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COMPANY NOTE | EQUITY RESEARCH | May 23, 2022

Resources: Metals & Mining **Initiation of Coverage**

American Resources Corporation | AREC - $1.52 - NASDAQ |

Buy

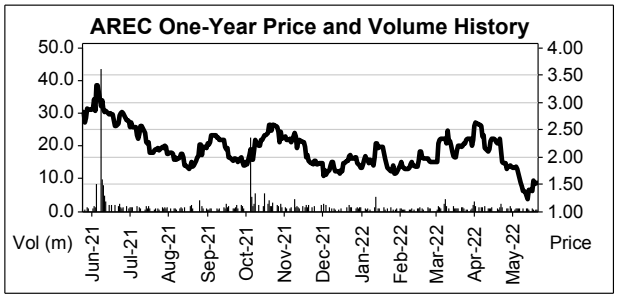
Stock Data	
52-Week Low - High	$1.20 - $4.22
Shares Out. (mil)	66.20
Mkt. Cap.(mil)	$100.63
3-Mo. Avg. Vol.	1,118,518
12-Mo.Price Target	$3.00
Cash (mil)	$5.2
Tot. Debt (mil)	$20.4

Revenue ($ millions)

Yr Dec	—2020—	—2021—	—2022E—
		Curr	Curr
1Q	0.5A	0.0A	9.1A
2Q	0.2A	0.4A	19.0E
3Q	0.3A	2.8A	21.0E
4Q	0.0A	4.5A	23.0E
YEAR	1.1A	7.8A	76.4E

EPS $

Yr Dec	—2020—	—2021—	—2022E—
		Curr	Curr
1Q	(0.12)A	(0.14)A	(0.04)A
2Q	0.05A	(0.13)A	(0.05)E
3Q	0.00A	(0.15)A	(0.03)E
4Q	(0.28)A	(0.17)A	(0.01)E
YEAR	(0.35)A	(0.59)A	(0.11)E



AREC: Emerging Critical Metals Recycler

AREC is becoming a leader in recycling critical and rare earth elements. AREC is at an inflection point in commercializing chromatography technology. This may break the U.S.'s dependence on importing rare earth elements from China. This could become a billion-dollar business, important for manufacturing and national defense. AREC has control of essential patents to introduce the cleanest and most effective process available. We are initiating research coverage with a Buy rating and price target of $3.00 per share.

Metallurgical carbon prices are at record-high levels. The coal industry has been under pressure from increasing regulations and public scrutiny. AREC selectively acquired undervalued and underutilized metallurgical carbon assets. Later, as the pandemic led to mine closures, the deterioration of plant and equipment and the drawdown of inventories led to record-high prices for metallurgical carbon. AREC is resuming production of metallurgical carbon from its Perry County Resources (PCR) and McCoy Elkhorn complexes in Kentucky, and is leasing its Deane Mining complex.

Technologies sought to recover valuable REE and reduce wastes. AREC recognized the upside for applying technologies to reduce wastes in processing metallurgical carbon and the opportunity costs of contained REE disposed of in landfills. AREC appealed to leading researchers and built a network of experts and portfolio of patents. This included electrolysis processes to concentrate REEs from wastes and chromatography patents to purify REE from concentrates to manufacturer specifications. AREC now controls 22 patents.

Chromatography extended to the recycling of EV batteries and permanent magnets. Permanent magnets used in windmills and EVs contain REE including neodymium, praseodymium and dysprosium. EV batteries contain CE including lithium, cobalt, nickel and manganese. Each year over one billion dollars of these end-of-life materials are lost to smelting or landfills. Recovered materials may contain CE and REE of up to 35% by weight that could be considered "super-grade" ore. The recovery of CE and REE may contribute to a sustainable "closed-loop" domestic supply chain, which is preferable to the current linear process of mining (importing), processing and disposal.

AREC is developing partnerships with academia, industry and government. AREC is well-advanced in building relationships and acquiring patents from academia, which include Purdue University. It has partnered with The Heritage Group (Heritage), an established private company, to secure a stable feedstock for processing CE and REE from end-of-life products and to build a distribution network. It has relationships with government entities such the U.S. Department of Defense and U.S. Department of Energy, and is aligned with the Restoring Essential Energy and Security Holdings Onshore for Rare Earths (REEShore) Act of 2022.

CLOSING THE LOOP ON CRITICAL AND RARE EARTH ELEMENTS

AREC is passing an inflection point. During a period of record prices, AREC has a large untapped metallurgical carbon asset base with a growing production profile. It has secured necessary processing and transportation infrastructure and is developing electrolysis and chromatography technologies to reduce operating costs. AREC built on this opportunity and, we believe, is uniquely positioned to fund and develop chromatography technologies to recover and purify final stage CE and REE from end-of-life products. AREC may soon cement its leadership position as the first domestic commercial producer of isolated and purified CE and REE in the U.S.

The introduction of chromatography has the potential to transform the current zero-sum, linear path supply chain for CE and REE (from ores to products to landfills) into a unique and stable, sustainable closed-loop of use and reuse. The potential may exceed the goals of the REEShore Act to establish a strategic reserve by 2025 to meet the needs of the U.S. military, defense industrial and technology sectors, for one year, in the event of a supply disruption. We believe that the full development and deployment of chromatography technologies may render the REEShore Act unnecessary.

AREC's American Rare Earth, LLC plans to put two "trains" into production in 2022. The first train will purify REE by recycling permanent magnets from windmills and EVs. The second train will purify CE from end-of-life EV batteries. The first train may come on line in the coming weeks and the second train in early 3Q22. Its chromatography technologies appear to be sufficiently flexible to add several additional trains to the existing site. Also, AREC is developing a seven-acre site with the potential to add an additional 12 trains. It expects to process REE concentrates from metallurgical carbon operations at this site. Both sites are in Noblesville, Indiana, a suburb of Indianapolis.

AREC's American Carbon. LLC has a backlog for its metallurgical carbon of approximately $110 million. Prior to the pandemic, metallurgical coal sold for under $100 per ton; it has since risen to over $200 per ton. AREC has resumed production from its PCR and McCoy Elkhorn complexes in Kentucky, and has recently leased its Deane Mining complex. We estimate that its PCR and McCoy Elkhorn complexes in Kentucky have an annual capacity of approximately 700 million tons. The operator of the Deane Mining complex has committed to produce at least one million tons and pay AREC at least $5.00 per ton. In 2023, it has plans to bring its Wyoming County, West Virginia complex (WCC) on line, which should include the application of its electrolytic and chromatography technologies.

CHROMATOGRAPHY IS A RELATIVELY CLEAN AND VERSATILE PROCESS

The elegance of chromatography in purifying CE and REE becomes clear when compared to the current process of conventional solvent-based extraction (CSX). Purification of REE is difficult because of its similar physical and chemical properties. CSX processes REE concentrates through a sequence of up to 1,000 individual mixer-settler tanks. Consequently, CSX operations are complex and require a relatively larger amount of power and a large industrial footprint to be economic. Exhibit 1 shows an example of a CSX facility.

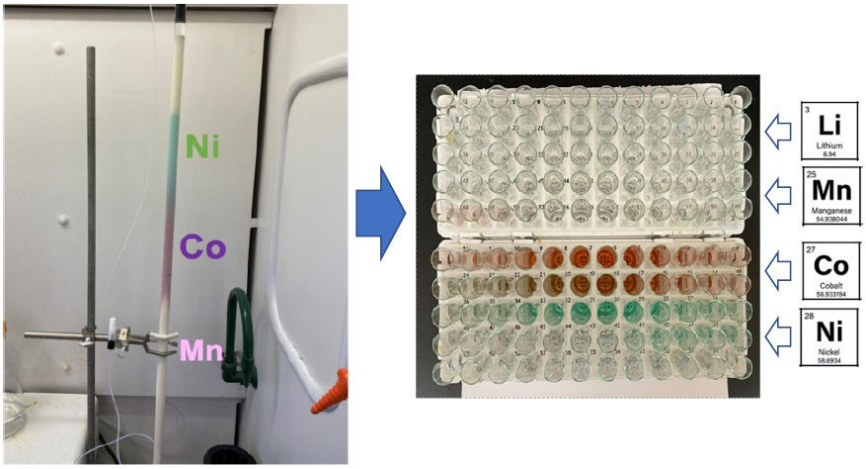
Exhibit 1: Conventional Solvent-based Extraction (CSX)

Source: American Resources Corporation (link)

A critical drawback of the CSX process is that the use of various chemicals such as solvents and extractants are applied to separate elements. At best, these chemicals may eventually separate challenging combinations of elements contained within concentrates with varying characteristics. The drawback is that these chemicals may be flammable, unstable and toxic. As these chemicals may have limited efficacy, large quantities may be required, and worse, may not be disposed of properly. For this reason, these facilities are expensive to operate and are located overseas. Logically, to reduce transportation costs, manufacturing facilities have relocated overseas to be closer to the source of REE.

In 1910, the chromatography process originated in Russia. It has since been developed for use in diagnostic labs and the pharmaceutical and food and beverage industries. Though various styles of chromatography have been in use for over a century, it was research and development at Purdue University for the purification of REE that led to the first patented processes. This has since been extended to CE.

Exhibit 2: Chromatography Separation/Isolated and Purification of Lithium-ion Batteries

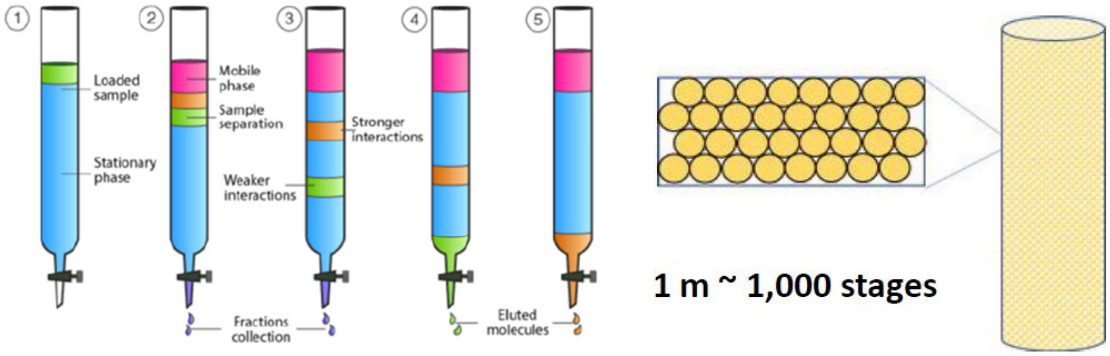


Source: American Resources Corporation (link)

AREC was looking for a solution for monetizing REE in metallurgical carbon wastes. Purdue University was looking for the optimal commercial partner to separate and purify REE concentrates. It was simple for both sides to recognize the potential for chromatography to be applied to REE and also CE, with the potential to develop a closed-loop domestic supply chain.

In February 2021, AREC exclusively licensed chromatography technology developed at Purdue University from Hasler Ventures LLC. These patented technologies are primarily controlled by two exclusive licenses: one, technologies for the separation and purification of REE from coal, coal byproducts, coal waste and acid mine drainage, utilizing Ligand Assisted Displacement (LAD) chromatography; and two, technologies for the extraction and purification of CE and REE from used or waste batteries and permanent magnets. Exhibit 2 shows the chromatography process for the purification of CE from black mass from end-of-life lithium-ion batteries used in EVs.

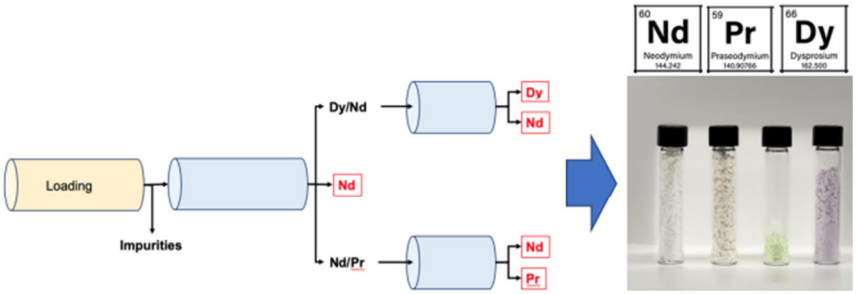
Exhibit 3: Ligand Assisted Displacement (LAD) Chromatography



Source: American Resources Corporation (link)

Exhibit 3 shows a generalized graphic of the ligand assisted displacement (LAD) chromatography process. In the case of AREC purifying REE and CE, chromatography is a fluid process whereby a mixture of elements in solution pass through columns. The column may have one or more intervals that contain resins which have an affinity for a particular element. As the fluid passes through this interval, it is stripped of that element which is collected through flushing, filtering or elution. The process differs for each particular element according to a number of factors depending on the characteristics of the element to maximize the affinity. Exhibit 4 shows a generalized graphic for the separation and purification of REE from permanent magnets and EVs with purified end product to meet manufacturer specifications.

Exhibit 4: Magnet Metal Isolation & Purification



Source: American Resources Corporation (link)

Important factors in the chromatography process include optimizing surface area and residence time according to rate of flow and volume. Relative to CSX, the process requires benign low-cost sorbents or resins, has lower power requirements, and may be completed at room temperature and ambient pressure. Chromatography has the unique potential to scale production of battery grade material to manufacturer specifications of over 99.5% purity.

Yi Ding, Post Doctoral Research Associate, Purdue University, and author of Critical & REEs from Complex Mixtures, said that chromatography process may be have ten times the productivity of CSX. For these reasons, we expect that chromatography may eventually supplant CSX. Exhibit 5 shows a comparison of potential tradeoffs between CSX and chromatography for the purification of REE and CE.

Exhibit 5: Advantages of Chromatography Relative to Solvent Extraction

	Solvent Extraction	ARE Chromatography	Advantages
Safety	• Flammable solvents • Toxic extractants • Harsh chemicals	• Aqueous solution • Dilute acid & base	Safer
Chemical cost	1	<0.5	Lower
Purity, Yield	99.5%, 88-90%	>99.5%, 99%	Higher
Productivity	1	10-100	Higher
Footprint	10-100	1	Smaller footprint
Start-up time	Months	Days	Shorter
Feedstocks and products	Specific	Flexible	More versatile
Separators	>1,000	5	Fewer
Initial investment	5	1	Lower
Waste	Acidic wastewater	Almost zero waste	Cleaner

Source: American Resources Corporation (link)

AREC is nearing completion of the first of its two production trains on its property in Noblesville, Indiana. This first production train will be used to isolate and purify REE from end-of-life permanent magnets and is anticipated to come on line in a couple of weeks. As 35% of the weight of end-of-life magnets may be REE, they may be considered to be super-grade ore consisting of neodymium, praseodymium and dysprosium. A second production train is expected to come on line approximately 60 days after the first train, and is focused on refining "black mass" from spent lithium-ion batteries producing battery-grade lithium, cobalt, nickel and manganese.

AREC acquired a seven-acre site in Noblesville, in August 2021, where it plans to construct a larger facility with the potential to contain up to 12 production trains to process a variety of CE and REE feedstock. This is expected to include a production train to process REE concentrates derived from waste material generated at its WCC metallurgical carbon complex in West Virginia. AREC anticipates that its first production train may come on line in two weeks and the second train in 3Q22. It has not given guidance for the precise timing of the ramp up and full commercialization of the expanded facility on its seven-acre site.

Modeling new potentially high-growth technologies is speculative. The introduction of new processes may be expected to encounter delays in ramping up operations. Earlier, AREC said that it could produce $5 million in revenue by producing 56,000kgs of 99%+ purity of marketable REE from its first two production trains. In addition, it said that it anticipated potential capacity at its seven acre site to produce over three million kgs of CE and REE. This would imply a stepped-up annual run rate of ~$270 million.

Since end-of-life feedstock may contain 35% by weight CE or REE, and in our opinion a heavy REE deposit at a grade of 1.0% may be potentially viable, we assume that there should be sufficient margin to cover costs for collection and purification of feedstock, and the distribution of manufacturer-grade product. Considering the growth potential of applying chromatography to a wide variety of feedstock, AREC may be in an enviable position of generating cash flow to cover working capital requirements and capital investments while growing rapidly.

Relationships have provided operational leverage. Developing the opportunity provided by Purdue University's patented technologies, and securing licenses from Hasler Ventures LLC, led to the introduction of William E. Smith III. Mr. Smith came out of retirement from Eli Lilly and Company (NYSE: LLY-NC) after 30 years of overseeing technical support of its worldwide manufacturing facilities. Mr. Smith is now overseeing the construction and start-up of AREC's initial chromatography trains. This is an example of AREC's entrepreneurial approach of collaboratively attracting academics and accomplished practitioners. In March 2022, this culminated with the partnership with IN3 (Indiana Innovation Institute), a hub of national security innovation between academia, industry and government.

In January 2022, AREC entered into a long-term strategic partnership with Heritage. AREC described Heritage as a private company with approximately "100 years of experience and innovation in transportation and infrastructure materials, environmental services and specialty chemicals." In addition, "Heritage consists of over thirty operating companies with approximately 170 worldwide locations and over 5,000 employees." We believe that Heritage may be the ideal partner for AREC with the ability to organize and execute the collection of end-of-life batteries, participate in the preparation and processing of CE and REE feedstock, and assist in marketing or in the formation of additional partnerships. Heritage has taken a 7.5% stake in American Rare Earth, LLC.

In January 2022, Senators Tom Cotton (R-Arkansas) and Mark Kelly (D-Arizona) introduced the Restoring Essential Energy and Security Holdings Onshore for Rare Earths (REEShore) Act of 2022. The Act requires the U.S. Department of Defense and the U.S. Department of the Interior to create a strategic reserve of rare-earth elements and products by 2025. The reserve must meet the needs of the U.S.'s military and technological sectors in the event of a supply disruption. The REEShore Act demonstrates the potential for bi-partisanship regarding the availability of CE and REE, essential to manufacturing advanced technologies for national defense and the environment.

It is not clear to what degree the REEShore Act will impact prices of CE and REE. It is apparent that policy makers anticipate that availability of CE and REE may be at risk. This may suggest that demand may exceed supply of a number of important elements for the foreseeable future. In addition, it reaffirms the importance of developing a closed-loop domestic supply chain for CE and REE. We believe that this places AREC in an excellent position, with the unique ability to purify end-of-use materials to manufacturer specifications.

METALLURGICAL CARBON ASSETS WITH REE BYPRODUCTS

AREC commenced acquiring metallurgical carbon assets in 2015. In 2017, AREC completed a transaction with Quest Energy Inc., including its coal mining and coal processing operations located in eastern Kentucky and western West Virginia. On November 25, 2020, Quest Energy changed its name to American Carbon LLC. In addition to extract untapped value and diversify revenues, AREC established American Metals LLC to recover and sell metal and steel, and American Rare Earth LLC to extract REE and other valuable elements from metallurgical carbon waste.

AREC's metallurgical carbon assets cover approximately 20,000 acres. Though AREC does not have carbon assets that have not been classified as reserves, it has said that its assets may have a remaining life of 20 to 40 years. It acquired these assets when the coal industry became depressed to where these assets could be acquired at low prices by assuming environmental liabilities. AREC acquired these assets by assuming approximately $50 million in environmental liabilities, of which approximately $21 million have been released.

Exhibit 6 shows AREC's summation of implied replacement costs of these acquisitions based on appraisals. We believe that this is useful to demonstrate the scale of AREC's acquisitions. We assume that if these assets are not resuming production, the value would be reduced to liquidation value composed of scrap, bonding and real estate net environmental liabilities. Conversely, AREC views its metallurgical carbon properties to have potential annual processing capacity of approximately 19 million tons. AREC believes that it has one of the largest metallurgical carbon growth platforms in the industry.

Exhibit 6: Appraised Replacement Values of AREC's Carbon Assets

American Resources Corp's Asset	Appraised Value[1]
Wyoming County Coal; Mineral	$17,408,545[2]
Wyoming County Coal; Facilities	$18,026,700[2]
McCoy Elkhorn Coal; Mine Infrastructure	$68,140,150[2]
McCoy Elkhorn Coal; Processing & Handling Facilities	$76,324,400[2]
Perry County Resources; Processing & Handling Facilities	$73,497,570[3]
Knott County Coal; Processing & Handling Facilities	$22,614,637[3]
Deane Mining; Processing & Handling Facilities	$45,229,274[3]
Equipment	$53,006,118[4]
TOTAL	**$374,247,394**

1: Appraised replacement value or implied replacement value is based on appraisals completed on the Company assets or using metrics based on appraisals for implied replacement value; 2: Darco Appraisal; 3: Implied on Darco Appraisal of McCoy Elkhorn Coal; 4: Purchase Price, Hilco Appraisal and Replacement Cost

Source: American Resources Corporation, Corporate Presentation, "Supporting Modern Infrastructure"

AREC completed these acquisitions at a time of low thermal coal prices. Metallurgical carbon is mined to produce steel, while thermal coal is used to generate electricity. Exhibit 7 shows recent trends in metallurgical and thermal coal prices leading up to the pandemic. This was due in part to a number of negative trends, which may include the closure of thermal coal plants in favor of green energy, manufacturing moving overseas, and a global oversupply. AREC recognized the opportunity with the bifurcation of the industry between thermal coal and metallurgical carbon prices. In addition, AREC recognized the areas potential for producing the highest quality metallurgical carbon, important for a growing domestic manufacturing base.

Exhibit 7: Comparison of Pre-pandemic Metallurgical and Thermal Coal Prices

Historic Metallurgical Coal Prices		Historic CAPP Thermal Coal Prices	
Year End	Hampton Road Index HCC - High	Year End	Big Sandy / Kanawha Rate District
2014	$ 100.35	2014	$ 56.00
2015	$ 80.25	2015	$ 45.55
2016	$ 223.00	2016	$ 50.65
2017	$ 210.00	2017	$ 60.90
2018	$ 205.34	2018	$ 68.12
2019	$ 135.00	2019	$ 60.30
2020	$ 101.00	2020	$ 54.35

Source: American Resources Corporation, 2021 Annual Report

Industry and pricing trends continued into the pandemic. AREC said that many coal producers were not allowed to cease production, leading to oversupply and further price declines. Producers were not in a position to develop resources or maintain equipment. AREC ceased mining and selling thermal coal in mid-2019. Once a mine operation ceases, it becomes difficult if not impossible to reopen. With a decline in production, inventories of metallurgical carbon were reduced to levels exposing a potential shortage with increasing demand. Exhibit 8 shows AREC's declining production and financial metrics prior to the idling of AREC's operations.

Exhibit 8: AREC Production and Financial Metrics

	Three month ended			Year ended December 31,	
	December 31, 2019	September 30, 2019	December 31, 2018	2019	2018
Sales Volume [a]					
Tons Sold	73.633	25.969	113.618	325.918	435.574
Company Production [a]					
McCoy Elkhorn	28.351	11.180	48.657	134.099	226.863
Perry County Resources	45.282	-	-	45.282	-
Deane Mining	-	14.789	64.961	146.537	208.711
Total	73.633	25.969	113.618	325.918	435.574
Company Financial Metrics [b]					
Revenue per Ton	$85.48	$ 71.13	$ 78.25	$ 75.04	$ 71.64
Cash Cost per Ton Sold [c]	$147.11	$ 113.84	$ 72.25	$ 80.04	$ 57.38
Cash Margin per Ton [c]	($61.63)	$ (42.71)	$ 6.00	$ (5.00)	$ 14.26
Development Costs	$1.324.063	$ 1.425.024	$ 1.626.402	$ 7.236.652	$ 3.815.235

Source: American Resources Corporation, 2021 Annual Report

With the waning of the pandemic, a resumption in manufacturing found a deficit in metallurgical carbon. This was exacerbated by the requirements of manufacturers to acquire specific types of metallurgical carbon. While the industry is highly competitive, successful producers have the ability to match supply with manufacturer demands. This contributed to higher prices across the spectrum of metallurgical coal types. AREC appears to have significant resource potential of high-quality metallurgical carbon to market that is used in steel making and several other industries. AREC said that all production and future investment will be for the mining of metallurgical carbon.

AREC said its backlog metallurgical carbon for 2022 is over $110 million. AREC said on its earning conference call for the first quarter of 2022, that with current market conditions it could sell its production "five times over." Production is sold on a combination of contracts and at spot. As contracts are renewed, we expect that AREC will realize prices approaching spot market levels. AREC said that pricing pressure is allowing contracts to be index-based, which would favor AREC in a rising-price environment. AREC expects to fulfill this backlog with production from PCR and from its Carnegie 1 and 2 mines processed through its McCoy Elkhorn facility.

AREC is focused on growing organically. Despite the temptation to refocus corporate priorities to expand production to meet increasing demand, AREC is determined to think "small and nimble" by focusing on producing metallurgical carbon to buyer specifications. It believes that this is essential to avoid the consequences and reputation for inflexibility that has impacted the industry. AREC believes that it has the potential to produce 700,000 tons of metallurgical carbon annually, 500,000 from its PCR complex and 200,000 from its Carnegie 1 and 2 mines through its McCoy Elkhorn complex. In addition, AREC recently leased its Deane Mining Complex with commitments to produce one million tons in its first year.

AREC's PCR complex may become one of the lowest-cost metallurgical carbon complexes in the U.S. According to AREC, the entire PCR complex has annual capacity to produce 1.0 to 1.5 million tons of carbon. Currently, the PCR complex is comprised of the E4-2 underground mine and the Davidson Branch Preparation Plant coal facility, with 1,300 tons-per-hour processing capacity and a batch-weight rail loadout with 135 car storage capacity and services by CSX Corp. (CSX-NC).

In November 2021, AREC acquired the E4-2 Deep Mine mineral reserves, securing the long-term viability of the PCR. The E4-2 mine is mined by room-and-pillar mining methods, using both continuous miners and continuous haulage systems, whereby mined material is belted directly from the mine to the stockpile at the Davidson Branch Preparation Plant less than a mile away. AREC said in a press release dated November 11, 2021, that it added a middling circuit to "increase recovery yield by over 5% - reducing magnetite waste, down time, utility costs and improved workforce efficiency and safety." AREC has estimated that the E4-2 mine capacity to produce up to approximately 80,000 tons per month of coal, or 960,000 tons per year.

In 2019, the E4-2 mine produced approximately 45,282 tons, sold at an average price of $81.37 per ton. Ninety-seven percent was sold as pulverized coal injection (PCI) with the remaining 3% being sold as industrial stoker. In 2020, the E4-2 mine produced only ~1,200 tons, sold at an average price of $52.30 per ton. In January 2020, the E4-2 mine was idled due to the adverse market conditions and the pandemic. The E4-2 Mine was restarted during March 2021.

Exhibit 9: McCoy Elkhorn Complex, in Pike County, Kentucky

Source: American Resources Corporation, AREC website

Production is increasing at AREC's McCoy Elkhorn Complex. Exhibit 9 shows an aerial view of the McCoy Elkhorn Complex. The McCoy Elkhorn complex previously processed material from Mine #15 and the Carnegie 1 Mine. Mine #15 was mined by room-and-pillar mining methods using continuous miners. In 2019, Mine #15 produced approximately 124,740 tons, sold at an average price of $76.40 per ton. In 2020, Mine #15 produced approximately 5,568 tons, and sold at an average price of $59.09 per ton. All of the coal extracted from Mine #15 was high-vol "B" metallurgical-quality coal sold into the PCI and metallurgical markets. In January 2020, Mine #15 was idled.

The Carnegie 1 Mine as an idled mine. In 2017, production from the Carnegie 1 Mine was reinitiated and mined by room-and-pillar mining methods, utilizing a continuous miner. In 2019, the Carnegie 1 Mine produced approximately 7,889 tons, and sold at an average of $138.00 per ton. All of the coal extracted from the Carnegie 1 Mine was high-vol "B" metallurgical-quality coal that was sold into the metallurgical carbon market. In January 2020, the Carnegie 1 Mine was idled and was restarted in October, 2021. Exhibit 10 shows pre-production work at the Carnegie 1 Mine.

Exhibit 10 - Carnegie 1 Mine - Pre-production

Source: American Resources Corporation, May 12, 2022

AREC estimates that the Carnegie 1 Mine has the capacity to produce up to approximately 10,000 to 15,000 tons per month, and anticipates that with improvements underway, production could be increased to 15,000 to 20,000 tons per month. Production material from the Carnegie 1 Mine is transported approximately 15 miles to the state-of-the-art processing facilities at its McCoy Elkhorn complex. With the addition of the Carnegie 2 mine, to come on-line later in 2022, AREC estimates that production could be increased to 200,000 tons per year. AREC recently signed a carbon offtake agreement along with a non-dilutive financial commitment of $2.5 million to restart the Carnegie 2 Mine. Lastly, AREC has the additional potential to bring the Carnegie 3 Mine on line. Altogether, AREC estimated potential annual production capacity of its McCoy Elkhorn complex to be 350,000 to 500,000 tons of high-quality metallurgical carbon.

AREC taps suspended value by leasing its Deane Mining Complex. AREC did not plan to bring the Deane Mining Complex back into production in the next five years. The lease provides an immediate increase in cash flow and shareholder value. The lessee will take over holding costs for permits and has agreed to pay AREC the higher of $5.00 per ton or 5% of gross sales price for processed coal. The lease has a five-year term. Bluegrass Resources, the project operator, is projecting one million tons of production in the first year. AREC has said that the Deane Mining Complex has only 3% of its total processing capacity demonstrating the scale of the suspended value in its asset base.

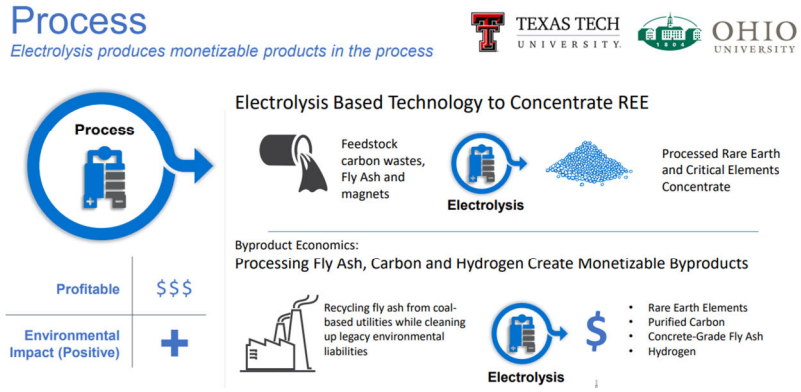
The Deane Mining Complex includes a preparation plant with an 800 ton-per hour coal preparation facility. In addition, there is a batch-weight loadout and rail spur with storage for 110 rail cars that is serviced by CSX Corp. In 2019, the Deane Mining Complex produced approximately 86,077 tons, and sold at an average price of $61.45 per ton. During 2019, 17% of the coal sold from Access Energy was sold as PCI coal, and 83% was sold as thermal coal. During 2019, the mine was idled, and as it was outside AREC's focus on the metallurgical and industrial markets, it was not a priority.

AREC's Wyoming County Coal (WCC) Complex is one of the last mid-vol complexes in the world. With the depletion of mid-vol deposits, producers blend high-vol and low-vol to meet purchaser requirements. Therefore, mid-vol coal is preferable for steelmaking. In addition to producing metallurgical carbon that is in high demand by steelmakers, the complex will showcase the "capture" and "processing" of wastes producing an REE concentrate and commercial grade, carbon-free hydrogen product. The complex is fully permitted and is in the stages for completion of a $45 million tax-exempt industrial development revenue bond. Upon restarting WCC, AREC may proceed on to restarting production at its Knott County Coal complex and its high-quality PCI carbon resources.

AREC acquired WCC in late 2018. The complex is located in western West Virginia and includes 1,100 acres of surface area on the Norfolk Southern Railway, with access to ports on the east coast. The complex includes onsite carbon processing, rail load out, two permitted underground mines and one surface mine. The two underground mines were expected to produce an estimated 55,000 tons of carbon per month, or 660,000 per year. AREC was considering expansion of WCC's carbon processing plant's capacity, from 350 tons per hour to approximately 700 tons per hour.

WCC is expected to showcase AREC's ability to lower operating costs by reducing wastes and producing marketable byproducts. As mining focuses on extracting metallurgical carbon, clays between carbon seams and surrounding hard rock are characteristically considered mine dilution composed of wastes which require disposal. These clays at the contact between the seams and hard rock may contain REE and other marketable elements.

Exhibit 11 – AREC's Electrolysis Based Technology Opportunity



Source: American Resources Corporation (link)

AREC recently acquired Energy Technologies Inc., a REE and carbon technology company, with the ability to analyze wastes to identify and separate REE and CE more efficiently. Exhibit 11 shows AREC's patented electrolysis-based technologies that are expected to produce an REE concentrate and a commercial grade, carbon-free hydrogen product. The concentrate will then be shipped to AREC's purification facility in Noblesville, Indiana for the purification of REE including Yttrium, Dysprosium, and Ytterbium.

FUNDING ANALYSIS

AREC recommenced production of metallurgical carbon in the second half of 2021. In ramping production, revenues have doubled each quarter. On its earnings conference call for the first quarter of 2022, AREC said that production reached approximately $6.0 million for the month of March. At this level, we expect quarterly revenues of at least $18.0 million. With a gross profit of 48%, we project that AREC may generate sufficient cash flow through 2022 to avoid having to issue equity. We anticipate that the convertible note due in the coming year will not be retired out of cash or converted, but extended one year or more. Our model anticipates that AREC should begin receiving revenues from leasing the Deane Mining Complex. We have not yet included revenues from its purification business in 2022. We expect that visibility on the purification business will improve in the coming months.

As of the end of its first quarter of 2022, AREC reported cash of $5.2 million and negative working capital of $11.0 million. The negative working capital position is primarily due to $8.9 million in convertible notes, payable within 12 months. While this note might be converted to shares, AREC anticipates that it is likely to be extended. AREC has a rapid-growth profile which may have the potential to stress working capital requirements.

AREC is optimistic that it will not need to raise equity capital given the increasing number of revenue sources generating positive cash flow in 2022. This would potentially include cash flow from its PCR and McCoy Elkhorn complexes and a recently completed lease on its Deane Mining Complex. In addition, it appears that its estimated capital costs for its purification business is relatively low, and we expect a relatively rapid attainment of break-even and payback of capital. As AREC is ramping up a number of operations simultaneously, these operations do not have historic information to complete a detailed funding analysis. In our opinion, AREC may not need to raise capital, and should it need to, it has a number of sources for funding.

AREC appears to be in position to attract non-dilutive capital. It recently completed an offtake agreement for $2.5 million to restart the Carnegie 2 Mine. It also is completing the $45 million tax-exempt industrial development revenue bond to develop its WCC Complex in West Virginia. With a growing pipeline of metallurgical carbon contracts, it is likely that there will be additional opportunities to utilize offtake agreements to increase liquidity. Also, given its potential to produce REE and CE, AREC is likely ahead of the line to secure government grants and loans. Lastly, it appears to have a loyal following of founding investors and has developed relationships with other commercial interests, such as Heritage, that would be an additional source of funding.

MANAGEMENT

In our opinion, AREC's management team appears to be composed of a number of capable entrepreneurs who are focused on achieving the goal. This would be the goal of profitably producing metallurgical carbon, and purifying REE and CE for both a sustainable environment and a domestic closed-loop supply chain for critical metals. AREC management has acquired credibility in a short time to secure and build relationships with leaders in academia, industry and government.

Mark Jensen (CEO, Chairman): Mr. Jensen has experience with major investment firms, which allowed him to significantly expand the company's asset base through strategic acquisitions and organic growth in a very accretive manner. Mark is a graduate from Kelley School of Business at Indiana University, with Bachelor degrees in Finance and International Studies, with a focus on East Asian culture and business.

Tom Sauve (President, Director): Mr. Sauve has worked over the last seven years with coal mining operations and various oil and gas wells throughout Texas and the Appalachia region. He has over 12 years in leading and managing mining operations and over 15 years investing, restructuring and building businesses. Mr. Sauve has a history of successfully identifying mining operations that have the ability to meet the company's model of cost cutting and efficiency. Mr. Sauve is a graduate from University of Rochester (Economics degree) and additional business studies from the Simon School of Business.

Tarlis Thompson (COO): Mr. Thompson oversees all operations at American Resources' Central Appalachian subsidiaries, which includes McCoy Elkhorn, Deane Mining, and Knott County Coal. He manages the activities at the company's various processing facilities and loadout, coordinates production at the company's various mines, manages environmental compliance and reclamation, and is responsible for quality control and shipments to customers. Mr. Thompson is a native of eastern Kentucky, with over 15 years of experience with companies that include Commercial Testing & Engineering, SGS Minerals, Massey Energy and CAM Mining. Mr. Thompson graduated from Millard High School in Pikeville, Kentucky, and has additional courses in Mining Engineering from Virginia Tech (Training), Business Administration Management from National College in Pikeville, and LECO Certified Course from West Virginia Training Institute.

Jeff Peterson (VP American Rare Earth): Mr. Peterson has nearly 20 years of experience including operations, engineering, sales, and product development with AREC. Mr. Peterson began his career as a Commissioned Officer in the United States Navy, serving onboard nuclear-powered submarines. After resigning his Commission, he joined Westinghouse Electric Company, where he served as part of the engineering and licensing team in the design of a U.S. Nuclear Regulatory Commission approved licensing of a first-of-its-kind Generation III+ pressurized water reactor for commercial electricity generation. Mr. Peterson then joined Cyient where he was rapidly promoted to sales, strategy, and product development leadership roles. He most recently worked with Hitachi Vantara as part of the North American sales team, selling digital transformation initiatives into key industrial markets. Mr. Peterson is a graduate of Purdue University and has his Master of Business Administration from the Joseph M. Katz Graduate School of Business at the University of Pittsburgh.

VALUATION

Our 12-month price target is based on the sum-of-the-parts. AREC is restarting metallurgical carbon production at its PCR and McCoy Elkhorn complexes. It recently leased its Deane Mining Complex to a third-party operator. AREC is planning to start production at its Noblesville, Indiana production facility in the coming weeks. We believe that AREC may issue additional equity on a discretionary basis, and will extend the convertible note due in the next 12 months beyond one year.

AREC's metallurgical carbon operation achieved positive cash flow from operations and has a backlog of $110 million. We have estimated revenues of $75 million for 2022 and ~$100 million for the next 12-months. We apply a sales multiple of 1.5 times 2022 sales to arrive at a $150 million value for this segment. Given the growth profile of its metallurgical carbon assets, and indexing of contracts going forward in a rising price environment, we believe that our estimate is conservative and may soon need to be updated.

AREC recently leased its Deane Mining Complex to a third-party operator. The lease is for at least $5 per ton or 5% of gross sales. The third-party operator has committed to produce one million tons in the initial year. The lease has a five-year term with renewal options. AREC is not required to put up capital for start-up and enjoys some operating relief on property maintenance. We anticipate that the available mineable material may support a long-term operation. We apply a cap rate of 10% to an annual cash flow of $5 million and assign a $50 million value to this segment.

We have not included the purification business in our sum-of-the-parts valuation. AREC said that it could produce $5 million in revenue by producing 56,000kgs of 99%+ purity of marketable REE from its first two production trains. In addition, it said that it anticipated potential capacity at its seven acre site to produce over three million kgs of CE and REE. This would imply a stepped-up annual run rate of ~$270 million. While the operation on the seven-acre site is expected to come on line after 2022, AREC said that it could add another four trains to the two under development on the existing site. While the near and long-term growth potential of this segment is large, we are unable to assume with confidence timing, revenues and operating expense.

We have also not included AREC's other assets in our sum-of-the-parts valuation. This would include the potential for bringing the WCC complex on line in 2023-2024. This also does not include the potential for opportunities to lease or monetize other metallurgical carbon or thermal coal assets in its portfolio. We also have not included AREC's 50% interest in Novusterra Inc., where AREC monetized patents for graphene and carbon nanotube production. We have also not included available cash of ~$5.0 million.

The addition of items not included in our sum-of-the-parts estimate demonstrate the conservative nature of our valuation. Based on the existing cash flow projections from AREC's metallurgical carbon segment, we estimate a market cap of $200 million, and with 65.6 million shares outstanding, this implies a target price of $3.05 per share, which we round to $3.00 per share. We are initiating research coverage of AREC with a Buy rating and price target of $3.00 per share.

Factors that could impede AREC from achieving our price target include operational risk at its own operated and leased properties. AREC also has substantial operating risk in the scaling of a novel technology. In addition, AREC has exposure to risks related to metallurgical carbon, thermal coal, and REE and CE commodity prices. Also, none of AREC's metallurgical carbon or thermal coal properties have Mineral Reserve estimates.

RISKS

Political risk. Natural resource companies are subject to significant political risk. Although most mining jurisdictions have known laws, the potential exists for these laws to change.

Commodity price risk. All natural resource companies have some form of commodity price risk. This risk is not only related to final products, but can also be in regards to input costs and substitute goods.

Operational and technical risk. Natural resource companies have significant operational and technical risks. Additionally, numerous unforeseeable issues can occur with operations and exploration activities.

Pre-revenue risk. Pre-revenue natural resource companies are dependent on available cash, marketable assets, and the ability to borrow or sell equity into capital markets to fund development, including exploration and construction. There is no guarantee that the company will become cash-flow positive.

Market risk. Although most natural resource companies are more closely tied to individual commodity price performance, large business cycle forces or economic crises can impact a company's valuation significantly.

Cautionary Note to US Investors: Estimates of Measured, Indicated and Inferred Resources

"Measured Mineral Resources" and "Indicated Mineral Resources." U.S. investors are advised that although these terms are required by Canadian regulations, the U.S. Securities and Exchange Commission (SEC) does not recognize them, and describes the equivalent as "Mineralized Material." U.S. investors are cautioned not to assume that these terms are any form of guarantee.

"Inferred Mineral Resources." U.S. Investors are advised that while this term is required by Canadian regulations, the SEC does not recognize it. "Inferred Mineral Resources" are not delineated with a great deal of certainty and should not be considered likely to be brought into production in whole or in part.

COMPANY DESCRIPTION

AREC is a next-generation, environmentally and socially responsible supplier of high-quality raw materials to the new infrastructure market. AREC is focused on the extraction and processing of metallurgical carbon, an essential ingredient used in steelmaking, critical and rare earth minerals for the electrification market, and reprocessed metal to be recycled. AREC has a growing portfolio of operations located in the Central Appalachian basin of eastern Kentucky and southern West Virginia where premium quality metallurgical carbon and rare earth mineral deposits are concentrated.

AREC Income Statement

Amounts in $ million	1Q20A	2Q20A	3Q20A	4Q20A	2020A	1Q21A	2Q21A	3Q21A	4Q21A	2021A	1Q22A	2Q22E	3Q22E	4Q22E	2022E
Revenue	0.5	0.2	0.3	0.0	1.1	0.0	0.4	2.8	4.5	7.8	9.1	19.0	21.0	23.0	76.4
Operating Expenses	(4.8)	(3.0)	(2.5)	(7.2)	(17.5)	(6.0)	(6.0)	(10.7)	(13.5)	(36.1)	(13.1)	(12.0)	(11.0)	(11.0)	(47.1)
Operating Income	(4.3)	(2.8)	(2.2)	(7.1)	(16.4)	(6.0)	(5.6)	(7.8)	(8.9)	(28.3)	(4.0)	(2.8)	(1.4)	(0.4)	(7.1)
Other Expenses	1.0	4.1	2.4	(1.3)	6.2	(0.4)	(1.1)	(1.1)	(1.6)	(4.2)	1.2	(0.5)	(0.5)	(0.5)	(0.3)
Pretax Income	(3.3)	1.3	0.1	(8.4)	(10.3)	(6.4)	(6.7)	(8.9)	(10.6)	(32.5)	(2.8)	(3.3)	(1.9)	(0.9)	(7.4)
Taxes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Income	(3.3)	1.3	0.1	(8.4)	(10.3)	(6.4)	(6.7)	(8.9)	(10.6)	(32.5)	(2.8)	(3.3)	(1.9)	(0.9)	(7.4)
Basic EPS	$ (0.12)	$ 0.05	$ 0.00	$ (0.28)	$ (0.35)	$ (0.14)	$ (0.13)	$ (0.15)	$ (0.17)	$ (0.59)	$ (0.04)	$ (0.05)	$ (0.03)	$ (0.01)	$ (0.11)
FD EPS	($0.12)	$0.03	$0.00	($0.28)	($0.35)	($0.14)	($0.13)	($0.15)	($0.17)	($0.59)	($0.04)	($0.05)	($0.03)	($0.01)	($0.11)
Shares outstanding million	27.3	26.8	26.8	30.0	29.4	46.9	52.1	60.1	61.8	55.2	65.3	65.4	65.5	65.6	65.4

Source: AREC company reports on SEDAR and ROTH Capital Partners estimates
Quarterly EPS may not sum to fully diluted EPS due to quarterly losses
Note: Company reports under U.S. GAAP

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Distribution of IB Services Firmwide

			IB Serv./Past 12 Mos. as of 05/23/22	
Rating	**Count**	**Percent**	**Count**	**Percent**
Buy [B]	**354**	**82.71**	**235**	**66.38**
Neutral [N]	**48**	**11.21**	**30**	**62.50**
Sell [S]	**2**	**0.47**	**1**	**50.00**
Under Review [UR]	**24**	**5.61**	**15**	**62.50**

Our rating system attempts to incorporate industry, company and/or overall market risk and volatility. Consequently, at any given point in time, our investment rating on a stock and its implied price movement may not correspond to the stated 12-month price target.

Ratings System Definitions - ROTH employs a rating system based on the following:

Buy: A rating, which at the time it is instituted and or reiterated, that indicates an expectation of a total return of at least 10% over the next 12 months.

Neutral: A rating, which at the time it is instituted and or reiterated, that indicates an expectation of a total return between negative 10% and 10% over the next 12 months.

Sell: A rating, which at the time it is instituted and or reiterated, that indicates an expectation that the price will depreciate by more than 10% over the next 12 months.

Under Review [UR]: A rating, which at the time it is instituted and or reiterated, indicates the temporary removal of the prior rating, price target and estimates for the security. Prior rating, price target and estimates should no longer be relied upon for UR-rated securities.

Not Covered [NC]: ROTH does not publish research or have an opinion about this security.

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