Chicago Business Bulletin

OCTOBER 2023 | Issue No. 6

CHICAGOLAND'S GREEN FUTURE

WORLD BUSINESS CHICAGO | THE RESEARCH CENTER

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Executive Summary

This report takes a first look into the dynamic landscape of Chicago's green ecosystem, highlighting its interconnected nature across various industries and verticals. As we navigate the urgent need to address climate change, this report emphasizes the role of technology solutions in unlocking scalability for readily deployable software, hardware, infrastructure, and alternative energy sources — crucial components in transitioning from fossil fuels to a decarbonized economy.

The Research Center explores the current market size and trajectory, uncovering the significance of talent and capital in propelling the green economy forward. It examines existing workforce availability and the talent pipeline for green economy jobs while scrutinizing private and public investment trends, including the role of grants. Innovation emerges as a pivotal driver of growth, as we examine research and development trends, technology transfer from Illinois universities, commercialization by licensees, and patent trends.

This report serves as a resource for stakeholders across sectors and geographies, offering insights into how technology and innovation can accelerate our collective efforts to address climate change and build a sustainable future.

Findings:

- Chicagoland's green economy produced over $18 billion in output in 2022, growing by nearly 180% between 2016 and 2022.
- With over 65,000 in employment, Chicagoland is ranked fifth out of the top ten metro areas for employment in the green economy.
- Roughly 25% of all clean and climate climate investments (deals) in Chicagoland were investments in climate tech startups, the highest proportion of all clean and climate tech total investments when compared to the Midwest, U.S., and world.
- Chicagoland's universities and research institutions — the University of Chicago, University of Illinois Chicago, Northwestern University, University of Illinois Urbana-Champaign, and Argonne National Laboratory — offer well over 200 cutting-edge technologies for commercialization.

The Green Ecosystem

A green economy and ecosystem is highly interdependent.

The 'green economy' is a rapidly evolving concept that has gained momentum worldwide. It represents an economic system where sustainability, environmental responsibility, and social well-being are central principles, and is driven by a combination of factors, including policy initiatives, technological advancements, and increasing public awareness of environmental issues.

The Research Center identified 10 major components to a green economy, and we focus this report on those that are relevant to economic development work that World Business Chicago leads.

Renewable and Clean Energy Production: Solar, wind, hydropower, nuclear, and geothermal energy have become major contributors to global energy production.

Sustainable Transportation: The green economy has seen advancements in sustainable transportation, with the rise of electric vehicles (EVs), improved public transportation systems, and a growing emphasis on shared mobility services.

Circular Economy Practices: Businesses and industries are increasingly adopting circular economy principles, which focus on reducing waste, reusing products and materials, and recycling.

Sustainable Agriculture and Food Systems: Sustainable agriculture practices, organic farming, and the promotion of plant-based diets are gaining traction. Innovations in precision agriculture and vertical farming are helping reduce the environmental footprint of food production while addressing global food security challenges.

Environmental Technologies and Innovation: The green economy has fostered the growth of environmental technologies, including solutions for water purification, waste management, air quality monitoring, and carbon capture and storage. Universities and tech startups have focused on various aspects of the green economy, from energy storage and grid optimization to water purification and waste management.

Green Finance and Investment: Financial institutions are balancing integration of environmental, social, and governance (ESG) criteria into their investment decisions alongside prioritization of positive financial returns. Green bonds, sustainable investing, and impact investing have become more familiar practices, channeling funds toward green initiatives and environmentally responsible projects.

Sustainability Reporting and Transparency: Transparency and accountability have become essential in the green economy. Companies are expected to disclose their environmental and social performance through sustainability reports, providing stakeholders with insight into their sustainability efforts and impacts.

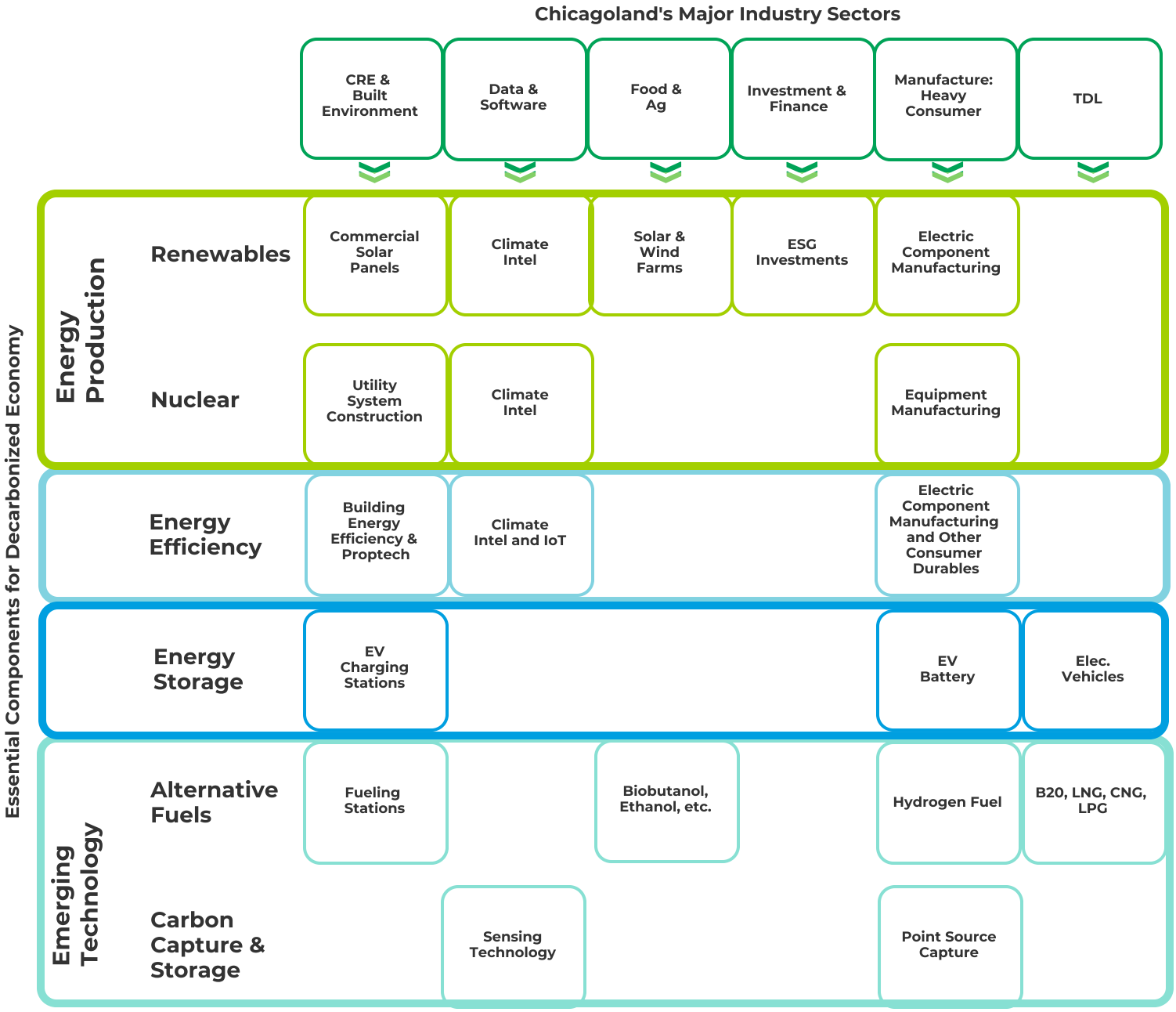
Government Policies and Initiatives: Governments around the world are enacting policies and regulations to promote green economic growth. This includes carbon pricing mechanisms, renewable energy mandates, emissions reduction targets, and incentives for green innovation.

Job Creation and Workforce Development: The green economy has led to the creation of numerous jobs in renewable energy, sustainable agriculture, and other environmentally focused sectors. Workforce development and education programs are helping train individuals for green careers.

Global Collaborations and Agreements: International agreements such as the Paris Agreement and C40 Cities Climate Agreement Group continue to drive global efforts to combat climate change and promote green economic practices. Collaboration among nations, cities, businesses, and civil society organizations remains essential in addressing global environmental challenges.

Chicagoland's Green Economy

Chicago is an emerging market where clean and climate-focused startups can deploy new technology to incumbent corporations that are making the transition to reduced carbon emissions.



This table illustrates areas where companies in Chicagoland have deployed clean or climate technology or otherwise partnered with existing industry to advance clean or climate technology. It is non-exhaustive, but also illustrates areas for future partnerships.

Chicagoland's Green Economy

Chicago offers the broadest access to industry partners that need to adopt new technologies to reduce carbon footprints.

The deployment of new clean and climate technology in Chicagoland's traditional industries presents a transformative opportunity for the region's economic landscape. By integrating cutting-edge solutions such as energy-efficient manufacturing processes, renewable energy sources, and advanced emissions control systems, Chicagoland's traditional sectors can undergo a sustainable revolution. The region's transition to clean and climate technology not only benefits the environment but also positions the metro area as a hub for innovation, creating economic opportunities and ensuring a more sustainable and resilient future for its residents.

Chicagoland's right to win in the green economic revolution is evident in where carbon emissions reductions are most critical. The U.S. Department of Energy has set forth an **Industrial Decarbonization Roadmap** that identifies critical pathways to reduce industrial greenhouse gas emissions through innovation, noting that industrial activity represents 30% of primary energy-related carbon dioxide (CO2) emissions in the U.S. Industries identified as the highest carbon emitting align with Chicagoland's largest sectors, like manufacturing, food and agriculture, and construction.

While the need to decarbonize is clearly delineated with identified goals, quantifying current efforts to reduce greenhouse gas emissions and the economic impact of those efforts is difficult. In the following sections of this edition of the Chicago Business Bulletin, the Research Center provides a series of estimates on:

- the size of Chicagoland's economy devoted to clean energy inputs (generation, storage, and efficiency) and emerging clean energy innovation (carbon capture and storage, and alternative fuels) — referred to as the **"green economy."**
- the size of Chicagoland's economy that is either an end user of clean energy or a critical input to the advancement of and transition to clean energy and climate technology — referred to as the **"green transitioning economy."**

This report represents a snapshot of where Chicagoland's green economy stands today, shedding light on the critical factors driving growth, the challenges that lie ahead, and the transformative potential it holds.

Other Resources

This report is not the exclusive source for information on Chicagoland's green economy. The Research Center recognizes these collective efforts and how they have enriched our knowledge of the challenges and opportunities associated with the economy's transition to an environmentally conscious and viable model.

For additional reading, please visit:

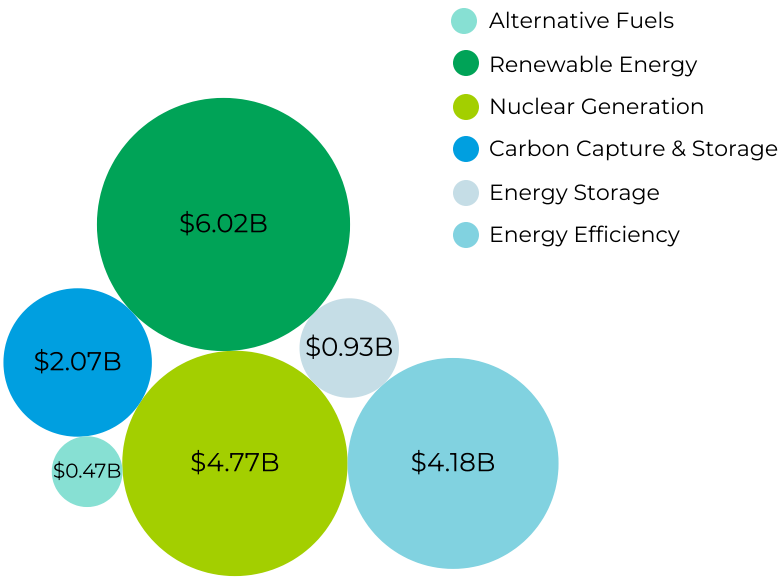
- The University of Illinois Chicago's Nathalie P. Voorhees Center for Neighborhood and Community Improvement — "Green Economy Firms in the Chicago Region" (2023)
- Current — "Upstream Illinois" (2023)
- WorkingNation — Green Jobs Now (2022)
- Illinois Green Economy Network

Market Size

In 2022, Chicagoland's green economy produced $18.4 billion in output, and is growing at a faster rate than other top metro areas.

Sectors in Chicagoland's green economy include nuclear generation, energy efficiency, energy storage, renewable energy, alternative fuels, and carbon capture and storage.

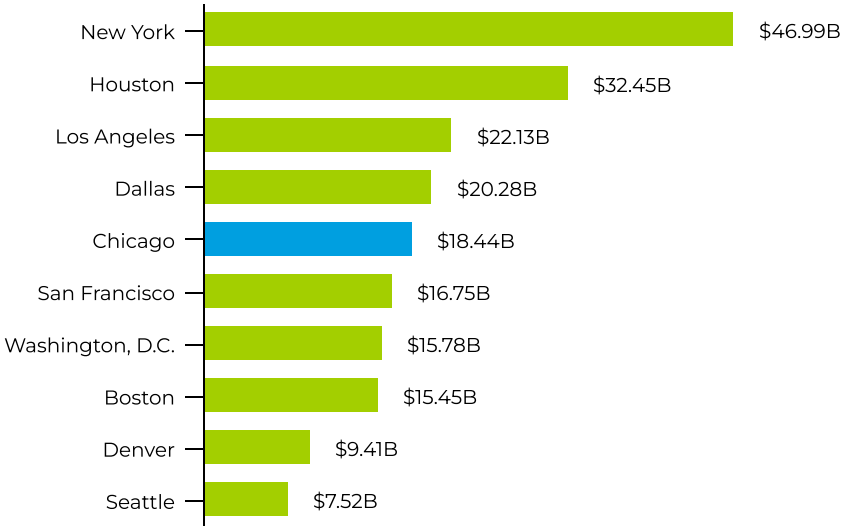
Chicagoland's Green Economy 2022 Output (GDP)
Sub-Industry Sectors



Chicagoland's green industry output makes up nearly **2.2% of Chicagoland's total economy.**

The largest contributor for Chicagoland's output is within energy generation — the renewable energy sector is the largest, followed closely by the nuclear generation sector. Renewable power generation is a linchpin in decarbonization efforts, and provides a range of benefits, including emissions reduction, climate change mitigation, improved air quality, energy security, economic growth, and technological innovation. Additionally, nuclear power provides a consistent and reliable source of baseload electricity, which is essential for maintaining grid stability and meeting constant demand.

Chicagoland's Green Economy 2022 Output (GDP)
Top Ten Metro Areas



Chicagoland's green economy output (GDP) grew by nearly **180%** between 2016 and 2022. This growth was driven largely by the power distribution sub-sector, which grew by over **$4 billion** from 2016 and 2022.

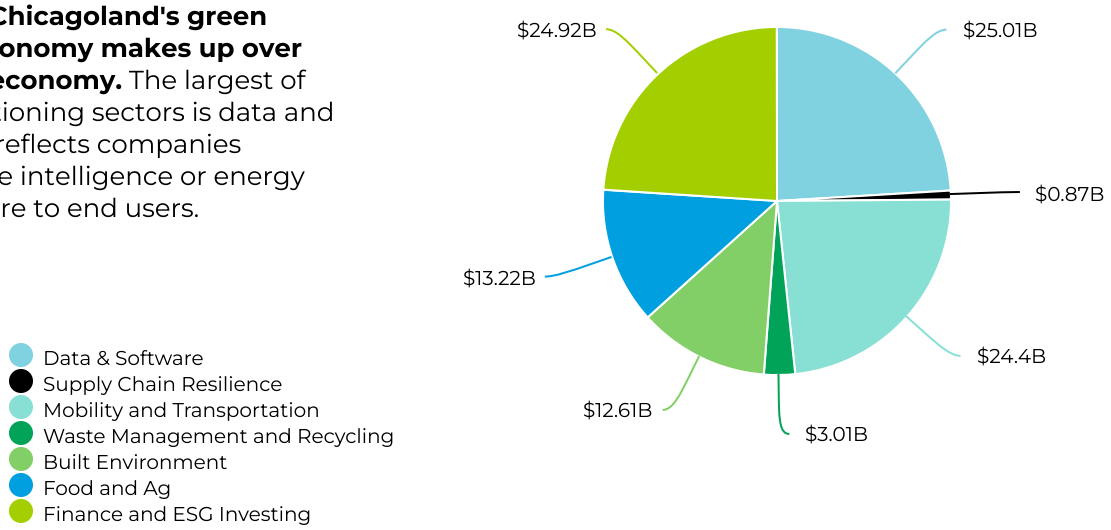
Even though Chicagoland ranks sixth among the top ten metro areas for total 2022 output, the region ranks **third** for overall percentage growth when compared to historically larger business ecosystems.

Market Size

Chicagoland's green transitioning economy produced over $104B in economic output in 2022.

The Chicago regional economy is massive — it reached $800 billion in output in 2022 and currently represents $833 billion in economic activity. **The Research Center estimates that Chicagoland's green transitioning economy makes up over 8% of the total economy.** The largest of the green transitioning sectors is data and software, which reflects companies providing climate intelligence or energy efficiency software to end users.

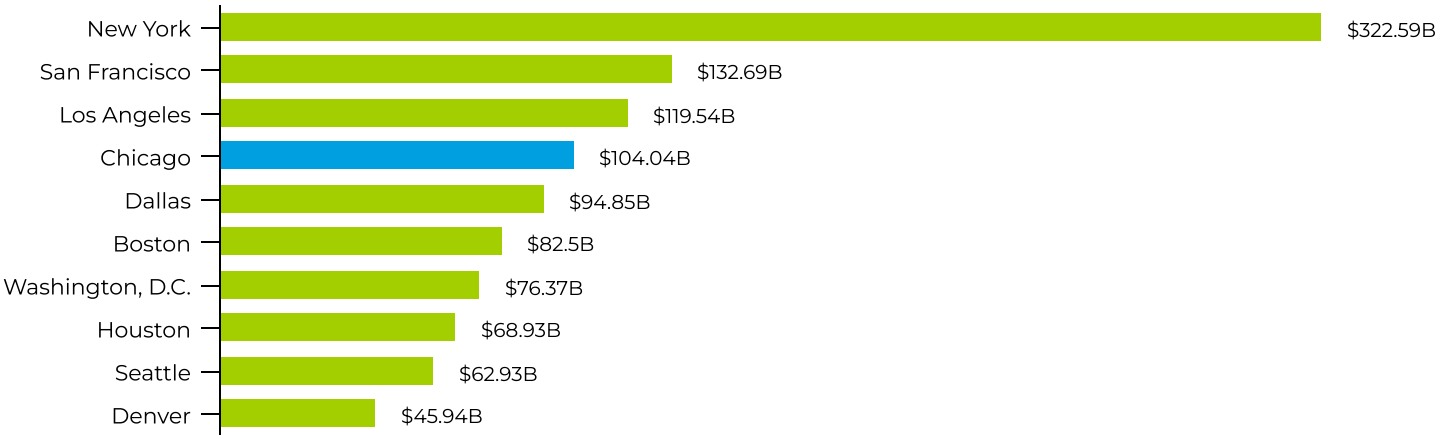
Chicagoland's Green Transitioning Economy 2022 Output (GDP)
Sub-Industry Sectors



Chicagoland's transitioning green economy has grown by over 80% from 2016 to 2022.

When compared to the top ten cities by output in the green transitioning economy, Chicagoland ranks fourth with a 2022 output of over **$104 billion**; nearly **$10 billion** more than Dallas and over **$20 billion** more than Boston. With a continuing growth trajectory and a competitive stance in ESG investments, Chicagoland offers businesses within the green transitional vertical a sustainable environment for opportunity and success.

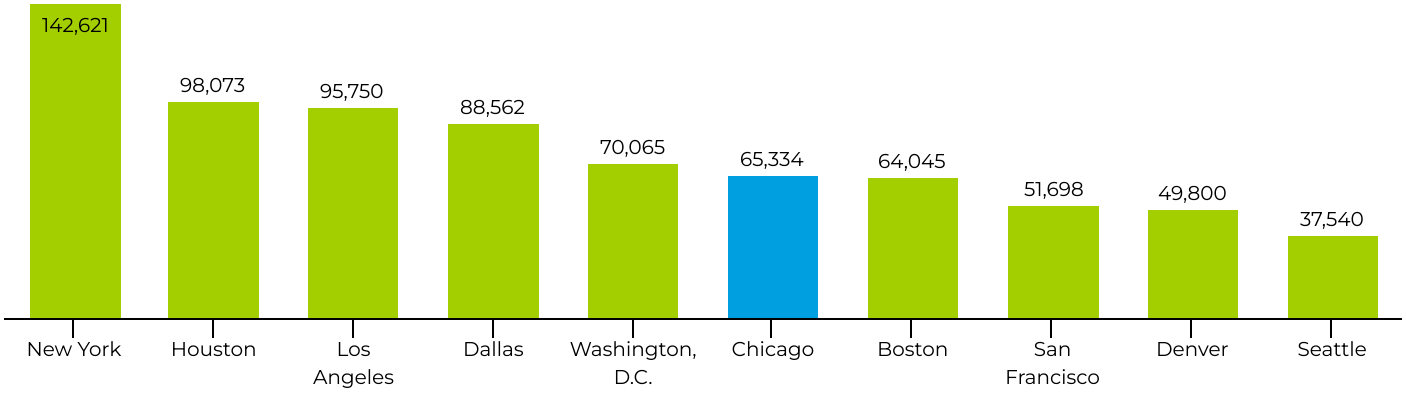
Chicagoland's Green Transitioning Economy 2022 Output (GDP)
Top Ten Metro Areas



Market Size

Chicagoland's green economy employed over 65,000 people in 2022.

Top Ten Metros Areas: Green Economy 2022 Employment

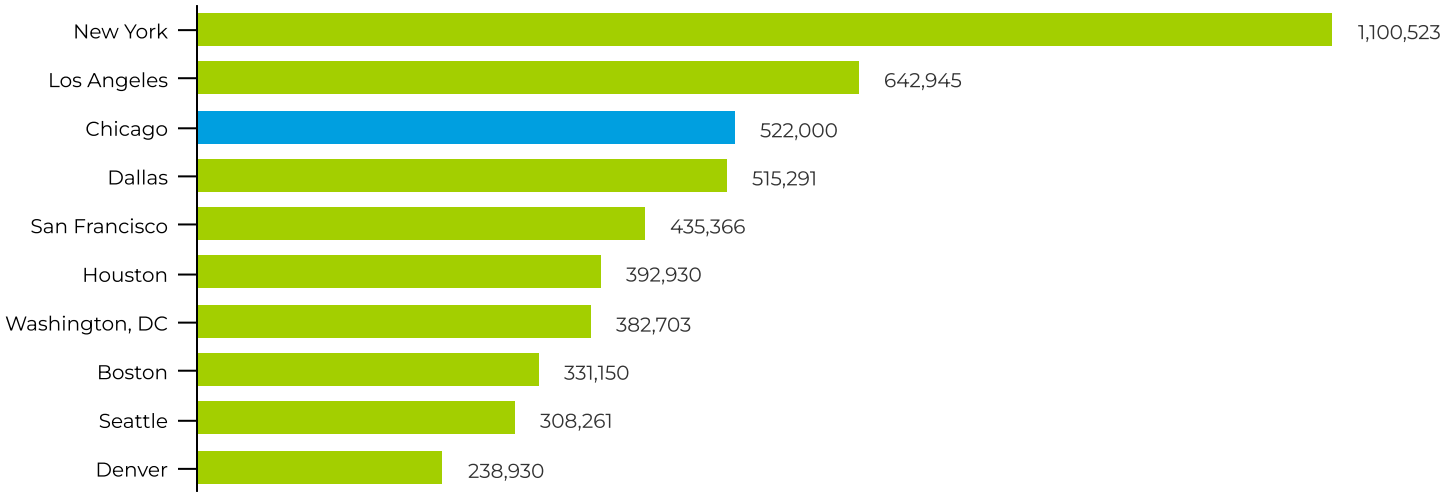


Chicagoland is ranked sixth out of the top ten metro areas for employment in the green economy. The largest vertical by employment for Chicagoland is energy efficiency, representing companies like S&C Electric, which has manufactured high-voltage electrical equipment for over a century.

Chicagoland's green transitioning economy employed over 500,000 people in 2022.

Chicago ranked third following New York and Los Angeles for employment in the green transitioning economy in 2022. Chicagoland's largest vertical for 2022 employment is mobility and transportation with over 188,000 employed. For companies that need to go green, Chicagoland offers a diverse and competitive talent ecosystem.

Top Ten Metro Areas: Green Transitioning 2022 Employment

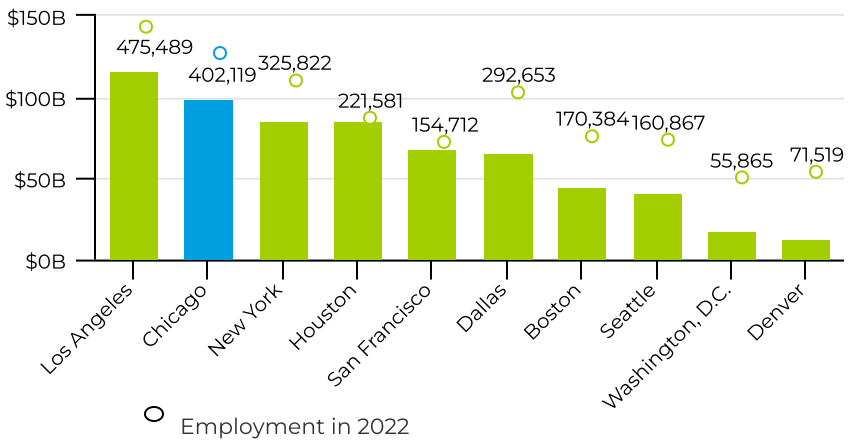


Manufacturing

As the second largest manufacturing hub in the US, Chicagoland is uniquely poised to lead industrial decarbonization efforts.

As articulated by the U.S. Department of Energy, decarbonizing the manufacturing industry is critical due to its significant impact on environmental sustainability, public health, economic efficiency, and global efforts to combat climate change. Moreover, in 2020, manufacturing and related industries accounted for 33% of the nation's primary energy use and 30% of energy-related carbon dioxide emissions. Chicagoland represents nearly 4% of the total U.S. manufacturing sector, making the region uniquely situated to lead industrial decarbonization efforts.

Manufacturing Output & Employment in 2022



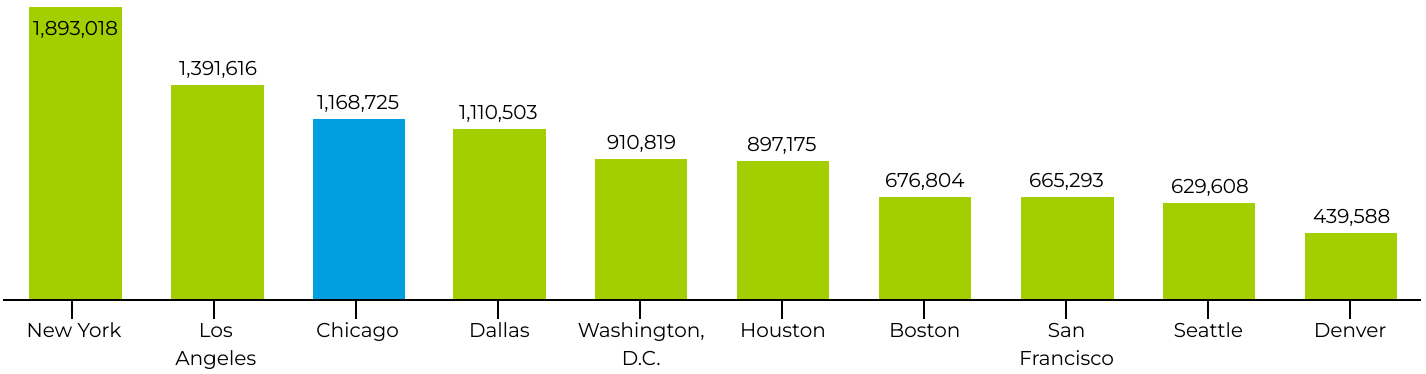
It is largely unknown to what extent the Chicago region's — or any region's — manufacturing sector has reduced energy usage or carbon emissions. Efforts like the Centre for Advanced Manufacturing and Supply Chains have brought together hundreds of manufacturers to share data and develop insights into the future of industrial strategies and supply chains. Given the size of Chicagoland's green economy and green transitioning economy, the **Research Center estimates that at least $13 billion of the total $99B output is directly involved in carbon reduction efforts.** This is based on the U.S. Department of Energy Better Plants report that estimates 13.8% of the U.S.'s manufacturing energy footprint has taken affirmative action to improve their energy efficiency and sustainability.

Workforce Availability

Chicagoland is leading the green economy through jobs.

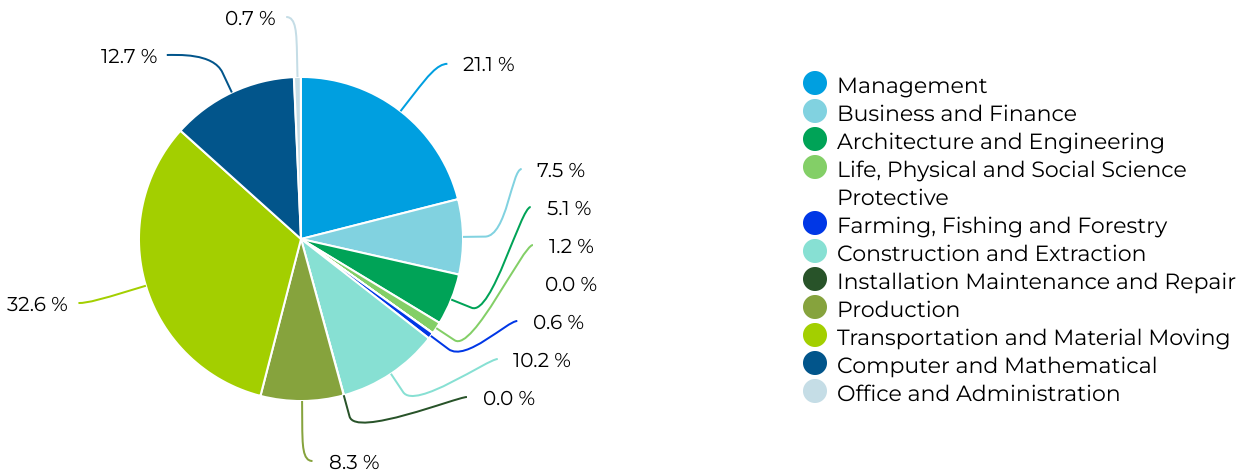
It is well known that Chicagoland's centralized location and diverse economy makes for a bountiful talent pool. This has further proven advantageous in assessing the metro area's workforce availability for the rising green economy. In 2022, there were nearly 1.2 million workers in Chicagoland that could be transitioned into green jobs, placing it third when compared to ten other major metropolitan areas in the U.S.

Green economy occupation count by metro area



Chicagoland's growing green and green transitioning economy will need employees in management, engineering, construction, production, and more. The Research Center has segmented occupations into two categories: conventionally green occupations and occupations that are divergent, supportive of the green economy, or could leverage green skills, thus designated as "green transitioning" occupations. Of the nearly 1,200,000 occupations that made up the Chicago area's green economy, 33,604 were conventionally green jobs and 1,135,121 were green affiliated jobs. Green occupations and green transitioning occupations grew 3% and 6% respectively from 2021, echoing the presence of a large green transitioning economy, as well as increasing demand of a healthier and more sustainable green economy.

Green economy occupation by major SOC category



Talent Pipeline

The Chicago region leads in graduates needed for decarbonization efforts.

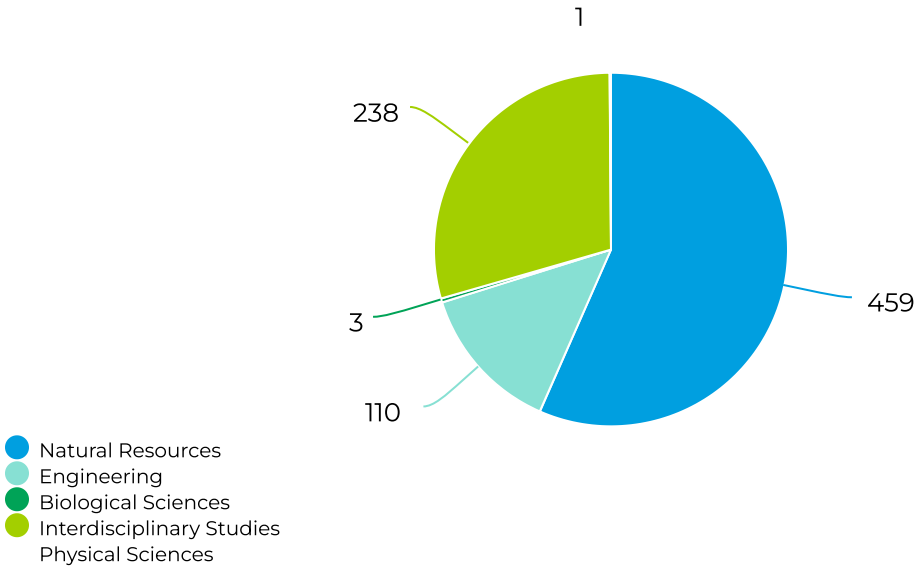
Recent college graduates play a vital role in driving industrial decarbonization, contributing knowledge, skills, and fresh perspectives to tackle the challenges of transitioning to a sustainable future. As students, their curriculum often requires participation in research projects, and their findings help inform industrial decarbonization efforts, providing valuable insights into reducing carbon emissions, optimizing processes, and developing sustainable materials. Graduate students often collaborate with industries to translate research into practical applications, driving progress toward decarbonization goals. **The Chicago region and Urbana-Champaign rank fifth in the nation for total number of graduates with environmental degrees. Breaking this down by education level: Chicago ranks sixth for Bachelor's degrees, fourth for Master's degrees, and eighth for Ph.D. degrees.**

Chicagoland's graduates are interdisciplinary.

Industrial decarbonization requires collaboration across various disciplines, including engineering, policy, economics, and social sciences. Recent college graduates, with their diverse educational backgrounds, can bridge these disciplines and foster interdisciplinary collaboration. By working with industry professionals, policymakers, and researchers, graduates can facilitate knowledge exchange, identify synergies, and develop comprehensive strategies for industrial decarbonization.

The Chicago region, including Urbana-Champaign, ranks 5th in the nation for number of graduates with environmental degrees — including in fields like Natural Resources, Engineering, Architecture, Biological Sciences, Physical Sciences, and Interdisciplinary Studies.

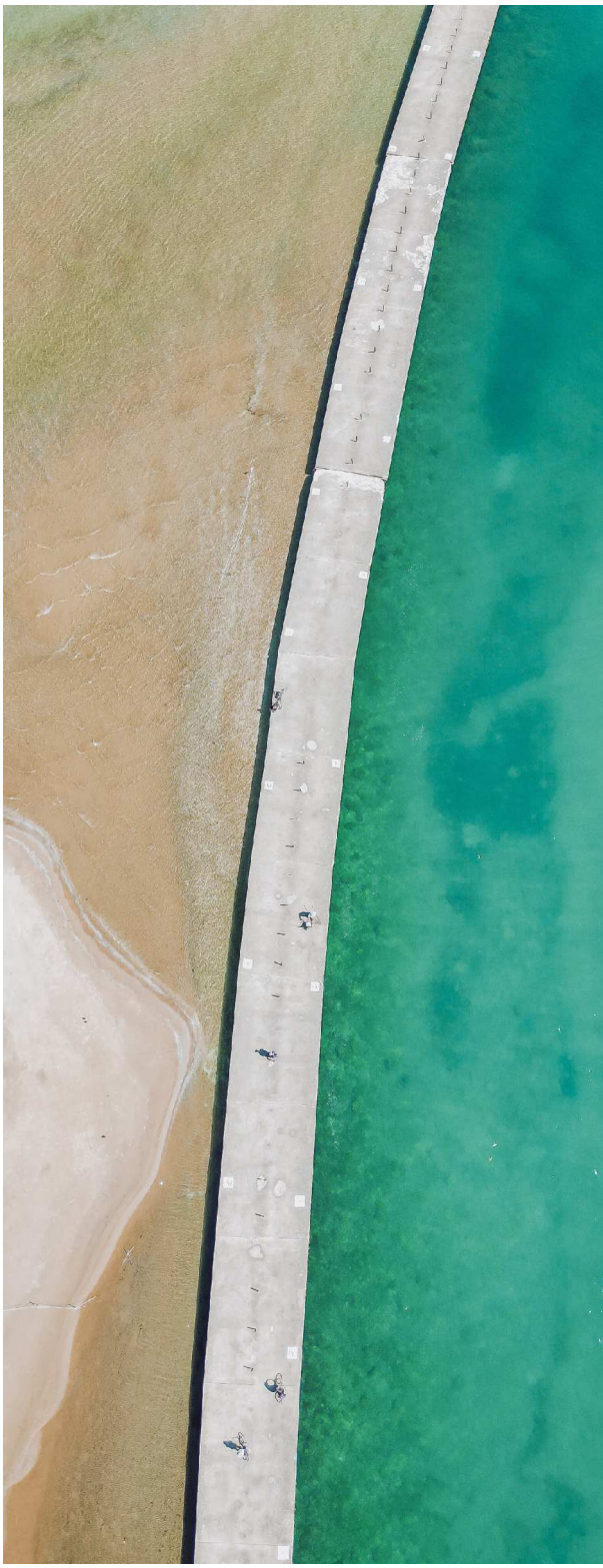
Chicagoland Graduates in Environment-Related Degrees, 2021



Talent Pipeline

Chicagoland offers 20 affordable sustainability certificate or degree programs at community colleges across the region.

College	Associate's Degree	Certificate Program
City Colleges of Chicago	Environmental Tech	Environmental Tech, Basic Cert.
City Colleges of Chicago	Building Energy Tech	N/A
City Colleges of Chicago	N/A	Sustainable Urban Horticulture, Advanced Cert.
College of Lake County	Sustainability	N/A
College of Lake County	N/A	Residential Energy Efficiency, Certificate
Elgin Community College	Energy Management	Energy Management, Vocational Cert.
Elgin Community College	Renewable Energy	Renewable Energy, Certificate
Morton College	N/A	Automotive Tech. Alt. Fuels, Career Cert.
Oakton Community College	Environmental Studies	N/A
South Suburban College	N/A	Solar Photovoltaic Install. Tech, Certificate
South Suburban College	N/A	Green Building Construction, Certificate
Triton College	Sustainable Agriculture Tech.	N/A
Triton College	Renewable Energy Tech.	N/A
Triton College	Environmental Science	N/A
Waubonsee Community College	Earth Science	N/A
Waubonsee Community College	Sustainability	N/A
William Rainey Harper College	Earth Science	N/A



SPOTLIGHT

Invenergy

The move to clean energy is here, and Invenergy is leading the way.

Invenergy is the leading privately held developer, owner, and operator of sustainable energy solutions. Powered by decades of experience, we have a proven track record of delivering clean energy to customers and communities around the world. We develop, own, and operate large-scale renewable and other clean energy generation, transmission and energy storage facilities in the Americas, Europe, and Asia.

Invenergy's global headquarters is located in Chicago. Invenergy is proud to call Chicago home, and recently announced that the Company is expanding its flagship office in Chicago's 1 S. Wacker, cementing its status as the building's anchor tenant.

The expansion of Invenergy's Chicago headquarters reflects the Company's rapid growth and ambitious plans for Invenergy's future. In the past 5 years, Invenergy has added over 1,300 new employees globally, 900 of those in Chicago, to develop and operate the Company's more than 200 renewable energy projects across four continents.

We're innovators building a sustainable world.

SPOTLIGHT

Current

Innovation in Chicago's blue economy

With cutting-edge research institutions, a nation-leading entrepreneurship ecosystem, a diverse community of industry headquarters, and access to the Great Lakes – the world's largest source of freshwater – Illinois is home to a growing $16.7 billion blue economy.

According to Current's **Upstream IL** strategy, the blue economy is defined as the collection of companies that develop and provide technologies, products and services that manage the movement, quality and use of water — in addition to inputs to make these products, supporting industries, and the customers that demand these products. It cuts across major water-using industries, like food and beverage, agriculture, manufacturing, energy, and more. Globally, water-stressed regions are struggling to keep up with the water demands of industry and consumers, making the Great Lakes region an attractive place to do business. Industry in the Great Lakes region needs innovative water technologies to prepare for this increased demand on fresh water.

THE BLUE ECONOMY AT A GLANCE

$16.7 billion
size of Illinois' blue economy

1.5 million
people employed in Illinois' blue economy, across 75,000 firms

3rd
Illinois is leading in sensor technologies, and among the top 10 states for filing water-related patents over the past 10 years.

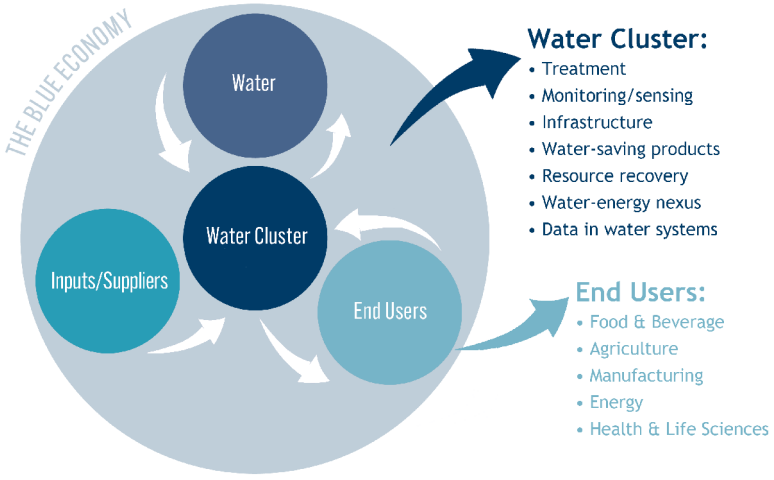


Image Credit: Current

"Innovators in Chicago are developing novel treatment, monitoring/sensing, infrastructure, and water-saving products as well as exploring emerging technologies like resource recovery, water-energy nexus, and data in water systems."

— Alaina Harkness, Executive Director, Current

Current is a catalyst for better, cleaner water, and collaborates with corporations, universities, nonprofits and governments to develop solutions that would be too risky or even impossible to undertake alone. Current's Great Lakes ReNEW is currently one of 16 finalists for the U.S. National Science Foundation's inaugural Regional Innovation Engines competition.

SPOTLIGHT

S2G Ventures

Investing in systemic changes needed to support climate transition.

S2G Ventures partners with companies working on solutions to some of the world's greatest challenges across food, agriculture, oceans, and energy markets. The firm provides flexible capital solutions, mentorship, and value-added resources to companies pursuing innovative market-based solutions that generate positive social, environmental, and financial returns. At the core of S2G Ventures' investment strategy is a systems approach aimed at investing strategically across sectors and value chains in order to create bigger-picture environmental and financial system impacts and synergies.

S2G Ventures' portfolio is made up of over 90 companies across five countries, including Chicago-based Hazel Technologies, and recent investments in Matter, TechMet, and Omeat. In addition to equity-based investments, S2G Ventures offers alternative financing options, such as term loans, project finance, and equipment finance, all of which are particularly critical to scaling climate assets and solutions.

In support of the firm's legacy of investing in food and agriculture companies, S2G Ventures' location in Fulton Market provides the team access to some of the food industry's largest and most innovative corporations and proximity to some of the nation's most productive farmland. As S2G expands to the oceans and energy sectors, the team is eager to engage with Chicago's robust investor and business ecosystem to progress innovative and impactful climate solutions.

SPOTLIGHT

Celadyne

Chicago's hydrogen ecosystem.

More than 50% of global greenhouse gas emissions are linked to industrial manufacturing, logistics, transportation, and heat. Yet, in 2018 when Celadyne was started, over 90% of capital and conversations were about battery electrification of the world. This was the backdrop on which Celadyne Technologies was founded. One of Chicago's first hydrogen companies, Celadyne is a developer and manufacturer of advanced membranes and electrolyzers to decarbonize industrial applications.

Freight transportation today accounts for 8% of global greenhouse emissions. Industrial manufacturing of materials like cement and steel that rely on high temperatures alone account for up to 19% of total greenhouse emissions. These use cases are difficult to decarbonize because of their size, scale and temperatures often rely on traditional high-energy density fuel like diesel and coal.

Celadyne believes hydrogen will be its new industrial fuel of the future because it can be stored long-term, combusted for heat, turned into electricity and scalable: we already use it to make fertilizers and launch rockets to space. To Celadyne, hydrogen is an inevitable reality, and it wants to use it to decarbonize all of energy.

Celadyne's patented materials technology uses low permeability membranes that block hydrogen crossover and leakage. The technology enables durable fuel cells that can be used to replace legacy diesel engines in trucking while providing a pathway for high-efficiency, safe hydrogen production. As one of the only commercial electrolyzer companies developing a differentiated electrolyzer product starting with a materials differentiator, Celadyne has a unique defensible position in the market.

"I am a hopeless romantic, and I can't think of a more poetic place to start revolutionizing logistics and industrial manufacturing than Chicago, the U.S.'s logistics and manufacturing hub of the last hundred years. If Chicago doesn't decarbonize, the U.S. can't decarbonize."

— Gary Ong, CEO, Celadyne

SPOTLIGHT

Energize Capital

Scaling sustainable innovation through climate software.

Energize Capital is a leading climate software investor partnering with best-in-class innovators to accelerate the sustainability transition. Founded in 2016 and based in Chicago, Energize invests in companies spanning early commercialization to profitable growth through their venture capital and growth equity strategies. Energize's investment thesis covers key themes at the intersection of software and: renewable energy, industrial operations, mobility and EVs, infrastructure resilience, and decarbonization.

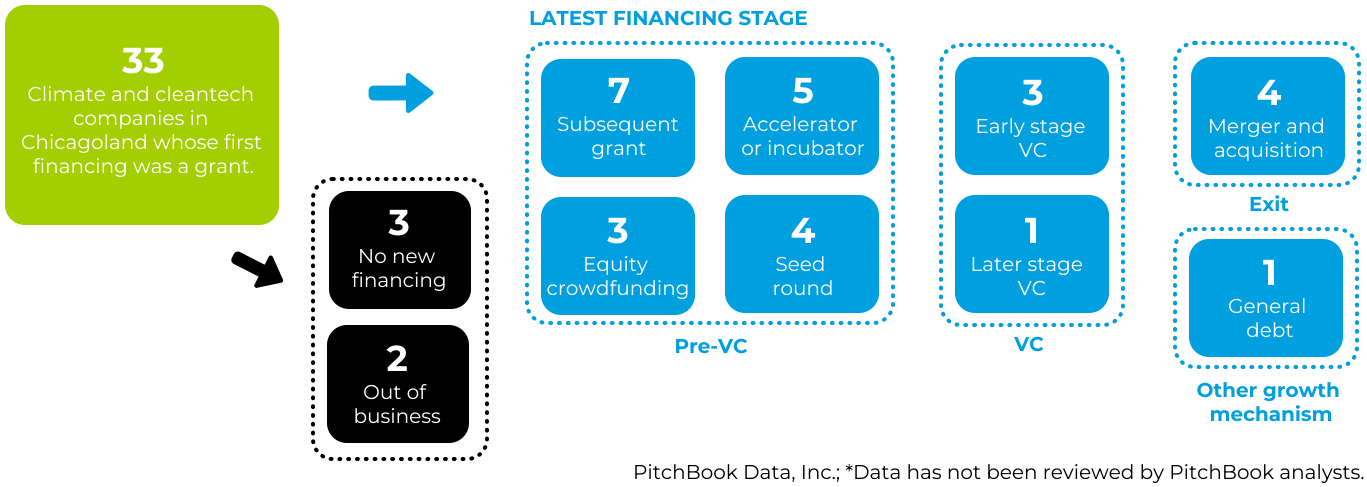
Energize invests in software-first climate technology businesses because the next wave of climate innovation is software solutions that unlock scale for readily deployable hardware and infrastructure. Transitioning from fossil fuels to a clean energy economy will require innovation across sectors and geographies, and digital tools can help accelerate the solutions addressing climate change's most urgent challenges. Software solutions that target these challenges can reduce soft costs and in turn enable massive scale within the energy transition.

Chicago and the greater Midwest represent the heart of the energy and industrial economy – from renewable energy developers and operators to manufacturing and construction firms. Many of the companies playing an influential role in the sustainability transition are based right here in Chicago and neighboring cities. Several of Energize's portfolio companies have a presence in Chicago or the greater Midwest, and startups based overseas are increasingly opening their U.S. offices in Chicago in an effort to tap into the city's expansive corporate innovation opportunities.

Public Investment

Grants are often the first step on the path of equity-based growth financing.

When novel technologies for climate and cleantech applications are first developed, they are often not viable for large-scale commercialization. Non-equity funding through grants help bridge the gap between a promising technology and its place in the market, especially through bringing operating costs down. This is evident in Chicagoland's climate and cleantech startup portfolio, where nearly 10% of companies were first financed through a grant — many of which have gone on to raise subsequent pre-venture capital or venture capital funding.



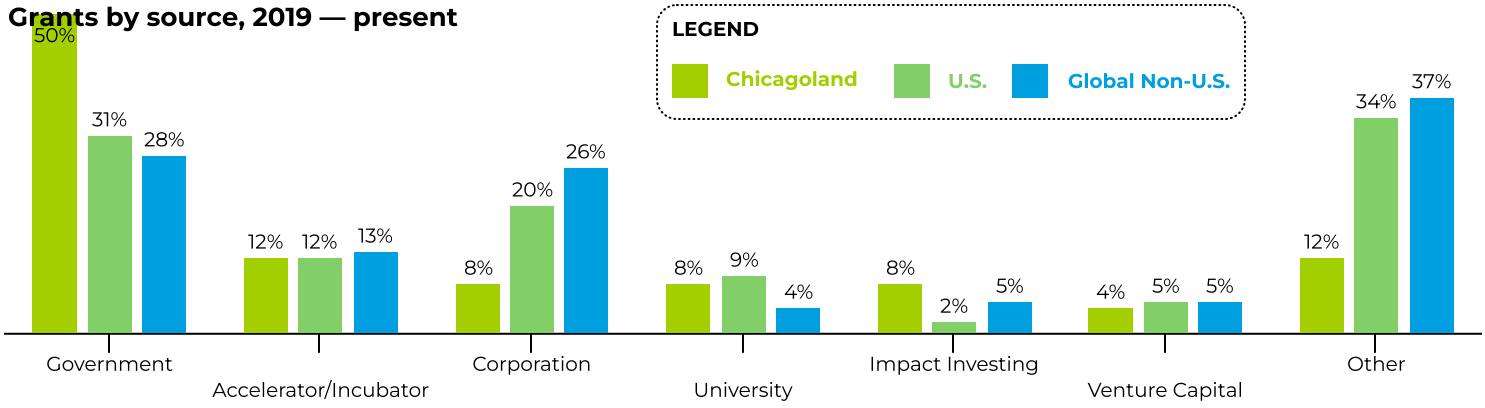
PitchBook Data, Inc.; *Data has not been reviewed by PitchBook analysts.

Government entities are Chicagoland startups' primary sources for grant funding.

According to Pitchbook, about half of grants awarded to Chicagoland climate and cleantech startups were done by government entities. Roughly two-thirds of grantors are federal government entities, while the remaining one-third are state government entities. Other key grantor types include accelerators and incubators, universities, and impact investors.

Chicagoland's grantor profile differs from both all U.S.-based startups and non-U.S. startups — startups receiving grant funding abroad, for example, are more likely to receive non-equity funding from corporations.

Grants by source, 2019 — present



PitchBook Data, Inc.; *Data has not been reviewed by PitchBook analysts.

SPOTLIGHT

Federal Investment

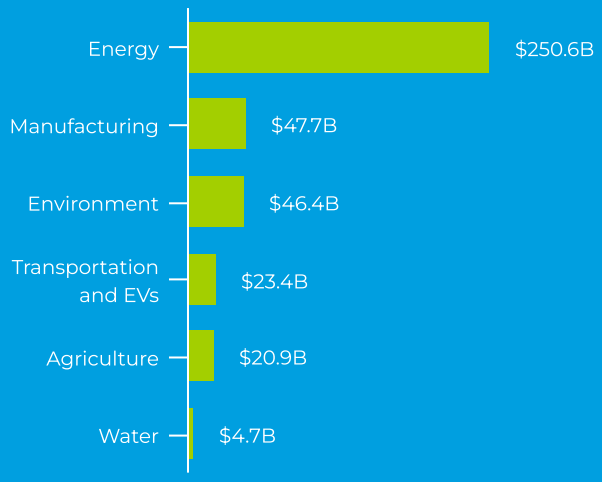
The federal government is prioritizing the transition to a carbon-neutral economy.

Significant funding for developing climate and clean technologies to reduce carbon emissions — in addition to an already wide pool of funding for causes related to the environment — is made available by a myriad of programs and grants administered through federal agencies. As of October 2023, there are 280 federal grants in the environmental and clean transition space available that businesses and governments to apply for.

Given the fact that many climate and clean technologies and startups in Chicagoland are first incubated by government grants, the sheer amount of funding available at the federal level presents opportunity to develop our local industry cluster. Key legislation, departmental grant programs, and other opportunities include:

Inflation Reduction Act (IRA) of 2022 directs $394 billion in federal funding towards the clean energy transition. With the **Bipartisan Infrastructure Law (BIL) of 2021,** over $370 billion is directed toward the energy industry sector. A year into existence, funding availability through the IRA is already underway through over 110 programs in 11 federal agencies.

$394 billion in IRA investments across sectors



SPOTLIGHT

The Greenhouse Gas Reduction Fund — a $27 billion federally funded investment administered by the U.S. Environmental Protection Agency to encourage the development of clean technology by mobilizing financing and private capital deployment across the nation. It consists of three parts:

- **National Clean Investment Fund** — $14 billion in grants to 2-3 institutions that will provide financing for clean technology projects across the country.
- **Clean Communities Investment Accelerator** — $6 billion in grants to 2–7 hub nonprofits to build clean financing capacity of lenders working in low-income and disadvantaged communities to deploy clean technology.
- **Solar for All** — $7 billion in 60 grants to expand the number of low-income and disadvantaged communities primed for residential solar investment.

SBIR/STTR — The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs awarded through the U.S. Small Business Administration fund small businesses to engage in Federal Research/Research and Development (R/R&D) with the potential for commercialization. These are administered through federal agencies, ranging from the U.S. Department of Agriculture to the U.S. Department of Defense. In 2022, 147 SBIR or STTR awards were made to companies in Illinois, including 27 sponsored by the Department of Energy.

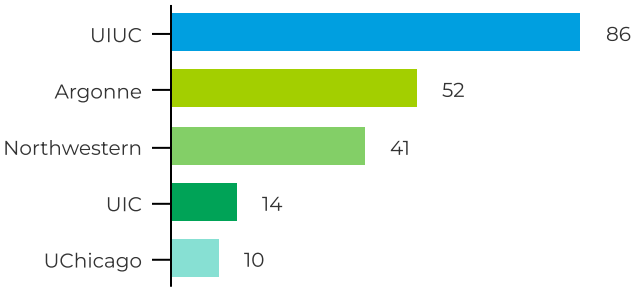
National Science Foundation — The NSF is an enormous funder of innovation in the U.S., primarily serving as a granting agency to support science and innovation. As a whole, NSF investments account for about 25% of federal support to America's colleges and universities for basic research — including in clean and climate tech.

Tech Commercialization

Chicagoland's consortium of research institutions are at the center of translating next-gen research to market-viable technologies.

Technology commercialization demonstrates Chicagoland universities' and research centers' integral role in climate and cleantech innovation. Tech transfer offices at these universities make available inventions and nascent technologies for investment, in addition to helping founders spin out market-viable startups.

Climate, clean, and related technologies available for commercialization (as of October 1, 2023)

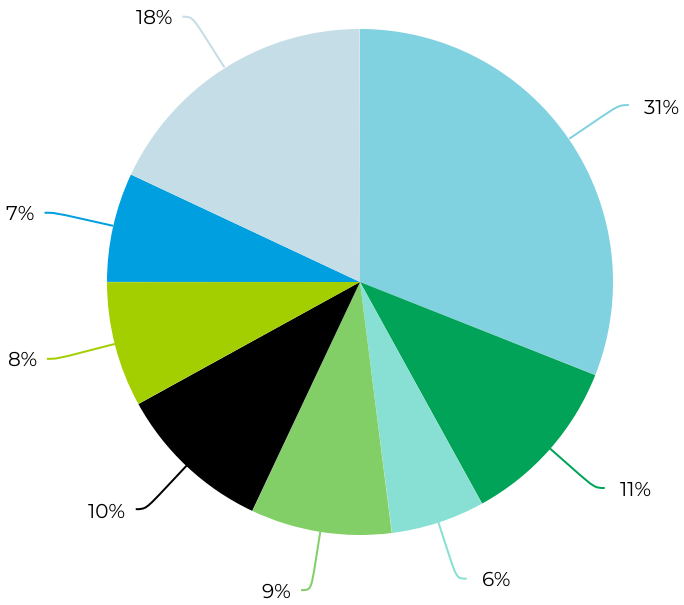


Climate and cleantech startups spun out of Chicagoland's universities

The breadth of technologies available for commercialization suggests where Chicagoland could incubate sub-industries.

The technologies available for licensing and commercialization are an indication of the next wave of innovation, and represent opportunities for future industry. Several of Chicago's universities are engaged in energy storage and battery technology, and technologies range from chemicals and materials science applications to hardware and devices.

Climate and cleantech technologies available for commercialization by sub-category:



EXAMPLE TECHNOLOGIES

Battery and Energy Storage
- Lithium ion battery improvement
- Carbon-based energy storage

Fuel Cells and Hydrogen
- Hydrocarbon fuel cells

Environmental and Water Treatment
- Stormwater management tools

Agriculture
- Crop harm reduction

Materials
- Biodegradable packaging

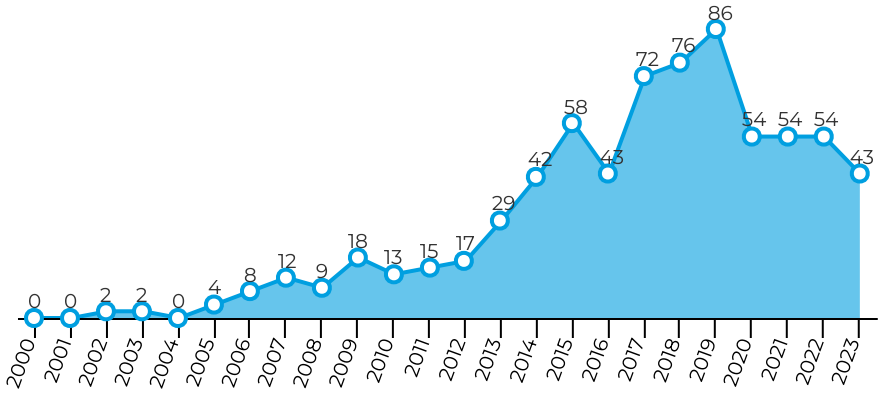
Chemical Recycling
- Plastics recycling methods

Patents

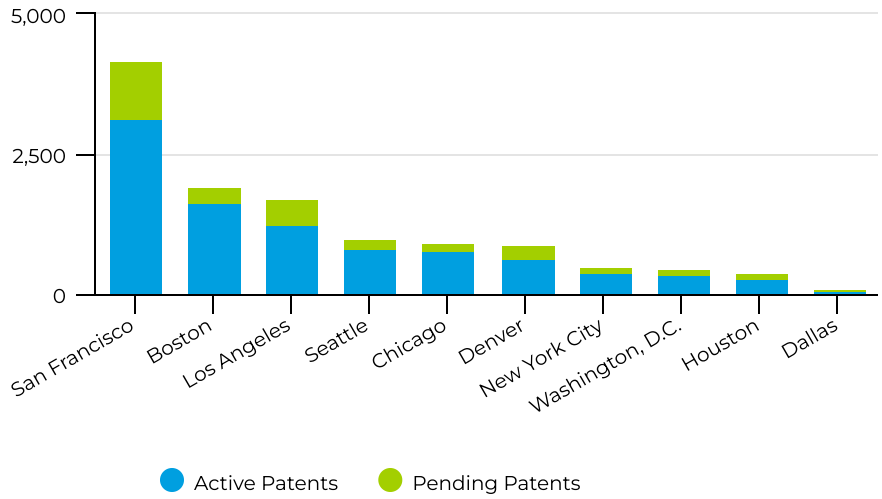
Chicagoland has an opportunity to leverage local assets to increase innovation.

Patents play a crucial role in the development of clean and climate technology by providing incentives for innovation, fostering growth in the green technology sector, and generating various forms of economic activity. Startups and companies with patented clean technologies are more likely to secure funding for research, development, and commercialization, which is vital for bringing green innovations to market.

Clean & Climate Tech Related Patents Granted - Chicago Region



Current Active & Pending Clean & Climate Tech Related Patents



Chicago area companies currently hold 788 patents related to clean and climate technology, with another 150 pending. Across the U.S., the number of patents related to clean and climate technologies has seen a dramatic increase since 2000. This surge in patent filings reflects heightened global interest in addressing environmental challenges and transitioning to a low-carbon economy.

Moreover, the U.S. Patent and Trademark Office (USPTO) recently announced the expansion and extension of the **Climate Change Mitigation Pilot Program.** The USPTO expanded the program eligibility requirements to encompass a more robust group of innovations in any economic sector that advance progress toward achieving net-zero greenhouse gas emissions. Additionally, USPTO expanded the **Patents for Humanity Awards Program** to include a new category for those who are responding rapidly to the challenges of climate change by developing green energy sources using game-changing technologies, including through wind, solar, green hydrogen, hydropower, geothermal, and biofuel technologies.

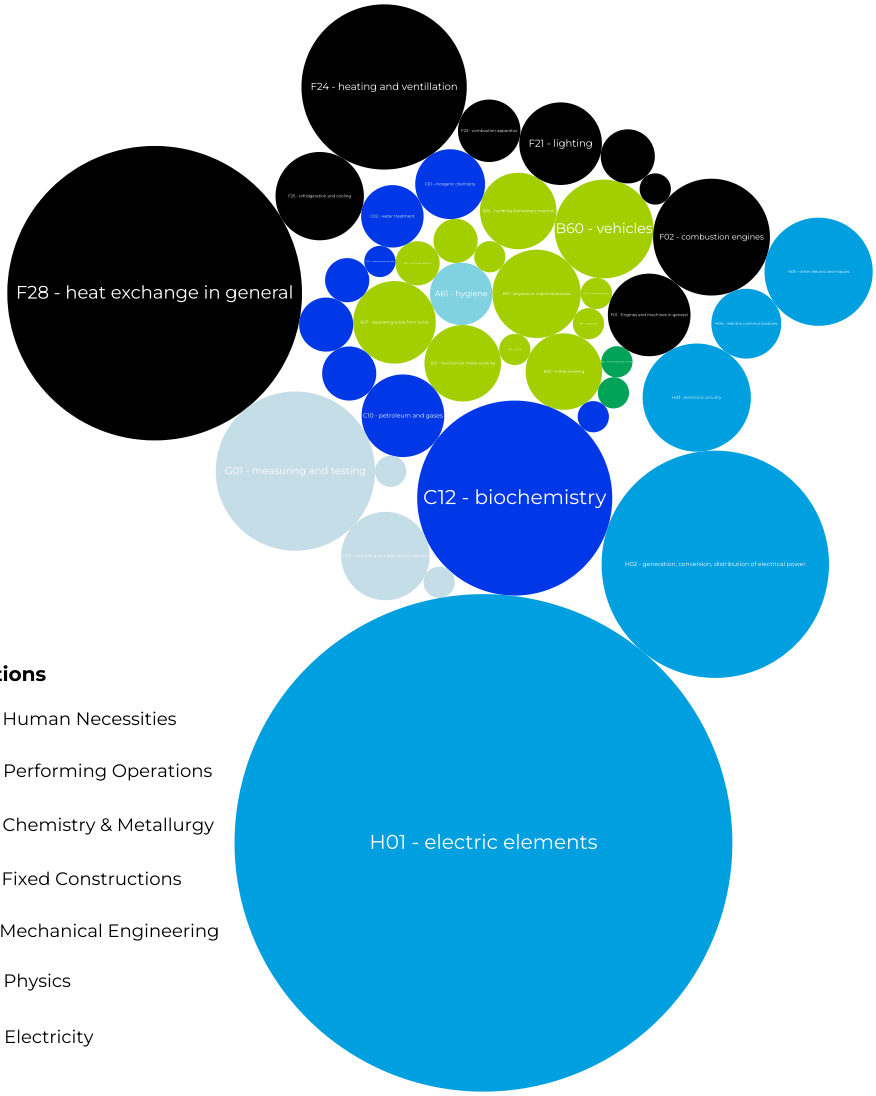
The Chicago region has an opportunity to improve its ranking among U.S. metros for the production of clean and climate tech related patents by leveraging local assets like R1 universities — University of Illinois at Chicago, University of Illinois Urbana-Champaign, Northwestern University, and University of Chicago — and national federal laboratories — Fermi National Accelerator Laboratory and Argonne National Laboratory. Both universities and national laboratories actively engage in technology transfer and commercialization activities. They partner with local startups, businesses, and industries to license innovative technologies and intellectual property developed within the lab, fostering entrepreneurship and supporting local companies.

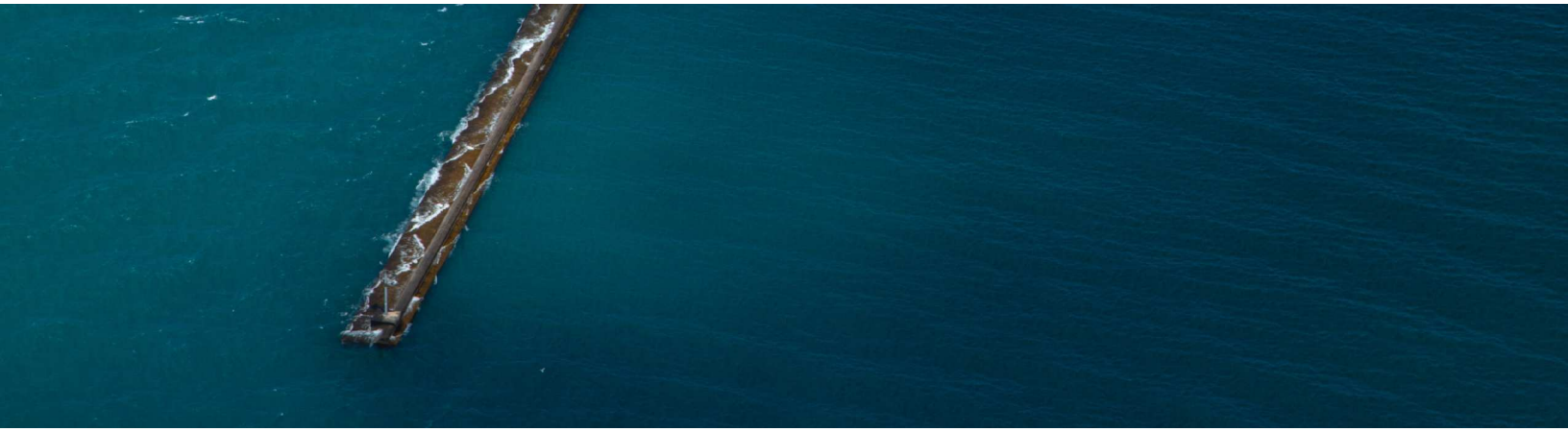
Patent Diversity

Chicagoland's patent diversity reflects the broader green economy diversity.

Environmental and sustainability challenges are multifaceted, spanning various industries and sectors. A diverse patent portfolio makes the green economy more resilient to changes in market dynamics, regulatory landscapes, and emerging challenges. Moreover, cross-pollination of ideas and technologies can lead to hybrid solutions that leverage the strengths of multiple innovations, accelerating progress in the green ecosystem.

A wide range of patents are related to clean and climate technology, reflecting the diversity of innovations aimed at addressing environmental challenges and reducing carbon emissions. The Chicago region has produced a variety of patents, but has particular strengths in patents related to energy efficiency and carbon transformation.





Private Investment

Global Investment

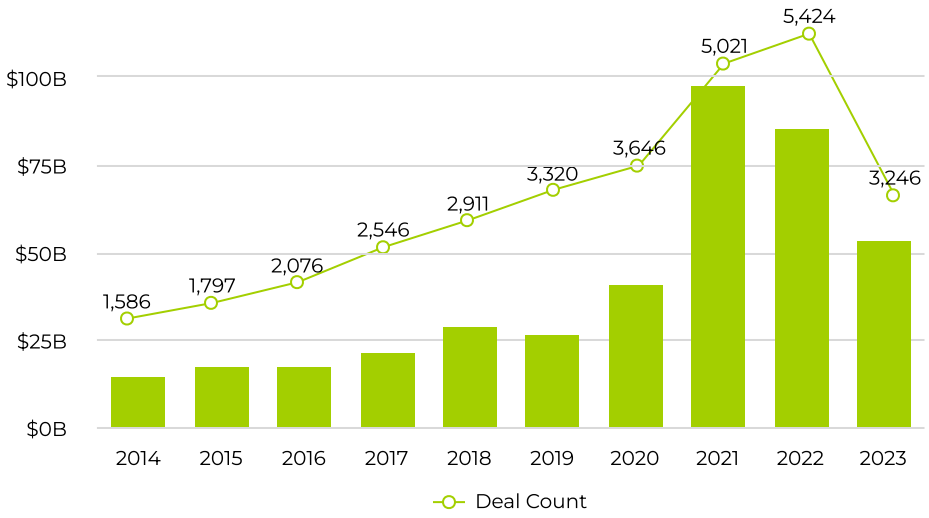
Global growth capital investment in climate and clean technology has grown substantially in recent years, with 82% of total capital invested globally occurring over the past decade; total private investment has reached nearly $495 billion with a total of over 42,000 deals.

Venture capital (VC) represents the largest deal type, encompassing over 63% of deal types with later stage VC representing 42% of deal types. The leading verticals by deal type globally are clean tech (26%) and climate tech (14%). Roughly 83% of VC deal sizes are $25 million and over, with the leading primary industry codes including automotive (14%), energy production (13%), and alternative energy equipment (9%).

The US is the leader in global climate and clean technology private investment, representing over 41% ($203 billion out of a total of $495 billion) of total global private investment. Other countries leading the way include China, India ($30 billion), the United Kingdom ($24 billion), Sweden ($18 billion), and Canada ($15 billion). In fact, China is approaching $100 billion in total capital invested, representing roughly 20% of the global total. In addition, China has witnessed the largest deal ever with CGN Wind Energy (roughly $4.8 billion). Other countries that have also experienced over $4 billion deals include Sweden, India, and Portugal.

Recent Trends: In 2014, total global capital investment reached $15 billion through 1,586 deals. In 2021 (the peak year), total global capital investment reached $98 billion with over 5,000 deals globally. The next year, 2022, total global deals reached their peak at over 5,400 deals. So far in 2023, total global capital investment has reached $54 billion (roughly half of its peak year in 2021) with over 3,200 deals.

Global Investment in Climate & Clean Tech Startups



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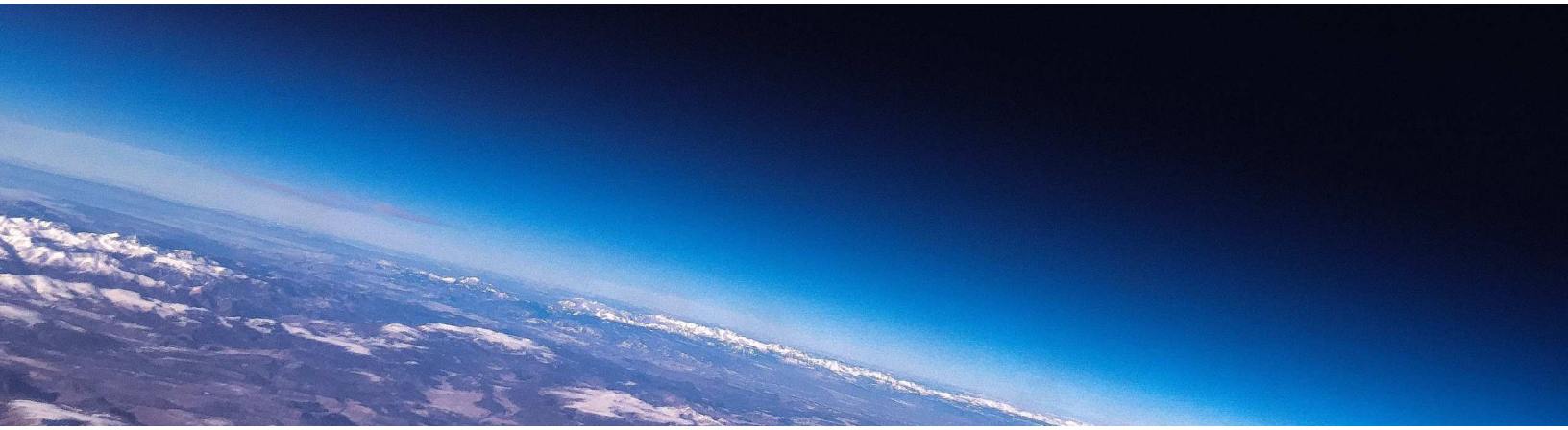


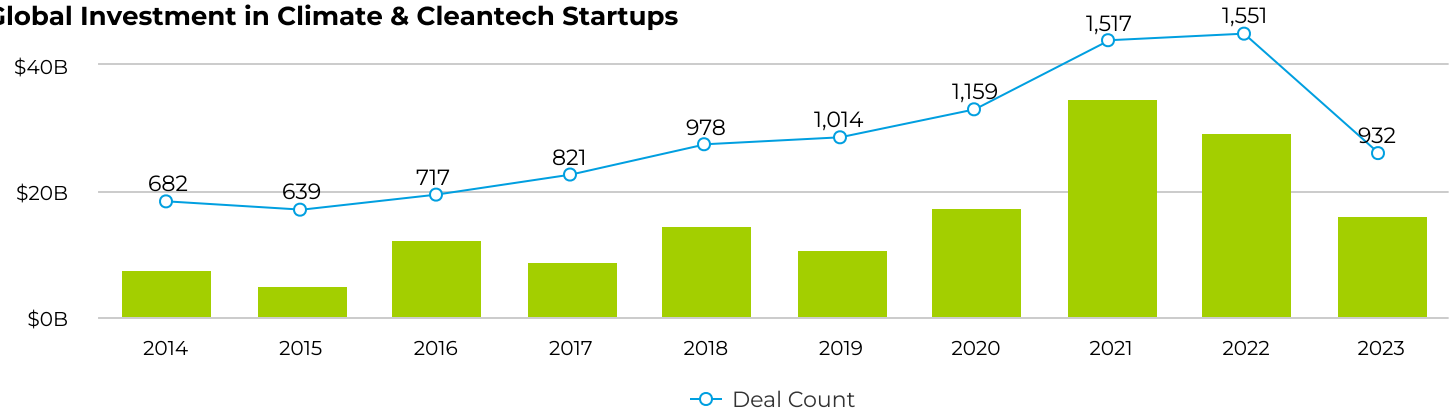
Private Investment

US Investment

Total capital investment in U.S.-based climate and clean technology startups has grown significantly in recent years, with 77% of total capital invested in them ($157 billion out of a total of $203 billion) occurring over the past decade. **Total private investment has reached nearly $203 billion with a total of over 14,000 deals.** VC represents the largest deal type encompassing over 66% of deal types with later stage VC representing 50% of deal types, followed by private equity growth/expansion, and early stage VC. The leading verticals by deal type globally are clean tech (24%) and climate tech (15%), which essentially mirrors global vertical investment. In addition, similar to global VC deal size, roughly 82% of VC deal sizes are $25 million and over, with the leading primary industry codes including automotive (12%), energy production (9%), and alternative energy equipment (9%) also mirroring global investment.

Recent Trends: In 2014, total capital investment in US startups reached $8 billion through 682 deals. In 2021 (the peak year), total U.S. capital investment reached $34 billion with over 1,500 deals nationally. The next year, 2022, total U.S. deals reached their peak at over 1,550 deals. So far in 2023, global capital investment in U.S.-based companies has reached $16 billion (roughly half of its peak year in 2021) with over 900 deals.

Global Investment in Climate & Cleantech Startups



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Midwestern Investment

Midwestern (Illinois, Wisconsin, Indiana, Michigan, Ohio, Iowa, Missouri, and Minnesota) total growth capital investment in climate and clean technology also saw strong growth — albeit not as substantial as global or U.S. totals — in recent years, with 65% of total capital invested occurring over the past decade. Total private investment has reached $8.5 billion through 1,340 deals.

VC encompasses over 54% of deal types, with later stage VC representing 33% of deal types, followed by private equity growth/expansion (32%), and early stage VC (21%). The leading verticals by deal type in the Midwest are cleantech (27%) and climate tech (11%), which closely resemble global and U.S. vertical investment. In addition, roughly 70% of VC deal sizes are $25 million and over (lower than both the global and U.S. amounts), with the leading primary industry codes including environmental services (15%), industrial supplies and parts (15%), and energy production (5%). **These areas do not mirror the capital investment seen in the global and U.S. figures, as the Midwest capital investment has minimal automotive or alternative energy equipment investment.**

Recent Trends: In 2014, total global capital investment was $15 billion with 1,586 deals. In 2021 (the peak year), total global capital investment reached $98 billion with over 5,000 deals globally. The next year, 2022, total global deals reached their peak at over 5,400 deals. So far in 2023, total global capital investment has reached $54 billion (roughly half of its peak year in 2021) with over 3,200 deals.

Private Investment

Illinois Investment

Illinois' total growth capital investment in climate and clean technology has grown significantly in recent years, with 85% of total capital invested ($1.4 billion out of a total of $1.65 billion) occurring over the past decade. Total private investment has reached $1.65 billion with 343 deals.

Largest Investments over Past Ten Years in Illinois

Company	Deal Value	Deal Type
White Oak Resources	$320M	Corporate VC
LanzaTech	$187M	Late Stage VC
Natural Fiber Welding	$85M	Late Stage VC
Intellihot	$50M	Late Stage VC
Lanzajet	$50M	Early Stage VC

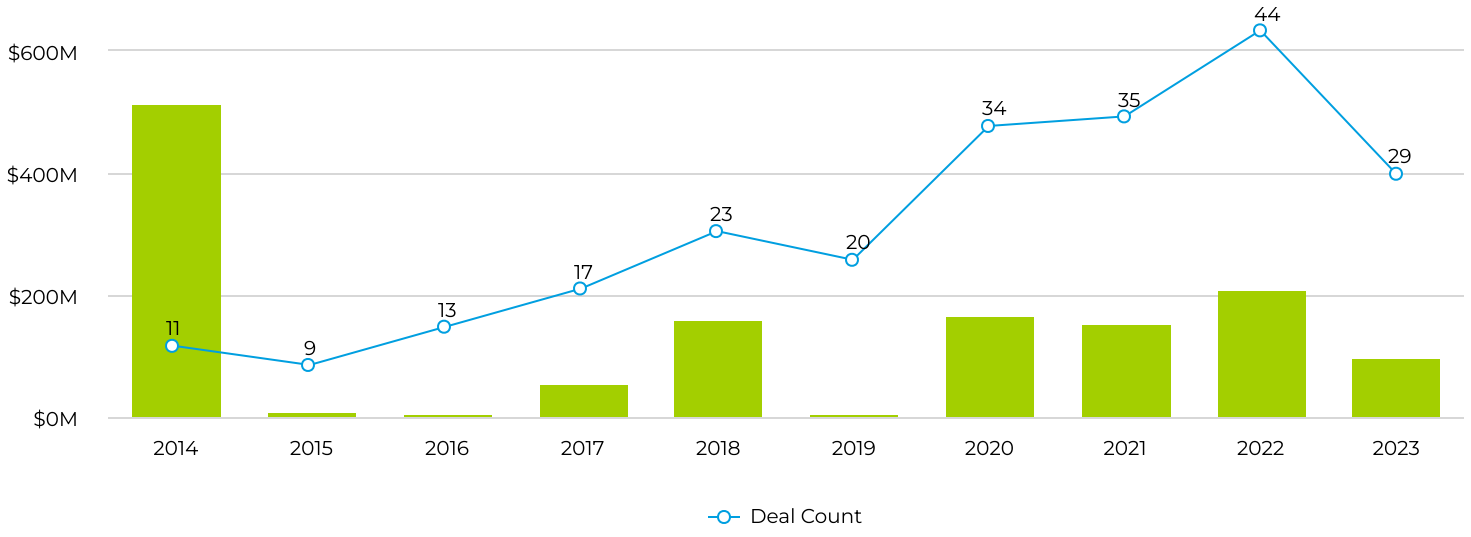
PitchBook Data, Inc.; *Data has not been reviewed by PitchBook analysts.

Venture capital represents the largest deal type, encompassing over 66% of deal types with later-stage VC representing 50% of deal types, followed by private equity growth/expansion, and early-stage VC. The leading verticals by deal type in Illinois are clean tech (28%) and climate tech (22%), which essentially mirrors global, U.S., and Midwest vertical investment with respect to clean tech. However, the climate tech vertical percentage of 22% is higher than the global, U.S., and Midwestern totals.

In addition, similar to Midwestern VC deal size, roughly 71% of VC deal sizes are $25 million and over, with the leading primary industry codes including environmental services (36%), coal mining (19%), and plant textiles at (10%). However, automotive (1%), energy production (less than 1%), and alternative energy equipment (1%) are not attracting capital investment like global and U.S. capital investment has experienced over the past decade.

Recent Trends: Unlike what has been experienced at the global, U.S., or Midwestern levels, the state of Illinois witnessed its peak year for total capital investment in 2014, when total capital investment reached $515 million. In fact, annual total capital investment has not exceeded $210 million annually since 2014. Total capital investment since 2020 has averaged $177 million. So far in 2023, total capital investment has reached $100 million with over 30 deals.

Investment in Illinois' Clean & Climate Tech Startups



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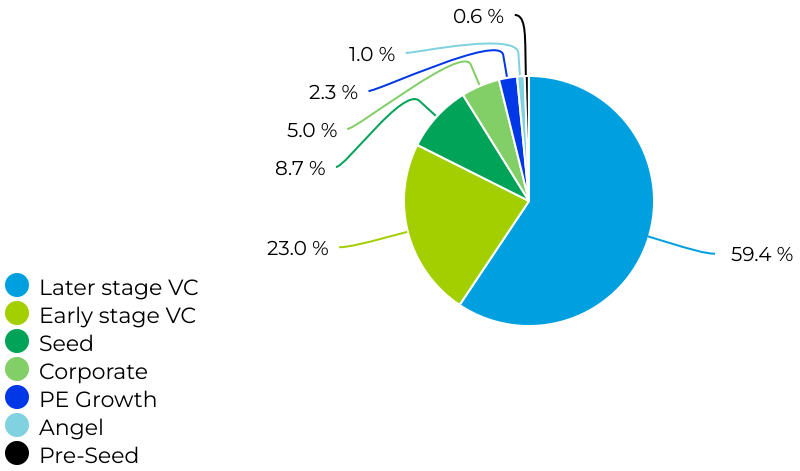
Private Investment

Chicagoland Investment

Total clean and climate tech private capital investment in Chicagoland has reached $1.12 billion, with roughly 300 deals. Venture capital (VC) represents the largest deal type encompassing 82% of deal types with later stage VC representing nearly 60% of deal types, followed by early stage VC, and private equity growth/expansion.

Investments in Chicagoland Clean & Climate Tech Startups, by Deal Type



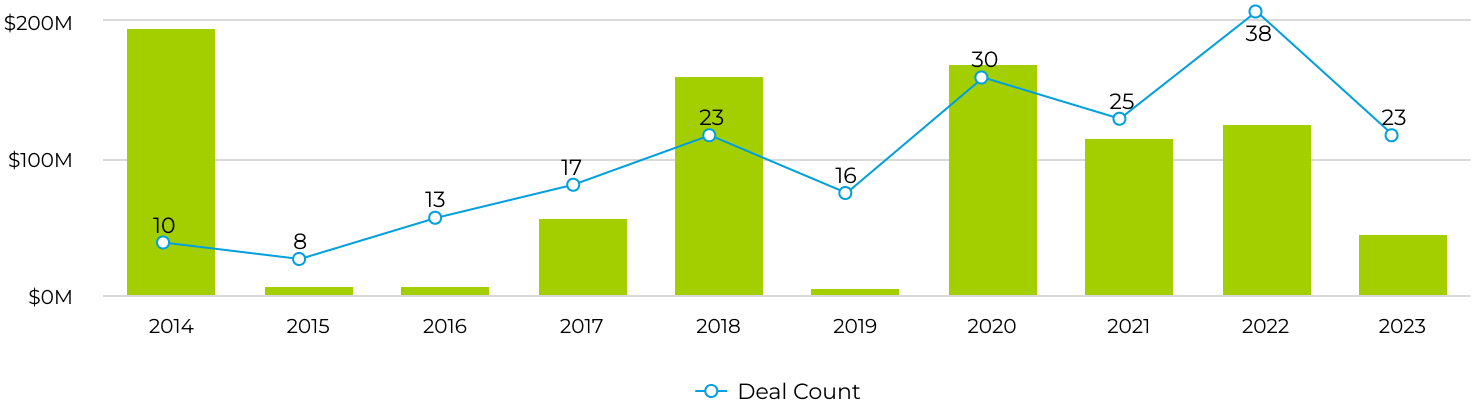
PitchBook Data, Inc.; *Data has not been reviewed by PitchBook analysts.

The leading verticals by deal type globally are climate tech (25%) and cleantech (24%), which does not mirror global and U.S. vertical investment. In fact, the Chicago metro has the highest proportion of climate tech deals at 25% when compared to the global, U.S., and Midwestern amounts. In addition, roughly 65% of VC deal sizes are $25 million and over.

The big difference between the Chicagoland region and other regions is that the leading primary industry code includes environmental services, which represents more than half of total capital investment (53%). This is higher than both the Midwestern and state of Illinois totals, respectively at 15% and 36%. Similarly, the Chicagoland total capital investment includes a minimal amount of automotive, energy production, and alternative energy equipment, unlike global and U.S. trends.

Recent Trends: Similar to Illinois, Chicagoland witnessed its peak year for total capital investment in 2014, when total capital investment reached $195 million with 1,586 deals. Total capital investment since 2020 has averaged $136 million, with 2020 recording the largest amount since the 2014 peak with $169 million. So far in 2023, total capital investment is approaching $50 million with over 30 deals.

Investment in Chicagoland Clean and Climate Tech Startups



PitchBook Data, Inc.; *Data has not been reviewed by PitchBook analysts.

Competitive Advantages

Chicagoland offers a dynamic ecosystem where cleantech startups can thrive, grow, and make meaningful contributions to sustainability and environmental progress.

- ## Market Potential

  The Chicago region's diverse industrial base provides clean and climate tech startups with access to a wide range of potential customers and collaborators, allowing them to tailor their solutions to specific market needs and explore multiple application areas. Moreover, this diversity extends beyond the traditional boundaries of industries like energy, manufacturing, transportation, and agriculture, and encompasses a wide array of businesses and organizations with differing needs and challenges. This diversity of industries fosters a culture of cross-pollination and knowledge exchange, where startups can draw inspiration from insights gained in one sector to innovate and create novel applications for their technologies in entirely different industries.

- ## Skilled Workforce Availability

  Chicagoland's skilled workforce, which includes one of the largest production workforces in the U.S., provides startups with a talent pool equipped with technical expertise crucial for developing and scaling cleantech solutions effectively. This workforce offers startups a competitive advantage in developing and deploying complex clean and climate tech solutions. Additionally, the depth of technical expertise in Chicagoland encompasses a wide range of disciplines, including not just those relevant to industrial sectors, like engineering, materials science, automation and precision manufacturing, but also a broad range of interdisciplinary fields, like business management, urban planning, and finance.

- ## Local Innovation Assets

  Proximity to Chicagoland's research institutions and universities fosters collaboration, enabling startups to tap into cutting-edge research, access specialized equipment, and benefit from the knowledge transfer, ultimately accelerating product development and innovation. Partnerships can take the form of joint research projects, technology validation, and collaborative innovation initiatives, allowing startups to pool resources, share knowledge, and tackle complex sustainability challenges with the support of academic experts. Additionally, research institutions typically house state-of-the-art laboratories and specialized equipment that startups may find prohibitively expensive to acquire independently.

Both Argonne National Laboratory and Fermilab are renowned for their scientific research and innovation and play pivotal roles in advancing science and technology.

Argonne

- 3,723 employees
- 1,451 scientists and engineers
- Multidisciplinary science and engineering research center
- $1.1 billion in funding in FY 2022

Fermilab

- 4,000 scientists from 50 countries
- 2,535 Ph.D. graduate students
- America's particle physics and accelerator laboratory
- $260 million in funding from the Inflation Reduction Act (IRA) of 2022

Findings

1. **Chicagoland's green economy produced over $18 billion in output in 2022, growing by nearly 180% between 2016 and 2022.**

   Chicagoland's green economy output (GDP) grew by nearly 180% between 2016 and 2022. This growth was driven largely by the power distribution sub-sector, which grew by over $4 billion from 2016 and 2022. Even though Chicagoland ranks sixth among the top ten metro areas for total 2022 output, the region ranks third for overall percentage growth when compared to historically larger business ecosystems.

2. **Chicagoland has the potential to develop the largest green workforce in the US.**

   With over 65,000 in employment, Chicagoland is currently ranked fifth out of the top ten metro areas for employment in the green economy. In 2022, there were nearly 1.2 million workers in Chicagoland that could be transitioned into green jobs, placing it third when compared to ten other major metropolitan areas in the U.S. These 1.2 million workers are skilled and reflect the interdisciplinary needs of a green economy, with skills ranging from engineering and production to business and policy.

3. **The climate and cleantech industries rely on institutional support to incubate market-viable technologies, and Chicagoland's universities and research institutions offer well over 200 cutting-edge technologies for commercialization.**

   Nearly 50% of startups in Chicagoland with grant funding as their first financing did so through a government grant; other top first financing included impact investing and universities. This demonstrates the role of institutional support in nascent clean and climate technology to make them market-viable. Chicagoland's strong consortium of universities and research centers are already producing next-gen technologies, and tech transfer offices are helping bridge the gap between proof-of-concept and market readiness — creating opportunity for investment in the region.

4. **Total cleantech and climate tech private capital investment in Chicagoland has reached $1.12 billion with roughly 300 deals.**

   Roughly 25% of all clean and climate climate investments (deals) in Chicagoland were investments in climate tech startups, the highest proportion of all clean and climate tech total investments when compared to the Midwest, U.S., and world. Venture capital represents the largest deal type, encompassing 82% of deal types with later stage VC representing nearly 60% of deal types, followed by early stage VC, and private equity growth/expansion. The big difference between Chicagoland and other regions is that the leading primary industry code includes environmental services, which represents more than half of total capital investment (53%).

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Methodology

Private Investment — based on the following query criteria:

- **Deal Types** (All Venture Capital Stages, Private Equity Growth/Expansion only, and Corporate Non-Control Transactions), AND
- **Ownership Status** (Privately Held (backing and no backing), In IPO Registration, Publicly Held, Acquired/Merged and Operating Subsidiary), AND
- **Verticals** (Cleantech and Climate Tech), OR
- **Emerging Spaces** > B2B > Natural Disaster Preparedness & Response > Microweather > Electric Flight > Climate Risk Modeling-as-a-Service > Sustainable Packaging - Energy - Materials and Resources > Cellular Agriculture > Hydrodgen Storage > Smart Waste Management > Lithium Ion Battery Recycling > Desalination Tech > Regenerative Agriculture > Reforestation, OR
- **Industries** > Energy > Energy Equipment > Alternative Energy Equipment - Energy > Energy Services > Energy Storage

Tech Commercialization — based on the following category criteria:

- **Northwestern University:** Energy & Sustainability
- **University of Chicago:** Cleantech
- **Argonne National Laboratory:** Energy storage, Environmental Science, Hydrogen & Fuel Cells, Nuclear Science, Transportation, plus a selection of other technologies in other categories that are related
- **University of Illinois at Chicago:** Tags including alternative energy, tags = smart grid, batteries, water, water management, lithium batteries, crop protection, energy, environmental sciences, fuel, fuel cells, green infrastructure
- **University of Illinois at Urbana-Champaign:** Energy Environmental Sciences and Materials

Industry NAICS Codes

- To further understand the NAICS codes that we used to define and analyze the "green economy," **please visit this link.**
- The NAICS codes used to define and analyze the "green transitioning economy" are available upon request.

Chicago Business Bulletin

About

World Business Chicago is Chicago's public-private economic development agency. Our mission is to drive inclusive economic growth and job creation, support businesses, and promote Chicago as a leading global city. Our vision is to ensure that all Chicagoans prosper.

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