GCxN

Shell + NREL:
A Global Energy GameChanger

Year in Review 2022

Founded by:

Shell + NREL

From the Program Managers

As we embark on a new year, it feels prudent to reflect before planning forward. 2022 was an eventful year: an ongoing war in Europe, the resulting humanitarian and energy crisis, and a doubling down and emphatic support for renewables, including billions of dollars in new government funding in the United States for clean energy. Against this backdrop, 2022 was full of memorable Shell GameChanger Accelerator™ Powered by NREL (GCxN) highlights and progress toward the energy transition. The program garnered awards, had a prominent presence at key industry events, welcomed new Steering Committee members, and is gearing up to explore exciting emerging technology themes. GCxN exists to accelerate its 19 portfolio companies, who similarly had banner years both within the program and beyond. With help from researchers at the National Renewable Energy Laboratory (NREL), they achieved technical breakthroughs, graduated from GCxN and carried on to other endeavors, made media headlines, secured millions in funding, grew their talented teams, and joined exclusive programs that will continue to support and accelerate their success and impact. Our program management team is incredibly proud and honored to share a few of those accomplishments in this Year in Review.

Leading GCxN fulfills and rewards us every day. This is especially the case when our peers recognize our collective efforts as the Federal Lab Consortium (FLC) did. After earning an award at the regional level, it thrills us to announce FLC awarded us a national Technology Transfer Innovation Award during the organization's annual conference. That's not the only stage where GCxN made an appearance. As travel and in-person gatherings became more possible, conferences featured GCxN, including the iconic South by Southwest festival in Austin, Texas; the massive international tech convening Web Summit in Lisbon, Portugal; and the 27th NREL Industry Growth Forum as well as other events hosted by the NREL Innovation and Entrepreneurship Center (IEC). In addition to growing our presence, we grew our Steering Committee and welcomed new members into each other's proverbial homes with visits and key strategic discussions at NREL's South Table Mountain and Flatirons campuses, as well as Shell's Technology Center Houston and TechWorks Boston.

This report contains volumes of compelling updates on the achievements, milestones, and headline news of our portfolio companies. A few items stand out:

- Five companies—BlueDot Photonics, Hygge Power, Icarus RT, Intertie Corp., and SPAN—graduated from the program after NREL researchers completed their technical projects and a Shell panel rigorously evaluated the results
- Antora (Cohort 1) secured $50 million and was featured in Times Square as part of the Impact100 list of 100 Ideas That Can Change 1 Billion Lives
- SPAN (Cohort 2) raised a $90-million Series B round
- EV infrastructure company BEAM Global acquired AllCell (Cohort 2)
- CNN, as well as other numerous premier media outlets, featured AIR COMPANY (Cohort 4) for their sustainable aviation fuel product
- Electrified Thermal Solutions (Cohort 5) Co-Founder and CTO Joey Kabel landed on Forbes' list of Under 30s Powering the Future of Energy and Sustainability.

There's plenty more—read on!

With ever-increasing focus and urgency around energy security, climate change, and making a smooth, just, and equitable energy transition to secure our collective future, GCxN's work is even more crucial and timely in 2023. In the year to come, we will onboard new startups in two cutting-edge technology themes that have immense potential for impact. We are eager to work alongside partners to discover and advance emerging clean technologies with the potential to dramatically alter the future energy landscape in 2023 and far beyond.

Yesim Jonsson
Shell GCxN Program Manager

Johanna Jamison
NREL GCxN Program Manager

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NREL GCxN Technical Project Manager

Contents

$67:$1

LEVERAGE RATIO FOR SHELL PROJECT FUNDING

$317M+

RAISED BY COHORT COMPANIES SINCE JOINING GCXN

Companies selected by GCxN raise an average of $16.7M thereafter, versus an average of $8.9M for those who apply but are not selected.

3.6

AVERAGE TECHNOLOGY READINESS LEVEL (TRL) UPON JOINING GCxN

285

NEW STARTUP HIRES SINCE JOINING GCxN

5.6

AVERAGE TRL AFTER GRADUATING FROM GCxN

About GCxN

The Shell GameChanger Accelerator Powered by NREL (GCxN) is a multimillion-dollar, multiyear program focused on discovering and advancing emerging clean technologies with the potential to dramatically alter the future energy landscape. GCxN identifies promising startup companies through our Channel Partners, an extensive ecosystem of cleantech business incubators, accelerators, and universities. Invited companies receive access to up to $250,000 in non-dilutive funding in the form of technical expertise and facilities to develop and demonstrate new energy technologies.

GCxN seeks companies operating in the new energy space, with rotating technology focus areas that span the energy continuum from generation to transmission and distribution. GCxN's goal is to help early-stage companies, preferably with technology at Technology Readiness Levels (TRL) II through V, meet critical milestones to advance to the next stage of development—accelerating their time to market while minimizing the risks associated with commercializing next-generation technology. Over the course of 18–24 months, participating GCxN companies gain access to NREL's world-class facilities and top-tier researchers from both Shell and NREL, who help incubate, develop, and validate companies' technologies.

About Shell

Shell's purpose is to power progress together with more and cleaner energy solutions. We believe that rising standards of living for a growing global population are likely to continue to drive demand for energy for years to come. At the same time, the need to tackle climate change means there are transitions underway to a lower-carbon, multisource energy system. Shell's technological capacity, customer-mindset, operational experience and market knowledge mean we are at the forefront of innovative and collaborative approaches to help build a sustainable energy future.

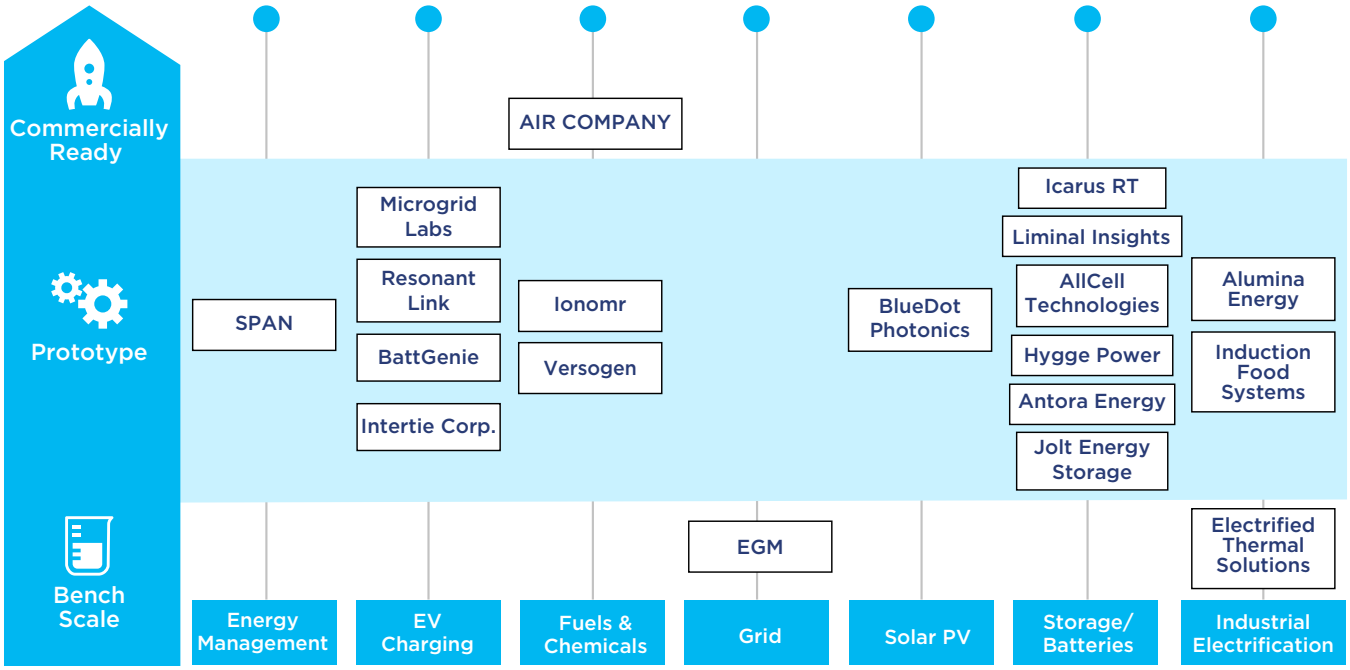
In addition to GCxN, which harnesses the power of Shell's collaboration with NREL for greater and faster innovations, Shell GameChanger works with startups and businesses on unproven early-stage ideas that have the potential to impact the future of energy. The program's team provides support, expertise and seed funding, while the startups keep the independence to make their own decisions. Founded in 1996, GameChanger has worked with more than 5,000 innovators from around the world and turned more than 150 ideas related to the energy transition, digital transformation, and a broad spectrum of energy technologies into productive reality.

About NREL

The National Renewable Energy Laboratory (NREL) is one of 17 U.S. Department of Energy national laboratories. NREL's more than 3,000 employees focus on research, development, and deployment of next-generation renewable energy technologies.

With its internationally renowned scientists and world-class facilities, NREL is a perfect partner for Shell GameChanger in supporting passionate cleantech entrepreneurs. NREL provides GCxN with unbiased third-party technology development, validation, and demonstration capabilities to advance and de-risk early-stage technologies.

19 GCxN Companies Across Technology Sector and Stage



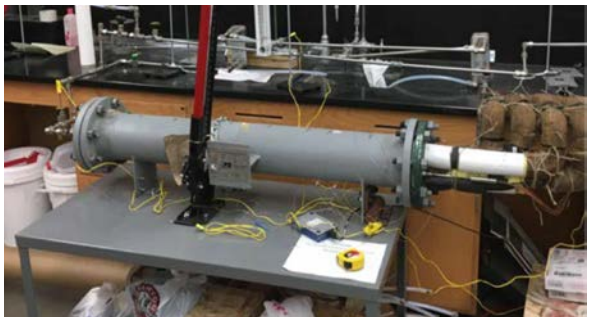
GCxN Portfolio Companies

AIR COMPANY

AIR COMPANY patented a process that mimics photosynthesis in a way that is more efficient and faster at purifying air. This technology transforms carbon dioxide captured from the air into impurity-free alcohols that can be used in spirits, fragrances, sanitizers, and a variety of consumer industries. In 2022, AIR COMPANY's announcement of its sustainable aviation fuel product and partners generated headlines on CNN, Forbes, and more. The company also raised a $30-million Series A round, secured awards from the Global Warming Mitigation Project and Crain's Detroit Business, and continues to grow its team.

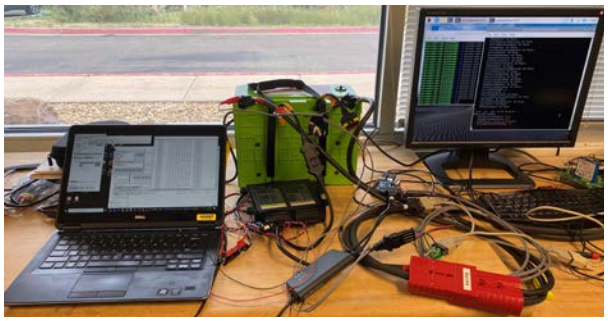
AllCell Technologies

AllCell Technologies introduced revolutionary lithium-ion battery packs that incorporate its patented phase-change composite (PCC) passive thermal management technology. PCC keeps the cells at optimal temperatures during operation, enabling a cost-effective energy storage solution with an improved cycle life, advanced performance, and enhanced safety. Autonomous shuttles, electric planes, robotics, lightweight electric vehicles, and commercial drones can use AllCell Technologies' batteries. In 2022, BEAM Global, an EV charging solution provider, acquired AllCell. That company has since received sizeable orders from various U.S. and Puerto Rico government agencies, partnered with the likes of Volvo, and garnered an Achievement in Product Innovation honor from the American Business Awards.



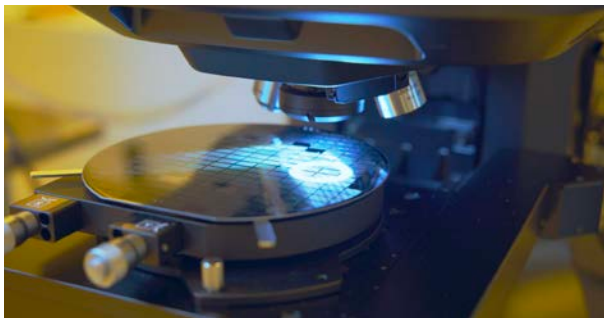
Alumina Energy

Alumina Energy develops HEATER (Heat Exchanger and Thermal Energy Reservoir), a cogeneration solution for industrial customers that is economical, flexible, and zero carbon. In 2022, Alumina made headway in collaboration with NREL on its GCxN project, as well as Technical Complexity Factor testing. The company submitted competitive grant applications for several outstanding opportunities and continues to participate in Wood Mackenzie's Long Duration Energy Storage Council.



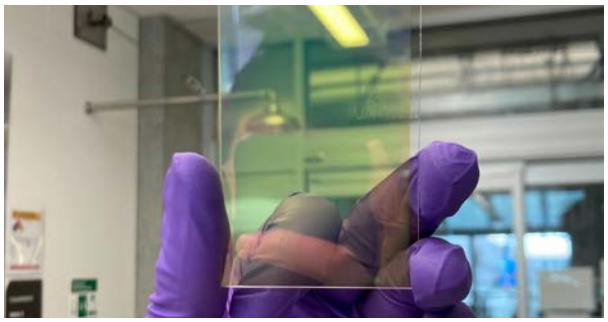
BattGenie

BattGenie provides software solutions for battery management systems to enable faster charging and longer battery cycle life for electric vehicles and grid storage battery applications. The company brought in almost $2 million in 2022 from a seed funding round and university grant and Third Derivative selected it for its distinguished accelerator program. BattGenie signed three contracts with large corporations and has more in the pipeline. They also added key team members with deep industry experience, and their CEO was featured on the final episode of GeekWire's Elevator Pitch series.



Antora Energy

Antora Energy created groundbreaking, low-cost thermal batteries for grid-scale, long-duration energy storage. Current technology, such as lithium-ion batteries, can store a few hours of power while Antora Energy's technology can store multiple days' worth of energy. In 2022, Antora Energy secured a $50 million financing round co-led by Breakthrough Energy Ventures, appeared on Times Square's digital billboard as an Impact100 "Idea That Can Change 1 Billion Lives," and broke ground on their first field pilot. They ended the year on a high note by acquiring Medley Thermal to support commercialization of Antora's technology and are hiring for several positions on their now 40-plus person team.



BlueDot Photonics

BlueDot Photonics works to develop the next generation of solar panels made of perovskite materials, with the goal of increasing output by at least 10%. After a rigorous review of project results and successfully graduating from GCxN in 2022, BlueDot continued to build on the program's technical progress and toward a viable solar prototype. The company is now exploring a pivot to other applications of perovskite materials where their unique properties can add value.

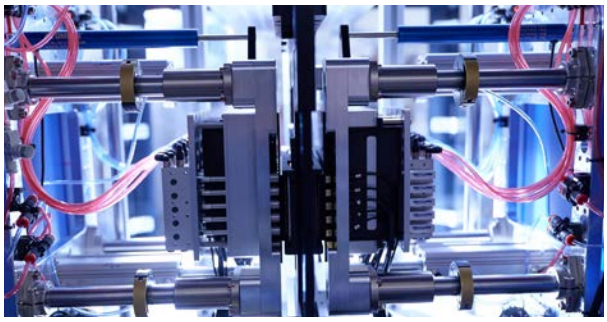
EGM

Electric Grid Monitoring (EGM) aims to digitize the grid and integrate distributed energy resources. EGM mitigates major grid challenges by delivering effective integration of distributed renewable energy to the grid, enhancing grid reliability, improving security levels, and reducing the cost of ownership. In 2022, EGM deployed their Meta-Alert Grid Operation and Management System solution in a world-first pilot involving collection of 60-plus data points on a transmission line in the Middle East. EGM (alongside the Israeli Electric Corporation) was also one of only two industry partners selected to participate in NREL's Advanced Distribution Management System (ADMS) Test Bed and presented at numerous industry conferences.

Liminal Insights

(formerly Feasible Inc.)

Liminal Insights pioneered a battery intelligence platform that combines ultrasound and data analytics to deliver unique insights across the value chain. Liminal Insights' technology, known as EchoStat, uses ultrasounds to probe the physical condition of batteries in ways that are not currently possible at commercial scale. This patented technology enables customers to build dependable, safe batteries and deliver premier performance at a lower cost. In 2022, the company raised an $8-million Series A1 round and more than doubled in size. In part via major industry conferences like the Battery Show North America, they got exposure to, gained traction with, and secured sizable orders from major customers, including original equipment manufacturers and auto manufacturers.



Electrified Thermal Solutions

Electrified Thermal Solutions (ETS) focuses on developing the Joule Hive: a new energy storage technology that converts surplus zero-carbon electricity into heat. The company gained significant momentum in 2022, raising a $4.5-million seed round to bolster their materials engineering, modeling, scale-up, and business development efforts by tripling the size of their team. Co-Founder and CTO Joey Kabel won a spot on the coveted Forbes "30 Under 30 Energy" list, and Co-Founder and CEO Daniel Stack won a Shell-hosted pitch competition at the massive global Web Summit technology conference. Looking ahead to 2023, they anticipate formalizing agreements with industrial players with whom conversations are already underway.

Icarus RT

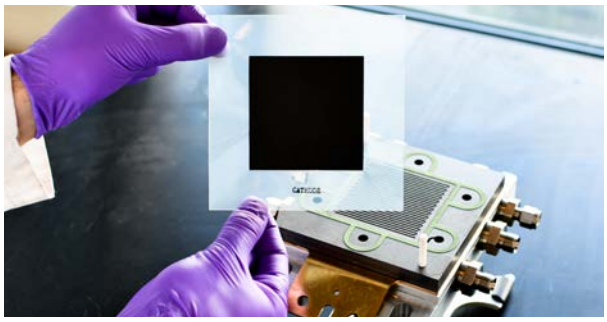
Icarus' product, Quartet, extracts, collects, and stores "waste heat" from solar panels to increase power output and lower system cost per kW. Quartet then converts the stored heat to hot water and/or power on demand. Icarus RT and its leadership took center stage in 2022 at the Web Summit where Shell hosted a pitch competition, at Rice Alliance's Energy Tech Venture Forum, and on the Freeing Energy podcast. The company also graduated from GCxN, their project indicating that Icarus technology improves PV electricity output and also collects thermal energy for heating domestic water, which effectively increases the electric equivalent energy output by 150%.

Induction Food Systems

Induction Food Systems (IFS) heats flowing fluids from the middle-out instead of the outside-in. This breaks fluid-heating bottlenecks for industry, improving productivity and helping to decarbonize operations. In 2022, IFS deployed its first units to customer sites for pilot and acceptance testing and focused on equipment refinements and output troubleshooting. The company now has commitments for two additional pilot units for testbeds in partnerships with nonprofit research institutions and successfully replicated results in another piece of industrial equipment.

Intertie Corp.

Intertie Corp. developed a battery-boosted charging station known as the EV ChargePod. The EV ChargePod uses a DC microgrid and battery buried underground with a charging station above ground that promotes a low-cost, user-friendly experience. Intertie Corp.'s technology combines fast charging capabilities, intelligent storage, and integrated solar power. Intertie has continued to build out its network of EV charging stations and microgrids with over $2 million in sales in 2022. Additionally, the company won the California Energy Commission BRIDGE grant to integrate 150 kW fast charging within its microgrid platform. Intertie plans to release this new battery-boosted fast charger in 2023.



Ionomr

Ionomr is a clean technology company that develops ion-exchange membranes for fuel cell systems, green hydrogen production and carbon capture, and utilization for CO2-neutral green fuels. Its membranes and polymers come from a hydrocarbon base, making them fully recyclable, recoverable, and bio-accumulative. 2022 was a banner year for Ionomr, who raised a $15-million Series A round including Shell Ventures, announced it will open a New York-based R&D facility, and cemented partnerships with key players SunHydrogen and TTP. The company also made several notable lists, including the Cleantech Group's 2022 Global Cleantech 100 List of Companies Committed to Taking Action on the Climate Crisis and Deloitte Canada's Technology Fast 50.

Jolt Energy Storage

Using organic compounds, Jolt Energy Storage makes organic redox flow batteries that have the same large-scale storage capabilities as lithium-ion, but are safer, more efficient, and less expensive. Jolt Energy Storage's multi-electron, higher-voltage capabilities enable utilities to capture energy from intermittent energy sources, such as solar panels or wind farms, and reliably deliver that energy on demand. In 2022, Jolt extended its collaboration with NREL and submitted an important patent application covering a recently discovered class of compounds with promise for flow battery applications, worked closely with a strategic partner who has provided technical assistance and introductions to other potential investors, and signed a Memorandum of Understanding with an Australian energy component.

Hygge Power

Hygge Power offers reliable energy through its in-home network of small storage devices. Hygge Power's smartphone application, CO-Z, enables users to manage their power through outage, price, and carbon alerts. CO-Z provides custom information through real-time inputs to create unique outage risk profiles for homes, apartments, and businesses. In 2022, Hygge Power officially launched the CO-Z application, received a second patent, and was selected for Google for Startups' Climate Change accelerator as well as one of the First Fifty companies in LG's Mission for the Future. Their intelligent energy storage solution also won Gold in the Edison Awards for Smart Home Products.

Resonant Link

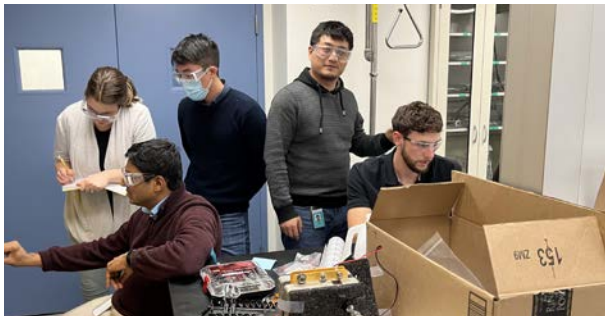
Resonant Link powers EV fleets while they work by charging wirelessly during short stops that already exist during operation. In 2022, the company raised a more than $9 million seed financing round, expanded their global team to 45, and moved into a new and tailored workspace. They are now launching into the industrial market with a groundbreaking 20 kW wireless charger for manual and autonomous lift trucks. CEO Grayson Zulauf was also recognized as a Dial Fellow, and Co-Founder Charles Sullivan was honored by the National Academy of Inventors.

Microgrid Labs

Microgrid Labs (MGL) is a consulting and software company dedicated to supporting the electrification of fleet vehicles. The technology determines system design including optimal sizing of batteries and chargers through its modeling, simulation, and optimization tools. MGL also offers fleet electrification planning and microgrid planning services. In 2022, the company raised a $2.25-million financing round and was selected into several competitive programs, including the Los Angeles Cleantech Incubator (LACI) Market Access Program, Transit Tech Lab, and the World Resources Institute India Better e-Bus Challenge. The company worked on several of its more than 12 fleet electrification projects so far and looks forward to supporting another 20+ contracted in the near future.

SPAN

SPAN aims to dramatically accelerate renewable energy adoption with its smart electric panel which provides data insights to allow homeowners to control their home energy via an app. SPAN also automatically adjusts power levels to ensure the energy in a home is properly balanced based on specific preferences. 2022 brought with it a $90-million Series B raise and launch of the company's second product—SPAN Drive—to market, enabling dynamic EV charging and better backup protection for homeowners. Partnerships with Suntuity Renewables and Sunrun for offerings in Puerto Rico were announced, and SPAN earned media coverage in Forbes, Bloomberg, and Fast Company.



Versogen

Versogen develops a breakthrough electrolyzer technology that uses water and renewable energy to produce green hydrogen at scale in a reliable and affordable way. Versogen's systems are built around its patented anion exchange membranes (AEM) and earth-abundant materials. In 2022, Versogen demonstrated an important milestone of a 1 kW prototype anion exchange membrane stack running on pure water feed. They also raised a $14.5-million Series A for further development and production of their electrolyzer and membrane technology, enabled by their relocation to an expanded space in New Jersey plus the addition of 50 employees.

*The Federal Lab Consortium (FLC) awarded GCxN a national Technology Transfer Innovation Award for "design[ing] a system of solutions—a pipeline to address both partners' desire for energy-technology diversification."**

* Federal Laboratory Consortium 2022 National Award Winners program.

Technical Achievements

ETS enhanced their understanding of the appropriate power conversion systems to maximize the performance of their Joule Hive thermal battery system. Based on industrial electrification heat needs, leveraging AC-grid connections will provide enhanced market opportunities for ETS. Design of a multilevel converter with power between 1.7 and 5 MW can accommodate thermal heat supply between 400 ° and 1,700°C operating temperatures for industrial users.

AllCell's recently completed GCxN project advanced their lithium-ion battery technology to meet the rapidly growing demand for battery fast-charging solutions. The project developed key understanding of the impact of operating temperature, state-of-charge, and current density on cell electrochemistry during fast charging of state-of-the-art nickel-rich Nickel Manganese Cobalt lithium-ion cells. The collaborative effort demonstrated that AllCell's intelligent battery thermal management will achieve 50% charging of battery capacity within 10–15 minutes without compromising battery safety or cycle life.

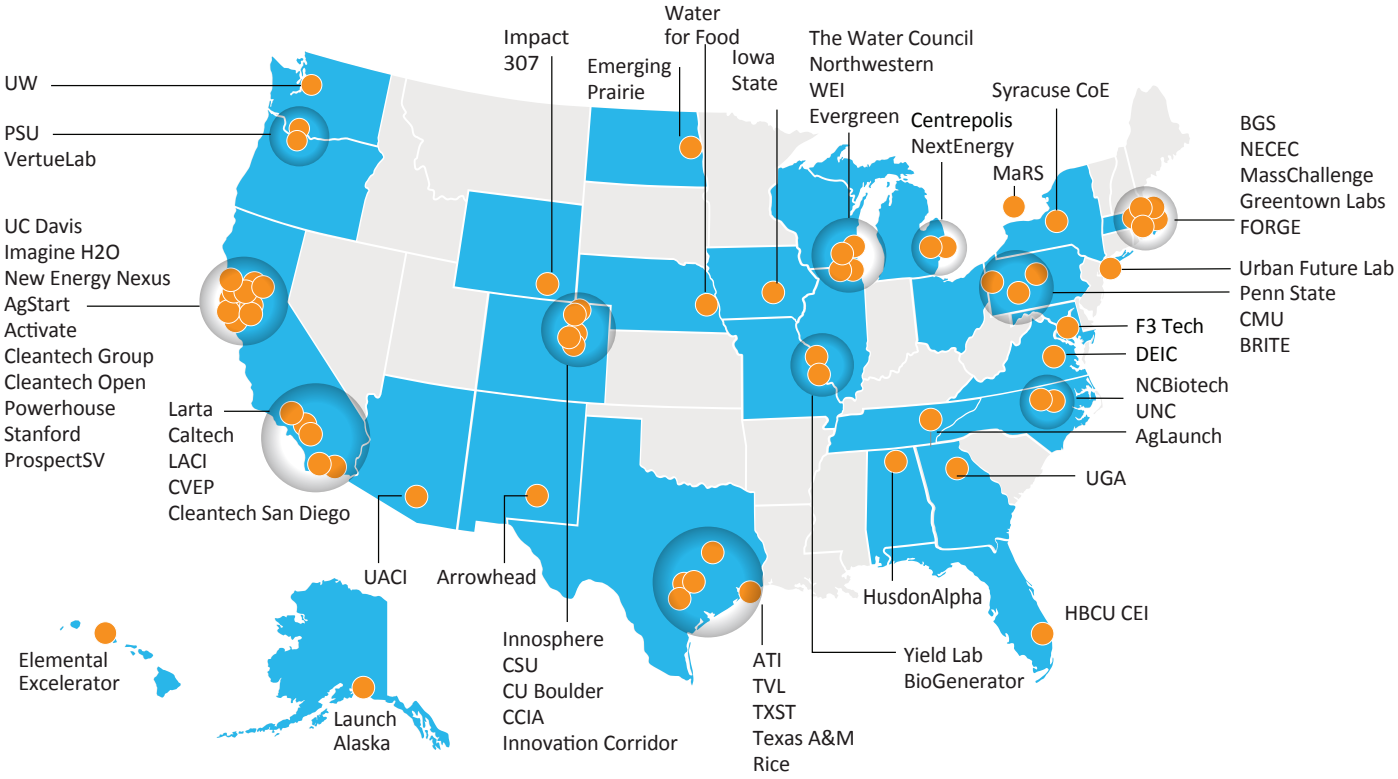
AIR COMPANY's GCxN project included technoeconomic analysis to help identify locations in New York that would provide low-cost electricity to drive the hydrogen-producing electrolyzer and to locate large carbon dioxide sources for their proprietary process to produce sustainable aviation fuel with their commercial-scale system in the range of 5 MW. A significant finding from the work identified wholesale energy pricing in the northern zone as the lowest in the state (up to $20 per megawatt-hour). This pricing has also been on a downward trend with increasing amount of wind turbine installations. The project was unique in that it also combined a hardware research aspect to identify systems integration opportunities to reduce cost and improve system efficiency by five to ten percent by closely coupling the electrolyzer with AIR COMPANY's downstream reactor.

Looking Ahead

In 2022, GCxN released its sixth cohort call in search of startups focused on two distinct themes: energy and chemical products via biology and carbon-negative building and infrastructure materials. Companies supported by this cohort will align with Shell's pursuit of negative emissions technologies (NET) to remove carbon dioxide from the atmosphere at the gigaton scale. One class of NET involves sequestering carbon into materials for buildings and infrastructure. Another class aims to leverage renewable feedstocks and bioconversion systems, which hold significant potential for overall carbon intensity reductions. Stay tuned on the announcement of Cohort 6 companies in 2023!

Our Ecosystem

During each call for participants, GCxN applicants are referred to the program through an ecosystem of cleantech business incubators, accelerators, funds, and universities: our Channel Partners. These partners represent the leading edge in academia, research, and industry—each providing unique insights into cleantech.



Events

GCxN portfolio company Electrified Thermal Solutions Co-Founder and CEO Daniel Stack (center) accepts his energy storage and dispatch pitch competition award among judges at the Shell Stand as part of Web Summit, a global gathering of more than 40,000 tech leaders.

GCxN Program Managers Yesim Jonsson and Johanna Jamison, from Shell and NREL, respectively, with a model hydrogen fueling station in the South by Southwest Shell House at historic music venue Antone's in downtown Austin, Texas.

GCxN Steering Committee

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Director, NREL Innovation &
Entrepreneurship Center

Ron Schoon
NREL Executive Manager
Partnership Development

"The collaboration between Shell, NREL and start-ups is one of a kind, allowing for start-ups to leverage the broad technical expertise and facility capabilities for targeted technology de-risking. There's also the additional consideration of investment for graduating companies from Shell's early stage seed fund, Shell Ventures X, that supports Shell's strategic research areas. Altogether, the program aims to create a winning recipe for technology development supporting the energy transition."

— Aimee LaFleur, Investment Principal, Shell Ventures X

"Participation in GCxN has given BattGenie the opportunity to have access to a world-class team of researchers and test equipment facilities, which are critical for scaling up BattGenie's technology at a pack level. This will ultimately lead to a faster adoption of BattGenie's technology in the automotive market."

— BattGenie

"Partnership with the engineers at NREL helped us in solving some of the most complex technical problems in the fleet electrification space."

— Microgrid Labs

"GCxN provided Icarus RT resources and connections crucial in our company's growth in rapid prototyping, manufacturing, and computational modeling of complex energy systems and components. Thanks to the experimental and economic validation provided by NREL via the GCxN program, our company and investors have an increased confidence in our products, business model, and vision that continues to propel us forward. Particularly important is the lasting ongoing relationships developed with Shell and NREL."

— Icarus RT

"GCxN was a wonderful opportunity to work with the Icarus RT team to tackle engineering challenges for a low-cost PV thermal collector option including a novel installation method for existing PV systems. Icarus is also at the forefront in thinking about controls for these panels in an ever-evolving electric grid. NREL's analysis showed the potential cost-saving benefits of controlling the system to take advantage of varying electric utility rates, which was recently published in the journal *Solar Energy*."

— Jason Woods, NREL

"The impartial feedback we received from NREL scientists through the GCxN program is helping our understanding of the technology improvements required to enable low-cost green hydrogen with our membranes as a basis."

— Versogen

"The GCxN program has really helped our company move forward. The NREL team worked with us to develop key algorithms for our software and confirm the value and operation of our residential energy storage system. The interaction with the team from Shell also proved very valuable with product and market insight and trends."

— Hygge

"The GCxN program has been critical in advancing funding and partnership expansion activities over the first year of the program, by providing highly credible third-party validation of Ionomr materials and claims. The quality of the expertise at NREL is unparalleled and set the strongest possible baseline to advance pilot activities with Shell and other customers in both green hydrogen production by water electrolysis and green fuel synthesis from CO_2."

— Ionomr

GCxN

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