inputs, including cobalt and lithium, for which demand will rise sharply. That dynamic has already begun to unfold; the costs of cobalt and lithium have more than doubled since 2015, an effect that has resulted in a net increase in EV production costs over that time (Exhibit 2).

Exhibit 2


**Electric-vehicle growth has already begun to strain demand for cobalt and lithium.**

**Raw-materials prices;** index: Jan 2013 = 100



Source: SNL Metals & Mining; McKinsey analysis

Will the availability of these materials constrain greater EV penetration? Optimistically, no. Even with the predicted rise in input costs, batteries can still come close enough to the \$75 to \$100 per kilowatt threshold needed to approach broad ICE price parity. While concerns such as a “cobalt cliff” exist and demand implications could present a temporary speedbump, the constraints and uncertainties should be addressable. Shifting to other battery chemistries can mitigate risks of shortage. Mining more of the raw materials will also be needed, which, we estimate, will require investments of \$100 billion to \$150 billion. As well, mining’s hard realities will still apply, including lead times of up to several years and ecological and social concerns in regions within Africa and South America where much of these raw materials are found. Even as a green solution, in other words, EVs will have costs as well as benefits

for society, our environment, and the resources we consume. 

<sup>1</sup> *Aspiring drivers weigh automotive revolution*, Driving-Tests.org, March–April 2017, driving-tests.org.

<sup>2</sup> *2017 hybrid & electric cars survey results*, CarMax Business Services, July 18, 2017, carmax.com.

<sup>3</sup> “Consumer appetite for electric vehicles rivals pickups,” NewsRoom, April 18, 2017, aaa.com.

<sup>4</sup> These refer to two European car segments. C-segment vehicles are the largest of the small cars, typically called compact cars in the US market (for example, Honda Civic, Ford Focus, and Toyota Corolla). D-segment vehicles refer to the smallest of the large cars, typically called midsize cars in the US market (for example, Chevrolet Malibu, Ford Fusion, Volkswagen Passat, and Audi A4).

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