Niron Magnetics, Not So Rare & Precious

By John Benson

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1. Introduction

The paper summarized and linked below was posted a few days ago.

Rare & Precious: *I have recently spent much time delving into new materials: "Many of my papers start with a chemists identifying a material that performs a particular function much more effectively than the incumbent material."*

However there is one type of material that chemists cannot create, elements. There are currently 118 elements. Other than using nuclear physics to create them (one atom at a time) there are only two ways to obtain elements: (1) recycle used materials to obtain their component elements, or (2) mine the ore containing an element, and refine it.

https://energycentral.com/c/rm/rare-and-precious

The above post described the extraordinary efforts the federal government is pursuing to find and extract rare-earth and other critical elements, the largest rare-earth mine in the U.S., and another large rare-earth mine in the U.S. that is under development.

However, there is frequently more than one road to Rome. One of the largest users of rare-earth elements are industries that use these to make permanent-magnets, and these are used in high performance motors that are needed for electric vehicles and also in large wind turbines.

The alternate road in this case, is to use a very common compound but modify its molecular structure such that it performs much like a permanent-magnet that uses rare-earth elements, but without the rare-earth elements.

2. Niron Magnetics' Clean Earth Magnet™

The world's first high strength, rare earth free permanent magnet.[1]

They're little-known to most consumers, but permanent magnets made with rare-earth metals power our modern lives. They go into motors and generators that enable electricity to be transformed into motion and motion into electricity for everything from electric vehicles to wind turbines.[2]

Because of their higher performance—allowing smaller, more powerful motors than alternatives—their use continues to rise, with global demand for rare-earth magnets expected to increase at 7.5% compounded annually through 2040, per Adamas Intelligence.

[1] Niron Mangnetics Home Page, 2023, https://www.nironmagnetics.com/

[2] Amy Feldman, Forbes, "Inside The Startup Whose Technology Promises An American Energy Transformation," June 13, 2023, https://www.forbes.com/sites/amyfeldman/2023/06/13/inside-the-startup-whose-technology-promises-an-american-energy-transformation/

All of that has created an enormous need to create the magnets with an alternative to the rare-earth metals that come from China. That's where Niron, an under-the-radar startup that has raised over $100 million, comes in.

In Niron's pilot plant in Minneapolis, workers take iron in powdered form and bubble nitrogen through it to create iron nitride, an extremely magnetic material. Historically, rare-earth alternatives haven't been as powerful as the permanent magnets they hope to replace, but Niron says its iron-nitride process can already replace some rare-earth magnets and it's continuing to improve the technology.

Some two dozen partners in areas like automotive, consumer electronics and power tools are conducting pre-production sampling of Niron magnets. The company's technology is based on research developed by University of Minnesota professor Jian-Ping Wang. He's spent most of his life studying magnets, and is Niron's chief scientific officer and on its board of directors.

Today, the pilot plant produces just 100 kilos of magnets and the company brings in minimal revenue. But it's begun scoping out locations for a full-scale production facility, which would cost hundreds of millions of dollars, that it expects to open within the next three or four years.

Demand for permanent magnets far outstrips supply, and most rare earth magnets come from China. Niron's new technology could fill that gap, while offering an answer to geopolitical tensions and supply-chain instability. "We have a solution to the rare-earth crisis," says CEO Jonathan Rowntree.

2.1. Technology

Niron's manufacturing process combines breakthroughs in nanomaterial engineering with well understood, mature metallurgical methods to deliver high performance magnets at less than half the cost of alternatives.[1]

Building off more than a decade of research and development, Niron's manufacturing techniques precisely control and manipulate the crystal structure of Iron Nitride to obtain high strength magnets.

For high performance applications, magnets made of rare-earth materials are the most widely used today (like Neodymium-Iron-Boron (NdFeB) magnets). However, the mining, extraction, and manufacturing processes are labor intensive, expensive, and damages the environment. Due to persistent supply chain and geopolitical issues, the prices of these materials have been historically unstable and have surged over the last year.

Niron's proprietary Clean Earth Magnet materials possess inherently higher magnetization and can be produced at a lower cost. Using a patented, scalable process, Niron will produce high powered magnets using commonly available iron and nitrogen raw materials that can be sourced globally and sustainably.

2.2. Leadership

Niron Magnetics is a startup, and the boards of most startups are heavily populated with their supporters, including investors, so let's start there:

OUR PARTNERS

UNIVERSITY OF MINNESOTA

arpa·e

NSF

DOE Seal

OUR INVESTORS

ANZU PARTNERS

ARTIMAN

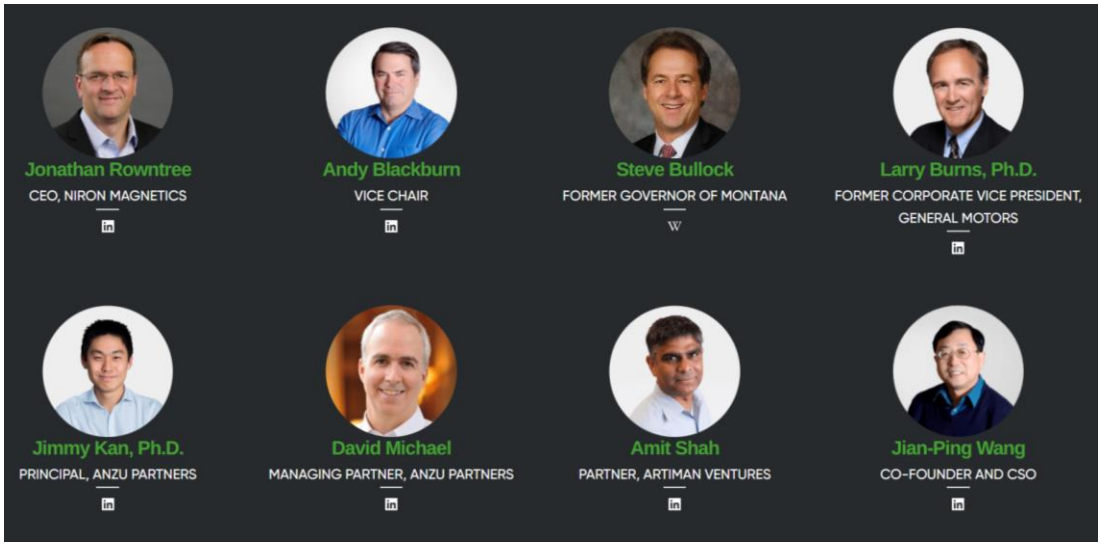
UNIVERSITY OF MINNESOTA

Western Digital.

+VOLTA ENERGY TECHNOLOGIES

VOLVO

Niron Magnetics Board of Directors:



I found details for each member and pasted them below.

*Niron Magnetics... today (Jan 18, 2023) announced the company has appointed **Jonathan Rowntree** as its new CEO. This leadership change represents a planned*

evolution of the company, as Niron advances from its focus on development towards scaling, commercialization, and productization of its Clean Earth Magnet® technology.[3]

Jonathan is a seasoned executive leader with a proven track record of commercializing new-to-the-world solutions in the advanced materials space, most recently as Senior Vice President of Advanced Electronics Solutions of Rogers Corporation. Previously, Jonathan also served as Senior Vice President of the Industrial Electronics business unit at Henkel Corporation, where he led the growth of its global electronic materials business for 11 years. Earlier in his career, Jonathan worked with other companies in the new and innovative materials space such as National Starch & Chemical, where he held various leadership positions and contributed to technological development and commercialization.

Andy Blackburn was formerly CEO until replaced by the above. His profile from LinkedIn follows. *General Manager with extensive experience driving corporate and business strategy. Broad experience in new technology adoption, product marketing, brand-building business model and pricing design. Particular depth in market and customer insight, competitive and go-to-market strategy, business and corporate development. Collaborative team-builder; transparent and energetic people leader with the ability to work effectively across diverse organizations.*

Steve Bullock is the obligatory politician on the board. He is a centrist Democrat. Go through the link below for more info. He was appointed to Niron's board in March 2021.

https://en.wikipedia.org/wiki/Steve_Bullock_(American_politician)

Larry Burns, Ph.D. is the obligatory former large-corporation officer on the board. Appointed at the same time as the above politician. See press release below for both Steve and Larry.

https://www.nironmagnetics.com/news/niron-magnetics-expands-its-board-of-directors-and-advisor-network-ahead-of-commercialization-efforts-for-rare-earth-free-magnets/

Jimmy Kan, Ph.D.,PRINCIPAL, and **David Michael, Managing Partner, Anzu Partners,** Investors

Amit Shah, Partner, Artiman Ventures, Investor

Jian-Ping Wang, Co-Founder and CSO:

The following article from the University of Minnesota is useful: *Niron Magnetics, a startup company born out of University of Minnesota Twin Cities Professor Jian-Ping Wang's research, received $17.5M from the U.S. Department of Energy to scale up prototyping of its sustainable permanent magnets. The grant is part of the DOE Advanced Research Projects Agency – Energy (ARPA-E) Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALEUP) program.*[4]

Niron is partnering with six leading global manufacturers of devices that rely on magnets for the SCALEUP project, including Volvo Cars, an automotive company; Peerless, a manufacturer of drivers and amps for audio speakers; and Western Digital, who makes

[3] Brandon Reid, Niron Magnetics Press Release, "Niron Magnetics Appoints Seasoned Innovative Materials Executive Jonathan Rowntree as New CEO," Jan 18, 2023, https://www.nironmagnetics.com/news/

[4] University of Minnesota News Release: "University-born company Niron Magnetics receives $17.5M DOE grant," Nov 29, 2022, https://cse.umn.edu/college/news/university-born-company-niron-magnetics-receives-175m-doe-grant

flash and hard drives for data storage applications. Leading power tool and wind turbine manufacturers are also involved. The company is completing a 25,000-square-foot pilot plant adjacent to its headquarters in northeast Minneapolis.

Permanent magnets are key components in electric vehicles, wind turbines, and many other clean energy technologies. They also help power common devices that we use daily, such as computers and electric appliances. However, current magnets are made using rare earth elements, which are less available and have negative environmental impacts.

Niron Magnetics' Clean Earth Magnet is the world's first high-powered, rare earth-free permanent magnet, made from abundant iron and nitrogen materials. These magnets will provide a less expensive, more sustainable way for the United States to achieve its goal of reaching net-zero emissions by 2050.

Wang founded Niron Magnetics in 2014 after he and his University of Minnesota research group developed the world's first iron nitride magnet. Now, he serves as the company's scientific advisor. Wang, who holds 65 patents, was inducted into the National Academy of Inventors this year and has founded three companies including Niron…

3. Energy Products using Permanent Magnets

3.1. Electric Vehicles

I did a recent post on the subject of Electric Vehicle (EV) motors, specifically some of the most advanced motors currently used in EVs, with a focus on Infinitum's motors.

Get your motor runnin': *This post is about axial-flux motor with a PCB stator. This design has been used in a number of machine designs, and will probably be critical in all types of electric vehicles (EVs) going forward, especially smaller lightweight EVs.*

https://energycentral.com/c/ec/get-your-motor-runnin

Get Your Motor Runnin', Part 2: *Part 2 is mainly about traction motors. I covered smaller applications in Part 1. These helped to get Infinitum's motors runnin', and put some capital plus experience into the company to prep for the big opportunity (EVs).*

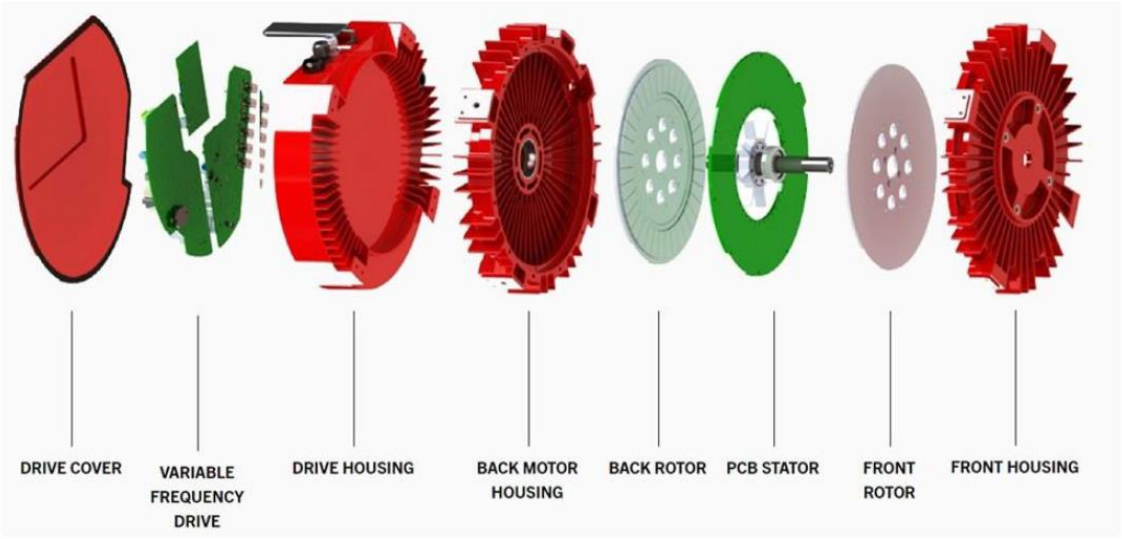
In researching this article, I identified two new firms that are also developing high-output motors using new designs, specifically targeting mobility application. One is in the U.S. and one in the EU. I will cover these briefly in the last section of this paper

However, if you are interested in this subject, I would start with part 1, as I will only provide the new information in this (probably very short) post. There is a link to part 1 in the Introduction of this paper.

https://energycentral.com/c/ec/get-your-motor-runnin-part-2

The figure below was used in both parts. The motor used in EVs *"features three printed-circuit stators sandwiched by four permanent-magnet disc rotors, and it's wound for three-phase operation.*

"Cooling oil enters under pressure through the output shaft, flowing axially out to directly cool the copper traces before collecting in a sump at the bottom. It's rated for 201 hp continuous. 402 hp peak - and note that superior cooling potentially allows it to sustain peak power longer than other designs could…"



The "…*two new firms that are also developing high-output motors using new designs…"* are identified and described in sections 4.2 and 4.2 of Part 2.

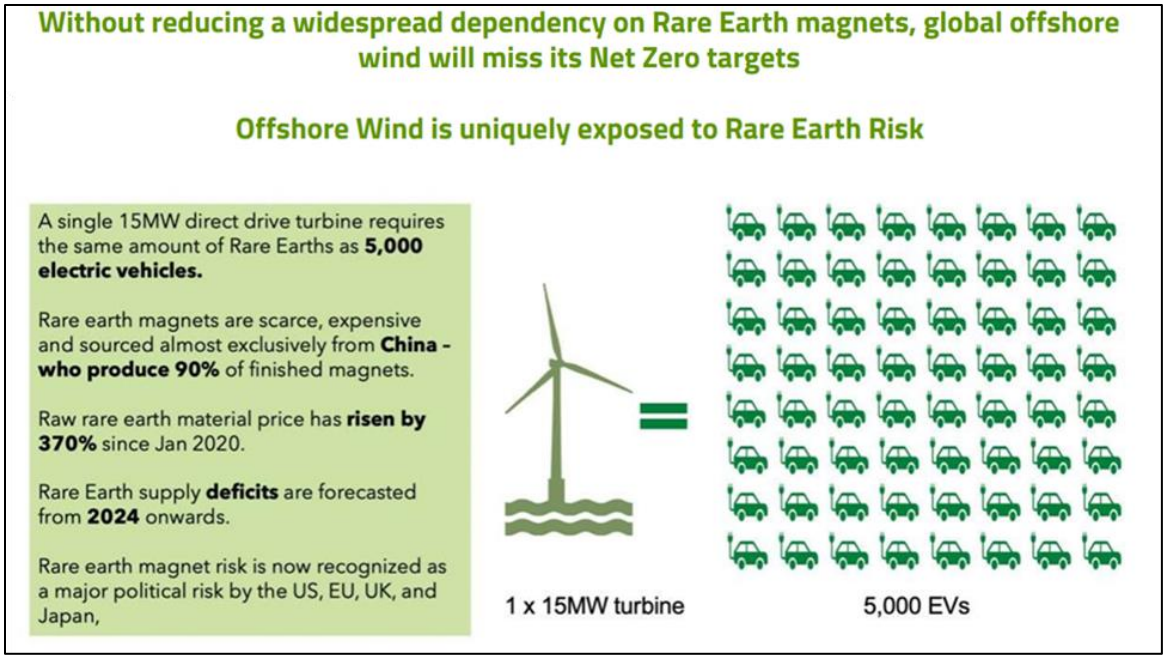
3.2. Off-Shore Wind Turbines

Most wind turbine drivetrains currently use generators that are connected to gearboxes, which speed up the rotation from the relatively slow speed of the turbine's blades (typically 5–15 rotations per minute for a modern machine), to the high speeds (1,000–1,800 rotations per minute) needed to generate electricity using a high-speed induction generator. Having all of those moving parts makes the gearbox one of the highest-maintenance parts of a wind turbine.[5]

One alternative is to use a "direct drive" generator that can generate electricity at much lower speeds. Direct drive systems do not require a gearbox and therefore have fewer moving parts. However, they usually use permanent magnets, which require expensive, heavy, rare earth materials such as neodymium and dysprosium, and they typically require heavier generators than geared machines for a given turbine capacity.

Currently the U.S. (and my home state, California) is in the midst of a major offshore wind turbine build-out. These will use the largest-scale wind turbines, and these are direct-drive designs that (currently) use rare-earth magnets. To give you an idea of the scale of these turbines, see the image below.[6]

[5] Energy.gov, EERE, "Advanced Wind Turbine Drivetrain Trends and Opportunities," July 2019, https://www.energy.gov/eere/articles/advanced-wind-turbine-drivetrain-trends-and-opportunities# .
[6] GreenSpur, a UK developer of rare-earth-free Wind Turbines and Niron Magnetics partner, https://www.greenspur.co.uk/



Although there are many other products that use permanent magnets, both of the above markets described in subsections 3.1 and 3.2 are very large and still growing rapidly. Thus these will have the greatest impact on demand for permanent magnets.