

CALIFORNIA CENTER FOR
JOBS & THE ECONOMY



A Closer Look At

California's Cobalt Economy

EXECUTIVE SUMMARY

January 2019

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Through a series of regulatory mandates, Executive Orders and high-profile laws, California has begun to transform its economy through energy policy. However, unlike other states and economies that rely on a more diversified energy portfolio, California's policies are leading to an over-reliance, if not complete dependence, on electrification including increasing generation from intermittent sources. This shift will require a significant investment in battery technology—currently dominated by lithium-ion—for a range of transportation and other applications, including storage technology not currently available.

These investments will put considerable strain on the existing markets for critical minerals needed to manufacture the batteries, likely contributing to currently-projected global resource shortages for battery-grade materials, which could keep costs elevated in the near future. Of greater concern, a key mineral used in the production of lithium-ion batteries, cobalt, is primarily mined in the Democratic Republic of the Congo (DRC), where reports from Amnesty International detail the use of child labor and other humanitarian and worker abuses related to “artisanal” cobalt mining. Increasing demands generated by the California policies will further increase reliance on materials from this unstable region.

Increased demand will also put additional pressures on other existing and emerging cobalt applications, including electronics like cellular phones, computers, wheelchairs, medical devices and myriad other battery-powered devices along with traditional uses for metallurgical and other chemical products. Cost increases could affect sales and production competitiveness for these products, which in turn will impact the state's employment in these industries along with collection of sales tax and other associated revenue.

Under its current climate change policies—including Executive order B-16-2012 which set a goal of 1.5 million ZEVs on California roads by 2025, and the subsequent B-48-18 which pushed the goal to 5 million by 2030—the state has made a significant shift away from its historic “technology neutral” approach to clean vehicles and has effectively moved to promotion of a specific, resource-heavy technology as the answer to its regulatory goals. This report looks at the increased demand on raw materials that are a direct result of the state's efforts to increase zero-emission vehicle (ZEV) use in California primarily through the promotion of electric vehicles and their associated battery use.

This report seeks to understand what impact this regulatory approach will have on the global supply of key minerals required to produce the batteries needed to meet the demands created by California regulations, the impact this increased demand will have on costs—both economic and human—a brief explanation of how these outcomes may impact other sectors of California's economy that rely on the same raw materials for their existing technologies, and an initial discussion of the risks that come with the current regulatory drive towards a single-source energy economy.

KEY FINDINGS:

The transformation to a single-source, battery cell energy policy will require an overreliance on overseas markets, particularly East Asia, to meet demand. Because of aggressively applied industrial policies, current battery cell production has concentrated to a high degree in the East Asia countries of China, South Korea and Japan. The resulting cost efficiencies that exist now from these supply clusters likely mean this concentration will endure and is currently on course to expand. At the same time, China-based firms are driving to secure cobalt and other battery-critical material supplies, further undercutting the ability of competitors elsewhere to compete or even enter the industry.

EV & Energy Storage Lithium-Ion Battery Cell Production Capacity (GWh)

	2010	2016	2017	2022
China	9	69	145	373
Asia-Pacific*	5	31	31	57
North America**	1	11	18	46
Europe	0	3	4	41
Other	0	0	0	79
<i>Total</i>	<i>15</i>	<i>114</i>	<i>198</i>	<i>596</i>

Source: IEA [2017]

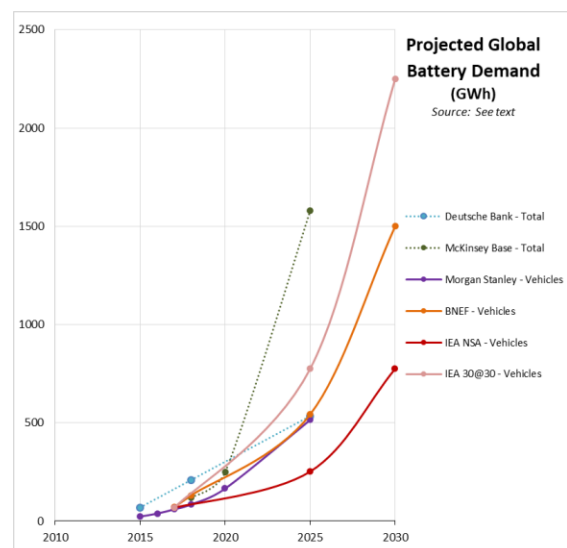
Notes: *Primarily Japan/South Korea;

**Growth primarily from Tesla Gigafactory (35 GWh cells/50 GWh packs by 2020)

History is repeating itself. Solar panel manufacturing in both California and the United States was undermined by a rapidly growing overcapacity created by government subsidies in Asia. There are now no solar panel manufacturers in California. Given China's aggressive drive to secure preferential access to the raw materials needed to develop the battery economy we are building, it is highly unlikely California manufacturers will ever benefit from the heavy investments of public and ratepayer funds the state is now making in this new technology, despite the fact that the industrial sector pays nearly twice as much as the rest of the nation in energy prices to help subsidize the transition to the new battery economy.

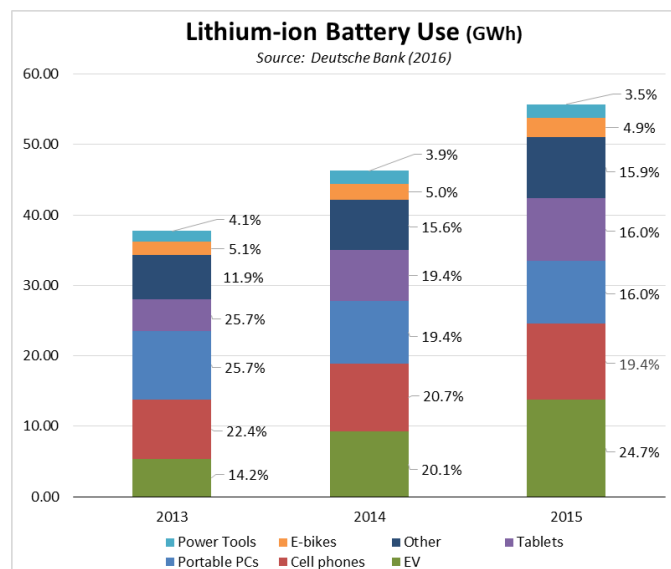
Battery cell shortages are now projected by 2025.

Because ZEV sales have lagged previous investment projections, the recent excess of battery capacity has contributed to declining vehicle battery prices. Moving into 2025, most analyses see tighter market conditions as battery cell demand comes more into balance with capacity, especially as cobalt constraints come into play. This shortage will come just five years before the deadline for the state's latest and most aggressive ZEV mandates and could significantly affect prices—batteries currently comprise about half of a typical ZEV cost—at a time when state policies will be heavily favoring producers of these vehicles. While other battery chemistries may come into play especially in the post-2025 timeframe to address these supply and cost



conditions, the accelerated schedules now mandated by California and other state and country ZEV policies mean in practice most producers are designing their models around the batteries available now and on the foreseeable commercial horizon.

Additional mining of cobalt will be required to meet national and California-specific ZEV mandates to not negatively impact other sectors of the economy. Cobalt is widely used throughout the economy for a range of metallurgic, chemical and non-mobility battery applications, in addition to the growing use for vehicle batteries. Growth in these competing demands alone is now projected to match current cobalt production levels, meaning the additional demand for vehicle batteries brought about by current national and sub-national policies likely will have to be met primarily through new and expansion of existing mines. Any delays in bringing this new production on line—as a result of permitting delays, changing investment assumptions, litigation, or shifting tax, regulatory, and security environments in the producing countries—will likely have a negative effect on increasingly tight supplies, increasing prices and the cost of the ZEV policies while affecting other sectors of the economy as well.



Based on currently announced expansions, The Democratic Republic of the Congo (DRC) is expected to provide 75 percent of global cobalt mine production by 2025. DRC currently accounts for 58 percent of global cobalt mine production and 49 percent of estimated reserves. Given the extreme amount of time to discover, delineate and permit new mining capacity, national and California policies will rely heavily on expanded DRC production to fulfill their goals. Based on current mine proposals, DRC’s share of the market is now projected to expand to 75% by 2025.

“Artisanal mining” in the DRC provides about 20 percent of the country’s current supply, or 10 percent of global supply and growing as DRC expands its production. In 2017, Amnesty International exposed artisanal mining for what it really is—as many as 40,000 child laborers, slave labor and significant abuses of worker and human rights. Reports from other organizations have detailed how foreign and rebel militias and units of the national military control much of artisanal mining in the country, along with the communities springing up around this activity.

Some companies, including Apple and Tesla, are attempting to develop tracking methods to ensure future cobalt comes from “ethical” sources. Previous efforts mandated by federal law for DRC gold, tantalum, tin and tungsten have failed and in fact have intensified the conditions that originally forced many to rely on artisanal mining in the first place. As developed countries increase their cobalt demand to produce electric vehicles for higher income buyers and \$1,000 cell phones, the incentives for artisanal mining will only increase, especially in a country where two-thirds of the population lives in extreme poverty (less than \$1.50 a day) and where most other income options have been destroyed by three decades of unrelenting civil unrest, civil war, and external conflict.

“The energy solutions of the future must not be built on human rights abuses.”

Seema Joshi, Head of Business and Human Rights at Amnesty International

Increased demand for cobalt will also require reliance on the DRC’s historically unsettled government. Civil war, foreign incursions and civil unrest have frequently led to disruptions of mining operations and global supplies. Corruption within the government and throughout the country has included the systemic looting of the national mining company, which resulted in the physical collapse of the Kamoto underground cobalt mine due to lack of funds for maintenance. Recent reports including from the [Jimmy] Carter Center have indicated redirection of mining revenues continues at high levels.

California’s energy future now relies on DRC and East Asian markets for success. By now choosing winners and losers in the technology sphere and creating a single energy source future, California’s future energy and, in turn, economic stability is now over-reliant on DRC and East Asia.

To put this dependence in perspective, the US reliance on OPEC oil production reached only one-third of consumption at its highest point in 1977, dropping to only 17 percent in the most recent data for 2017.

The ambitious schedule for ZEV sales—especially in China and California—leave little slack between expected cobalt demand and anticipated supply expansions. The projections anticipate periods of shortage after the 2025 timeframe even with accelerated introduction of lower-cobalt chemistry batteries, and prior to 2025 if announced mine expansions are not fully completed or if production overall is negatively affected by the recent changes to DRC mining law.