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Minerals Report

North Carolina's Phosphate, Quartz (Silica), and Lithium Resources in Clean Energy

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Executive Summary

The U.S. Geological Survey estimates that North Carolina has $2.72 billion of annual non-fuel mineral production assets, including phosphate, high-purity quartz (HPQ), and lithium. These minerals are essential inputs for many vitally important, high-growth industries.

PHOSPHATE

- The Aurora phosphate mine in Beaufort County, NC, operates at production levels well below its nameplate capacity, indicating that there is room for volume growth. The global phosphate rock market is forecast to grow from $16.44 billion in 2024 to $21.34 billion by 2029. If the Aurora mine were to scale its output proportionally with this increase in demand while remaining within capacity and regulatory limits, its annual production could increase to over 5 million tonnes by the end of the decade. We estimate that this volume growth would increase the mine's revenue from $250 million in 2024 to $386 million in 2029.

HPQ

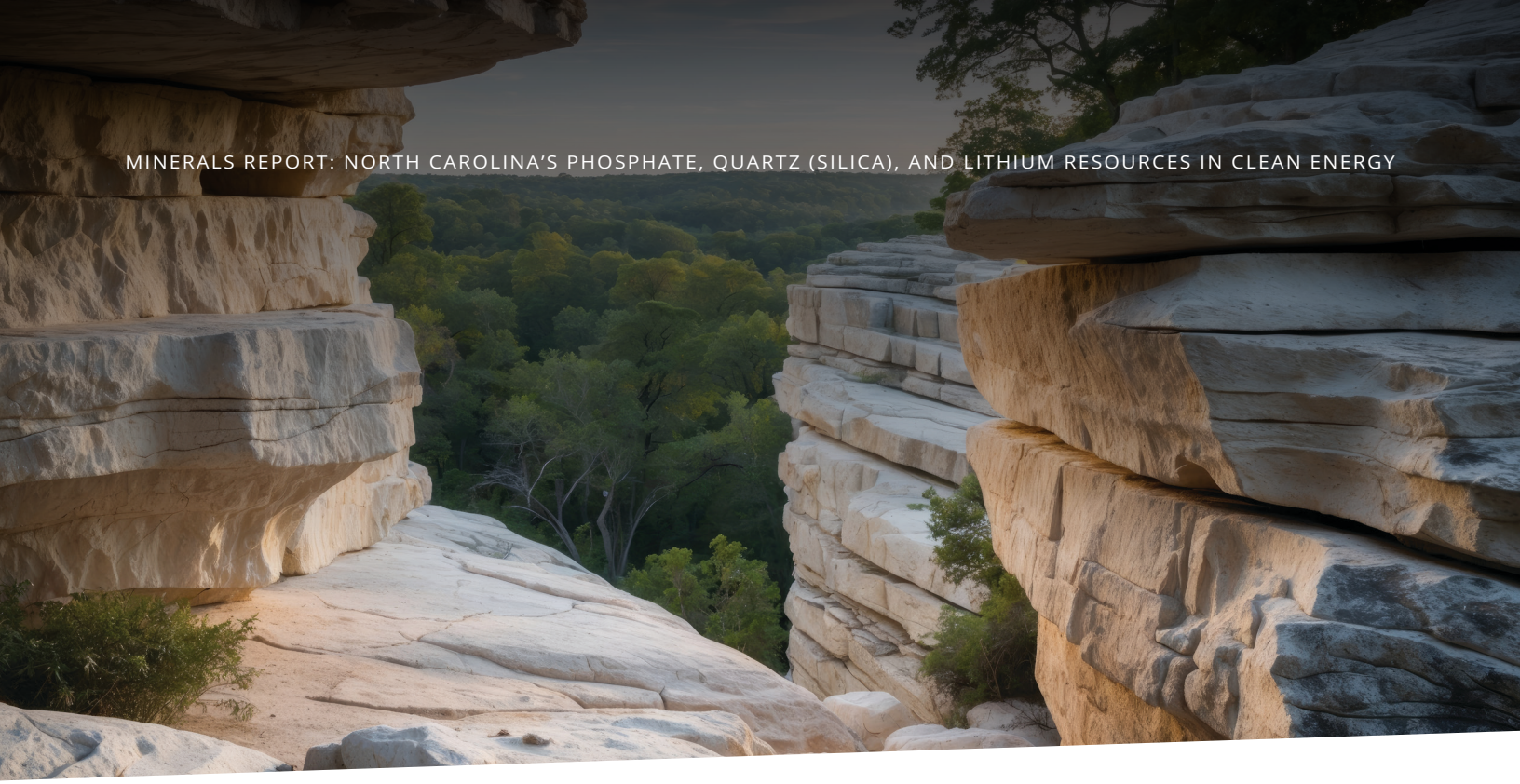
- Two European-owned companies, Sibelco (Belgian-owned) and The Quartz Corp (French-Norwegian-owned), operate HPQ mines at North Carolina's Spruce Pine Mining District. Using empirical parameters for volume and price growth, our model finds that the Spruce Pine HPQ operations could increase their annual revenue from $2.4 billion in 2024 to $5.7 billion in 2029.

LITHIUM

- Two companies have near-term plans to start mining the Carolina Tin-Spodumene Belt again in two counties just west of Charlotte, NC. Albemarle Corp. plans to reopen a mine south of Kings Mountain in Cleveland County by 2029, and Piedmont Lithium, a Belmont, NC, company, is planning to build a lithium mine in Gaston County, just outside Cherryville, NC. That mine's construction is slated to commence this year, and it would begin operation in 2027. We estimate that, by 2029, those mines could gross an annual $397 million for spodumene and an additional $196 million for lithium hydroxide produced by Piedmont Lithium.

We estimate potential revenue from North Carolina's production of lithium, phosphate and quartz/silica, assuming two different tax regimes: the volume-based approach used in California, Florida and Arkansas and a 2.5% royalty rate used in Arkansas for lithium, which is a common severance tax rate in other states on hard rock mining. Using a volume tax, we estimate potential tax revenue of between roughly $5 million and $90 million in 2026 from existing phosphate and quartz production — the large range results from different modeled tax regimes. With more lithium production coming online in 2027, tax revenue could rise to between $10 million and $130 million and, by 2029, be as large as $230 million.

Additional analysis of global markets and consultation with mineral producers about their needs and capabilities is essential to develop an optimal severance tax policy, one that incentivizes domestic production, local value-added processes and alignment of supply chains while promoting environmental protection, sustained private sector growth and robust public sector revenue.



Introduction

Rich in natural resources, North Carolina holds vast deposits of the minerals that power the world's vital industries and indispensable technologies — from fertilizers to computer chips, electric engines to communications infrastructure.

> **"The Tar Heel State has an estimated $2.72 billion of non-fuel mineral assets, ranking it 12th nationally and accounting for 2.57% of the U.S. total, according to the U.S. Geological Survey.**

Among the state's mineral commodities, which include construction and industrial sand, gravel and crushed stone, North Carolina is a major supplier of phosphate and high-purity quartz (HPQ) (silica) in domestic and global supply chains. In addition to its valuable and, in the case of HPQ, exceedingly rare mineral production wealth, the state boasts significant lithium reserves, which have remained untapped for more than 30 years. The global lithium market has undergone unprecedented growth over the past decade, largely due to the booming electric vehicle (EV) and energy storage industries, and now two lithium mines are slated to reopen in the state.

HPQ, lithium and phosphate are critical minerals — vitally important inputs for many industries, including agriculture, clean energy, semiconductors and battery production, all of which are fundamental constituents of the 21st century economy. For North Carolina, exploiting these resources would help support economic growth and industrial development and serve as a source of some state and local tax revenue. This revenue could help support environmental preservation, civic infrastructure and other facets of vibrant local communities. Developing domestic critical mineral production industries is also foundational to keeping supply stable and enhancing national security. The key question for North Carolina's mineral producers and the government offices overseeing them is how to develop and grow the state's minerals sector in an optimal way, with guidelines and policies that would help the industry meet its great potential.

Phosphate

What do plants, toothpaste and electric vehicles have in common?

Phosphate is a naturally occurring mineral group containing the phosphate ion (PO_4^{3-}), a compound of phosphorus and oxygen. An essential input in many key economic sectors, most commoditized phosphate is used in fertilizers, where it serves as one of the three fundamental nutrients required for plant growth, alongside nitrogen and potassium. In plants, phosphate's primary function is to support root development and flowering, and thus to boost crop yields in agricultural systems.

Phosphate is also used in animal feed, human food products, cosmetics and personal care items such as toothpaste. In recent years, phosphate-based compounds have become integral components in emerging energy technologies, particularly in the production of lithium iron phosphate (LFP) batteries for electric vehicles and stationary energy storage systems. These batteries are highly valued for their safety, thermal stability and long cycle life, making phosphate an increasingly important strategic material in the global transition from fossil to mineral energy sources. With no viable substitute and many applications across food production, consumer goods and clean energy markets, phosphate is critically important to the global economy today and into the foreseeable future.

Current Supply

Florida is the country's largest phosphate producing state, and central Florida's Bone Valley region is home to several major phosphate mining operations, including those operated by The Mosaic Company, the largest U.S. producer. North Carolina, the second-largest phosphate producing state, is home to the Aurora mine in Beaufort County, operated by Nutrien Ltd. The Aurora mine has an annual production capacity exceeding 6 million metric tonnes of phosphate ore, yet production levels since 2022 have been well below capacity, staying between 2.5 million and 2.6 million metric tonnes, due to factors including fluctuating global demand, maintenance cycles, regulatory constraints on environmental permits and strategic production management aimed at aligning output with profitability and market conditions.[2,] Aurora's proven reserves are estimated at **356 million metric tonnes**, with operations expected to continue until around **2050** — an operational horizon that likely reflects regulatory permits, infrastructure depreciation schedules and expectations about economically recoverable volumes, rather than total physical depletion.[4]

In addition to domestic phosphate production, the

U.S. imported 2.4 million to 2.6 million metric tonnes per year between 2020 and 2024.[4] Originating almost exclusively from two countries — Peru (≈98%) and Morocco (≈2%) — these imports accounted for 6% to 16% of total U.S. phosphate consumption annually in that period.[8] In 2024, the U.S. imported an additional 3.5 million metric tonnes of phosphate rock, primarily from Peru. The figures expose a supply bottleneck and the U.S.'s dependence largely on one country for its supplementary supply of phosphate.[2]

Future Production

Nutrien has not announced plans for expansions in ore extraction volumes at its Aurora facility, as the company is increasingly focused on improving operational efficiency and securing self-sufficiency in phosphate rock supply. A manufacturer of fertilizer and other phosphate-based products, Nutrien's operations require a secure, steady supply of phosphate rock, only some of which the firm's mining operations now provide. According to the company's 2023 annual report, Nutrien's strategic objective is to eliminate reliance on imports by fully meeting its phosphate needs through domestic production. This self-sufficiency initiative entails investments in processing capacity and infrastructure optimization, rather than expanding raw ore output.

Given that the Aurora mine's current production levels are well below its nameplate capacity of over 6 million metric tonnes, there is room for volume growth — a move that would make financial sense if market demand for fertilizer and phosphate-based products increases. Overall U.S. phosphate demand is expected to rise modestly over the next five years, stemming from worldwide growth in agricultural intensification, electric vehicle battery production and renewable energy storage. Meanwhile, the global phosphate rock market is forecast to grow from $16.44 billion in 2024 to $21.34 billion by 2029, a compound annual growth rate of 5.4%.[2] If Nutrien were to scale its output proportionally with this increase in demand while remaining within capacity and regulatory limits, its annual production at Aurora could increase to over 5 million tonnes by the end of the decade.[4,9] This growth, however, would be predicated on the firm maintaining its environmental permits.

At the national level, imports from Peru and Morocco may remain necessary to meet U.S. consumption, especially during periods of domestic shortfall or mining disruptions. Yet domestic production increase by Nutrien could reduce the country's import dependency and improve critical mineral supply chain resilience.

Market Value

On April 8, 2025, Governor Josh Stein issued a Phosphorus Week proclamation noting that North Carolina's phosphate industry contributed about $250 million in total economic value to the state's economy in 2024, accounting for about one-sixth of mining's total contribution to state GDP.[10,11] Nationally, marketable phosphate rock was valued at **$2 billion** in 2024, according to the USGS.[2] This $2 billion valuation is derived from an estimated 20 million metric tons mined in the U.S. in 2024 at a dollar value of $100 per ton. The USGS obtains this information from voluntary surveys completed by over 18,000 minerals-related producers and consumers. These surveys gather data on aspects of the

mineral industry including production, consumption, shipments and unit value (price), and the price quote from the USGS is consistent with the average prices at which Nutrien has sold its phosphate ore recently, according to the firm's annual report.

To estimate the future market value of phosphate rock extracted from North Carolina's Aurora mine, we used 2024 as a baseline year with production at 2.5 million metric tonnes and a stable price of $100 per metric tonne — values that align with long-term averages reported by Nutrien and USGS. We applied a conservative annual production growth rate of 5%, consistent with recent operational trends and remaining nameplate capacity at the Aurora facility. While phosphate prices have remained relatively flat in recent years, projected total value increases are driven by expected volume growth. Total value is calculated as production multiplied by the fixed price.

Uncertainty

There is considerable uncertainty in predicting phosphate market prices due to cyclical fluctuations in supply, shifting trade dynamics and resulting price volatility — even as underlying demand is expected to grow steadily. Prices surged in 2021–2022 amid supply chain disruptions and geopolitical instability, then moderated in 2023–2024 as global supply conditions improved.[2,4] Future pricing remains challenging to predict, as prices are influenced by many variables, including agricultural demand cycles, clean energy policies and international trade regulations. The U.S.'s dependence on phosphate imports from two countries, Peru and Morocco, is a key vulnerability, as these imports made up as much as 16% of annual domestic consumption from 2020 and 2023.[8] This reliance exposes the domestic supply to geopolitical turmoil and external market shocks. New U.S. tariff regulations on imported phosphate products are expected to raise import costs, which will put upward pressure on prices and boost incentives to increase U.S. production. Meanwhile, domestic expansion — particularly at large, environmentally sensitive sites like North Carolina's Aurora mine — faces constraints from environmental permitting and climate-related disruptions[4], adding tension to the relationship between supply resilience and regulatory compliance.

Table 1: **Forecasted Phosphate Rock Value**

YEAR	PRODUCTION (MT)	PRICE RANGE (USD/MT)	TOTAL (USD MILLIONS)	SOURCE / SUPPLIER	LOCATION
2024	2.5	$100	$250	Aurora Mine (Nutrien)	NC, USA
2025	2.7	$100	$273	Aurora Mine (Nutrien)	NC, USA
2026	3	$100	$298	Aurora Mine (Nutrien)	NC, USA
2027	3.3	$100	$325	Aurora Mine (Nutrien)	NC, USA
2028	3.5	$100	$354	Aurora Mine (Nutrien)	NC, USA
2029	3.9	$100	$386	Aurora Mine (Nutrien)	NC, USA

Quartz (Silica)

What if the sand beneath your feet were the secret ingredient behind smartphones, solar panels and satellites?

High-purity quartz (HPQ), a silicon dioxide (SiO_2) mineral, is a crucial raw material input in the production of many advanced technologies. Quartz is one of the most abundant minerals on Earth, yet only a few known deposits have the exceptional purity required for high-tech applications. Spruce Pine, a small town in North Carolina's Blue Ridge Mountains, is home to the world's largest recoverable deposit of ultra-high-purity quartz, a rare distinction that indicates quartz deposits of 99.999% purity or greater. This specialized silica is essential for manufacturing semiconductors, photovoltaic cells, fiber optics and precision glass used in aerospace and telecommunications. The material's purity directly affects the performance and efficiency of these technologies, making Spruce Pine's quartz an irreplaceable input in global supply chains. Already a strategic asset enabling the digital and clean energy technology economy, North Carolina's quartz resources will only grow in distinction as demand for microchips, electronics and clean energy technologies expands.

Current Production

The ultra-pure quartz mined from North Carolina's mountains is far from ordinary sand. North Carolina's Spruce Pine Mining District is unique because no other place on Earth has as much or as minable pure quartz[12], which is the key input for producing the silicon wafers used in computer chips, smartphones and other high-tech products. Two European-owned companies, Sibelco (Belgian-owned) and The Quartz Corp (French-Norwegian-owned), dominate the global high-purity quartz industry and are the only firms with HPQ mining operations at Spruce Pine. Sibelco controls 70% to 90% of the global market, supplying roughly 200,000 metric tonnes annually, and The Quartz Corp produces around 30,000 metric tonnes annually.[2,12] The extraction processes at these mines are highly proprietary and closely guarded, protecting these firms' market dominance.[12]

Future Production

Responding to rising global semiconductor demand driven by growth in renewable energy and digital technologies, Sibelco in 2022 invested $200 million to double the installed capacity of its HPQ operations at its Spruce Pine facility.[13] HPQ production from Spruce Pine is estimated to have reached 0.20 million metric tonnes annually from 2022 to 2024. The feasibility studies for a second expansion are slated to be com-

pleted in 2027. These expansions create new jobs and attract investment to the region.[13] Despite geopolitical tensions and concerns about China's efforts to establish alternative high-purity quartz sources, Spruce Pine's reserves are robust enough to continue operations for at least another century.[12]

Market Value

A scarce and essential component in semiconductors, solar panels and fiber optics, high-purity quartz commands premium market prices. USGS estimates the price of silica to range from $500 to $20,000 per tonne. The wide range reflects the great variation in purity of silica and its different uses. Given that the silica from North Carolina mines is of the highest quality, we estimate an average price per tonne of $12,000 for the HPQ coming from these mines in 2025. This figure reflects a conservative estimate, and the highest-quality quartz from Spruce Pine may command the premium prices of about $20,000. Assuming the conservative $12,000 price, North Carolina's HPQ market value is estimated at $2.62 billion in 2025. Actual realized prices may vary depending on product grade and end-use application, yet this estimate underscores the resource's importance to global silicon technology supply chains and the regional economy.

To estimate the future market value of HPQ for the years 2025 through 2029, we applied a straightforward projection model using conservative annual growth assumptions based on historical performance and anticipated demand trends. Using 2024 as the base year with 0.20 million metric tonnes production and an average price of $12,000/MT, we applied a 9% compound annual growth rate to both variables, reflecting projections from Sibelco's Spruce Pine facility.[13] Total market value is calculated by multiplying projected production by projected price, showing HPQ's potential economic development amid growing global demand from clean energy and semiconductor markets.

Uncertainty

Despite projections of long-term demand growth, the HPQ market exhibits price volatility, largely due to cyclical fluctuations in global demand for semicon-

Table 2: **Forecasted Silica Value**

YEAR	PRODUCTION (MT)	PRICE RANGE (USD/MT)	TOTAL (USD BILLIONS)	COMPANY NAME	LOCATION
2024	0.200	$12,000	$2.4	Sibelco and The Quartz Corp	Spruce Pine, NC, USA
2025	0.218	$13,080	$2.85	Sibelco and The Quartz Corp	Spruce Pine, NC, USA
2026	0.238	$14,257	$3.39	Sibelco and The Quartz Corp	Spruce Pine, NC, USA
2027	0.260	$15,540	$4.04	Sibelco and The Quartz Corp	Spruce Pine, NC, USA
2028	0.283	$16,938	$4.79	Sibelco and The Quartz Corp	Spruce Pine, NC, USA
2029	0.309	$18,450	$5.70	Sibelco and The Quartz Corp	Spruce Pine, NC, USA

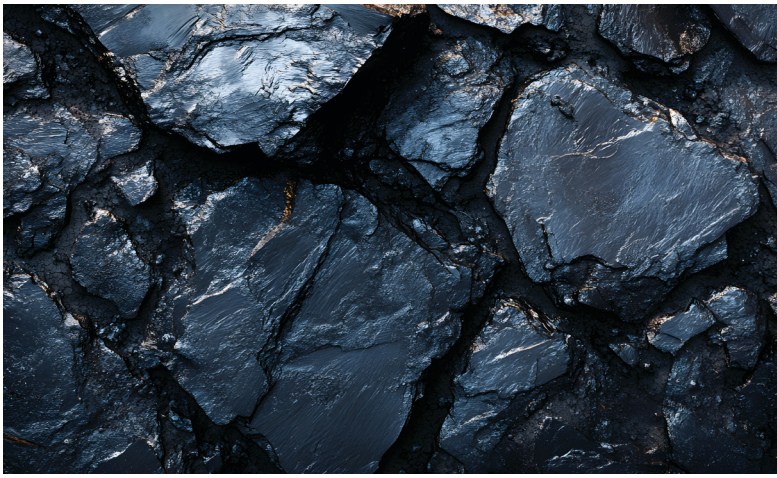
ductors, solar panels and advanced electronics. The resource's limited supply network, with North Carolina's Spruce Pine region among the world's only HPQ sources, elevates risks of operational disruptions, permitting delays and geopolitical shifts. These factors make long-term price and production forecasts inherently uncertain, and projections should be interpreted with caution.

Continued operations and expansion of phosphate and quartz mining activities are contingent upon acquiring and maintaining environmental permits. While this report does not analyze environmental risks, it is important to acknowledge that permitting is a critical step ensuring the long-term feasibility of any mining operation.

Lithium

The mineral powering the global future.

The third element on the periodic table, lithium is a highly reactive, soft and lightweight alkali metal. It is an excellent conductor of heat and electricity, and many of its myriad manufacturing applications are little known to the general public. For instance, including lithium in the production of glass and ceramics reduces the energy needed in the manufacturing process while giving the materials a more desirable consistency, making them easier to work with, and yielding the end products improved strength and thermal shock resistance. Lithium is also used to make lubricating greases, as it has good lubricating properties and is resistant to pressure and water. Lithium has pharmaceutical applications and is part of metal alloys used in the aerospace and defense industries.[14]



There are two methods of mining and producing raw lithium — hard rock mining of lithium-rich spodumene and pumping lithium-rich brine found deep underground. Once mined, lithium can be used directly as a mineral or it can be chemically processed into lithium carbonate or lithium hydroxide, the two compounds used to make lithium batteries.

This application is the main use for lithium today — as a key component in batteries. As of 2024, lithium-ion battery production accounts for about 87% of the world's lithium supply.[15] Lithium-ion batteries are among the most energy dense commercial battery technologies, and they are also low maintenance with no "memory effect," which causes shortened runtimes in batteries made with other metals.[16] All sorts of electronic products, including phones, lawnmowers, electric vehicles, computers and power tools are powered by lithium-ion batteries. The demand for these batteries has grown from about 150 gigawatt-hours (GWh)

in 2018 to almost 1,150 GWh in 2024, an increase of 667%.[17] The EV industry is driving most of this growth, as demand for EV batteries expanded from 107 GWh in 2018 to 955 GWh in 2024, an increase of 793%.[18] Lithium is a critical material input for the rapidly growing EV and stationary energy storage industries, and the demand for this resource is on a meteoric rise.

Current Production

From the 1950s to the 1980s, most of the world's lithium was supplied by mines in North Carolina's Carolina Tin-Spodumene Belt. Yet today, North Carolina has no active lithium mines, and worldwide production of lithium is dominated by Australia, Chile and China. These three countries accounted for 73% of all lithium mined in 2024, while the U.S. accounted for less than 2%.[15]

There is only one active producer of lithium in the United States: the Silver Peak mine in Esmeralda County, Nevada, owned and operated by Albemarle Corp. since 2015. The Silver Peak mine pumps lithium-rich water, or brine, from hundreds of feet underground onto the surface where it undergoes a process of solar evaporation that concentrates the lithium as the brine moves through a series of ponds.[19] The concentrated lithium brine is then chemically processed to create lithium carbonate. Historically, the Silver Peak mine "averaged around 3,500 to 4,000 metric tonnes per year of lithium," according to a Global Business Reports interview in 2024 with Silver Peak's operations manager. In 2020, Albemarle announced it would invest in the operation to increase production capacity to 10,000 metric tonnes per year by 2025.[20]

Future Production

KINGS MOUNTAIN

Two companies have near-term plans to start mining the Carolina Tin-Spodumene Belt again in North Carolina. Albemarle, Silver Peak's parent company, plans to reopen a mine South of Kings Mountain in Cleveland County by 2029. This site is in the process of dewatering — removing groundwater from the mining site to ensure a safe working environment. Construction is set to begin in 2026 and take two to three years to complete. Albemarle plans to operate the mine for nine years, producing an average of 420,000 metric tonnes of spodumene per year for a total production of 3.78 million metric tonnes of spodumene concentrate. The mine may continue operation after the initial nine years, depending on profitability. The Kings Mountain spodumene would initially be sold directly to battery makers. Albemarle has plans to build a lithium hydroxide Mega-Flex facility in Chester County, SC. This facility can process a diverse lithium feedstock, including lithium from recycled batteries, and would process the Kings Mountain spodumene once it is built.[21]

CAROLINA LITHIUM

Piedmont Lithium, a Belmont, NC, company, is also planning to build a lithium mine in the state, outside of Cherryville in Gaston County called Carolina Lithium. The mine's construction is slated to begin this year, and it would begin operation in 2027. Along with a spodumene mine, the Carolina Lithium site will include an adjacent lithium hydroxide processing plant. Piedmont Lithium plans to operate the Carolina Lithium mine for 11 years, producing an annual average of 242,000 metric tonnes of spodumene concentrate for

a total production target of 2.56 million metric tonnes. The lithium hydroxide plant would operate for 30 years, processing the spodumene from the mine next door for the first 11 years and then switching to imported spodumene from Quebec and Ghana for years 12 through 30. On average, the processing plant would produce 29,400 metric tonnes of lithium hydroxide per year.[22] The tons of spodumene and the tons of lithium carbonate equivalent (LCE) are both shown in Table 3. LCE is a standard measurement that allows the different forms and concentrations of lithium — mined, brine and chemically processed — to be compared. The conversion formula for calculating LCE for each metric tonne of 6% spodumene is 6% / 100 x 2.473 = 0.14838 metric tonne of lithium carbonate.

Market Value

The prices of lithium, for both its raw forms (spodumene and brine) and processed (lithium hydroxide) have been volatile in recent years. At the beginning of 2021, a metric tonne of spodumene had a market value of about $500. By the end of that year, a metric tonne of spodumene was worth $1,500. In December 2022, that same metric tonne of spodumene was worth almost $6,500.[23] As of June 2025, spot prices for spodumene hover around $600 per metric tonne, less than one-tenth the price level at the end 2022.[24] The price for lithium hydroxide has followed a similar path. Per metric tonne, lithium hydroxide was worth about $9,200 at the beginning of 2021 and almost $27,000 by the end. It peaked in January 2023 at $76,000 per metric tonne and sits at $8,300 as of June 2025.

The fluctuation in the price of lithium was driven by a temporary shortage of lithium chemicals (lithium carbonate and lithium hydroxide), due to a large and rapid increase in demand for EV batteries, which account for roughly 72% of all lithium consumed. According to the International Energy Agency's (IEA) Global EV Outlook 2025, in 2020, nearly 3 million new EVs were sold worldwide. In 2023, that number rose to 13.7 million,

Table 3: **Forecasted Spodumene Production**

YEAR	PRODUCTION (MT)	LCE EQUIVALENT (MT)	PRICE RANGE (USD/MT)	TOTAL (USD MILLIONS)	SOURCE / SUPPLIER	LOCATION
2024	NA	NA	$900	NA	NA	NA
2025	NA	NA	$600	NA	NA	NA
2026	NA	NA	$600	NA	NA	NA
2027	242,000	35,908	$600	$145.2	Piedmont Lithium	Spruce Pine, NC, USA
2028	242,000	35,908	$600	$145.2	Piedmont Lithium	Spruce Pine, NC, USA
2029	662,000	98,228	$600	$397.2	Kings Mountain 420,000 (Albemarle) Piedmont Lithium 242,000	Spruce Pine, NC, USA

a growth of 361% in just three years. China accounted for 65% of this growth. As demand outpaced the supply of lithium chemicals, prices soared. Over 2024 and the first half of 2025, prices fell to roughly back to what they were prior to 2021, likely driven by suppliers finally increasing their capacity and new suppliers entering the lithium market. This price volatility in the lithium chemical market impacted upstream markets for lithium precursors (spodumene and brine), driving the price to record highs for spodumene in 2023 before coming back down in 2024 and 2025.

For this report, we assume the extreme volatility in the prices for both spodumene and lithium hydroxide from 2022 to 2024 was an outlying event and have modeled the prices at $600 and $8,300 per metric tonne for spodumene and lithium hydroxide, respectively. Using these constant price factors, we can estimate the market value of the lithium produced from the two North Carolina mines.

The Albemarle mine, producing 420,000 metric tonnes, would generate **$252 million** worth of spodumene per year starting in 2029. Piedmont Lithium's mine, producing 242,000 metric tonnes, would generate **$145.2 million** worth of spodumene per year starting in 2027. Piedmont Lithium has set a production target of 2.56 million metric tons over the lifetime of the mine and would process 2.0 million metric tonnes of this in their lithium hydroxide plant. The other 0.56 million metric tonnes would be sold to third parties.

Piedmont Lithium would sell an average of 52,998 metric tonnes of spodumene concentrate, worth $31.8 million, to third parties each year for the first 11 years from its Carolina Lithium site. The other 189,002 metric tonnes of spodumene concentrate produced each year, worth about $113.4 million, would be converted to lithium hydroxide. The Carolina Lithium plant is projected to produce, on average, $244 million worth of lithium hydroxide per year over the 30-year life of the plant. During the first 11 years, the lithium plant would process only lithium from the Carolina Lithium mine, so the amount of lithium hydroxide produced from the 189,002 metric tonnes of spodumene concentrate would be about 23,625 metric tonnes, or about $196.09 million worth of lithium hydroxide, each year.

Table 4: **Forecasted Lithium Hydroxide Production**

YEAR	PRODUCTION (MT)	PRICE RANGE (USD/M)	TOTAL (USD MILLIONS)	SOURCE / SUPPLIER	LOCATION
2024	NA	$11,000	NA	NA	NA
2025	NA	$8,300	NA	NA	NA
2026	NA	$8,300	NA	NA	NA
2027	23,625	$8,300	$196	Piedmont Lithium	NC, USA
2028	23,625	$8,300	$196	Piedmont Lithium	NC, USA
2029	23,625	$8,300	$196	Piedmont Lithium	NC, USA

Uncertainty

The largest source of uncertainty for lithium is demand. In 2024, 87% of lithium was used to make batteries and 83% of those were used in EVs.[17,18] This means that lithium prices are at the whims of the EV market, which is currently experiencing a glut of lithium-ion batteries. Lithium-ion battery production in 2025 is expected to be about 3,800 GWh, but demand is expected for only 1,500 GWh, less than half the supply. Meanwhile, in China, the world's largest producer of processed lithium and lithium batteries, the average utilization of battery plants is less than 50%.[17] EV demand is expected to grow, but not quickly enough to immediately take up the slack in the battery market. This likely means that prices for lithium hydroxide and spodumene will fall in the coming years.

Tariffs are another source of uncertainty. Increased duties on imports into the U.S. would make importing spodumene from Canada and Ghana more expensive for Piedmont Lithium, cutting into its margin and making it less competitive in the global lithium hydroxide market. Reciprocal tariffs, if imposed, would affect both Albemarle and Piedmont Lithium if they seek to export their products abroad. If Albemarle and Piedmont Lithium can sell to domestic battery makers, it would take some of the sting out of the tariffs, but the firms would still feel indirect effects from the tariffs stemming from increased costs and lower international demand for U.S.-made automobiles.

Severance Tax Overview

Severance taxes are excise taxes imposed by state and local governments on the removal — or "severance" — of natural resources from within their taxing jurisdiction. These taxes are commonly associated with the extraction of fossil energy resources such as oil, natural gas and coal but also extend to minerals such as lithium, phosphate and quartz. Severance taxes are typically levied in jurisdictions where subsurface minerals are privately owned. In cases where resources are publicly owned, extracting companies often pay resource royalties to the state for extraction rights.

Severance taxes are an important mechanism for state and local governments to generate revenue. In 2021, state and local governments in the U.S. collectively garnered $11.8 billion from severance taxes.[25] This sum constitutes a relatively small percentage (0.3%) of government revenue nationwide, yet the amount collected in resource-rich states such as Texas, New Mexico, North Dakota, Wyoming and Alaska is meaningful. Most of these natural resource-rich states have created endowments from portions of their severance tax revenue, which helps state budgets endure industry volatility and demographic shifts. The Alaska Permanent Fund is by far the largest of these endowments, with a 2024 market value of $80 billion. Revenue in Alaska has fallen, however, because of declining oil production and price fluctuations, revealing one of the challenges for states relying on severance tax income.

In addition to revenue, severance taxes are intended to provide compensation for resource depletion. These taxes also aim help internalize externalities by offsetting the environmental and social costs associated with mineral extraction, damages that include land degradation, water and air pollution, and the socio-economic disruptions local communities experience stemming from commodity boom and bust cycles. The

calculation methods for severance taxes vary and are typically based on the value and/or volume of the resource produced, with specific methodologies differing by resource type and state.

There are many challenges inherent to severance tax implementation. First is these taxes' impact on the production and consumption of the targeted resources — the economic deadweight loss. Theory and empirical research indicate that these taxes disincentivize production and, depending on the economics of production, could prevent the commodity from being produced at all. This effect is particularly salient in globally traded commodity markets, where in most cases the producer is a price taker.

The volatility of severance tax revenue is another key challenge for states. Driven by fluctuating commodity prices and production volumes, this unpredictability can cause fiscal instability if states become overly reliant on these funds for recurring expenditures.

The challenges of raising the cost of production are further complicated when a producer strives to use extracted resources to make higher-value goods locally (e.g., lithium going into batteries). Vertically integrated producers may try to minimize their severance tax by lowering the transfer price between the mining and refining arms (e.g., spodumene to lithium carbonate).

Accurately measuring mineral value and preventing transfer pricing evasion is another common challenge for states trying to implement severance taxes. Evading pricing of assets is especially straightforward for integrated multinational companies. Firms can manipulate internal prices between related parties to reduce taxable income in higher-tax jurisdictions. From the severance tax collector's perspective, the simplest way to avoid this is to tax the volume extracted rather than the value of the mineral. Alternatively, the Organization for Economic Cooperation and Development and Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development have created a transfer pricing framework for lithium, and the Comparable Uncontrolled Price (CUP) method is an established approach to transfer pricing, one that involves comparing the price of related-party sales to those of independent transactions under similar conditions.

Severance Taxes in Practice

Most severance taxes, and research on these levies, have focused on the energy sector. In 2022, over 70% of crude oil, natural gas and coal extraction was subject to a severance tax. Most states apply the tax to gross or net receipts as a taxable base. There are a handful of states that implement severance taxes on North Carolina's three key mineral resources: phosphate, quartz (silica) and lithium.

PHOSPHATE

- **Florida**, the top-producing state, imposes an excise tax on the severance of phosphate rock at $1.61 per bone-dry ton (2023–2025), down from $1.80 per ton (2015–2022). Mosaic reported paying about $18.9 million in Florida severance taxes in 2022, which constitutes more than 90% of the state's total "solid minerals" severance tax revenue collected that year. A notable feature of this revenue stream is the detailed earmarking of income to specific funds, such as the State Park Trust Fund and Phosphate Research Trust Fund,

as well as to counties affected by the mining. This earmarking links tax revenue to environmental mitigation and community needs, helping to build public support.

QUARTZ

- **Arkansas** is the only major quartz-producing state to levy a severance tax. It is not clear if quartz falls under the category of "silica sand" or "other natural resources" for severance tax purposes. Silica sand is taxed at a rate of 1.5 cents per ton while other natural resources are taxed at a 5% rate. Nonetheless, quartz tax revenue totaled $1,280 in the fiscal year ending in June 2025. Arkansas is not the only state with this ambiguity. In Maine there is a debate whether "common rock forming minerals" such as quartz are excluded from metallic mineral taxation.

LITHIUM

For the states with significant potential or existing (Nevada) lithium production, the following tax regimes are in place:

- **Nevada** does not have a specific tax designated for lithium; it does have a severance tax with a cap of 5% on net proceeds that applies to all minerals extracted in the state. In 2021–2022, the latest data available, the active lithium mine (Silver Peak) generated approximately $41.7 million in gross revenue.[26] After roughly $25.4 million in tax deductions, the state's 5% net proceeds tax generated a mere $816,000 in tax revenue from lithium sales.

- **Arkansas** passed Act 1012 in 2025 authorizing a tax of $2.75 per 1,000 barrels on brine produced for lithium extraction.[27] There are sales/use tax exemptions for firms investing over $100 million in lithium/battery facilities that pay employees total compensation of at least $3 million. There is an additional 2.5% royalty paid to landowners for their mineral rights.

- **California** passed Senate Bill 125 in 2022, establishing a volume-based tax on extracted lithium.[28] This approach is favored for its administrative simplicity, as it is based on the volume of lithium carbonate equivalent (LCE) extracted, does not require any price verification and provides potential revenue stability compared with gross receipts taxes. In 2025, the tax rates based on lifetime cumulative production are:
  - $413 per metric ton for the first 20,000 MT of LCE extracted,
  - $620 per metric ton extracted from over 20,000 up to 30,000 MT, and
  - $826 per metric ton for LCE extracted over 30,000 MT.

At present, the vast majority of the world's lithium is produced outside the U.S. and faces the following royalty rates:

- **Australia:** A 5% state royalty based on the realized revenue from spodumene concentrate.
- **Chile:** Sliding royalties that range from 6.8% to 40% of the lithium export sale price.
- **China:** Unknown.
- **Argentina:** Maximum royalty of 3% on the pithead value of extracted lithium.

Estimates of Potential Severance Tax Revenue

We use these existing tax regimes to help us estimate potential revenue from North Carolina's production of lithium, phosphate and quartz/silica. We assume two different tax regimes: the volume-based approach used in California, Florida and Arkansas and a 2.5% royalty rate used in Arkansas for lithium. This royalty rate aligns with severance tax rates in other states on hard rock mining, without any exemptions.

Using a volume tax, we estimate potential tax revenue of roughly $5 million to $90 million in 2026 from existing phosphate and quartz production — the large range results from different modeled tax regimes. With more production lithium coming online in 2027, tax revenue could rise to between $10 and $130 million and by 2029 be potentially as large as $230 million, although this depends on the imposition of a California-style lithium volume tax rather than a 2.5% severance tax. Since the lithium production in Table 4 is not extracted, we assume a severance tax regime

Table 5: **Forecasted Phosphate Rock Tax Revenue Using FL Tax Rate or 2.5% Severance Tax**

YEAR	PRODUCTION (MT in Mil.)	PRICE RANGE (USD/MT)	TOTAL (USD MIL.)	FL TAXRATE (PER US TON)	TAX REVENUE (USD MIL.)	2.5% SEVERANCE TAX	TAX REVENUE (USD MIL.)
2024	2.5	$100	$250	$1.61	$4.44	2.50%	$6.25
2025	2.7	$100	$273	$1.61	$4.79	2.50%	$6.83
2026	3	$100	$298	$1.61	$5.32	2.50%	$7.45
2027	3.3	$100	$325	$1.61	$5.86	2.50%	$8.13
2028	3.5	$100	$354	$1.61	$6.21	2.50%	$8.85
2029	3.9	$100	$386	$1.61	$6.92	2.50%	$9.65

Table 6: **Forecasted Silica Tax Revenue Using AR Tax Rate or 2.5% Severance Tax**

YEAR	PRODUCTION (MT in Mil.)	PRICE RANGE (USD/MT)	TOTAL (USD BIL.)	AR TAX RATE (PER US TON)	TAX REVENUE (USD MIL.	TAX RATE ($ VALUE)	TAX REVENUE (USD MIL.)
2024	0.2	$12,000	$2.40	$0.015	$0.003	2.50%	$60.00
2025	0.218	$13,080	$2.85	$0.015	$0.004	2.50%	$71.25
2026	0.238	$14,257	$3.39	$0.015	$0.004	2.50%	$84.75
2027	0.26	$15,540	$4.04	$0.015	$0.004	2.50%	$101.00
2028	0.283	$16,938	$4.79	$0.015	$0.005	2.50%	$119.75
2029	0.309	$18,450	$5.70	$0.015	$0.005	2.50%	$142.50

Table 7: **Forecasted Spodumene Tax Revenue Using CA Tax Rate or 2.5% Severance Tax**

YEAR	PRODUCTION (MT)	PRICE RANGE (USD/MT)	TOTAL (USD MIL.)	LCE EQUIVALENT (MT)	CA TOP TAX RATE (PER MT)	TAX REVENUE (USD MIL.	2.5% SEVERANCE TAX	TAX REVENUE (USD MIL.)
2024	NA	$900	NA	NA	$800	NA	2.50%	NA
2025	NA	$600	NA	NA	$826	NA	2.50%	NA
2026	NA	$600	NA	NA	$843	NA	2.50%	NA
2027	242,000	$600	$145.20	35,908	$859	$20.12	2.50%	$3.63
2028	242,000	$600	$145.20	35,908	$877	$31.48	2.50%	$3.63
2029	662,000	$600	$397.20	98,228	$894	$76.65	2.50%	$9.93

CA Tax Rate is graduated based on cumulative production, the top tax rate is shown and adjusted for assumed 2% inflation. For 2029, revenues are based on Piedmont (242,000) and Albemarle (420,000) production.

does not apply to that plant, though it does impact the price of inputs.

This model assumes that the levy of a severance tax has no impact on output, which, as we discuss below, is not consistent with economic theory and historical evidence. Based on the price sensitivities discussed below, the imposition of the 2.5% severance tax would lower tax revenue by between $0.5 and $1 million in 2026, and from $1 to $2 million in 2029. We assume that the severance tax does not discourage the lithium mines from going into production, a supposition that depends on the economic viability/profitability of the mine prior to the imposition of the tax, something we unfortunately do not have insight into. The more than 20% equilibrium tax rates implied by the California volume tax, however, give us significant pause regarding the existential threat this level of taxation would pose for any mining project.

The economic viability of the lithium hydroxide plant described in Table 4 may be affected by these taxes. If North Carolina were to impose a volume-based lithium tax, we would suggest a graduated rate like in California, perhaps with higher cutoff rates to incentivize production beyond the first year and levels that would imply meaningfully lower tax rates.

Economic Impact of Severance Taxes

Since most severance taxes are levied on the energy sector, most research on these taxes' impacts has focused on energy sector commodities —oil production in particular. In some cases, the economics of oil drilling is comparable to the mining projects described above, such as deep-water drilling with large, fixed costs. In other cases, such as with hydraulic fracking projects, which have relatively low fixed costs, the economics are quite different. In general, research has

found that a severance tax's most meaningful impact affects the decision to drill a well, rather than the amount of oil produced after a well is drilled. Estimated supply elasticities associated with a severance tax are relatively small (-0.1% to -0.5%), with a recent paper refining those to -0.2% to -0.4%. These numbers imply that the imposition of a 2.5% severance tax would lower output on average by between 0.5% and 1%.[29] The existing research leaves unresolved questions around the long-term impacts of a tax. The literature suggests that supply elasticity could be larger than what is reported because firms may be less willing to find new reserves or do research and development in the presence of a tax regime.

For existing mines, such as Aurora and Spruce Pine, these figures suggest that a severance tax has a minimal impact on production, but for mineral deposits with lower rates of return, a tax may cause these to go unquarried. For the reopening lithium mines, the key question is whether a severance tax would lower the producer's rate of return enough to make opening the mine unprofitable, a particular concern in this environment of low lithium prices. Reflecting an understanding of a tax's potential chilling effects on new starts, the recent Arkansas lithium tax law provides exemptions for new mines, while California's has a graduated tax scale, with firms paying half the rate for the first 20,000 tonnes of cumulative LCE production. Meanwhile, Texas halves its severance tax rate of 4.6% for a new or expanded enhanced oil recovery project's first 10 years.[30]

Severance Taxes and Downstream Industries

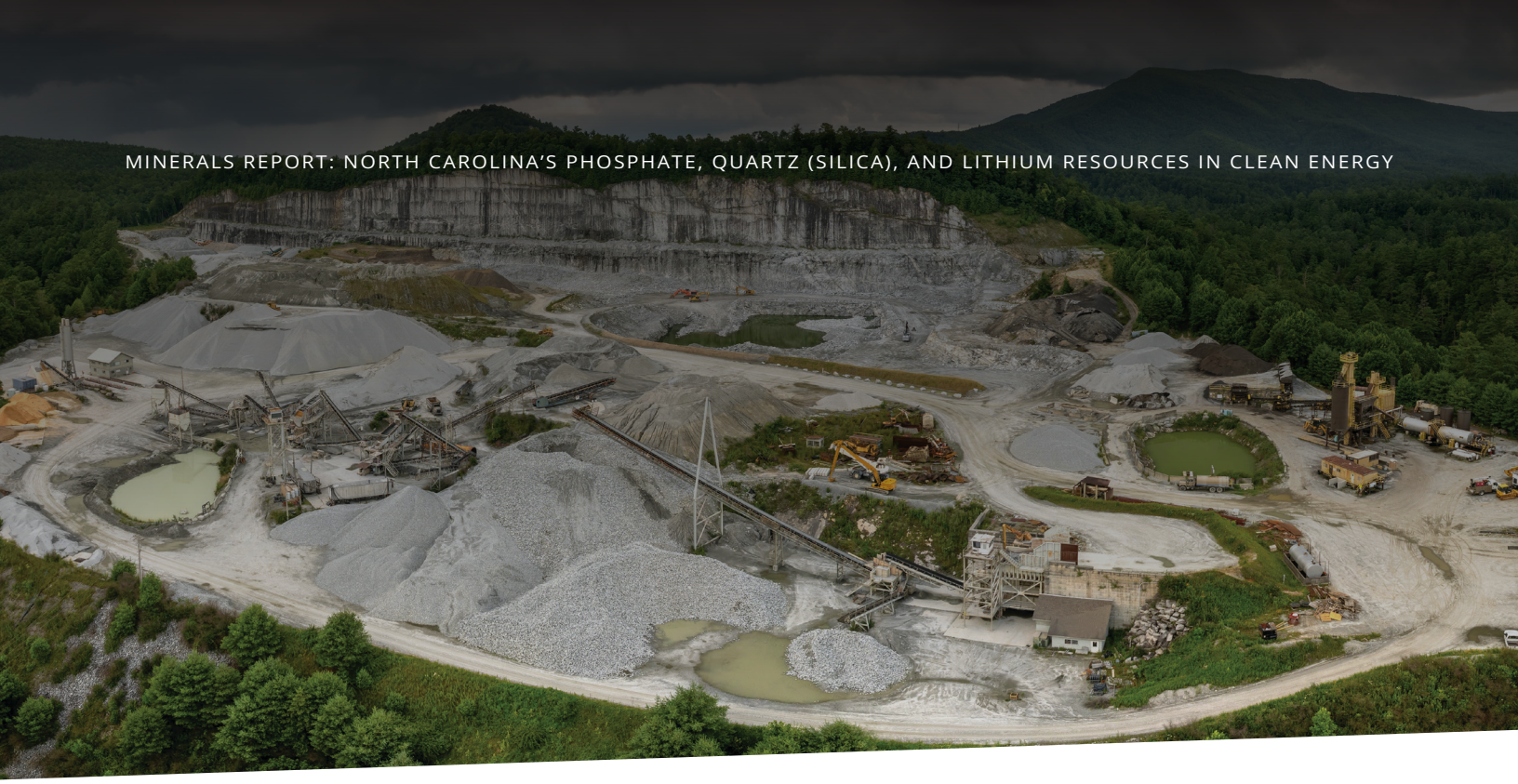
The economic benefits of mineral resource exploitation extend far beyond extraction, a fact that governments increasingly recognize. There is a growing imperative to maximize economic returns through local processing, refining and manufacturing, thereby fostering high value-add industrial development and strengthening domestic supply chains. To build out these capabilities, some countries[31] have implemented lower royalty rates for processed minerals compared with raw minerals to encourage downstream investment. Some governments provide other incentives, such as Arkansas' sales and use tax exemptions for firms investing over $100 million in lithium/battery facilities.

With its rich lithium deposits, North Carolina should consider a similar severance tax incentive policy to encourage downstream investment in refining operations and in battery and EVs manufacturing (including electric planes). Fostering these developments would mitigate the budgetary impacts caused by the economic incentives that attract these plants to the state. The industrial expansion would stimulate public revenue

by growing the proverbial economic pie: by incentivizing additional and longer-term industrial operations tied to mineral extraction, the state would lessen the deadweight costs of the severance tax and any other taxes needed to meet budget shortfalls caused by the incentives.

Optimal Severance Taxes

When building a coherent severance tax regime, policymakers must consider many potentially countervailing factors. Will the tax maximize state revenue while minimizing environmental costs? Will it incentivize high-value production, which may be in downstream refining or manufacturing? Once these questions are resolved, the state can determine an optimal severance tax rate, one that a mining firm can add to its production costs and remain economically viable. This viability would mean that the after-tax commodity price provides a reasonable rate of return to the producer so that it starts and continues production of the resource. Given the many unknowns about mineral production — in particular, the uncertainty around commodity prices set by global markets — it is difficult to determine an optimal severance tax rate for North Carolina's mineral operations. Additional analysis of global markets and consultation with mineral producers about their needs and capabilities is essential to develop an optimal severance tax policy, one that incentivizes domestic production, local value-added processes and alignment of supply chains while promoting environmental protection, sustained private sector growth and robust public sector revenue.



Conclusion

The global economy has begun its shift from a system largely fueled by petroleum to one powered by minerals. Endowed with extraordinary mineral wealth, North Carolina is in a favorable position, set to capitalize on the 21st century mineral economy as this shift gains momentum. Our phosphate resources help feed the world, as demand for agricultural products increases. The unrivaled HPQ found in Spruce Pine is the key to making advanced microchips and solar panels, technologies integral to today's economy and that of the future. And the Carolina Tin-Spodumene Belt, once the world's largest source of lithium, will soon be mined again, supplying the critical metal for EVs and many other uses, as these technologies increasingly supplant fossil fuel-based energy systems.

As the economic winds blow in our favor, state officials and firms operating here must set their proverbial sails to harness the breeze. Mineral producers can meet the growing demand for their products by increasing production volumes and vertically integrating downstream processing and manufacturing. With the right set of policies, state and local governments can incentivize this economic growth, nurture a robust and long-lasting tax base, and reinvest in their communities. It will not be simple to fulfill this promise. Exploiting the state's great mineral assets to benefit all stakeholders will mean threading a needle. Producers will need to mine and manufacture at greater volumes while maintaining competitive prices and profitability. Policymakers must set tax rates and regulate environmental standards robust enough to protect and support the state's local communities but moderate enough so that producers remain profitable and are incentivized to expand operations. Given long-term outlooks that reflect increasing demand for North Carolina's minerals and a growing imperative to shore up domestic critical minerals production, threading the needle can be done. North Carolina's mineral future is bright, even if the process of fulfilling its great promise is a rocky road.

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