

Innovative Commercialization Efforts Underway at the National Renewable Energy Laboratory

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ABSTRACT

New clean energy and energy efficiency technology solutions hold the promise of significant reductions in energy consumption. However, proven barriers for these technologies, including the technological and commercialization valleys of death, result in promising technologies falling to the wayside. To address these gaps, NREL's Innovation & Entrepreneurship Center designs and manages advanced programs aimed at supporting the development and commercialization of early stage clean energy technologies with the goal of accelerating new technologies to market. These include:

- **Innovation Incubator (IN²) in partnership with Wells Fargo:** this technology incubator supports energy efficiency building-related startups to overcome market gaps by providing access to technical support at NREL
- **Small Business Voucher Pilot:** this program offers paid vouchers for applicants to access a unique skill, capability, or facility at any of the 17 DOE National Laboratories to bring next-generation clean energy technologies to market
- **Energy Innovation Portal:** NREL designed and developed the Energy Innovation Portal, providing access to EERE focused intellectual property available for licensing from all of the DOE National Laboratories
- **Lab-Corps:** Lab-Corps aims to better train and empower national lab researchers to understand market drivers and successfully transition their discoveries into high-impact, real world technologies in the private sector
- **Incubatenergy Network:** the Network provides nationwide coordination of clean energy business incubators, share best practices, support clean energy entrepreneurs, and help facilitate a smoother transition to a more sustainable clean energy economy
- **Industry Growth Forum:** the Forum is the perfect venue for clean energy innovators to maximize their exposure to receptive capital and strategic partners. Since 2003, presenting companies have collectively raised more than \$5 billion in growth financing.

INTRODUCTION

The National Renewable Energy Laboratory (NREL) is a national laboratory funded primarily by the Department of Energy's, Office of Energy Efficiency and Renewable Energy (EERE). NREL develops clean energy and energy efficiency technologies and practices, advances related science and engineering, and provides knowledge and innovations to integrate energy systems at all scales. NREL is unique from the other in two primary ways; NREL is the only single mission EERE focused laboratory, NREL is also an applied laboratory, meaning innovation is focused on direct market impact. This emphasis has resulted in a robust set of innovation commercialization efforts at the laboratory, particularly within the Innovation and Entrepreneurship Center (IEC).

NREL’s IEC fosters the acceleration of renewable energy and energy efficiency technologies into the marketplace by connecting lab resources with the clean energy ecosystem. Additionally, IEC creates an innovative and entrepreneurial environment at NREL that enables seamless engagement with industry allowing for direct feedback from potential customers and/or acquirers of the technology regarding possible successful technology exit scenarios.

TECHNOLOGICAL AND COMMERCIALIZATION VALLEYS OF DEATH

Much if not all of IEC’s work efforts are designed with two significant obstacles in mind, specifically financing gaps, often referred to as Valleys of Death (VoDs): the (early stage) technological and (later stage) commercialization VoDs (see Figure 1). While obtaining financing can be an obstacle for most innovative technologies, the challenge is particularly acute in the energy sector (Jenkins and Mansur 2011).

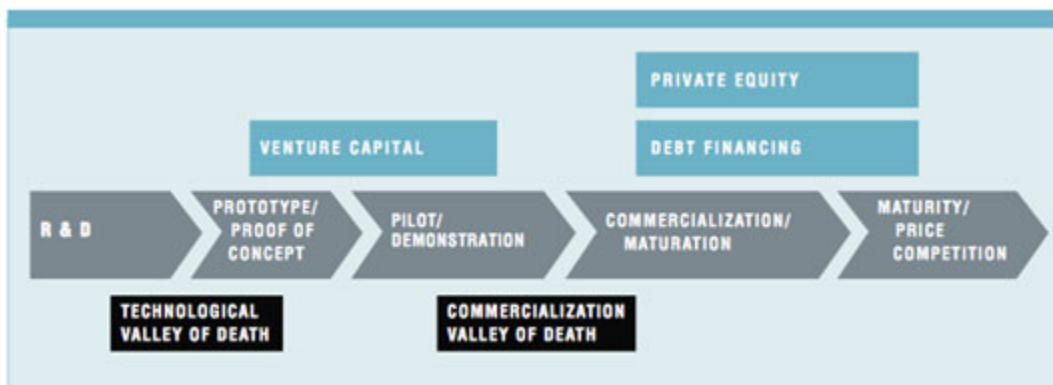


Figure 1. The energy innovation cycle and the clean energy valleys of death
Source: Jenkins and Mansur 2011.

The technological VoD occurs early in the innovation and development process, as entrepreneurs conduct research and require capital to develop, test, and refine technologies. It is in this phase that entrepreneurs demonstrate product and market viability to private funders. This stage is characterized by high technical, market, and management risks as well as long development horizons. The second challenge emerges with the commercialization VoD, which exists between the demonstration and commercialization phases of development. It reflects the gaps between the traditional role of VCs and those of other project financiers and later stage debt/equity investors (Jenkins and Mansur 2011). Because project financiers typically seek to finance commercial-scale projects only for proven technologies with less risk, the commercialization VoD can increasingly prove an insurmountable barrier. This is particularly true for technologies that have successfully completed the proof-of-concept stage, but still require large capital investments to demonstrate design and manufacturing capabilities for full-scale commercialization. The combined effect of these financing challenges ultimately results in promising clean energy innovations never making it to the marketplace.

IEC PROGRAMS - NEW PATHWAYS FOR ACCELERATING CLEAN ENERGY COMMERCIALIZATION

IEC as a Convener

Many IEC programs seek to utilize the Lab's convening power to connect key ecosystem stakeholders and data within the clean energy community to help ensure a greater probability of early-stage success. As an independent third party, with such rigorous expertise in research and development, as well as testing and validation, NREL is an authority within the space and operates as a convener within the clean energy ecosystem. The following programs create platforms from which to bring together ecosystem participants to find out who has the interest, capabilities, and financing needed to support emerging technologies and startups through the commercialization process.

Colorado Center for Renewable Energy Economic Development (CREED)

CREED, formed in 2012, is a joint effort between the State of Colorado, NREL, and affiliated stakeholders who are devoted to clean energy economic development. Through its role in CREED, NREL catalyzes clean energy and energy efficiency innovation and entrepreneurship in Colorado by offering direct access to the local cleantech ecosystem and relevant stakeholders. CREED stakeholders include government partners, universities, industry associations, incubators, venture capital organizations, and small businesses. Together they act as a hub of knowledge for the cleantech ecosystem and provide programmatic support within the region.

CREED stakeholders, currently comprised of over 26 organizations from across the state, meet on a quarterly basis to discuss timely industry-related topic areas, share latest happenings and explore opportunities for collaboration. By gathering and sharing information on a regular basis, the CREED network also offers the opportunity to identify duplicative efforts early on among stakeholders and determine solutions or partnering strategies. For example, two CREED stakeholders recently joined forces to jointly host their annual awards celebrations as exposure to one another's attendee profile enriched the networking objectives. This forms new relationships and gives wider exposure to startups and other key ecosystem stakeholders.

NREL's Industry Growth Forum (IGF)

Now in its 20th year, the IGF is the nation's premier event for emerging clean energy and energy efficiency startups to gain exposure to and feedback from venture capitalists, corporate investors, government agencies, and strategic partners. The forum offers startup presentations, panels led by industry leaders, one-on-one meetings with investors, and technology accelerator workshops.

Since 2003, over 350 companies have presented their business theses to a group of top investment firms, entrepreneurs, and executives. These companies represent a wide range of clean energy innovations such as solar and wind technologies, advanced engine and renewable fuels, and advances in building efficiency and energy storage. Exposure to the right investment

community and industry stakeholders is a key tenet to making the IGF a successful event. Since 2003, these presenting companies, collectively, have raised over \$5 billion in growth financing since presenting.

NREL Investor Advisory Board (IAB)

The NREL IAB, made up of 25 investors representing diversity across the investment spectrum, is an excellent resource for sourcing entrepreneurs. Many of the members' firms have Executive-in-Residence (EIR) programs in addition to personal networks comprised of clean energy professionals with experience in the startup space looking for their next endeavor. NREL convenes the IAB on a quarterly basis to provide the Lab a window into the investment community and to provide investors insights into the latest developments, findings, and innovations in renewable energy and clean technology research. Additionally, the Lab provides the IAB with insight into next generation clean energy research.

The relationship between the IAB and NREL has been mutually beneficial to both organizations while helping to overcome commercialization barriers. We've seen this impact first hand as investors have provided guidance and mentorship to NREL lab-corps teams, referred companies to the IN2 program that have ultimately been selected for participation, and invested in companies featured at the IGF.

Incubatenergy Network

A partnership between the Electric Power Research Institute (EPRI) and NREL, funded by the Department of Energy, the Network launched in 2015 to provide nationwide coordination among clean energy business incubators. U.S. clean energy incubators support entrepreneurs in many ways, providing access to mentorship, workspace, funding opportunities, corporate partnerships, and more. Their highly selective screening processes and high-value support services can lead to greater success for early-stage clean energy companies, helping promising technologies to more quickly demonstrate their value, scale up production, and gain mass adoption.

The Incubatenergy Network convenes and connects incubators across the nation to help identify best practices for supporting entrepreneurs, as well as to create a platform to share information about and further support member program offerings and portfolio companies, upcoming events and opportunities where the network members may be aligned to partner.

Though still in its relative infancy, the Incubatenergy Network is actively helping startups overcome commercialization challenges through creating a wider, more robust network. Members of the Incubatenergy Network have enhanced their partnerships and signed Memorandums of Understanding in order to create mechanisms to better support their companies. These incubators often support the same companies at different stages of development, based on need. These relationships strengthen the support for startups to bridge the

commercialization challenges they face. Based on their reported metrics, incubators in the network have supported more than 350 companies and have collectively received over \$1 billion in follow-on funding.

IEC as a Connector

In addition to playing a convening role in the ecosystem, NREL's IEC acts as a portal for entrepreneurs and industry to access the Lab's many resources, includes capabilities, expertise, facilities and equipment. Navigating the Lab to find the appropriate points of contact can be overwhelming and time consuming. The IEC helps facilitate introductions on a daily basis through numerous mechanisms, with the greatest mass impact occurring through the following programs:

NREL's Commercialization Assistance Program (NCAP)

NCAP helps emerging companies overcome technical barriers to commercializing clean energy technology by providing invaluable access to NREL researchers for assistance with testing, analysis, and insight on emerging technologies. This program also offers NREL researchers the unique opportunity to engage with clean energy startups in their early stages of development, paving the way for future partnership and licensing opportunities. The program provides up to 40 hours of a NREL researcher's time free of charge to a company to support a specific current technical challenge. In FY15 NREL helped 28 companies through its Commercialization Assistance Program by providing 661 hours of in-kind staff time, worth more than \$65,000 in value.

Department of Energy Lab-Corps Program

NREL leads the DOE Lab-Corps program, launched in 2015. This program aims to train and empower National Laboratory researchers to better understand the market application of technologies they are developing within the laboratory. This is done through extensive training coupled with customer discovery interviews, allowing the teams to develop a deep understanding of industry needs and pain points. Researchers are then able to take this real world perspective back to the laboratory. The intension of the program is to foster a spirit of entrepreneurial thinking within the laboratory, as well as target DOE funded research to be even more applied to industry wants and needs in the clean tech space. DOE Laboratories across the country are able to send teams to participate in this 7 week program.

The second cohort of Lab-Corps teams has recently completed the program, bringing the total number of graduating teams to 28 at the time this paper was written. The program is widely regarded as a successful initiative and has secured funding for multiple upcoming rounds.

Small Business Voucher (SBV) Pilot Program

Through the SBV pilot program, eligible small businesses can tap into the thought leadership of National Laboratory intellectual and technical assets to overcome critical technology and commercialization challenges such as:

- prototyping,
- materials characterization,
- high performance computations,
- modeling and simulations,
- intermediate scaling to generate samples for potential customers,
- validation of technology performance, and
- designing new ways to satisfy regulatory compliance.

Selected projects receive between \$50,000 to \$300,000 to fund National Laboratory researchers work with small businesses in order to create and commercialize new and improved products and processes. The pilot program launched in late September 2015. In March 2016, 33 small businesses were selected for the first of three rounds. The department's Office of Energy Efficiency and Renewable Energy will invest nearly \$6.7 million under Round 1 of the new Small Business Vouchers (SBV) pilot. These partnerships between clean energy small businesses and DOE National Laboratories help promote economic development and American innovation by pairing DOE's unparalleled laboratory resources and expertise with small business drive and creativity.

While it is too early to see long-term impacts of the SBV program, we anticipate the customized approach of this program will help provide small businesses the right tools, leveraging the DOE National Laboratories, to overcome their own unique and specific commercialization challenges. Awards for Round 1 of the SBV pilot were awarded to 33 small businesses and totaled approximately \$6,675,000 in funding. At the time this paper was written the program was accepting applications for Round 2.

The Wells Fargo Innovation Incubator (IN²)

The Wells Fargo Innovation Incubator (IN²) Program is a unique platform designed to foster and accelerate early stage commercial buildings technologies that provide scalable solutions to reduce the energy impact of commercial buildings. Founded in 2014, IN² is funded by the Wells Fargo Foundation and co-administered by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL). This exclusive program provides awardees with funded access to NREL and the potential to beta test their technology within the Wells Fargo portfolio.

IN² Process:

Through a competitive and diligent three-stage review process, select early stage companies are formally invited into the program where they receive up to \$250k in technical assistance from the laboratory and project related support. Participating companies have access

to NREL's world-class researchers and facilities, and they spend a period of time further developing, testing, validating, and/or incubating their technologies at NREL to help them meet key validation milestones on their path to commercialization.

Applicants to this program are strategically sourced through a pre-selected group of channel partners. These channel partners consist of universities, Cleantech business incubators, and other partners actively engaged in the Cleantech community. This system allows IN² to source the most promising technologies as well as provides added value for the channel partners to pass on to their portfolio companies. This method further enhances the robust and targeted support within the clean energy community.

Selected companies also receive access to Wells Fargo financial services, products, education and mentorship, and ultimately an opportunity to potentially beta test their technology within the Wells Fargo footprint. The potential beta test is mutually beneficial as it allows the awarded company the opportunity to test their technology in a real world setting to see exactly how it performs and it allows Wells Fargo the opportunity to deploy leading edge clean energy and energy efficiency technologies within their building envelope.

In line with this emphasis, IN² accepts applications within the following areas of technical focus:

- Energy efficiency
- Net zero-energy
- Lighting
- Windows, skylights, doors
- Indoor air quality
- Waste reduction
- Materials efficiency
- Space heating & cooling
- Sensors and controls
- Plug loads
- Operations optimization
- Energy modeling
- Water data & analysis software
- Buildings water management and treatment

The IN² platform is seeking to support various stages of emerging clean technologies categorized into three tiers: Tier 1; Bench Scale, Tier 2; Prototype, and Tier 3, Commercially-Ready. The goal is to help each tier meet critical milestones to help them advance to the next stage — ultimately helping them in their quest toward commercialization.

The IN2 program is successful as a culmination of five crucial stakeholder groups.

1) NREL. The world-class researchers, facilities, and expertise within NREL provides awardees with the technical support they need to bridge the VoDs. Work is primarily performed within the NREL Commercial Buildings group, however it also spans other groups and expertise across the lab, including residential buildings, analysis, materials, and chemistry and

nanoscience. Through this program, awarded companies gain access to expertise and facilities that may be out of reach otherwise. Tier 1 and 2 companies are able to access NREL expertise to potentially further develop and enhance their innovation while Tier 3 companies in the program, obtain third party testing and validation from NREL which is crucial for a potential Wells Fargo beta and to obtain further investment from financiers.

2) Wells Fargo. The Wells Fargo Foundation has committed to strong environmental goals, including a \$100 Million commitment to support environmental grants. Much of the success of the IN² program can be attributed to a dedicated partner willing to encourage, fund, and potentially open their facilities to leading edge clean energy and energy efficiency technologies.

3) Channel Partners. The robust ecosystem of universities, Cleantech business incubators, and other stakeholders is a vital part of this program. These channel partners supply IN² with highly credible applicants that have worked with these leading organizations. Opportunities such as IN² also contribute to the long list of benefits that channel partners can offer their portfolio companies.

4) External Advisory Board. Applications move through three rounds of review, with the final selection made by an IN² External Advisory Board. The board is made up of 11 experts within the commercial buildings space. These board members have key insights into the market viability of applicant technologies, thus increasing the likelihood of successful commercialization of these technologies.

5) Innovative applicants. The entrepreneurial community is consistently offering clean energy and energy efficiency technologies that have the power to be truly disruptive. The commercial building technologies that have applied to the IN² program span the areas of program focus. The awardees and applicants to the program reflect the robust clean energy and energy efficiency opportunity.

The IN² program is designed around core NREL capabilities, both technical and partnership, paired with Wells Fargo Foundation funding, interests, commitments, and resources. This program allows the co-administrators the opportunity to impact the ecosystem in a unique and innovative way.

Since the program launched, 10 companies have been invited to the program. In 2014, four companies were invited into the program during Round 1 (see Figure 2). In 2015, six more companies were invited in Round 2 (see Figure 3). For Round 3, an additional 8 companies will be invited in fall 2016.

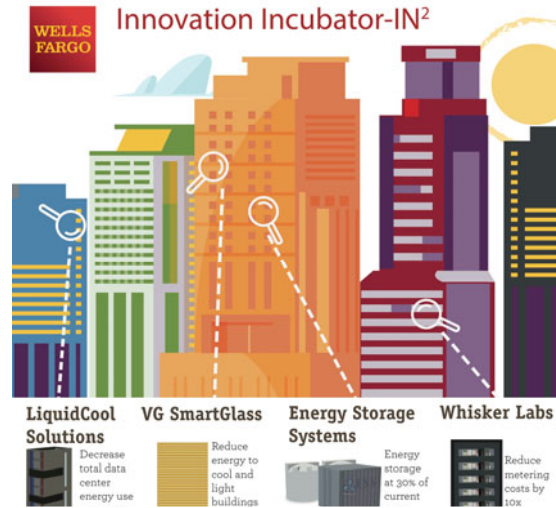


Figure 2: Wells Fargo Innovation Incubator (IN²) Round 1 awardees



Figure 3: Wells Fargo Innovation Incubator (IN²) Round 2 awardees

CONCLUSION

NREL’s Innovation & Entrepreneurship Center is actively applying lessons learned to improve our current programs to further support startups in their journey to commercialization. IEC intends to continue creating impactful programs and look for new partners, innovative program structures, and opportunities to further leverage the Lab’s unique resources and capabilities in order to best support a transition to a clean energy economy.

References

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