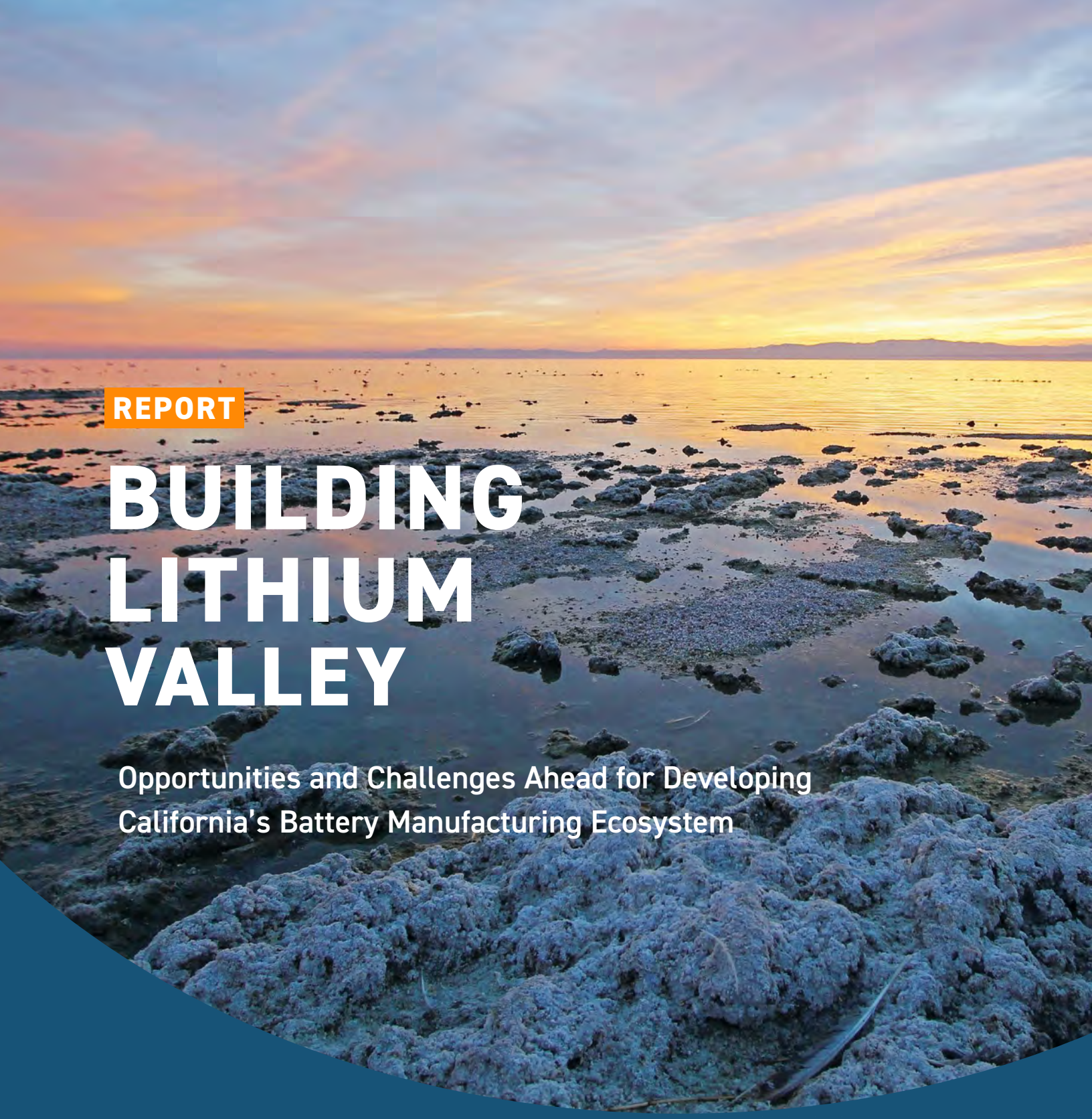

REPORT

BUILDING LITHIUM VALLEY

Opportunities and Challenges Ahead for Developing California's Battery Manufacturing Ecosystem

NEW ENERGY NEXUS

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TABLE OF CONTENTS

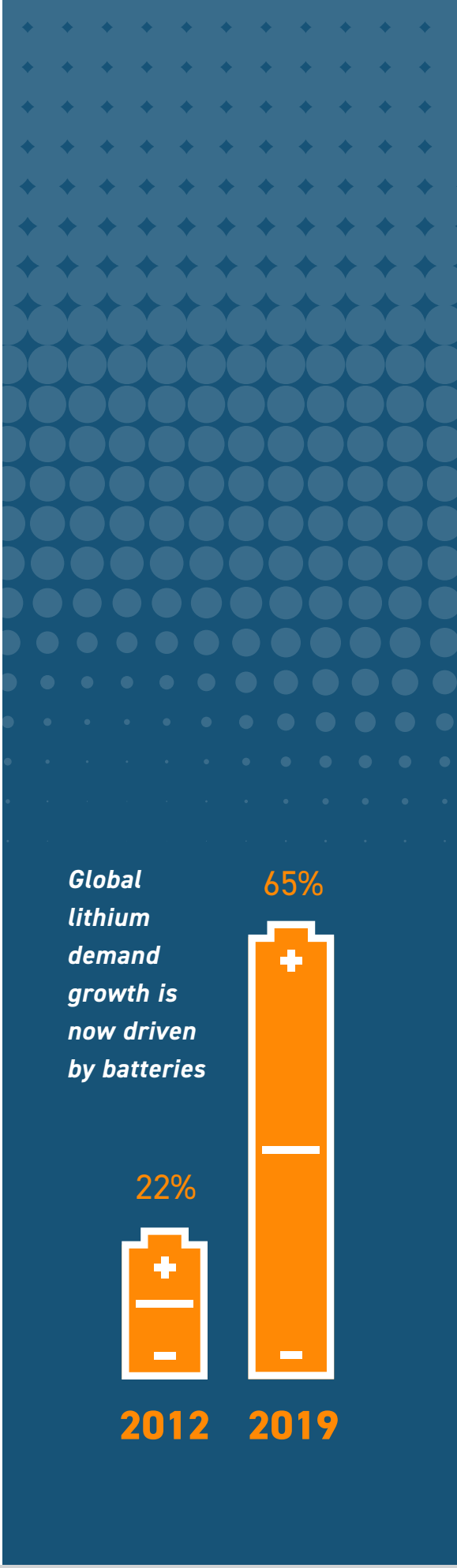
EXECUTIVE SUMMARY

California is leading the nation in the transition to a clean energy economy. The state is at the forefront of policy, technology and investment in renewable energy and transportation electrification. There is, however, significant work ahead to build on this progress.[1] New measures must be considered with a focus on the joint specter of climate change and post Covid-19 economic recovery. The opportunity exists today to meet these challenges by developing California's "Lithium Valley," located in Imperial County. Lithium Valley can serve as the anchor to a fully integrated, domestic battery supply chain, including development of critical minerals for battery materials, research and development on battery components and efficiency improvements. Establishing a full battery manufacturing ecosystem will support both the transition to electrified transportation and advance progress toward the goals of California's SB 100.[2] Moreover, the full promise of Lithium Valley exemplifies a just transition for the energy system in both California and the United States.

Lithium Valley development can support three key goals for a just transition in California's energy system:

1. Drive investment and job growth in Imperial County, one of the most economically disadvantaged counties in the state;
2. Help achieve California's climate and emission reduction goals by anchoring a domestic battery supply chain, serving both transportation electrification and stationary energy storage for grid scale and distributed applications;
3. Develop a California supply of a critical mineral deemed "essential to the economic and national security of the United States."[3]

Global demand for lithium is projected to grow tenfold in the next decade, but current domestic U.S. lithium production is de minimis on the global scale. In 2019, more than 95% of global lithium extracted came



1 Transportation is now the largest source of greenhouse gas pollution in California. See https://ww2.arb.ca.gov/ghg-inventory-data

2 Chapter 312, Statutes of 2018, SB 100 (DeLeon)

3 Lithium was listed in the Federal Register as a critical mineral "essential to the economic and national security of the United States" pursuant to the 2017 presidential Executive Order No. 13817 titled "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals."

from Australia, Chile, Argentina and China[4] despite significant lithium reserves in the United States. Located in the far southeast corner of California, Imperial County is home to the Salton Sea geothermal resource area and the site of Lithium Valley. Industry experts estimate the region could satisfy more than one-third of today's global lithium demand. Lithium demand growth is now driven by batteries, representing 65% of demand in 2019, up from 22% in 2012.[5]

Industry experts estimate the region could satisfy more than one-third of today's global lithium demand.

Rapid battery demand growth, and thus lithium demand growth, is driven by transportation electrification[6] similar to the rapid expansion of the global polysilicon market as it transitioned from primarily serving the semiconductor market to dominance by solar demand between 2000 and 2010.[7] Global electric vehicle (EV) market growth is projected to rise from 1.7 million vehicles in 2020 to 26 million vehicles in 2030 and 54 million by 2040.[8] California accounted for 48% of 2019 domestic EV sales[9] and is the primary U.S. launch market for new EV models.

In Daniel Yergin's new book, "The New Map," he illuminates how the U.S. is in a trailing position to "China's solar manufacturing juggernaut...[which is] now the source of almost 70% of the world's solar panels." In addition, Yergin extends that point to batteries and electric vehicles, which are about a decade behind the growth curve: "China already dominates in lithium, the necessary ingredient for batteries for electric cars....[and] stands atop the entire supply chain, with over 80% of the world's battery manufacturing capacity."[10] In contrast to semiconductor and solar manufacturing and associated supply chains, which are well established in China, a window exists for California to establish the domestic anchor of a comprehensive lithium battery supply chain in Lithium Valley. The state's dynamic energy innovation ecosystem coupled with the Salton Sea resource offer Imperial County a unique opportunity to capitalize on the critical and growing global market and in doing so, derisk future supply chain disruptions.[11]

Yet, the nation's security is not the only thing at stake. Lithium Valley can unleash billions of dollars of both private capital investment and revenue generation directed into California, bringing significant employment opportunities to the region and creating an economic engine delivering value for generations.[12] The full vision of Lithium Valley expands beyond lithium recovery to the co-location of battery and EV manufacturing as well. Importantly, a domestic supply chain also offers the benefit of reduced carbon emissions; lithium can be recovered and transformed into batteries for electric cars domestically, thereby reducing the overall carbon footprint of transportation between continents. What's more, Lithium Valley, uniquely, can produce lithium as a by-product of geothermal energy. Lithium Valley enables simultaneous generation of carbon free decarbonized baseload power production and lithium recovery serving to electrify transportation as well as enable the SB 100 vision of a 100% clean energy future.

4 Moldhanov, Pavel and Brian MacArthur, "As Battery Demand Surges, the World is NOT Running Out of Lithium — but More Investment Needed," Raymond James & Associates Global Research, [private report] September 2020,

5 Ibid.

6 See graphic of Lithium Demand by Segment Actual 2011-2019 and forecast 2020-2030: Stringer, David and Akshat Rathi, "The Electric Car Battery Boom Has Screeched to a Halt, For Now," Bloomberg, June 2020 https://www.bloomberg.com/news/articles/2020-06-17/the-electric-car-battery-boom-has-screeched-to-a-halt-for-now

7 Mehta, Shyam, "The Shifting Relationship Between Solar and Silicon in Charts," Greentech Media, February 2014 https://www.greentechmedia.com/articles/read/Solar-and-Silicons-Shifting-Relationship-in-Charts

8 Electric Vehicle Outlook 2020, Bloomberg New Energy Finance, May 2020 https://about.bnef.com/electric-vehicle-outlook/

9 https://www.veloz.org/2019-electric-car-sales-round-up/

10 Yergin, Daniel. "The New Geopolitics of Energy," Wall Street Journal, September 2020. https://www.wsj.com/articles/the-new-geopolitics-of-energy-11599836521

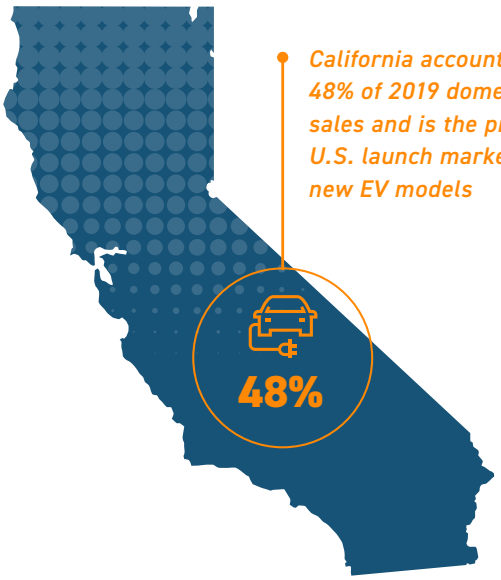
11 Stringer, David and Akshat Rathi, "The Electric Car Battery Boom Has Screeched to a Halt, For Now," Bloomberg, June 2020 https://www.bloomberg.com/news/articles/2020-06-17/the-electric-car-battery-boom-has-screeched-to-a-halt-for-now

12 California Energy Commission, "Geothermal, Lithium Recovery Projects Get Boost from California Energy Commission," [press release] May 2020 https://www.energy.ca.gov/news/2020-05/geothermal-lithium-recovery-projects-get-boost-california-energy-commission

Recognizing this unique value proposition, the California State Legislature passed AB 1657 on August 31, 2020 to establish a Blue Ribbon Commission on Lithium Extraction in California. The Commission will review, investigate and analyze safe environmental methods for lithium extraction from geothermal brines as well as its processing and production, and deliver a report to the legislature on its findings on or before October 1, 2022. The author of the bill, Assemblymember Eduardo Garcia, who represents the California State Assembly District 56, including the Imperial Valley and the Salton Sea, believes the Commission can "serve as a valuable lever of our state's economic recovery strategy to help bring back jobs and recoup critical economic losses due to the COVID-19 pandemic."[13]

The establishment of a Lithium Valley anchored 'Clean Energy Hub' focused on attracting battery component, battery cell and electric vehicle manufacturers to Imperial County could supercharge the state's financial recovery while also promoting the sustainable wellbeing of a county with the highest unemployment rate in the state.[14] The wake of the Covid-19 pandemic, as well as ongoing crises including the fight for racial justice and equity, raise the need to re-examine the nation's many examples of environmental and economic inequality. Lithium Valley presents a unique near-term opportunity for policy makers, entrepreneurs and investors to pursue a long-lasting solution with an emphasis on equity and sustainability while addressing climate change. A collaborative planning process with robust community outreach supported by an international certification organization, such as IRMA,[15] could ensure a socially and environmentally conscious opportunity for all Imperial County residents. Development in the region could also bring much needed investment for habitat enhancement and dust abatement projects.[16]

Lithium Valley offers an exceptional opportunity in its timing, scale and alignment with California's goals for a just transition in our energy system. To facilitate this initiative, the state must foster an environment that is conducive to the timely development of the industry. The critical areas of focus are adopting policy and financing strategies to streamline lithium recovery projects and aligning stakeholders, including local communities, at the outset and throughout the process. The California state government, through the California Energy Commission, has initiated funding for project research and development activities. In addition, the federal government recently designated lithium as a critical mineral, emphasizing the necessity for its domestic development. This paper provides insight into Lithium Valley's current development status, cites potential bottlenecks to enabling investment, and seeks to lay the groundwork for continued progress at the state and federal levels. By establishing a foundation for understanding current global lithium markets and projects in the Salton Sea, this report encourages further dialogue and action to make Lithium Valley an opportunity for *all*.



13 California State Assembly Democratic Caucus, "Senate Energy Approves Assemblymember Eduardo Garcia's Lithium Commission Bringing Economic Opportunities Closer to Imperial," [press release] August 2020 https://asmdc.org/press-releases/senate-energy-approves-assemblymember-eduardo-garcias-lithium-commission-bringing

14 According to the U.S. Census Bureau's latest five-year estimate, Imperial County's unemployment rate stands at 16% — four times greater than the state's overall jobless rate of 4.2%.

15 The Initiative for Responsible Mining Assurance (IRMA) is an independent third-party verification and certification organization. https://responsiblemining.net

16 Kirby, Kayla, "Newsom responds to Salton Sea emergency," The Desert Review, January 2020 https://www.thedesertreview.com/news/newsom-responds-to-salton-sea-emergency/article_f1115ab8-3195-11ea-a4ce-6b146c73e830.html

II

INTRODUCTION

1. California's Policy Backdrop

California has demonstrated global leadership in climate, energy and environmental policy. According to the U.S. Energy Information Administration, California is among the top five states in the nation for electricity produced from renewable sources, and leads the country in generation from solar, biomass and geothermal sources[17]. These energy triumphs are underscored by California's carbon emissions reductions in the past few decades. Greenhouse Gas (GHG) emissions, GHG emissions per capita and GHG emissions per GDP have all dropped since 2000. In 2017, California's GHG emissions were 424 million metric tons of CO_2 equivalent ($MMTCO_2e$), a 14% decrease from 2004 levels. Per capita GHG emissions have dropped 24% from their peak in 2001.[18] These reductions are a result of policies and initiatives taken by California and local agencies fighting climate change.

Specifically, California's Renewable Portfolio Standard (RPS), implemented in 2002 and amended several times since, initiated these successful trends.[19] According to the Energy Information Administration, California's RPS called for retail sales of electricity to be generated from 33% renewables by 2020, 60% by 2030 and 100% by 2045. The state is currently on pace with 24% of retail electricity generated from renewables in 2018. In addition, California's Global Warming Act of 2006 set emissions reductions targets to reach 1990 levels by 2020 and 80% of 1990 levels by 2050. To support these goals, the state passed comprehensive cap-and-trade legislation that limits the statewide sources responsible for producing 85% of emissions.[20] Other electricity sector policies include the California Solar Initiative that offered rebates to homes and businesses that have installed solar panels.[21]

As of 2018, California had already reached the 2020 emissions goal. The California Energy Commission (CEC), the California Air Resources Board (CARB) and the California Public Utilities Commission (CPUC) are working to jointly prepare a report by January 1, 2021, outlining a roadmap to meet the goals established by SB 100. The bill, sponsored by then Senate Pro Tem Kevin DeLeon, sets a target for renewable energy and zero-carbon resources to supply 100% of electric retail

17 US Department of Energy, Energy Information Agency, California State Profile and Energy Estimates. https://www.eia.gov/state/analysis.php?sid=CA

18 Ibid.

19 Ibid.

20 Ibid.

21 California Public Utilities Commission, "California Solar Initiative" CPUC Website https://www.cpuc.ca.gov/General.aspx?id=6043

sales to end-use customers and 100% of electricity procured to serve state agencies by December 31, 2045.[22]

Similarly, as transportation is the largest carbon emitting sector in California,[23] multiple agencies are working together to move all segments of the transportation sector to electrification to meet the State's climate goals.[24] The Low Carbon Fuel Standard (LCFS) of 2007, administered by CARB, calls for emissions reductions in the transportation industry.[25] The CPUC leads transportation electrification initiatives initiated by the utilities,[26] including those that overlap with the LCFS program at CARB. Electric vehicle charging infrastructure and investment programs are administered by the CEC, coordinating with the CPUC on utility investment.[27]

In contrast to California's RPS, which set the target of 100% carbon-free electricity by 2045, no equivalent 100% target exists for California's vehicle fleet. However, on June 25, 2020 CARB passed the Advanced Clean Trucks rule which will require increasing percentages of new trucks sold in California to be zero-emission electric vehicles until reaching 100% of sales in 2045.[28] The light duty electric vehicle market is being driven by global conditions, including policy-driven mandates in China and Europe.[29] The California Zero Emission Vehicle (ZEV) regulation, which has been adopted by more than a dozen other U.S. states,[30] creates a market for ZEV credits that has largely been driven by the success of Tesla electric vehicles while other manufacturers have allocated their electric vehicles production in the last two years to China and Europe.[31] [32] [33]

Electric vehicle global production is driving exponential growth in lithium-based battery manufacturing. Although new battery manufacturing capacity has been announced in the United States, internal lithium production is virtually non-existent, setting up a scenario where domestic battery and electric vehicle manufacturing is dependent on a few countries for this critical mineral. Anchoring the full battery supply chain domestically — beginning with lithium production—will require cooperation from the private sector, including the technology and finance industries, as well as welcoming communities hosting lithium production and industrial activities.

Lithium Valley provides California with a unique resource for scaled lithium recovery from its existing and potential geothermal resources as a byproduct of electricity generation. By leveraging its leadership in climate policy and economic development, California can anchor a domestic battery supply chain within the state. Success will require cross sector engagement with a combination of stakeholders familiar with California climate policy engagement as well as new allies. As noted by Peter Fiske, director of Berkeley Lab's Water-Energy Resilience Research Institute, "The challenge is not simply lithium extraction. It's a complex tangle of chemical, engineering, economics, and supply chain issues."[34]

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22 California Energy Commission, California Public Utilities Commission, and California Air Resources Board, "SB100 Joint Agency Report Website" https://www.energy.ca.gov/sb100

23 California Air Resources Board, "California Greenhouse Gas Emissions for 2000 to 2017" 2019 Edition https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2016/ghg_inventory_trends_00-16.pdf

24 For example, the CEC and CARB recently held a workshop for zero emission drayage trucks. https://cafcp.org/content/carbcec-pre-solicitation-workshop-zero-emission-drayage-truck-and-infrastructure-pilot

25 California Air Resources Board, "Low Carbon Fuel Standard" CARB Website https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

26 California Public Utilities Commission, "Zero Emission Vehicles" CPUC Website https://www.cpuc.ca.gov/zev/

27 California Energy Commission, "Clean Transportation Program" CEC Website https://www.energy.ca.gov/programs-and-topics/programs/clean-trasportation-program

28 California Air Resources Board, "Advanced Clean Trucks" CARB Website https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks

29 Hall, Dale, Hongyang Cui, and Nic Lutsey, "Electric vehicle capitals: Accelerating the global transition to electric drive" The International Council on Clean Transportation" October 2018 https://theicct.org/publications/ev-capitals-of-the-world-2018

30 Berman, Bradley, "Minnesota, New Mexico, and other states are poised to adopt California ZEV rules" electrek April 2020 https://electrek.co/2020/04/13/minnesota-new-mexico-and-other-states-are-poised-to-adopt-california-zev-rules/

31 California Air Resources Board, "Zero-Emission Vehicle Program" CARB Website https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about

32 Weiss, Miles and David Welch, "GM and Fiat Chrysler Unmasked as Tesla's Secret Source of Cash," June 2019 https://www.bloomberg.com/news/articles/2019-06-03/tesla-s-secret-source-of-cash-unmasked-as-gm-and-fiat-chrysler

33 For a worldwide database of EV Sales, see EV-Volumes. https://www.ev-volumes.com/

34 Berkeley Lab, "Geothermal Brines Could Propel California's Green Economy," [press release] August 2020 https://eta.lbl.gov/news/article/geothermal-brines-could-propel

2. What is Lithium, and Why it's important

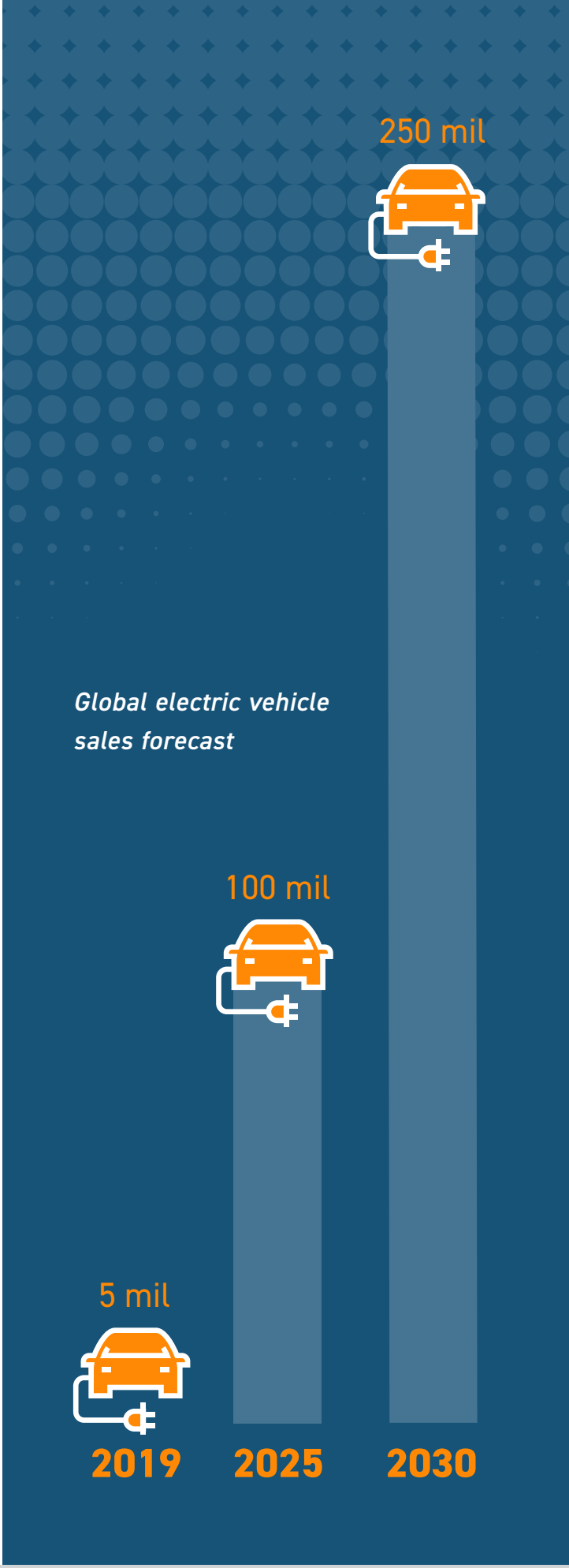
Lithium (Li) is a critical material which can be found in pegmatitic ores, sedimentary materials, and brines around the world. Lithium makes up approximately 0.006% of the earth's crust, positioning the metal as more rare than zinc, copper and tungsten but more common than cobalt, tin and lead[35]. Lithium is used to make lithium-ion rechargeable batteries — typically used in laptops, cellphones, and other digital consumer devices. Additionally, lithium carbonate is sold as a pharmaceutical to treat bipolar disorder and lithium compounds are used widely in lubricants, grease, and glass.[36] Historically, the supply and demand for lithium has been structured and scaled around non-battery products. Current demand growth, however, is rooted in lithium-ion batteries, used as the new mechanism for energy storage in electric vehicles. According to the U.S. Geological Survey (USGS), in 2019 lithium-ion batteries made up 65% of global end-use markets for lithium.[37]

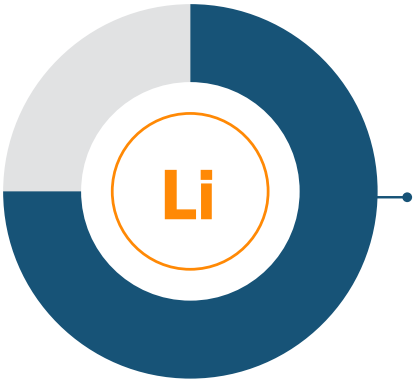
Projections show that the global demand for electric vehicles will grow exponentially in the coming decades, fundamentally changing the market for lithium going forward. The International Energy Agency forecasts that global electric vehicle sales will rise from 5 million in 2019

35 Azevedo, Marcelo, Nicolò Campagnol, Toralf Hagenbruch, Ken Hoffman, Ajay Lala and Oliver Ramsbottom, "Lithium and cobalt – a tale of two commodities," McKinsey June 2019. https://www.mckinsey.com/~/media/mckinsey/industries/metals%20and%20mining/our%20insights/lithium%20and%20cobalt%20a%20tale%20of%20two%20commodities/lithium-and-cobalt-a-tale-of-two-commodities.ashx

36 Szalay, Jessie, "Lithium Medication: Dosage & Side Effects," LiveScience, January 2015 https://www.livescience.com/43558-lithium-medication.html

37 U.S. Geological Survey, "Mineral Commodity Summaries," January 2020 https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf





Batteries will become the dominant application for lithium, reaching over 75% by 2025

to 100 million in 2025, and 250 million in 2030.[38] This will spur a supply chain revolution for lithium compounds including lithium carbonate, lithium hydroxide monohydrate, and potentially lithium metal. This will, in turn, force supply to adapt to new industries, locations, purity requirements, and scale. If strategic in identifying lithium recovery opportunities domestically, the U.S. has a unique opportunity to become a global leader in this emerging market.

Bloomberg New Energy Finance (BNEF) projects that more than 50% of all passenger vehicles sold will be electric vehicles by 2040.[39] This will be a result of increased charging infrastructure, improved and cheaper battery technology and sales growing in new markets. Electric vehicles need lithium-ion batteries, and the demand for lithium is driven by battery applications (estimated at nearly 40% of all applications in 2017). As the electric vehicle industry expands, batteries will become the dominant application for lithium, reaching over 75% by 2025.[40] It is projected that lithium demand for batteries will double every five years, reaching over 1.6 million metric tons of lithium carbonate equivalent (Mt LCE) by 2030.[41] As the market for lithium expands, so do the capabilities and technology of lithium ion batteries. For example, BNEF projects that global production capacity for lithium-ion batteries will grow almost 14-fold to 1,755GWh by 2030.[42] If done properly, this technical and economic boom will open the door for companies, states and countries to absorb environmental and economic benefits up and down the battery supply chain.

Electric vehicle manufacturing relies on lithium, including lithium compound processing and cathode manufacturing. As companies along this supply chain develop and decide where to root themselves, accessibility to domestic lithium resources will be an attractive asset for production efficiency. For example, proximity to the resource will cut emissions, risk and costs associated with transportation of the mineral.[43] According to Benchmark Mineral Intelligence, there are now 150 lithium battery megafactories in development around the world.[44]

38 International Energy Agency, "Global EV Outlook 2019," May 2019 https://www.iea.org/reports/global-ev-outlook-2019

39 Electric Vehicle Outlook 2020, Bloomberg New Energy Finance, May 2020 https://about.bnef.com/electric-vehicle-outlook/

40 Azevedo, Marcelo, Nicolò Campagnol, Toralf Hagenbruch, Ken Hoffman, Ajay Lala and Oliver Ramsbottom, "Lithium and cobalt – a tale of two commodities," McKinsey June 2019 https://www.mckinsey.com/~/media/mckinsey/industries/metals%20and%20mining/our%20insights/lithium%20and%20cobalt%20a%20tale%20of%20two%20commodities/lithium-and-cobalt-a-tale-of-two-commodities.ashx

41 Lu, Sophie and James Frith, "Will the Real Lithium Demand Please Stand Up? Challenging the 1Mt-by-2025 Orthodoxy," Bloomberg New ENergy Finance, October 2019 https://about.bnef.com/blog/will-the-real-lithium-demand-please-stand-up-challenging-the-1mt-by-2025-orthodoxy/

42 Electric Vehicle Outlook 2020, Bloomberg New Energy Finance, May 2020 https://about.bnef.com/electric-vehicle-outlook/

43 Norris, Meagan, Tatiana Tsaprailis and Stefan Sabo-Walsh, "Electric vehicles: ESG risks set to rise as demand for raw materials ramps up," Verisk Maplecroft Website, October 2017 https://www.maplecroft.com/insights/analysis/electric-vehicles-esg-risks-rise-raw-material-demand-ramps-up/

44 Benchmark Mineral Intelligence, "EV Battery Arms Race Enters New Gear With 115 Megafactories, Europe Sees Most Rapid Growth," BMI Website, December 2019 https://www.benchmarkminerals.com/ev-battery-arms-race-enters-new-gear-with-115-megafactories-europe-sees-most-rapid-growth/

3. Purpose and Data

The purpose of this report is to provide a tool for the community, policymakers and battery supply chain stakeholders to understand the current development status and roadblocks to progress for the lithium recovery initiative at the Salton Sea in Imperial Valley, California. With this clear synthesis of the lithium market, current state of technologies, companies operating in the region, potential roadblocks, opportunities and next-steps, all stakeholders can use this report to further progress and improve what could be a large domestic lithium industry. There has already been interest and financial support for this initiative at the state and federal levels, signifying the legitimacy and seriousness of Lithium Valley — now at the design stage is the time to get it right so that it can benefit all for decades to come.

The data for this report was obtained from stakeholder interviews and secondary sources including policy and economic reports. We interviewed representatives from various sectors including lithium market experts, state government officials, technical experts, community stakeholders and company personnel to account for multiple perspectives on this specific initiative in the Salton Sea and the global market for lithium more generally. The diversity of fields and organizations our subjects represented provided an adequate range for an unbiased assembly of data. The secondary sources provided additional quantitative and qualitative information to properly assess the opportunity for lithium recovery at the Salton Sea.

Global Lithium Supply

Total global lithium reserves in 2019 was estimated by the USGS as 90 million metric tonnes of LCE while identified lithium resources have increased to more than 420 million tonnes.[45] Lithium resources are supplied in several raw forms, and then converted into materials that can be used by any manufacturer, for example, lithium carbonate. In 2019, Albemarle, a leading lithium producer, estimated that the world produced roughly 325,000 metric tons of Lithium Carbonate Equivalent (LCE). Chile, China, the U.S., and Argentina ranked as the top 4 producers of lithium materials in 2018, with Australia producing 51,000 metric tons of lithium in spodumene concentrate, which was converted into lithium materials in China.

In terms of LCE, lithium demand is expected to reach 1 million tons LCE by 2025 and 2 million tons LCE by 2030.[46] North America holds 8.5% of known lithium resources.[47] In the U.S. participation in the supply, there is only one current brine extraction operation in Nevada.[48]

According to the London Metal Exchange, as of July 30, 2020, battery grade LCE is priced at $7.25/kg.[49] Current overproduction during the global coronavirus pandemic have led to depressed prices. While it is evident that there will be significantly increased demand in the coming decade with the influx of electric vehicles, the current price is limiting investment and expansion to account for the needed supply in the future. The market has delayed investment due to short term realities.[50]

45 US Geological Survey, "Lithium Data Sheet - Mineral Commodity Summaries 2020," https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-lithium.pdf

46 Lu, Sophie and James Frith, "Will the Real Lithium Demand Please Stand Up? Challenging the 1Mt-by-2025 Orthodoxy," Bloomberg New Energy Finance, October 2019 https://about.bnef.com/blog/will-the-real-lithium-demand-please-stand-up-challenging-the-1mt-by-2025-orthodoxy/

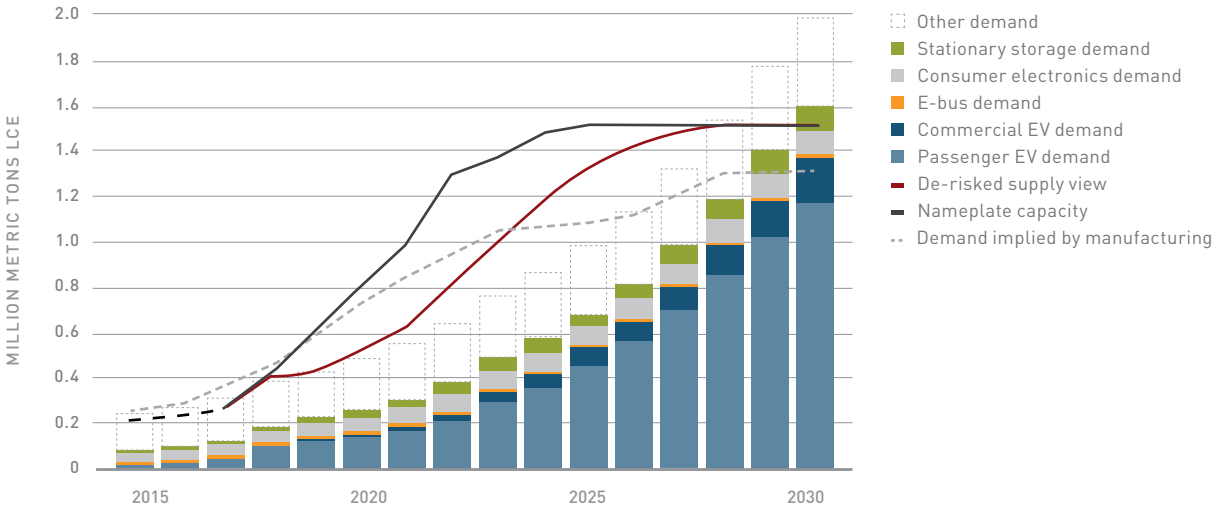
47 US Geological Survey, "Lithium Data Sheet - Mineral Commodity Summaries 2020," January 2020 https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-lithium.pdf

48 Ambrose, Hanjiro and Alissa Kendall, "Understanding the future of lithium: Part 1, resource model," Journal of Industrial Ecology, (80-89), October 2019 https://doi.org/10.1111/jiec.12949

49 London Metal Exchange, Website accessed July 30, 2020. https://www.lme.com/Metals/Minor-metals/Lithium-prices#tabIndex=0

50 Azzopardi, Tom, "SQM delays decision on Mount Holland lithium project to 2021" S&P Global, January 2020 https://www.spglobal.com/platts/en/market-insights/latest-news/metals/012320-sqm-delays-decision-on-mount-holland-lithium-project-to-2021

FIGURE 1. GLOBAL LITHIUM SUPPLY AND DEMAND FORECAST, COMPARING METHODOLOGIES



Source: BloombergNEF, Avicenne.

Note: BNEF takes bottom-up forecasting methodology designed for each specific end-use. Consumer electronics demand is based on Avicenne's forecast. Battery demand for lithium has built-in material scrappage, and waste assumptions include an additional 7.5% waste material, 5% inactive material and 15% material loss during formation cycle. 'Demand implied by manufacturing' is estimated from total lithium-ion battery cell manufacturing facilities, as tracked by BNEF, assuming 80% utilization. BNEF normally considers post-2025 capacity announcements as speculative, therefore they do not factor significantly into our battery-manufacturing capacity forecast. Demand expressed in yearof metal demand, which occurs approximately one year before year of battery demand.

Types of Lithium Resources

There are three main families of lithium resources: brines, sediments, and pegmatities (or "hard rock"). The highest quality brines in the world are mainly found in South America's "Lithium Triangle" of Argentina, Chile, and Bolivia, however some brine production also takes place in Nevada and Qinghai, China. The most common pegmatite being mined today is spodumene, a mineral found in economic grades across Australia, Canada, North Carolina, and a handful of other jurisdictions. Today, around half of lithium used for industrial applications originate from brines in South America, while the other half comes from spodumene mined in Australia and processed in China. BNEF projects that 98% of economically viable lithium is currently in Chile, Australia, Argentina, and China.[51] These numbers signify a vital need for the U.S. to focus on domestic supply chain security so the country does not continue to be reliant on a handful of other nations to produce lithium in a rapidly expanding battery market.

Brines in South America are largely processed using evaporation ponds. The brine is pumped into pools where the water is evaporated and impurities removed until a final LiCl solution is created for delivery to manufacturing customers. Lithium extraction using evaporation ponds is primarily utilized in Chile, Argentina and Bolivia (the south Andean region), as well as in countries such as China, Russia and the U.S. state of Nevada at the Silver Peak mine owned by Albemarle.

For this process to be economically viable, the minimum lithium content in the brine ranges from 150-590mg/L assuming the market price of lithium is at $8/kg LCE.52 Although brine extraction is considered the most economically viable of

51 Mustri, Sharon, "Advancing Water Efficiency in Lithium Extraction Survey of emerging extraction technologies" Bloomberg New Energy Finance [private report] September 2019

52 Mustri, Sharon, "Unconventional Lithium: The Road to Supply Security Decentralizing Critical Mineral Extraction" Bloomberg New Energy Finance [private report] April 2020

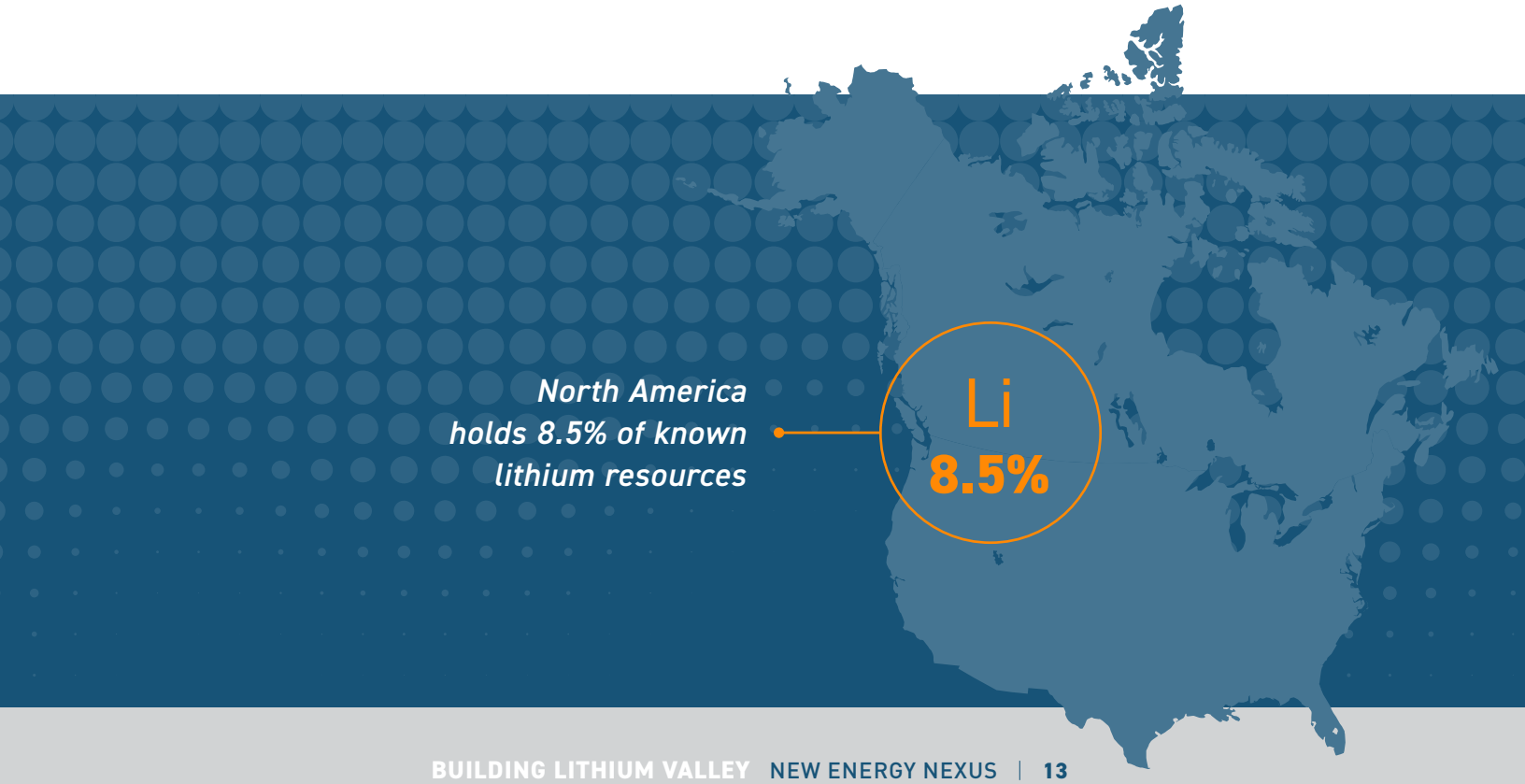
lithium extraction methods, there are several problematic environmental impacts which have received attention lately. Despite the fact that brine is itself not a viable water source for humans, animals, or plants, operators in South America have been criticized for evaporating large quantities of water from brines in the most arid desert on the planet. The concern being that this could have the impact of disrupting water tables since aquifers containing brackish or freshwater which humans and animals depend on may be destroyed in the process. There is still scientific uncertainty around this point, but other issues such as susceptibility to weather, the production of large quantities of impurity salt wastes, and massive physical footprints have raised challenges to the social license to operate evaporation ponds in South America.

Hard rock mining occurs mostly in Australia, with some projects in China as well, including processing of other pegmatites like lepidolite. Spodumene is a mineral with a very high concentration of lithium found in igneous rocks. In hard rock extraction, spodumene is identified and mined from granitic pegmatites. The crushed ore is then milled, other contaminant minerals are expelled, and it forms a purified spodumene concentrate that is an upgrade of 4 to 6 times from the natural resource.[53] This product can be used to manufacture lithium hydroxide monohydrate or lithium carbonate using energy, reagents, and water in China. The environmental hazards associated with this method of extraction are consistent with classic mining practices. Thermochemical processes involved in hard rock mining may be particularly detrimental when it comes to pollution and waste products. Additionally, mining and landscape damages associated with this type of extraction can be very costly and disruptive. A life-cycle assessment (LCA) by Minviro in January 2020 showed that the CO_2 intensity of producing lithium hydroxide monohydrate from spodumene was up to 3 times higher than recovering lithium from brine resources.

Sedimentary deposits take the consistency of dirt, and can be found across the Western U.S. from Oregon to Mexico. They are sometimes thought of as a middle point between brines and spodumene, since they can be processed chemically similar to spodumene but without the need for heat or energy intense grinding. Brines are in fact a result of millions of years of rainwater seeping through sediments around closed basins, while sediments can be formed by millions of years of weathering pegmatites. No sediment project is in operation yet, however some projects may be in operation by 2030.

Only a handful of lithium deposits of different families of resources have been developed around the world to date, and

53 SaltWorks, "Lithium Brine Extraction Technologies & Approaches" SaltWorks website, June 2018 https://www.saltworkstech.com/articles/lithium-brine-extraction-technologies-and-approaches/

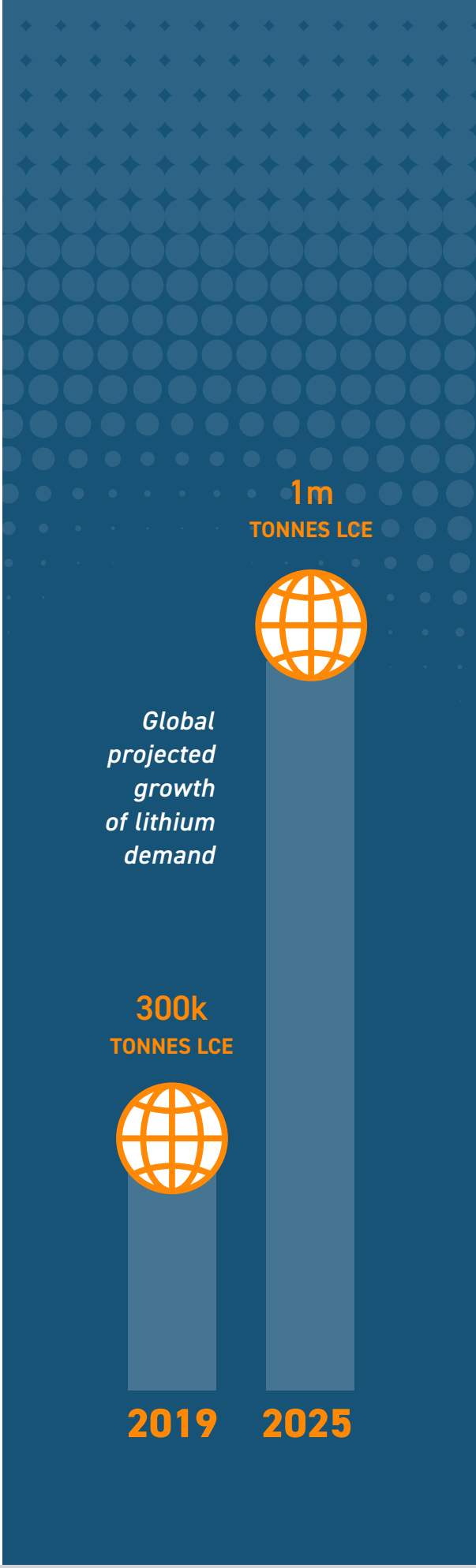


technological innovation in those projects has been minimal. However, as demand for lithium increases, other types of resources will need to be developed in order to satisfy lithium demand. Development of the Salton Sea geothermal lithium brine resource would signify a substantial diversification to global supply and help meet demand in the future, enhancing the opportunity for the U.S. to become a leader in this industry.

The U.S. currently produces approximately 1% of global lithium supply. But according to the USGS, the U.S. has 8.5% of the world's lithium resources, many of which do not fit the mold of spodumene and high grade brine such as is found in South America. New technologies are required for processing these resources. Direct lithium extraction (DLE) technologies are being developed for a number of different types of brines across the U.S.[54]

Oilfield brines are another type of lithium resource. North America hosts many oil drilling sites that produce brine containing lithium as a byproduct during petroleum extraction. DLE technologies have been developed to extract the lithium from these brines in Alberta, Canada, Utah, and there is some testing going on in the U.S. Oilfield brines tend to have lithium concentrations in the 10-75mg/L range, but some can contain more, such as Arkansas' Smackover Formation. Historically this region has produced bromine and calcium chloride from this brine, so permitting methods for mineral extraction and infrastructure already exists.[55] Standard Lithium has a joint cooperation effort with Lanxess AG to develop a DLE plant at an existing brine flow. Their preliminary economic assessment concluded that this plant could produce 20,900 tonnes of lithium carbonate annually with an operating cost in the $4,000/tonneLi2CO3 range, making it potentially feasible if the technology can be scaled up.

Extraction from geothermal brines represents a very promising source of lithium, and shares some similarities to oilfield brines. Typically, wastewater from geothermal energy plants is reinjected into the geothermal reservoirs from which it came. However, minerals such as zinc, manganese and lithium can be extracted from this brine and commercialized, but are currently reinjected with the waste brine. In the United States, the most notable example of this type of extraction was attempted by Simbol Materials for zinc and lithium extraction in the Salton Sea region in California's Imperial Valley in 2010. At the time, the company failed to commercialize the successful technical pilot because the mineral co-products from the Featherstone geothermal



54 U.S. Geological Survey, "Mineral Commodity Summaries," January 2020 https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf

55 Pistilli, Melissa, "US Unconventional Lithium Play: Rapid Lithium Extraction Technology Unlocking Value" Investing News Network, January 2019 https://investingnews.com/innspired/rapid-lithium-extraction-technology-arkansas-smackover-formation/

plant were delivered at a cost structure too high for market pricing. There are, however, currently three companies developing DLE in the Salton Sea for lithium production. With the lithium market set to boom in the 2020s, and having had the opportunity to learn from the failures of the past, these projects are exciting prospects for near-term lithium production in California. At least one of these developers believes that lithium could be produced in real time, via a closed loop environmentally friendly process, all powered by 100% renewable energy. In addition, battery grade lithium could be produced onshore without the need to be exported for further processing.

Lithium Demand

According to lithium market experts, the current demand for lithium has softened due in part to the Covid-19 pandemic. In lithium demand models from Benchmark Mineral Intelligence, they predict lithium supply will have to increase at a 19% CAGR over the next 6 years to meet 2025 demand.[56] To meet this demand, Lithium Valley is positioning the Salton Sea as a viable option for secure lithium supply with the highest environmental standards in the second largest automobile market in the world.

BNEF predicts that annual electric vehicle sales will increase from 1.1 million in 2017, to 11 million in 2025, and 30 million in 2030.[57] According to Benchmark Mineral Intelligence, global demand for lithium is expected to increase from 300,000 tonnes LCE in 2019 to ~1,000,000 tonnes LCE by 2025.[58] In the short term, the Covid-19 pandemic has had a significant influence on global lithium demand in 2020. However, this dip is expected to have minimal impact on the long-term trajectory of the demand curve. S&P shows that there has been a drop in lithium demand in 2020 but it will again grow steadily through 2025 and beyond.[59] This trend is a result of net consumption of lithium for lithium-ion battery manufacturing projected to increase by a factor of 8-10 times from 2020-2030.[60]

California's Battery Market

The current battery market in California has been driven by U.S. and international automakers' plans to introduce a wide range of electric vehicles at commercial scale by 2025 and beginning with launches in 2020. State and national stakeholders such as the U.S. Department of Energy, are making concerted efforts to bring battery manufacturing onto U.S. soil to align the electric vehicle supply chain with domestic automakers. At the moment, there are very few commercial battery manufacturers operating in California and no battery supply chain investments comparable to Tesla's Nevada Gigafactory. There are, however, hundreds of projects in pilot and prototype stages.

The biggest U.S. buyer in the battery industry is Tesla. Tesla has a car manufacturing facility in Fremont, California, and jointly operates the Nevada Gigafactory with their partner, Panasonic--where batteries are manufactured, battery packs are assembled, integrated and sent to Fremont for integration into a finished Tesla vehicle. Tesla recently announced its next Gigafactory in Austin, Texas and has signaled additional U.S. factories. Tesla buys cathode materials from Japan, although it has indicated that they are working on their own cathode manufacturing facilities, including piloting in Fremont. If this process is scaled up, it will represent the first use of lithium hydroxide to manufacture batteries by Tesla on U.S. soil.

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56 Benchmark Mineral Intelligence, "Lithium's Price Paradox," BMI Website, July 2019 https://www.benchmarkminerals.com/lithiums-price-paradox/

57 Electric Vehicle Outlook 2020, Bloomberg New Energy Finance, May 2020 https://about.bnef.com/electric-vehicle-outlook/

58 Vivas, Kumar, "Lithium-ion battery supply chain technology development and investment opportunities," Benchmark Mineral Intelligence, Presentation, June 2020 https://www.benchmarkminerals.com/wp-content/uploads/20200608-Vivas-Kumar-Carnegie-Mellon-Battery-Seminar-V1.pdf

59 Latham, Emmanuel, Ben Kilbey and Abdulrhman Ehtaiba, "Lithium supply is set to triple by 2025. Will it be enough?" S&P Global, October 2019 https://www.spglobal.com/en/research-insights/articles/lithium-supply-is-set-to-triple-by-2025-will-it-be-enough

60 Grant, Alex, Robert Pell and David Deak, "Geothermal Lithium: The Final Frontier of Decarbonization," Minviro Lithium LCA Partnership, May 2020 https://www.jadecove.com/research/finalfrontier

Other key players in the battery supply chain in California are SILA Nanotechnologies located in Alameda, QuantumScape located in San Jose and Enovex located in Fremont. SILA has bypassed a $1 billion valuation working on the cathode side of manufacturing. They are making a composite of high energy density cathodes. Most of their components are silicon and carbon, but they have also integrated lithium. QuantumScape is also a highly valued start-up based in the Bay Area that recently secured a $200 million investment from Volkswagen and announced plans on Sept. 3, 2020 to go public through a merger with Kensington Capital Acquisition Corp. They are building lithium metal solid state batteries that contain high energy density and relatively little space. QuantumScape represents one player among hundreds of California-based startups working on perfecting their battery tech and scaling. Another one of note is Enovex, developing a lithium ion battery with a silicon anode. Enovex is planning to build a pilot plant in California with the hopes of bringing this to scale.

Another type of company in the California battery supply chain are the chemical manufacturers. For example, Solartex has developed a lithium powder solution to manufacture a nanoparticle that can be used in the cathode. They are in the prototype stage but are very actively working to commercialize their product and get to scale in California. This represents another ecosystem in the value chain that can utilize lithium.

Role of China in the Lithium Market

Some countries have anticipated the burgeoning electric vehicle market and positioned themselves favorably for the impending lithium demand spikes. Specifically, China has taken significant steps to develop a domestic electric vehicle supply chain and incentivize electric vehicle adoption. China has set market targets for electric vehicles, plug-in hybrids, and hydrogen fuel cell vehicles by 2025. In the last 10 years, the Chinese government has invested close to $60 billion towards supporting the supply chain for electric vehicles. China is home to the biggest car market in the world, and a government keenly focused on reducing pollution. Overall, China's market is well situated to potentially become the key hub for the electric vehicle industry in the coming decades.

Chinese automakers have also benefited from policies incentivizing electric vehicle production. For example, since 2015 the government has subsidized auto manufacturers that use domestically produced batteries. This catapulted Chinese battery producer, CATL, to become a global leader for battery manufacturing. As of July 2019, China began phasing out these subsidies. Battery companies such as CATL have, however, already benefited from considerable lead time to grow their market share.[61]

With the Covid-19 induced economic recession, China has re-committed to subsidizing this industry to help with economic recovery. Specifically, consumers who purchase new electric vehicles through 2022 will receive subsidies and tax exemptions for 2 years.[62] The goal of this policy is to drive down the cost of electric vehicles for consumers. China has spent the last decade preparing their supply and demand for global electric vehicle adoption, and they are poised to emerge as leaders in the market. However, the U.S. auto manufacturers are similarly committed to transportation electrification and will want to derisk their global battery supply chains with domestic options.

61 Goldman, Abby R., Frank S. Rotondo and Jessica G. Swallow, "Lithium Ion Battery Industrial Base in the U.S. and Abroad," Institute For Defense Analyses, December 2019 https://www.ida.org/-/media/feature/publications/l/li/lithium-ion-battery-industrial-base-in-the-us-and-abroad/d-11032.ashx

62 Ibid.

III

LITHIUM VALLEY OVERVIEW

1. The Salton Sea

The Salton Sea is California's largest inland body of water. The current iteration of the sea was formed in 1905 when the Colorado River flooded the seabed, known as the Salton Sink, located in California's Imperial and Coachella Valleys. However, according to the Salton Sea Authority, there is geologic evidence that this Salton Basin hosted intermittent lakes over the past millennia.[63] The Salton Sea was once a tourist destination in the mid 20th century before it was overflowed with nutrient runoff from the surrounding industrial agriculture of the region. Now, the region around the Sea is a unique asset to the region — yielding renewable energy, critical mineral resources as well as crippling environmental hazards. The Salton Sea hosts 11 geothermal energy plants that provide renewable energy to the surrounding region of Imperial Valley, California and neighboring States. However, the Salton Sea's playa — which has emerged from the recession of the Sea—has also contributed over recent decades to air quality hazards for those same communities.

2. Salton Sea Environmental Status

The recession of the Salton Sea has accelerated the release of toxic materials from the playa. The Salton Sea is positioned in the valley of an agricultural region, and includes arsenic and selenium in its sand. This qualifies the Sea as a toxic waste location due to agricultural runoff including chromium, zinc, lead, and pesticides. As the Salton Sea water levels fall, the region's dry winds carry dust particulates from the exposed playa through the air. This phenomenon has caused major air quality challenges for the region of Imperial Valley.[64]

Evaporation, water conservation efforts and minimal rainfall are rapidly exposing the Sea's shoreline more and more each year. According to a 2017 study conducted at USC, this issue is directly linked with respiratory health problems in

63 The Salton Sea Authority, "Timeline of Salton Sea History," Salton Sea Authority Website http://saltonseaauthority.org/get-informed/history/

64 Lindberg, Eric, "As Salton Sea shrinks, experts fear far-reaching health consequences, University of Southern California News, August 2019 https://news.usc.edu/159380/salton-sea-shrinking-asthma-respiratory-health-air-quality/

Imperial Valley's vulnerable populations — particularly the Torres-Martinez and Fort Yuma Quechan Tribal communities and low-wage farmworkers.[65] The State of California, in partnership with the Salton Sea Authority, are currently implementing "Phase 1" of the Salton Sea Management Program aimed at suppressing this dust by 2028. However, this environmental justice and public health issue requires immediate and increased mitigation efforts to protect these exposed communities.

3. Imperial Valley — Local Economy

The Imperial Valley includes some of the most economically disadvantaged communities in California. A high percentage of the labor force works in agriculture, and farming is a major source of the region's income. The Covid-19 pandemic has had a particularly difficult impact on the Imperial Valley, with the civilian unemployment rate climbing to 27.8% as of May 2020.[66] Based on statistics collected from the State of California's Employment Development Department, this is an increase from 16.5% in May 2019. Compared to the California unemployment rate of 15.9% May 2020 (up from 3.6% May 2019) and national unemployment rate of 13.0% in the same period, the jobs in Imperial Valley have been hit especially hard during this recession. In the farming sector specifically, in May 2020, there were 10,000 jobs compared to the 12,200 jobs in May of 2019 — an 18% decrease from the previous year.[67] The pandemic has economically battered this already vulnerable population on an individual and community wide basis with unemployment and decreased local revenue.

On a broader scale, the municipalities and State-sanctioned funds for Imperial Valley are struggling to cover the costs of the Salton Sea Management Plan to address air quality issues in the region. According to a study by the Resilience Alliance,[68] the Salton Sea Management Plan lacks appropriate funding and progress for a long-term air quality solution. Thus, community engagement and stable local revenue streams are vital to protect the disadvantaged populations of Imperial Valley and ensure they do not bear the burdens of climate change. The air quality issues associated with the Salton Sea need urgent attention and a steady funding stream to ensure they are addressed.

65 Ibid.

66 State of California, Employment Development Department, Labor Market Information Division, https://www.labormarketinfo.edd.ca.gov/file/lfmonth/ecen$pds.pdf

67 Ibid.

68 Buck, H. J. "Understanding inaction in confronting ecosystem collapse: community perspectives from California's Salton Sea," Ecology and Society 2020 https://doi.org/10.5751/ES-11443-250127

The geothermal energy produced by the Salton Sea serves California's goal of 50% renewable energy by 2030 and 100% by 2045

4. Existing Geothermal Power Production

Existing geothermal energy plants operating in the Salton Sea have brought environmental and economic benefits to the region. In terms of environmental benefits, these geothermal plants have been constructed to cover exposed playa — helping to reduce the issue of toxic dust blowing through the air. In addition, the companies operating these plants are required to perform air quality mitigation measures as part of the permitting process. The plants provide jobs and income for the community members of Imperial Valley. The energy produced in these plants is completely renewable and generated around the clock. The geothermal energy produced in the Salton Sea serves California's goal of 50% renewable energy by 2030 and 100% by 2045. More geothermal energy could help support the grid by providing power at all times of the day, replacing the energy and capacity lost when the Diablo Canyon nuclear units retire in 2024 and 2025.[69]

There are 11 geothermal plants currently operating in the Salton Sea Known Geothermal Resource Area. This land is located at the south east corner of the watershed and primarily owned by the Imperial Irrigation District, the public utility provider in the region. These plants have a combined capacity of approximately 345 net megawatts of geothermal energy.[70] However, there's an estimated additional 2,000 megawatts of untapped geothermal energy potential in this area.[71] The energy produced at these plants is distributed throughout the southwestern states in the US.

Ten of the eleven geothermal plants are owned by CE Energy and operated by CalEnergy Operating Corporation, a subsidiary of Berkshire Hathaway Energy. These ten plants sell power to Southern California Edison Company, City of Riverside, Salt River Project, Sacramento Municipal Utility District, Imperial Irrigation District (IID) and Arizona Public Service. The energy is delivered to these customers on transmission lines owned and operated by the IID. The remaining plant is owned and operated by EnergySource; currently under a 30-year Power Purchasing Agreement with the Salt River Project, a power and irrigation district in Tempe, Arizona. Additionally, the Australian-based company, Controlled Thermal Resources recently signed a 25-year Power Purchasing Agreement with the IID in exchange for land they've leased for their planned Hell's Kitchen plant.

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69 Roth, Sammy, "California needs clean energy after sundown. Is the answer under our feet?" Los Angeles Times, January 2020 https://www.latimes.com/environment/story/2020-01-22/california-needs-clean-energy-after-sundown-geothermal-could-be-the-answer

70 US Department of Energy, Office of Energy Efficiency and Renewable Energy, "Imperial Valley Geothermal Area" US DOE Website https://www.energy.gov/eere/geothermal/imperial-valley-geothermal-area

71 Imperial Irrigation District,"Unlocking the Salton Sea's renewable energy potential," IID Website https://www.iid.com/home/showdocument?id=8599

5. Lithium Valley Vision

The vision for Lithium Valley includes the development of a world-class, environmentally sustainable battery materials manufacturing ecosystem in California, positioning the Imperial Valley as the epicenter and leader in this field. If done collaboratively with the community, this initiative will also establish long-term equitable benefits for the Imperial Valley and Salton Sea communities. The project is oriented around maximizing investment, tax revenue, and jobs for the community of Imperial County, one of the most economically disadvantaged in California. The plan is to co-produce renewable energy and lithium from geothermal plants operating in the Sea. Currently, there are three companies with plans to retrofit existing and build new geothermal energy plants with safe and clean mechanisms for lithium extraction.

As the electricity market continues its transition toward renewables as the most viable option for power production, Imperial Valley can build on its status as a leader in clean geothermal power production by leveraging that resource to produce low-emission lithium recovery. Further, the production and commercialization of lithium from geothermal plants will amortize the fixed cost of geothermal energy production over a wider revenue range. Three companies have proposed investments which provide thousands of community jobs, dozens of factories, and related businesses downstream. When fully realized, this project has the potential to act as a public-private partnership that ensures that many of the advantages associated traditionally with resource recovery—such as any potential royalties and tax revenue — are tied to benefits that go directly to the community, the ecosystem, and local tribes.

These long-term goals will begin with the construction and retrofitting of geothermal energy plants operating in the Salton Sea to include technology and infrastructure for lithium recovery. The three companies with existing geothermal plants and plans, Controlled Thermal Resources (CTR), Berkshire Hathaway Energy (BHE) and EnergySource Minerals (ESM), are already in the process of planning and testing this co-production of renewable energy and critical minerals. The economic, environmental, political and national security advantages resulting from this development could situate the U.S. and California as pioneers in electrified transportation development. There are, however, several barriers that must be addressed for these plans to come to fruition. Additionally, there are many stakeholders that will need to be part of properly executed planning and execution phases.

6. Economic and Jobs Opportunity

Lithium Valley comes with the potential for strong economic and employment opportunities for Imperial Valley and the State. Direct job numbers expected to be created from the Salton Sea lithium recovery projects are detailed below in the company descriptions. However, the creation of indirect jobs — jobs that emerge as a result of the projects' direct jobs — could add further to those totals.

Geothermal plant direct/indirect job numbers/Labor

The International Brotherhood of Electrical Workers (IBEW) and communities of Imperial Valley have sought to ensure that the labor force is hired locally. In addition, these groups also have expressed an interest that projects abide by public safety standards, metal labor standards and provide onsite workforce training. The people operating and maintaining the facilities need to be provided the necessary skills to safely maintain these facilities. The IBEW ensures that local infrastructure exists for training the workforce necessary for this initiative.

7. Government Initiatives

The following are current policy and financing initiatives that have been proposed and passed relating to lithium recovery in California and the United States. These initiatives are helping to catalyze Lithium Valley, however it is evident that these are only the first steps. For these projects to garner the momentum they need, California and the Federal government must pass more legislation and create more financing opportunities with domestic lithium extraction as a top priority.

California:

a. *AB 1657:* State Energy Resources Conservation and Development Commission. Previously AB 3100, Assemblymember Eduardo Garcia's AB 1657 was passed by the legislature in the 2020 session.[72] Assuming it becomes law in September 2020, it will establish a Blue Ribbon Commission on Lithium Extraction in California by March 1, 2021. The Blue Ribbon Commission is tasked to review, investigate, and analyze safe environmental methods for lithium extraction from geothermal brines as well as its processing and production. The Blue Ribbon Commission will deliver a report to the legislature with its findings on or before October 1, 2022.

b. Financing/ Incentives

Enterprise Zone: Imperial County is designated as a California Enterprise Zone. This means that companies developing projects in this region are eligible for Enterprise Zone tax credits and deductions including: Hiring Tax Credits, Sales and Use tax credit, Business Expense Deduction, Net Interest Deduction for Lenders. These policy incentives could be another facet that attracts development in the low-income communities of Imperial Valley — bringing jobs and revenue along with it.

CA Infrastructure and Economic Development Bank (IBank): The Climate Catalyst Revolving Loan Fund was established in January 2020. This revolving loan fund was established to provide capital to shovel-ready projects addressing climate change.

California Energy Commission (CEC) Grants: The CEC has held informational workshops and presentations on the Lithium Valley opportunity over recent years. Additionally, the CEC has funded R&D activities to progress lithium recovery technology.

Federal

a. *S.3694:* Onshoring Rare Earths Act of 2020 (ORE Act): this proposed legislation would amend the Internal Revenue Code of 1986 to permanently allow a tax deduction at the time an investment is made in property used to extract critical minerals and metals from the United States. This bill was proposed by Senator Ted Cruz (May 12, 2020) to include lithium and cobalt as rare earth minerals. This Bill establishes a Secretary of Defense grant program for pilot projects extracting critical minerals (not to exceed $10M) and will incentivize development of Imperial Valley's lithium deposits.

b. *H.R.4481* - Securing Energy Critical Elements and American Jobs Act of 2019: Introduced in the House by Rep Swalwell (D-CA-15) in September 2019 and currently being discussed in the House Science, Space, and Technology Subcommittee on Energy. This Bill seeks to develop the United States' capabilities for production and technology around critical minerals. The Bill would spur research and development for energy critical minerals and ensure that these efforts could not be discontinued by the DOE.

c. The House Select Committee on The Climate Crisis published a report in June 2020 discussing different opportunities for clean energy incentives and implementation.

72 California Assembly Bill 1657, "State Energy Resources Conservation and Development Commission: Blue Ribbon Commission on Lithium Extraction in California: report" https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB1657

IV

OVERVIEW OF THE ACTIVE SALTON SEA PROJECTS

The companies interviewed for this report currently active in development of lithium recovery in the Salton Sea are described below including the lithium recovery scale, timing, employment, technology and partners. Each offered perspectives on bottlenecks to reaching commercial operation for their lithium recovery business.

1. Controlled Thermal Resources

Overview: Controlled Thermal Resources (CTR) is developing its Hell's Kitchen Lithium and Power Project to be located on Salton Sea exposed playa overlaying the Salton Sea Geothermal Resource. CTR leased land and its mineral rights from the local utility, Imperial Irrigation District, along with signing a 25-year PPA for a portion of the clean energy produced. They are using direct lithium extraction technology to vertically integrate lithium extraction and geothermal power production. CTR's goal is to advance California's lithium market and renewable energy portfolio with the co-production of battery-grade lithium and geothermal power.

Lithium Production Stats:

- *Site:* Hell's Kitchen Lithium Production and Power Plant
- *Quantity:* Field wide concentration of lithium ranges between about 160ppm and 350 ppm. The Project is a staged production pathway to approximately 34,700 tonnes per annum of Lithium Carbonate Equivalent (LCE) utilizing 100% renewable, base load geothermal power.
- *Which feedstock / minerals / final product*:
  - In CTR production plan: Eight stages with each stage producing approximately 34,700 tonnes per annum LCE for a total production when fully developed in excess of 300,000 tonnes per annum LCE.
- *Production Start Date:* The anticipated commercial operation date for the first 17,350 tonnes per annum train is late 2023.
- ***Jobs Created:*** When all eight stages are fully developed the estimated total local impact is over 4,000 jobs inclusive of 1,400 permanent jobs, and 480 continuous construction jobs for the duration of the 8 stages of this project. With the creation of 1,400 permanent jobs in Imperial County, there is a multiplier effect on the community across several industry sectors, which is estimated to result in more than triple the initial jobs created in the region. **These projections total nearly 2,500 ancillary jobs with an estimated 581 direct jobs, 109 indirect jobs and 1,715 induced jobs, per an Imperial Valley Economic Development Corporation (IVEDC) economic assessment.**

- *Technology Description:* CTR is partnering with another California-based company, Lilac Solutions, to utilize their ion exchange technology to recover lithium. Ion exchange technology has been in operation for 80+ years in various industries including mineral recovery, and Lilac tailored this technology to be highly selective for lithium achieving recovery rates of about 90%. CTR and its engineering firm Hatch completed extensive test work and design work to demonstrate that direct lithium extraction from Salton Sea geothermal brine is competitive on a worldwide basis.

- *Partners:*
  - Imperial Irrigation District (IID): CTR's geothermal resource area is under lease from IID. In addition, CTR executed a 40MW power purchase agreement with IID for a 25 year term, currently valued at nearly $627 M. CTR is also in final negotiation for an additional 600 acres of industrial land for manufacturers looking to collocate due to the lithium resource.
  - *Lilac Solutions:* CTR selected Lilac Solutions as its lithium extraction technology provider. Lilac recently received venture capital funding of $20 M from Breakthrough Energy.
  - *Hatch:* CTR selected Hatch, the world's premier lithium process engineering firm. There are multiple Hatch designed lithium production facilities in operation worldwide.
  - *CEC:* CTR was recently awarded two grants from the CEC totaling approximately $4.6 M to develop technologies that support the extraction of lithium from geothermal brines.
  - *Lawrence Berkeley National Lab (LBN*L): CTR and LBNL are collaborating on the work funded by the CEC.
- *Bottlenecks:*
  - Permitting timeliness at both the national and state levels. California statewide recognition of the need for geothermal energy to assist in the management of a stable and reliable electric grid.
  - *Additional Economic Benefits:* For every $1 spent on payroll, the project is estimated to generate an additional $1.23 for the community in local taxes and ancillary earnings. The creation of 1,400 jobs will result in an estimated $161.4 million in initial earnings and an additional $197.9 million in local taxes and ancillary job earnings, per an IVEDC economic assessment.

2. Berkshire Hathaway Energy

Overview: BHE Renewables, a wholly owned subsidiary of Berkshire Hathaway Energy, is working on modifying its existing geothermal power plants operating in the Salton Sea for lithium extraction. These power plants are operated by another wholly owned subsidiary, CalEnergy and will serve as the site for BHER's pre-commercial geothermal brine pre-treatment for the lithium recovery. BHER is working with AquaMin to scale up its lithium recovery technology to process 100 gallons per minute (gpm) of geothermal brine from the Region facilities to recover lithium chloride (LiCl) and convert it into lithium carbonate (Li_2CO_3) and BHE Renewables currently produces 350MW of its 4,000 MW of renewable power with geothermal generation in Imperial Valley.

- Lithium Production Stats
  - *Quantity:* BHER's resources alone could produce as much as 300,000 metric tons per annum (tpa) of high-quality, battery-grade lithium carbonate equivalent (LCE). See graphic for details. Full commercialization would see 60,000 metric tons battery grade lithium hydroxide. For Operating plant:

Potential annual 90 ktpa Li_2CO_3 production. For Greenfield plant: potential annual 210 ktpa Li_2CO production.

- Which feedstock / minerals / final product: Lithium carbonate

- *Production Start Date:* 5.5 year timeline until full commercialization, measured from end of Q2 2020. Initial operating plant estimated to be operational after 30 months and reach capacity of 1,000mt in the following year. The initial plant will serve as pilot and example for cash generation to validate full scale plant ideas.

- ***Jobs Created: Average monthly construction employment:*** **230 workers. Full Time Management and Administrative employment: 400 workers.**
  - Berkshire Hathaway estimates that if fully built out, its lithium operations would bring 230 temporary construction jobs.

- *Technology Description:* pilot-tested to process 100 gallons per minute (gpm) of geothermal brine from the region facilities to recover lithium chloride (LiCl). Also applying under a Funding Opportunity Announcement to the U.S. Department of Energy to design, build, and demonstrate an innovative lithium hydroxide (LiOH) conversion plant. When complete, the plant will accept approximately five gallons per minute (gpm) of an 8% lithium chloride solution from an adjacent lithium recovery demonstration facility funded by the California Energy Commission (CEC). Via electrolysis, the proposed plant will convert this solution into approximately 25kg/hour of the 99.5%-pure lithium hydroxide monohydrate (LiOH-H2O) for quality validation testing by a major manufacturer of electric vehicle batteries.

- *Bottlenecks:*
  - *Technological:* The brine that comes from the ground, cycles through a geothermal plant and returns to ground at a very high temperature (difficult to separate the impurities). The brine is very saturated with impurities — usually the 330ppm brine would be solid but because of the high temperature it's a liquid. Brine includes unwanted silica and iron oxide. They have the technical capability to deal with this but it still presents a challenge.
  - Regulatory/permitting challenges should not be an issue because the geothermal plants already exist and they have support from a very strong player in the region, IID. However, they are being considered a potential bottleneck regardless.
  - Would like more state guidance regarding these questions: If California moves to become a major lithium producer, which agency oversees this? Would the Blue ribbon commission help guide this process, eliminate red tape?
  - *Timeline:* Covid-19 has not caused any delays for BHE Renewables' project.

- *Additional Economic Benefits:* Potential to generate indirect funds for Salton Sea environmental hazard mitigation.

3. EnergySource Minerals

Overview: EnergySource Minerals is a privately held company developing lithium projects in Imperial Valley's Salton Sea, as well as other brine resources. The company is developing its first project alongside the John L. Featherstone geothermal plant.

- *Lithium Production Stats*
    - *Quantity:* 19,000 tonnes per year as lithium hydroxide
    - *Which feedstock / minerals / final product:* producing lithium hydroxide but also will produce mineral coproducts that are commercially extractable (currently no firm estimates but this is expected to represent incrementally more jobs and tax base).

- *Production Start Date:* target is construction in the middle of 2021 with a two-year construction schedule. Lithium supplies will be online by 2023. The schedule has been slightly delayed due to the pandemic. Project timeline and supply/demand curves have shifted but the long-term projections remain the same as pre-pandemic.

- ***Jobs Created:*** **Lithium hydroxide production will have direct employment on site of 60 people.** Indirectly, there will be a large multiple effect from surrounding sectors of support including transportation, maintenance and outside services.

- *Technology Description:* EnergySource Mineral's extraction process, relies on commercially proven technologies to extract lithium under 300mg/L in Salton Sea brines, which are lower concentration than conventional brine resources in South America. EnergySource Minerals has integrated hydrometallurgical techniques, a proprietary lithium selective adsorbent, and state of the art crystallization approaches to achieve battery grade lithium hydroxide. They have already tested this process with geothermal brines and have completed an engineering package. The advantage of this technology is it will make this process more cost efficient. Major elements of EnergySource Mineral's technology platform can be applied to any lithium brine resources and will serve as a model for future projects around the world.

- *Business Model Information:* Co-produced minerals from brine resource from Featherstone Geothermal Plant — environmental footprint has already been made. There is no need to consider wetlands or endangered species mitigation concerns because they are on an existing industrial site.
    - There is a hope that California will incentivize companies to source locally (which could be in the form of tax breaks or a credit system) to align more with the entire value chain from the standpoint of entering the California market.

- *Bottlenecks:* Covid-19 has pushed back the schedule by about half a year.
    - Making partnerships with cathode manufacturers and OEMs has been challenging because of the uncertainty surrounding new resource supply.
    - *Regulatory:* This is less of an issue for ESM in the Salton Sea because they are retrofitting an existing industrial site.

- *Additional Economic Benefits:* It is estimated that the plant will generate over $25 million per year in direct economic benefits to the local community including employee salaries, royalties, utilities, and taxes. The annual maintenance program for the plant will generate an additional $60 million each year for the community.

V

LITHIUM VALLEY CHALLENGES

1. Financial

According to stakeholders in the industry, a major challenge for these developing lithium recovery projects is attracting financial support for demonstration and commercialization. Historically, battery manufacturers and automakers have not shown willingness to make direct investments this far upstream. Without early investment to demonstrate the technology cost and quality at commercial scale, manufacturers have been hesitant to contract with new lithium producers. Investment in large scale mining projects, whether from a brine resource or hardrock is also challenging in the U.S. due to the length of time for permitting and construction. As with many emerging technologies, the financial investment to scale from demonstration to full-scale commercialization is likely to include a step that marries public and private funding. For lithium recovery, the private funders may include mining companies, energy companies, manufacturers and diversified industrial companies, all of whom tend to have conservative investment parameters and limited risk appetite for new technology.

2. Policy

Experts and stakeholders cited California's strict environmental regulations as a bottleneck for developing Lithium Valley. In fact, multiple developers stated that the primary barrier for lithium development in the Salton Sea is regulatory compliance and permitting issues. For example, several stakeholders mentioned that there is no central state agency assigned to jurisdiction of lithium recovery. Without clarity for the steps and timeline for the development process, delivery timing discussions with potential customers and investors can be challenging.

The main regulatory hurdle echoed among many stakeholders was California Environmental Quality Act (CEQA) guidelines. There is confusion from both developers and state agencies regarding which bodies are responsible for each step and concerns about perceived overlap. Also, California's strict CEQA permitting requirements can extend the development process substantially compared to other states. Some of the companies developing in the Salton Sea have requested a committee or policy to streamline CEQA reviews.

Another barrier is the difficulty of attracting cathode manufacturers to California. Cathode manufacturing requires high volumes of energy and water — both of which are considered expensive in California compared to other options like upstate New York and Quebec where there is ample, affordable hydropower and clean water availability. Lithium market experts suggest that for California to become a competitive state for attracting this industry, they must incentivize battery manufacturers with policy initiatives. California requires more alignment along the battery supply chain to make it easier for manufacturers and upstream processes to develop. According to industry personnel, historically, California has not been effective at orienting policies, regulations and tax arrangements around decision-making efficiency. There is a growing desire for California to incentivize battery manufacturers to source locally-- using tax breaks, subsidies or a credit system — to vertically align players in the value chain entering the market in California.

On the federal side, questions exist regarding jurisdiction. According to experts, there is no natural fit for one specific agency to take charge of national lithium development. There could be an argument for the U.S. Department of Labor,

the Department of Commerce or the Department of Energy to be the primary agency. This initiative however ties to many industries which makes this streamlining of oversight and regulation complicated. This bureaucratic challenge has the potential to be an obstacle for federal dollars flowing to California for development of the critical mineral supply. This could mean that applying for federal support — such as grants and loans — could be challenging without clarity on a specific agency counterparty.

3. Technology and Timeline

The consensus among lithium producers interviewed for this report was that the extraction technology is ready for commercial demonstration. The scale of the resource at the Salton Sea, however, has not been independently verified. The USGS is reported to be working on a reserve and resource analysis. In addition to technology, the other area to demonstrate is the timing required to deliver commercial scale lithium recovery plants.

The lithium recovery projects at the Salton Sea plan to co-produce geothermal energy and lithium. As these companies try to develop both, there are two different sets of issues and challenges around the development process. Experts caution that every resource is different — the brine from the Salton Sea is unique and will take time to get to scale. Additionally, battery manufacturers' specifications regarding the quality of lithium will continue to be refined as battery chemistry advances. Manufacturing standards will evolve as higher energy density cathodes mature, requiring lithium materials quality to improve. Aligning the end-product quality from lithium recovery operations with the timeline for commercial operations adds a dimension of complexity to commercial contract negotiations.

4. Environmental

There are several environmental challenges associated with the projects in the Salton Sea. The first of which is finding the most effective way for companies to contribute to remediation of the air quality concerns from the playa at the Salton Sea. One example proposed would be to revert revenue directly from lithium recovery plants to a Salton Sea trust fund. The three companies working on lithium recovery development have all expressed interest in participating in mechanisms for achieving environmental remediation.

When contemplating Salton Sea environmental remediation options, the investing companies will benefit from community engagement with local stakeholders to gain insight about where and how remediation investment can be most effective. Additionally, there are several known endangered species in the Salton Sea (pupfish, birds) that need to be mapped and accounted for in development of plants. Salton Sea environmental stakeholders include the National Audubon Society, California Fish and Wildlife, U.S. Fish and Wildlife. These concerns could be addressed through CEQA guidelines on wildlife preservation.

VI OPPORTUNITIES AND NEXT STEPS

During the first nine months of 2020, key actions have been taken by policymakers to advance the prospects of establishing Lithium Valley as the anchor for the domestic lithium battery supply chain. California state funding has been allocated for demonstration of lithium recovery and AB 1657, by Assemblymember Eduardo Garcia, was passed by the legislature on August 31, 2020.

1. State Level Measures

- **California Energy Commission (CEC) initiatives:** The CEC has led dialogue and funding since 2018 on the potential of developing Lithium Valley. It has funded GFO 19-306, a spring 2020 funding opportunity that provided nearly $8 million to further this work and continues to use its convening ability to bring together stakeholders.
- **Blue Ribbon Commission on Lithium Extraction in California:** Assemblymember Eduardo Garcia's bill AB-1657 was approved by the legislature in the 2020 California legislative session.[73] Assuming this bill becomes law in September, 2020, it will create a Blue Ribbon commission on or before March 1, 2021 to review, investigate, and analyze safe environmental methods for lithium extraction from geothermal brines as well as its processing and production. Of the 14-member Commission, four seats have been specifically reserved to represent local voices and community needs. The Blue Ribbon Commission will deliver a report to the legislature with its findings on or before October 1, 2022.
- **Developing a community centered "Inclusion and Innovation Hub (I-HUB)" in Lithium Valley:** This would entail a program of support for start-ups and small businesses related to the development of Lithium Valley that uplift local communities through economic opportunities and jobs. *IE RISE*—which focuses on counties adjacent to Imperial County—is an existing model for the type of community led thinking needed to develop Lithium Valley in a way that can benefit all for decades to come.[74]

73 Ibid.
74 https://ierise.org/

- **Economic Stimulus legislation:** This action could take a number of different approaches to support job creation and economic recovery. One area for consideration is a production tax credits or subsidy to battery manufacturers that use a certain percentage of domestically produced lithium in their production facilities. Other potential areas include incentives for consolidating efforts around a statewide battery storage manufacturing program, as well as exploring lithium recycling.
- **Supporting development of cathode manufacturing:** California does not currently have a cathode manufacturing plant. As discussed in the California battery market section of this report, this is a significant gap in the State's electric vehicle supply chain. Domestically recovered lithium is currently sent overseas for manufacturing cathodes. An opportunity exists to support policies and programs to incentivize the development of a cathode manufacturing plant. This would vertically integrate and internalize the battery supply chain to keep jobs and revenue in the state while minimizing environmental externalities associated with transportation of lithium. California policymakers could engage with counterparts in other regions producing lithium such as North Carolina, Nevada and Arkansas.
- **Addressing California Environmental Quality Act (CEQA) and project permitting:** In terms of amending current policies, the most notable bottleneck for developers is permitting requirements under CEQA. Finding a mechanism to streamline CEQA — by exemption or making the process more straightforward/concise—has been noted by project developers. However, a consideration is ensuring that environmental impacts are fully identified and mitigated. This also takes into account public participation-- including engagement with environmental justice and labor groups.

2. Federal Level measures:

- **Federal Economic Stimulus:** In June 2020, the House Select Committee on The Climate Crisis in its report expressed specific interest in domestic lithium recovery. A potential economic stimulus package in 2020 or 2020 as part of a federal Covid-19 response could include funding for clean energy and climate mitigation projects, similar to the Housing and Economic Recovery Act in 2008. These dollars could possibly be leveraged to help finance lithium projects in the Salton Sea. Other parts of the federal government have also expressed support for domestic lithium recovery. In 2018, the U.S. Department of the Interior declared lithium as a critical mineral for U.S. economic and national security.

- **National Environmental Policy Act (NEPA):** NEPA dictates permitting and regulations under federal law. Similar to CEQA at the state level, streamlining NEPA processes could be beneficial for companies seeking to develop in the Salton Sea area. Considerations regarding environmental justice and protections should also be considered for this work.

- **Project Financing from the U.S. Department of Energy (DOE) and U.S. Department of Agriculture (USDA):** Opportunities in the U.S. Department of Energy's Loan Programs Office and through the U.S. Department of Agriculture's Rural Economic Development Loan & Grant Program to fund new clean energy projects. Both could be explored to fund lithium recovery and/or manufacturing in rural Imperial Valley, possibly by financing the electricity generation activities tied to such projects.

- **Supply Contracts:** A further measure that DOE or other federal agencies could take is to encourage and/or supplement long term contracts between lithium production facilities and domestic and/or international battery developers. Providing a stable market for lithium is one of the most important factors that will drive future private investment and expansion, especially during the current pandemic crisis.

VII

SELECTED LITHIUM VALLEY STAKEHOLDERS

In the process of developing Lithium Valley, a range of public and private stakeholders are key in coordinating activities. Some of the important stakeholders include:

1. Imperial Valley Stakeholders

- Imperial Valley Government Stakeholders
  - Imperial County Air Pollution Control District (APCD)
  - Imperial Valley Workforce Development Board
  - Imperial County Economic Development Department
  - Imperial County Board of Supervisors
  - Imperial City Council
  - Imperial County Community Development Department
  - Imperial County Planning Commission
  - Salton Sea Authority: The Salton Sea Authority is a Joint Powers Authority (JPA) empowered to revitalize the Salton Sea in consultation and cooperation with state and federal governments. It works in cooperation with California on the restoration of the Salton Sea.
- Imperial Irrigation District (IID): Non-profit publicly owned utility provider for much of Imperial Valley. Leases land to companies for geothermal/lithium projects. Signed a 25 year PPA with CTR for the geothermal energy produced at their plant Hell's Kitchen. IID has also taken the lead for overseeing CEQA issues and engagement with various agencies regarding endangered species protection. IID's lithium valley interest: Imperial Valley Economic Development Corporation: provided an economic and jobs assessment for CTR's Hell's Kitchen plan at the Salton Sea.
- Local Tribal representatives
  - Torres-Martinez Tribal TAMF (Temporary Assistance for Needy Families)
  - Fort Yuma Quechan Indian Tribe Government and Council Members
- Community groups local to Imperial Valley region
  - Comité Cívico del Valle, Inc.: Luis Olmedo's org that works on improving lives of disadvantaged populations in the Imperial Valley (PD, education, etc.)
  - IVANN Community Air Monitoring Network
  - Salton Sea Community Outreach Education & Engagement
  - AIREE Collaborative
  - UC Cooperative Extensive: Dr. Oli Gurmu-Bachie, UC Riverside vice chair

- Alianza Coachella Valley
- Leadership Council for Justice and Accountability
- Los Vigilantes

2. State Level Stakeholders

- AB 617 Community Steering Committee: body under the California Air Resources Board involved with air quality control in California's Imperial Valley. Issues annual grants to organizations addressing environmental hazards associated with air quality in California.
- California Air and Resources Board (CARB): body responsible for protecting California communities from air pollution, emissions and climate change.
- California Energy Commission: The state's primary energy policy and planning agency.
- California Environmental Protection Agency (CalEPA): Cabinet level agency responsible for overseeing and enforcing environmental laws in California. This agency regulates air, water and soil quality, pesticide use and waste recycling and reduction.
- California Geologic Energy Management Division (CalGEM): part of the California Department of Conservation. Responsible for overseeing California's oil, natural gas and geothermal industries.
- California Natural Resources Agency: State cabinet level agency responsible for protecting and conserving California's natural resources. This includes biodiversity, water, natural lands and cultural and historical resources.
- Governor's office of Business and Economic Development (GO-Biz): responsible for business assistance, job growth and general economic development for the State.
- California Infrastructure and Economic Development Bank (IBank): created in 1994 to finance public infrastructure and private development. IBank has broad authority to issue tax-exempt and taxable revenue bonds, provide financing to public agencies, provide credit enhancements, acquire or lease facilities, and leverage State and Federal funds. IBank's current programs include the Infrastructure State Revolving Fund (ISRF) Loan Program, California Lending for Energy and Environmental Needs (CLEEN) Center, the Climate Catalyst Revolving Loan fund, Small Business Finance Center and the Bond Financing Program.

3. Federal Stakeholders

- U.S. Department of Agriculture
- U.S. Department of Commerce
- U.S. Department of Energy
- U.S. Department of the Interior
- U.S. Environmental Protection Agency. (California is part of Region 9.)

4. Notable Private Efforts

Initiative for Responsible Mining Assurance: mining guidelines that could be utilized for lithium recovery. It is a coalition of nongovernmental organizations, mining companies, businesses purchasing minerals and metals for resale in other products, affected communities, and trade unions. IRMA's vision is that of a world in which the mining industry is respectful of the human rights and the aspirations of affected communities; provides safe, healthy and respectful workplaces; avoids or minimizes harm to the environment; and leaves positive legacies. Its mission is to establish a multi-stakeholder and independently-verified responsible mining assurance system that improves social and environmental performance and creates value for the mine sites which lead.

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