incubateenergy network

Pathways to Success: Clean Energy Innovation Ecosystems

Best Practices Report #3

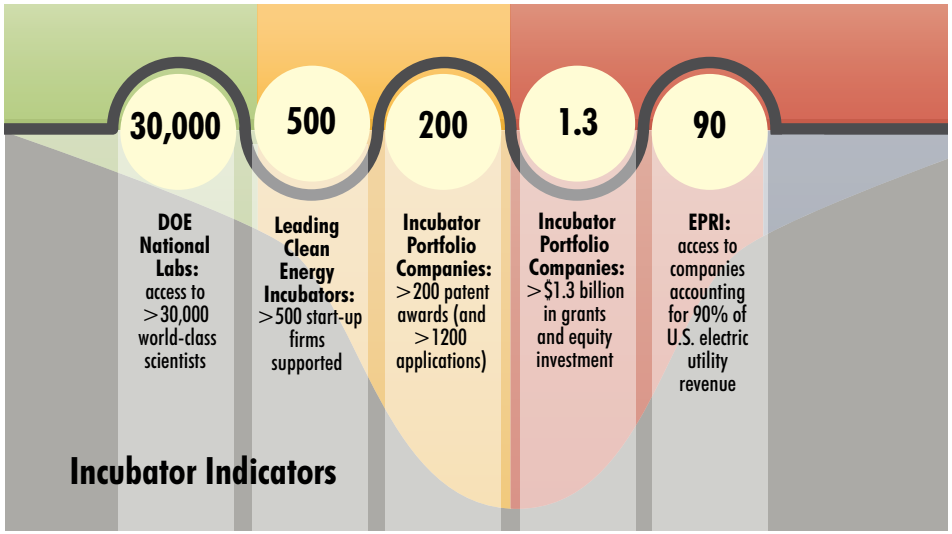
November 2016

Executive Summary

The journeys taken by successful clean energy entrepreneurs are often long and challenging. Several different types of organizations typically provide critical support services to help transform ideas into real-world innovations. Startup success stories highlight the important role of clean energy ecosystems in helping innovators navigate complex and changing technical, financial, organizational, and commercial landscapes.

Individual clean energy innovation pathways are varied. This white paper identifies common touchstones along the way toward commercialization: Successful entrepreneurs often receive **research support** from universities and laboratories, **development support** from incubators and accelerators, and **deployment support** through public-private funding sources and corporate partnerships.

Support networks are in place in many areas around the United States to help guide entrepreneurs along their paths to success. Clean energy incubators often serve as hubs for strong regional innovation ecosystems encompassing diverse roles and participants. The U.S. Department of Energy (DOE), National Renewable Energy Laboratory (NREL), Electric Power Research Institute (EPRI), and other energy sector organizations foster and support innovation across the country.



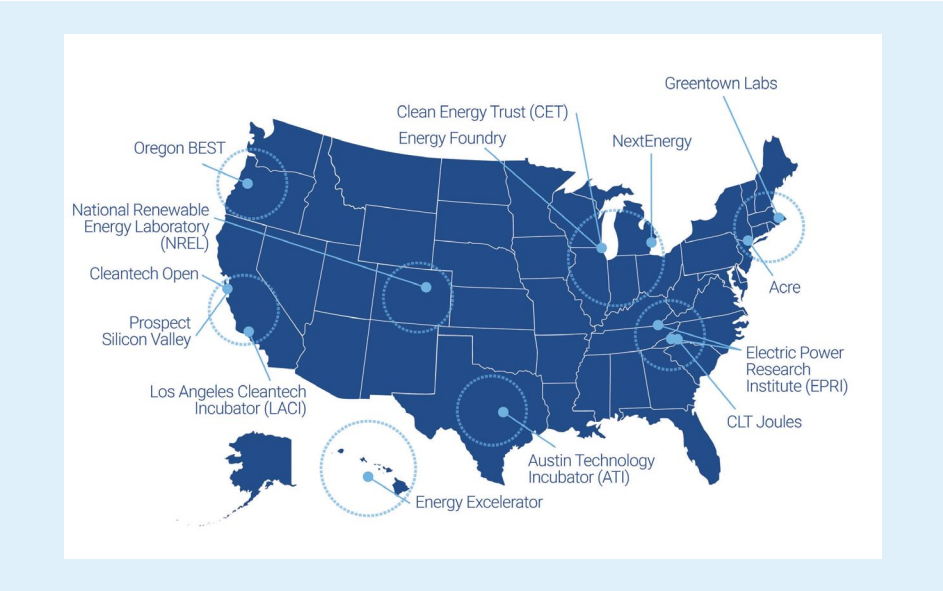


Figure 1 – Incubatenergy Network Members

The Incubatenergy Network members illustrated in Figure 1 are working together to help strengthen interregional collaboration and national coordination for the benefit of the cleantech entrepreneurial community.

Additional outreach, connections, and coordination are recommended within the United States and internationally to build the robust global support network needed for bringing game-changing innovations to market and deploying them at scale.

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Introduction

The Incubatenergy Network (incubatenergy.org) provides a forum for sharing information, experiences, and services to strengthen the overall U.S. clean energy ecosystem. The network brings together leading cleantech incubators across the United States, as well as NREL and EPRI. Incubatenergy members are joined by a shared mission and passion for a clean energy future.

The first Incubatenergy white paper highlighted the rigorous and highly selective processes that leading clean energy incubators apply in building a portfolio of companies that merit support. It also provided an overview of the services that incubators offer. The second Incubatenergy white paper focused on how portfolio companies achieve higher levels of success—as measured by follow-on funding and other indicators—due to the mentoring, networking, office and lab space, business services, funding sources, and partnership opportunities available through incubators.

This white paper highlights clean energy innovation pathways, typically lengthy journeys navigated successfully by only a small fraction of entrepreneurs. Figure 2 illustrates six tech transfer stages along the pathway and lists some of the various types of organizations engaged in providing support services as ideas transform into practical applications. Stages are depicted in linear order, but the process toward commercialization is not necessarily straightforward. Progress tends to be intermittent rather than continuous. Often, several iterations are required at each step—and certain stages may be revisited along the way—as entrepreneurs pivot to meet changing technical and business objectives, development standards, and market needs.

The tech transfer stages shown in Figure 2 overlap with three key phases—research, development, and deployment—in the broader technology commercialization process displayed in Figure 3. Many ventures and technologies fail within the "valley of death," where government funding wanes, engineering and cost challenges associated with prototyping and piloting real-world applications are high, and

Figure 2 – Some Organizations Facilitating Technology Transfer on the Clean Energy Innovation Pathway

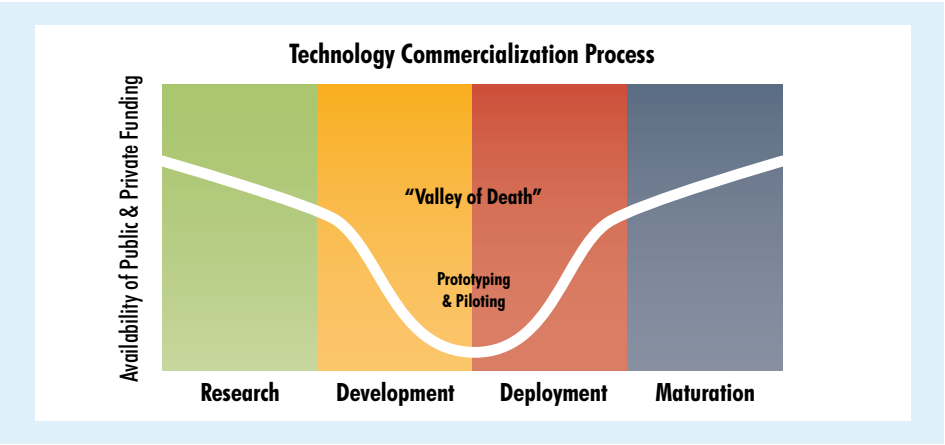


Figure 3 – Technology Readiness & Funding Availability

sufficient commercial funding is not yet available. Clean energy incubators have emerged to help bridge the gap between public and private capital, while a surrounding ecosystem of organizations is providing technical and business services to facilitate this transition process.

Research

Across the country, there are many resources for entrepreneurs engaged in exploratory

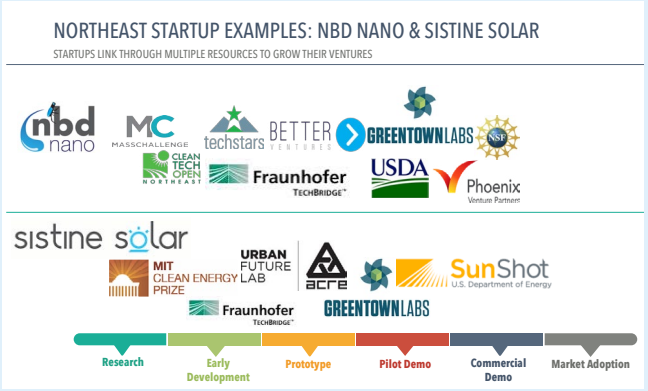
research and proof-of-concept testing focusing on clean energy technologies, services, and business strategies. As illustrated by Case Study 1, startups typically receive support from multiple organizations.

Traditionally, a significant portion of the technical work done by universities, U.S. national laboratories, and independent inventors has been supported by DOE and other public sources of funding for basic science and early-stage research. EPRI and other technology- or industry-centered institutions dedicate a percentage of their portfolios to exploration and strategic investment in long-term clean energy innovation.

DOE's Small Business Vouchers (SBV) Pilot is one example of how emerging businesses can access the expertise and unique capabilities at the national labs, free of charge. This new program provides vouchers up to $300,000 for eligible businesses and startups to "spend" in speeding development of clean energy technologies through access to lab facilities and researchers. The first two SBV rounds support 76 companies with voucher awards totaling about $15 million.

Case Study 1: NBD Nano & Sistine Solar

NBD Nano, launched by students from Boston College, makes specialized coatings and additives for modifying the wettability of metal, plastic, glass, and painted surfaces to increase efficiency or realize other performance objectives. Sistine Solar, out of MIT, customizes the appearance of solar photovoltaic (PV) panels to match roofing materials or achieve other aesthetic goals. In addition to their university connections, both companies have received tech transfer support from several groups within the northeast innovation ecosystem, starting with programs focused on the earlier stages and then transitioning to incubators and independent testing labs. U.S. agency funding is helping advance their clean energy innovations to real-world demonstration. In addition, NBD Nano is running a pilot to test coated condenser tubes for improving power plant efficiency, largely as a result of utility contacts made through the Incubatenergy Network.



Increasingly, universities and national labs are fostering innovation within the communities they bring together and serve. Most leading U.S. clean energy incubators are hosted by or have strong connections with universities. DOE's Cleantech University Prize (UP) program has identified eight leading regional universities and supporting organizations that help earlier-stage companies led by students develop their technologies, business strategies, and more. The 2016 Cleantech UP finals took place in Denver, Colorado, showcasing top student teams from around the country competing for $100,000. Ultimately, the top two prizes of $50,000 and $30,000 went to Heila Technologies (Massachusetts Institute of Technology) for its universal microgrid controller and XStream Trucking (Stanford University) for its high-efficiency tractor-trailer connector, respectively. NovoMoto (University of Wisconsin-Madison), which is focused on bringing solar-powered microgrid technology to the developing world, secured third place and $20,000 after previously winning $90,000 through the Clean Energy Trust (CET) Challenge.

Federal labs are also getting increasingly involved in the technology incubation model, with the recent launch of Cyclotron Road at Lawrence Berkeley National Lab, Chain Reaction Innovations (CRI) at Argonne National Lab, and Innovation Crossroads at Oak Ridge National Lab. In addition, NREL co-administers the Wells Fargo Innovation Incubator (IN^2) program and is leading DOE's Lab-Corps program. NREL also hosted its first Innovation Showcase in October 2016 featuring Lab-Corps, SBV, IN^2, and Cyclotron Road companies. By fostering entrepreneurialism among lab experts and cultivating

emerging talents through training, mentoring, and other programs, these initiatives are facilitating tech transfer at early stages in the innovation process.

The DOE lab system recently convened at the Lab Impact Summit hosted by NREL. Spanning more than 30,000 scientists and engineers and world-class experimental facilities around the country, the system represents a tremendous resource with a growing focus on helping internal and external innovators bring ideas to market. A 2016 Lab-Corps cohort graduated during the summit, with participants pitching market applications for the technologies they are developing.

As DOE's national and regional clean energy innovation support network expands, corporate and foundation interest in early-stage technology development is growing. At the DOE Lab Impact Summit, the Ford Motor Company described its transition from a traditional focus on car manufacturing to the much larger mobility market, encompassing increased interest in automated vehicles, ride sharing, and other innovations. Technology leaders from companies such as Duke Energy, General Motors, and Hawaiian Electric addressed the essential need and major opportunity for innovation in renewable energy, grid integration, electrification, and additional clean energy solutions to meet the challenges posed by climate change.

After several years of retreat from the cleantech sector by venture capital (VC) investors, new models are emerging for corporate engagement with early-stage innovators, often facilitated through incubators. Government pledges and foundation commitments leading up to and in the afterglow of the Paris Agreement under the United Nations Framework Convention on Climate Change suggest potential for increased public-private investment in basic science and research translation over the long term, an essential element in turning new knowledge and insight into practical applications meriting validation and prototyping.

Development

As innovations transition into the development phase, there are several models for providing incubation support to clean energy entrepreneurs. Figure 4 identifies some of the participants in the Incubatenergy Network that support tech transfer after proof of concept is achieved. These and other groups provide validation testing and other technical and business services falling into four main categories: lab + incubation, physical incubators, challenges, and pilot project demonstrations.

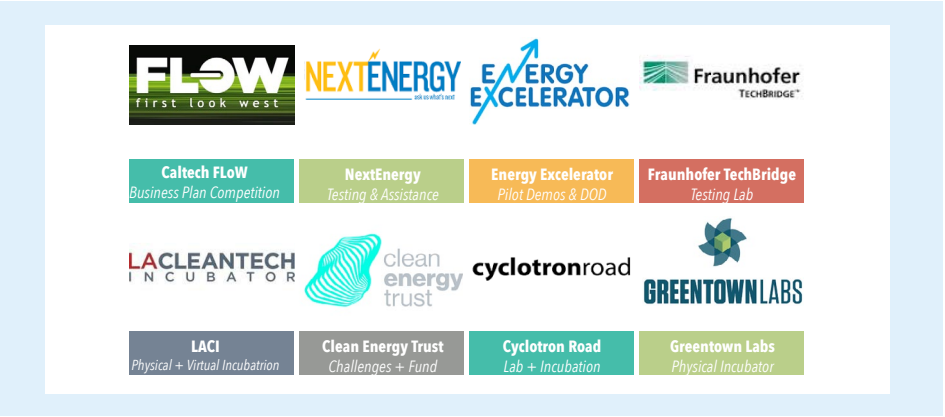


Figure 4 – Sample Clean Energy Support Organizations & Roles

Lab + Incubation. Technology incubation programs like Cyclotron Road, CRI, and IN^2 are centered around access to the experimental and testing facilities available from the national labs. Others work closely with universities, as noted above. These types of programs support a smaller number of earlier-stage innovations by furthering technology development, as well as providing more traditional incubator services such as mentoring, connections to community partners, corporations, and investors.

For example, the Austin Technology Incubator (ATI) is closely affiliated with the University of Texas system, ACRE works with New York University, and Oregon BEST supports a shared-user network of lab facilities at Oregon State, Portland State, and University of Oregon. Oregon BEST also provides funding of up to $250,000 for individual startups to de-risk their technologies by working collaboratively with universities. This includes cases in which the

technology is being transferred from the university to the private sector and instances when the university is providing development assistance or validation testing for a technology developed by a startup. Additional lab testing groups like Fraunhofer TechBridge and NextEnergy also fall into this category, bolstered by public and private funding.

Physical Incubators. Greentown Labs in Boston and the LA Cleantech Incubator (LACI) are examples of organizations supporting energy entrepreneurs with physical incubator space. These large facilities—more than 60,000 square feet at LACI and a new $11 million expansion to double the available space at Greentown Labs—offer entrepreneurs a robust network of support, including not only co-working and meeting rooms but also prototyping and laboratory services. They accommodate a relatively large portfolio of companies, with Greentown Labs listing over 50 in its current cohort.

Challenges. Challenges, business plan competitions, and other contests provide entrepreneurs with the opportunity to present their innovations at a demonstration day or pitch-type event with an audience of investors, corporate partners, and other important stakeholders that can help with technology development and deployment. Often, application, vetting, and mentoring/training processes are employed to help ensure that entrepreneurs are ready to compete. One example is the First Look West (FLoW) competition, which works with earlier-stage companies such as those involved with the Cleantech UP program. FLoW offers both "Transformational Idea" and "Ready to Commercialize" tracks. Similarly, the CET Challenge, profiled in Case Study 2, provides a cash infusion to advance energy innovations through both a student track and at later stages of development, having supported almost 100 startups to date.

Pilot Demonstrations. Support programs with an emphasis on pilot demonstration help entrepreneurs secure funding and develop partnerships required to test their innovations in the real world and expand their customer bases. The Energy Excelerator in Hawaii represents one example. Working closely with Hawaiian Electric, companies such as Stem, Shifted Energy, and Ibis Networks have been able to pilot later-stage technologies. As described in Case Study 3, Prospect Silicon Valley (ProspectSV) is launching pilots by drawing on public and private support mechanisms.

Case Study 2: Clean Energy Trust Challenge

The sixth annual CET Challenge showcased 14 innovative technologies competing for $1 million. The startup accepting the largest funding award was Nexmatix, which makes energy-efficient pneumatic control products applicable to many industries. Other prize winners include the enterprise ride-sharing platform SPLT, which connects employees within organizations, and NovoMoto, which aims to empower communities in the Democratic Republic of Congo and elsewhere in sub-Saharan Africa with MicroPlant technology combining PV, advanced control and monitoring systems, and social networks.

Case Study 3: ProspectSV & California Energy Commission

ProspectSV is supporting three pilots funded in part by the California Energy Commission. An "Internet of Energy" project at the College of San Mateo (CSM) applies monitoring and control software from Growing Energy Labs, Inc. (Geli), to coordinate and optimize a microgrid incorporating PV, battery storage, end-use loads, and building management systems. The pilot is demonstrating Geli technology for increasing the value of distributed resources, both for CSM and the larger grid. The other two projects involve zero-net-energy (ZNE) building retrofits in San Francisco. They began with a technology discovery phase, including a call for ZNE innovations that was publicized by other Incubatenergy Network members. Together, these ProspectSV projects demonstrate the value of collaboration and public-private partnerships in developing pilots that would not otherwise be possible.

Deployment

The transition from development to deployment is not sharp, fast, or easy for clean energy innovations, creating the need for extensive support during pilot demonstration and then scale-up. Fundraising is critical, with a variety of different sources spanning government programs and foundations and including angel investors, VC, and project finance. A recent MIT Energy Initiative report examined why the VC model has not worked well in the clean energy industry, where scaling innovations and displacing existing technologies takes time, can be expensive, and offers an unfavorable risk-reward profile for many traditional sources of capital.

Recently announced increases in long-term funding by governments and global philanthropy and technology leaders are targeted at fostering, accelerating, scaling, and quickly deploying clean energy solutions. Examples include Mission Innovation, which engages the United States, China, and many other countries, and the Breakthrough Energy Coalition, co-chaired by Bill Gates and designed to bring additional private capital into play. Strong and sustained policy commitments and pricing signals also are essential for fostering market transformation and reducing cost barriers to deployment.

Even as entrepreneurs address the challenges of securing funding, finding customers, scaling production, and expanding markets, they often must make modifications and enhancements based on lessons learned and customer feedback received in deploying their technologies through real-world demonstrations. Working in close cooperation with industry groups and trade allies can help facilitate this process. Clean energy incubators and startups are increasingly taking advantage of the opportunity to collaborate with commercialization partners like EPRI and its members on a facilitated path to market adoption. Case Study 4 highlights some examples.

Case Study 4: EPRI - Utility Engagement

Per stages shown in the technology readiness level (TRL) diagram, EPRI engages its utility members in cultivating applied innovation through scouting and exploration (TRL1-3), in developing applications through lab validation and testing (TRL4-5), and then in accelerating commercialization through pilot testing and demonstration (TRL6-7) and coordinated early deployment (TRL8). New connections developed through the Incubatenergy Network are leading to a growing number of EPRI scouting and application studies, pilot projects, and larger programs helping startups advance technology readiness in partnership with utilities and other stakeholders active in various stages along the clean energy innovation pathway.

Bidgely, fostered by Energy Excelerator, has participated in EPRI laboratory research and is partnering with several utilities around the world to deploy its non-intrusive load monitoring system. Chai Energy, emerging from LACI, is working with PG&E, SDG&E, and SCE to employ a smart metering app to increase grid-edge flexibility in California. Ibis Networks, also supported by Energy Excelerator, is running a program with over 1,000 plug-load management devices deployed across three university campuses. UtilityAPI, accelerated by Powerhouse and helped by Energy Excelerator, has deployed its data collection solution with utilities such as National Grid, Pepco, and Xcel Energy.

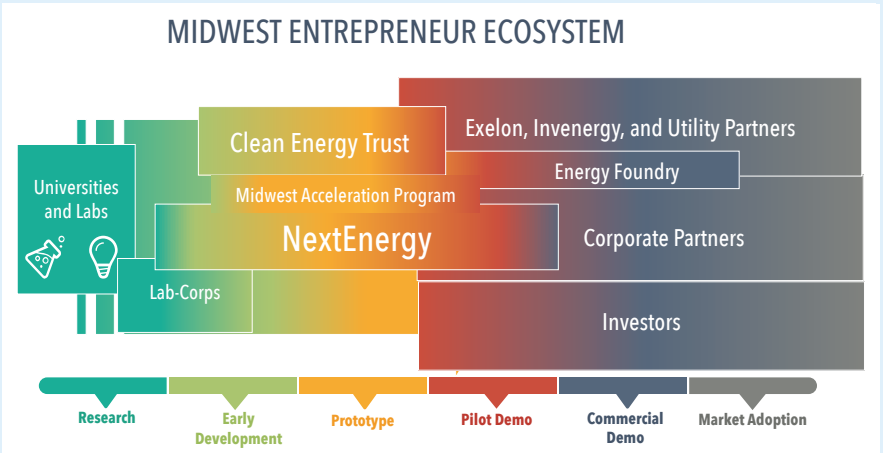
ConnectDER, supported by Energy Excelerator, is running pilot programs for its plug-and-play PV interconnection technology with Arizona Public Service, Austin Energy, Hawaiian Electric, and National Grid. AllCell Technologies, fostered by CET, is working with EPRI to test a phase-change material developed to manage heating within lithium-ion battery systems as a possible option for standalone high-efficiency thermal energy storage applications. Shifted Energy, helped by Energy Excelerator, has run tests of its water heater preheating system for storage of renewable energy in an EPRI-Hawaiian Electric pilot.

Through EPRI, utilities, other energy companies, and additional members pool funding to support research, development, and demonstration projects across all aspects of electricity production, delivery, and utilization. Collaborative work often includes government support and involves technical teams spanning EPRI staff scientists and engineers, utility and other experts, major equipment vendors, and additional key commercialization partners.

More than 10 startups supported by Incubatenergy Network members have engaged in technology development and demonstration projects supported by EPRI members. Several were featured at the network's August 2016 meeting in Los Angeles. Additional collaborative projects are being pursued.

Building Clean Energy Ecosystems

Strong regional clusters of clean energy innovation like those shown in Figure 5 have emerged across the United States, complementing national efforts to support entrepreneurs. Incubator programs serve a natural convening role because of their position in the middle of the development cycle and their reach into both the research and deployment phases.



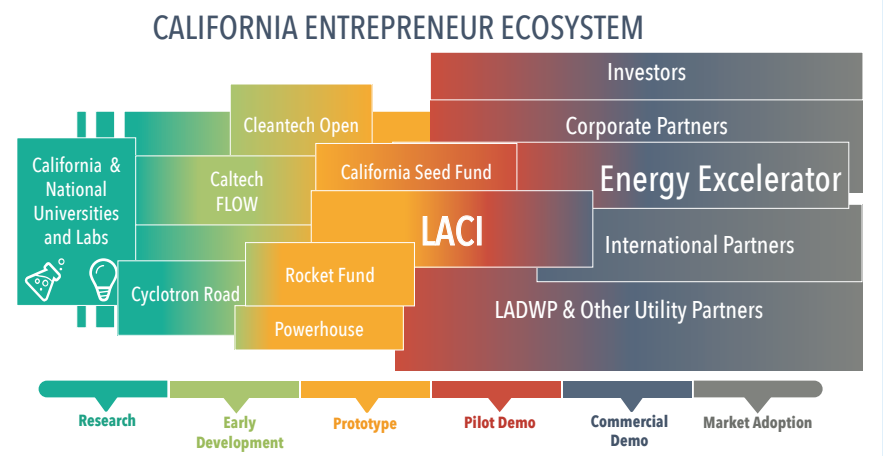


Figure 5 – Sample Regional Clean Energy Clusters

CET, Oregon BEST, and some other leading incubators offer formal connector programs, while organizations such as the New England Clean Energy Council and CleanTx exist largely to build regional momentum. Collaboration and cross-fertilization among diverse stakeholders and organizations help strengthen overall support plus avoid duplication of effort.

Listed below are six geographic clusters with existing incubators at the center:

- **Northeast**: Greentown Labs & ACRE
- **Southeast**: CLT Joules
- **Southwest**: ATI
- **Midwest**: CET & NextEnergy
- **Rocky Mountain**: Innosphere
- **West**: LACI, Energy Excelerator, ProspectSV, Powerhouse, Cyclotron Road & Oregon BEST

As shown in Figure 5 for the U.S. Midwest, CET in Chicago and NextEnergy in Detroit connect with research stakeholders, represent main players in technology development, and support tech transfer with utilities and others later in the process. University and lab programs such as I-Corps Energy & Transportation are available to help early-stage entrepreneurs take their research into the development stage. Case Study 5 highlights the innovation pathway followed by SiNode Systems and SkySpecs.

As shown in Figure 5 for California, entrepreneurs at national labs and universities may flow into earlier-stage incubator and accelerator programs such as the Cleantech Open, Cyclotron Road, FLoW, and Powerhouse. LACI typically supports development at later stages, while Energy Excelerator, investors, corporations, and other partners help bring technologies to market within the state, in other states, and internationally. Case Study 6 characterizes the ecosystem providing support to FreeWire Technologies.

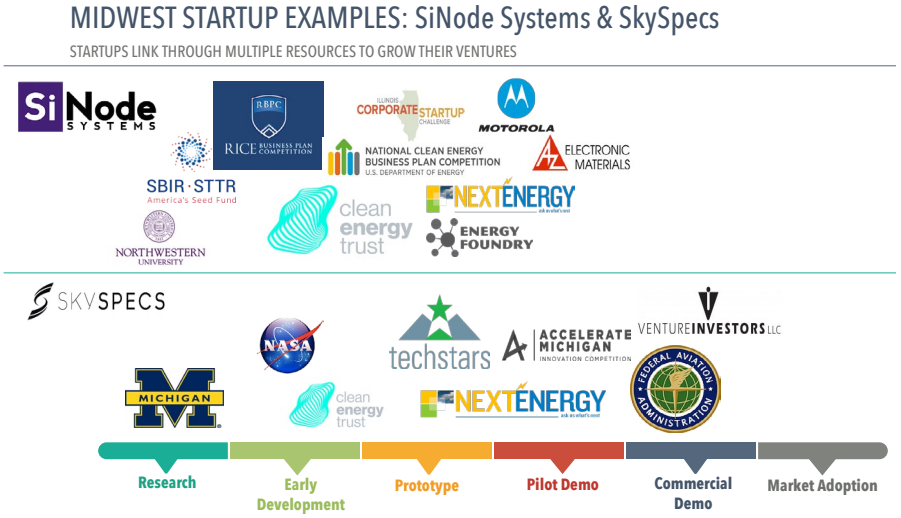
The Incubatenergy Network has, to date, been quite successful in encouraging greater collaboration between leading incubators and accelerators around the country, as well as in strengthening their connections to national agencies and organizations. For example, Greentown Labs recently announced a strategic partnership with Oregon BEST and has established similar relationships with LACI and others.

Robust innovation clusters exist in some U.S. regions, but others are less well organized. Expanding and extending connector programs, events, and resources could help encourage greater development of regional ecosystems and stronger collaboration between them.

The Incubatenergy model also could be applied regionally and nationally to increase coordina-

Case Study 5: SiNode Systems & SkySpecs

SiNode Systems is developing advanced materials for the next generation of lithium-Ion batteries. Supporters include universities and labs, several incubator and accelerator programs, government agencies, and large corporations. SkySpecs makes drones for inspecting wind turbines, transmission lines, and other large structures. After emerging from University of Michigan, the startup has been fostered by federal funding, incubators, accelerators, and investors as it moves into commercial demonstration.

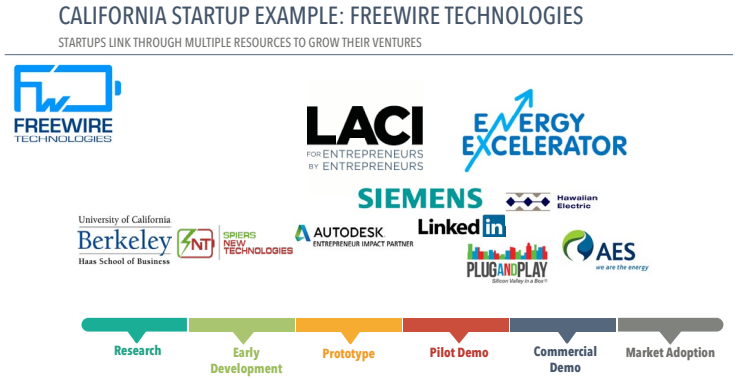


tion for groups such as universities, foundations, institutional investors, and corporate partners across clean energy, high technology, and other industries. Adding an international component to the overall strategy for strengthening the U.S. clean energy ecosystem represents another opportunity.

For example, KIC InnoEnergy—a commercial enterprise that brings together utilities, universities, research institutes, and other entities to support entrepreneurs in several European countries—attended the August 2016 Incubatenergy Network meeting and is working to build new partnerships through the network and with its members. Also, Energy Excelerator and EPRI recently collaborated to introduce Shifted Energy, FreeWire Technologies, and other startups to utilities in Asia through a demonstrator event held in Korea. Other invited startups included AutoGrid Systems, which provides an application program interface for distributed resource integration, and BK Litec, which makes smart high-efficiency light bulbs.

Case Study 6: FreeWire Technologies

FreeWire Technologies, which offers mobile EV charging systems, has been supported primarily through the western regional clean energy ecosystem. Along the path to commercialization, the company received support first from University of California Berkeley and another technology developer, next transitioning to LACI for incubation services. Energy Excelerator then selected the Mobi charging unit for demonstration project funding in pilot deployments engaging utilities and customers in Hawaii and Asia. The company is now working to partner with large corporations around the world.



Incubatenergy Network members are interested in continuing to expand their reach by developing partnerships with other organizations around the world.

Conclusion

Successful clean energy entrepreneurs follow many different paths and, often, an iterative process as their innovative solutions journey through the research, development, and deployment phases. Typically, tech transfer support is provided by diverse organizations—starting with universities and labs, then on to incubators, accelerators, public-private funding sources, corporate partnerships, and others. The biggest challenge is to bridge the "valley of death" and advance technologies through the prototyping and piloting stages.

Since its launch in early 2015, the Incubatenergy Network has demonstrated that bringing together leading incubators, building on support networks existing around the country, and expanding collaboration among regional and national stakeholders can help strengthen the U.S. clean energy innovation ecosystem.

Partnering with incubators and support networks around the world—and creating opportunities for U.S. entrepreneurs to access these resources—promises similar benefits.

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ABOUT

The Incubatenergy Network is a community of clean energy incubators distributed around the country, working together to share best practices and build connections for supporting the entrepreneurs who are driving innovation in the energy industry.

The network is supported with funding from the U.S. Department of Energy and the Electric Power Research Institute (EPRI), managed in partnership with the National Renewable Energy Laboratory (NREL).

RESOURCES

www.incubatenergy.org

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