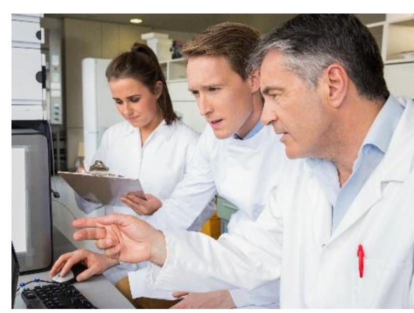
Energy I-Corps Program: Year 1 Process and Impact Evaluation

Final Report

November 28, 2016



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Notice

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Acronyms and Abbreviations

ANL	Argonne National Laboratory
ARPA-E	Advanced Research Projects Agency-Energy
COI	Conflict of interest
CRADA	Cooperative Research and Development Agreement
DOE	U.S. Department of Energy
EERE	DOE Office of Energy Efficiency and Renewable Energy
EL	Entrepreneurial Lead
IM	Industry Mentor
INL	Idaho National Laboratory
IP	Intellectual property
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
MOU	Memorandum of Understanding
MTA	Material Transfer Agreement
NFS	Non-federal sponsors
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
ORNL	Oak Ridge National Laboratory
ORTA	Office of Research and Technology Application
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
SBIR	Small Business Innovation Research program
SBV	Small Business Voucher pilot
SPP	Strategic Partnership Projects
STTR	Small Business Technology Transfer program
SNL	Sandia National Lab
TTO	Technology Transfer Office
WFO	Work for Others Agreement

Glossary

This glossary defines terms whose usage may be specific to Energy I-Corps. The glossary also serves as a primer on key Energy I-Corps concepts and activities. All terms are explained as they pertain to the first Energy I-Corps training, in the fall of 2015. The participating laboratories (labs) continue to refine the pilot, and so details may change over time.

Business model canvas (BMC)	A framework used in lean startup practices; the business model canvass is a summarized business model that lets one look at nine building blocks of a business on one page. Essentially, this is a diagram of how a company creates value for itself and its customers. The BMC is a key component of the Energy I-Corps training curriculum.
Cohort	A term used to designate one group among many in a study. In this report, the first cohort is the group of lab scientists and engineers that participated in the fall 2015 Energy I-Corps training.
Conflict of interest (COI)	A personal, professional, organizational, or financial relationship or interest that unduly affects the impartiality of a party. Conflicts of Interest can be actual (i.e., a relationship exists that affects a party's impartiality) or apparent (i.e., a relationship does not actually result in a conflict, but the nature of the relationship is such that a third party with an understanding of the facts would have cause to question the impartiality of a party to the relationship).
Continual feedback	Method used by instructors in Energy I-Corps training in which the instructors interrupt and give feedback during teams' presentations.
Cooperative Research and Development Agreement (CRADA)	A collaborative agreement that allows the Federal Government, through its labs, and non-federal partners to optimize their resources, share technical expertise in a protected environment, and access intellectual property emerging from the effort. CRADAs offer both parties the opportunity to leverage each other's resources when conducting mutually beneficial research and development (R&D).

Curriculum development	Energy I-Corps curriculum was built off the fundamentals of I-Corps. Throughout the pilot, Node and Site Labs continue to hone the curriculum based on what they find is needed and effective in the lab environment.
Customer discovery	A process in which innovators (in this case, participating technology teams) conduct in-depth interviews with potential customers and other market contacts to obtain feedback relevant to how their innovation might be received in the market. In response to such feedback, innovators can refine their innovations to increase their market appeal. This process is the core of the Energy I-Corps curriculum; it takes the teams out of the building and perhaps out of their comfort zone. First cohort teams were challenged to conduct 10 to 15 interviews per week.
Entrepreneurial Lead (EL)	Leads the technology team's investigation, through interview research, into customer requirements and the commercial landscape and assists in development of commercialization next steps.
Entrepreneurial leave	The breadth and depth of Entrepreneurial Leave Programs (ELP) at the national labs differ. ELP enables lab employees to take a leave of absence (or establish the terms of separation) to start or join a company commercializing a new technology. ELPs may be structured to reduce some of the job security risks facing employees considering entrepreneurship by guaranteeing a job at the lab if returning within well-defined constraints. ELPs establishing terms of separation typically provide only partial assurance that the employee can return to a job.
Faculty	The first cohort Energy I-Corps training had six instructors, three designated as "core faculty" and three as "adjunct faculty."
First cohort training	Fourteen technology teams participated in the first Energy I-Corps training, held in Denver, Colorado, October-November 2015; in this report, also referred to as the fall 2015 training.

Go/no-go decision	Lean LaunchPad describes the customer discovery process as leading to a go/no-go decision for the innovation. Commercialization necessitates a market willing to purchase the innovation at a price that exceeds the cost to provide it, with a market size sufficient to warrant the investment. The customer discovery process results in a no-go decision when there does not appear to be such a market for the innovation.
I-Corps	The National Science Foundation's Innovation Corps (I-Corps) – innovation training on which Energy I-Corps was modeled.
Industry mentor (IM)	Provides business and commercialization guidance to the technology team's Principal Investigator and Entrepreneurial Lead. Selected IM's had extensive industry experience directly or indirectly related to the team technology, and may have been a lab employee or been employed by industry.
Industry Night	A "speed dating-like" event consisting of visitors from relevant industries engaging in quick one-on-one conversations with pilot teams, augmenting the teams' customer discovery activity.
Innovations	See "technology"
Intellectual property (IP)	Intellectual property (IP) refers to creations of the mind, such as inventions, literary and artistic works, designs, and symbols, names, and images used in commerce. Lab IP that transfers to the commercial sector is commonly patented and licensed.
Lab	A DOE national laboratory.
Lean LaunchPad®	A technology and startup development approach codified by Steve Blank that uses the business model canvas to develop a minimum viable product and customer discovery to explore market receptiveness and conditions.
Lean startup	A method of scientifically testing hypotheses about a possible new technology or product using interviews with customers. One such method is called Lean LaunchPad method.
Material Transfer Agreement (MTA)	An MTA is a contract that governs the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes. The MTA defines the rights of the provider and the recipient with respect to the materials and any derivatives.

Michigan NSF I-Corps training	NSF I-Corps Energy and Transport Regional Program at the University of Michigan in May-June of 2015. Three Energy I-Corps pilot teams attended this training, along with Energy I-Corps pilot management staff and Energy I-Corps faculty, as part of the Energy I-Corps curriculum development process.
Minimum viable product	In product development, the minimum viable product is a product sketch with just enough features articulated to gather validated learning about the product's market potential to inform its continued development.
No-go decision	See go/no-go decision.
National Science Foundation (NSF)	The National Science Foundation (NSF) is the primary Federal agency supporting research at the frontiers of knowledge, across all fields of science and engineering (S&E) and all levels of S&E education. It developed and conducts I-Corps training, which trains university-affiliated innovators.
Node Lab	The National Renewable Energy Laboratory (NREL) serves as the primary implementer (node) for the Energy I-Corps pilot by designing the curriculum, leading pilot efforts, and supporting the participating labs and technology teams.
Office hours	The Energy I-Corps faculty holds "office hours" at night following the training so that teams can get one-on-one assistance.
Pivot	A term from Lean LaunchPad that describes a substantial change made to a business model canvas in response to customer discovery interviews.
Post-docs	Post-doctoral researchers employed by the labs.
Principal investigator (PI)	Serves as technology team's technical lead and overall project manager.
SBIR	The Small Business Innovation Research Program (SBIR) is a highly competitive program that encourages domestic small businesses to engage in federal research and/or research and development (R/R&D) that has the potential for commercialization. (See STTR, below, and Appendix G.2.7.)

SBV	Small Business Voucher pilot provides U.S. small businesses with unparalleled access to the expertise and facilities of DOE's national labs by awarding to competitively selected small businesses vouchers valued between $50,000 and $300,000 to cover the cost of lab services.
Site Lab	Labs that sends technology teams to the Energy I-Corps training. For the fall 2015 training, NREL was both the Node Lab and a Site Lab.
SPP	Strategic Partnership Projects (the successor to WFO; see below) is a policy to encourage and facilitate DOE and the national labs to pursue projects in partnership with other federal government agencies, state and local institutions, universities, private companies, and/or foreign entities.
Startup	A newly formed business enterprise. Lean LaunchPad provides a more descriptive definition: A temporary organization used to search for a repeatable and scalable business model.
STTR	Small Business Technology Transfer (STTR), like SBIR, expands funding opportunities in the federal innovation research and development (R&D) arena. Unlike SBIR, it requires small businesses to formally collaborate with a research institution. STTR's role is to bridge the gap between the performance of basic science and commercialization of resulting innovations. (See Appendix G.)
Technology	In this study, "technology" refers to the innovations developed by the training teams and encompasses hardware, software, and methods.
Technology Readiness Level	Technology Readiness Level (TRL) is a widely-used indicator of degree of development of a technology toward validation at commercial scale in the actual operating environment; degree of development is described on a scale of 1-9, with 9 being fully deployment ready.
Technology team	The team of lab innovators that participate in the training.
Technology transfer	The process by which technology or knowledge developed in one place or for one purpose is applied and used in another place for the same or different purpose.

Technology Offices (also known as Program Offices)	EERE develops research agendas and directs and funds research through its Technology Offices (TO): Advanced Manufacturing Office (AMO), Bioenergy Technologies Office (BETO), Building Technologies Office (BTO), Fuel Cells Technology Office (FCTO), Geothermal Technologies Office (GTO), Solar Energy Technology Office (SETO), Vehicle Technologies Office (VTO), Water Power Technologies Office (WPTO), and Wind Energy Technologies Office (WETO).
Technology Transfer Offices (TTO)	Offices in federal labs staffed with "highly competent technical managers" who are "full participants [along with the innovating scientist or engineer] in the technology transfer process." They are empowered to develop and promote the key partnerships necessary for technology transfer.
User facility agreement	Agreement enabling businesses or universities engaged in areas of commercial and basic science research to use facilities at all DOE national labs with approved designated user facilities.
WFO	Work for Others (WFO) was the predecessor to SPP. WFO was a policy to enable national labs, which are owned and directed by DOE, to partner on projects with other (non-DOE) entities.
Value proposition	Articulation of the value – in words and, ideally, in dollars – the technology offers the target market, including an identification of the bundles of products and services being offered to the potential customer and the problems solved or benefits offered.
Viable product	Viable products are products anticipated to yield a positive revenue stream. The Site Labs selected technology teams to participate in Energy I-Corps for technologies they believed showed promise of being, after further development, viable.

Executive Summary

Energy I-Corps (formerly Lab-Corps), one of a handful of U.S. Department of Energy programs within the National Laboratory Impact Initiative, is intended to accelerate the commercialization of clean energy technologies from DOE national laboratories (labs). The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) provided $2.3 million (fiscal year 2015) for the Energy I-Corps pilot and launched the pilot August 14, 2014 with a request for lab participation.

This report, conducted by an independent evaluator, documents the pilot's design, first-round (fall 2015) training, and baseline conditions. It provides findings on pilot early outcomes and processes, identifies lessons learned, and offers recommendations. The outcomes assessment objectives are three-fold:

- **Learning:** Assess the extent to which the pilot training increased lab researcher understanding of the commercialization process and private sector needs.
- **Commercialization:** Assess the extent to which the pilot advanced team technologies in the commercialization process (over time, to increase the number of national lab-developed technologies that are transferred into commercial development or industry agreements).
- **Institutional Support:** Assess the extent to which the pilot strengthened lab institutional support for researcher commercialization activities.

The longer-term outcomes for commercialization are not assessed in this evaluation.

This report is based on findings from:

- Baseline and follow-up surveys with lab researchers participating in the first training,
- Baseline and follow-up surveys with nonparticipating lab researchers selected to serve as a comparison group,
- Baseline and mid-training interviews with lab pilot managers,
- Follow-up interviews with instructors and DOE managers,
- Onsite observation of the training and of the subsequent debriefing held by lab pilot managers,
- Informal interviews with pilot managers, researchers (principal investigators [PIs], entrepreneurial leads [ELs], and industry mentors [IMs]), and faculty during the onsite training,
- Lab pilot proposals, and
- Analysis of lab technology transitions metrics (2010-2015), which DOE compiles from lab-provided information in compliance with the annual reporting requirements set forth by the Stevenson-Wydler Technology Innovation Act, 15 U.S.C. § 3710(f)(2).

The Energy I-Corps pilot continues through 2016; developments beyond cohort 1 (December 2015) are outside of this report's purview and are not reflected in its findings.

PILOT DESCRIPTION

In October 2014, two months after it launched the pilot with a request for lab participation, EERE announced their Node Lab and Site Lab pilot participant selections. Through a merit-reviewed competitive process, EERE selected the National Renewable Energy Laboratory (NREL) to serve as the Node Lab (in essence, the pilot implementation contractor) and the following to serve as Site Labs (key lab pilot participants): Argonne National Laboratory (ANL); Idaho National Laboratory (INL); Lawrence Berkeley National Laboratory (LBNL); Lawrence Livermore National Laboratory (LLNL), in partnership with Sandia National Laboratory-California (SNL); and Pacific Northwest National Laboratory (PNNL). This report uses the term "lab pilot managers" to describe pilot managers from both Node and Site Labs.

Selected teams of lab researchers (including technology Principal Investigators, or PIs) participate in a training that takes a scientific approach to commercialization by guiding teams in developing and testing key hypotheses relating to the technology's commercialization. Throughout the six-week training, teams engage in an experiential customer discovery process through which they test their commercialization hypotheses by interviewing relevant contacts within their target market. The pilot design borrowed heavily from the National Science Foundation's (NSF) successful Innovation-Corps (I-Corps) program, which in turn was patterned on the respected Lean LaunchPad® model of commercialization.

The Node Lab and the six Site Labs, plus Oak Ridge National Laboratory (ORNL), sent 14 teams of researchers to the first Energy I-Corps training, held in October/November 2015. These 14 teams comprise the first Energy I-Corps training cohort (cohort 1). This evaluation assesses pilot activities through December 2015. The labs sent their second cohort of teams to training March/April 2016 and simultaneously requested applicants for the third and fourth cohorts; those activities are not addressed by this evaluation.

Within two to four months of their selection by DOE as pilot lab participants, the labs announced the Energy I-Corps opportunity to their research staff. Each lab approached team selection differently. One Site Lab went so far as to conduct a two-month commercialization training (February and March 2015) and selected its teams based on their performance during that training. Most of the labs held a pitch competition of some sort to select teams. Labs began announcing selected teams by early April and all teams were selected by mid-July. The labs sent three of the selected teams to NSF Innovation-Corps (I-Corps) training, on which Energy I-Corps is modeled, mid-May to mid-June 2015, which the Node Lab and selected Energy I-Corps faculty also attended in preparation for developing a unique Energy I-Corps curriculum. The cohort 1 onsite training began October 11, 2015. For two weeks prior, the Node Lab engaged the teams in webinars and reading assignments to prepare them for the intensive onsite training. In addition to these Node-organized training activities, some of the lab pilot managers engaged their teams in additional preparatory work in the months leading up to the training.

KEY FINDINGS

The evaluation team, in its peer-reviewed technical evaluation plan, developed performance metrics by which to gauge the pilot's progress in achieving its desired outcomes. The metric findings suggest the pilot has met with first-year success. The study findings address only early stage outcomes and process lessons. The findings are organized as follows: learning outcome findings, commercialization findings, institutional support findings, process findings, lessons learned, and recommendations.

Learning Outcomes Findings

Evaluation findings on learning outcomes suggest early pilot success. As evidenced by the findings below, the pilot is reaching its goal of increasing researcher understanding of the commercialization process and private sector needs.

1. **Energy I-Corps training increased trainees' understanding of the commercialization process.** The great majority (92%) of trainee survey respondents indicated substantial increases in their understanding of market needs related to their technologies and 83% reported increases in their understanding of the various potential commercialization routes, significantly higher than the gains reported by comparison nonparticipants (33% and 33%, respectively). The proportion of trainees indicating they understood the technology commercialization process increased to 87% following the training, from 13% prior to the training, a statistically significant increase and significantly different from changes reported by nonparticipants over the period. The cohort 1 findings indicate the Energy I-Corps training is highly effective in substantially increasing teams' understanding of the five facets of the commercialization process most directly relevant to their needs as researchers. These most relevant activities, for which teams' baseline and follow-up survey responses showed statistically significant increases in strong understanding of the activity, include:
   - **Value Proposition**: Team principal investigator (PI) trainees increased their ability to articulate and investigate their technology's value proposition (baseline proportion of respondents indicating strong understanding: 60%; follow-up: 100%; a statistically significant difference).

- **Customer Segments**: PI trainees reported statistically significant gains in their ability to discover whether initially targeted customer segments are likely to find the technology valuable, and how to discover additional potential markets (baseline: 30%; follow-up: 100%).
- **Customer Relationships**: PI trainees increased their understanding of how to attract and keep new customers (baseline: 30%; follow-up: 80%; a statistically significant difference).
- **Key Partners**: PI trainees increased their knowledge of potential key partners, suppliers, and their activities, such as identifying distribution channels (baseline: 20%; follow-up: 67%; a statistically significant difference).
- **Key Activities**: PI trainees increased their understanding of the commercialization continuum and the progression of needed activities. (baseline: 10%; follow-up: 50%; a statistically significant difference).

2. **Nonparticipants had an opportunity to learn some of the concepts taught by Energy I-Corps through three routes** – during the application process as they made the case to be selected for the training, after the selection of trainees as they pursued on their own interests that were piqued during the application process, and from trainees who shared some of the learnings with their lab colleagues.
3. **Trainees' increase in understanding of the commercialization process exceeded that of nonparticipants.** The two groups' baseline understanding was similar, ruling out (although not definitively) a rival explanation that the trainees' own characteristics, rather than the training, that led to the reported knowledge gains.
4. **Trainees received less training in revenue streams, cost structure, and key resources** (due to constraints imposed by a training period that is shorter than necessary to fully address all **business model canvas [BMC]** elements), and showed smaller increases in learning in these areas.
5. **Teams averaged about 70 customer discovery interviews with a variety of stakeholders** (potential customers, partners, suppliers, etc.), meeting the training goal of 50 to 100 interviews per team.
6. **Training led to technology pivots and refinements.** Engagement in Energy I-Corps training results in pivots (major changes) and refinements to researchers' conceptions of what the technology offers to whom (its value proposition), including pivots and refinements to the technology itself.
7. **All teams created, for the first time in team members' careers, a BMC and, over the course of training, increased BMC quality and viability.** All teams showed evidence of refining their BMCs throughout customer discovery, as well

as pivots in one or more areas. Teams identified next steps that included determining appropriate pivots.

8. **Final BMCs varied in quality and viability,** reflecting differences both in starting points for teams (clarity of technology's value proposition to an identified target market) and in team progress over the training.
9. **Most teams made "go" decisions, indicating they believed customer discovery activities confirmed some degree of market appeal for the technology as currently envisioned.** Only one of 14 teams reported a "no-go" decision, suggesting the technology would need additional pivots to obtain market appeal, and two teams reported they did not know whether their technology was a "go."
10. **More than 80% of trainees are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of subsequent innovations.**

Commercialization Findings

Findings suggest Energy I-Corps has very high potential to increase the commercialization of a trained PI's lab technologies. However, at this early stage research for which data collection ended one month after training, we could only access in a limited way the extent of trainees' commercialization activities. Teams expressed challenges in further progressing toward commercialization.

1. **Trainees are positioned for continued commercialization activities.** The majority (83%) of trainees responding to the follow-up survey appear to be positioned for continued commercialization activities. They indicated they have a go-to-market strategy for their technology that includes target customer segments, channels, and pricing tactics and/or the appropriate licensing partner to get to market. The majority (89%) of those who reached a "go" decision reported it likely that they would continue commercialization activities on their pilot technology during the three months following the pilot. About half (56%) of nonparticipants also reported that they were likely to continue commercialization activities, but the proportion was statistically lower than that of PI trainees.
2. **Lab pilot managers anticipate that perhaps 5 of the 17 teams trained in 2015 (14 cohort 1 Energy I-Corps teams, plus 3 NSF I-Corps teams) were well positioned to begin launching their technologies in the next year.**

3a. **There is no evidence of advancement in pilot technologies' Technology Readiness Level (TRL)** during Energy I-Corps training, a finding that conforms to expectations given that training activities do not encompass technical research. However, many trainees reported they plan to refine their research agendas based on their customer discovery.

3b. **The study was unable to assess the extent to which cohort 1 trainees engaged during Energy I-Corps training in commercialization activities beyond those included in the curriculum.** Although the baseline and follow-up survey we administered sought to assess commercialization activities, we did not find the follow-up survey responses credible, as trainees indicated they had conducted activities during the six-week training that seem at best unlikely, due to the time required for the activity, or which we understand did not occur. Commercialization is a lengthy process, and lab pilot managers and instructors indicated that commercialization activities generally are expected to occur in the years following training. Most trainees and pilot managers expressed enthusiasm for commercialization activities and anticipate continuing to engage in them following the training.

4. **By the end of training, teams' technology value propositions had received varying degrees of validation.** The most advanced teams, characterized by validated value propositions, still have a lot of work remaining to transfer their technologies to the private sector, which they might undertake or partner with another entity to undertake. Most teams received encouraging customer discovery feedback that enabled them to evolve their value propositions, yet still lack fully validated value propositions. These teams need additional technology and target market refinements. Few teams received mostly discouraging customer discovery feedback and at the end of training were struggling to articulate a value proposition and associated target market. These teams need substantial pivots to their technologies and target market plans.

5. **Trainees indicated they face challenges in further progressing toward commercialization.** Some challenges trainees indicated include lack of certainty regarding lab institutional support, inconsistent lab management support, lack of or insufficient commercialization funding to accomplish planned Energy I-Corps-taught activities, lack of sufficient training on final commercialization steps (that is, revenue streams, cost structure, and key resources), and insufficient understanding of lab-specific commercialization policies. For trained team members to apply their training throughout their careers, across their research contracts, they need sources of funding to charge time spent in customer discovery and related activities.

6. **Trainees reported a better understanding for their technologies' commercialization positioning than did nonparticipants**. PI trainees were statistically more likely than nonparticipants to report in follow-up surveys that they understand their technologies' value proposition (100% versus 44%), have a clear understanding of who makes the buy decision and the attributes considered

(100% versus 56%), and understand the next three steps needed to commercialize their technology (91% versus 22%).

Institutional Support Findings

The variation across labs in pilot implementation and involvement with other efforts to stimulate commercialization activities (such as CRADAs and Agreements for Commercializing Technology), make it difficult to come to clear conclusions of changes in institutional support. Other sources of variation in Labs and their contexts include differences in organization and coordination of commercialization activities, financial and time resources to support commercialization, commercialization expertise of researchers and TTO staff, technology area strengths, and proximity to relevant markets (geographic location).

Given that caveat, early findings suggest some small institutional change via information sharing and some slight improvement in lab institutional support for commercialization activities, commensurate with the initial period of a small pilot.

1. **Trainees shared knowledge with nonparticipants.** Two-fifths (41%) of respondents reported having shared, by the end of the pilot, the ideas from the Energy I-Corps experience with groups and individuals in their labs. Ninety percent of nonparticipants reported they learned some Energy I-Corps concepts from their trainee colleagues. Lab pilot managers reported plans for increased outreach for future trainings, including articles in internal lab newsletters, case studies, email blasts, and website content.
2. **Lab's institutional support for commercialization activities has strengthened in small ways.** Respondents including trainees, lab pilot managers, and staff in labs' Technology Transfer Offices (TTO) and related departments supporting the lab pilot managers reported some increase in institutional support for commercialization activities.

   Individual researchers gained greater understanding of commercialization activities, which pilot managers recognized. Pilot managers also credited the pilot training with transforming their thinking and observed first-hand considerable growth in their teams' understanding and capabilities.

   Some trainees reported informing their senior research managers about the activities and benefits of training. Pilot managers described plans to more widely promote Energy I-Corps benefits throughout their labs.

   Some pilot managers recognized that lab TTO staff would benefit from the training and were considering, at the end of the first cohort training, including a TTO staff person on subsequent technology teams.

All pilot managers reported their lab management was aware of and supportive of the pilot. A few lab senior research managers publicly expressed their assessment that Energy I-Corps offered high value to the labs.

3. **There is no evidence that trainees understand their lab's commercialization policies or fully know their lab's institutional supports for commercialization next steps.** Trainees were aware of the following kinds of commercialization supports, however only 13% of trainee respondents believed lab staff commonly take advantage of the commercialization-support resources their labs offer.
   - Education, mentorship, or opportunities to interact with peers (70% aware)
   - Financial incentives such as returning a portion of royalties to researchers or offering entrepreneurial leave (63% aware)
   - Partnerships with individuals or organizations outside of the lab (54% aware)
4. **There is no evidence of substantial non-pilot support provided to teams.**
5. **Lab pilot managers identified barriers and approaches in their pilot proposals.** Managers explicitly described barriers to commercialization and approaches to mitigating them through and because of their pilot participation. Identified barriers related to:
   - **The focus of lab research**: DOE's research agendas do not include the development activities needed to take a technology to commercialization.
   - **The management structure of lab research**: Lab senior and mid-level managers and senior research staff might be reluctant to embrace commercialization activities for two related reasons: concern that time spent on commercialization (including Energy I-Corps participation) may decrease productivity on research contracts, and concern over attrition ("brain drain").
   - **The external environment in which the labs operate**: Labs' local economies, proximity to areas active in the commercialization sphere, and interactions and exchanges with labs' commercialization networks can all support, or conversely, pose barriers to lab technology commercialization.
6. **Both trainees and nonparticipants indicated a need for additional resources or funding for time to support commercialization activities**.
7. **Energy I-Corps has good alignment with trainees' professional goals and moderate alignment with their performance assessment.** More than 90% of trainee follow-up survey respondents believed the activities they learned through Energy I-Corps are a good fit with their professional goals, although 39% believe the activities align with how their lab management assesses their performance.

Process Findings

The pilot infrastructure – spanning curriculum development, faculty selection and guidance, team formation and support, partner engagement, and pilot promotion – appears to be working well.

1. **It appears the Energy I-Corps training increased trainees' knowledge, understanding, and ability to continue commercialization efforts.** Compared to nonparticipants, trainees were more likely to report statistically significant increases in their understanding of Energy I-Corps concepts. Trainees also were statistically more likely than nonparticipants to report that they would carry out commercialization activities in the short- and longer-term.
2. **Trainees were highly satisfied with the training.** Ninety-two percent of trainees reported the Energy I-Corps training exceeded their expectations. About 95% agreed or completely agreed that they understand their technologies' value proposition, the next steps for their team to continue commercialization activities, and what market actors would make decisions to buy their technology. All or most respondents agreed the various training methods were appropriate to the training objectives.
3. **The training demands a substantial time commitment from trainees, and thus has some negative affect on trainees' concurrent research activities.** Nearly two-thirds (65%) of trainee follow-up survey respondents described their workload as increasing *substantially* during the six-week training compared to their typical workload prior to training. Respondents on the same team generally provided identical or similar responses. Labs with more than one team had consistent assessments of their experiences with the workload. Half (52%) of trainee follow-up survey respondents described their Energy I-Corps related work as having a *significant* negative impact on their ability to meet ongoing responsibilities during the six weeks. In addition, 22% of respondents indicated the converse – that their other lab work had a *significant* negative impact on planned Energy I-Corps activities.
4. **Trainees offered suggestions for improving the training.** Trainee follow-up survey respondents provided suggestions to improve the Energy I-Corps training, most commonly referring to the curriculum and content of the training (50%) and course length/organization (42%). The specific open-ended suggestions varied; the most commonly offered suggestions were to increase the training length to 12 weeks (17%) and provide concrete examples and techniques/best practices for interviewing (17%).
5. **The labs have established respectful, collaborative working relationships.** Interactions among lab pilot managers were characterized by mutual respect for

others' expertise, opinions, and contributions, respectful acknowledgement of lab differences, and a strong willingness to work together to meet pilot challenges. Pilot managers shared approaches and lessons learned at a December debriefing meeting held for that purpose.

6. **Each lab pilot manager was supported by a team (typically TTO staff).** All labs and trainees developed new and deepened existing partnerships throughout the training, through customer discovery, Industry Night (which brought in contacts from the business community relevant to the teams' technologies), and other activities. Two labs involved partners closely in team formation and preparation.

Lessons Learned

The key lessons learned from the pilot development activities and operations concern the pilot's organizational structure, the curriculum, the faculty, and the teams.

1. **The Node and Site Lab structure of the Energy I-Corps pilot appears to be working well, consistent with I-Corps' experience.** The Site Labs appreciate Node Lab leadership. Labs have established collaborative working relationships and are learning from each other and their own training experiences.
2. **Additional targeted lab-provided training prior to the start of the onsite training, as well moving into that targeted training period material included in the cohort 1 initial onsite sessions, might improve teams' performance, especially during the first half of the training.**
3. **Minor changes to curriculum content and delivery would improve the training.** These changes include: reduced emphasis on and discussion of startups as a key commercialization pathway, greater consistency on the elements of the business model canvas across presentations, and increased lab guidance (and consistency of guidance) of teams on discussing proprietary aspects of their work, both with interview contacts and with other teams during training exercises.
4. **Competent faculty are key to pilot cohesiveness and success.**
5. **Faculty compensation is low compared to the experts' opportunity costs.** Low faculty compensation may jeopardize: faculty long-term participation, quality and commitment of faculty, and Energy I-Corps' long-term viability.
6. **A balance between autonomy and guidance is needed.** Lab pilot managers and cohort 1 faculty appreciated that the Node offered faculty latitude in the information they presented and their style of trainee engagement. Nonetheless both groups thought subsequent trainings would benefit from greater Node direction.

7. **Recruiting external (non-lab staff) team members in the roles of entrepreneurial leads (ELs) and industry mentors (IMs) involves a trade-off.** External talent augment teams' expertise and experience, and can be a source of new ideas and contacts. However, the lab pilot managers described challenges in vetting external parties during the team selection process and in holding them accountable during the training period, especially because they were not paid for their time. A drawback to the use of external talent is the lost opportunity to train an additional lab researcher and to have that researcher share his or her learning with colleagues.
8. **Team selection criteria were not uniform across labs.** Lab pilot managers suspected more uniform selection criteria across the labs might result in an enhanced learning environment for the cohort.
9. **More institutional support and involvement of TTOs is needed.** For Energy I-Corps to noticeably affect technology commercialization rates and lab institutional support for commercialization, participating labs might benefit from developing a plan to increase involvement of the TTOs. Trainees need additional information on commercialization pathways available to lab researchers, the resources available to them after the training, and how to work with their TTOs to access the resources. Some lab pilot managers concluded the labs would derive benefit from adding a fourth position to the teams – a TTO staff member.
10. **Several teams appearing the least motivated indicated they believed their labs were not interested in or supportive of commercialization, and so it was not worth it to them to extend a lot of effort during the training.** This lesson, if validated by subsequent cohort experiences, suggests it would be beneficial for labs to discuss with teams the latter's perspectives of lab support for commercialization, clear up any misconceptions, and reiterate lab support. Findings suggest that researchers' views of lab support are influenced by the senior research managers they report to as much, and perhaps more than, their views are influenced by lab policies.
11. **Trainees' knowledge gain is likely insufficient in and of itself to increase lab technology commercialization in the absence of increased institutional support (funding, assistance, policies)**.

Recommendations

1. **DOE should engage in a process to bring clarity to the issues related to program design that challenge Energy I-Corps' ability to meet its long-term goals**, including considering such things as:
   - How many researchers would it like to train each year?

- What degree of commercialization activity can labs undertake and remain consistent with their mission and non-compete constraints?
- To what extent does DOE want to incorporate a customer discovery process in its research agendas?
- What are desired characteristics of the technologies considered within Energy I-Corps, including level of technology readiness?
- What magnitude of DOE and lab resources should be devoted to the customer discovery necessary for commercialization activities?
- What might be unintended negative consequences from scaling up these activities (that is, training, customer discovery, and other commercialization activities)?

2. **DOE and the Node and Site Labs should make plans to increase the size of Energy I-Corps to some defined scale.** The business model canvas taught by Energy I-Corps provides a framework for this activity. Several questions would need to be considered.
    - What offices and groups within DOE constitute target markets?
    - What is the value proposition for each of those markets?
    - What is the cost structure?
    - What are the revenue streams/funding mechanisms?
    - Who are the key partners and what resources do they offer?
    - What channels and approaches work best for reaching lab PIs?
    - What channels and approaches work best for obtaining lab management and senior research manager support, demonstrating that training benefits exceed the costs of diversion from existing project deadlines and brain drain?
3. **DOE should maintain the Node Lab and Site Lab structure, which includes monitoring, evaluation, and feedback,** and have confidence that the participating labs are following continual improvement best practices.
4. **Consider expanding the curriculum for training to include revenue streams, cost structure, and key resources,** considered by some to be important downstream elements of the commercialization process. The labs would have to address constraints imposed by the additional time necessary to introduce these components to the training.
5. **DOE should continue tracking cohort 1 and its comparison group for an additional one or two years to assess the mid-term effects of Energy I-Corps that are not detectable after one year.** This would include metrics such as: new CRADAs, funding received from market actors, new material transfer agreements, new licenses, entrepreneurial leave (EL) taken, startups launched, and commercialized technologies. However, given the very small proportion of

lab researchers trained through the pilot, a difference of differences evaluation (one that compares the percentage change of trainees and comparison-group nonparticipants) might be unlikely to detect an Energy I-Corps impact unless participating labs have substantially revamped their technology transfer support activities. As of this report's publication date, DOE has started implementing this recommendation, in part.

6. **DOE must increase institutional support** by recognizing the challenges, frame the extent of outcomes desired, and match its activities, resources and policies to meet the challenges sufficiently. These DOE actions are necessary to attain desired outcomes of training more researchers, transferring more technologies to the market, and influencing labs to increase their support for commercialization.
7. **DOE should identify funding for Energy I-Corps**, to enable it to transition to scale, and to assure labs of the program's longevity as they consider how to best support it.
8. **Participating labs need to recognize that scientists need lab support to conduct customer discovery and subsequent commercialization activities,** and to develop their strategy and plans to provide such commercialization support while still satisfying their research missions. This support could take the form of funded time for staff to pursue customer discovery and subsequent commercialization activities, take Energy I-Corps training, etc.
9. **Lab TTOs need greater involvement in Energy I-Corps and to provide more institutional support for trainees.** For Energy I-Corps to noticeably affect technology commercialization rates and lab institutional support for commercialization, participating labs might benefit from developing a plan to increase involvement of the TTOs.

Section 1 Introduction

Energy I-Corps (formerly Lab-Corps), one of a handful of U.S. Department of Energy programs within the National Laboratory Impact Initiative, is intended to accelerate the commercialization of clean energy technologies from DOE national laboratories (labs).[1] The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) provided $2.3 million (fiscal year 2015) for the Energy I-Corps pilot and launched the pilot August 14, 2014 with a request for lab participation.

This report, conducted by an independent evaluator, documents the pilot's design, first-round (fall 2015) training, and baseline conditions. It provides findings on early outcomes and processes, identifies lessons learned, and offers recommendations.

The longer-term outcomes for commercialization are not assessed in this evaluation. This report is based on findings from:

- Baseline and follow-up surveys with lab researchers participating in the first Energy I-Corps training,
- Baseline and follow-up surveys with nonparticipating lab researchers selected to serve as a comparison group,
- Baseline and mid-training interviews with lab pilot managers,
- Follow-up interviews with instructors and DOE managers,
- Onsite observation of the training and of the subsequent debriefing held by lab pilot managers,
- Informal interviews with pilot managers, researchers (principal investigators [PIs], entrepreneurial leads [ELs], and industry mentors [IMs]), and faculty during the onsite training,
- Lab pilot proposals, and
- Analysis of lab technology transitions metrics (2010-2015), which DOE compiles from lab-provided information in compliance with the annual reporting requirements set forth by the Stevenson-Wydler Technology Innovation Act, 15 U.S.C. § 3710(f)(2).

1.1 ENERGY I-CORPS PILOT OVERVIEW

Energy I-Corps is a DOE-funded pilot intended to accelerate the commercialization of clean energy technologies from DOE national laboratories (labs). EERE's Technology-to-Market program provided $2.3 million (fiscal year 2015) to launch what was then termed the Lab-Corps pilot, and received FY 2016 and FY 2017 funding to continue operations. Energy I-Corps trains selected lab scientists and engineers in techniques to

[1] For a description of these programs see http://energy.gov/eere/technology-to-market/national-laboratory-impact-initiative

accelerate technology commercialization. Training occurs in a group setting with extensive individual coaching and feedback provided by experienced entrepreneurs.

At the one-year mark, EERE hoped the pilot would increase understanding of the commercialization process among teams of trained researchers (including an increased appreciation for, and understanding of, private sector needs for the teams' technologies), have participating teams know the next steps needed to move their technologies along the commercialization continuum, and strengthen participating labs' institutional support for commercialization activities.

Broader goals (beyond year one) of the Energy I-Corps pilot as stated in EERE's request for lab participation, are:[2]

1. Train national lab researchers to better understand the commercialization process and private sector needs;
2. Increase the number of national lab-developed technologies that are transferred into commercial development or industry agreements; and
3. Transform national lab culture to value commercialization and entrepreneurial activities.

As the pilot progressed, EERE revised the third goal from transforming lab culture to "strengthen and focus the entrepreneurial spirit driving our nation's top scientific minds in the pursuit of a more sustainable and secure energy future."[3] This revised third goal was set after the peer-reviewed technical evaluation plan and data collection for the study was completed.

Like the National Science Foundation's (NSF) I-Corps model,[4] Energy I-Corps consists of a Node Lab (which provides overall pilot management and implementation), selected Site Labs (participating labs), faculty, and technology teams from Site Labs that receive commercialization training and funding to cover lab staff time engaged in commercialization activities. The Node Lab acts as a central point of contact for both the Site Labs and EERE, ensuring that Site Labs successfully select and support qualified teams and that EERE remains informed of Site Lab activity and progress.

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[2] Laboratory Call Issue Date – August 14, 2015. *Lab-Corps Call for Proposals_Aug 2014.pdf*

[3] Private communication from EERE to the evaluation team, received October 11, 2016.

[4] Energy I-Corps is modeled on the National Science Foundation's (NSF) successful Innovation Corps (I-Corps) program. NSF's I-Corps has trained more than 300 teams (primarily from academia), resulting in more than 125 startup companies created and a higher than average rate of receipt of further funding (such as Small Business Innovation Research [SBIR] grants) for follow-up on research and technology development (R&D). Ten Advanced Research Projects Agency-Energy (ARPA-E) teams have successfully completed I-Corps since 2013. The National Institutes of Health (NIH) completed a successful I-Corps pilot in December 2014.

After issuing a request for lab participation in August 2014 and completing a merit-reviewed competitive process, in October 2014 EERE announced its selection of the participating Node Lab and Site Labs.[5] EERE selected the National Renewable Energy Laboratory (NREL) to serve as the Node Lab and the following national labs as Site Labs: Argonne National Laboratory (ANL); Idaho National Laboratory (INL); Lawrence Berkeley National Laboratory (LBNL); Lawrence Livermore National Laboratory (LLNL), in partnership with Sandia National Laboratory-California (SNL); and Pacific Northwest National Laboratory (PNNL).[6]

With modest inter-lab coordination facilitated by the Node Lab, each Site Lab used its own approach and criteria for team selection;[7] however, all pilot teams are composed of the following team members:

- Principal Investigator (PI) – Serves as technical lead and overall project manager.
- Entrepreneurial Lead (EL) – Leads the investigation, through interview research, into customer requirements and the commercial landscape, and assists in development of commercialization next steps.
- Industry Mentor (IM) – Provides business and commercialization guidance to the PI and EL.[8]

Selected teams participate in a training that takes a scientific method approach to commercialization by guiding teams in developing and testing key hypotheses relating to the technology's commercialization. The six-week training consists of a three-day onsite opening session, weekly web-based sessions, and a two-day onsite closing session.[9] The onsite sessions included a mixture of lectures, workshops, team presentations, and group and individual feedback; the web-based sessions were primarily team presentations with feedback. Throughout this training, teams engage in an experiential customer discovery process – "get out of the building!" is a refrain of the training – through which teams test their commercialization hypotheses.

The Energy I-Corps pilot conducted its first training in October-November 2015.

Table 1-1 provides the timeline for the Energy I-Corps pilot through end of cohort 1.

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[5] *Lab-Corps Call for Proposals_Aug 2014.pdf* EERE announced selected labs in October 2014.

[6] For more info on the participating labs, see Appendix D *Site Lab Descriptions of Their Team Selection Approaches*.

[7] NREL and Oak Ridge National Laboratory (ORNL) also sent teams to the first training.

[8] Selected IM's had extensive industry experience directly or indirectly related to the team technology, and may have been a lab employee or been employed by industry.

[9] This structure describes the first training (fall 2015); subsequent trainings may have a different structure due to continuous improvement activities undertaken by the Node Lab.

Table 1-1: Energy I-Corps Pilot Timeline through End of Cohort 1

Date	Description
Spring 2014	EERE provided $2.3 million (fiscal year 2015) to launch Energy I-Corps pilot
August 14, 2014	Laboratory Call for Proposals for labs to participate in Energy I-Corps pilot
September 26, 2014	Submission date for lab pilot proposals
October 2014	EERE conducted merit review of lab proposals
October 29, 2014	EERE announced at Industry Growth Forum its selection of participating Node Lab and Site Labs
November 2014 to April 2015	Node and Site Labs conduct initial preparation for pilot involvement; Site Labs prepare to solicit teams for training, culminating in announcing Energy I-Corps opportunity to their research staff
Early April to mid-July 2015	Labs announced team selection; pilot-funded teams selected by April, additional lab-funded teams added in summer
Mid-May to mid-June 2015	Labs sent three teams to NSF I Corps training, hosted by NextEnergy and University of Michigan
October 11 to Nov 19, 2015	Cohort 1 onsite training
December 4, 2015	Node and Site Lab debriefing meeting on cohort 1 training

This Energy I-Corps evaluation study of Cohort 1 began in February 2015, with data collection ending March 2016. The labs sent their second cohort of teams to training March/April 2016 and simultaneously requested applicants for the third and fourth cohorts; those activities are not addressed by this evaluation.

1.2 CONTEXT FOR THE ENERGY I-CORPS PILOT

The 17 DOE national labs are home to world-class scientists, engineers, and managers and house unique, advanced instruments. These intellectual and technical assets have solved critical national challenges and originated many inventions and other intellectual property that have significantly improved human lives.

Promising discoveries and innovations at the lab bench cannot effectively address energy challenges unless and until they are successfully transferred to the marketplace for further development or as commercial products and services. EERE collected input from a wide array of stakeholders about the barriers to, and opportunities for, increasing the commercial impact of the national labs.

The U.S. DOE EERE seeks to increase the overall effectiveness and impact of all EERE activities through key crosscutting initiatives and strategic analyses, communications, and technology-to-market activities, which includes the National Laboratory Impact Initiative, under which the Energy I-Corps pilot is being conducted. Through the Lab Impact Initiative, launched in December 2013, EERE aims to substantially increase the impact the national labs have on the U.S. clean energy sector. The Lab Impact Initiative aligns with President Obama's 2011 directive to accelerate technology transfer,[10] as well as with the Technology Transfer and Commercialization Act of 2000, to accelerate the transfer of federally funded research and innovation to the private sector and thereby generate a greater return on taxpayer investment.[11,12]

Based on stakeholder input and published research, EERE identified factors that currently limit the commercial impact of lab research, including:

- The ability of staff to pursue commercialization-related activities;
- Lab culture related to pursuing the commercialization of innovations;
- Lab policies facilitating entrepreneurship; and
- The degree to which lab staff perceive a sense of urgency about commercial impact.[13]

Based on this input, EERE identified several opportunities that could be addressed through a commercialization training and accelerator program. These findings, and NSF's I-Corps experience – with which DOE was familiar, contributed to the development of the Energy I-Corps pilot.

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[10] Presidential Memorandum -- Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses, 2011, *https://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali*

[11] This paragraph incorporates phrasing describing the U.S. DOE EERE and the Lab Impact Initiative appearing on the site *http://energy.gov/eere/about-us/office-strategic-programs accessed February 2016*.

[12] According to the Technology Transfer and Commercialization Act of 2000, "It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nation's Federal investment in research and development. To this end the Federal Government shall strive where appropriate to transfer federally owned or originated technology to State and local governments and to the private sector." From *Report on Technology Transfer and Related Technology Partnering Activities at the National Laboratories and Other Facilities, Fiscal Years 2009-20013,* Report to Congress, U.S. Department of Energy *http://energy.gov/sites/prod/files/2016/02/f29/FY%2009-13%20Annual%20Report%20on%20Technology%20Transfer_0.pdf*

[13] See Science and Technology Policy Institute. 2011. *Technology Transfer and the Commercialization Landscape for Federal Laboratories,* Institute for Defense Analysis. IDA Paper NS P-4728, 2011.

1.3 ENERGY I-CORPS PILOT DESCRIPTION

Energy I-Corps is a technology accelerator and commercialization training curriculum specifically tailored to the needs of researchers in national labs who have developed potentially marketable technologies. The Energy I-Corps pilot (specifically, the initial fall 2015 training) is focused on clean energy technologies. Through Energy I-Corps, Site Labs support entrepreneurial-focused technology teams to identify and pursue market applications for their technologies through direct engagement with industry, entrepreneurs, and investors.[14]

1.3.1 The Training

Energy I-Corps seeks to accelerate successful technology transfer by implementing a commercialization training model that modifies the respected Lean LaunchPad® entrepreneurship curriculum.[15] The Node Lab sought to tailor the Energy I-Corps curriculum to the unique features of the labs to enable lab researchers to pursue a variety of commercialization pathways that extend beyond startup development to include industry agreements, technology licensing, and other partnerships with the private sector. The Node continues to refine the curriculum based on training experiences.

True to its Lean LaunchPad roots, the Energy I-Corps training course instructs and critiques training participants (hereafter, trainees) as they examine nine areas – components of a business model considered necessary to commercialize a new technology:

1. **Key Partners:** Identification of key partners, suppliers, their activities, and the resources acquired from them.
2. **Key Activities:** Identifying distribution channels, revenue streams, and customer relationships.
3. **Value Proposition:** Articulation of the value – in words and, ideally, in dollars – the technology offers the target market, including an identification of the bundles of products and services being offered to the potential customer and the problems solved or benefits offered.
4. **Customer Relationships:** Articulation of how to attract and keep new customers, how customers are integrated into the business model, and how costly the relationships with customers are.

[14] In this study, "technology" refers to the innovations developed by the training teams and encompasses hardware, software, and methods.

[15] See Steve Blank, "Why the Lean Start-Up Changes Everything," *Harvard Business Review,* May 2013. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything

5. **Customer Segments:** Identification of customer archetypes and for whom the technology creates value.
6. **Key Resources:** Identification of key resources required, their distribution channels, and revenue streams.
7. **Channels:** Identification of the channels through which customers are reached, which channels work best, and which channels are most cost-effective.
8. **Cost Structure:** Identification of most important costs and which key resources and activities are most expensive.
9. **Revenue Streams:** Development of the revenue model, pricing tactics, and estimation of customers' willingness to pay for the technology.

Together, these nine areas comprise what is termed the *business model canvas* (BMC). They also comprise a minimum viable product – a product sketch with just enough features articulated to gather validated learning about the product's market potential to inform its continued development.

In its initial formulation, the BMC contains a series of hypotheses specific to the technology about market players, needs, and conditions. Through a process termed *customer discovery* (with "customer" broadly denoted to encompass all relevant market players) teams seek to confirm the hypotheses. Teams adjust (small and large adjustments, the latter known as "pivots") to the BMC in response to findings. Throughout the process, teams identify new hypotheses in response to their increasing understanding of the market, in line with the adage "the more you know, the more you know what you don't know."

1.3.2 The Pilot

The pilot enables DOE and the national labs to test innovative approaches to lab commercialization support. Through the pilot and its coincident evaluation (the findings from which are reported here), DOE and the labs are gathering and analyzing data on quantitative and qualitative metrics to identify lessons learned so that Energy I-Corps can be optimized for possible subsequent larger-scale implementation within DOE, including multiple program offices and mission areas. Thus, evaluation is built into the pilot's implementation.

The participating labs assemble, train, and support entrepreneurial teams to identify private sector opportunities for commercializing lab technologies in the areas of energy efficiency, renewable power, and sustainable transportation.

Each team is paid to participate in the training, an element critical to the success of the pilot as lab researchers need to account for all their time by billing to established charge codes. Pilot participation could be billed to an associated charge code up to a maximum of $75,000 for the team.

The Node Lab and Site Labs also receive funding to conduct pilot and team management activities, $550,000 for the Node Lab (to cover staff time and direct costs such as facility rental for onsite training and hotel rooms for training attendees) and $200,000 for each Site Lab for a 12-15-month performance period.

1.3.3 2015 Pilot Activities

Following lab selection, the Node Lab organized a kick off meeting for participating labs, engaged in a blog and other networking tools, and lead conference calls to discuss implementation issues, such as team selection, training preparation, and support.

In late 2014 and early 2015, a few months after being selected for participation, the labs announced the Energy I-Corps opportunity to their research staff. Each lab approached team selection differently. One Site Lab went so far as to conduct a two-month commercialization training (February and March 2015) and selected its teams based on their performance during that training. Most of the labs held a pitch competition of some sort to select teams. Labs began announcing selected teams by early April and all teams were selected by mid-July. The labs sent three of the selected teams to NSF I-Corps training mid-May to mid-June 2015, which the Node Lab and selected Energy I-Corps faculty also attended in preparation for developing a unique Energy I-Corps curriculum. The cohort 1 onsite training began October 11, 2015. For two weeks prior, the Node Lab engaged the teams in webinars and reading assignments to prepare them for the intensive onsite training. In addition to these Node-organized training activities, some of the lab pilot managers engaged their teams in additional preparatory work in the months leading up to the training.

Fourteen teams participated from seven labs or lab partners in the cohort 1 training (Table 1-2).[16] Ten of these teams received funding from the Energy I-Corps pilot; four teams were funded by their lab's TTOs. We note the diversity of these teams in terms of technology type and stage of development and discuss in Section 2 the implications of this diversity for this year-one assessment.

Table 1-2: Labs, Teams, and Technologies in Cohort 1

Lab	Team	Technology
ANL	Dynamic Aperture	Dynamic Aperture Using Actuated Baffle Displays
ANL	SonicLQ	Acoustic Building Infiltration Measurement System Software
INL	ARAI	Advanced Renewable Aerial Inspection

[16] While eight labs sent teams to the cohort 1 training, six labs/lab partners (LLNL/SNL) are participating as pilot lab managers.

Lab	Team	Technology
INL	SPS	Switchable Polarity Solvent Forward Osmosis
LBNL	Ring Burner	Flame Design for Near-zero Emission Combustion of Natural Gas
LLNL/SNL	C-Best	Commercial Building Energy Saving Technology
NREL	Eco-AC	Mini-split Modular Air Conditioning Solution
NREL	WISDEM	Wind Plant Integrated Systems Design and Engineering Model
ORNL	CI-ReClad	Building Envelope Recladding Technology
ORNL	Tunation	Zero Touch Audit Software for Building Efficiency
PNNL	Co-culture Green	Photobioreactor Co-culture Platform
PNNL	HYDRA	Network Interchange Forecasting in the Power Grid
PNNL	STARS	Solar Thermochemical Advanced Reactor System
PNNL	Sub Lambda	Scalable Nanostructured Coatings for Energy Efficient Windows

The Site Labs differed in the methods they used to select the teams (see Appendix D). All but one lab formed teams by soliciting from lab researchers their interest in the training and/or technology proposals; the remaining lab identified promising technologies, explored team formation around these technologies, and selected the team/technologies demonstrating the most likelihood of benefiting from the training.

The Site Labs varied widely in their approaches to soliciting lab researchers, ranging, at the most intensive end of the spectrum, from a multi-month preparatory training that culminated in the juried selection of the teams demonstrating the most likelihood of benefiting from the training to, at the least intensive end of the spectrum, an informal solicitation of ideas and discussion with candidates. The Site Labs in the middle of this spectrum had teams pitch their technologies and themselves, supported by PowerPoint presentations, to a team of reviewers that scored the candidates.

Following team selection, three selected teams and identified Energy I-Corps instructors attended NSF's I-Corps Energy and Transportation Regional Program training at the University of Michigan in May-June 2015. Based on this NSF I-Corps training,[17] the

[17] The teams had previously received awards from ARPA-E. Appendix F.6 provides a brief description of the ARPA-E program.

Energy I-Corps Node, with stakeholder assistance, modified the NSF I-Corps curriculum for the first Energy I-Corps training in fall 2015.

The Energy I-Corps curriculum retained, with some adjustments, I-Corps' focus on customer discovery and the development of the technology's value proposition. The Node developed identified faculty (who are entrepreneurial experts), and developed the curriculum through extensive discussions with entrepreneurial experts (including Steve Blank, the developer of Lean LaunchPad), other national labs, and from lessons it learned through its observation of the NSF I-Corps training. The Node wove into the Energy I-Corps training new elements that it deemed valuable, including Industry Night (which brought in contacts from the business community relevant to the teams' technologies), tying activities during the training to specific lectures, and provision of continual feedback.

The first cohort Energy I-Corps training had six instructors, three designated as "core faculty" and three as "adjunct faculty."

The onsite instruction period for the 2015 pilot training launched October 11 and concluded November 19, with the onsite activities held in Golden, Colorado, at conference facilities near the NREL campus. The Node and Site Lab staff most involved in the pilot met on December 4 at LBNL to engage in reflecting on the pilot, and in identifying and discussing lessons learned (hereafter, the "debriefing meeting").

1.3.4 Pilot Logic Model

The evaluation team developed a logic model of the Energy I-Corps Pilot (Figure 1-1) from its inception through implementation, illustrating how the pilot's activities will achieve its one year and broad goals (see Section 1.1). Appendix A provides more detailed pilot logic models, including those for the Node Lab, Site Labs, and teams.

The three principal Energy I-Corps goals are seen in the bottom row of the high-level logic model shown in Figure 1-1.

The activities of EERE and the Node Lab (top row of Figure 1-1) comprise four areas:

- EERE staff design the pilot with input from the national labs and NSF I-Corps program managers. Pilot design includes funding for lab management of their pilot activities and for trainees.
- EERE writes and issues the call for lab proposals and uses merit review to select the Node and Site Labs.
- The Node Lab communicates with and coordinates across the Site Labs.
- The Node Lab works with faculty to develop the curriculum to meet EERE needs.

The Site Labs respond to the EERE and Node Lab activities, responses that constitute the outcomes of the EERE and Node activities. The four groups of Site Lab activities (second row of Figure 1-1) are:

- Develop lab-specific approaches to team selection and support.
- Select and fund technology teams.
- Engage their teams in training activities prior to the onsite training and provide commercialization support to teams during and after the training.
- Strengthen their institutional support for commercialization.

The participating technology teams respond to the Site Lab and EERE/Node activities, responses that constitute the outcomes of the Site, EERE, and Node activities. The four groups of team activities (third row of Figure 1-1) are:

- Teams prepare for training by each drafting a BMC in response to initial faculty guidance and presenting their draft canvases during first training session.
- Teams engage in training sessions and activities, interview potential customers and other market actors to learn about private sector needs and conditions, and explore the options for and feasibility of different commercialization pathways.
- Teams respond to market and faculty feedback received and improve their BMCs, making small or more substantive adjustments or a no-go decision, and present elements of the revised model (or decision) at final training session.[18]
- Teams engage in technology transfer activities.[19] Such activities include forming partnerships, identifying funding, initiating agreements to transfer their technology into commercialization, or pursuing the creation of startup companies (perhaps using entrepreneurial leave).

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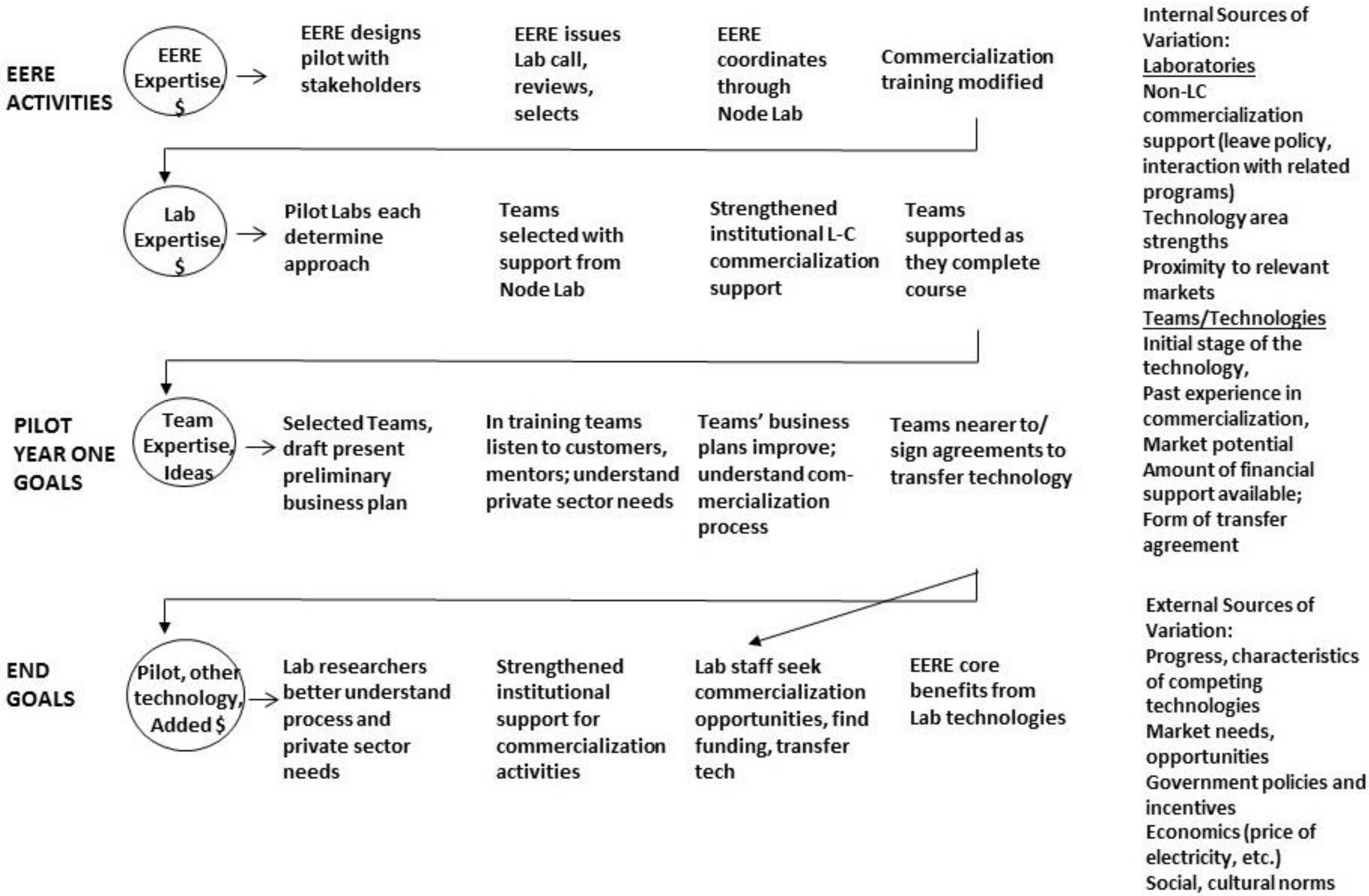
[18] Lean LaunchPad describes the customer discovery process as leading to a go/no-go decision for the innovation. Commercialization necessitates a market willing to purchase the innovation at a price that exceeds the cost to provide it, with a market size sufficient to warrant the investment. The customer discovery process results in a no-go decision when there does not appear to be such a market for the innovation.

[19] During or immediately following the training, teams largely engage in only the initial stages of these technology transfer activities.

Figure 1-1: High Level Logic Model for Energy I-Corps Pilot



1.3.5 Internal and External Influences on Pilot Success

There are influences both internal and external to the Energy I-Corps pilot that may drive or constrain success of the pilot overall, at individual labs, and for individual technology teams. Those identified are consistent with those identified in an IDA 2011 technology transfer report as variations among labs that affected commercialization outcomes (Appendix F has additional detail).[20]

Internal to the pilot, the primary sources of variation influencing success include:

- Variation in labs and their contexts
  - General commercialization expertise of researchers
  - Technology areas of specialization
  - Proximity to relevant markets (geographic location)
  - Non-Energy I-Corps support for commercialization
  - Lab organization and coordination of commercialization activities, including priority lab places on commercialization
  - Financial, time, and technical resources to support commercialization
  - Lab commercialization requirements and processes
- Variations among the teams and technologies involved
  - Stage of the technology (see Appendix H for definitions of Technology Readiness Levels, or TRLs)
  - Past team experience with commercialization
  - Non-Energy I-Corps financial support available
  - Market potential (as described by the nine areas captured by the BMC, such as size of potential demand and extent to which market delivery infrastructure exists)

For example, the labs vary in pilot implementation and involvement with other efforts to stimulate commercialization activities (such as CRADAs and Agreements for Commercializing Technology), make it difficult to come to clear conclusions of changes in institutional support. Other sources of variation in Labs and their contexts include differences in organization and coordination of commercialization activities, financial and time resources to support commercialization, commercialization expertise of researchers and TTO staff, technology area strengths, and proximity to relevant markets (geographic location).

The teams differ in the match between their personalities and the talents needed for successful commercialization, as well as the stage of their lab careers.

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[20] See Science and Technology Policy Institute. 2011. *Technology Transfer and the Commercialization Landscape for Federal Laboratories,* Institute for Defense Analysis. IDA Paper NS P-4728, 2011.

External to the pilot are influences that primarily affect the two ends of the program logic, that is, the inputs and end outcomes. These include:

- Government commercialization policies and incentives
- Market needs/ opportunities
- Progress of competing, supporting and emerging technologies
- Emerging technologies
- Economics, including energy prices, price of what the new product would replace, availability of skilled labor, etc.
- Social/cultural norms, such as consumer preferences, time horizon, etc.

We note these external influences here for completeness; most of these influences are most pertinent when technologies are close to commercialization and so are less relevant to the early Energy I-Corps pilot outcomes explored in this study.

Section 2 Methods

This final evaluation report on the Energy I-Corps pilot documents the pilot's design, first-round (fall 2015) implementation, and baseline conditions, provides findings on early outcomes, including a comparison of trainee and nonparticipant comparison group outcomes. The report also documents the results of a process assessment, identifies lessons learned, and offers recommendations.

This evaluation:

- Establishes a **baseline** of technology transfer activities and attitudes prior to participation in the Energy I-Corps pilot
- Assesses **early outcomes** per the pilot's three one year or early stage goals
  - **Learning:** Assess the extent to which the pilot increased researcher understanding of commercialization process and private sector needs
  - **Commercialization:** Assess the extent to which the pilot advanced team technologies in the commercialization process
  - **Institutional Support:** Assess the extent to which the pilot strengthened lab institutional support for researcher commercialization activities
- Documents and assesses pilot **processes**
  - **Document:** Document pilot design, implementation, and outcomes
  - **Lessons Learned:** Identify lab pilot approaches associated with pilot success in the context of that lab
  - **Opportunities:** Identify opportunities for improving Energy I-Corps

2.1 ASSURING RESEARCH DESIGN QUALITY

Our research design for assessing early outcomes of the pilot is a quasi-experimental design using a carefully chosen comparison group. The comparison group is discussed in the section that follows.

Conducting the evaluation roughly concurrently with the Energy I-Corps pilot supports *evidenced-based* policy decisions. Our approach ensures the research yields valid, meaningful findings and conclusions that support an assessment of the generalizability of the pilot experience and decisions regarding pilot scale up, with appropriate cautions. Additionally, the draft evaluation plan was reviewed by a high-level team of external experts, from private industry and universities.

To meet this goal, we have, among other things, identified factors that might confound the interpretation of the pilot results by suggesting either the pilot was more effective or less effective than it actually was (Type 1 and 2 errors). By collecting data on these confounding factors and attempting to "hold them constant" in our assessments by explicitly comparing outcomes within and across confounding conditions, we can more reliably identify the pilot's contribution to commercialization planning process changes and product advancements.

Confounding factors include the internal influences on the pilot identified in Section 1.3.3: initial stage of the technology, technology sector, past commercialization experience, non-Energy I-Corps resources and support, form of transfer, and Laboratory proximity to customers and markets.

Our evaluation treats one source of internal variation – differences in Laboratory approach – as a *moderating variable*. As a moderating variable, we will be assessing interactive effects between the pilot and Laboratory approach and thereby assessing which Laboratory approaches to pilot implementation appear most promising in what contexts.

Our approach avoids *temporal antecedence* by collecting baseline data and asking respondents to provide examples in support of their opinions on pilot contribution to identified effects.

Our research strives for rigor and internal and external validity. In summary, our evaluation design:

- Provides valid and reliable answers to the multiple research objectives;
- Is feasible within the constraints of pilot roll-out underway, short (one year) pilot length, and limited evaluation resources;
- Uses multiple lines of evidence on which to base conclusions;
- Includes descriptive statistics with pre-post comparisons and cross-Laboratory comparisons, including a pre- post-training survey; and
- Uses a limited quasi-experimental design to compare early outcomes related to commercialization plans to those of a group who did not receive training (status quo).

2.2 STUDY LIMITATIONS

As described in Section 1.3.5, there are many variations among the trainees, their technologies, the technologies' technical readiness, and their labs that influence pilot outcomes. This study does not attempt to trace the influence of these variations on early pilot outcomes.

2.3 EARLY OUTCOME METRICS

The peer-reviewed technical evaluation plan established performance metrics for assessing Energy I-Corps (then termed Lab-Corps) early outcomes in the areas of learning, commercialization, and institutional support (Table 2-1).[21]

Table 2-1: Early Outcomes Metrics

Evidence for Learning, Commercialization, and Institutional Support Outcomes	Metric
Learning	Discovery interviews conducted by team
	Information added to BMC
	Refinements/pivots made to BMC
	"No-go" decision made
	Commercialization activities engaged in
	Sharing information with nonparticipants
	Increased understanding of commercialization process
	Increased quality/viability of BMC
Commercialization	Refined R&D plans
	Technology advanced (TRL)
	New CRADAs
	Funding received from market actors (non-federal source [NFS] funds)
	New material transfer agreements
	New licenses (exclusive of software)
	(New) Software licenses
	Entrepreneurial leave taken
	Startup launched
	Commercialized technologies
	Technology sales

[21] *Lab-Corps Pilot Technical Evaluation Plan,* July 31, 2015. Submitted to U.S. DOE EERE by NMR Group, Inc., Research Into Action, Inc., Gretchen Jordan, Ph.D., Albert Link, Ph.D., and East Mountain IP. Peer-reviewed by Donald Siegel, Ph.D., Irwin Feller, Ph.D., Brian Zuckerman, Ph.D., Maryann Feldman, Ph.D., and Lori Lewis, Ph.D.

Evidence for Learning, Commercialization, and Institutional Support Outcomes	Metric
Institutional Support	Pilot differences from labs' baseline characteristics
	Non-pilot support provided to teams due to labs' Energy I-Corps participation
	Lab-identified barriers to commercialization and approach to reducing barriers
	Researcher assessment of support
	Researchers' ability to flexibly meet demands of commercialization planning
	Intra-lab learning opportunities
	Inter-lab learning opportunities
	Support from other involved staff, partners

2.4 EVALUATION DATA SOURCES

This evaluation uses the data sources of document review, tracking data analysis, web-based surveys, in-depth semi-structured interviews, informal interviews, and onsite observation, as summarized in Table 2-2. Methodological details follow in Table 2-3.

Table 2-2: Data Sources by Methods and Evaluation Activity

Method	Source	Sample Size	Evaluation Activity		
			Baseline	Outcome	Process
Document review	Site and Node Labs	6	✓		✓
In-depth telephone interviews	Site and Node Lab pilot managers/ managing teams	7	✓	✓	✓
	Training faculty	4		✓	✓
	U.S. DOE managers	4			✓
Web survey: baseline	Energy I-Corps Cohort 1 teams	28	✓	✓	✓

Method	Source	Sample Size	Evaluation Activity		
			Baseline	Outcome	Process
	Nonparticipating researchers considered for Cohort 1	9		✓	✓
Web survey: follow-up	Energy I-Corps Cohort 1 teams	24	✓		✓
	Nonparticipating researchers considered for Cohort 1	9	✓		✓
Onsite observation	Cohort 1 onsite training (days)	5		✓	✓
	Site and Node Lab pilot managers/ managing teams (days)	1	✓	✓	✓
Informal interviews	Pilot managers, researchers (PIs, ELs, IMs), and faculty at onsite training	~20	✓	✓	✓
Technology transitions metrics analysis	DOE Office of Technology Transitions	N/A	✓	✓	

Table 2-3: Methodological Detail

Method	Detail
Document review	We reviewed program descriptions prepared by EERE, the August 14, 2014 Lab Call, lab proposals, team proposals, and team scoring information.
In-depth telephone interviews	We conducted by telephone interviews of 90 to 120 minutes with each Site Lab and the Node Lab. One interview was with a single individual; the other interviews were conducted with two to three individuals per lab. We conducted two interviews with Node Lab staff. We conducted by telephone interviews of 30 minutes with four Cohort 1 instructors.

Method	Detail
	We conducted by telephone interviews with four U.S. DOE managers knowledgeable about the pilot. Appendix I provides the interview guides.
Trainee Web Surveys: Baseline & Follow-up	As part of its pilot management activities, the Node Lab administered baseline and follow-up web-based surveys to the members of Cohort 1 technology teams. The trainee baseline survey was fielded from September 16 to October 5, 2015. The follow-up survey was fielded from November 20 to December 14, 2015. (Onsite training began October 11 and concluded November 19, 2015.) We report results from participating principal investigators and entrepreneurial leads employed by the labs. (Additional respondents, not reported, include industrial mentors and non-lab staff. We exclude industrial mentors, who may or may not have been lab staff, because these individuals were chosen for the teams based on their extensive market experience.) A total of 29 unique individuals (meeting our reporting criteria for team role and lab employment) from all 14 teams completed the surveys, of which 23 individuals completed both the baseline and follow-up surveys. Appendix I provides the web survey instruments.
Nonparticipant Web Surveys: Baseline & Follow-up	As part of its pilot management activities, the Node Lab administered baseline and follow-up course web-based surveys to nonparticipating researchers that had been considered by their pilot lab managers for Cohort 1. The nonparticipant baseline survey was fielded from October 2 to October 23, 2015. The nonparticipant follow-up survey was fielded from April 4 to April 13, 2016. (Onsite training began October 11 and concluded November 19, 2015.) Rationale and sample selection for the nonparticipant survey is described in Section 2.7. Appendix I provides the web survey instruments.
Onsite Observation	The Node Lab invited evaluation team members to observe the fall 2015 training and a subsequent manager meeting. One evaluation team member attended the initial onsite training October 11 to 14. A second team member attended the closing onsite training November 18 to 19 and attended a day-long (December 4) debriefing meeting of

Method	Detail
	Site and Node Lab pilot managers who reflected on the training and lessons learned.
Informal Interviews	During breaks on the days of the training and manager meeting, the evaluation team members conducted informal interviews with pilot participants (Site and Node Lab pilot managers, faculty, principal investigators, entrepreneurial leads, and industry mentors) about their experiences.
Technology transitions metrics analysis	We analyzed six years (2010 to 2015) of DOE's technology transitions metrics relevant to Energy I-Corps objectives: • New CRADAs • Non-federal sponsors (NFS) funds • New material transfer agreements (MTAs) • New licenses (total) • Software licenses (total) • Startup launched • Commercialized technologies

2.5 SOURCES USED TO ASSESS OUTCOME METRICS

To assess Energy I-Corps outcomes, we compare program outcomes with an estimate of what would have happened in the absence of the program. The basis of our comparison is:

- Matched "runner-up" research teams – teams that applied but were not selected for participation; they are teams considered by lab managers for pilot participation that provide a good match with selected teams based on team and technology characteristics (see Sections 2.7 and 2.8 for methodological details), and
- Training teams' prior commercialization experience/activity, combined with their statements of Energy I-Corps' influence on their thinking or activities.

Using this approach, we sought to determine whether Energy I-Corps teams' understanding of the commercialization process and market needs, as well as their progress in developing a commercialization plan or business model canvas, exceeded that of their counterparts, and whether any observed differences owed, perhaps, to the main rival explanation that prior commercialization experience was responsible for team performance.

Table 2-4 identifies the data sources used to assess the early outcome metrics.

Table 2-4: Data Sources for Early Outcome Metrics Assessment

Evidence for Learning, Commercialization, and Institutional Support Outcomes	Metric	Team Surveys	Lab Pilot Manager Interviews	Faculty Interviews	DOE Manager Interviews	Document Review	Technology Transitions Metrics Analysis
Learning	Discovery interviews conducted by team	✓		✓			
	Information added to BMC	✓		✓			
	Refinements/pivots made to BMC	✓		✓			
	“No-go” decision made	✓					
	Commercialization activities engaged in	✓					
	Sharing information with nonparticipants	✓					
	Increased understanding of commercialization process	✓	✓	✓	✓		
	Increased quality/viability of BMC	✓	✓	✓			
Commercialization	Refined R&D plans	✓	✓	✓	✓		
	Technology advanced (TRL)	✓					
	New CRADAs	✓	✓				✓

Evidence for Learning, Commercialization, and Institutional Support Outcomes	Metric	Team Surveys	Lab Pilot Manager Interviews	Faculty Interviews	DOE Manager Interviews	Document Review	Technology Transitions Metrics Analysis
	Funding received from market actors (NFS funds)	✓	✓				✓
	New material transfer agreements	✓	✓				✓
	New licenses (exclusive of software)	✓	✓				✓
	(New) Software licenses	✓	✓				✓
	Entrepreneurial leave taken	✓	✓				
	Startup launched	✓	✓				✓
	Commercialized technologies	✓	✓				✓
	Technology sales	✓	✓				
Institutional Support	Pilot differences from baseline	✓	✓			✓	
	Non-pilot support provided to teams due to labs' Energy I-Corps participation		✓			✓	
	Lab-identified barriers to commercialization and approach to reducing barriers		✓			✓	
	Researcher assessment of support	✓					

Evidence for Learning, Commercialization, and Institutional Support Outcomes	Metric	Team Surveys	Lab Pilot Manager Interviews	Faculty Interviews	DOE Manager Interviews	Document Review	Technology Transitions Metrics Analysis
	Researchers' ability to flexibly meet demands of commercialization planning	✓					
	Intra-lab learning opportunities	✓	✓				
	Inter-lab learning opportunities	✓	✓				
	Support from other involved staff, partners		✓				

2.6 SOURCES USED TO DOCUMENT AND ASSESS PILOT PROCESSES

Table 2-5 identifies the data sources used to document and assess pilot processes.

Table 2-5: Data Sources for Pilot Process Documentation and Assessment

Document and Assess Program Processes	Areas of Investigation	Team Surveys	Lab Pilot Manager Interviews	Faculty Interviews	DOE Manager Interviews	Document Review	Technology Transitions Metrics Analysis
Document Pilot	Pilot design		✓		✓	✓	
	Pilot implementation	✓	✓	✓	✓	✓	
	Pilot outcomes	✓	✓	✓	✓	✓	✓

Document and Assess Program Processes	Areas of Investigation	Team Surveys	Lab Pilot Manager Interviews	Faculty Interviews	DOE Manager Interviews	Document Review	Technology Transitions Metrics Analysis
Identify Lessons Learned and Opportunities for Improvement	Approaches to team/ technology selection		✓			✓	
	Approaches to partner selection and role		✓			✓	
	Pilot and non-pilot support provided; related lab policies/ programs	✓	✓	✓		✓	
	Lab satisfaction with Lab Call, selection, and participation; positive perception; intention to continue		✓			✓	
	Researcher satisfaction with participation; positive perception; intention to continue	✓					
	Lab/ researcher dissatisfaction; recommendations offered	✓	✓	✓		✓	
	Fit of Energy I-Corps with lab environment	✓	✓	✓	✓	✓	

2.7 NONPARTICIPANT SURVEY

Effective hands-on training programs such as Energy I-Corps equip trainees with knowledge, tools, and skills. As findings from the surveyed trainees suggest (see Section 4.3), it also empowers trainees, a term used to connote favorable changes in beliefs and attitudes. Energy I-Corps training enables participants to clarify the degree to which they are interested in pursuing the steps necessary for successful commercialization of their innovations, clarity they are unable to have in the absence of knowledge of and some direct experience with what it takes for successful product launches.

We examined alternatives satisfying the conditions necessary for a quasi-experimental design that compares processes and outcomes related to R&D and commercialization plans to an appropriate comparison group. The three groups considered were non-selected teams, I-Corps participants, and lab staff undertaking entrepreneurial activities. We determined that non-selected teams were the most appropriate comparison group because they are like selected teams on intent / motivation to pursue commercialization and in overall lab environment and location. The Laboratories would also have some leverage for collecting data on their activities and outcomes that can be provided to the evaluators. The composition of the non-selected teams also could be designed in a matched-pairs manner such that they resemble as closely possible the participating teams on characteristics such as technology area, technology readiness level, etc.

We designed a nonparticipant sampling plan that best constitutes a comparison group for the Energy I-Corps training. Lab researchers that applied to be selected for training and were judged worthy but not selected due to a limited cohort size (that is, the runner-up applicants) constitute the group most like the trainees. There may be other lab researchers that similarly have interest and willingness, and research at the appropriate juncture, but they either did not know about the training opportunity or were not able to commit to the training at that time; regardless of their reasons for not applying, we had no feasible method for identifying such researchers.

While fully appropriate, this designation of runner-up applicants to the Energy I-Corps training as the study's comparison group nonetheless limits what the evaluation can conclude about the net impacts of the training, where net is understood to mean trainee commercialization knowledge and activities above and beyond that of nonparticipants. The runner-up researchers are more properly partial participants than nonparticipants; they participated in the application and other very early stages of the pilot. While applying for training, these researchers learned a bit about the concepts taught in the training. This exposure to Energy I-Corps concepts varied considerably among the labs, ranging from an application process that engaged in a mini commercialization training largely consistent with Energy I-Corps principles to a process that started by developing a short list of promising technologies and then interviewed the associated researchers to make a final selection. The applicants typically developed and delivered presentations making the case that they and their technologies were posed to best benefit from the training process. The audience for presentations varied across the labs, ranging from presentations to a team that included outside reviewers, to presentations to a team comprised of the few individuals responsible for their labs' pilot participation.

Applicants had an opportunity to learn some of the concepts taught by Energy I-Corps through three routes – during the application process as they made the case to be selected for the training, after the selection of trainees as they pursued on their own interests that were piqued during the application process, and from trainees who shared some of the learnings with their lab colleagues. Recognizing this spillover from the Energy I-Corps application process and Energy I-Corps trainees, our nonparticipant follow-up survey fielded after cohort 1 had completed training asked nonparticipants several questions to explore the influence Energy I-Corps had on their interest in and activities concerning commercialization after they had applied for the training.

2.8 NONPARTICIPANT SAMPLE SELECTION PROCEDURE

The evaluation team provided guidance to the Node and Site Lab pilot managers in identifying candidate nonparticipant teams for us to survey. The guidance asked that matched teams meet the following criteria: (1) Applied to attend (or were considered by the lab pilot managers for) the Energy I-Corps cohort 1 training, (2) Would not be participating in the Energy I-Corps cohort 1 training, (3) Had not participated in any I-Corps training, including the Michigan I-Corps training and (4) Was – out of the set of teams with roughly comparable characteristics – the highest ranked on the Energy I-Corps applicant scoring system.

The five Site Labs identified twelve matched nonparticipant teams from three Site Labs (ANL, INL, and LLNL/SNL); no applicant teams from LBNL or PNNL passed the screening.[22]

We emailed a request to respond to the nonparticipant baseline web survey to the PI and EL members of the twelve matched nonparticipant teams. More than half of the selected nonparticipant teams had no EL; the 12 teams encompassed 17 PIs and ELs. Nine of the PIs from nine different teams completed the baseline survey. We closed the survey after three weeks, during which we sent three reminder emails.

A Node Lab pilot manager explained that the nonrespondent PIs had little incentive to complete the survey. The survey, which took about 15 minutes to complete, ranked low in priority among the activities researchers attend to in their workweeks, which commonly exceed 50 hours, according to our lab contacts.

Given nonparticipant response to the baseline survey, we designed the follow-up survey to be completed in seven minutes or less. We invited the nine respondents to the baseline survey plus the three nonrespondent PIs to complete the follow-up survey and received nine completes, eight of which we are certain completed both surveys (they provided their names each time). The respondent(s) for one team that completed both

[22] The five Site Labs provided us with information on a total of 45 teams that had applied for cohort 1 training. Ten of these teams were participating in the cohort 1 training (along with two teams from the Node Lab and two teams from a lab that was not participating as a pilot Site Lab, for a total of 14 cohort 1 teams.) The Site Labs identified another 23 teams as unsuitable for inclusion in the nonparticipant sample due to the following reasons: (1) Technology not as appropriate as others (not closely linked to EERE interests, not sufficiently developed) (12 teams); (2) Team had attended I-Corps (5 teams); (3) Lack of team availability, commitment, or receptiveness to feedback (3 teams); (4) PI had left the lab after applying (the teams included post-docs and interns) (3 teams).

the baseline and follow-up surveys did not identify themselves and we are uncertain whether the baseline and follow-up survey responses came from the same individual.

Section 3 Near-Term Outcome Metric Findings

As described in Section 2, we identified 27 metrics to assess the degree to which Energy I-Corps attained its learning, commercialization, and institutional support outcomes. Table 3-1 through Table 3-3 provide the corresponding evaluation findings for trainees and their labs, and identifies the data sources that yielded those findings.

3.1 LEARNING

Table 3-1 summarizes the key evaluation findings and associated data sources for trainee learning metrics.

Table 3-1: Evaluation Findings for Trainee Learning Metrics

Metric	Findings	Data Source and Report Section
Discovery interviews conducted by team	Teams averaged about 70 customer discovery interviews with a wide range of stakeholders, where previously teams had done few to no such interviews.	Cohort 1 follow-up survey (Section 4.5)
Information added to BMC	All teams created, for the first time in their careers, a BMC in advance of training. All teams substantially added to their BMCs.	Cohort 1 follow-up survey (Section 4.1); faculty interviews (6.3.1); onsite observation and informal interviews on final day of training (6.3.1)
Refinements/pivots made to BMC	All teams evidenced refinement of BMC throughout customer discovery, as well as pivots in one or more areas. Teams identified next steps that included determining appropriate pivots.	Cohort 1 follow-up survey (Section 4.1); faculty interviews (6.3.2); onsite observation and informal interviews on final day of training (6.3.2)
Increased quality/viability of BMC	All teams evidenced increased quality/viability of BMC. Final BMCs varied in quality. Managers anticipate that perhaps 5 of the 17 lab teams trained in 2015 (at NSF I-Corps or Energy I-Corps) were well positioned to begin launching their technologies in the next year. In contrast, one team reported a “no-go” decision and two teams reported they did not know whether their technology was a go or no-go.	Faculty interviews (Section 6.3.2); onsite observation and informal interviews on final day of training and at debriefing meeting (6.3.1 and 6.3.2)
“No-go” decision made	One of 14 teams reported a “no-go” decision and two teams reported they did not know whether their technology was a go or no-go.	Cohort 1 follow-up survey (Section 4.3)

Metric	Findings	Data Source and Report Section
Increased understanding of commercialization process	Proportion of trainees indicating they understood the technology commercialization process increased to 87% after the training, from 13% prior to the training, a statistically significant difference. Team PI's understanding of eight of the nine components of the business model canvas increased from baseline to follow-up – five of which increased significantly. Trainees' increase in understanding of the commercialization process exceeded that of nonparticipants. The two groups' baseline was similar, ruling out (although not definitively) a rival explanation that the trainees' own characteristics, rather than the training, that led to the reported gains.	Cohort 1 baseline and follow-up surveys (Section 4.1), trainee and nonparticipant baseline (5.1), trainee and nonparticipant knowledge gains (5.3)
Continued commercialization activities	The majority (83%) of trainees appear to be positioned for continued commercialization activities. They indicated they have a go-to-market strategy for their technology that includes target customer segments, channels, and pricing tactics and/or the appropriate licensing partner to get to market. The majority (89%) of those reaching a "go" decision reported it likely that they would continue commercialization activities on their technology during the three months following the pilot.	Cohort 1 follow-up survey (Section 4.3)
Sharing information with nonparticipants	41% of cohort 1 reported they had discussed the Energy I-Corps experiences with groups and individuals in their labs.	Cohort 1 follow-up survey (Section 4.2)

3.2 COMMERCIALIZATION

Table 3-2 lists near-term commercialization outcomes. As noted in Section 2.3, these quantitative metrics are longer term; the technical evaluation plan anticipated that success on these metrics might not be evident at the time of this early findings pilot evaluation report.

Indeed, as of our final data collection from the lab pilot managers in December 2015, none of these outcomes had occurred for cohort 1 team technologies. However, lab pilot managers and trainees are anticipating one or more outcomes will occur, possibly in 2016, for seven of the nine metrics.

Table 3-2: Evaluation Findings for Near-Term Commercialization Metrics

Metric	Anticipated Outcomes	Data Source and Report Section
Refined R&D plans	All trainees developed insights through customer discovery that influenced their technology thinking; many described anticipating they will refine their research agendas as a result.	Cohort 1 follow-up survey (Section 4.1); onsite observation and informal interviews on final day of training (6.3.3)
Technology advanced (TRL)	There is little evidence that team's technologies advanced through TRL stages by the end of Energy I-Corps training. (This finding is expected given that training activities do not encompass technical research.)	Cohort 1 follow-up survey (Section 4.1).
New CRADAs	Lab pilot managers anticipate one or more cohort 1 technologies will engage in new CRADAs by the end of 2017.	Onsite observation and informal interviews on final day of training and at debriefing meeting (Section 5.2)
Funding received from market actors (NFS funds)	Lab pilot managers anticipate one or more cohort 1 technologies will receive NFS funds by the end of 2017.	
New licenses & software licenses	Lab pilot managers anticipate one or more cohort 1 technologies will be licensed by the end of 2017.	
Entrepreneurial leave (EL) taken	A few trainees reported they were contemplating taking EL. (This metric is applicable only to labs with EL programs; see Table 8-3.)	
Startup launched	As of mid-2016, one cohort 1 technology spun a startup firm (SonicLQ). Lab pilot managers anticipate one or more additional technologies will lead to startups by the end of 2017.	

Metric	Anticipated Outcomes	Data Source and Report Section
Commercialized technologies	One cohort 1 technology commercialized by mid-2016. Lab pilot managers anticipate one or more additional technologies will be commercialized by the end of 2017.	

3.3 INSTITUTIONAL SUPPORT

Table 3-3 provides the evaluation findings and associated data sources for metrics associated with near-term changes in institutional support for commercialization.

Table 3-3: Evaluation Findings for Near-Term Institutional Support Metrics

Metric	Findings	Data Source and Report Section
Pilot differences from baseline	All respondents agree that their Energy I-Corps activities constituted a substantive departure from labs' prior approaches to supporting researchers to commercialize their technologies, including 1) training researchers in a scientific approach to commercialization, 2) funding researchers to engage in training activities, and 3) forming and/or deepening partnerships.	Cohort 1 surveys (Section 4), faculty interviews (5 and 6), pilot lab manager interviews (5, 6, and 7), onsite observation and informal interviews (5)
Lab-identified barriers to commercialization and approach to reducing barriers	Lab pilot managers identified barriers and approaches in their pilot proposals. Managers explicitly described barriers and approaches to mitigating them through and because of their pilot participation.	Cohort 1 surveys (Section 4), pilot lab manager interviews (5, 6, and 7), onsite observation and informal interviews (5)
Researcher assessment of support	Nearly all trainee follow-up respondents (92%) reported the Energy I-Corps training exceeded their expectations (50% said "exceeded," 42% said "greatly exceeded"), with the remaining two respondents indicated the training met their expectations.	Cohort 1 follow-up survey (Section 4.4)
Researchers' ability to flexibly meet demands of commercialization planning	Nearly two-thirds of trainee follow-up respondents described their workload as increasing *substantially* during the prior six weeks compared to their typical workload prior to the Energy I-Corps training. Energy I-Corps pilot funding for teams was sufficient according to two-thirds of trainees.	Cohort 1 follow-up survey (Section 4.6)

Metric	Findings	Data Source and Report Section
Intra-lab learning opportunities	41% of trainees reported sharing findings with co-workers. Lab pilot managers reported plans for increased outreach for future trainings, including articles in internal lab newsletters, case studies, email blasts, and website content.	Cohort 1 follow-up survey (Section 4.1), onsite observation and informal interviews at debriefing meeting (7.6)
Inter-lab learning opportunities	Interactions among lab pilot managers were characterized by mutual respect for others' expertise, opinions, and contributions, respectful acknowledgement of lab differences, and a strong willingness to work together to meet pilot challenges. Pilot managers shared approaches and lessons learned at debriefing meeting.	Onsite observation and informal interviews at debriefing meeting (Section 7)
Support from other involved staff, partners	Each lab pilot manager was supported by a team (typically Technology Transfer Office (TTO) staff). All labs and trainees developed new and deepened existing partnerships throughout the training, through customer discovery, Industry Night, and other activities.* Two labs involved partners closely in team formation and preparation.	Interviews with lab pilot managers, onsite observation and informal interviews during last day of training and at debriefing meeting (Sections 5 and 6).
Non-pilot support provided to teams due to labs' Energy I-Corps participation	The evaluation did not find evidence of non-pilot support provided to teams.	Pilot lab manager interviews (Sections 6 and 7)

* Industry night is a "speed dating-like" event consisting of visitors from relevant industries engaging in quick one-on-one conversations with pilot teams, enabling the teams to augment their customer discovery activity.

Section 4 Trainees Knowledge Gain and Satisfaction

This section presents and compares baseline and follow survey responses for trainees. Section 5 provides comparison group findings.

As part of its pilot management activities, the Node Lab administered baseline and follow-up web-based surveys to the members of participating Energy I-Corps (then termed Lab-Corps) teams.[23] Twenty-nine unique PIs and ELs employed by the Site Labs responded to the surveys (Table 4-1). (Survey respondents also included other technology team respondents that we do not report on. We exclude Industry mentors (IMs) and team members not employed by the lab, as neither are the target group for the training.)[24]

Twenty-three PIs and ELs responded to both the baseline and follow-up surveys; all tables in this section provide compare the baseline and follow-up responses for this group of respondents.[25]

Table 4-1: Number of Trainee Respondents by Role and Survey Wave

Team	Baseline and Follow-up survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
Principal Investigator (PI) or Co-PI	12	4	16	-	12
Entrepreneurial Lead (EL)	10	1	11	1	11
Other role (Co-PI and EL)	1	-	1	-	1
Total	**23**	**5**	**28**	**1**	**24**

Team members from every Site Lab (except for SNL-California, a partner to LLNL) responded to one or both surveys (Table 4-2).

[23] The Node fielded the web-based baseline survey from September 16, 2015 to October 5, 2015 (prior to the training), with an initial distribution and four follow-up emails to nudge nonrespondents. The Node fielded the web-based follow-up survey from November 20, 2015 to December 14, 2015 (after the training), with an initial distribution and weekly follow-up emails to nonrespondents.

[24] IMs were excluded because, according to the Node contact, "They were brought into the program on the assumption they already possessed a great deal of relevant knowledge." (February 4, 2016 email from Jennifer Ramsey).

[25] About one-fifth of respondents indicated that team roles changed after the team's initial formation.

Table 4-2: Number of Trainee Respondents by Lab and Survey Wave

Organization	Baseline and Follow-up survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
ANL	3	1	4	-	3
INL	4	-	4	-	4
LBNL	3	-	3	-	3
LLNL	-	1	1	-	-
NREL	4	-	4	-	4
ORNL	5	-	5	-	5
PNNL	4	3	7	1	5
Total	**23**	**5**	**28**	**1**	**24**

Members of every team responded to one or more surveys (Table 4-3).

Table 4-3: Number of Trainee Respondents by Team and Survey Wave

Team	Baseline and Follow-up survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
ARAI	2	-	2	-	2
C-Best	0	1	1	-	0
CI-ReClad	3	-	3	-	3
Co-culture Green	0	2	2	1	1
Dynamic Aperture	1	1	2	-	1
Eco-AC	2	-	2	-	2
HYDRA	2	-	2	-	2
Ring Burner	3	-	3	-	3
SonicLQ	2	-	2	-	2
SPS	2	-	2	-	2
STARS	1	1	2	-	1
Sub Lambda	1	-	1	-	1
Tunation	2	-	2	-	2

Team	Baseline and Follow-up survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
WISDEM	2	-	2	-	2
Total	**23**	**5**	**28**	**1**	**24**

4.1 TRAINEES' KNOWLEDGE GAIN

Respondents' understanding of the technology commercialization process increased after the training, from 13% in the baseline survey to 87% in the follow-up survey, rating their understanding a "4" or "5" on a five-point scale, a statistically significant difference.[26] Most respondents indicated substantial increases in their understanding of market needs related to their technologies (92%) and of the various potential commercialization routes (83%) during the Energy I-Corps training.[27]

Trainee follow-up survey respondents described the greatest insights they achieved through the training (Table 4-4).[28]

Table 4-4: Greatest Insights from Energy I-Corps Training (n=23) (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Count	Percent
Better understanding of the market and market opportunities	14	61%
Understanding of the value of the customer discovery process	12	52%
Understanding of how to pivot to adapt to market needs	8	35%
Better understanding of the value of the technology and associated services	7	30%
Understanding how to improve early technology development	3	13%
Better understanding of effort required to successfully take a technology to market	2	9%
Better understanding of approaches to commercialization	2	9%

[26] Percentage of respondents (n=23 baseline and 23 follow-up) providing a "4" or "5" rating of their understanding of "the technology commercialization process and the elements needed for success" on a 5-point scale, where 1 equals *no understanding* and 5 equals *a great deal of understanding*.

[27] Percentage of respondents (n=24 follow-up) providing a "4" or "5" rating of the extent to which their understanding increased during the training, on a 5-point scale, where 1 equals *not at all* 5 equals *a great deal*.

[28] Appendix B *Additional Findings from Energy I-Corps Baseline and Follow-up Surveys* provides respondents' verbatim responses.

Response	Count	Percent
Understanding of the benefits and versatility of the business model canvas	1	4%
Better understanding of lab processes and options for commercialization	1	4%
Understanding of the benefits of developing case studies or other tools to demonstrate technology to the market	1	4%
Total Respondents	**23**	**--**

Two comments illustrate respondents' views:

> *"Both the Team interaction involved in the BMC process and the knowledge gained through the Customer Discovery interviews were invaluable. Many hypotheses were validated and several were strongly invalidated, but as a whole, [I think] it changed the way all of the lab-funded technology teams perceive market demand for their innovations and added valuable insights as to the many obstacles to commercialization of any technology...."*

> *"The whole program has completely revolutionized how I approach technology development and research."*

Team PI's understanding of eight of the nine components of the business model canvas increased from baseline to follow-up survey – five of which showed statistically significant increases (customer segments, customer relationships, key partners, key activities; Table 4-5).[29] Nearly three-quarters (71%) of team PIs responding to the baseline survey reported little familiarity with the business model canvas approach.[30]

[29] These five components evidencing statistically significant change in team knowledge correspond to the focus of the cohort 1 training, described by interviewed faculty; faculty reported less training focus on revenues, costs, and resources.

[30] Percentage of respondents (n=14) providing a "1" or "2" rating of their familiarity with the business model canvas approach, on a 5-point scale, where 1 equals *not at all familiar* 5 equals *very familiar*.

Table 4-5: Trainee Understanding of Business Model Canvas Components Baseline and Follow-up (n=10)*

Item	Percent "4" or "5"		Statistical Significance**
	Baseline	Follow-up	
Customer segments, customer archetypes (n = 10,10)***	30%	100%	$p < 0.01$
Customer relationships (n = 10,10)	30%	80%	$p < 0.05$
Key partners, suppliers (n = 10, 9)	20%	67%	$p < 0.05$
Value propositions (n = 10,10)	60%	100%	$p < 0.05$
Key activities, such as identifying distribution channels (n = 10,10)	10%	50%	$p < 0.05$
Channels through which customers are reached (n = 10,10)	30%	60%	n.s.
Revenue streams (n = 10,10)	10%	40%	n.s.
Cost structure (n = 10,10)	20%	40%	n.s.
Key resources (n = 9, 10)	33%	30%	n.s.

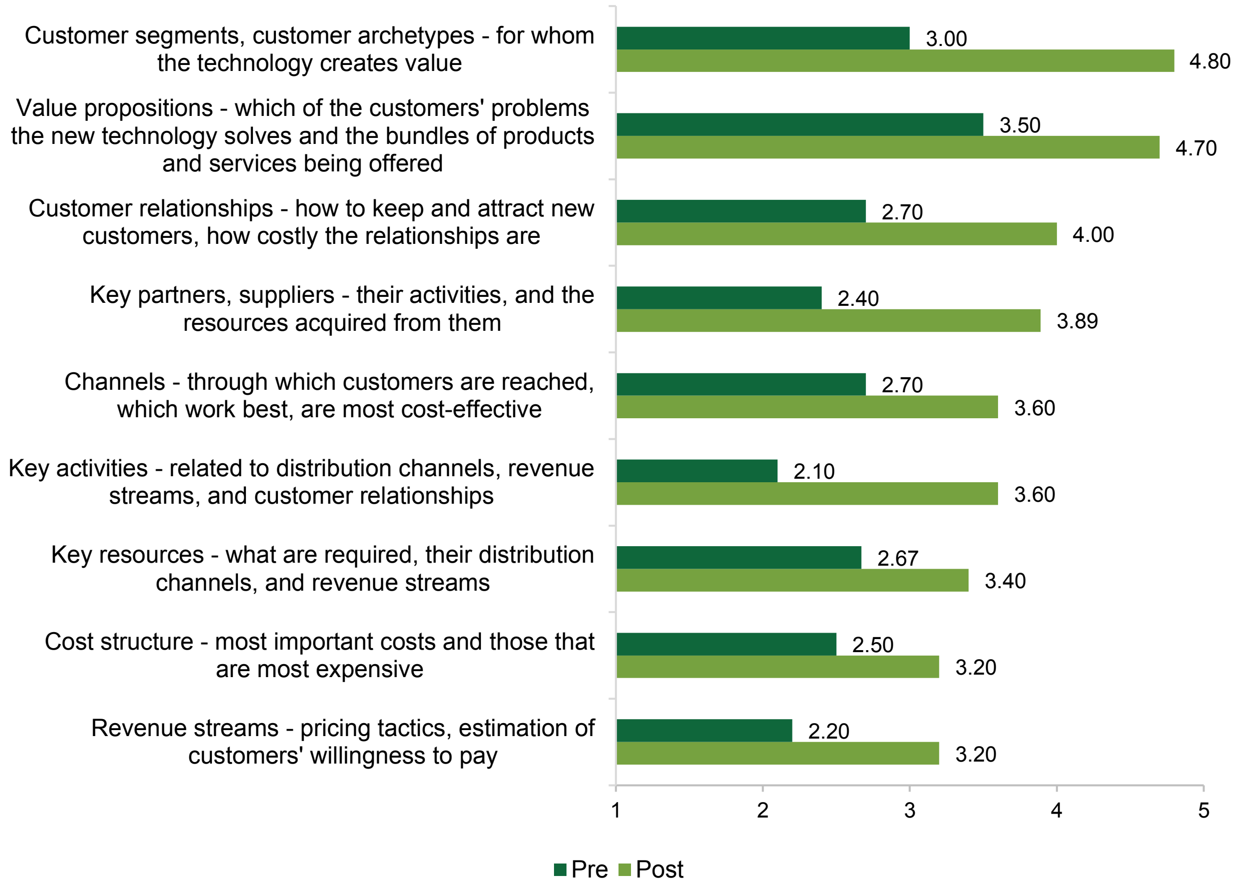
* Percentage of respondents providing a “4” or “5” rating on a 5-point scale, where 1 equals *not at all knowledgeable* and 5 equals *very knowledgeable*. Table reports one respondent per team (the PIs) so that the teams are the unit of analysis, not the individuals. Table rows are ordered by descending size of baseline/follow-up difference.

**Column describes the statistical significance between baseline and follow-up responses. “n.s.” indicates no statistically significant difference.

***Numbers in the parentheses indicate the number of respondents who responded on the baseline and follow-up surveys, respectively.

Figure 4-1 illustrates the same trainee information in another way, showing the mean understanding ratings on each of the nine BMC components for baseline and follow-up.

Figure 4-1: Trainee Baseline and Follow-up Understanding of Business Model Canvas Components (n=10)*



* Respondents providing a “4” or “5” rating on a 5-point scale, where 1 equals *not at all knowledgeable* and 5 equals *very knowledgeable*.

4.2 SHARED KNOWLEDGE

Trainees shared knowledge. Respondents reported informing others in their lab about the business model canvas approach after completing the Energy I-Corps training. Forty-one percent (41%) of respondents reported sharing the ideas with interested colleagues, and two respondents had already conducted presentations for other groups in the lab (Table 4-6).

Table 4-6: Trainee Activities to Promote Business Model Canvas Approach (n=23) (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Count	Percent
Discussion with colleagues who are interested (fellow researchers, managers, etc.)	9	41%
Nothing yet; not yet but plan to inform others in my lab	6	27%
Planning a lab-wide presentation for the near future	5	23%
Presentations for other lab groups	2	9%
Kept supervisor and lab directors apprised of Energy I-Corps activities	1	5%
Advocated for similar training for all Principal Investigators	1	5%
Total Respondents	**22**	**--%**

4.3 TEAMS POSITIONED FOR CONTINUED COMMERCIALIZATION ACTIVITIES

Most (83%) of trainee follow-up survey respondents somewhat or completely agreed with the statement "I have a go-to-market strategy for my technology that includes target customer segments, channels, and pricing tactics and/or the appropriate licensing partner to get to market."[31]

Respondents indicating they had reached a "go" decision assessed the likelihood that they would continue conducting commercialization activities on their pilot technology during the next three months. Eighty-nine percent reported they were highly likely (a rating of "5") or likely (a rating of "4") to continue (Table B-2 in Appendix B). One respondent provided a "3" rating and explained that the technology was not ready and that the team needed additional funding to complete interviews and find next-step partners.[32]

Two respondents (9%) stated that they *don't know* and just one (4%) indicated the team had reached a "no-go" decision, due to "the [lack of] maturity of our technology and challenge[s] associated with capital investment in downstream processing equipment."

Respondents who in the follow-up survey stated that they were likely to conduct commercialization activities in future years were asked about their efforts to further fund

[31] The average rating was 4.0, on a 5-point scale where 1 equals completely disagree and 5 equals completely agree.

[32] One additional respondent had replied "don't know" to the question of likelihood of continuing commercialization activities.

their work on their Energy I-Corps technology. Three of the 22 reported they had received funding (or a commitment to fund) for late stage development or commercialization, and six reported they were in discussion with potential funders (Table 4-7). Most commonly, respondents said they were interested in pursuing funding, but were not in active discussions with funders. Those who said that they had received additional funding reported that the source was DOE. The respondents in discussion with funders reported a variety of sources such as governmental organizations (3 respondents), CRADAs with industry (2 respondents), venture capitalists (1 respondent), oil and gas companies (1 respondent), and lab internal discretionary funding (1 respondent).

Table 4-7: Trainee Efforts to Further Fund Work on Energy I-Corps Technology (n=22)

Response	Count	Percent
Interested in pursuing funding, but not in active discussion with funders	9	40%
In discussion with funders	6	24%
Received funding	3	12%
Looking for more funding from DOE (LDRD, CRADA, etc.)*	4	12%
Do not plan to pursue additional funding in the next year	1	4%
Total	**22**	**100%**

LDRD = Laboratory Directed Research and Development

More than 80% of trainees are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of *subsequent* innovations. About three-fourths (74%) rated themselves *highly likely* (a rating of “5”), and another 3 (13%) rated themselves *likely* (a rating of “4”) on this question in the follow-up survey.

4.4 TRAINEE SATISFACTION

Nearly all trainee follow-up survey respondents (92%) reported the Energy I-Corps training exceeded their expectations (50% said “exceeded,” 42% said “greatly exceeded"), with the remaining two respondents indicated the training met their expectations.[33]

About 95% of trainee follow-up survey respondents agreed or completely agreed that they understand their technologies' value proposition, the next three things they need to do to continue to commercialize their technologies, and who would make decisions to buy their technology and what attributes they continue buying (Table 4-8).

Table 4-8: Trainee Understanding of Their Technologies' Commercialization Positioning (n=23)

Statement	Agree or Completely Agree		
	Count	Percent	Average Rating*
I understand my technologies' value proposition (the potential for my technology to provide value to a specific customer)	23	96%	4.77
I have a clear understanding of the next three things I need to do to continue to commercialize my technology	23	96%	4.57
I have a clear understanding of who makes the buy decision for my technology, and the attributes they consider in buying	23	96%	4.45

* Average ratings exclude respondents who indicated that an item was done prior to Energy I-Corps involvement. Average ratings were based on a 5-point scale where 1 equals completely disagree and 5 equals completely agree.

All respondents agreed the Energy I-Corps training gave them new skills and broadened their understanding of the commercialization process (Table 4-9). All or most respondents agreed the training methods were appropriate to the training objectives.

[33] Response options: Did not meet at all, partially met, met, exceeded, greatly exceeded. Appendix B *Additional Findings from Energy I-Corps Baseline and Follow-up Surveys* provides additional survey responses, including baseline survey statements of expectations for the training and baseline and follow-up interest in commercialization activities.

Table 4-9: Trainee Assessment of Effectiveness of Training (n=23)

Statement	Agree or Completely Agree*		
	Count	Percent	Average Rating
Training Built Skills and Understanding			
Energy I-Corps gave me new skills that will be useful in my commercialization activities (n=23)	23	100%	4.9
Participation in Energy I-Corps broadened my understanding of the commercialization process (n=23)	23	100%	4.7
Training Methods Appropriate			
The teaching team encouraged appropriate levels of participation by trainees (n=23)	23	100%	4.8
Overall, activities were well suited to the learning objectives of the course (n=23)	23	96%	4.4
The teaching team provided relevant critique/feedback to trainees (n=23)	23	91%	4.5
The education climate was conducive to learning (n=23)	23	100%	4.5
The teaching team motivated us to do our best work (n=22)	22	95%	4.4

* A 5-point scale where 1 equals *completely disagree* and 5 equals *completely agree.* Ratings of "4" or "5" are tallied as "agree" or "completely agree." Average rating is average of all responses.

Trainees favorably rated all training components as defined by the training agenda, with roughly at least two-thirds of respondents rating the components as valuable or high value (Table 4-10).

Table 4-10: Trainee Assessment of Value of Energy I-Corps Training Activities (n=23)

Activity	Average Rating*	Count	
		Valuable or High Value	Don't know
Customer discovery	4.87	23	0
Office hours (one-on-ones)	4.30	21	0
Networking (workshop, reception)	4.26	18	0
Team presentations	4.00	17	0
Lectures	3.91	14	1
Weekly web-based sessions	3.83	16	0

* A 5-point scale where 1 equals *no value* and 5 equals *high value*. Ratings of "4" or "5" are tallied as "valuable" or "high value." Average ratings exclude don't know and NA responses.

More than 90% of trainee follow-up survey respondents believed the activities they learned through Energy I-Corps are a good fit with their professional goals, although about half that many (39%) believe the activities align with how their lab management assesses their performance (Table 4-11). Over three-quarters believed the activities were a good fit with goals of their lab's Technology Transfer Office (TTO). Responses suggest the composition of the first Energy I-Corps cohort – that of lab scientists and engineers – was appropriate; relatively few respondents agree that the activities are a good fit for post-doctoral researchers (post-docs) at their labs.

Table 4-11: Trainee Assessment of Energy I-Corps Alignment with Lab Professional Culture (n=23)

The activities I learned through Energy I-Corps are a good fit with…	Agree or Completely Agree*		
	Count	Percent	Average Rating
My professional goals	22	96%	4.70
The role of my lab's technology transfer office	18	78%	4.35
My understanding of the professional goals of many of my lab's established researchers	14	61%	3.52
How lab management assesses my performance	9	39%	3.22
Post-doc positions	5	22%	2.91

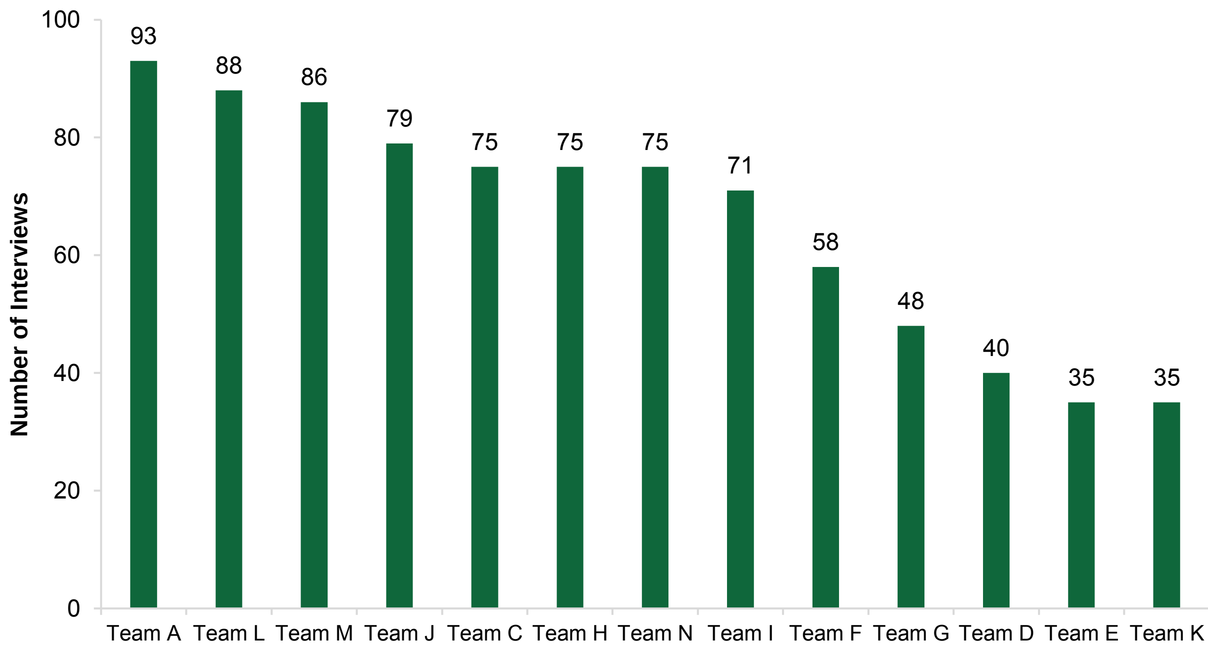
* Rating on a 5-point scale, where 1 equals *not at all agree* and 5 equals *completely agree.*

4.5 TRAINEES UNDERTOOK CUSTOMER DISCOVERY AND OTHER COMMERCIALIZATION ACTIVITIES

Respondents reported conducting or participating in an average of 69 customer discovery interviews and had scheduled approximately 35 more.[34,35] Across teams, the number of completed interviews ranged from 35 to 93 (Figure 4-2), with 10 of the 13 teams reporting interviews within the target Energy I-Corps range of 50 to 100 interviews per team. One member of a teams that conducted fewer than 50 interviews offered this comment in its suggestions to improve subsequent trainings:

> *The [target] number of interviews (100) is unrealistic, and in the case of a technical field like ours (wind), it is really a matter a quality interviews. You would know whether you have verified hypotheses pretty quickly. In my case, after 3 interviews, I realized where we stood and what else should be done in the technology development to arrive at a successful product. It was good to have reinforcement, but the emphasis on too many interviews as opposed to targeted interviews is not useful. For other technologies, with a much larger customer base (web/phone apps etc.) that may make more sense.*

Figure 4-2 : Customer Discovery Interviews by Trainee Team (n=13)

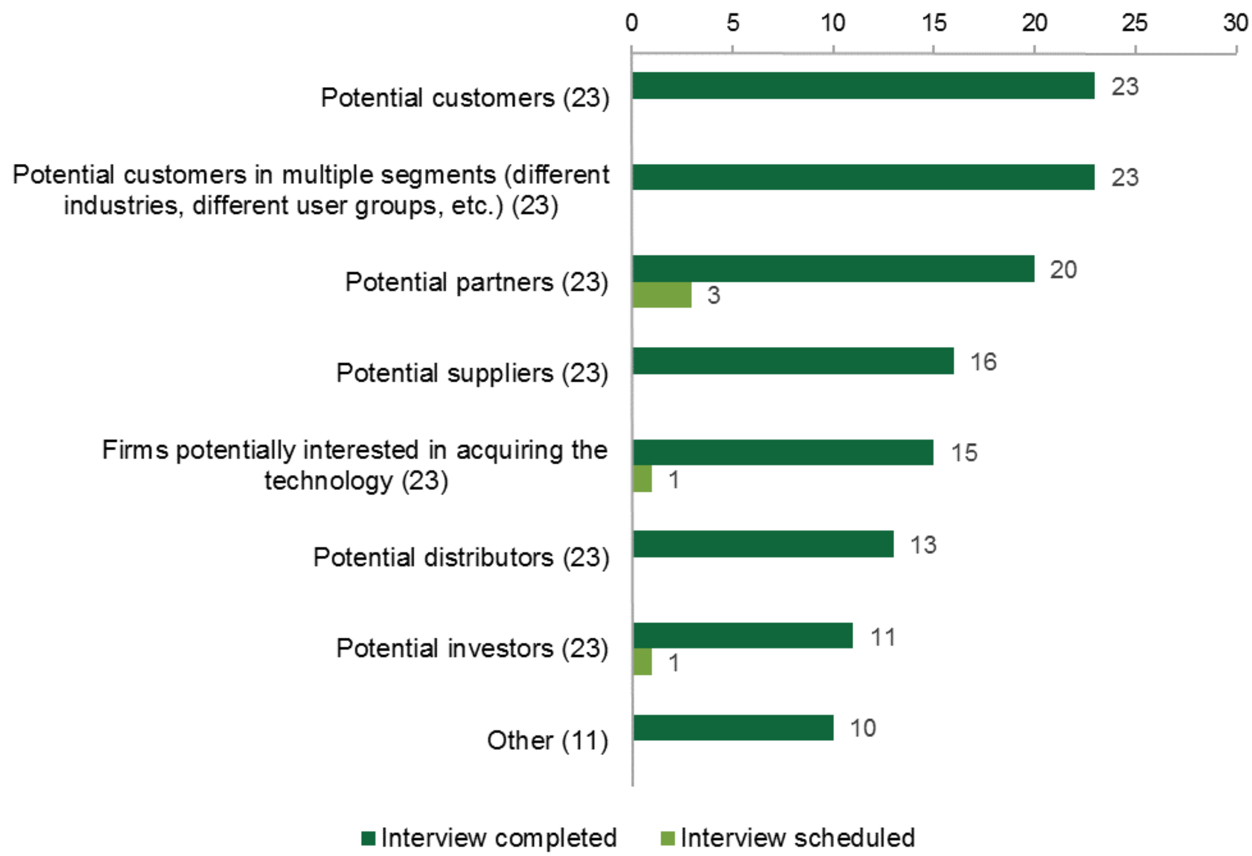


[34] Although the training terminology refers to these as "customer discovery" interviews, the interview contacts include potential customers, partners, suppliers, distributors, and more.

[35] Respondents could have conducted interviews individually or as part of a team.

Respondents interviewed a variety of types of potential customers – including those in multiple segments (such as different industries), as well as potential partners, suppliers, distributors, investors, and firms potentially interested in acquiring the technology (Figure 4-3).

Figure 4-3: Number of Trainees Conducting or Participating in Interviews by Stakeholder Type (n=23)



4.6 TRAINEES WORKLOAD AND FUNDING CHALLENGES

4.6.1 Workload Increase

Trainee workload increased substantially during training. In response to a baseline survey open-ended question eliciting any concerns respondents had about the upcoming training, four of 17 respondents mentioned the anticipated time commitment.

Nearly two-thirds of trainee follow-up survey respondents described their workload as increasing *substantially* during the prior six weeks compared to their typical workload prior to the Energy I-Corps training (Table 4-12). One respondent noted that his or her "workload actually decreased thanks to management's understanding." Respondents on the same team generally provided identical or similar responses. Labs with more than one team had consistent assessments of their experiences with the workload.

Table 4-12: Trainee Assessment of Workload during Energy I-Corps Training (n=23)

Response	Count	Percent
Decreased*	1	4%
Remained about the same	2	9%
Increased somewhat	5	22%
Increased substantially	15	65%
Total	**23**	**100%**

* One respondent reported this as “other,” which we incorporated with the existing categories of options included on the survey.

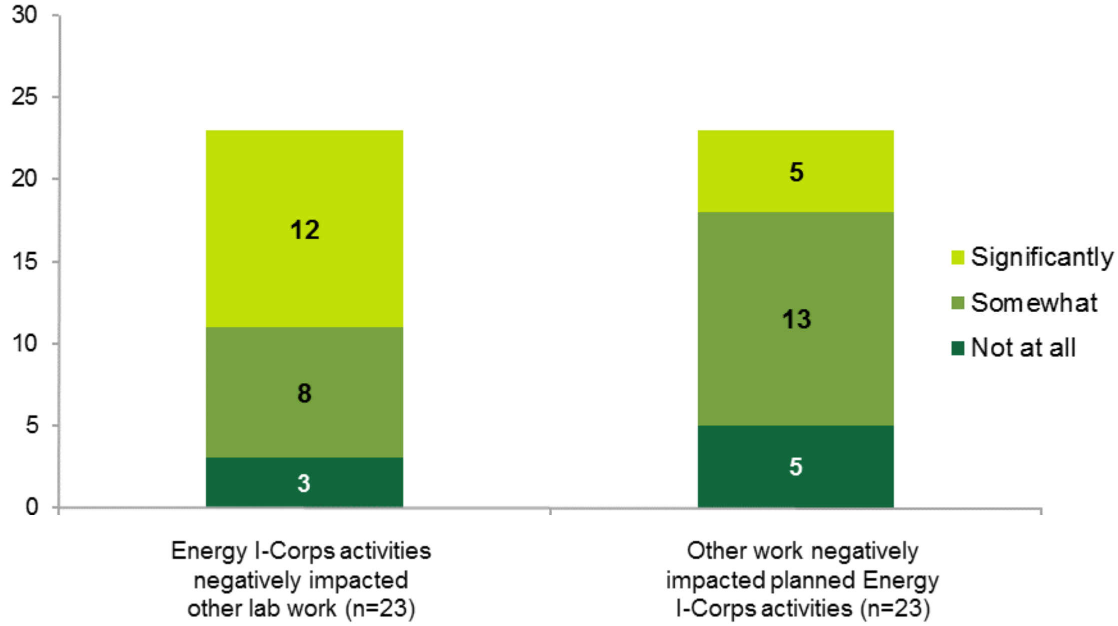
Nearly two-thirds of respondents reported in the follow-up survey that they spent more than 20 hours a week on Energy I-Corps activities (Table 4-13).

Table 4-13: Average Number of Hours per Week Trainees Spent on Energy I-Corps Activity (n=22)

Number of Hours	Count	Percent
1 to 10 hours	3	14%
11 to 20 hours	3	14%
21 to 30 hours	8	36%
31 to 40 hours	5	23%
41 to 50 hours	3	14%
Total	**22**	**100%**

Twelve of the 23 respondents (52%) described their Energy I-Corps related work as having a *significant* negative impact on their ability to meet ongoing responsibilities (Figure 4-4). Yet some of the respondents’ ongoing responsibilities could not be postponed and thus cut into their time available for Energy I-Corps; for the 22% of respondents who indicated their other lab work had a *significant* negative impact on planned Energy I-Corps activities, one can infer they would have spent more time on Energy I-Corps could they have negotiated it.

Figure 4-4: Trainee Assessment of Balance of Energy I-Corps and Other Lab Responsibilities (n=23)



4.6.2 Funding Provided for Training Sufficient for Two-Thirds of Respondents

In the follow-up survey, one-third of respondents (39%) indicated they did not think the funding provided for training was sufficient to accomplish their planned Energy I-Corps related activities (Table 4-14). There was little variation in the responses within teams and within labs. There were only two teams (at separate labs) whose respondents differed in their assessments of whether the level of funding was sufficient.

Table 4-14: Was Energy I-Corps funding sufficient to cover the accomplishment of your planned Energy I-Corps related activities? (n=23)

Response	Count	Percent
Yes	14	61%
No	9	39%
Total	**23**	**100%**

Among seven respondents who described the funding as insufficient, four said that 20% more funding would likely cover the costs of their activities and three said that 30% or more funding would have been needed (Table 4-15).

Table 4-15: About how much additional funding would you likely have needed to cover the accomplishment of your planned Energy I-Corps related activities? (n=7)

Response	Count	Percent
Up to about 10% more funding	0	0%
Up to about 20% more funding	4	57%
Up to about 30% more funding	1	14%
More than 30% more funding	2	29%
Total	**7**	**100%**

These seven individuals who said that funding was insufficient represented four different teams from three different labs.

4.7 TRAINEE RECOMMENDATIONS

Trainee follow-up survey respondents provided suggestions to improve the Energy I-Corps training, most commonly referring to the curriculum and content of the training (50%) and course length/organization (42%; Table 4-16). Suggestions regarding the curriculum indicated that many respondents thought it preferable to have a longer course (such as 12 weeks), as well as using advance preparation time for reading and videos. Respondents also valued the one-on-one feedback and recommended offering more of it. Those who commented on the course length and organization wanted to have more examples from case studies or other sources and felt that there should be less focus on the start-up option for commercialization.

Table 4-16: Trainees Suggested Improvements to Labs-Corps Training (n=24) (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Count	Suggestion
Structure, length, organization	10	• Lengthen course and/or shorter days: ▪ 12-week course (4) ▪ Add 1 day ▪ Reduce evening activities; shorter days • Advance preparation ▪ 1-2-week advance preparation, for reading and videos (2) ▪ All opening session homework should be due at outset ▪ More time for industrial partners to prepare prior to start • Other restructuring ▪ More one-on-one feedback (2) ▪ Teach all classes in first 1-2 weeks and cover remaining content in webinars, key notes, team presentations ▪ Provide more classwork time and reduce lectures ▪ Smaller groups for the weekly webinars ▪ Three meetings at the Node ▪ Improve structure for workshops during the face-to-face training
Content	12	• Tighter content, deeper dive ▪ Reduce duplication and redundancy (2) ▪ Offer tighter lecture-based curriculum, more geared to lab experience ▪ Delve deeper into content, with fewer overviews ▪ More general business training (e.g., how to do a market analysis) ▪ Explain TRL stage that is most effective for customer discovery process ▪ Content was not directly applicable to lab product development environment

Response	Count	Suggestion
		• Less focus on startups ▪ Provide more examples to commercialization pathways, such as licensing and partnerships for non-startup technologies (2) • Increase examples and discussion ▪ Provide more case studies and examples (e.g., BMC principles, startups that went through the process) (2) ▪ Include more discussion, and focus on investment readiness level • Other content suggestions ▪ Include lecture on conflicts of interest (within and across teams) (2) ▪ Videos were not very useful; reduce emphasis on team videos (2) ▪ Have anonymous feedback from instructors, especially at end ▪ Add investor pitch at end of course
Interviewing	7	• Provide greater guidance on interviewing ▪ Provide concrete examples and techniques for interviewing, including templates for open-ended questioning; share best practices (4) ▪ Include more training/exercises on value proposition and testable hypotheses (2) ▪ Have teams complete several interviews before the first full-cohort in-person meeting ▪ Have teams share initial interview experiences • Reconsider number of interviews assigned ▪ Emphasize quality versus quantity for interviews; require a manageable level of interviews (75+ is too many) (2)

Response	Count	Suggestion
Faculty/team composition	5	• Faculty composition ▪ Include faculty/advisor with expertise in each technology market (2) ▪ Include faculty with experience working with DOE labs • Team composition ▪ Have one external party on each team ▪ Combine teams with different backgrounds to share best practices and lessons learned ▪ Include a more equal distribution of responsibility between the EL and the PI
Tools	2	• Tools ▪ Improve webinar tools, update weekly webinar outline to match mentors' objectives ▪ Demonstrate how to best work with Launchpad Central (or similar tool) at the beginning of the training
Follow-up	1	• Provide follow-on funding to implement lessons learned at Energy I-Corps training

Both the baseline and follow-up surveys solicited suggested changes respondents' labs could undertake that might increase commercialization activity among lab researchers (Table 4-17).[36]

[36] For full listing of responses from the baseline and follow-up surveys, see Table 8-5.

Table 4-17: Trainee Suggestions for Lab Changes to Support Commercialization (Coded from Open-ended Survey Responses; Multiple Responses)

Suggestions	Baseline (n=10)	Follow-up (n=20)
Increase financial resources available to directly support commercialization activities	5	4
Offer more education and training opportunities	4	-
Provide clear mechanisms for turning good ideas into Laboratory Directed R&D (LDRD) projects, licenses, and new companies	-	3
Offer or improve leave of absence policy to work on commercialization activities	3	3

Nearly one-fifth of baseline survey respondents (5 of 28) reported they had been involved in other initiatives that develop entrepreneurial skills.

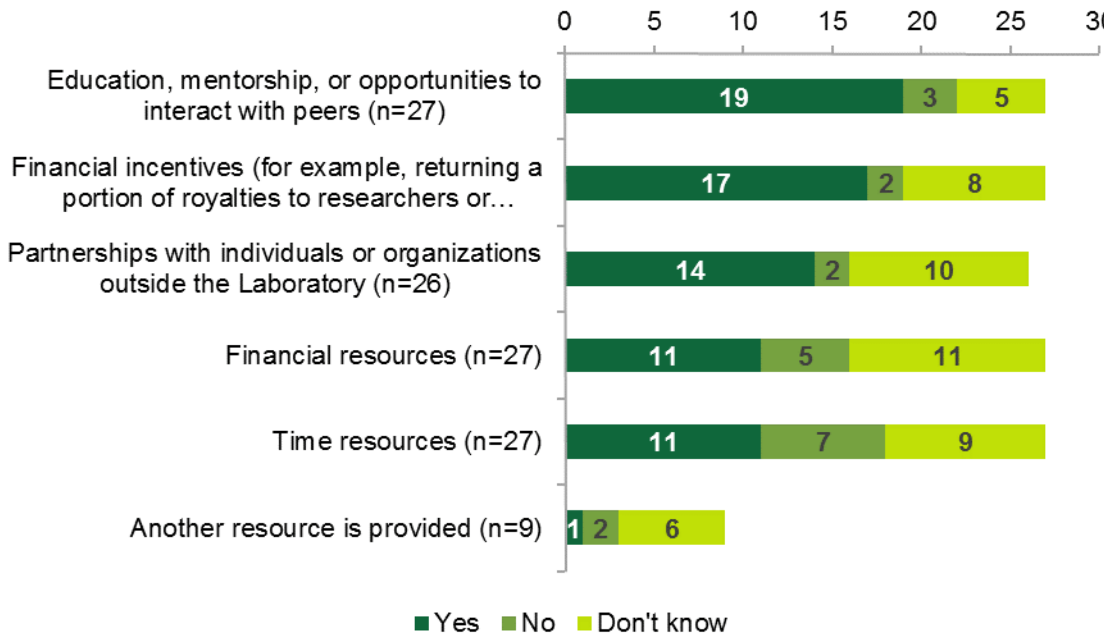
Over two-thirds of the baseline survey respondents described their labs as supportive of activities related to the commercialization process.[37] Trainee baseline survey respondents described the types of resources they were aware that their labs provide to support the commercialization process (Figure 4-5). More than half of respondents indicated their labs offered the following resources. However, few (13%) respondents believed lab staff commonly take advantage of the commercialization-support resources their labs offer.[38]

- Education, mentorship, or opportunities to interact with peers (70%)
- Financial incentives such as returning a portion of royalties to researchers or offering entrepreneurial leave (63%)
- Partnerships with individuals or organizations outside of the lab (54%)

[37] Eight of 29 respondents (28%) rated their Lab supportiveness a "5," 12 (41%) rated it a "4," 6 (21%) rated it a "3," and 2 (7%) answered "don't know", using a 5-point scale where 1 equals *not at all supportive* and 5 equals *very supportive.*

[38] These respondents provided ratings of "4" and "5" on a 5-point scale where 1 equals *not at all common* and 5 equals *very common.*

Figure 4-5: Resources Labs Provide to Support the Commercialization Process



4.8 LESSONS LEARNED

1. Trainees report an increase in their commercialization knowledge and skills, and the richness with which they understand their technologies' fit with the market.
2. Early indicators appear to confirm the hypothesis that commercialization knowledge will pass from trained researchers to their colleagues, as posited by the logic model.
3. Most trainees appear to leave training with an increased understanding of the next steps needed to move their technologies along the commercialization continuum, although there is little evidence that they know the institutional supports for those next steps.
4. The training demands a substantial time commitment from trainees, and thus has some negative affect on trainees' concurrent research activities. Similarly, trainees' concurrent research has some negative affect on their Energy I-Corps activities.
5. Although highly satisfied with the training, trainees offered several suggestions for improving it.

Section 5 Nonparticipant Baseline and Knowledge Gain

This section first compares the trainee and nonparticipant baseline survey responses to establish the nonparticipants as a comparison group. Next, it examines Energy I-Corps' influence on the nonparticipants, as eight of the nine respondents described how the process of being considered for participation in the Energy I-Corps (then termed Lab-Corps) training, as well as their exposure to Energy I-Corps ideas from the trainees, influenced their actions since the baseline survey. Next, it compares trainee and nonparticipant commercialization knowledge gain over the period by presenting the baseline and follow-up survey responses of trainee and nonparticipants. The section concludes with nonparticipants' suggestions to improve lab commercialization support.

We note that the nonparticipant respondents were PIs for their technologies; thus, all comparisons between trainee and nonparticipant responses are limited to PI trainees (that is, the comparisons do not include trainee EL responses).

The Node Lab administered nonparticipant baseline and follow-up web-based surveys to the proposed principal investigators and/entrepreneurial leads of nonparticipating teams that the labs had considered but not selected for cohort 1 participation.[39] The nonparticipant sample is restricted to those candidate teams most like the participating teams – those teams the lab pilot managers indicated were runner-up applicants. The nonparticipating teams used in the sample came from four of the seven labs that fielded participating teams (Table 5-1).

Table 5-1: Number of Nonparticipant Respondents by Lab and Survey Wave

Organization	Baseline and Follow-up survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
ANL	1	1	2	2	3
INL	2	0	2	0	2
LLNL	3	0	3	0	3
SNL	1	1	2	0	1
Total	**7**	**2**	**9**	**2**	**9**

[39] The Node fielded the web-based nonparticipant baseline survey from October 2 to October 23, 2015, with an initial distribution and four follow-up emails to nudge nonrespondents. The Node fielded the web-based nonparticipant follow-up survey from April 4 to April 13, 2016, with an initial distribution and weekly follow-up emails to nonrespondents.

Members of every candidate team in the nonparticipant sample responded to one or more surveys (Table 5-2).[40]

Table 5-2: Number of Respondents by Candidate Team and Survey Wave

Technology Team	Baseline and Follow-up Survey	Baseline Survey		Follow-up Survey	
		Only	Total	Only	Total
AD Up	0	1	1	2	2
CO2 Geostorage Energy Systems	2	0	2	0	2
Evolution Transportation	1	0	1	0	1
Impedance Measurement Box	1	0	1	0	1
Laser-Less Time-Resolved Depth-of-Field Controlled Particle Image Velocimetry	1	0	1	0	1
Novel Continuous-Flow Microreactor	1	0	1	0	1
Sea-going Algae Biorefinery	0	1	1	0	0
Water Sampler Concentrator	1	0	1	0	1
Total	**7**	**2**	**9**	**2**	**9**

The comparison of the nonparticipant and trainee samples contributes to the interpretation of Energy I-Corps influence. Yet, as described in Section 2.8 *Nonparticipant Sample,* the nonparticipants have had exposure to, and thus may have been influenced by, Energy I-Corps. Indeed, one pilot goal is knowledge transfer from trainees to their colleagues (see Section 4.2, *Shared Knowledge*). Accordingly, our survey sought information on, and our analysis calls out, Energy I-Corps influence on nonparticipant commercialization activities after the time they were considered for participation.

[40] One nonparticipant from the Ad Up team completed a baseline survey but did not include his or her name on the survey. The evaluation team attempted to match this survey with one of the two follow-up surveys, but there was not enough bridging information to do so. Consequently, these baseline and follow-up survey responses are reported separately (that is, they are not matched by individual).

5.1 BASELINE COMPARISON OF TRAINEES AND NONPARTICIPANTS

PI trainees were more likely than nonparticipants to indicate in baseline responses that they were knowledgeable about the components of the business model canvas. Customer segments and archetypes, customer relations, and value propositions are all areas where PI trainees were statistically more likely than nonparticipants to report a "4" or "5" rating (Table 5-3). Note, however, that familiarity with the business model canvas components does not equate with understanding the technology commercialization process, which we discuss next.

Table 5-3: Trainee and Nonparticipant Baseline Understanding of Business Model Canvas Components*

Response	Percent "4" or "5"**				Statistical Significance***
	PI Trainees (n=14)		Nonparticipants (n=9)		
	Count	Percent	Count	Percent	
Customer segments, customer archetypes	3	21%	0	0%	p <0.10
Customer relationships	3	21%	0	0%	p <0.10
Value propositions	7	50%	0	11%	p <0.05
Key activities	1	7%	0	0%	n.s.
Key partners, suppliers	2	14%	0	0%	n.s.

* Table 5-3 differs from comparable data presented in Table 4-5 in the following respects: (1) Table 4-5 shows results for all trainees, while Table 5-3 shows results for PI trainees only, for comparability with the nonparticipant respondents. (2) Table 4-5 presents all nine business model canvas components, while Table 5-3 lists five components. We fielded to nonparticipants shorter surveys than we fielded to participants with the goal of maximizing the response rate, given that nonparticipants had no incentive to complete the survey.

** Percentage of respondents providing a "4" or "5" rating on a 5-point scale, where 1 equals not at all knowledgeable and 5 equals very knowledgeable.

*** Column describes the statistical significance between trainee and nonparticipants responses. "n.s." indicates no statistically significant difference.

Responses suggest no statistically significant differences between PI trainees and nonparticipants in their baseline understanding of the technology commercialization process (Table 5-4). The similarity between PI trainees and nonparticipants in their baseline survey understanding of the technology commercialization process suggest that the follow-up survey differences between trainees and nonparticipants shown subsequently are indicative of a positive Energy I-Corps effect.

Table 5-4: Trainee and Nonparticipant Baseline Understanding of the Technology Commercialization Process*

Rating	PI Trainees (n=14)		Nonparticipants (n=9)		Statistical Significance**
	Count	Percent	Count	Percent	
1 – No understanding	1	7%	0	0%	n.s.
2	2	14%	2	22%	n.s.
3	8	57%	4	44%	n.s.
4	2	14%	2	22%	n.s.
5 – A great deal of understanding	1	7%	1	11%	n.s.

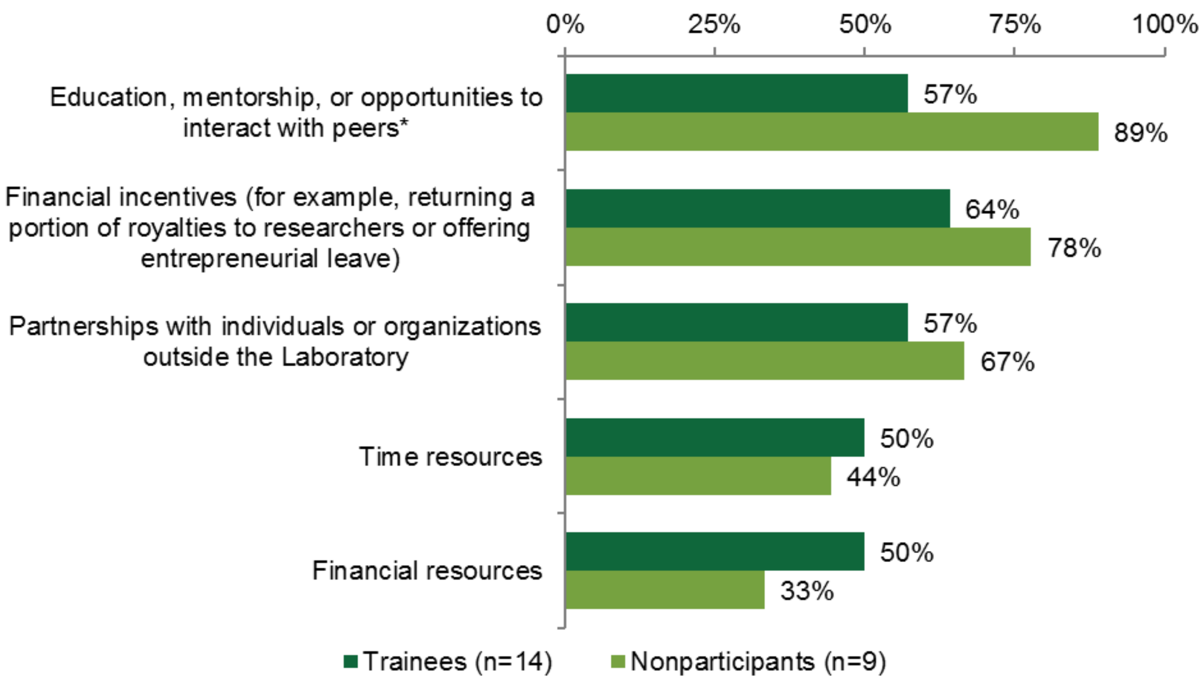
* Table 5-4 differs from comparable data presented in Table 4-5 because Table 4-5 shows results for all trainees, while Table 5-4 shows results for PI trainees only, for comparability with the nonparticipant respondents.

** Column describes the statistical significance between trainee and nonparticipants responses. “n.s.” indicates no statistically significant difference.

When asked on the baseline survey about the resources that their labs provide to support the commercialization process, nonparticipants were significantly more likely than PI trainees to indicate that they benefit from education, mentorship, or opportunities to interact with peers (89% versus 57%, see Figure 5-1 and Table 5-5). This difference was statistically significant. Nonparticipants were also more likely to report receiving financial incentives (78% versus 64%) and having partnerships with individuals or other organizations outside of the lab (67% versus 57%), although these differences were not statistically significant. PI trainees, on the other hand, were more likely than nonparticipants to indicate that they receive time resources (50% versus

44%) or financial resources (50% versus 33%); in each of these areas there were no statistically significant differences.

Figure 5-1: Resources Labs Provide to Support the Commercialization Process



* Significant differences between participants and nonparticipants (p <0.10).

Table 5-5: Trainee and Nonparticipant Indentification of Resources Labs Provide to Support the Commercialization Process*

Lab Supports	PI Trainees (n=14)		Nonparticipants (n=9)		Statistical Significance**
	Count	Percent	Count	Percent	
Education, mentorship, or opportunities to interact with peers*	8	57%	8	89%	p <0.10
Financial incentives (for example, returning a portion of royalties to researchers or offering entrepreneurial leave)	9	64%	7	78%	n.s.
Partnerships with individuals or organizations outside the laboratory	8	57%	6	67%	n.s.
Time resources	7	50%	4	44%	n.s.
Financial resources	7	50%	3	33%	n.s.

* Table 5-5 differs from comparable data presented in Figure 4-5 because the figure shows results for all trainees, while Table 5-5 shows results for PI trainees only, for comparability with the nonparticipant respondents.

** Column describes the statistical significance between trainee and nonparticipants responses. “n.s.” indicates no statistically significant difference.

5.2 ENERGY I-CORPS INFLUENCE ON NONPARTICIPANTS

As discussed in Section 2.7, the nonparticipants were exposed to Energy I-Corps concepts during the application process. The follow-up survey asked nonparticipants several questions to assess the extent to which the Energy I-Corps pilot may have had an influence on them (Table 5-6). In addition, respondents had an opportunity through open-ended to responses to indicate other ways in which they felt the pilot influenced them. Results from the baseline survey reveal that eight of the nine nonparticipants reported some level of influence due to their exposure to the Energy I-Corps pilot.

Table 5-6: Energy I-Corps Influence on Nonparticipants' Commercialization Activities (n=9)*

Energy I-Corps Pilot Contributed to Decision to:	Count	Percent**
Learn more about commercialization (n=5)	4	80%
Undertake activities that led to increased understanding of market needs related to technology (n=7)	6	86%
Undertake activities that led to increased understanding of market commercialization routes (n=6)	5	83%
Conduct interviews with customers, suppliers, etc. about their technology (n=7)	5	71%
Present a business idea to investors (n=4)	4	100%
Found venture(s) to develop and sell products, or taken entrepreneurial leave (n=1)	1	100%
Have an invention be listed as background IP (intellectual property) in a CRADA (cooperative research and development agreement) (n=1)	0	0%

* Influence was determined by the number of respondents who indicated a rating of 3 or higher on a scale of 1 to 5 where 1 equals not at all and 5 equals a great deal. The total number of respondents for each item varies based on whether the respondents indicated that they had conducted such activities.

** Percent is relative to the number of respondents indicating they had conducted such activities.

When asked on the follow-up survey about the various ways in which they may have been influenced by Energy I-Corps, nonparticipants most commonly reported that they had discussed the training with participating lab teams (89%) and reviewed training materials (78%; Table 5-7).

Table 5-7: Nonparticipant Assessment of Energy I-Corps Influence (n=9)*

Response	Count	Percent
Discussed the Energy I-Corps training with participating lab teams	8	89%
Reviewed Energy I-Corps training materials	7	78%
Studied or reviewed commercialization books or other resources	5	56%
Completed any commercialization training	2	22%
Found another source of funding to pursue commercialization activities	2	22%

* Nonparticipants indicated their Energy I-Corps experiences had influenced the activities reported in this table.

The follow-up survey asked nonparticipants to indicate the extent to which their understanding of market needs related to their technology and their understanding of market commercialization routes had increased since October 2015 (Table 5-8). For each item, 33% of nonparticipant respondents gave a 4 or 5 rating, which is substantially lower than levels reported by trainees (92% and 83%, respectively; see Section 4.1).[41]

Table 5-8: Nonparticipant Increase in Understanding of Market Needs and Commercialization Routes (n=9)

Understanding of:	"4" or "5" Rating*	
	Count	Percent
Market needs related to your technology	3	33%
Market commercialization routes	3	33%

* Percentage of respondents providing a "4" or "5" rating on a 5-point scale, where 1 equals not at all in regards to increase in understanding and 5 equals a great deal of increase in understanding.

Nonparticipants generally reported that they intended to continue to conduct commercialization activities in the short- and longer-term (Table 5-9). Fifty-six percent of nonparticipants reported they were highly likely (a rating of "5") or likely (a rating of "4") to continue commercialization activities during the next three months, and 67% indicated that they would conduct such activities on subsequent innovations in future

[41] PI trainees were not asked these questions; consequently, we cannot make a direct comparison with nonparticipants on these two items.

years. In comparison, 89% of trainees who reached a “go” decision indicated that they were likely or highly likely to continue conducting commercialization activities on their pilot technology during the next three months while more than 80% of trainees reported they are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of subsequent innovations in future years (see Section 4.3).

Table 5-9: Nonparticipant Likelihood of Continuing Commercialization Activities (n=9)

Likelihood of conducting:	"4" or "5" Rating*	
	Count	Percent
Commercialization activities on their technology during the next three months	5	56%
Commercialization activities on subsequent *innovations* in *future years*	6	67%

* Percentage of respondents providing a “4” or “5” rating on a 5-point scale, where 1 equals not at all likely and 5 equals highly likely.

When asked about their efforts to further fund work on their technology, nonparticipants most commonly noted that they were conducting discussions with funders (56%). An additional 22% reported that they were interested in pursuing funding, but were not engaging in active discussions. One respondent indicated that he or she did not plan to pursue additional funding in the next year. These findings are not statistically different from those of PI trainees (Table 5-10).

Table 5-10: Trainee and Nonparticipant Efforts to Further Fund their Technology*

Response	PI Trainees (n=10)		Nonparticipants (n=9)		Statistical Significance**
	Count	Percent	Count	Percent	
Received funding	1	10%	0	0%	n.s.
In discussion with funders	3	30%	5	56%	n.s.
Interested in pursuing funding, but not in active discussion with funders	3	30%	2	22%	n.s.
Do not plan to pursue additional funding in the next year	1	10%	1	11%	n.s.
Looking for more funding from DOE (LDRD, CRADA, etc.)	2	20%	0	0%	n.s.
Don't know	0	0%	1	11%	n.s.

* Table 5-10 differs from comparable data presented in Table 4-7 because Table 4-7 shows results for all trainees, while Table 5-10 shows results for PI trainees only, for comparability with the nonparticipant respondents.

** Column describes the statistical significance between trainee and nonparticipants responses. "n.s." indicates no statistically significant difference.

5.3 TRAINEE AND NONPARTICIPANT KNOWLEDGE GAINS

This subsection compares the baseline and follow-up survey responses of nonparticipants with those of PI trainees. The samples for both groups are restricted to those individuals answering both the baseline and follow-up surveys.

PI trainees evidenced higher gains in their understanding of the elements of the business model canvas than did nonparticipants, consistent with an interpretation that the pilot is effective (Table 5-11).[42] Consistent with the baseline survey results presented above in Table 5-3, the PI trainees' baseline understanding of BMC elements exceeded that of the nonparticipants. (Note, however, that Table 5-11 reports only the responses of the 10 PI trainees that answered both the baseline and follow-up surveys, whereas Table 5-3 presented the results of all 14 trainees that answered the baseline

[42] Both trainees and nonparticipants were asked about their understanding of the elements of the business model canvas on the follow-up survey. To compare gains attributable to the pilot, trainees reported their understanding prior to training in the baseline survey, while nonparticipants retrospectively rated their understanding in these areas in the follow-up survey. (The nonparticipant baseline survey omitted this question to be as brief as possible.)

survey.) Trainees completed the baseline survey a week or two prior to the on-site instruction, but several months after they had been accepted into the pilot. By the time of the baseline survey, many of the trainees had acquired some familiarity with the BMC through lab-sponsored activities or self-initiated investigation prior to the on-site instruction.

Table 5-11: Trainee and Nonparticipant Baseline and Follow-up Understanding of Business Model Canvas Components*

Response	PI Trainees (n=10)			Nonparticipants (n=9)		
	Baseline	Follow-up	Significance**	Baseline	Follow-up	Significance**
Customer segments, customer archetypes	30%	100%	$p < 0.01$	0%	56%	$p < 0.01$
Customer relationships	30%	80%	$p < 0.05$	0%	44%	$p < 0.05$
Value propositions	60%	100%	$p < 0.05$	11%	56%	$p < 0.05$
Key activities	10%	50%	$p < 0.05$	0%	22%	n.s.
Key partners, suppliers	20%	67%***	$p < 0.05$	0%	22%	n.s.

* Percentage of respondents providing a “4” or “5” rating on a 5-point scale, where 1 equals *not at all knowledgeable* and 5 equals *very knowledgeable*. Table 5-11 differs from comparable data presented in Table 4-5 in the following respects: (1) Table 4-5 shows results for all trainees, while Table 5-11 shows results for PI trainees only, for comparability with the nonparticipant respondents. (2) Table 4-5 presents all nine business model canvas components, while Table 5-11 lists five components. We fielded to nonparticipants shorter surveys than we fielded to participants with the goal of maximizing the response rate, given that nonparticipants had no incentive to complete the survey.

** Column describes the statistical significance between trainee and nonparticipants responses. “n.s.” indicates no statistically significant difference.

*** Nine trainees provided a response for this item.

PI trainees also reported a better understanding for their technologies’ commercialization positioning than did nonparticipants, again suggesting an interpretation that the pilot is effective (Table 5-12). Based on follow-up survey responses, PI trainees were statistically more likely than nonparticipants to report that they understand their technologies’ value proposition (100% versus 44%), have a clear understanding of who makes the buy decision and the attributes considered (100% versus 56%), and understand the next three steps needed to commercialize their technology (91% versus 22%).

Table 5-12: Trainee and Nonparticipant Understanding of Their Technologies' Commercialization Positioning*

Statement	Agree or Completely Agree				Statistical Significance**
	PI Trainees(n=11)		Nonparticipants (n=9)		
	Count	Percent	Count	Percent	
I understand my technologies' value proposition (the potential for my technology to provide value to a specific customer)	11	100%	4	44%	$p < 0.01$
I have a clear understanding of who makes the buy decision for my technology, and the attributes they consider in buying	11	100%	5	56%	$p < 0.05$
I have a clear understanding of the next three things I need to do to continue to commercialize my technology	10	91%	2	22%	$p < 0.01$

* Percentage of respondents providing a "4" or "5" rating on a 5-point scale, where 1 equals *completely disagree* and 5 equals *completely agree*. Table 5-12 differs from comparable data presented in Table 4-9 because Table 4-9 shows results for all trainees, while Table 5-12 shows results for PI trainees only, for comparability with the nonparticipant respondents.

** Column describes the statistical significance between trainee and nonparticipants responses. "n.s." indicates no statistically significant difference.

5.4 NONPARTICIPANT SUGGESTIONS TO IMPROVE LABS COMMERCIALIZATION SUPPORT

The baseline and follow-up surveys asked nonparticipants to provide suggestions for how their labs might better support commercialization activities. On both surveys, nonparticipants most commonly recommended additional funding for time or resources to support these activities. Nonparticipants also frequently mentioned a need for a cultural shift to support or accept such work (Table 5-13).

Table 5-13: Nonparticipant Suggestions to Support Researcher Activity in Commercialization Processes (n=9)

Response	Nonparticipants			
	Baseline		Follow-up	
	Count	Percent	Count	Percent
Funding/billable time available to support commercialization activities; increase funding/resources to support commercialization	5	56%	4	50%
Include commercialization in job descriptions and performance reviews; provide researchers incentives	1	11%	1	13%
Cultural acceptance of entrepreneurial activity; allow scientists to participate in both R&D and commercialization; align lab activities with Energy I-Corps-type approach	4	44%	3	38%
Raise awareness; motivate with success stories and case studies	1	11%	0	0%
Increase mid-management buy-in and excitement, such as rewarding divisions for staff participating in training	2	22%	1	13%
Purchasing equipment to conduct pre-field scale trials	0	0%	1	13%
Total Respondents	9	--	8	--

5.5 NONPARTICIPANT RESPONSE TO THEIR ENERGY I-CORPS INVOLVEMENT

As discussed in Section 2.8 and at the outset of this section, surveyed nonparticipants were runner-up applicants in the trainee selection process. Nonparticipants had an opportunity to learn some of the concepts taught by Energy I-Corps through three routes – during the application process as they made the case to be selected for the training, after the selection of trainees as they pursued on their own interests that were piqued during the application process, and from trainees who shared some of the learnings with their lab colleagues (see Section 4.2, *Shared Knowledge*).

Four of the nine nonparticipants offered these comments about Energy I-Corps in their answers to open-response survey questions.

> *"The [Energy I-Corps] process has been instrumental in catalyzing our entrepreneurial and commercialization efforts. I cannot say how much I appreciate having been invited to the [Energy I-Corps] process. I sincerely believe that my innovative output has dramatically increased since becoming involved. …This process has developed into an exciting and highly motivating adventure that can lead to the industrial-scale deployment of technology needed to reduce the carbon and water intensity of energy in the U.S. and globally. …Nations and companies are looking for solutions to this global challenge, and the [Energy I-Corps] process has helped propel our entrepreneurial team to have a meaningful impact in meeting this challenge."*

> *"[Energy I-Corps] really opened my eyes to the business development and technology commercialization process. …The skills I've learned in [Energy I-Corps] about understanding and interviewing your vendors and their extended network is invaluable. I could not be more thrilled with the program and think that virtually all our PIs could get something useful out of the training. It helps to shift the focus from research purely for the sake of academic advancement to research in the name of making a tangible impact to large-scale problems that only national labs can. …[Energy I-Corps] is a critical breath of fresh air for the laboratory, not only in terms of increasing our sphere of influence in the national mission space, but also for increasing engagement and partnership opportunities in the private sector. …Please continue to strength [Energy I-Corps] and offer it to wider audience. We need this to help stay relevant in the face of increasing economic strength in the private sector!"*

> *"I had been considering trying to commercialize the technology for two years or so, but had never moved forward with the effort, mostly due to a lack of knowledge of how to do so. [Energy I-Corps] came at the VERY beginning of my first efforts toward commercialization."*

> *"We participated with the [Energy I-Corps] program [team recruitment process] and I met our business development team. Without [Energy I-Corps], I don't know that I would have ever been aware that they [the business development team] existed."*

5.6 SUMMARY OF ENERGY I-CORPS INFLUENCE SUGGESTED BY NONPARTICIPANT INVESTIGATION

The similarity between PI trainees and nonparticipants in their baseline survey understanding of the technology commercialization process suggest that PI trainees' greater increase from baseline to follow-up in knowledge and understanding relative to that of nonparticipants supports a conclusion that the Energy I-Corps training is effective. These data suggest (not definitively so) that we can rule out the main rival explanation that trainee team performance owed to their prior commercialization experience rather than to the training.

The nonparticipant survey responses also provide evidence that the pilot is influencing the knowledge, attitudes, and activities of nonparticipant lab researchers beyond those that receive training, consistent with the pilot's logic.

Section 6 Early Outcomes as Described by Participants

This section presents findings from Energy I-Corps' first cohort participants, including Node Lab pilot managers, Site Lab pilot managers, technology teams (trainees), and faculty, obtained through the methods identified in Section 2 (in-depth interviews, onsite observation, informal interviews, and surveys). This section uses the term "lab pilot managers" to refer to Energy I-Corps managers in both Node and Site Labs, and uses the team "pilot participants" to describe the lab pilot managers and the cohort 1 technology teams and faculty.[43]

6.1 PARTICIPATING LABS ANTICIPATE WIDE-RANGING OUTCOMES

Increased or enhanced technology commercialization is just one of many outcomes lab pilot managers anticipate will result from their Energy I-Corps participation, based on their experiences in fall 2015. The lab pilot managers all reported benefits of their participation that extended well beyond the increased knowledge of effective commercialization methods.

Table 6-1 presents the managers' anticipated quantitative outcomes (that is, outcomes that can be tracked and counted), their anticipated qualitative outcomes (which can be assessed), and associates each outcome with possible revenue and process benefits the labs would accrue and/or broader economic development effects.

Table 6-1: Lab Pilot Managers' Anticipated Outcomes from Energy I-Corps (Coded from Open-ended Interview Responses)

Anticipated Outcomes	Associated Benefits		
	Revenues	Process	Economic Development
Quantitative (Trackable)			
Startup/spin-out	✓	✓	✓
Publication, conference presentation		✓	✓
License	✓	✓	✓
CRADA, SPP (formerly WFO)*	✓	✓	✓
SBIR/STTR/SBV funds received*	✓	✓	✓

[43] The qualitative (interview, observational) data obtained from technology teams include data from PIs, ELs, and IMs. The quantitative (survey) data from technology teams include data from PIs and ELs, as indicated in Section 4.

Anticipated Outcomes	Associated Benefits		
	Revenues	Process	Economic Development
User facility agreement*	✓	✓	✓
New external partners	✓	✓	
Qualitative (Assessable)			
Better research agendas	✓	✓	✓
Enhanced recruitment and retention of innovative staff	✓	✓	
Deeper relationship with external partners		✓	
Valuable skills gained by researchers, careers enhanced	✓	✓	✓
Partnership with another lab on research	✓	✓	

* See Glossary for definition of terms.

Lab pilot managers' positive response to the pilot stemmed in large part from the benefits Energy I-Corps afforded both their ongoing commercialization programs and their planned entrepreneurial program and policy expansions. The Node and Site Lab pilot managers all reported expecting benefits to accrue to their labs over time (Table 6-2).

Table 6-2: Lab Pilot Managers' Reported Benefits of Energy I-Corps (Coded from Open-ended Interview Responses)

	Site Labs					Node Lab
	ANL	INL	LBNL	LLNL/ SNL	PNNL	NREL
Mission alignment	✓	✓	✓	✓	✓	✓
Understanding of customer discovery and technology market role	✓	✓	✓		✓	✓
Increased lab interest in commercialization	✓			✓		✓
Provides evidence of customer interest		✓		✓		

	Site Labs					Node Lab
	ANL	INL	LBNL	LLNL/ SNL	PNNL	NREL
Business model training		✓		✓		
Commercialization assistance		✓				
Promotes entrepreneurship				✓		

* Source: Energy I-Corps Participating Lab Leads Baseline In-depth Interview Guide (Appendix I.2) Q17. Categorization of interview responses.

6.2 SOME PARTICIPATING LABS ANTICIPATE LICENSES, PARTNERSHIPS AND STARTUPS IN 2016

Lab pilot managers characterized several of the technology teams – perhaps as many as 5 of the 17 teams trained in 2015 (in the Michigan NSF I-Corps training and the fall Energy I-Corps training) – as well positioned by the end of the training to begin launching their technologies through licenses, partnerships, and even startups.[44] They anticipated these technologies might launch as soon as sometime in the coming year.

An unsystematic review of a few lab websites undertaken during the finalization of this report in April 2016 found a January 13, 2016 an announcement by LLNL that two of the LLNL/SNL teams (LLNL's C-Best, and SNL-California's TwistAct, which participated in the Michigan NSF I-Corps training) "are moving toward commercialization." The article continued, "About half of the national lab teams that participated in the Energy I-Corps program have chosen to go forward with their technologies, including the LLNL and Sandia projects, which could advance through startup companies, Werne [the deputy director for LLNL's Industrial Partnerships Office and the industry mentor on the C-Best team] said."[45]

EERE reports the current status of Energy I-Corps team activities at

https://energy.gov/eere/technology-to-market/energy-i-corps-teams

[44] Partnerships include the following elements from Table 6-1: CRADA, SPP, SBIR, STTR, SBV, user facility agreement, and new external partners.

[45] https://www.llnl.gov/news/labcorps-tech-moves-toward-commercialization, accessed April 20, 2016.

6.3 PILOT PARTICIPANTS SEE SIGNS OF EARLY POSITIVE OUTCOMES

Pilot participants (lab pilot managers, technology teams, and instructors) cited the following benefits already apparent from their participation in Energy I-Corps.

6.3.1 Knowledge Gain

Pilot participants characterized the knowledge they gained through Energy I-Corps participation as two-fold:

1. Increased technology-specific knowledge about the technology's path to commercialization; and
2. Acquisition of a scientific methodology – a method characterized by the formulation of hypotheses and empirical testing (through interviews and, to a lesser extent, secondary research) – that increases the effectiveness and speed of commercialization activities.

As described in Section 4.1, the baseline and follow-up survey responses given by trainees showed statistically significant increases in their understanding of five of the nine BMC components, and smaller increases in understanding of another three of the nine components. These five components evidencing statistically significant change in team knowledge correspond to the focus of the cohort 1 training, described by interviewed faculty; faculty reported less training focus on revenues, costs, and resources. Section 4 also documents insights, such as better understanding of market opportunities and of the value of the customer discovery process, the trainees attributed to the training.

Teams reported the training left them with a new understanding of, and respect for, the market's demands and business expertise—both areas in which the trainees said they had limited prior knowledge.

Finally, the training also gave pilot participants – researchers, faculty, and lab pilot managers – a common lexicon for discussing technology value. This common lexicon and the BMC structure clarified the complex, multifaceted endeavor of bringing an innovation to market, enabling teams to bring precision to thinking that previously suffered from generalities about market opportunities.

6.3.2 Pivots

Pilot participants agreed that all the technology teams refined their BMCs (that is, pivoting and repositioning their technologies to address market needs and conditions) in significant ways because of their participation, as illustrated most emphatically by the comments of one faculty member.

> *The initial BMC – even with the preparation we gave the teams – were almost universally wrong, unsuitable, and naïve. So having them participate in didactic webinars, [part of team preparation in advance of the onsite training, so that teams could develop initial BMCs] won't do it. By the end, in nearly every case, we saw major pivots in the initial markets. We saw tremendous depth in the value proposition refinement, and much better judgment of the overall opportunity.*

Interviewed faculty offered two caveats, however.

BMC development varied by team. It appears from faculty comments that about half of the teams made "remarkable" progress (these teams "were all extraordinary, far better than I thought they would be"). Most of the remaining seven teams made considerable progress yet did not reach the clarity regarding value proposition (a single concept that reflects the overall development of the multifaceted BMC) evidenced by the former group. Finally, both faculty and lab pilot managers characterized one or two teams as having more limited evolution of their BMCs. Interviewees attributed lack of motivation, discouragement owing to team member perceptions that their labs were not interested in or supportive of commercialization activities, or attitudes that there was little to be gained from training as they already knew their markets and paths to commercialization.

By design Energy I-Corps focuses on the technologies' ecosystems, a term interviewers used to indicate the people in a market and the connections among them (that is, customers, suppliers, and strategic partners – and the value proposition the technology offers them; customer segments, customer relationships, and market channels; and key activities/next steps).[46] Thus, while teams' BMCs substantively advanced during the training, the majority of BMCs remained undeveloped with respect to costs, revenues, and resources.

6.3.3 Refining Research Agendas

Several technology teams reported refining their research agendas for their technologies as result of the Energy I-Corps experiences, as illustrated by the words of one researcher during the closing day of training.

> *These six weeks of effort, while extremely demanding, has saved me a year of research that would have ultimately been unproductive.*

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[46] Lab-Corps (currently termed Energy I-Corps) provides limited treatment of costs and revenues and key resources. One instructor explained that when he guides startups through the Lean LaunchPad principles on which Lab-Corps is modeled, the training period is three to four months, in contrast to Lab-Corps' six weeks.

The benefit extends beyond the research associated with the teams' pilot technologies. Lab researchers work simultaneously on multiple (typically four to seven) research projects. Many pilot researchers reported their experiences with Energy I-Corps would enable them to improve the research agendas of any project they worked on, current or future, by enabling them to focus their efforts in the areas that best position the technologies to the target markets. Some researchers mentioned they appreciated the professional development they had through Energy I-Corps, training they anticipated would help them throughout their careers.

The anticipated Energy I-Corps benefits related to refined research agendas extend even further, beyond the participating scientists to the participating labs. One Site Lab pilot manager reported plans to investigate the potential of evaluating the lab's internal investment in technology using the BMC scientific approach.

6.3.4 Relationships with Private Sector

As part of the application of the BMC scientific approach, each Energy I-Corps team was required to interview between 50 and 100 prospective customers and other market actors (suppliers, potential partners) to assess the accuracy of their hypotheses for each of the nine BMC components. During the final day of training, team after team reported that most prospective customers were receptive to discussing the teams' projects: overall, teams estimated that roughly 90% of those they approached participated in interviews.

In addition to gaining the technology-specific feedback they sought, multiple teams reported the unexpected benefit of establishing new relationships with potential partners, funders, suppliers, and customers that they believed would be long-term. The teams believed they would continue (after Energy I-Corps training) to receive from these contacts technology development and commercialization support.

Many of the contacts with whom new relationships were formed have an ongoing interest in Energy I-Corps, in contrast to an interest in a specific technology. One lab pilot manager reported a team's external IM wanted to continue to be involved with Energy I-Corps to identify investment opportunities. Although many of the industry contacts expressed initial skepticism about Energy I-Corps, lab pilot managers described the enthusiasm with which their contacts responded after they learned more about the pilot. One lab pilot manager reported that an external (non-lab) technology team member who very reluctantly agreed to join the team quickly joined a second team and is, in the words of the pilot manager, "thrilled to be involved."

More wide-reaching, the clean energy incubators with which lab pilot managers have been in touch responded very favorably and indicated they would like to engage with Energy I-Corps.

6.3.5 Relationships Among Labs

Participation in Energy I-Corps strengthened relationships among and within participating labs. By intention, Energy I-Corps brought together people with different mindsets and opinions to support curriculum development, contribute to the selection of technology teams, and facilitate the customer discovery process.

The participating labs did not perceive one another as competitors within the Energy I-Corps setting. One lab pilot manager credited this multi-lab partnering relationship with enabling the managers to learn the details of commercialization and entrepreneurial activities and approaches at other labs. For example, several lab pilot managers were very impressed when they learned more about the activities and outcomes of LBNL's Cyclotron Road.[47]

Section 7 further discusses lab collaboration and its contribution to Energy I-Corps success.

6.3.6 Commercialization Knowledge Transfer

Culture change at the labs, one of the pilot's originally stated three near-term goals, depends in part on how readily and extensively Energy I-Corps pilot participants impart their new knowledge to their peers and upward to their management. As detailed in Section 4, Table 4-6, half of the technology team members had discussed their Energy I-Corps activities with interested colleagues, some of whom had conducted presentations for other lab groups. One researcher reported having advocated for Energy I-Corps or similar training for all the lab's PIs. The researchers who, at the time of the follow-up survey, had not shared any knowledge gained from Energy I-Corps with co-workers indicated they intended to do so.

Within one week of the end of training, one lab pilot manager had scheduled "lunch and learn" meetings with all of research groups to disseminate information on the Energy I-Corps approach and to engender interest among researchers in participating in future training cohorts.

6.3.7 Overcoming Impediments to Commercialization Activity

Lab pilot managers believed the Energy I-Corps concepts and approach would be useful to lab managers and staff supporting technology transfer, innovation, entrepreneurial efforts, business development, and regional economic development. They believed that a well-supported Energy I-Corps program would have the potential to

[47] Cyclotron Road is public private partnership between LBNL and DOE Office of Energy Efficiency and Renewable Energy's Advanced Manufacturing Office. The program serves as an incubator for early-stage energy technology. The program provides researchers with financial and R&D support, as well as physical office space, access to advisory networks, and mentorship.

change labs in large and small ways, including approaches to the research agenda, priorities, policies, support available to researchers, and attitudes.

Prior to their participation in Energy I-Corps, the Site Labs varied significantly in the extent of their commercialization activities. As discussed in Section 8, *Establishment of Pilot Baseline,* some labs had little to no focus, while others were highly focused on commercialization. Despite these differences, all the lab pilot managers reported they leveraged aspects of the Energy I-Corps experience to establish, continue, or improve active commercialization initiatives within their organizations. Examples of this invigoration included:

- Establishing new commercialization and entrepreneurial programs
- Rethinking lab Technology Transfer Office (TTO) activities[48]
- Adopting and adapting ideas from successful commercialization initiatives at other labs
- Re-evaluating relevant lab policies, such as entrepreneurial leave

Further, pilot managers felt their participation in Energy I-Corps – and the attention their participation generated – would increase the lab's senior managements' receptivity to allocating additional resources to the commercialization of clean energy technologies. Though the labs have historically been required to allocate some budget to commercialization activities – largely through the TTOs – before Energy I-Corps there had not been any EERE funding earmarked specifically for the commercialization of energy efficiency and renewable energy technologies.

The interviewed lab pilot managers anticipated that participation in Energy I-Corps would help their labs to be more supportive of commercialization. Respondents reported that their labs had increased attention to commercialization because of DOE's desire for the labs to impact the national economy. Interview findings suggest that Energy I-Corps played an important role in reinforcing DOE's commitment to this objective by providing funding to support the labs' commercialization activities. In the in-depth interviews, Lab pilot managers from three Site Labs mentioned the importance of direct funding for commercialization. According to one of these respondents, "This program has a tremendous impact on the lab. This is the only direct funding that we get from DOE for developing entrepreneurism. It directly emphasizes the importance of bringing technology into the marketplace."

Consistent with DOE's priorities, respondents noted that researchers in their labs were interested in commercialization, and anticipated that Energy I-Corps would help

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[48] Each lab has an office responsible for obtaining patents and licenses for lab innovations and other activities related commercialization – transferring technologies out of the labs. Generically, these offices are referred to as Technology Transfer Offices (TTO), although each lab organizes its commercialization related activities differently and the offices may not be called TTO.

mobilize that interest. According to one respondent, while some programs to change lab approaches and practices encounter resistance, “This is the right time and the right program. We are going to get a lot of mileage out of this internally.” This respondent suggested that Energy I-Corps could help drive the development of policies friendly to commercialization, saying, “If I’ve got Energy I-Corps teams that want to take a leave of absence, we had better get our policies in place. That is giving me a little bit of leverage to push some of those things along.”

The interviewed lab pilot managers anticipated that the teams their labs sent to Energy I-Corps training would share their knowledge of the commercialization process once they returned. Respondents also noted that some of the industry actors with whom their teams had interacted during Energy I-Corps were interested in continuing their relationships with the lab and remaining involved with commercialization efforts after the pilot ended. One respondent suggested that an example of a lab-developed technology that was extremely successful in its transition to the market, for example forming the basis of a large company, could drive a great deal of change within their lab.

Addressing concerns over attrition, a lab pilot manager anticipated that an increased focus on commercialization could ease the challenges their lab faces in recruiting and retaining researchers. This respondent suggested that support in gaining access to the market to commercialize technologies they develop could make working at the lab more attractive to researchers who might otherwise pursue opportunities in industry.

Lab pilot managers also anticipated that Energy I-Corps would increase researchers’ understanding of how the technologies they develop fit into the market and thus influence their future research. Site managers from the Node Lab and four Site Labs anticipated that the experience of completing the customer discovery process would help researchers focus their efforts to develop technologies more closely aligned with market needs. According to one respondent, the training will develop researchers…

> *…who know how to create technology based on industry needs, versus the evolution of science, which is great and can have a tremendous impact, but not in the near term. In the near term, researchers have to be out there working with commercial partners.*

6.4 LESSONS LEARNED

1. Lab researchers appear very receptive to the Energy I-Corps opportunity.
2. Pilot lab managers learned that Energy I-Corps participation offers labs wide-ranging benefits that exceeded their initial expectations, for example improved research agendas and enhanced ability to recruit and retain innovative staff.
3. Although the Energy I-Corps process is designed to accelerate commercialization, commercialization remains a lengthy process. By the end of training, teams' technology value propositions had received varying degrees of validation.
    - The most advanced teams, characterized by validated value propositions, still have need to do a lot of work to transfer their technologies to the private sector.
    - Most teams received encouraging customer discovery feedback that enabled them to evolve their value propositions, yet they still lack fully validated value propositions.
    - A few teams received mostly discouraging customer discovery feedback and at the end of training were struggling to articulate a value proposition and associated target market.
4. Even though the commercialization process is lengthy, lab managers anticipate that perhaps as many as five technologies may advance to partnerships, licensing, or startups in 2016.
    - The experiences of subsequent cohorts will suggest whether this cohort 1 outcome is generalizable, as the teams that applied to cohort 1 may reflect a pent-up demand for entrepreneurial action – a demand that diminishes over time, although how quickly remains unknown.[49]
    - On the other hand, lab pilot managers planned to increase their promotion of the pilot based on their positive cohort 1 experiences, making it difficult to anticipate the composition of subsequent cohorts.
5. Lab pilot managers and faculty learned that the degree of team motivation appears to be a strongly associated with value proposition outcomes. Motivation includes both a desire to advance the technology toward commercialization, as well as a desire to learn from commercialization experts.
    - Some respondents suggested that the teams appearing the least motivated indicated they believed their labs were not interested in or

[49] About half of cohort 1 survey respondents indicated they were interested in starting their own companies (Section 4.3).

supportive of commercialization, and so it was not worth it to them to extend a lot of effort during the training.

- This lesson, if validated by subsequent cohort experiences, suggests it would be beneficial for labs to discuss with teams the latter's perspectives of lab support for commercialization, clear up any misconceptions, and reiterate lab support. Findings presented subsequently in Section 7, *Establishment of Pilot Baseline,* suggest that researchers' views of lab support are influenced by the senior research managers they report to as much, and perhaps more than, their views are influenced by lab policies.
- Lab pilot managers and faculty also learned that although their experiences largely confirmed their thoughts on the types of applicants that will be successful, they also noted that one team that appeared unengaged during early training activities went on to join the ranks of the teams whose thinking evolved most during the training.

6. Lab pilot managers and researchers learned that the value of Energy I-Corps participation lies in the acquisition of a method. The technologies that teams worked on during the training provided the opportunity for experiential learning; the evolution during training of the market-positioning of those technologies is a secondary training benefit.

    - Consistent with this, Energy I-Corps trainees identified as a key training benefit their improved ability to refine their research agendas.
    - Thus, key elements of the method, principally, customer discovery, are valuable throughout the technology development process.
    - Additional research is needed to determine how a technology's state of development (as indicated by its TRL) affects trainees' learning outcomes.

Section 7 Energy I-Corps Infrastructure

As with the two preceding sections, this section presents findings from Energy I-Corps' first cohort pilot participants, including Node Lab pilot managers, Site Lab pilot managers, technology teams, and faculty, obtained through the methods identified in Section 2 (in-depth interviews, onsite observation, informal interviews, and surveys).[50]

Although as an expedient, pilot participants used the term "Lab-Corps" (the early pilot name) to refer to the training, the Energy I-Corps pilot as well as any subsequent full-scale program encompasses much more than the delivery of training. Energy I-Corps is a complex program designed to address challenging barriers. Training delivery is contingent on the support of and coordination between numerous managers and staff at multiple labs, the formation and nurturing of new partnerships, the refinement of tailored training on highly technical subjects, and other resources. Energy I-Corps' initial and continued success necessitates the development and ongoing fine-tuning of substantial infrastructure, including the following components:

- Pilot organizational structure
- Curriculum development
- Faculty selection, training, and direction
- Team selection, formation, preparation, and support
- Facility requirements
- Energy I-Corps promotion within and beyond labs
- Establishment of Energy I-Corps partnerships and networks

7.1 PILOT ORGANIZATIONAL STRUCTURE

EERE designed the pilot to have a Node Lab and Site Labs, analogous to the NSF I-Corps structure.[51] Having established this framework, EERE had little day-to-day involvement in the pilot design and implementation.

7.1.1 The Node Lab

The Node Lab acts as a single point of contact between EERE and the Site Labs, with faculty, and with training facilities. The Node provides overall direction and support for Site Labs.

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[50] The qualitative (interview, observational) data obtained from technology teams include data from PIs, ELs, and IMs. The quantitative (survey) data from technology teams include data from PIs and ELs, as indicated in Section 4.

[51] I-Corps has several I-Corps Nodes, which administer the curriculum and onsite activities. I-Corps Sites recruit teams and catalyze additional groups within their organizations to explore potential I-Corps Team projects and other entrepreneurial opportunities that build on basic research. I-Corps Teams are composed of academic researchers, student entrepreneurs, and business mentors. These teams participate in the I-Corps curriculum.

Early in the spring of 2015, the Node initiated regularly scheduled conference calls with the Site managers. The Node and Site personnel identified three areas for collaboration:

- *Site support,* which focused on the organizing question: Do the Site Labs have adequate guidance and support to establish a pilot approach?
- *Team assembly,* which focused on the organizing question: Do the Site Labs have adequate guidance and support to select teams suited to Energy I-Corps' (then Lab-Corps) intent?
- *Execution*, which focused on the organizing question: Do the Site Labs have adequate guidance, resources, and direct assistance to see all teams through the pilot, including preparation for training, customer discovery, and understanding of processes for commercializing lab-developed technologies?

Energy I-Corps training necessitated participation by all trainees in all exercises. Without the labs' coordinated – though not identical – approach to team selection, preparation, and support, the cohesion and thus effectiveness of the cohort 1 training would have suffered.

Following the training period, we asked lab pilot managers to describe the organizational structure and timeline of the pilot. The descriptions provided by each Site Lab described matched one another as well as the organization envisioned by the Node. The degree of uniformity in lab pilot manager responses speaks to the effectiveness of the Node's communication efforts.

The Node Lab increased the Site Labs' buy-in and improved pilot outcomes by engaging pilot managers in pilot development and planning. The Node leveraged Site managers' wealth of collective experience and commitment to Energy I-Corps. For instance, the Node called on one site manager with a deep understanding of the history and nuances of lab commercialization efforts to develop a component of the curriculum around this topic.

During interviews the Site Lab pilot managers expressed satisfaction with NREL serving as the Node Lab and supported the Node and Site Lab designations. A Node pilot manager indicated willingness for Energy I-Corps to have two designated Nodes, if useful to support program delivery.

7.1.2 The Site Labs

The Site Labs uniformly viewed Energy I-Corps as fitting a pre-existing commercialization mission and either complementing related initiatives already in development or offering a means of stimulating and increasing lab focus on commercialization. This mission alignment across the Site Labs helped to instill early buy-in among the pilot management structure.

Despite historic competition between the labs for research funding, the TTO and other lab staff supporting innovation and technology transfer commonly had working relationships with one another that predated the Energy I-Corps pilot. These relationships strengthened with the pilot. The evaluation team observed interactions among lab pilot managers that were characterized by mutual respect for others' expertise, opinions, and contributions, respectful acknowledgement of lab differences, and a strong willingness to work together to meet pilot challenges.

The Site Lab pilot managers all had extensive backgrounds in commercialization. Everyone had more than 10 years' commercialization experience, most in leadership positions, several in the private sector. Most were employed in their lab's TTO, though some were based in offices of directorates.

While the experience of the site managers was consistent, the managers varied in their conception of Site Lab responsibilities. Managers at two Site Labs described their role as simply selecting teams and reporting to the Node. Managers at two other Site Labs described their role as more of a co-developer of the pilot. They indicated that their responsibilities extended beyond selecting teams and reporting and included participating in the formation the Energy I-Corps program and garnering knowledge for in-lab initiatives. The remaining lab manager saw role of Site Lab as midpoint between these poles.

Consistent with EERE's initial pilot design, the Site Labs did not provide additional funding against which the technology teams could bill their time; however, several labs funded additional teams to participate and one lab that is not a Site Lab funded and sent teams to the training. Several managers described in-kind support the Site Labs provided to teams, such as advising, which they funded by reallocating TTO monies.

Energy I-Corps requires the Site Labs to provide the Node and EERE with regular reports. Site managers reported that they complied with the EERE reporting guidelines, but otherwise tracked their own management, oversight, and support activities in non-uniform and improvised ways.

7.2 CURRICULUM DEVELOPMENT AND REFINEMENT

7.2.1 Cohort 1 Curriculum Development

The Node had primary responsibility for curriculum development for the first Energy I-Corps' training. The Node undertook this task in a transparent manner; the Site Labs supported the curriculum development by providing feedback during the process.

The Node pilot managers, identified Energy I-Corps instructors and selected three Energy I-Corps technology teams to attend the NSF I-Corps Michigan training. Based on those experiences, as well as numerous conversations with entrepreneurial experts and Site Lab pilot managers that proceeded the Michigan training, the Node revised the NSF I-Corps curriculum and teaching style, which NSF had designed for the university researchers it funds, to tailor it to the needs of lab researchers on EERE Technology Office funded projects.[52]

The Node retained the customer discovery process, fundamental to both NSF I-Corps and Lean LaunchPad, noting that:

> *The training activity with the greatest impact on commercialization is the customer discovery process. As labs, they are generally not in touch with customer needs. Far and away this component has the greatest impact.*

Based largely on lessons the Node learned from attending the NSF I-Corps Michigan training (and input from faculty and technology teams that attended), the Node wove three new elements into the Energy I-Corps training. The Node incorporated Industry Night, a “speed dating”-like event in which visitors from relevant industries had quick one-on-one conversations with pilot teams to augment the teams’ customer discovery activity. The Node designed some team activities to tie directly to the lectures that preceded them as a means of immediately reinforcing the lectures’ key content through demonstration and application. The Node also added to the Energy I-Corps curriculum a regulatory discussion, commercialization training from a lab perspective, and a preview of the value chain of energy companies.

Like its predecessors, the Node retained for Energy I-Corps immediate feedback to teams from faculty, which occurred throughout the training day. In addition, faculty held “office hours,” during which they met one-on-one with teams to provide more detailed direction. Three instructors were assigned to each team and technology teams reported appreciating the opportunity to obtain feedback from instructors with a variety of perspectives and experiences.[53] However, unlike its predecessor training programs, the Node directed faculty to adopt a more constructive and supporting feedback style, less harsh than observed at NSF I-Corps, which the Node felt bordered on being humiliating. Though the style differed, the content of feedback was the same. In the words of one instructor:

> *The best thing about the training is the process. The faculty and everyone managing the process [the Node and Site Labs] are engaged in a disciplined and diligent process. It is not about the outcome. Team's struggle thinking the commercialization outcome is the most important thing. It’s not. The disciplined, diligent process is the most important thing.*

[52] While the Lab-Corps (currently termed Energy I-Corps) technology teams are researchers on projects funded by the Technology Offices (see glossary), all cohort 1 teams were funded through the Lab-Corps pilot (funded by the U.S. DOE EERE Technology-to-Market program); no cohort 1 teams were funded by Technology Offices, nor were the Technology Offices involved in the selection of cohort 1 teams.

[53] Three faculty supported 7 of the 14 teams, and three faculty supporting the remaining 7 teams.

The Energy I-Corps curriculum included team presentations on the last day of training of key elements of their BMC. Teams were instructed to include in their presentations a statement of whether their technology was a go or a no-go. The go/no-go decision is a concept Energy I-Corps borrowed from NSF I-Corps and its predecessor Lean LaunchPad that describes the customer discovery process as leading to a go/no-go decision for the innovation. Commercialization necessitates a market willing to purchase the innovation at a price that exceeds the cost to provide it, with a market size sufficient to warrant the investment. The customer discovery process results in a no-go decision when there does not appear to be such a market for the innovation.

In informal interviews conducted during the last days of training, one team expressed the opinion that the go/no-go decision was not appropriate to include in the Energy I-Corps training. This team thought it unlikely that any of the lab's technologies, developed through extensive research agendas, could be shown to have no commercial value, which they believe a "no-go" decision implies. The team thought the customer discovery conducted through Energy I-Corps might well indicate substantial pivots are needed (such as in target market and value proposition), and may lead researchers to refine their research agendas (as described elsewhere in this report), but did not think one could conclude from the Energy I-Corps training period that the technology was a "no-go."

In interviews, some lab pilot managers speculated that a "go/no-go" framework might reduce Energy I-Corps' acceptability to lab management, who are understandably concerned with losing talented staff. While in the phrase "go/no-go," "go" signifies the BMC is viable, in the context of lab operations, "go" might be interpreted as Energy I-Corps encouragement to leave the lab to form or join a startup.

7.2.2 Curriculum Refinements for Future Trainings

While all pilot participants – lab pilot managers, trainees, and faculty – viewed the cohort 1 training and curriculum as a success, all parties identified ways in which the training could be improved. The recommendations of technology teams are presented in Section 4.7. This section provides findings for the interviews with lab pilot managers (conducted in fall/winter 2015/2016) and instructors (conducted in March 2016), and observations made by the evaluation team at the lab pilot manager's debriefing meeting to discuss lessons learned. This section does not attempt to document the differences between the cohort 1 and cohort 2 training, which began in March 2016.

All lab pilot managers participated in a debriefing meeting to identify and share lessons learned. At the Node's request, managers arrived with a description of their labs' approach to selecting and supporting their teams, along with an assessment of the strengths and weaknesses of those approaches and their plans for selecting and supporting the next cohort.

Consistent with the spirit of customer discovery, the lab pilot managers anticipate the need to iteratively refine the training based on the experiences of each cohort. The Node and Site Labs planned to work more collaboratively on curriculum revisions than they worked on the cohort 1 curriculum, which was principally designed by the Node Lab. The pilot managers also floated the idea, in the debriefing meeting, of tailoring the curriculum to specific training cohorts, such as: cohorts in earlier versus later stages of technology readiness; cohorts interested in continuing their exclusive lab employment versus those considering part-time or full-time involvement in non-lab ventures.

Most significantly, perhaps, the lab pilot managers recognized the need to educate technology teams in commercialization pathways most likely to be relevant to them – that is, pathways other than startups. These pathways include licenses and partnerships of many types, including partners providing additional research funding and partnerships in commercialization.[54] Lab pilot managers agreed that technology teams need to learn not simply the range of opportunities, but also their implications, the steps necessary to pursue them, and legal considerations associated with the pathways, such as avoiding conflicts of interest in the journey from lab-funded and thus lab-owned innovation to commercialized private-sector technology. Lab pilot managers thought subsequent trainings might reduce content provided to cohort 1 on startups and venture funding.

Incorporating more information on non-startup commercialization pathways and lab support available to pursue those pathways poses some challenges to the training, however, as every lab has unique policies and resources. Technology teams need to work with their own labs' TTO throughout the commercialization process. Thus, the lab pilot managers recognized that some of this pathways education can occur during the onsite training with the full cohort, while each lab needs to individually provide its teams with training on lab-specific policies, a training activity that the managers discussed as best occurring in the team preparation activities that precede the onsite cohort training.[55]

In addition to expanding the team preparation activities to include commercialization pathways education, the lab pilot managers thought that the team preparation activities might also be expanded to include videos, reading, and other "canned" content that was delivered to cohort 1 during the onsite training. As a lab pilot manager described one theme from conversations assessing the cohort 1 training:

> *Everyone agreed there was too much crammed in during onsite time. The trainees were too overwhelmed to take it all in.*

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[54] See Section 6.1, Table 6-1.

[55] See Section 7.4, *Team Solicitation, Selection, Formation, Preparation, and Support.*

The first onsite session ran from Sunday afternoon to Wednesday afternoon with scheduled activities starting at 8 am and ending at 10 pm. Recognizing the onsite training involved long days, the lab pilot managers considered, during the debriefing meeting, shortening the training days and lengthening the training period (from the six-week format of cohort 1). In addition to moving content into the team preparation period Lab pilot managers also discussed adding a second Industry Night at the end of the training, so that industry guests could learn about teams' refined technologies (refined minimum viable products).

7.3 FACULTY SELECTION, DIRECTION, AND RECRUITMENT

7.3.1 Faculty Selection

The cohort 1 faculty comprised instructors, including four directors of organizations that develop and/or invest in technologies and startups, one director of a firm he started to commercialize a clean water technology he developed and one of the Energy I-Corps Site Lab pilot managers. Two of the four directors of organizations developing and investing in startups are involved with scientists at one of the Site Labs. Another of the four directors is an experienced NSF I-Corps trainer and directs an organization focused on energy and transportation. The instructor who directs a firm he started is a former national lab scientist.

Based on the cohort 1 training experiences, lab pilot staff and technology team participants expressed views that, among the various pilot elements, competent faculty was key to pilot cohesiveness and success. Collectively, the experience faculty brought to the pilot included:

- Decades of technology and startup incubation experience,
- Decades of venture capital and private equity experience,
- NSF I-Corps training experience,
- Lab commercialization experience,
- Experience starting up a company to sell lab-developed technology, and
- Lab TTO perspective.

The six instructors comprised five men and one woman, all white non-Hispanic. In informal interviews conducted during the final days of onsite training, two technology team members separately noted to the evaluator that an ideal faculty would reflect greater demographic diversity.

During their debriefing meeting to reflect on the cohort 1 training, lab pilot managers agreed that understanding of energy technologies was essential for Energy I-Corps faculty. This energy specificity contrasted with the NSF I-Corps training, which a lab pilot manager described as essentially treating the trainees' innovations as "black boxes;" neither the training activities (lectures and exercises) nor faculty feedback were tailored to the NSF I-Corps trainees' innovations.

Lab pilot managers also agreed that instructors need to be fully committed to the Energy I-Corps model (to the exclusion of other commercialization tools) in all interactions with trainees, and have good teaching skills. In support of these objectives, the pilot managers suggested that the Node review instructors' slide decks prior to their presentations.

7.3.2 Faculty Direction

Lab pilot managers and interviewed instructors appreciated the latitude the Node provided instructors regarding the content they presented on a given topic and their approaches to coaching the technology teams. In the words of one instructor, the Node Lab pilot managers were:

> *Really, really good. They let it [the training] happen. They put a soft fence around the activity and then just let it happen. I will teach cohort 2 because I really enjoyed the cohort 1 experience. And the biggest reason – other than the students – was the freedom that was happening within a clear, well-developed curriculum.*

However, both groups (managers and instructors) concluded that subsequent trainings might benefit from closer direction of instructors in the arenas of content to convey during lectures and feedback provided to students – both how hard they can push students and still be effective and to what instructional objective. One instructor requested to receive from Lab pilot managers "blunt feedback on my strengths and weaknesses" as an instructor.

Lab pilot managers during the debriefing meeting also suggested eliminating, for subsequent trainings, the cohort 1 designation of faculty as core and adjunct instructors.

7.3.3 Faculty Recruitment

The Node required the Energy I-Corps instructors to be available for the entire training period, which for cohort 1 was a six-week period that included six days on site and active participation in four teaching webinars, each lasting several hours.

The Node manager discussed during the debriefing meeting the difficulty of finding qualified, interested individuals to serve as instructors for the fixed-fee that Energy I-Corps has budgeted for faculty, which, for the cohort 1 training, was $10,000. According to the Node manager, NSF pays its I-Corps instructors $25,000. The Node manager reported he was "laughed at" by a professor he approached to be an instructor when he disclosed the sum.

Instructors have discussed this situation of low compensation both with the pilot lab managers and with the evaluation team in in-depth and in informal interviews. While they are supportive of Energy I-Corps and continue to be involved in training, they anticipate they would not be able to have a role long-term due to the low compensation. The entrepreneurial experts qualified to teach Energy I-Corps incur a high opportunity cost to do so, regardless of their enjoyment of the lab students and their belief in the Energy I-Corps mission.

The pilot lab managers as well as at least one instructor have discussed the negative impact that low instructor compensation is likely to have on the program's long-term viability. As one instructor explained,

> *I am concerned about the economic viability of the [Energy I-Corps] program, and especially its ability to continue to recruit outstanding instructors. The instructors had an enormous amount of work associated with this program. I doubt that the current compensation structure will enable DOE to maintain a stable corps of instructors over the long run.*

Faculty payment has ramifications beyond faculty recruitment. In the lab pilot managers' debriefing on cohort 1 experiences, the Node manager indicated that lengthening the Energy I-Corps training – an idea discussed in Section 7.1 – might not be feasible, as that would require an even greater time commitment by faculty for no additional compensation.

7.4 TEAM SOLICITATION, SELECTION, FORMATION, PREPARATION, AND SUPPORT

7.4.1 Team Solicitation

All but one of the Site Labs solicited proposals from teams throughout their organizations and used a competitive process to select those that would receive Energy I-Corps training, although some also reached out directly to highly qualified candidates to encourage them to apply. Three of the labs that took this approach held events to inform all interested researchers about the pilot and advise them on effective ways to present their technologies. Site Labs asked the teams interested in participating in Energy I-Corps to pitch their technologies in front of a board made up of both internal lab staff and external industry experts.

Pilot lab managers at the one lab that differed from this approach examined all the lab's available technologies and conducted one-on-one interviews with the researchers that developed the technologies the lab managers saw as most promising. In interviews, the pilot lab managers informed the researchers about Energy I-Corps training and the commitment participation would require.

7.4.2 Team Selection

Following kickoff, pilot managers developed distinct processes for team selection, taking divergent approaches at the encouragement of the Node and EERE.[56] One interviewed Node manager noted that because Energy I-Corps was a pilot, it was not necessary that the labs be consistent in their team selection methods; it was the Node's responsibility to ensure that each Site Lab had a system in place.

Table 7-1 illustrates the Site Labs' various approaches and selection criteria, as described by the interviewed lab pilot managers.

Table 7-1: Selected Labs' Team Selection Approaches and Criteria (Coded from Open-ended Interview Responses)

	Site Labs				
	ANL	INL	LBNL	LLNL/ SNL	PNNL
Selection Process					
Pitch contest to panel (with audience)	✓			✓	
Presentation to selection committee			✓	✓	
Interviewed potential trainees		✓			✓
Lab chose and ranked viable technologies					✓
Selection Criteria					
'Quality' of PI and team (open-minded/ teachable, motivated, capable, good interpersonal dynamics)	✓	✓	✓	✓	✓
Technology has energy-related impact	✓	✓	✓	✓	✓
Technical viability / Growth opportunities in market segment	✓	✓	✓	✓	✓
Team has clear/relevant value proposition	✓	✓		✓	
Team has customer understanding	✓		✓	✓	
Team/PIs have interest in participation and availability	✓		✓		✓
Team or lab likely to benefit from training	✓		✓		

[56] Appendix D *Site Lab Descriptions of Their Team Selection Approaches* for a detailed description of the approach taken by each Site Lab to select cohort 1 teams.

	Site Labs				
	ANL	INL	LBNL	LLNL/ SNL	PNNL
Technology's technical readiness		✓	✓		
Team has support of managers		✓			
Team has clear business model				✓	

Source: Participating Energy I-Corps Leads Baseline In-depth Interview Guide Q33 and Lab scoresheets

In selecting teams to participate in Energy I-Corps, pilot lab managers reported considering both characteristics of the individuals on a team and the technology the team sought to commercialize. The Node emphasized to pilot managers the importance of "willingness to learn" as a key criterion for team selection.

Pilot lab managers reported seeking individuals that were open to, and interested in, receiving feedback and instruction, and that were interested in immersing themselves in the market and pursuing the challenge of commercialization. According to one respondent,

> *You need to have [a technology] to go in with, but it doesn't matter as much what it is; it matters that you have a team that wants to evaluate what it is.*

This perspective is consistent with the quotation from an instructor reported in Section 7.2.1 that mastering the "disciplined and diligent process" at the heart of Energy I-Corps as more important than any specific commercialization outcome.

Three of the four interviewed instructors described the essential trainee characteristic as willingness to learn and the closely related characteristic of motivation:

> *If they [the trainees] come in with an open mind [they will be successful].*
>
> *Find out who really has the motivation to be there.*
>
> *Like all scientists, they [cohort 1 trainees] had to get over the fact that they are smarter than everyone else. But not in this program! They got over that. That's what happens [during the training]. You take extraordinary people and give them more [additional] extraordinary qualities. I have seen them grow and they are continuing to grow – I am in contact with them.*

Lab pilot managers agreed during the debriefing meeting that the ideal trainee is very interested in learning what it takes to commercialize an innovation. However, the pilot managers, as well as one interviewed instructor, noted that this interest could be difficult to assess at the team selection stage. As lab researchers, candidates for the Energy I-Corps training understandably are very reluctant to imply they might be interested in leaving the lab for entrepreneurial pursuits, and prior to training, they lack understanding of other paths to commercialization available to them. Lab managers and the one instructor illustrated the difficulty in assessing candidates by noting that one team appeared at the outset of training to have limited motivation and willingness to learn, yet was among the teams that, by the end of the training, had advanced most in its BMC development.

Interviewed lab pilot managers reported using metrics like the technology readiness level[57] and status of any patents on the technology to evaluate the viability of a technology for Energy I-Corps. Respondents suggested that, while it may not be as important as the ability of teams to identify and adapt to market needs, the technology with which a team enters the pilot is important to its success. One respondent noted that, to effectively use the Energy I-Corps approach, researchers must identify a sufficiently targeted range of applications for their technology. Technologies that are early in their development may have too wide a range of potential applications for an effective customer discovery process.

The freedom the Node gave to the Site Labs to develop their own processes resulted in a demonstration of multiple approaches to team selection, which yielded valuable insights during the real-time pilot development preceding the cohort 1 training. The Node described that one Site Lab used a more intensive approach to select its teams, and shared its criteria and methods with the other Site Labs.

All pilot managers reported they planned changes to their selection processes for the cohort 2 training. The planned changes discussed during the debriefing meeting ranged from minor to more substantial, addressing the labs' concerns about generating interest in the training, the submittal requirements and process, the selection committee, and selection criteria. As discussed in Section 8.1, lab pilot managers also discussed tailoring over time team selection to create specific training cohorts.

The lab pilot managers noted challenges inherent in team selection. They felt team quality would improve with more extensive marketing to lab personnel, and that team recruiting would improve as the labs become more receptive to commercialization. Thus, Energy I-Corps initial successes will contribute to creating the conditions for its future success. The view that labs need to more broadly support commercialization for teams to be successful in training was echoed by an instructor, who emphatically described that two teams appeared to lack motivation because they perceived their labs (two different labs) did not support commercialization and, therefore, they would not be able to put their Energy I-Corps training to use.

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[57] Technology Readiness Level or TRL is described in Appendix H.

Finally, in the debriefing meeting the pilot managers discussed issues relating to cross-lab coordination during team selection. Managers discussed whether it would be beneficial to ensure a training cohort does not include two teams from different labs with potentially competing technologies, as was true to some extent for two cohort 1 teams. Conversely, the pilot managers also want to further consider whether it is desirable for teams to be formed with members from multiple labs and, if so, how to facilitate such teams.

7.4.3 Team Formation

Following NSF I-Corps' team structure, Energy I-Corps' teams included a PI (or two co-PIs), an EL, and an IM.[58] Many teams began with only a PI, although some teams originally presented as two to four individuals that had been working together. All lab pilot managers reported that the PI was involved in the selection of his or her team members.

Some labs started with the idea that teams would benefit by sourcing ELs and IMs from outside the lab, on the basis that external parties are more likely to bring fresh ideas, be more in tune with market needs and conditions, and be less constrained by lab conventional wisdom. Other labs focused on recruiting talent from within the lab, wanting to maximize the number of lab staff receiving training, and thus increase diffusion of pilot benefits. Teams participating in the fall 2015 training represented a mix of those entirely comprised of lab staff, those comprising an internal EL and an external IM, and those comprising an external EL and an internal IM. All PIs came from within the labs, although one team had a co-PI from a university.

Pilot managers worked with TTOs and external partners to identify candidates who would pair well with PIs, as either ELs or IMs. Several labs struggled with outside participation: they found the vetting and accountability of external partners challenging and grappled with issues ranging from background accuracy and communication problems to poor suitability for the role. Lab pilot managers noted that a few external IMs in particular failed to follow through on key components of their pilot tasks. The lab managers also noted that external team members are not paid. In two informal interviews between external team members and the evaluation team that occurred during the last days of the onsite training, the external team members characterized their Energy I-Corps duties as requiring a large time commitment that they had not been prepared for, nor were able to fully meet due to the requirements of other (paid) work.

By the conclusion of the training, most lab managers continued to prefer including outside talent on technology teams, but conceded that more planning and vetting

[58] For I-Corps teams, the PI is an academic researcher, the EL is a student entrepreneur, and the IM is a business mentor from the field served by the technology.

needed to go into the selection process. Lab pilot managers recognize that compensating external team members could improve recruitment and follow through.

Pilot lab managers suggested in interviews, and discussed during the debriefing meeting they held to explore lessons learned, that teams would benefit by including a member of the lab's TTO team. According to one respondent,

> *The TTO staff are crucial to the commercialization of lab-developed technology. Deepening their understanding of the [Energy I-Corps] program and their understanding the principles of [Energy I-Corps] would greatly help increase the impact of the program.*

At the debriefing meeting, all pilot managers agreed that they had learned lessons from their varying approaches and would change aspects of their team formation process for cohort 2, including reconsidering:

- Which roles are external,
- Qualities and characteristics sought by role,
- Approach to securing committed individuals who understand the time requirements and other expectations of the role,
- The advantages and drawbacks of including on teams a commercialization manager from TTO, and
- Attention paid to fostering trust and establishing working relationships among team members ("team forming and norming").

7.4.4 Team Preparation for Training

All labs engaged their teams in activities, with the intention that all teams would arrive at the training with a rudimentary understanding of curriculum terms (such as business model canvas, customer discovery, and minimum viable product) and of the participation activities and associated time commitment required of them.

Following that common intention, the labs differed markedly in their approaches to preparing their teams for the onsite training. Providing the most comprehensive approach, one lab conducted commercialization training over the course of several months in weekly onsite and offsite meetings that proceeded its team selection and, indeed, factored into team selection because meeting attendance and participation was taken as a proxy of team desire to master the Energy I-Corps content.

The Node ensured that the content the labs used to prepare their technology teams for training was "in-line with the customer discovery and business model canvas methodology." For example, one Site Lab planned to prepare its teams through an existing program they coordinated with a university that used a model that differed considerably from the Energy I-Corps model. The Node requested the lab change its training preparation activities to teach only Energy I-Corps concepts, as not to confuse trainees with multiple models.

Each Site Lab decided the extensiveness of their team preparation activities. Table 7-2 provides a general overview of the labs' team preparation activities. Most commonly, interviewed lab pilot managers described providing teams with training in conducting interviews (as customer discovery interviews are a cornerstone of Energy I-Corps and its predecessor commercialization training programs) and oriented teams to Energy I-Corps concepts and objectives. In addition to these activities organized by the Site Labs, all teams were responsible for watching videos and reading materials on Lean LaunchPad.

Table 7-2: Labs' Team Preparation Activities (Coded from Open-ended Interview Responses)

	ANL	INL	LBNL	LLNL/ SNL	PNNL
Interview training	✓	✓	✓	✓	
Energy I-Corps orientation			✓	✓	✓
Training in the presentation of complex ideas	✓				
Lab policies and procedures around technology deployment		✓			
Basic introduction to Business Model Canvas			✓		
Detailed entrepreneurship training, including courses with partners (universities or incubators)				✓	
Developed list of potential interviewees in related market segments					✓

Source: Participating Lab-Corps Leads Baseline In-depth Interview Guide Q26.

One site lab implemented a more detailed entrepreneurship training in partnership with a nearby university and a local business incubator. This training began before the lab had selected teams to participate in Energy I-Corps and thus trained many more researchers than were ultimately included in cohort 1. The pilot manager from this lab reported that the training, while extensive, required less of a time commitment than

Energy I-Corps, was very positively received by researchers, and effectively prepared teams for more intensive Energy I-Corps training.[59]

Site Lab managers reported differing perceptions of the Node's expectations for team preparation. Some managers interpreted Node direction as requirements, while others perceived the Node's direction to be suggestive. The lab pilot managers attributed observed variation in teams' experiences as one of the contributors to the variation in teams' performance, especially in the first half of the training period. Many managers concluded the trainees would have benefited from more uniform preparation activities integrated across the sties.[60]

These managers observed that the challenging aspects of the curriculum appeared to be easier for researchers introduced to key concepts in advance of the training. In addition, several team members had told their lab managers that they found the preliminary customer discovery lists developed in preparation for the training to be immensely helpful, enabling them to "hit the ground running."

The lab pilot managers shared during the debriefing meeting lessons learned they identified concerning their team preparation activities, and all described plans to modify their approach for cohort 2. The debriefing meeting gave each lab an opportunity to learn from the others, as previously many aspects of each lab's pilot activity had not been shared with the group.

One issue needing inter-lab consistency that was revealed through the course of conversation at the debriefing meeting concerned the need teams have for guidance regarding how they discuss proprietary aspects of their work, both with interview contacts and with other trainees during training exercises. The lab pilot managers held somewhat varying views on the extent to which trainees should be guarded or unguarded in their discussions.

7.4.5 Team Post-training Support

The Site Labs reported plans to continue supporting their Energy I-Corps teams' commercialization efforts once the teams completed the Energy I-Corps training. These efforts, which labs reported planning to pursue through their TTOs, included pursuing additional funding for commercialization, providing market research support, and building relationships with market actors identified through the customer discovery process.

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[59] This is the lab described at the outset of this section as using training preparation accomplishments as a proxy for assessing commitment during team selection.

[60] As discussed in Section 7.3, the pilot lab managers considered for the cohort 2 training moving curriculum content from the onsite training into the training preparation activities.

Nonetheless, team post-training support appears to be the least developed pilot facet. Indeed, at the end of the onsite training pilot managers appeared to have just begun grappling in earnest with teams' need for post-training support.

At the final training day, as each team concluded its presentation, faculty unanimously made comments to the effect of "Great work; and much work remains" to every team, along with comments pertinent to each team's individual presentation. Even the handful of teams that pilot managers anticipated might attain licenses, partners, or startups within the year (see Section 6.2) had what the faculty described as "substantial" work ahead of them.

The Energy I-Corps training enables teams to identify when they have a viable product with some favorable market response that might yield a positive revenue stream. Yet identifying a viable product and producing a viable product are not the same.

Lab pilot managers with commercialization experience outside of the labs expressed the view that lab staff typically consider technologies to be ready for commercialization at much earlier stages of development than those at which funders and potential buyers consider to be market-ready. Pilot managers described this difference as a "chasm" that needs to be bridged.

The Energy I-Corps method helps researchers to shorten the development period, and to redirect efforts that are unlikely to meet with market success. Having identified a viable product, commercialization entails further steps including, but not limited to:

- Obtaining patents and licenses
- Developing a prototype or the software equivalent
- Conducting repeated customer discovery interviews with successive iterations of the prototype
- Conducting demonstrations at scale
- Forming partnerships for subsequent product development and/or for product launch
- Determining whether a team member wants to take the product to market (startup) or whether the team wants to find an external party to take the product to market
- Forming a team with the mix of skills needed to take the technology to market
- Lining up suppliers
- Estimating production costs
- Developing pricing
- Developing the "face" of the product (the packaging, the user interface)
- Attracting buyers (messaging, marketing)
- Producing full scale and selling the product

Interviews with managers and trainees suggested that a minority of trainees were interested in leaving their labs any time soon to pursue commercialization. The post-training support (financial and in-kind) that most, if not all, teams will need to further commercialization of their technologies will be in the areas of:

- Ongoing commercialization guidance,
- Support navigating lab policies, including assistance obtaining patents and licenses and associated legal assistance,
- Support developing partnerships,
- Support in developing prototypes and demonstrations at scale, and
- Support in conducting repeated customer discovery interviews.

7.5 FACILITIES

The onsite training requires both a large conference room, for sessions involving all pilot participants, and breakout rooms for instructors to hold office hours, during which they provide one-on-one assistance, and for the individual teams to work together and to conduct interviews. At the cohort 1 training, many if not most of the small group activities occurred in the hotel common spaces (conference room corridors, lounge).

Some of the lab pilot managers reported similar facility challenges in working with their teams at their own labs. According to one manager:

> *We had trouble getting space to meet, phones, computers, cameras. And where do the external team members sit when they come to collaborate? We need an office, not a table somewhere.*

Space preferences differ by teams, however, and not all labs reported facility constraints. One lab conducted pilot activity and pre-pilot training at the off-site facilities of a pilot partner. Taking teams off-site, they reported, helped staff feel relaxed and outside the strictly defined roles that typify the lab environment.

Nonetheless, the Node and Site Labs need to plan for the facilities to be used during the training. The pilot's budget constrains the choices of facilities potentially available to the Node, which also needs to cover team lodging costs. Facility selection for onsite training in turn constrains the number of attendees that can be accommodated during training. And lab facility utilization constrains the choices labs can offer their teams while not onsite.

7.6 ENERGY I-CORPS PROMOTION WITHIN AND BEYOND LABS

In their proposals to EERE for pilot participation, the labs described plans to publicize the training within their organizations and use rigorous, and high profile, selection processes to choose teams to take part in the training. Labs also reported plans to engage with, and gain support from, upper management early in their participation to ensure that the selected teams would be committed to Energy I-Corps activities.

Site Labs used a variety of internal communication channels, including emails, newsletter content, and brownbag presentations, to inform staff members about the Energy I-Corps opportunity and solicit researchers' interest in participating. Interview findings suggest these communication efforts were largely effective. While pilot lab managers reported receiving some staff requests for clarification and advice on submitting strong applications, none of the interviewed pilot managers identified particular aspects of the pilot that had met with staff confusion. Pilot lab managers typically reported receiving greater interest in Energy I-Corps than they could accommodate during the pilot.

Reflecting on their experiences of the cohort 1 training, which had just ended two weeks earlier, lab pilot managers expressed in the debriefing meeting a deepened enthusiasm for and commitment to Energy I-Corps. One pilot lab manager had spent the intervening two weeks promoting Energy I-Corps to encourage applicants for cohort 2. The manager said,

> *I tell them, "You can do research and get published in Nature, or Science. Or, you can do research that might change the world through adoption of your technology, and get published in Nature, or Science."*

The Node Lab plans to lead the development of a coordinated communication and marketing plan to support future rounds of Energy I-Corps training. Centrally developed communication resources could include articles to publish in internal lab newsletters, case studies, content for email blasts, and website content. Node Lab managers anticipate that these resources would provide consistency in the messaging around Energy I-Corps, while also allow for some customization by each lab. Each lab would control distribution of the messaging within their organization.

Node Lab staff also thought that a coordinated marketing effort could help inform and generate interest among industry actors outside the National Labs, as well among lab researchers.

All the lab pilot managers cited a video that one of the October training teams produced with help from a professional videographer as an example of an effective outreach tool. Pilot managers stated that this two-minute, end-of-training video effectively promoted the value of Energy I-Corps and was suitable for broad dissemination.

However, pilot managers also recognized that not all video captured as part of the Energy I-Corps process would be effective as promotional material, noting that some footage came from untrained videographers using the equipment at hand with little time to edit and produce final products. Pilot managers also noted that some footage might reflect a team's early thinking or contain sensitive information. As a result, pilot managers intend to develop guidelines or a process to ensure a consistent approach to the creation and release of videos to avoid content that could negatively impact their labs' reputations.

7.7 ESTABLISHMENT OF ENERGY I-CORPS PARTNERSHIPS AND NETWORKS

While the labs varied in their use of formal and informal partnerships, all lab pilot managers accessed existing relationships, and some formed new relationships, to build a network of support for Energy I-Corps. Anticipated partners and networks changed from initial pilot planning and proposal through the training period.

The partnerships that Site Labs developed with non-lab, non-DOE entities failed to match the partnerships envisaged in their applications for pilot participation. In the site proposals, labs described plans for leveraging networks of partners if selected as a site. With a few exceptions, the partnerships depicted in site proposals greatly overstated the roles that partners would play in the pilot.

Site managers contended that this overstatement of partner role resulted, in part, from the structure of EERE's Lab Call, which simultaneously solicited proposals for participation as the Node Lab and as a Site Lab, as opposed to selecting sites once the Node had been clearly designated. Most labs therefore structured their proposed approach, including their planned partnering activity, as though they held both positions.

Partnerships did emerge and played an important, but limited, role in the pilot. Partnering organizations primarily supported Site Labs in the following ways.

- Team selection
  - Vetting teams and technologies under consideration for Energy I-Corps
- Team formation
  - Identifying potential external IMs and ELs
- Customer discovery
  - Identifying contacts for teams to interview during customer discovery activities
- Researcher training (at one Site Lab)
  - Training around core entrepreneurial concepts
  - Training around key commercialization activities

Several labs struggled with outside participation: they found the vetting and accountability of external partners challenging and grappled with issues ranging from background accuracy and communication problems to poor suitability for the role.

7.8 LESSONS LEARNED

The key lessons learned from the pilot infrastructure activities concern the organizational structure itself, the curriculum, the faculty, and the teams.

7.8.1 Pilot Organizational Structure

1. The Node Lab and Site Lab organization, originated by NSF for NSF I-Corps, served Energy I-Corps well.

7.8.2 Curriculum Development Lessons Learned

1. Additional targeted training preparation, as well moving material from the initial onsite sessions into training preparation, might improve teams' performance, especially during the first half of the training.
   - Increased uniformity across the labs in the training preparation content and methods might improve teams' performance.
2. Researchers need additional information on commercialization pathways available to lab researchers, the resources are available for post-training support, and how to work with their TTOs to access the resources.
   - Providing such information will, among other benefits, enable labs to address individual team's concerns about lab support for commercialization (see Section 5.4).
   - Some of the needed information is general and can be presented to trainees in the large group setting, such as the notion that the TTO must remain central to the commercialization process.
   - Much of the information on commercialization pathways is lab-specific, and so needs to be conveyed in small groups.
3. Reduce emphasis on and discussion of startups as a key commercialization pathway.
   - Move away from framing Energy I-Corps customer discovery outcomes as resulting in technology go/no-go decisions.
4. Trainees appeared confused by some lectures and instructor comments. The training objectives would be better met through revision of the content of some lectures and accompanying PowerPoint presentations to address with greater consistency on the elements of the business model canvas.

5. Pilot lab managers identified a need for consistency in the guidance labs provide their teams on discussing proprietary aspects of their work, both with interview contacts and with other trainees during training exercises.
    - Lab pilot managers held somewhat varying views on the extent to which trainees should be guarded or unguarded in their discussions.

7.8.3 Faculty Lessons Learned

1. Competent faculty are key to pilot cohesiveness and success.
2. Lab pilot managers and cohort 1 faculty appreciated that the Node offered faculty latitude in the information they presented and their style of trainee engagement. Nonetheless both groups thought subsequent trainings would benefit from greater Node direction.
3. Low faculty compensation may jeopardize:
    - Faculty long-term participation
    - Quality and commitment of faculty
    - Energy I-Corps' long-term viability

7.8.4 Team Lessons Learned

1. Recruiting external (non-lab staff) ELs and IMs involves a trade-off. Lab pilot managers learned:
    - External talent:
        - Offers teams outside-the-box ideas and contacts
        - Are challenging for lab pilot managers to vet during selection process
        - Are challenging for managers to hold accountable
        - Were not paid for cohort 1; informal interviews with external ELs and IMs they were less able to devote the necessary time due to their other commitments and opportunity costs
    - Internal talent:
        - Is expected to increase knowledge dissemination to colleagues.
2. Team selection criteria was not uniform across labs. Lab pilot managers suspected more uniform selection criteria might result in an enhanced learning environment for the cohort.
3. The relationship between technology readiness and team learning remains a research question.

4. Lab pilot managers suggested the labs would derive benefit from adding a fourth position to the teams – a TTO staff member, although no change in approach made at that time.
   - PIs and other team positions held by lab staff would benefit from establishing relationships with and learning from TTO staff while they are in training.
   - TTO activities would benefit from TTO staff trained in the Energy I-Corps methods.

Section 8 Establishment of Pilot Baseline

This section describes the baseline of the Energy I-Corps pilot labs in terms of their experiences, strengths, and priorities. This analysis draws from in-depth interviews with Node and Site staff, the survey of participating researchers, informal interviews conducted during the training and the pilot lab debriefing meeting, and an analysis of lab proposals.

The section also presents a baseline analysis (2010-2015) of lab technology transitions metrics, which DOE compiles from lab-provided information in compliance with the annual reporting requirements set forth by the Stevenson-Wydler Technology Innovation Act, 15 U.S.C. § 3710(f)(2).

8.1 SITE LAB'S PROPOSED PILOT APPROACHES

Site lab's proposed pilot approaches differed. Throughout their proposals, the selected labs emphasized their commitment to commercialization, as evidenced by the support they planned to provide their lab teams. The labs' approaches were similar in what they planned to provide. All labs, for example, planned to provide some form of commercialization assistance for the technology teams, and most planned to provide mentoring. Whether this support would be offered by internal or external parties varied by lab and their expertise. Two Site Labs relied more heavily on their external partners to provide support and expertise, both as evidenced in their past commercialization efforts and in their proposed pilot approach. Two other Site Labs demonstrated in their proposals that they provide a comparatively higher level of internal support for current and future commercialization efforts. Across all Site Labs, the internal support labs proposed to provide primarily took the form of in-house training, commercialization assistance, and mentoring.

All lab proposals discussed lab plans to leverage existing relationships and partnerships in their pilot approach, especially during the technology team selection process. Labs planned to leverage the expertise of partners in the entrepreneurial community to help assemble qualified teams (from staff internal to the lab and external parties) and to advise or train the selected teams. Both through internal and external channels, Site Labs described that they provide educational programs that support commercialization, and encourage researchers to move technology to the private sector.

8.2 LABS PRE-PILOT COMMERCIALIZATION SUPPORT

Two labs included extensive discussion of their past commercialization experiences and success in their proposals, while the remaining labs focused on the support they planned to provide to Energy I-Corps teams. Existing policies to promote commercialization highlighted in lab proposals included lab support for researchers interested in commercialization and educational programs to facilitate technology transfer. These labs also provided specific examples of their past commercialization experience, which lab pilot managers discussed further in in-depth interviews. In-depth interviews, pilot managers from the labs that detailed their commercialization experience in their applications speculated that this proof of success was one of the reasons they were selected to participate in the pilot. For example, one lab pilot manager stated that his lab "has a long history of creating startups and our conflict of interest policy is fairly straightforward, and well established. We have established more than 40 startup companies."

Findings from the trainee baseline survey support labs' assertions in their pilot proposals that they offer policies favorable to commercialization. Three-quarters (77%) of Energy I-Corps team members rated their labs as supportive of commercialization (rating four or five on a five-point scale), although one team member from each lab provided a lower rating (three on a five-point scale).

All Site Labs offer researchers opportunities to learn about entrepreneurship (Table 8-1). Most often cohort 1 baseline survey respondents reported these opportunities came from peer-to-peer interactions, although respondents also reported that some labs hold more structured presentations or events, in some cases in coordination with external partners like nearby universities. Some labs offer formal mentorship programs. All the Site Labs also maintain partnerships with business schools, business incubators, and private businesses to support commercialization of their technologies.

Table 8-1: Types of Commercialization Support Provided

Type of Support	Number of Labs Providing (n=6)*
Education, mentorship, or opportunities to interact with peers	6
Partnerships with individuals or organizations outside the lab	6
Financial incentives (for example, returning a portion of royalties to researchers or offering entrepreneurial leave)	5
Financial resources	3
Time resources	3

* Number of labs in which at least 50% of surveyed team members reported their lab provides each type of support.

Labs also frequently offered financial incentives to researchers who commercialize technologies. Elaborating on these incentives, cohort 1 respondents most often cited the opportunity to earn a portion of the royalties from a licensed technology. Based on figures survey respondents cited, the portion of royalties allocated to patent holders appears to vary between labs, ranging from 20% to 35% (Table 8-2).

Table 8-2: Technology Licensing Royalties Allocated to Inventors (Coded from Open-ended Survey Responses)

Proportion of Royalties Allocated to Inventors	Number of Labs (n=6)
35%	1
30%	2
20%	1
Not specified	2

Cohort 1 respondents were least likely to agree with survey statements that their labs provided them with financial and time resources to support commercialization (Table 8-1, above). One respondent stated that doing commercialization activities "on your own time is the default." Others explained that it was difficult to use their own time on commercialization activities. One respondent said,[61]

> *[Providing time for commercialization] is not something the lab does well. I need to charge all my time to projects and funds available for commercialization won't fund my time.*

Some team members noted that their labs allow them to access time through legal experts, market researchers and other staff that support technology transfer. Possibly reflecting, in part, the difficulty of finding time and money to work on commercialization activities, only one cohort 1 respondent reported it was common for staff in their lab to take advantage of the resources the lab provides to support commercialization.

Respondents from three labs reported their labs offered entrepreneurial leave. The interviews with pilot lab managers substantiate the differences noted by cohort 1 respondents among labs in their policies to support commercialization, including the level of the individual researchers' input into licensing negotiations and entrepreneurial leave policies. For example, one pilot lab manager noted that their lab does not guarantee that researchers who take entrepreneurial leave will be able to return to the position they held prior to their leave. Another lab does not have an entrepreneurial leave policy. Table 8-3 describes the entrepreneurial leave (EL) programs or related policies of the Node Lab, Site Labs, and of ORNL, which sent two teams to cohort 1

[61] This respondent is from a different lab than the respondent saying, "on your own time is the default."

training, as described in a White Paper prepared by the labs for the DOE Office of Technology Transitions.

Table 8-3: Entrepreneurial Leave and Related Policies at Cohort 1 Trainees' Labs

Lab	Relevant Policy	Reinstatement Provision and Other Notes
ANL	[information not available]	
INL	Professional Leave of Absence Policy	Reinstatement to active full-time employment is not guaranteed, although the lab makes every effort to return the employee to a comparable position.
LBNL	[information not available]	
LLNL	Entrepreneurial Separation	No reinstatement. Employees terminate from lab (to avoid intellectual property entanglement). Considering an Entrepreneurial Leave Program (ELP).
NREL	Sabbatical policy	Yes. (Policy details related to separation for technology transfer are unavailable.) Exploring options (as of 2015) to create an ELP.
ORNL	ELP (for 20+ years)	Subject to current business conditions of ORNL at the time, employee returned to former position, or its equivalent pay, benefits, and other terms and conditions. If reinstatement not possible, employee receives normal severance pay.
PNNL	None reported	No reinstatement, due to no ELP. Prior ELP ended 2002. Developing a new ELP targeted to start FY2016
SNL	Entrepreneurial Separation to Transfer Technology (ESTT) program (started 1994)	Return to same job guaranteed if return is within two years of start of leave. 145 Sandia researchers have left on ESTT since 1994; 41 have returned. (For comparison, Sandia employs about 10,000 people.) Of 99 companies impacted by the program since 1994, 49 were startups and 50 were expansions.

Source: Pete Atherton, Sandia National Laboratories, *Implementing an Entrepreneurial Leave Program (ELP): A White Paper for the DOE Technology Transfer Working Group.* SAND2015-4310 O. Sourced from www.indico.fnal.gov

Follow-up surveys of cohort 1 identified some notable differences by lab in perceived lab support for commercialization efforts that go beyond the labs' explicit policies around commercialization activities. While most respondents from all labs reported the commercialization activities they had learned through Energy I-Corps training were a good fit for their labs' TTOs, most respondents from most labs anticipated that the training would not influence how their own managers assess their performance.

The interviewed lab pilot managers anticipated this finding by suggesting that one barrier faced by Energy I-Corps is that researchers may not see commercialization activity as likely to contribute to their career advancement. Notably, cohort 1 respondents from only two labs, as shown in Table 8-4, thought their Energy I-Corps experiences were a good fit with how their management assesses their performance.[62]

Table 8-4: Fit of Training Activities with Other Elements of Work

The activities I learned through Energy I-Corps are a good fit with:	Number of Labs with Majority Agreement (n=5)*
My professional goals	5
The role of my lab's technology transfer office	5
How lab management assess my performance	2
My understanding of the professional goals of many of my lab's established researchers	2
Post-doc positions	0

* Labs with at least 50% of respondents rating each statement 4 ("Somewhat Agree") or 5 ("Completely Agree") on a 5-point scale from "Completely Disagree" to "Completely Agree." Statement used the pilot name of Lab-Corps.

Most respondents from all labs agreed that the activities they learned from Energy I-Corps were a good fit for their own professional goals. This finding likely reflects the types of researchers interested in, and likely to be selected for, Energy I-Corps. Fewer respondents thought Energy I-Corps fit well with what they understood to be the professional goals of many of their labs' researchers.

The lab pilot managers described thorny issues relating to researcher conflict of interest (COI). The moment researchers walk into TTO offices and declare their intention to leave the lab – through resignation or entrepreneurial leave – to pursue the commercialization of a technologies they invented, the researcher "wears two hats," as one contact termed it – that of lab employee and private sector employee. The researcher immediately becomes subject to the lab's COI policies and the TTO staff

[62] One of these labs was located in the San Francisco Bay Area, a region known for its entrepreneurial activity.

immediately act to enforce those policies and protect the lab's interests. The COI loop is somewhat circular:

- A lab researcher generates intellectual property (an invention) that can be licensed.
- The lab licenses the invention.
- The lab receives royalties from use of the license.
- The researcher as entrepreneur pays the lab to use the license.
- The lab splits the royalties with the researcher.

As the researcher and TTO staff negotiate this terrain, neither parties are confident in their estimation of the monetary value of the license, yet they must come to agreement over time on the terms by which the researcher and lab will benefit from the licensing and from its repeated use in product sales.

8.3 BARRIERS TO COMMERCIALIZATION

The interviewed pilot lab managers universally reported there is a great deal of lab-developed technology that is not being commercialized. While this backlog of technology represents an opportunity for Energy I-Corps training, it also reflects the existence of barriers to commercialization that, to date, has hindered this commercialization. The barriers lab pilot managers described fall into three categories, those related to: the focus of lab research, the management structure of lab research (including funding and incentives within the labs) and the external environment in which the labs operate.

8.3.1 Alignment of Lab Research Focus with Commercialization

As discussed in Section 7.4.5, *Team Post-training Support,* three lab pilot managers spoke of the "chasm" that needs to be bridged between "what a researcher might think is a commercial-ready technology and what someone who has done a couple of startups or is an investor thinks is commercial-ready."

This chasm reflects aspects of the way research is structured within the labs. Three inter-related factors describe how the research structure is established.

1. DOE's research agendas do not include the development activities needed to take a technology to commercialization;
    - The proposals lab scientists and engineers submit to DOE to pursue those research agendas do not include tasks and budgets for commercialization research; and
    - Lab PIs lack of experience in the private sector and with the commercialization process.

2. As expressed by one lab pilot manager,

   For the most part, the lab PIs don't understand how the business world works and how the technologies may get into the market. That is reflected in how technology is developed and what state it gets to.

Because of these factors, lab researchers tend to think a technology is commercial-ready at the point when they have answered the key research questions associated with it.

Until research agendas include, and research proposals specify, commercialization research, commercialization remains an underfunded and under-executed activity. Until PIs learn an effective method for pursuing commercialization, such as that conveyed through Energy I-Corps training, they will not know how to scope commercialization research in their proposals to DOE.

In short, until PIs know what to do and have the contract to support it, commercialization research – and, consequently, commercialization – will occur for far fewer lab-developed technologies than have the potential to succeed in the market. In the words of one lab pilot manager,

> *[Researchers] can't just sit with this technology unless they've got funding. They need to fund their time and move on to other things. It's challenging for our PIs to be able to see the technology through sufficiently, so that it gets out to the market.*

The budget for entrepreneurial activity stands apart from the researchers' core work stream, typically compensating only the hours spent by TTO officers. A lab pilot manager noted that lab TTOs primarily focus on, and have budgets for, licensing, rather than providing broader, and more resource-intensive, support for entrepreneurship.

Finally, respondents also noted that some types of lab research do not easily lend themselves to discreet technologies that could be commercialized. For example, one Site Lab reported their research focused more on understanding capabilities of, and processes involved in, batteries and biofuels than developing specific technologies that could be commercialized. Thus, a Lab Energy I-Corps training program will be relevant to relatively fewer researchers at this lab than at other some other labs.

8.3.2 Management Structure of Lab Research

Most lab researchers work under the supervision of senior research staff, who act as mid-level managers with responsibility for executing current research and securing funding for additional research. Lab pilot managers explained that these mid-level managers might be reluctant to embrace commercialization activities for two related reasons: concerns over productivity, and concerns over attrition.

Senior research staff may be concerned that the time researchers spend on commercialization (including Energy I-Corps participation) may decrease their productivity on existing research, with negative impacts on quality or timeliness of project delivery.

According to interviewed pilot managers, lab senior research and management staff may also worry that engagement in commercialization activity could shift key staff members' focus away from activities more traditionally aligned with the labs' mission, including writing proposals for new funding streams.

While most commercialization pathways for lab-developed technologies do not result in the researcher leaving the lab,[63] senior lab management may nonetheless fear that commercialization could result in occasional and unpredictable turnover of key staff. One lab manager estimated that their lab lost more than $5 million in annual research funding due to departure of researcher(s) that it otherwise would have been awarded when a team commercialized a technology and left the lab.

Some pilot managers feel that post-docs are appropriate for Energy I-Corps training because labs expect that few post-docs will be continuing at the lab after their three-year commitment. That prospect, along with the typical high-energy of post-docs, make them good candidates in the eyes of these pilot managers to take on the activities associated with taking lab-developed technologies to market.

However, these pilot managers note the reluctance of senior researchers to divert post-docs from their heavy research schedules and post-docs have little leverage within the labs to negotiate for training. According to the lab pilot managers, many post-docs expressed interest in Energy I-Corps, but struggled to convince supervisors that they could participate in Energy I-Corps without interfering with their current obligations. At the other end of the Energy I-Corps team formation process, as we reported in Section 2.7, three of 35 (9%) nonparticipating teams considered for the nonparticipant sample had PIs (including post docs and interns) that had left their labs by the start of the cohort 1 training.

We note that a minority of cohort 1 respondents from each lab thought the Energy I-Corps training would fit well with the post-doc research positions at their labs (Section 8.2, Table 8-4, above).

8.3.3 External Factors beyond Lab Control

Lab pilot managers suggested that the local economy surrounding a lab influences the commercialization network the lab is able to develop and thus the resources and

[63] See Table 6-1 in Section 6.1.

partnership opportunities available. Interactions and exchanges with their commercialization network in turn influence a lab's support for commercialization.

For example, the two pilot labs in the San Francisco Bay Area (LBNL and LLNL) benefit from proximity to many renowned public and private research institutions and to startup incubators and venture capitalists in Silicon Valley. In addition, the pilot managers at these labs said that it was common for lab staff, including senior management, to have experience working in the private sector. The pilot managers speculated that staff with private sector experience might be more interested in commercialization than other staff and have greater risk tolerance: risk to the labs of researchers leaving the lab, and risk to researchers of startup failure.[64]

In comparison, there is little activity in rural Idaho, home to INL, and eastern Washington (PNNL). Although the commercialization activity in Chicago and other Midwest cities near ANL is much greater than that in rural Idaho and Washington, it remains substantially less than in the Bay Area. Lab pilot managers in these areas reported that limited access to partners in research, industry, and finance was a barrier to commercialization. In addition, respondents suggested that staff and other market actors in these areas might be less accustomed to the risk-return thinking necessary to work with startups.

Interview findings suggest that proximity to areas with a great deal of technology commercialization activity can also have drawbacks for the labs. Pilot lab managers in the Bay Area reported facing a great deal of competition for skilled researchers and experiencing a high level of attrition among researchers. Labs in areas with less private commercialization activity may be better able to attract and retain researchers.

8.3.4 Cohort 1 Suggestions to Improve Labs Commercialization Support

Table 8-5 provides trainees' baseline and follow-up survey suggestions (open-ended) for changes their labs could make that might better support commercialization activity.[65] Most commonly, respondents to both the baseline and follow-up surveys suggested providing researchers with commercialization training and with funding/billable time to pursue training and commercialization activities, and improving lab policies supporting entrepreneurial and commercialization activities.

[64] See the previously referenced (as the source of Table 8-4) *Implementing an Entrepreneurial Leave Program (ELP): A White Paper for the DOE Technology Transfer Working Group,* by Pete Atherton, Sandia National Laboratories. Sandia report ID: SAND2015-4310 O. Sourced from www.indico.fnal.gov

[65] Note that although 20 baseline and 20 follow-up respondents provided suggestions, some individuals provided only baseline responses and others provided only follow-up responses. Further, note that the baseline and follow-up survey response counts for a given row might not refer to the same individuals, as frequently respondents' baseline and follow-up survey answers differed.

Table 8-5: Suggested Changes to Support Researcher Activity in Commercialization Processes (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Baseline		Follow-up	
	Count	Percent of Respondents	Count	Percent of Respondents
Provide training on commercialization (possibly mandatory), such as Energy I-Corps, a shortened version of Energy I-Corps, lunchtime lectures, a road-map to guide researchers, or a few webinars and tools with filled-in examples	10	50%	7	37%
Funding/billable time available to support commercialization activities	5	25%	7	37%
Provide, improve, simplify, clarify, and/or make more liberal lab commercialization policies and mechanisms (entrepreneurial leave, paths to transfer ideas into CRADAs, licenses, startups)	6	30%	3	16%
Include commercialization in job descriptions and performance reviews; provide researchers incentives	4	20%	3	16%
Organizational acceptance of entrepreneurial activity; allow scientists to participate in both R&D and commercialization; align organization with Energy I-Corps-type approach	2	10%	4	21%
Raise awareness; motivate with success stories and case studies	3	15%	2	11%
Provide access to, facilitate interactions with mentors, investors, entrepreneurs	3	15%	-	-
Include customer discovery in proposals	-	-	2	11%
Increase mid-management buy-in and excitement, such as rewarding divisions for staff participating in training	1	5%	1	5%

Response	Baseline		Follow-up	
	Count	Percent of Respondents	Count	Percent of Respondents
Provide requested assistance	-	-	1	5%
Total Respondents	**20**	**--**	**19**	**--**

8.4 BASELINE VALUES OF TECHNOLOGY TRANSITION METRICS

DOE has been engaged for many decades in promoting and tracking technology transfer from the labs to the private sector. It compiles lab technology transition metrics from lab-reported information in compliance with the annual reporting requirements set forth by the Stevenson-Wydler Technology Innovation Act, 15 U.S.C. § 3710(f)(2). DOE maintains a confidential database of lab-reported metric values by year. The labs are guided in their reporting by a document that defines 68 metrics for measuring technology transfer activities.[66]

We analyzed six years (2010 to 2015) of DOE's technology transitions metrics relevant to Energy I-Corps objectives:

- New CRADAs
- Non-federal sponsors (NFS) funds
- New material transfer agreements (MTAs)
- New licenses
- Software licenses
- Startup launched
- Commercialized technologies

We compared the average metric values for labs participating in Energy I-Corps with the average values of nonparticipating labs. We selected for the comparison the following nonparticipating labs based on completeness of the relevant data:

- Ames
- Brookhaven
- Los Alamos
- Oak Ridge
- Sandia (only Sandia-California participated in the pilot)

[66] *Department of Energy Technology Transfer Working Group Reporting and Appraisal Guide for DOE Technology Transfer Activities.*

We weighted the labs to provide a meaningful comparison across labs of much different sizes. We weighted each lab based on its research and science funding.[67] Appendix C provides additional detail.

8.4.1 Findings

Appendix C provides a graphical analysis of the data.

The participating Energy I-Corps labs differ from the comparable nonparticipating based on a comparison of all average weighted metrics examined. Energy I-Corps labs lag (have lower average metric values) for three of the seven metrics assessed:

- New CRADAs
- New licenses
- Startup launched

Energy I-Corps labs exceed nonparticipating labs in their average values for two of the metrics.

- New material transfer agreements (MTAs)
- Non-federal sponsors (NFS) funds

There is no clear pattern of difference between Energy I-Corps labs and nonparticipating labs in their average values for two of the metrics.

- Software licenses
- Commercialized technologies

8.4.2 Discussion

Considering the seven metrics collectively, we found no clear patterns between the Energy I-Corps labs and nonparticipant labs. It is possible that the scheme used to weight the data has amplified differences between the labs. We cannot rule out the possibility that through some unknown correlation between the weights and lab characteristics, the weighted data characterize the nonparticipating labs as more active in the commercialization space than would be the case of a different weighting scheme were used.

It is also possible that the nonparticipating labs are not only different than the participating labs, but are different in ways that make them an inappropriate comparison group. Clearly, the labs differ in their areas of specialization, and some areas may lend themselves to greater activity of the types depicted here than do other areas.

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[67] Source: *Department of Energy FY 2017 Congressional Budget Request, Laboratory Tables Preliminary*, Office of Chief Financial Officer, February 2016. Line items per lab research and science for (1) Total Electricity Delivery and Energy Reliability, (2) Total Nuclear Energy, (3) Total Energy Efficiency and Renewable Energy, (4) Total Science.

Because participating in the Energy I-Corps pilot was determined through a competitive bid process, it is a reasonable assumption that the participating labs' relative advantage in commercialized technologies was one of the factors leading to their selection, although the evaluation team did not investigate this hypothesis during DOE staff interviews.

In subsequent years, researchers might want to take a difference of differences approach to investigating possible Energy I-Corps effects by comparing the percentage change baseline to follow-up in average metric values for trainees and nonparticipants. Researchers taking this approach will need to recognize that the Energy I-Corps pilot is training a very small proportion of lab researchers.

Section 9 Key Findings and Recommendations

This section presents the key findings and recommendations from this study.

9.1 PILOT ON TRACK TO MEET ONE-YEAR GOALS

Although the Energy I-Corps pilot has three broad goals (see Section 1.1), at the one year mark, EERE hoped the pilot would:

- Increase understanding of the commercialization process among teams of trained researchers (including an increased appreciation for, and understanding of, private sector needs for the teams' technologies),
- Have participating teams know the next steps needed to move their technologies along the commercialization continuum, and
- Strengthen participating labs' institutional support for commercialization activities.

The Energy I-Corps pilot is on track to meet its one-year goals.

9.1.1 Teams Increased Understanding of Commercialization Process

The cohort 1 findings indicate the Energy I-Corps training is highly effective in substantially increasing teams' understanding of the five facets of the commercialization process given the most coverage in the training most directly relevant to their needs as researchers. These most relevant activities, for which teams' baseline and follow-up survey responses indicating strong understanding of the activity showed both statistically significant increases and increases significantly larger than nonparticipant, include:[68]

- **Value Proposition:** PI trainees increased their ability to articulate and investigate their technology's value proposition. Most teams demonstrated a substantial increase in this ability.
- **Customer Segments:** PI trainees learned how to discover whether initially targeted customer segments are likely to find the technology valuable, and how to discover additional potential markets.
- **Customer Relationships:** PI trainees increased their understanding of how to attract and keep new customers.
- **Key Partners:** PI trainees increased their knowledge of potential key partners, suppliers, their activities, and resources that might be acquired from them.

[68] The Node Lab, in designing the curriculum, prioritized these five facets as most relevant to the technical research in which lab researchers principally engage. The Node Lab recognized that lab researchers that are more likely to further technology commercialization by engaging in partnerships with the private sector than by launching a startup:

- **Key Activities:** Teams increased their understanding of the commercialization continuum and the progression of needed activities.

Teams had less exposure to, and accomplished less in terms of knowledge gained and business model refinement, in the other facets of the commercialization process (as captured by the BMC).[69]

Trainees' increase in understanding of the commercialization process exceeded that of nonparticipants. The two groups' baseline understanding was similar, ruling out a rival explanation that the trainees' own characteristics, rather than the training, that led to the reported gains.

Cohort 1 researchers in their final presentations described the huge change in their understanding of the potential market, their technologies' strengths, and weaknesses with respect to the market, and the scientific approach that led them to this increased understanding. In addition, they came away with an understanding of the commercialization process, the activities entailed, and the pathways leading to that end, as well as an appreciation for the considerable business acumen required for commercialization.

Nonparticipants had an opportunity to learn some of the concepts taught by Energy I-Corps through three routes – during the application process as they made the case to be selected for the training, after the selection of trainees as they pursued on their own interests that were piqued during the application process, and from trainees who shared some of the learnings with their lab colleagues.

9.1.2 Teams Know Steps to Advance Commercialization of Their Technologies

In addition to increased understanding of the commercialization process, most teams over the course of training advanced progress with their technologies along the commercialization continuum.

Most teams improved their technology value propositions. A handful of teams honed their value propositions sufficiently to attract private sector interest. At the other end of the spectrum, the value propositions of about three teams failed to elicit much positive target market response, indicating the need for a substantial pivot in one or more aspects of the business model.

Close to half the teams in their presentations on the last day of training described that their customer discovery activities had led to initial discussions with private sector firms and non-lab organizations exploring partnering opportunities. In a few cases, teams had received initial statements of intent to partner.

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[69] These facets are: channels through which customers are reached, revenue streams, cost structure, and key resources.

Most teams ended training confident in their knowledge of the next steps applicable to advancing their technology along the commercialization continuum. The teams with the most articulated value propositions similarly had the clearest articulation of next steps.

The less confident teams were in their value proposition, the less confident they were in next steps. For the few teams that had not managed to develop a promising value proposition during the training, the appropriate next steps would be to iterate Energy I-Corps activities until they honed the value proposition, and yet the trainees were aware they lacked funding for this iteration and so did not have a clear path forward. These teams still believed in the value of their technologies, but were discouraged about the prospect of this value being monetized – that is, the technology becoming commercialized and technology sales occurring.

As the instructors made clear to the most advanced teams on the last day of training, now the hard work for those teams begin. The steps between their position at the end of training and the commercialization of their technology require much hard work, significant risk (and, by implication, considerable luck), support from their TTOs, and financial and perhaps other partnerships with the private sector.

9.1.3 Labs' Institutional Support for Commercialization Activities Strengthened in Small Ways

Through participation in Energy I-Corps, lab's institutional support for commercialization activities has strengthened, yet strengthened in small ways commensurate with the initial period of a small pilot.

- **Senior research managers** learned from their teams about the activities and benefits of training.
- **Lab pilot managers –** all of whom have positions within their lab's commercialization groups – have found the training experience transformative. Their proposals to EERE for pilot participation described their interest in the training and the alignment between Energy I-Corps and their labs' missions. Even so, their pilot experiences exceeded their expectations. At a meeting two weeks after the training, most of the managers described activities underway or planned to promote Energy I-Corps. Having accompanied their teams from selection through final presentation, the pilot managers observed first-hand the considerable growth in their teams' understanding and capabilities. Having learned from the instructors and training activities, the lab pilot managers developed a deepened understanding of the commercialization process and of the activities needed to move technologies along the commercialization process. Lab pilot managers (although not their entire technology transfer departments) now have the same toolkit that Energy I-Corps provided the participating researchers: a scientific method to advance technology commercialization.

- **The lab staff supporting the lab pilot managers (typically from the TTOs)** similarly gained in knowledge and understanding. None of the lab pilot managers worked alone on the pilot. They conducted and managed their lab's pilot participation through teams of individuals positioned within their lab's commercialization groups. Recognizing the value of Energy I-Corps exposure to their commercialization teams, the pilot managers (at the debriefing meeting) discussed the benefits of expanding future technology teams to include a member of the TTO, in addition to the roles of IP, EL, and IM.
- **Lab management** was aware of and supportive of the pilot. A few lab senior research managers publicly expressed their assessment that Energy I-Corps offered high value to the labs.

9.2 RECOGNITION OF THE CHALLENGES

The three broad goals of the Energy I-Corps pilot include:

- Train national lab researchers to better understand the commercialization process and private sector needs;
- Increase the number of national lab-developed technologies that are transferred into commercial development or industry agreements; and
- (Original) Transform national lab culture to value commercialization and entrepreneurial activities; (Revised) Strengthen and focus the entrepreneurial spirit of lab researchers.

The three broad pilot goals are ambitious and many barriers stand in their way, including an articulation by DOE of how extensive these attainments need to be to judge an Energy I-Corps program a success. The pilot's accomplishments to date already satisfy the first goal (by training over 30 lab researchers), suggest progress toward attainment of the second goal by as many as five technologies from cohort 1 alone (including the three Energy I-Corps teams sent to the preceding I-Corps Michigan training), and is making a small contribution to labs' placing increase value on commercialization and entrepreneurial activities. The Energy I-Corps pilot is just one of many lab activities (see Appendix E) and DOE initiatives and programs (see Appendix F) in support of commercialization of lab innovations.

However, to train more researchers, to transfer more technologies to the market, and to influence labs to increase their support for commercialization requires that DOE recognize the challenges, frame the extent of outcomes desired, and match its activities, resources and policies to meet the challenges sufficiently to attain the desired outcomes.

The following issues need to be addressed for Energy I-Corps to be judged successful in meeting its objectives:

- How can DOE take the Energy I-Corps pilot to scale to train more lab researchers?
  - How many PIs would DOE liked to train per year through the multi-week, experiential Energy I-Corps training? Working on contracts under which of DOE's offices? Working at which labs?
  - Can a "Energy I-Corps-Lite" (that is, a less intensive and costly training) be effective? How effective would suffice?
  - Can DOE find a stable funding source for:
    - Energy I-Corps (and related training)?
    - For Energy I-Corps management and implementation?
    - For research team members' time?
- How far along the commercialization continuum should labs be supporting technologies?
  - At what point does the risk offset the needed investment?
  - At what point might lab activity be construed as competing with the private sector?
  - At what point does the totality of their commercialization activities threaten to divert labs from their core missions?
- What are the implications of customer discovery for research agendas?
  - What reporting would DOE want on customer discovery findings?
  - To what extent would DOE want to increase alignment between its funded research and indications of market need obtained through customer discovery?
  - Might there arise situations where researchers encounter negative consequences from customer discovery that suggests a weak value proposition?
- What support is available to Energy I-Corps-trained researchers as they continue in their careers and seek to conduct customer discovery at points throughout their multiple research agendas?
  - To what charge codes will researchers bill their time?
  - To what extent, and under what circumstances, are DOE contract managers willing to request that, and contract for, researchers to conduct customer discovery?

- What support – types and extensiveness – should labs provide Energy I-Corps-trained researchers who ended training with what appear to be viable product ideas propositions? These researchers are at the juncture in technology development that instructors described as “where the hard work [read: considerable investment] begins.”
    - How do labs decide which technologies to pursue (to “bet on”)?

9.3 CONCLUSIONS

Early evaluation findings suggest the pilot is a success and is effectively building on the lessons learned by the participating labs and instructors to improve the training of future cohorts.

1. **Findings suggest Energy I-Corps has the potential to increase the commercialization of trained PI’s lab technologies** through partnerships with the private sector, licensing and, to a lesser extent, startups initiated by lab staff. Early evaluation results indicate that Energy I-Corps training appears to be have substantially deepened trainees’ understanding of how to evolve a technology and lay the groundwork for commercialization. Energy I-Corps teams also show progress toward achieving commercialization of their technologies.

   Engagement in Energy I-Corps training results in pivots (major changes) and refinements to researchers’ conceptions of what the technology offers to whom (its value proposition), including pivots and refinements to the technology itself. Some researchers reported that the market understanding and insights they gained from this method has changed their approach to their research agendas; one trainee described the experience as saving him a year of fruitless research.

2. **The Node and Site Lab structure of the Energy I-Corps pilot appears to be working well,** consistent with I-Corps experience. The labs have established respectful, collaborative working relationships and are learning from each other and their own training experiences.

   The pilot infrastructure – spanning curriculum development, faculty selection and guidance, team formation and support, partner engagement, and pilot promotion – appear to be working well. The Node and Site Labs are focused on continuous improvement. Based on their learning from each other and their own experiences, they planned as of the end of this evaluation’s data collection period to improve the pilot infrastructure for the second training cohort.

   For Energy I-Corps to noticeably affect technology commercialization rates and lab institutional support for commercialization, DOE and Node and Site Labs need to develop a plan to train more technology teams and increase involvement of the TTOs.

3. **Some Lab institutional support exists, but could be strengthened.** For trained team members to apply their training throughout their careers, across their research contracts, they need sources of funding to charge time spent in customer discovery and related activities.

   For trained team members to further pursue commercialization of their pilot technologies, they need support from their TTOs that goes beyond the support typically offered, as they need to engage in activities that researchers typically do not engage in.

9.4 RECOMMENDATIONS

1. **DOE should engage in a process to bring clarity to the issues related to program design that challenge Energy I-Corps' ability to meet its long-term goals**, including considering such things as:
   - How many researchers would it like to train each year?
   - What degree of commercialization activity can labs undertake and remain consistent with their mission and non-compete constraints?
   - To what extent does DOE want to incorporate a customer discovery process in its research agendas?
   - What are desired characteristics of the technologies considered within Energy I-Corps, including level of technology readiness?
   - What magnitude of DOE and lab resources should be devoted to the customer discovery necessary for commercialization activities?
   - What might be unintended negative consequences from scaling up these activities (that is, training, customer discovery, and other commercialization activities)?
2. **DOE and the Node and Site Labs should make plans to increase the size of Energy I-Corps to some defined scale**. The business model canvas taught by Energy I-Corps provides a framework for this activity. Several questions would need to be considered.
   - What offices and groups within DOE constitute target markets?
   - What is the value proposition for each of those markets?
   - What is the cost structure?
   - What are the revenue streams/funding mechanisms?
   - Who are the key partners and what resources do they offer?
   - What channels and approaches work best for reaching lab PIs?
   - What channels and approaches work best for obtaining lab management and senior research manager support, demonstrating that training benefits

exceed the costs of diversion from existing project deadlines and brain drain?

3. **DOE should maintain the Node Lab and Site Lab structure,** which includes monitoring, evaluation, and feedback, and have confidence that the participating labs are following continual improvement best practices.
4. **Consider expanding the curriculum for training to include revenue streams, cost structure, and key resources,** considered by some to be important downstream elements of the commercialization process. The labs would have to address constraints imposed by the additional time necessary to introduce these components to the training.
5. **DOE should continue tracking cohort 1 and its comparison group for an additional one or two years** to assess the mid-term effects of Energy I-Corps that are not detectable after one year. This would include metrics such as: new CRADAs, funding received from market actors, new material transfer agreements, new licenses, entrepreneurial leave (EL) taken, startups launched, and commercialized technologies. However, given the very small proportion of lab researchers trained through the pilot, a difference of differences evaluation (one that compares the percentage change of trainees and comparison-group nonparticipants) might be unlikely to detect an Energy I-Corps impact unless participating labs have substantially revamped their technology transfer support activities. As of this report's publication date, DOE has started implementing this recommendation, in part.
6. **DOE must increase institutional support** by recognizing the challenges, frame the extent of outcomes desired, and match its activities, resources and policies to meet the challenges sufficiently. These DOE actions are necessary to attain desired outcomes of training more researchers, transferring more technologies to the market, and influencing labs to increase their support for commercialization.
7. **DOE should identify funding for Energy I-Corps**, to enable it to transition to scale, and to assure labs of the program's longevity as they consider how to best support it.
8. **Participating labs need to recognize that scientists need lab support to conduct customer discovery and subsequent commercialization activities,** and to develop their strategy and plans to provide such commercialization support while still satisfying their research missions. This support could take the form of funded time for staff to pursue customer discovery and subsequent commercialization activities, take Energy I-Corps training, etc.
9. **Lab TTOs need greater involvement in Energy I-Corps and to provide more institutional support for trainees.** For Energy I-Corps to noticeably affect

technology commercialization rates and lab institutional support for commercialization, participating labs might benefit from developing a plan to increase involvement of the TTOs.

Appendix A Detailed Logic Models

Figure A-1: Energy I-Corps Pilot Program High Level Logic and Metrics

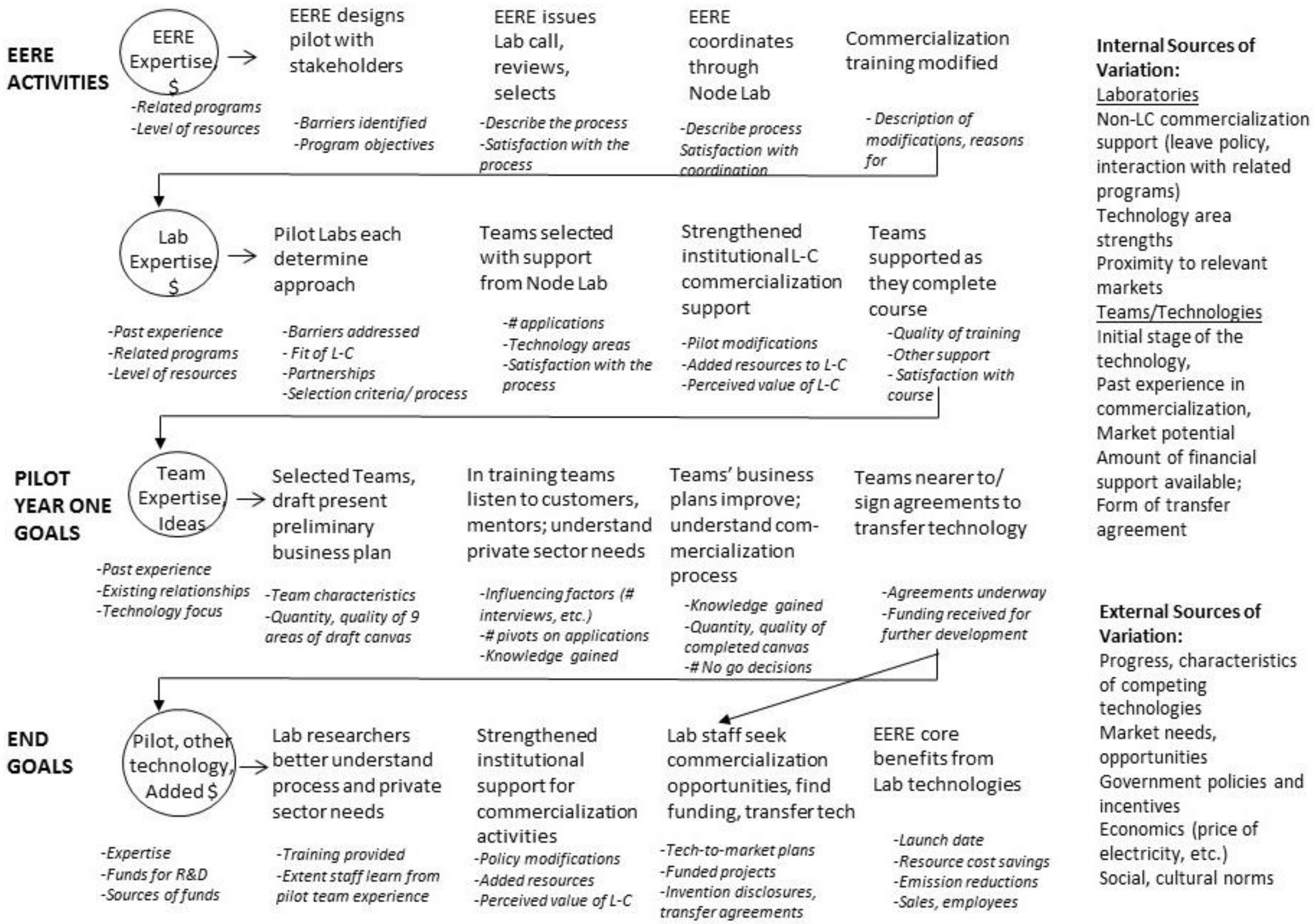


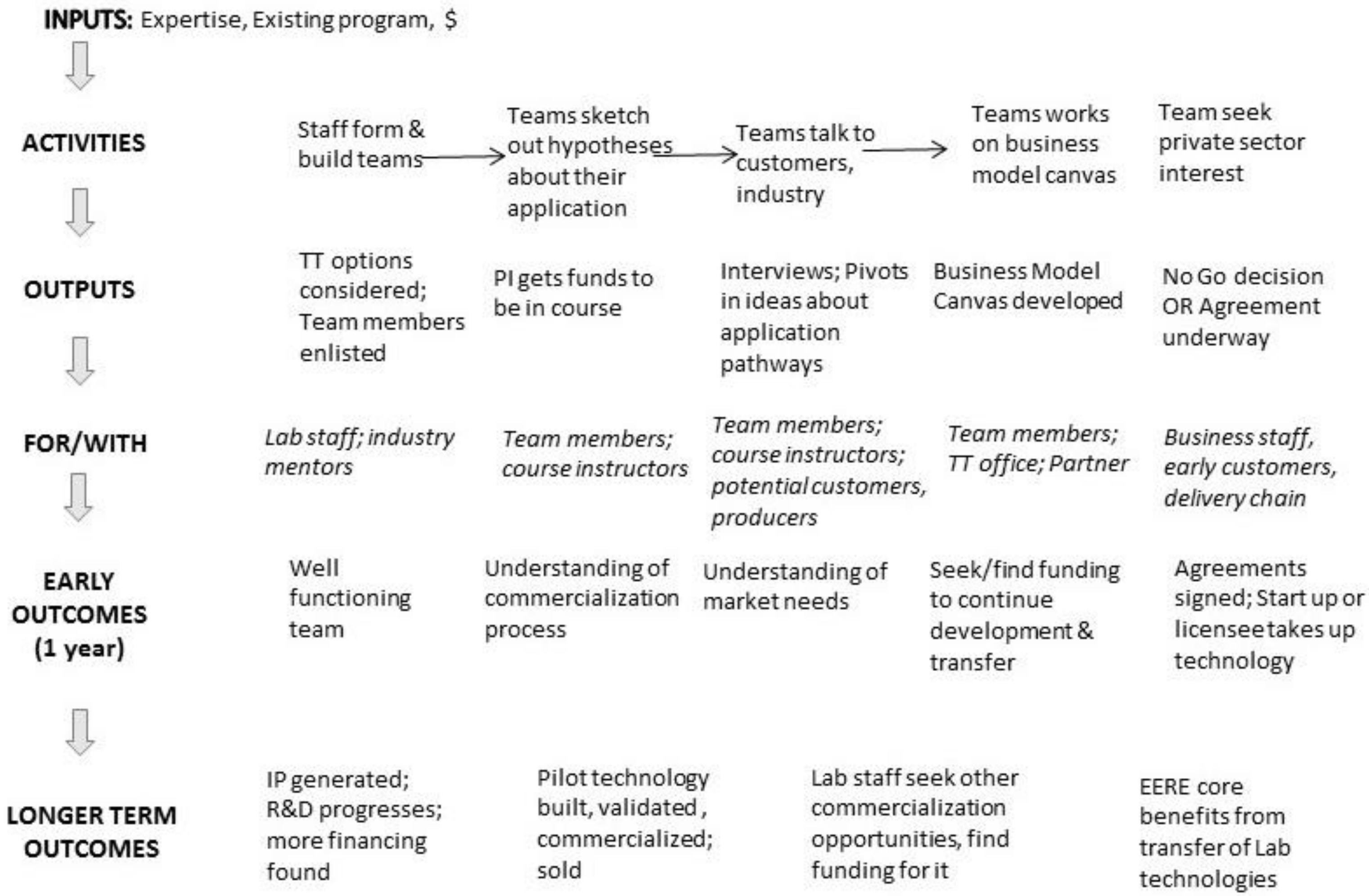
Figure A-2: Energy I-Corps Pilot Logic Model for EERE and Node Lab Activities, Processes

INPUTS: Expertise, Existing program, $

ACTIVITIES	EERE designs with stakeholders →	EERE Reviews, selects Labs →	EERE coordinates pilot start up →	Lab Node designs, delivers training →	Lab Node coordinates Labs →	EERE monitors, evaluates
OUTPUTS	Lab call reflecting ways to lower TT barriers	Reviewer comments; Node & 5 Labs notified	Meetings; Guiding advice	Curriculum; Instructors trained; Course held	Regular calls; IT platform;	Requirements RFQ, select contractor; Tech. plan
FOR/WITH	*Lab management, I-Corps, TT experts*	*DOE Labs; Expert reviewers?*	*Participating Labs; I-Corps staff*	*Participating Labs; I-Corps staff*	*Participating Labs; I-Corps staff, graduates*	*HQ program & evaluation staff; Contractor, Expert reviewers*
EARLY OUTCOMES (1 year)	Labs submit proposals	Designated Lab office receives funds; Press release	Processes influenced; Lab satisfaction with process, teams are supported	Teams complete & are satisfied; Share with others; Commercialization plans, agreements	Cross lab learning; Increase likelihood of success	Baseline report; Process and Early Impact Report; Lessons

Internal Sources of Variation: Initial stage of the technology, Technology focus, Past experience in commercialization; Amount of likely financial support available; Form of transfer agreement; Laboratory "model" for commercialization including time commitments of staff, and location, Related programs at the Lab.

Figure A-3: Energy I-Corps Pilot Logic Model for the Ten Pilot Teams



External Sources of Variation: Progress, characteristics of competing technologies; Market needs, opportunities; Government policies and incentives; Economics (price of electricity, etc.); Social, cultural norms.

Figure A-4: Energy I-Corps Logic Model for Processes at the Five Pilot Laboratories

INPUTS: Expertise, Existing program, $

ACTIVITIES	Labs prepare to write proposal →	Labs submit proposal →	Labs prepare to select teams →	Lab select teams →	Lab supports teams →	Lab change other TT process
OUTPUTS	Champion; Baseline data; Value proposition; Partner interest	Agreement on approach; Commitments to participate	Solicit teams; Meetings; Criteria set Process set	Review applications; Decision	Fund PIs time; TT, IP help;	Debate; Proposals
FOR/WITH	*Lab management, Leaders of related efforts*	*Project champion, lead office, partners*	*EERE, Lab node, potential team members*	*Proposers; Expert reviewers*	*Teams, Lab staff, related efforts*	*Lab management, staff; EERE*
EARLY OUTCOMES (1 year)	Better understanding of barriers, solutions	Process changes because of submission, before award	Lessons learned; Quality applications received	Teams participate in training	Increase potential for team success	Approval, take up of new process(es); Lessons learned

TT = Technology Transfer
IP = Intellectual Property

Internal Sources of Variation: Initial stage of the technology, Technology focus, Past experience in commercialization; Amount of likely financial support available; Form of transfer agreement; Laboratory "model" for commercialization including time commitments of staff, and location, Related programs at the Lab.

Appendix B Additional Findings from Energy I-Corps Baseline and Follow-up Surveys

B.1 TRAINING EXPECTATIONS

Because satisfaction is closely related to the extent expectations are fulfilled, baseline survey respondents described what they hoped to gain from the Energy I-Corps (then termed Lab-Corps) training. More than one-third of comments expressed a desire to gain a clearer understanding of the entire commercialization process and the toolset to effectively engage in that process (Table B-1).

Table B-1: Expectations for the Energy I-Corps Pilot Training (Multiple Responses)

Response	Count	Percent
Gain a clearer understanding of the entire commercialization process; acquire toolset to conduct commercialization process and to target customer segment(s)	11	42%
Learn how to build a start-up company and determine if a start-up should be formed to commercialize our technology; determine whether to pursue license vs. start-up for our technology	9	35%
Gain skills for gauging customer interest and interviewing potential customers so that solutions directly address business needs; assess technology and market viability	6	23%
Gain connections to, and learn how to interact with, the target industry	3	12%
Learn the fundamentals of successful entrepreneurial engagement	2	8%
Gain a better understanding of market forces and dynamics	1	4%
Learn how to apply this knowledge effectively within the national lab environment	1	4%
Increase visibility of my research both within and outside of DOE	1	4%
See how to learn and to prepare myself to do more to help society	1	4%

Response	Count	Percent
Investigate opportunities to develop and commercialize new technologies	1	4%
Keep an open mind and make a final decision	1	4%
Engage in an exceptional team building and learning experience	1	4%
Total	**26**	**--**

Baseline training respondents most commonly indicated they did not have questions or concerns regarding the training (6 of 17). Expressed concerns include:

- Concern about the time commitment (4 of 17),
- Concern that the training goals would not meet lab needs (2) or be suited to their individual characteristics (1)
- Concern that the training had too strict a beginning and end, without emphasis on learning and support before or after the program (2),
- Concern that the training would focus on how to launch a startup to the detriment of a focus on customer assessment (2),
- Concern about program funding (1),
- Concern that the training will not be sufficiently in-depth or practical (1), and
- Concern that the program had not established methods to measure success or improvement (1).

B.2 BASELINE AND FOLLOW-UP COMMERCIALIZATION INTEREST AND ACTIVITIES AMONG TRAINEES

Table B-2 describes PI's interest in commercialization activities prior to participating in Energy I-Corps.

Table B-2: PI Trainee Interest in Commercialization Activities (Baseline and Follow-up) (n=10)*

Item	Agree or Completely Agree**	
	Baseline	Follow-up
I am interested in licensing my technology to an existing company (10, 9)	90%	89%
I am interested in getting a CRADA to do further work on my technology (10, 8)	90%	100%
I am interested in some other partnership to transfer my technology (10, 9)	90%	100%
I am interested in starting my own company (10, 9)	60%	56%
I am interested in working in a startup someone else started (10, 10)	30%	40%

* Table reports one respondent per team (the PIs) so that the teams are the unit of analysis, not the individuals. Follow-up survey counts exclude individuals that reported, "I have already done this."

** Rating on a 5-point scale, where 1 equals not at all agree and 5 equals completely agree.

Table B-3 describes trainees' experiences with commercialization activities prior to participating in Energy I-Corps.

Table B-3: Trainees' Baseline Commercialization Activities (Multiple Responses)

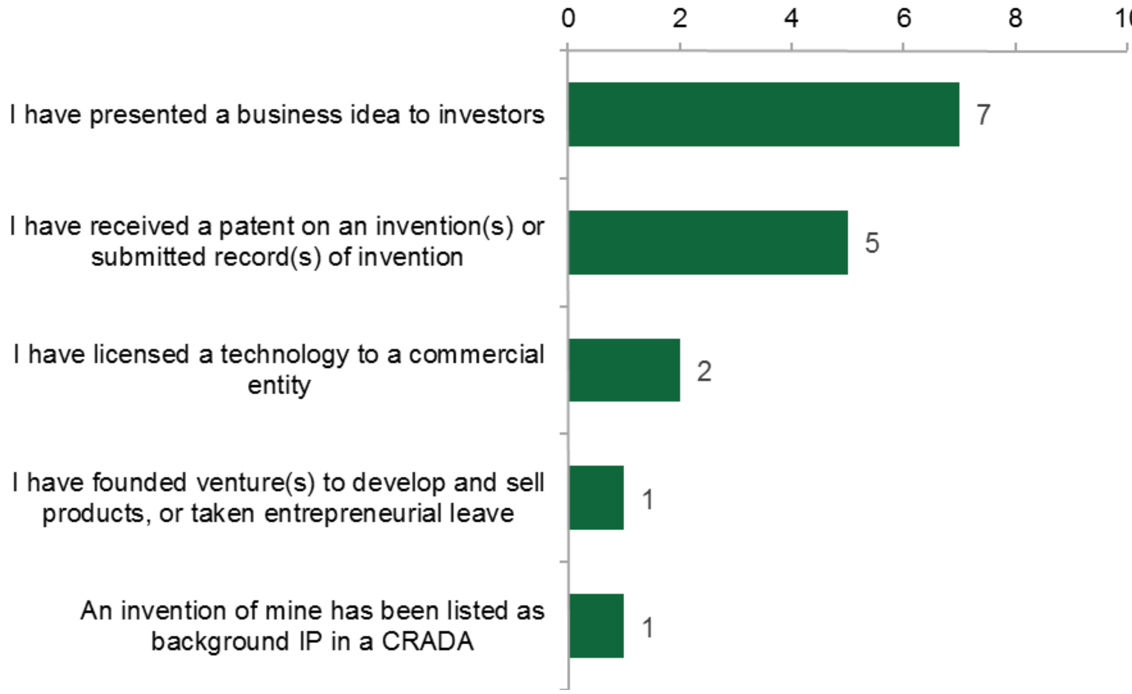
Response	Count	Percent
I have interviewed potential customers about a product, service, or technology	17	63%
I have submitted a record of invention or software record to my technology transfer office	17	63%
I have presented a business idea to investors	13	48%
I have received a patent on an invention(s)	11	41%
I have licensed a technology to a commercial entity	5	19%

Response	Count	Percent
I have founded venture(s) to develop and sell products, or taken entrepreneurial leave	5	19%
An invention of mine has been listed as background IP in a CRADA	4	15%
Other	4	15%
None of the above	2	7%
Total	**27**	**--**

Energy I-Corps trainees engaged in several activities (in addition to interviews; Figure 4-3, above) associated with the commercialization process since being chosen to participate in Energy I-Corps (Lab-Corps) in September 2015. Answers ranged from seven (of 13) teams who reported a relatively early-stage activity of having presented a business idea to investors to one team that reported a late-stage commercialization activity of having either founded a venture to develop and sell products or taken entrepreneurial leave (Figure B-1).[70]

[70] Participants also reported, on both the baseline and follow-up surveys, their involvement in various commercialization activities. An analysis of the responses did not reveal a consistent pattern of differences between the baseline and follow-up survey responses.

Figure B-1: Follow-up Status of Commercialization Activities by Team (Multiple Responses)



B.3 TRAINING INSIGHTS

Table B-4 provides the verbatim responses of team members' experiences with commercialization activities prior to participating in Energy I-Corps.

Table B-4: Greatest Insights from Training (Verbatim Responses)

Verbatim Responses: Greatest Insights from Training
I learned how to talk to business people about buying/selling/making products, what they wanted, what their real concerns are, etc.
We refocused our earliest market adopter based on interviews when we realized that the largest market did not have a large enough pain/frustration to need our product.
Customer discovery is hugely important. / More knowledgeable about lab's processes and option for commercialization of technology
I did not anticipate the vastness of the market, nor the opportunity therein
Homeowners, architects, and energy managers want to see case studies before putting their money on envelope retrofit. Energy service companies (ESCOs) want to have simple tool to estimate energy/cost savings that can be achieved by [technology]. Having case studies and an easy-to-use tool is needed to boost the building envelope market.

Verbatim Responses: Greatest Insights from Training
The greatest insight was the quantification of value (in terms of dollars) for this technology to ESCOs, and likely how much Business Development Managers there are willing to pay for this calibration technology.
Just getting a much better understanding that it is not just about the technology that was originally proposed. It is about the entire offering - the tech and the service provided by the tech that will truly help the industry.
I have realized that the market for this technology is not quite there, but that an improvement of the product in different areas not targeted before would open a lot of opportunities. There is a lot of work to do, but if we get there it would be a guaranteed winner
We basically have three approaches to commercialization, which we didn't know before.
Understanding exactly where the technology fits and how much it is worth.
With the emergence of renewable energy sources, accurate forecasting tools will be in greater demand.
Conducting interviews that directly test hypotheses about commercialization activities can and should be performed while the tech-features are being developed. This is a great way to make sure that we are directing our early tech development efforts into areas that can have success and impact in the market space.
There is no one great insight. The whole program has completely revolutionized how I approach technology development and research. The whole program was a great insight.
The greatest insight I gathered is that the retrofit market needs to be primed as it is currently not ready for our technology or other available technologies. The main reason is that there are minimal data that demonstrate the financial benefits from retrofitting the building envelope, and many of the estimates that we encountered during our interviews did not seem to be supported by robust data.
Focusing on one customer segment at a time and really understanding what their needs are is important to understanding your value proposition which is critical to understanding the commercial potential of your technology
Through customer discovery, I learned the true market potential. It is way different than the theoretical potential I thought before the process.

Verbatim Responses: Greatest Insights from Training
The technology team had to think strategically about commercialization and really develop a demonstration strategy for commercialization. You can't penetrate all markets at once.
Customers unanimously gave us very clear description of the level of prototype hardware development and testing they expect from us before engaging in serious business discussions of collaboration/licensing. The required prototype is significantly different than what we expected. Personally, I would like to make Customer Discovery a significant portion of my job. I would like to lead [Energy I-Corps]-style sprints for other technologies being developed at the labs.
For me, the greatest insight into a commercialization pathway for SPS forward osmosis technology into industrial wastewater treatment was the ecosystem through which technologies in the field are currently deployed. This helped me understand that the relationships that we would need are not actually with the end users our technology. Instead, we would want to license our technology to the part manufacturers and possible OEMs. They already have the relationships with the end-use customers and better understanding of their diverse needs than we would be able to develop on our own.
Our value proposition has crystallized into a very simple and powerful form.
Customer discovery process was crucial in confirming customer interest in [technology], identifying potential early buyers, required proof of performance and other factors to support a decision to buy, evaluating and prioritizing customer pain points to be solved by [technology], fine-tuning the value proposition and forming relationships with future development partners and customers.
It has been very beneficial to get a firsthand understanding of the market potential of the technology and some potential synergistic benefits beyond simple energy efficiency. There are also a significant number of other deciding factors that go into marketability of this (or any) technology beyond energy efficiency.
That the BMC can be applied to a division of the INL looking to develop a scope of work almost as well as a finished "widget" or service.

Appendix C Baseline Values of Technology Transition Metrics

C.1 TECHNOLOGY TRANSITIONS METRICS ANALYZED

Table C-1 identifies the metrics we analyzed to develop baseline values for Energy I-Corps, and create Figure C- through Figure C-5, which compare the (weighted) average metric values for the Node and Site Labs compared with nonparticipating labs.

Table C-1: Technology Transitions Metrics Analyzed

Variable	Figure
New CRADAs	Figure C-
New Income-bearing and Non-income-bearing Licenses	Figure C-
Number of Startup Companies	Figure C-
New Material Transfer Agreements (MTA)	Figure C-
Active non-federal sponsors (NFS) agreements	Figure C-4
Open Source Products Licensed	Figure C-4
Commercialized Technologies	Figure C-5

We selected the following nonparticipating labs based on completeness of the relevant data:

- Ames
- Brookhaven
- Los Alamos
- Oak Ridge
- Sandia (only Sandia-California participated in the pilot)

We weighted the labs to provide a meaningful comparison across labs of much different sizes. We weighted each lab based on its research and science funding.[71] We developed weights to normalize each lab to be "average" – that is, normalized each lab to the average amount of funding across all labs. We multiplied a given lab's metric values by the lab's weight (Table C-2). We then found the average weighted metric value for the Energy I-Corps labs and the non-Energy I-Corps labs.

[71] Source: *Department of Energy FY 2017 Congressional Budget Request, Laboratory Tables Preliminary*, Office of Chief Financial Officer, February 2016. Line items per lab research and science for (1) Total Electricity Delivery and Energy Reliability, (2) Total Nuclear Energy, (3) Total Energy Efficiency and Renewable Energy, (4) Total Science.

Table C-2: Derivation of Weights Used to Compare Labs

Lab	2017 Requested Research and Science Funding	Size in Relation to Average	Weight
AL	$ 51,713,000	0.140654	7.109654
ANL	$ 543,626,000	1.478604	0.676313
BNL	$ 471,915,000	1.283558	0.779084
INL	$ 487,006,000	1.324604	0.754943
LANL	$ 108,785,000	0.295884	3.379708
LBNL	$ 628,021,000	1.70815	0.585429
LLNL	$ 136,649,000	0.371671	2.690554
NREL	$ 303,891,000	0.826551	1.209847
ORNL	$ 910,875,000	2.477482	0.403636
PNNL	$ 262,654,000	0.714391	1.399794
SNL	$ 139,142,000	0.378451	2.642348
Average	$ 367,662,000	1.0	NA

C.2 TECHNOLOGY TRANSITIONS METRICS FOR WHICH LAB PARTICIPANTS LAG NONPARTICIPANTS

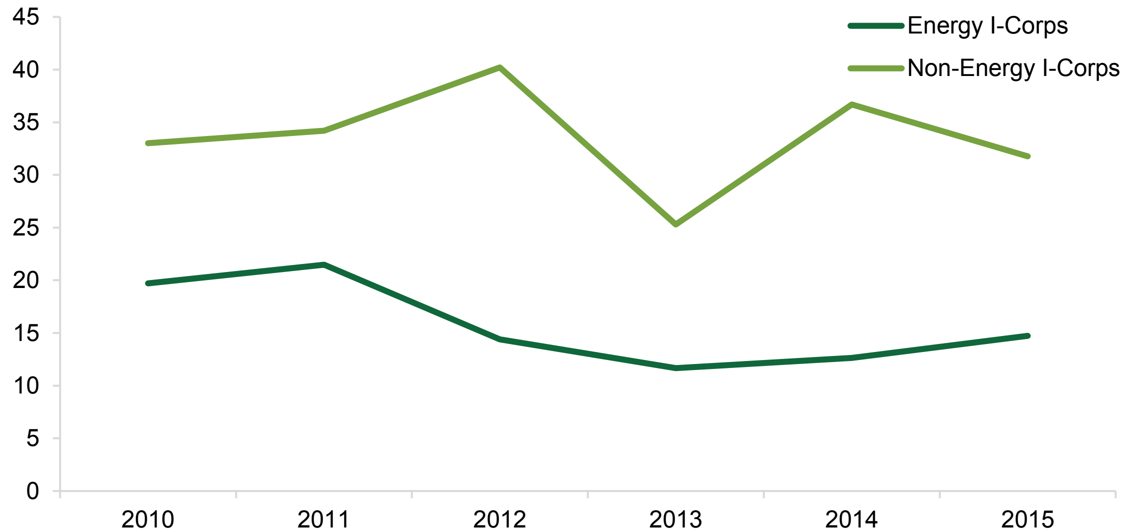
The participating Energy I-Corps labs differ from the comparable nonparticipating based on a comparison of all average weighted metrics examined. Energy I-Corps labs lag (have lower average metric values) for three of the seven metrics assessed.

Figure C-1 thru Figure C-3 shows results graphically.

C.2.1 Lab Baseline Values for New CRADAs

Figure C-1 shows the weighted average number of new CRADAs by participating and nonparticipating labs, 2010 through 2015.

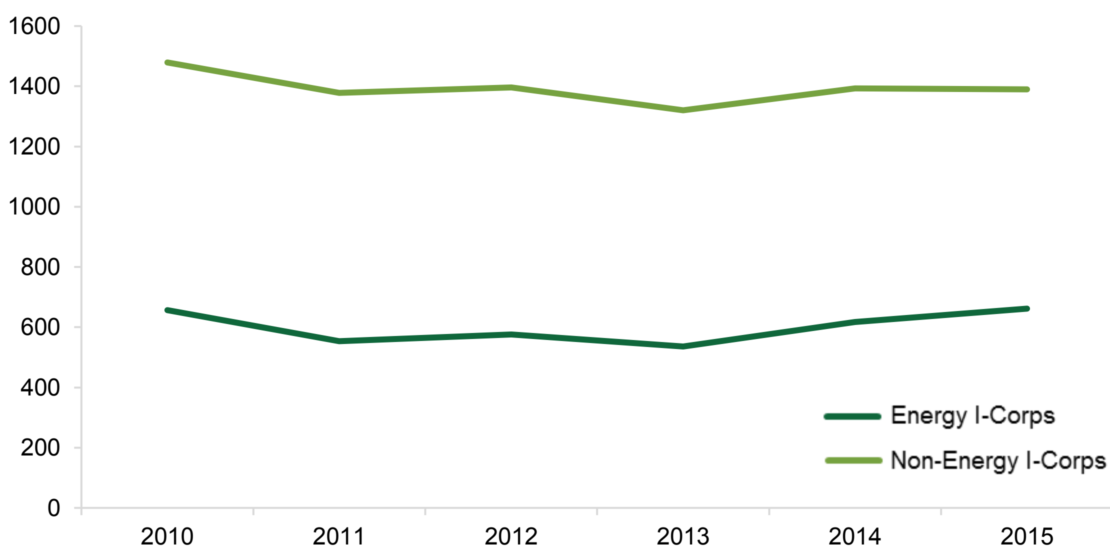
Figure C-1: Weighted Average Number of New CRADAs by Participating and Nonparticipating Labs (2010 – 2015)



C.2.2 Lab Baseline Values for Total New Licenses

Figure C-2 shows the weighted average number of new licenses (both income-bearing and non-income bearing) by participating and nonparticipating labs, 2010 through 2015.

Figure C-2: Weighted Average Number of Total New Licenses* by Participating and Nonparticipating Labs (2010 – 2015)

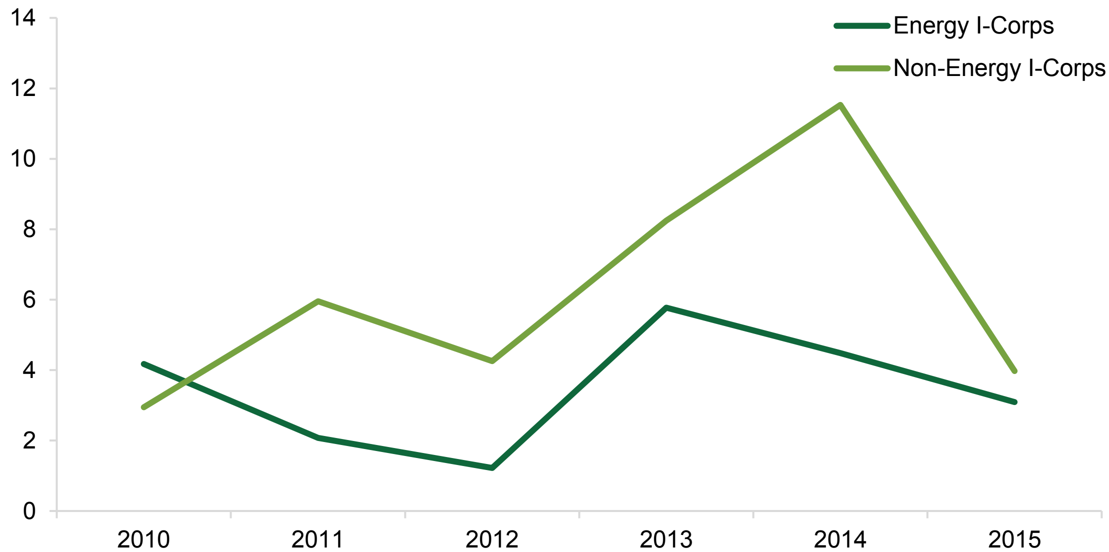


* Includes new income-bearing and non-income-bearing licenses.

C.2.3 Lab Baseline Values for Startup Companies

Figure C-3 shows weighted average number of startup companies per year by participating and nonparticipating labs group, 2010 through 2015.

Figure C-3: Weighted Average Number of Startup Companies per Year by Participating and Nonparticipating Labs (2010 – 2015)



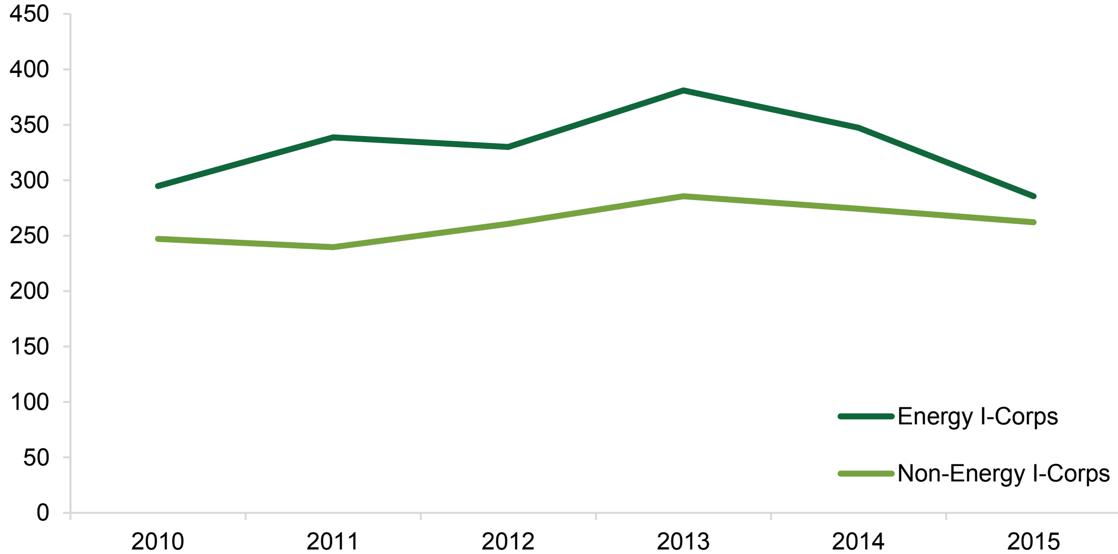
C.3 TECHNOLOGY TRANSITIONS METRICS FOR WHICH LAB PARTICIPANTS EXCEED NONPARTICIPANTS

Energy I-Corps labs exceed nonparticipating labs in their average values for two of the metrics. Roughly speaking, the extent to which their average values exceed the nonparticipants on these two metrics is less than the extent to which the nonparticipants' average values exceed theirs for the metrics discussed in Section C.2.

C.3.1 Lab Baseline Values for Active NFS Agreements

Figure C-4 shows weighted average number of active Non-Federal Sponsors (NFS) agreements by participating and nonparticipating labs, 2010-2015.

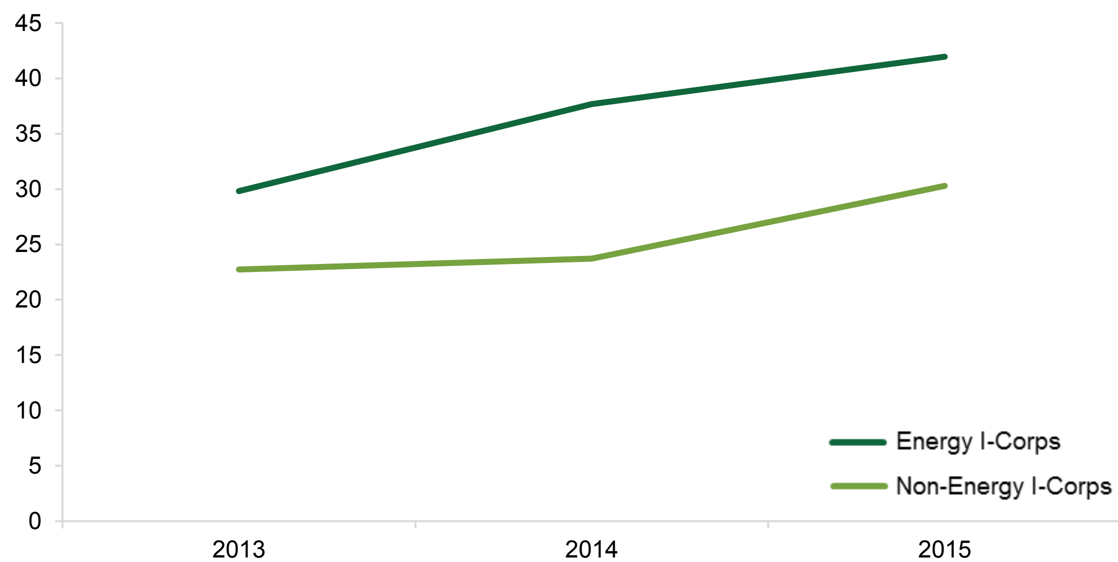
Figure C-4: Weighted Average Number of Active NFS Agreements by Participating and Nonparticipating Labs (2010 – 2015)



C.3.2 Lab Baseline Values for New Material Transfer Agreements

Figure C-5 shows weighted average number of new material transfer agreements by participating and nonparticipating labs, 2013-2015.

Figure C-5: Weighted Average Number of New Material Transfer Agreements by Participating and Nonparticipating Labs (2013 – 2015)



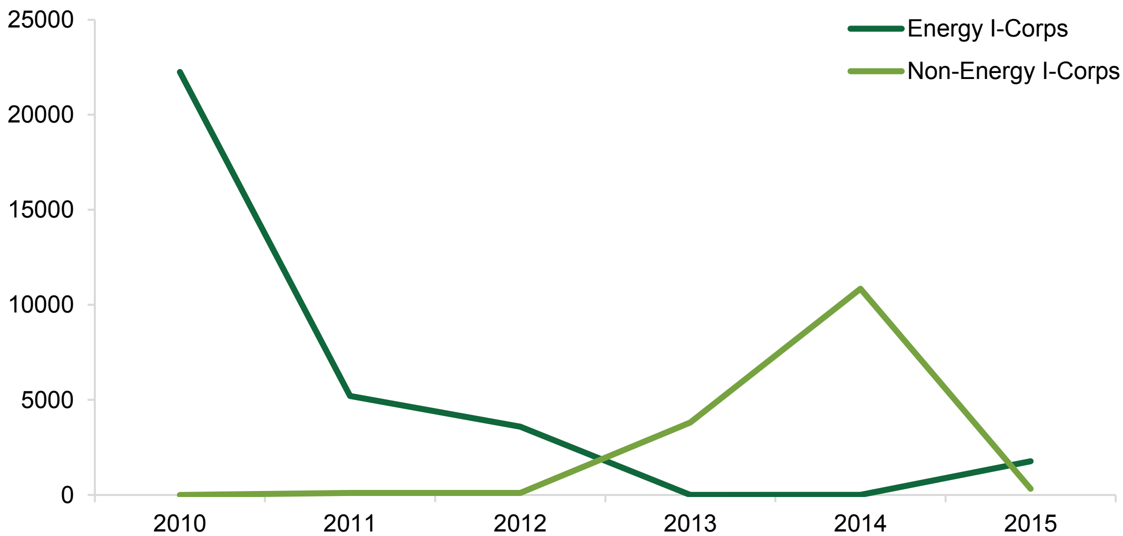
C.4 TECHNOLOGY TRANSITIONS METRICS FOR WHICH LAB PARTICIPANT AND NONPARTICIPANT TRENDS INTERSECT

There is no clear pattern of difference between Energy I-Corps labs and nonparticipating labs in their average values for two of the metrics.

C.4.1 Lab Baseline Values for Open Source Products Licensed

Figure C-4 shows the weighted average number of open source products licensed by participating and nonparticipating labs, 2010-2015.

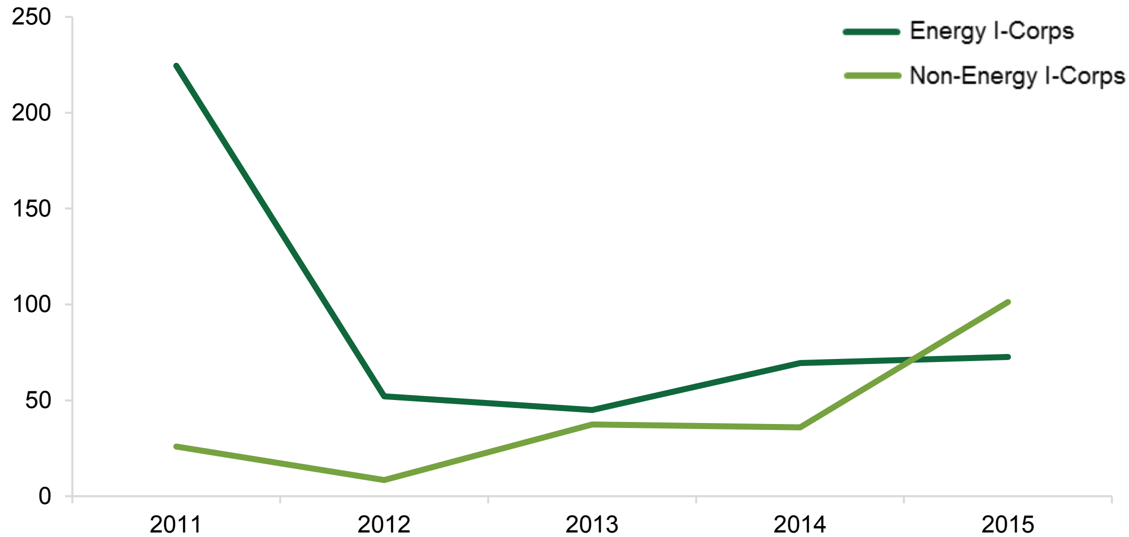
Figure C-4: Weighted Average Number of Open Source Products Licensed by Participating and Nonparticipating Labs (2010 – 2015)



C.4.2 Lab Baseline Values for Commercialized Technologies

Figure C-5 shows weighted average number of commercialized technologies by participating and nonparticipating labs, 2011 through 2015.

Figure C-5: Weighted Average Number of Commercialized Technologies by Participating and Nonparticipating Labs (2011 – 2015)



Appendix D Site Lab Descriptions of Their Team Selection Approaches

The Site Labs provided the evaluation team with the following descriptions of their approaches to selecting Lab-Corps (currently termed Energy I-Corps) cohort 1 teams; we edited their descriptions for clarity.

D.1 ANL

We used a two-stage application process. The first stage was an online application followed up by a phone interview; the second stage was a pitch contest. The online application solicited information including the problem solved by the technology, the potential customer, competitors, and steps already taken to commercialize the technology. The phone interview was used to follow up on the information provided in the online application and to assess the ability and willingness of the teams to commit the time required to the program.

Multiple reviewers scored applications and the scores were used to select six finalists who participated in a pitch contest.

In the pitch contest, teams made a pitch to a panel of four technologists and entrepreneurs in the clean energy space. The pitches were seven minutes long, followed by a five-minute Q&A session. The pitch contest took place in front of an audience of lab personnel. We provided training in making business pitches.

Pitches were scored based on:

1. ability of the team to benefit from Lab-Corps training, and
2. likelihood that the technology would find a market.

D.2 INL

We first used an internal down select focused on technology, while vetting PI characteristics as go/no-go. Next, we used an external down select focused on PI characteristics, while vetting the technology as go/no-go.

Boise State works with Boise Angel Alliance and suggested we interview potential participates, as they do, to get an idea of PI characteristics, because it is hard to measure enthusiasm.

Selection Metrics –

1. PI Characteristics (pro-active, open-minded, passionate, communication, coach-able),

2. EERE clean energy market impact,
3. Technology maturity,
4. PI management team support / PI flexibility
5. Regional Impact,
6. Customer / customer segments, and
7. Financial / ROI / revenue velocity.

D.3 LBNL

We held several information sessions to generate interest in Lab-Corps before soliciting applications. We held four brownbag lunch informational sessions about the program and selection process. We held four brownbag lunch sessions to help interested researchers with their applications and team matching.

We reviewed the applications, which were a combination of biographies, technology descriptions, and project/application descriptions, and provided feedback to each team. All five teams were invited to give presentations. We met with teams to help them prepare presentations.

We formed a selection panel to review in-person presentations. The selection panel was composed of two external and reviewers and five internal reviewers. We provided a scoring sheet as a guideline for selection panel.

We had each panelist read the applications and then listen to 10-minute presentations by teams with Q&A interspersed (that was designed to simulate Lab-Corps instructor questioning). The panel deliberated after presentations. Each panelist ranked the teams and then we tallied the rankings for each team - for example, team A was ranked first by 3 panelists, second by 2 panelists, and so on. We looked at the tallied rankings for a clear first team and second team, and debated teams competing for the second ranking.

IPO I-Corps leads met with each team in person to provide feedback and deliver results of selection process.

D.4 LLNL/SNL

We held entrepreneur-training events at both the i-GATE Innovation Hub in downtown Livermore and at the UC Davis campus. In general, about 20-25 people attended each of 14 I-GATE sessions, while about 3-7 people consistently participated in the UC Davis workshops.

At the end of this ~9-week training process, we held a selection event, in which each team gave a 10-minute presentation followed by 10 minutes of questions to the

Selection Input committee, which consisted of the LLNL EERE program manager, members of the LLNL and SNL industry partnerships offices, members of our industry advisory board, a representative from the UC Davis Innovation Institute, a representative from the i-GATE Innovation Hub, and the Lab-Corps project leaders.

This committee provided a numerical rating and commented on subjective metrics of enthusiasm and teachability to the Final Selection Committee, which was composed of the Lab-Corps project leaders, a member of the UC Davis Innovation Institute, and the Industry Advisory Board chair. The Final Selection Committee made the final decision on teams to go forward based on selection committee input and the overall EERE project objectives.

D.5 PNNL

Commercialization managers and clean energy sector managers at PNNL provided a list of candidate technologies to the PNNL Lab-Corps support team. Those technologies were then vetted by the group that submitted them, as well as by the Lab-Corps team and were ranked based on the following criteria:

1. mission fit,
2. strength of technology, and
3. perceived market opportunity.

There were four technologies that rose to the top, based on the relative ranking. The PIs for these technologies were interviewed to determine their interest in participating in Lab-Corps. Once the technologies and PIs were selected, ELs and IMs were chosen from a list of candidate ELs (volunteers within the lab, general inquiries from outside the lab, and those identified through the economic development office as potential candidates) and IMs (identified through strategic partners and the economic development office), based on fit with the technologies.

Appendix E Descriptions of Participating National Laboratories

This appendix provides brief descriptions of the labs participating in the Energy I-Corps pilot, and of their Technology Transfer Offices (TTO), which go by different names at the different labs.

E.1 ARGONNE NATIONAL LABORATORY (ANL), ARGONNE, IL

Argonne National Lab has been relocated twice since engineering the world's first controlled nuclear chain reaction on December 2, 1942 *under* the football stadium of University of Chicago. Argonne still leverages its proximity to Chicago to bring together multi-organizational teams of scientists for projects "providing solutions to the grand challenges of our time: sustainable energy, a healthy environment, and a secure nation." Energy-related programs include a search for higher performance in batteries, fuel cells, vehicle engines, alternative fuels, and smart electrical grids.

One Argonne research directorate is entirely focused on photons other sub-atomic beams--the circular linear accelerator building is a recognizable symbol of science in the U.S. Three other directorates denote Argonne's strength in physical sciences and engineering (including nano-engineering); energy and global security; life sciences and super-computing.

Technology Development and Commercialization division is the gateway into Argonne assistance for organizations that want to bring new technology into the market. Technologies available for licensing are categorized as: Energy Storage, Industrial & Manufacturing Process, Software, Life Science, Materials, and Transportation. In May 2015, about 100 research and economic development representatives met as part of an outreach pilot by Argonne and Fermilab to increase particle accelerator applications in medicine, energy, and industry (Accelerator Stewardship Test Facility Pilot Program).

ANL employs approximately 3,350 staff (according to ANL's website accessed in March 2016).

E.2 IDAHO NATIONAL LABORATORY (INL), IDAHO FALLS ID

Established in 1949, INL is a science-based, applied engineering national lab that performs work in three primary areas: nuclear science and technology, national and homeland security, and energy and the environment. INL is the nation's lead lab for nuclear energy research and development. Over the past ten years, the U.S. Patent and Trademark Office (USPTO) has issued 391 patents in all the focused areas to either INL or to DOE based on the inventions of INL work. To support commercialization of INL-developed intellectual properties, INL's Technology Deployment (TD) office facilitates the deployment of technologies developed at the lab to the private sector.[72]

INL's TD office does not currently provided support for lab researcher entrepreneurial activities.

INL employs approximately 3,900 staff (according to INL's website accessed in March 2016).

E.3 LAWRENCE BERKLEY NATIONAL LABORATORY (LBNL), BERKLEY CA

Established in 1931, LBNL utilizes a multidisciplinary scientific approach to solve global problems in human health, technology, energy and the environment. LBNL has six primary research areas: biosciences, computing sciences, earth and environmental sciences, energy sciences, energy technologies, and psychical sciences. The Innovation and Partnerships Office (IPO) leads LBNL's efforts to transition technologies from the lab into the marketplace through licensing lab-developed technologies, collaborative research with industry, and supporting lab researchers through entrepreneurship and intrapreneurship opportunities.

The IPO's Berkeley Lab Innovation Crops (BLIC) aims to expose lab researchers to commercialization principles and increase private sector interactions. The first BLIC initiative is DOE's Lab-Corps Pilot program. In addition to the BLIC, the IPO also offers Innovation Grants to lab researchers to aid in the commercialization of lab developed technologies and distributes 35% of the net income from royalties to the lab inventors.[73]

LBNL employs approximately 3,200 staff (according to LBNL's website accessed in March 2016).

E.4 LAWRENCE LIVERMORE NATIONAL LABORATORY (LLNL), LIVERMORE, CA

LLNL was founded in 1952 with a mission to respond to national security challenges, through development and application of science and technology to global threats such as terrorism, weapons of mass destruction, and nuclear stockpiles. In 2013, 72% of the budget was related to weapons and non-proliferation research. For DOE, LLNL conducts projects on energy generation and efficiency, as a response to broader "security threats" such as U.S. energy shortages and global climate disruption.

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[72] https://www.inl.gov/wp-content/uploads/2014/11/business-with-INL.pdf. https://www.inl.gov/wp-content/uploads/2014/11/business-with-INL.pdf.

[73] http://ipo.lbl.gov. http://ipo.lbl.gov/wp-content/uploads/sites/8/2014/09/LBNL_About_TechTransfer.pdf

Industrial Partnerships Office (IPO) works to encourage lab scientists to deploy technologies and software into for-profit commercial ventures. IPO staff conduct ‘Intellectual Property evaluations’ on the legal protection, commercial potential, and best market transfer mechanisms, including marketing plans and entrepreneurial separation leaves. IPO also hosts monthly webinars when lab scientists introduce LLNL technologies to entrepreneurs and investors.

In 2010 LLNL and Sandia National Laboratory-California, with municipal and college entities, launched “i-GATE Innovation Hub,” a nonprofit to support startups with working space, business mentors, and lab capabilities. i-Gate will continue to support seven unsuccessful Lab-Corps applicants from Livermore/Sandia.

LLNL employs approximately 6,300 staff (according to LLNL’s website accessed in March 2016).

E.5 NATIONAL RENEWABLE ENERGY LABORATORY (NREL), GOLDEN, CO

NREL focuses its research scientists exclusively in the areas of sustainable transportation, energy productivity in buildings, renewable electricity, and grid systems integration. NREL is the singular federal lab working on renewable energy and on energy consumption reduction. NREL is the location of three national basic science centers, in bioenergy, photovoltaics, and wind technology, as well as three collaborative user facilities, for solar energy and systems integration, and biorefinery research.

NREL seeks to reduce private sector risk and enable adoption (transfer) of new technologies through five different commercialization programs that connect entrepreneurs, investors, and NREL innovations. NREL manages the DOE Energy Innovation Portal to provide a master list of clean energy technologies available for licensing from all national labs. The Innovation and Entrepreneurship Center guides clean energy toward more market orientation by linking with the financial community and others key to a commercialization process. An Industry Growth Forum gives clean energy innovators the chance to present business cases to an expert panel of investors and executives.

NREL employs approximately 1,500 staff (according to NREL’s website accessed in March 2016).

E.6 PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL), RICHLAND, WA

Established in 1965, PNNL's multidisciplinary scientific team focuses on chemistry, energy, the environment, data analytics, and national security. PNNL is home to the Environmental Molecular Science Laboratory (EMSL) which facilities collaboration to enable discoveries and innovations that respond to energy and environmental problems. PNNL's Technology Commercialization Program (Tech Comm) focuses on matching scientific innovation with marketplace needs and facilitates the transfer of lab-developed technologies into the hands of industry partners.

PNNL's Tech Comm Program does not currently provided support for lab researcher entrepreneurial activities.[74]

PNNL employs approximately 4,400 staff (according to PNNL's website accessed in March 2016).

E.7 SANDIA NATIONAL LABORATORIES-CALIFORNIA (SNL-CA), LIVERMORE, CA

Sandia National Laboratories-California is participating in the Energy I-Corps pilot as a partner with LLNL.

Sandia National Laboratories began as the Albuquerque extension of the Los Alamos Manhattan Project in New Mexico, and a lab supporting Lawrence Livermore Laboratory in California was added. Like LLNL, Sandia Labs are part of the DOE National Nuclear Security Administration in DOE. "National security is our business. We apply science to help detect, repel, defeat, or mitigate threats," as Sandia's website states most clearly. Initially managed by AT&T and focused on nuclear weapons, Sandia's mission has expanded. Energy, climate, and power infrastructure security are now a primary focus, since reliable and sustainable energy is essential to true national security. A Lockheed Martin Corporation subsidiary manages and operates Sandia Labs for the DOE, since 1993.

The Intellectual Property Licensing Portal guides consideration of technology transfer opportunities in eight areas, and Sandia reports recent increases in technology licenses and patent applications. Sandia's technology transfer efforts "have focused heavily in the last few years on educating Sandia scientists to consider market opportunities in everything they do," according to director Paul Hommert. Technology Showcases are year-round series connecting lab inventions with commercial appeal to investors and entrepreneurs. Sandia Labs is building an "expanded front door" in 2015--the Center for

[74] http://www.pnnl.gov/business/techtransfer/documents/TechCommOverview-singlepgs.pdf

Collaboration and Commercialization (C3) to allow potential partners “one stop” to access technology transfer staff, conferences, and agreement negotiators, instead of navigating multiple security entrances and driving through an Air Force base.

SNL employs approximately 10,540 staff across all locations (according to SNL’s website accessed in March 2016). About 1,000 of these are located at the California site.

Appendix F Factors that Affect Technology Transfer and Commercialization at Federal Laboratories

This appendix describes factors that affect technology transfer and commercialization at Federal laboratories. It draws on finding from a 2011 IDA study - *Technology Transfer and the Commercialization Landscape for Federal Laboratories*.

1. **Laboratory mission.** Technology transfer varies across laboratories due to the diversity and scope of their missions. Some laboratories are more inclined towards technology transfer that leads to commercialization because it is in the interest of achieving the mission of the lab, agency, or sub-agency.
2. **Laboratory management.** Differences between Government-Owned, Government-Operated (GOGO) and Government-Owned, Contractor-Operated (GOCO) laboratories can affect technology transfer and commercialization activities. GOCO lab leadership is often explicitly tasked to perform technology transfer and commercialization, while GOGO laboratories must comply with certain government regulations that do not affect GOCOs.
3. **Congressional support and oversight.** Despite congressional support for technology transfer at the federal laboratories, congressional action and oversight can have the unintended consequence of encouraging a risk-averse culture towards technology transfer. Furthermore, technology transfer activities can be undermined when congressional priorities shift, as technology transfer requires long-term support.
4. **Agency leadership and lab director support.** Support from agency leadership and lab directors can have a marked effect on technology transfer and commercialization activities. For example, lab directors who support technology transfer may provide resources, flexibility, and creative license to their Office of Research and Technology Applications (ORTAs). Those ORTAs who are not supported by their lab leadership can be severely constrained.
5. **Organization and coordination of technology transfer and commercialization activities.** The centralization/decentralization of technology transfer functions at the agency and lab levels affects the speed of implementation of technology transfer actions, the consistency of policies across laboratories within an agency, and the ability to share best practices. The location of ORTAs within an agency and lab can affect the visibility of technology transfer.
6. **Offices of Research and Technology Applications.** Operations that seem to affect technology transfer and commercialization include the responsibilities of the office; the science, technology, and business expertise of the staff; the

processes of the office; and the legal authorities available to the lab and how ORTA staff interpreted them.

7. **Researchers.** Lab researchers, whose participation in technology transfer and commercialization processes varies across laboratories, may lack the knowledge, ability, and incentives necessary to undertake the research, administration, and business development involved in successful technology transfer.
8. **Government-industry interactions.** Federal laboratories are not visible and accessible to industry, and certain regulations make it difficult for federal laboratories and industry to interact. According to partnership intermediaries, groups designed to broker partnerships between the laboratories and industry, industry is largely unaware of opportunities to collaborate with the federal laboratories.
9. **Resources.** Resources devoted to technology transfer and commercialization vary across laboratories and agencies. Further, the extent to which the agencies and laboratories leverage federal, state, and local programs that support technology-based economic development may also affect technology transfer and commercialization.

Appendix G National Laboratory Initiatives and Technology Commercialization Initiatives Having Some Indirect Lab Involvement

In addition to the Energy I-Corps pilot – the subject of this evaluation study – there are other national lab initiatives. Also, there are a number of technology commercialization initiatives that indirectly involve the labs.

G.1 LAB INITIATIVES

G.1.1 DOE's Small Business Voucher Pilot (SBV) (2015 to Present)

EERE's Small Business Vouchers (SBV) pilot connects clean energy small businesses with the world-class resources at the U.S. Department of Energy's national laboratories. Through 2016, EERE is providing up to $20 million in vouchers so that small businesses can request technical assistance from national laboratories to help bring the next generation of clean technologies to market. Through the SBV pilot, eligible small businesses can tap into the reserve of national laboratory intellectual and technical assets to overcome critical technology and commercialization challenges, including: 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. Eligible small businesses can request a voucher for use at a national laboratory valued between $50,000 and $300,000.

G.1.2 Lab-Embedded Entrepreneurship Program (LEEP) (2014 to Present)

Lab-Embedded Entrepreneurship Program (LEEP) provides an institutional home for researchers to build their research into products and train to be entrepreneurs. LEEP is funded by EERE's Advanced Manufacturing Office, and co-managed with EERE's Technology-to-Market Program. LEEP takes top entrepreneurial scientists and engineers and embeds them within the U.S. national laboratories to perform applied research and development (R&D) with the express goal of launching a clean energy business. In addition to technological access and support, LEEP trains innovators to develop entrepreneurial acumen and skills, while introducing them to the ecosystem partners needed to facilitate commercial and investment opportunities. This dual focus on R&D and entrepreneurial development provides innovators with the platform they need to take their ideas from the lab and onto the commercialization pathway.

G.1.3 Agreement for Commercializing Technology (ACT) (2011 to 2017)

The ACT was created in response to feedback received in a Notice of Inquiry Concerning Technology Transfer at DOE National Laboratories. Initially launched as a three-year pilot program in December 2011, the ACT allows lab contractors to negotiate and enter agreements directly with the private sector sponsors using terms and conditions that are more consistent with industry practices. These privately sponsored research agreements are performed at the contractor's risk. Under ACT, the contractor may charge those parties additional compensation beyond the direct costs of the work at the lab. Some of the benefits that the contractors offered under an ACT include waiver of Advanced Payment requirements, fixed price contracting, performance guarantees, IP flexibility, and the option for a government research license for subjects' inventions instead of the broader a government use license.

G.1.4 Technology Commercialization Fund (TCF) (2005 to Present)

The TCF is a nearly $20 million funding opportunity that leverages the R&D funding in the applied energy programs to mature promising energy technologies with the potential for high impact. It uses 0.9 percent of the funding for the Department's applied energy research, development, demonstration, and commercial application budget for each fiscal year from the Office of Electricity, Office of Energy Efficiency and Renewable Energy (EERE), Office of Fossil Energy, and Office of Nuclear Energy. These funds are matched with funds from private partners to promote promising energy technologies for commercial purposes. The goal of the TCF is two-fold. First, it is designed to increase the number of energy technologies developed at DOE's national labs that graduate to commercial development and achieve commercial impact. Second, the TCF will enhance the Department's technology transitions system with a forward-looking and competitive approach to lab-industry partnerships. TCF enhance DOE's technology transitions efforts by providing national lab technologies funds for maturation, empowering a broader set of potential industry partners to engage with the national laboratories, and focused industry engagement to identify high-quality partners. EERE is the largest contributor to this program.

G.1.5 Entrepreneur-in-Residence (2007 to 2008)

EERE began its Entrepreneur in Residence (EIR) initiative in 2007 to support clean energy technology commercialization and to address long-standing concerns that national lab inventions were not being sufficiently transferred into the marketplace. After conducting a competitive solicitation, EERE selected venture capital-sponsored entrepreneurs and placed them at key national laboratories. EERE's goal was to accelerate lab technology transfer by enabling start-up entrepreneurs to work directly with the laboratories, thereby bridging the gap between leading scientific and business talent.

G.1.6 Historical Technology Maturation Programs

For more information about the history of DOE technology maturations programs see "Department of Energy Technology Maturation Programs", IDA Science and Technology Policy Institute, May 2013 available at *https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/ida-p-5013.ashx*.

G.2 COMMERCIALIZATION INITIATIVES INDIRECTLY INVOLVING LABS

G.2.1 Build4Scale Manufacturing Training for Cleantech Entrepreneurs (2016 to Present)

The Energy Department's Build4Scale Manufacturing Training for Cleantech Entrepreneurs is a joint effort between the Clean Energy Manufacturing Initiative (CEMI) and the Office of Energy Efficiency and Renewable Energy's (EERE's) Technology-to-Market Office that provides entrepreneurs with the tools they need to identify and address manufacturing challenges early in the process. Understanding how to navigate these challenges saves time and capital, making cleantech startups more attractive to industry partners and investors.

G.2.2 DOE's clean technology university prize competition (Cleantech Up) (2015 to Present)

Energy Department's (DOE's) Cleantech University Prize (Cleantech UP) aims to inspire and equip the next generation of clean energy entrepreneurs and innovators by providing them with competitive funding for business development and commercialization training and other educational opportunities.

Launched in 2015, Cleantech UP builds on its precursor, the DOE National Clean Energy Business Plan Competition. Eight institutions will host annual Cleantech UP Collegiate Competitions, where students receive entrepreneurial support and compete for cash prizes and services to further support the commercialization of their clean energy technologies. The Collegiate Competitions will establish team development and training that will aid students in developing the skills to move clean energy technologies from the discovery phase to the marketplace. Winners of the Collegiate Competitions will be eligible to compete in the Cleantech UP National Competition. In 2016, the National Competition included a $50,000 voucher at a National Laboratory.

G.2.3 DOE's National Incubator Initiative for Clean Energy (NIICE) (2014 to Present)

The National Incubator Initiative for Clean Energy (NIICE) enables U.S. companies with new clean energy technologies and business models to enter the marketplace or reach commercial readiness faster than before through technical services and connections to industry. NIICE has established a national network of more than 19 different incubators and supporting organizations. Known as the Incubatenergy Network, its members are working together to share best practices and build connections to support entrepreneurs that are driving innovation in clean energy sectors across the nation. Incubatenergy is led by the Electric Power Research Institute in partnership with the National Renewable Energy Laboratory. The initiative also funded several regional incubators that have attracted leading industry partners to help companies scale up, develop markets, and deploy energy innovations at an expedited rate.

G.2.4 DOE National Clean Energy Business Plan Competition (2011 - 2015)

DOE's National Clean Energy Business Plan Competition built regional networks of student-focused business creation contests across the country, with six regional organizations receiving a total of $ 2 million over three years to host competitions, including $100,000 each in annual prize money for the first-place teams. The regional competitions shared common objectives that included creating a new generation of entrepreneurs to address the nation's energy challenges. The regional winners competed each year for the Grand Prize in a final nationwide Competition. Sponsors of the National Competition included the National Renewable Energy Laboratory.

G.2.5 America's Next Top Energy Innovator (2011 - 2013)

To increase engagement with small businesses, the America's Next Top Energy Innovator Program was launched in May 2011. The program made it easier for start-ups to evaluate inventions and technologies developed at the DOE's national laboratories by lowering the cost of an option agreement for up to three patents for $1,000. An option agreement is a precursor to a license agreement and allows companies time to evaluate the technology and to assemble resources required to commercialize the technology. The option duration was set at 12 months, with the potential for a three to six-month extension. Participating start-ups were invited to enter the America's Next Top Energy Innovator Competition. Each participant in the competition uploaded a short video onto the DOE website, and a public voting competition was held to select the most innovative company. The site received one-half million unique hits. Experts conducted a separate review of the companies and scored them based on their potential economic and societal contributions. The winners of the competition were featured at the 2012 Advanced Research Projects Agency-Energy (ARPA-E) Energy Innovation Summit and had the opportunity to meet the Secretary of Energy.

G.2.6 Energy Innovation Portal (2010 to Present)

The Energy Innovation Portal is a one-stop resource to locate energy-related technologies developed with EERE funding and available for licensing from national laboratories and participating research institutions. Developed and managed by the

National Renewable Energy Laboratory (NREL), the Portal was created to simplify access and increase private sector licensing of energy efficiency and renewable energy technologies at DOE laboratories. The Portal contains over 16,000 DOE-created patents and patent applications, providing streamlined searching and browsing of patents, patent applications, and marketing summaries for clean energy technologies. The Portal also allows interested parties to directly contact the licensing representative from each lab and improves opportunities for "cross-laboratory" intellectual property bundling.

G.2.7 Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) (1983 To Present)

The Small Business Innovation Research (SBIR) program is a highly competitive program that encourages domestic small businesses to engage in federal research and/or research and development (R/R&D) that has the potential for commercialization. The Small Business Technology Transfer (STTR) program, like SBIR, expands funding opportunities in the federal innovation research and development (R&D) arena. Unlike SBIR, it requires small businesses to formally collaborate with a research institution. STRR's role is to bridge the gap between the performance of basic science and commercialization of resulting innovations.

In fiscal year 2013, the SBIR/STTR Programs Office within the Office of Science initiated an effort to utilize the SBIR and STTR programs to assist with technology transfer. This initiative, called the SBIR Technology Transfer Opportunity Pilot, was motivated by the opportunity to combine the commercialization objectives of the SBIR and STTR programs with the technology transfer goals of the Department. Participation in the SBIR Technology Transfer Opportunity Pilot is voluntary and covered by an MOU between DOE and the participating research institution.

Appendix H Technology Readiness Level

H.1 TECHNOLOGY READINESS DEFINITIONS

Technology Readiness Level, or "TRL" is a widely used indicator of degree of development of a technology toward deployment on a scale of 1-9, with 9 being fully deployment ready.

- **TRL 1 Basic Research:** Initial scientific research has been conducted. Principles are qualitatively postulated and observed. Focus is on new discovery rather than applications.
- **TRL 2 Applied Research:** Initial practical applications are identified. Potential of material or process to solve a problem, satisfy a need, or find application is
- **TRL 3 Critical Function or Proof of Concept Established:** Applied research advances and early stage development begins. Studies and lab measurements validate analytical predictions of separate elements of the technology.
- **TRL 4 Lab Testing/Validation of Alpha Prototype Component/Process:** Design, development and lab testing of components/processes. Results provide evidence that performance targets may be attainable based on projected or modeled systems.
- **TRL 5 Laboratory Testing of Integrated/Semi-Integrated System:** System Component and/or process validation is achieved in a relevant environment.
- **TRL 6 Prototype System Verified:** System/process prototype demonstration in an operational environment (beta prototype system level).
- **TRL 7 Integrated Pilot System Demonstrated:** System/process prototype demonstration in an operational environment (integrated pilot system level).
- **TRL 8 System Incorporated in Commercial Design:** Actual system/process completed and qualified through test and demonstration (pre-commercial demonstration).
- **TRL 9 System Proven and Ready for Full Commercial Deployment:** Actual system proven through successful operations in operating environment, and ready for full commercial deployment.

Appendix I Instruments

I.1 LAB-CORPS NODE-LAB LEADS – BASELINE – IN-DEPTH INTERVIEW GUIDE

I.1.1 Background

The evaluation team will conduct interviews with the leads at the Node-Lab which is assisting DOE with the implementation of the Lab-Corps pilot. The Node plays a critical role in helping coordinate across the Site Labs and modifying the Lean LaunchPad training course curriculum in consultation with others.

The purpose of the interview is to inform the following researchable questions:

1. What is the management structure of the Lab-Corps pilot and the Node Lab roles and responsibilities within that?
2. What has happened to date and what is planned in the areas of communication/coordination, the training course, and reporting?
3. What is the motivation for participating, and the approach of Node and each Site Lab, and how is the pilot different from business as usual?

I.1.1.1 Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	In-depth interview
Estimated Time to Completion	60-90 minutes
Population	Node lead team
Project Stage	Baseline

I.1.2 Introduction

Thanks for taking the time to talk with me today. This interview is for our baseline report. Our work focuses on the pilot as a whole, and our research will help DOE design any larger roll-out of Lab-Corps. Do you have any questions about our work?

And before we begin, is it alright if I record our conversation? The recording is just to support my own note taking. We won’t share the recording or notes with anyone outside of the research team, and we will do our best to report findings in a way that doesn’t identify individual respondents. That said, with so few respondents, there may be comments that someone very familiar with the program could tell came from you.

[If ok] Let us jump right in.

I.1.3 Management and Oversight Structure of the Pilot

Before we discuss specifics of NREL's role, I would like to discuss pilot management and the oversight structure of the Lab-Corps pilot.

1. What is your title and what office or department are you in?
2. What are your specific responsibilities as the Node Lab pilot manager? Staff?
3. Briefly, what are your non-pilot job responsibilities?
4. From the DOE to the lab teams, please describe the organizational structure of the pilot.
5. What are the Node responsibilities for the pilot?
6. Are you or someone else the most senior person at the [Lab] directly assuring accountability for the pilot? [Title, Department, name is helpful but optional]
7. What proportion of your time is spent on the pilot?
8. Are there any other NREL offices that the team interacts with, and if so, in what capacity?

I.1.4 Roles and Responsibilities of the Node Lab

9. Before we ask about specific roles, could you explain your perception of why DOE thought it was necessary to have a Node Lab for the pilot?
10. One aspect of the Node's role is to communicate and coordinate the Pilot across participating labs on behalf of the DOE. Can you explain what this has entailed, during both the start-up and now during implementation?
11. DOE planned to have the Node maintain a blog and host conference calls with participating labs to help guide various stages of the pilot.
    a. What is your plan for the blog? How has it been used thus far?
    b. What are your thoughts on the costs and benefits of the blog requirement?

i. What is your plan for conference calls? How many have you had so far?

    c. What topics have your conference calls with the labs covered to date?

12. Do you report to DOE on behalf of all participating labs, or do the labs report directly to DOE, or something else?
13. How is your Node Lead activity being recorded and tracked?
14. Aside from reporting to DOE, what other plans have you made for the records (for example, wrap-up presentations, inclusion in non-pilot lab reporting, etc.)?
15. Are you aware of any pilot tracking (or planned tracking) by lab leads beyond what they will report to you or DOE? [If yes] What? (Answer by lab as relevant.)

16. What influence has the Node Lab had on Pilot design and implementation? For example, we have heard that much changed from original lab proposals due to interaction with the Node and the other labs, or other examples of cross-lab learning.

I.1.5 NREL Institutional Support for Commercialization (aside from the pilot)

17. Why do you think NREL was chosen as the Node Lab? What strengths and weaknesses does NREL have for this role?

18. What resources, if any, does your lab add to the Lab-Corps pilot?

[Probe for annual allocation of staff FTE and funds, names of offices]

19. As we've mentioned, this interview is in support of our baseline reporting. Can you describe support NREL dedicates to commercialization at NREL generally prior to or outside of the pilot?

[Probe for annual allocation of staff FTE and funds, names of offices]

20. Since you wrote the NREL's proposal to be the Lab-Corps node, how has your understanding changed, if at all, of the challenges NREL faces in commercializing lab inventions?

21. And how has your understanding changed, if at all, of the strengths NREL brings to the commercialization challenge?

I.1.6 Motivation for Participating in the Pilot

I would now like your opinion of participating labs on aspects of the Pilot. We are particularly interested in similarities and differences across the labs. If you don't know the details asked, just tell me and we will move to the next section of questions.

22. What barriers to commercialization of lab-developed technologies by researchers themselves – launching a start-up for instance – did lab personnel describe in proposals and start up meetings and calls?

23. And now please describe what lab personnel see as barriers to commercialization of lab-developed technologies by *transferring directly to private sector actors.*

24. How, if at all, did the Lab Call fit a pre-existing commercialization mission at the labs?

25. Briefly, why do you think the pilot will be successful in increasing tech transfer success for the teams? What elements are most essential for success?

26. How do you anticipate the teams themselves from the various lab will benefit from participating in Lab-Corps?
27. Aside from the direct benefit to the personnel involved in the teams, how do you anticipate the labs will learn and benefit from participating in the pilot?
    a. How might the pilot influence other lab researchers?
    b. How might it influence commercialization and technology transfer strategy?

I.1.7 Lab Approach to the Pilot

Now I would like to hear about the various lab approaches to the pilot. We are particularly interested in similarities and differences across the labs.

28. Did any of the labs consult with you about how to select their teams – such as the process or the criteria, or which teams to select? [If yes] What issues did you discuss? (Answer for each lab.)
29. Did the labs modify their approach to selection based on discussion with you? With each other? In what ways?
30. After completing the full six-week training, what is expected of labs for the duration of the pilot? Have labs established next steps? [If yes] Please provide examples.
31. How are labs establishing accountability to ensure teams continue within the budget and on time for the duration of the pilot? Are there formal reporting steps? To whom?
32. Are the labs adding anything to the education portion of the training for their teams before, during, or after the Lab-Corps course?
33. Are there existing and/or new partnerships with external organizations that will provide support for pilot teams? If so, what role do they play? What resources will they provide?
34. Besides the team selection process and the training course/education, what additional or different institutional support will be provided to selected pilot teams during and after training (E.g., mentoring, IP assistance, etc.)? By whom?

I.1.8 Metrics

National labs vary in their approach to commercialization, and outcomes also vary widely. When we assess the program overall we will be using technology transitions metrics data and other metrics to evaluate success.

35. Do these technology transitions metrics data accurately reflect the past success of the lab in tech transfer? If not, why not? What is missing?
36. How well do you feel that the common metrics for assessing progress toward commercialization will enable us to assess pilot impacts, where assessment entails both a pre/post analysis for participating labs, as well as a comparison with nonparticipating labs?
37. What metrics could be developed that would better measure impacts of Lab-Corps, if any?

I.1.9 Approach to the Training Course

Now I would like to hear about your modification of the training course, including your experience attending the I-Corps training in Michigan.

38. Have you documented the ways in which you modified the I-Corps training to create the Lab-Corps training, and the rationale for such changes? If yes, may we have a copy of that documentation?
39. Were there any key ideas you took away from the Michigan I-Corps training and the participant survey responses that influenced your approach to creating the Lab-Corps curriculum and assisting the participating labs during start up?
40. Can you briefly explain your goals and approach to modifying the I-Corps training?
41. Very briefly, as we will go into this in more detail in interviews several months from now, how well do you think the Lab-Corps training met those goals?

I.2 LAB-CORPS PARTICIPATING LAB LEADS – BASELINE - IN-DEPTH INTERVIEW GUIDE

I.2.1 Background

The evaluation team will conduct interviews with participating lab leads who are managing the team or teams within their respective labs that are carrying out activities as part of the Lab-Corps pilot.

The purpose of the interviews are to inform the following researchable questions:

1. What institutional support does each lab currently provide for researcher commercialization activities, aside from the pilot?
2. How successful has each lab been with commercialization of lab-developed technologies in the past, and what motivated the lab to participate in the pilot?
3. What is the approach and management structure of each lab and how is the pilot different from business as usual?

I.2.1.1 Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	In-depth interview
Estimated Time to Completion	60-90 minutes
Population	Lab lead teams
Project Stage	Baseline

I.2.2 Preparing the for Interview

Interviewers must read lab’s proposal (including team), AOP, description of how teams were selected, and team proposal scoring. Also read background sections of evaluation plan and a list of common metrics. Be familiar with the lab organization chart.

I.2.3 Introduction

Thanks for taking the time to talk with me today. This interview is for our baseline report. Our work focuses on the pilot as a whole, and our research will help DOE design any larger roll-out of Lab-Corps. Do you have any questions about our work?

And before we begin, is it alright if I record our conversation? The recording is just to support my own note taking. We won’t share the recording or notes with anyone outside of the research team, and we will do our best to report findings in a way that doesn’t identify individual respondents. That said, with so few respondents, there may be comments that someone very familiar with the program could tell came from you.

[If ok] Let us jump right in.

I.2.4 Management and Oversight Structure of the Pilot

Let's begin by discussing the oversight structure of the Lab-Corps pilot.

1. What is your title and what office or department are you in?
2. What are your specific responsibilities as the pilot manager?
3. Briefly, what are your non-pilot job responsibilities?
4. From the DOE to the lab teams, please describe the organizational structure of the pilot.
5. What are the Site Lab responsibilities for the pilot?
6. Are you or someone else the most senior person at the [Lab] directly assuring accountability for the pilot? [Title, Department, name is helpful but optional]
7. What proportion of your time is spent on the pilot?
8. Are there any other lab offices that you interact with, and if so, in what capacity?

Now I have a few questions about how the pilot's management structure originated.

9. How did you first learn of Lab-Corps and how did you come to be the Lead for your lab?
10. Who was responsible for putting together [Lab's] proposal for the pilot?
11. What is your past experience with commercialization activities and lab technology development?

I.2.5 Site-Lab Institutional Support for Commercialization (aside from the pilot)

12. Why do you think [Lab] was chosen as a Site Lab? What strengths and weakness does [Lab] have for this role?
13. What resources, if any, does your lab add to the Lab-Corps pilot?

[Probe for annual allocation of staff FTE and funds, and names of offices]

14. As we've mentioned, this interview is in support of our baseline reporting. Can you describe the support [Lab] dedicates to commercialization of lab technologies generally, prior to or outside of the pilot?

[Probe for names of these such as Entrepreneurial Leave, annual allocation of staff FTE and funds, and names of offices]

I.2.6 Motivation for Participating in the Pilot

I would like to learn about [Lab's] motivation for participating in the pilot.

15. What barriers to commercialization of lab-developed technologies by researchers themselves – launching a start-up for instance – does your lab face?
16. And now please describe barriers to commercialization of lab-developed technologies *by transferring directly to private sector actors*?
17. How, if at all, did the Lab Call fit a pre-existing commercialization mission at the labs?
18. Briefly, why do you think the pilot will be successful in increasing tech transfer success for your lab? What elements are most essential for success?
19. What value does the Lab-Corps program offer that goes beyond your existing technology transfer resources?
20. Aside from the direct benefit to the personnel involved in the teams, how do you anticipate your lab will benefit from participating in the pilot?
21. How do you anticipate the teams from your lab will benefit from participating in Lab-Corps?

I.2.7 Lab Approach to the Pilot

Now I would like to hear about the lab's approach to the pilot.

22. How were lab personnel notified that team proposals were requested? Was there any follow up?
23. Did you or anyone else directly solicit applications from personnel known to be working on technologies that would be strong candidates for Lab-Corps?
24. Did you receive requests for clarification from personnel interested in proposing?
25. After completing the full six-week training, what is expected of the teams for the duration of the pilot? Have next steps been established? [If yes] Please provide examples.
26. How are labs establishing accountability to ensure teams continue within the budget and on time for the duration of the pilot? Are there formal reporting steps? To whom?
27. Is your lab adding anything to the education portion of the training for your pilot teams before, during, or after the Lab-Corps course?
28. Are there existing and/or new partnerships with external organizations that will provide support for your pilot teams? If so, what role do they play? What resources will they provide?

   a. Will these partnerships provide any other support for lab's pilot activities?

29. Besides the team selection process and the training course, what additional or different institutional support will be provided to selected pilot teams during and after training (e.g., mentoring, IP assistance, etc.)? By whom?
30. How is your pilot management activity and the team activity being recorded and tracked? Aside from reporting to DOE, what other plans have you made for the records (e.g., wrap-up presentations, inclusion in non-pilot reports, etc.)?

I.2.8 Metrics

National labs vary in their approach to commercialization, and outcomes also vary widely. When we assess the program overall we plan to use the technology transitions metrics data and other metrics to evaluate success.

31. Do these technology transitions metrics data accurately reflect the past success of the lab in tech transfer? If not, why not? What is missing?
32. Do you anticipate that the Lab-Corps pilot experience might lead over time to increases in any of the activity tracked by the technology transitions metrics? If so, in what time frame?
33. How well do you feel that the common metrics for assessing progress toward commercialization will enable us to assess pilot impacts, where assessment entails both a pre/post analysis for participating labs, as well as a comparison with nonparticipating labs?

What metrics could be developed that would better measure impacts of Lab-Corps, if any?

I have a few questions about how the selection of teams was done.

34. On what criteria were [Lab's] pilot teams chosen?
35. How were the entrepreneurial leads (EL) and industry mentors chosen?
    a. [If not clear] Had the PIs of the pilot teams previously worked with the entrepreneurial lead (EL) and industry mentor?
36. Are there any other pilot team members, such as researchers supporting the PIs, for the Denver-trained teams?
    a. Did they also attending the training?
37. What do you see as the strengths and weaknesses of each of [Lab's] pilot team that went to Denver?

I.3 LAB-CORPS COHORT 1 FACULTY INTERVIEW GUIDE

1. What worked best about the (entire) training?
2. Describe the evolution you saw from teams' initial business model canvas to their final models.
    a. What elements of the model were the hardest for teams to make progress on?
    b. How responsive were the lab teams?
3. Did any teams seem to benefit less from the training? (If so, did you see less evolution of their BMCs?)
    a. What, if anything, would improve team selection, to optimize both the within-team and across-team the learning experience?
4. What, if anything, was unique or special about working with the lab teams compared with your comparable commercialization assistance work with other teams/entrepreneurs? Are there needs the lab staff have, or the lab environment poses, that Lab-Corps needs to attend to (in contrast to other trainings or assistance)?
5. In retrospect, what, if anything, do you think would have improved the Cohort 1 training? (lessons learned, recommendations. Soup to nuts – all aspects – content, structure, logistics, etc.)

I.4 U.S. DOE MANAGERS KNOWLEDGEABLE ABOUT LAB-CORPS

I.4.1 Guide for Strategic Managers

1. How did Lab-Corps come about, who championed it, and what is the fit of Lab-Corps and EERE goals; Why?
2. Where does Lab-Corps fit going forward, home in EERE, responsibility; uncertainties;
3. Would Lab-Corps stay under strategic programs and not move under the technology offices
4. Any tension between the EERE Technology Offices and Lab-Corps?
5. What is the role of the EERE Technology Offices in the selection process?
6. What are the greatest challenges facing the program?

I.4.2 Guide for Bioenergy Technology Office (BETO) Manager

1. What is the fit between Lab-Corps and BETO goals? When Lab-Corps was first being considered, what was your response?
2. What has been your involvement in / experience with Lab-Corps to date?
3. What do you think is most promising about Lab-Corps in terms of meeting BETO needs/interests?
4. How do you envision BETO and Lab-Corps working together in the future? Where does Lab-Corps fit going forward in terms of its organizational home in EERE, authority and responsibility, who is recognized for accomplishments and shortfalls, funding, and fit with forward-looking goals? What are the uncertainties about these things?
5. To what extent do you think other technology managers share your views? I think so.
6. What do you believe are the greatest challenges facing the program – consider both internal and external, from design and implementation through follow-up?

I.5 LAB-CORPS PARTICIPANTS AND NONPARTICIPANTS PRE-TRAINING SURVEY

I.5.1 Instrument Information

I.5.1.1 Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	Less than 30 minutes
Population Description	Participants in DOE Lab-Corps Pilot training and selected comparison teams
Contact Sought	National lab staff and other team members participating in training
Fielding Firm	NMR on behalf of Node Lab

[PROGRAMMING] Programming instructions are in bracketed CAPS.

I.5.2 Instrument

I.5.2.1 Introduction

Thank you for taking this survey. Your responses will contribute to the development and refinement of the Lab-Corps Pilot.

I.5.2.2 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE]

1. ANL
2. INL
3. LBNL
4. LLNL
5. PNNL
6. SNL
7. Another National Laboratory (please name): [OPEN-ENDED RESPONSE]
8. Other (not a national Lab) (please name): [OPEN-ENDED RESPONSE]

Q2. Are you scheduled to attend the upcoming Lab-Corps training in Denver in October 2015? [REQUIRED RESPONSE]

1. Yes
2. No

[ASK IF Q2 = 1, YES, PARTICIPATING]

Q3. Which technology team do you represent? [REQUESTED RESPONSE]

1. Acoustic Building Infiltration Measurement System (ABIMS)
2. Battery Health Management
3. Co-culture Platform
4. Commercial Building Energy Saving Technology (CBEST)
5. Dynamic Aperture Using Actuated Baffle Arrays
6. Hydra Framework for Network Interchange Forecasting
7. Optimization of Building Efficiency
8. Ring Burner
9. Scalable Nanostructured Coatings for Energy Efficient Windows
10. STARS (Solar Thermochemical Advanced Reactor System)
11. Windmill Diagnostics

96. Other (please name): [OPEN-ENDED RESPONSE]

[ASK IF Q2 = 2, NO, NOT PARTICIPATING]

Q4. Which technology team do you represent? [REQUESTED RESPONSE]

1. AD Up
2. Advanced Electrolyte Model
3. Algae-based Biofuel
4. CO2 Geostorage Energy Systems
5. Evolution Transportation
6. Flow-through Electrode Capacitive Desalination (FTE-CD)
7. Impedance Measurement Box
8. Laser-Less Time-Resolved Depth-of-Field Controlled Particle Image Velocimetry
9. Novel Continuous-Flow Microreactor
10. Sea-going Algae Biorefinery

11. Water Sampler Concentrator
96. Other (please name): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q5. To confirm your reply, please enter your name here:

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q6. Has a company (new or established) or other entity already made a commitment to fund late stage development or commercialize this technology?

[SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[IF Q6 = YES]

Q7. What is the approximate month and year that company or entity made that commitment?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q8. Prior to June 2015, have you been involved in any initiatives (other than Lab-Corps) to develop entrepreneurial skills? [SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[IF Q8 = 1, YES]

Q9. Please name or describe the (other than Lab-Corps) initiative(s) you are involved in to develop entrepreneurial skills?

1. [OPEN-ENDED RESPONSE]

[ASK IF PARTICIPANT = 1, YES]

Q10. What is your role on your Lab-Corps Pilot team?

[SINGLE RESPONSE]

1. Principal Investigator (PI)
2. Entrepreneurial Lead (EL)

3. Industry Mentor (IM)
4. Researcher working under PI's direction
96. Other role (please describe): [OPEN-ENDED RESPONSE]

Q11. (Optional) Please use this space to elaborate on the previous few questions about your team's characteristics: [OPEN-ENDED RESPONSE]

I.5.2.3 Commercialization Experience and Interest

[ASK ALL]

Q12. On a scale from 1 to 5, with 1 meaning "no understanding" and 5 meaning "a great deal of understanding," how well do you understand the technology commercialization process and the elements needed for success?

[SINGLE RESPONSE]

1. 1 – No understanding
2. 2
3. 3
4. 4
5. 5 – A great deal of understanding

[ASK ALL]

Q13. Which of the following activities in the commercialization process have you done in your work prior to June 2015?

[MULTIPLE RESPONSE]

1. I have interviewed potential customers about a product, service, or technology
2. I have presented a business idea to investors
3. I have licensed a technology to a commercial entity
4. I have submitted a record of invention or software record to my technology transfer office
5. I have received a patent on an invention(s)
6. I have founded venture(s) to develop and sell products, or taken entrepreneurial leave
7. An invention of mine has been listed as background IP (intellectual property) in a CRADA (cooperative research and development agreement)
8. Other (please describe): [OPEN-ENDED RESPONSE]

9. None of the above

[ASK IF Q9 = 1 OR 4 (PI OR RESEARCHER)]

Q14. To what extent do you agree with the following statements?

[MATRIX QUESTION: SCALE]

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	97 (Does not apply to me)
I am interested in starting my own company						
I am interested in working in a startup someone else started						
I am interested in licensing my technology to an existing company						
I am interested in getting a CRADA to do further work on my technology						
I am interested in some other partnership to transfer my technology						

[ASK IF ANY ITEM IN Q14 = 1 OR 2]

Q15. Why do you have little interest in…

[MATRIX QUESTION]

[Display Items Rated 1 Or 2 In Q14]	[Open Ended Response]
Starting your own company?	
Working in a startup someone else started?	
Licensing your technology to an existing company?	
Getting a CRADA to do further work on my technology?	
Some other partnership to transfer my technology?	

Q16. [ASK ALL] (Optional) Please use this space to elaborate on the previous few questions about your involvement in technology commercialization: [OPEN-ENDED RESPONSE]

I.5.2.4 Lab Support for Commercialization

[ASK IF Q1 ≠ 8 (IS LAB RESPONDENT); IF Q1=8 (NON-LAB RESPONDENT) SKIP TO NEXT SECTION]:

[ASK ALL IF Q1≠ 8]

Q17. On a scale of 1 to 5, with 1 meaning "not at all supportive" and 5 meaning "very supportive," how supportive of activities related to the commercialization process is your Lab?

[SINGLE RESPONSE]

1. 1 - Not at all supportive
2. 2
3. 3
4. 4
5. 5 -Very supportive

97. Not applicable
98. Don't know

[ASK ALL OF Q1≠ 8]

Q18. Other than the support provided through the Lab-Corps Pilot, does your Lab provide any of the following resources to support the commercialization process for the technologies you develop?

[MATRIX QUESTION]

Item	1. Yes	2. No	98. I don't Know
Education, mentorship, or opportunities to interact with peers			
Financial incentives (for example, returning a portion of royalties to researchers or offering entrepreneurial leave)			
Financial resources			
Time resources			
Partnerships with individuals or organizations outside the Laboratory			
Another resource is provided (please explain)			

Q19. Please briefly describe the resources or support for the commercialization process your Lab provides. (Please address each item you checked "Yes" to above.):

Item	Elaboration
Education, mentorship, or opportunities to interact with peers	
Financial incentives (for example, returning a portion of royalties to researchers or offering entrepreneurial leave)	
Financial resources	
Time resources	
Partnerships with individuals or organizations outside the Laboratory	
Another resource is provided (please explain)	

[IF ANY Q18 RESPONSE = YES]

Q20. In your opinion, how common is it for staff in your Lab to take advantage of the resources your Lab provides to support the commercialization process?

[SINGLE RESPONSE]

1. Not at all common
2.

3.
4.
5. Very common

[ASK ALL OF Q1≠ 8]

Q21. What changes at your Laboratory, if any, do you think might help to increase researcher activity in commercialization processes?

1. [OPEN-ENDED RESPONSE]

Q22. (Optional) Please use this space to elaborate on the previous few questions about your lab's support for commercialization of technology: [OPEN-ENDED RESPONSE]

I.5.2.5 Knowledge of the Commercialization Process

[ASK IF Q10 = 1 OR 4 (PI OR RESEARCHER)]

Q23. How knowledgeable are you about each of the following elements of the commercialization process as it might apply to commercializing your innovations?

[MATRIX QUESTION: SCALE]

[LOGIC] Item	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable	97 NA	98 DK
Customer segments, customer archetypes - for whom the technology creates value							
Customer relationships - how to keep and attract new customers, how costly the relationships are							
Channels - through which customers are reached, which work best, are most cost-effective							
Key resources - what are required, their distribution channels, and revenue streams							
Value propositions - which of the customers' problems the new technology solves and the							

[LOGIC] Item	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable	97 NA	98 DK
bundles of products and services being offered							
Key activities - related to distribution channels, revenue streams, and customer relationships							
Revenue streams - pricing tactics, estimation of customers' willingness to pay							
Key partners, suppliers - their activities, and the resources acquired from them							
Cost structure - most important costs and those that are most expensive							

[ASK IF Q10 = 1 OR 4 (PI OR RESEARCHER)]

Q24. The Lab-Corps Pilot training is organized around the Business Model Canvas and its nine components. How familiar are you with the Business Model Canvas approach?

[SINGLE RESPONSE]

1. 1 - Not at all familiar
2. 2
3. 3
4. 4
5. 5 - Very familiar

[IF Q24 ≠ 1 OR 2]

Q25. Prior to June 2015, had you used the Business Model Canvas approach in your work?

[SINGLE RESPONSE]

1. Yes

2. No
98. Don't know

[IF Q25= 1]

Q26. How had you used the Business Model Canvas approach in the past?

1. [OPEN-ENDED RESPONSE]

Q27. (Optional) Please use this space to elaborate on the previous few questions about commercialization stages and Business Model Canvas: [OPEN-ENDED RESPONSE]

I.5.2.6 Course Expectations

[ASK IF Q2 = 1, YES, PARTICPATING]

Q28. What are your expectations for the Lab-Corps Pilot training?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q29. What questions or concerns, if any, do you have regarding the Lab-Corps Pilot training?

1. [OPEN-ENDED RESPONSE]

I.5.2.7 Closing

Thank you very much for all of your valuable time. We know it was a significant investment, and we appreciate it.

CLICK "SUBMIT" IF YOU ARE FINISHED WITH YOUR SURVEY QUESTIONS.

THANKS AGAIN!

I.6 LAB-CORPS PARTICIPANT FOLLOW-UP COURSE SURVEY

Date of last revision: 11/18/2015

I.6.1 Instrument Information

I.6.1.1 Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	<30 minutes
Population Description	Participants in DOE Lab-Corps training
Contact Sought	National lab staff and other team members participating in training
Fielding Firm	NMR on behalf of Node Lab

[PROGRAMMING] Programming instructions are in bracketed CAPS.

I.6.1.2 Invitation Information

Subject line: DOE Lab-Corps Training Post Participation Survey

Email invitation content:

Hello [First Name] [Last Name],

Thank you for attending the Lab-Corps training. The following survey asks about your training experiences. Your responses are voluntary and will contribute to the development and refinement of the Lab-Corps Pilot. The survey should take 20-30 minutes to complete. This link is unique to you. If you need to exit the survey and return to it at a later time, you can return to it using the link; your responses will be saved. The survey will be available until December 4, 2015. Please click the link below to begin the survey.

Thank you,

____

I.6.2 Instrument

I.6.2.1 Introduction

Thank you for taking this survey regarding your Lab-Corps participation. Your responses will contribute to the development and refinement of the Lab-Corps pilot.

I.6.2.2 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE]

1. ANL
2. INL
3. LBNL
4. LLNL
5. PNNL
6. SNL
7. NREL
8. ORNL
9. Another National Laboratory (please name): [OPEN-ENDED RESPONSE]
10. Jacksonville State University
11. University of California, Davis
12. Private consultant
13. Other (not a national Lab) (please name): [OPEN-ENDED RESPONSE]

Q2. Which technology team do you represent? [REQUESTED RESPONSE]

1. ARAI (Advanced Renewable Aerial Inspections; drones)
2. SonicLQ (Acoustic Building Infiltration Measurement System)
3. Battery Health Management
4. Co-culture Green (Co-culture Platform)
5. C-Best (Commercial Building Energy Saving Technology)
6. Dynamic Aperture (Using Actuated Baffle Arrays)
7. Eco-AC
8. HYDRA (Framework for Network Interchange Forecasting)
9. Optimization of Building Efficiency
10. Ring Burner
11. Sub Lambda (Scalable Nanostructured Coatings for Energy Efficient Windows)
12. STARS (Solar Thermochemical Advanced Reactor System)
13. Switchable Polarity Solvents (SPS) Applications

14. CI ReClad (THERMAX Wall System)
15. Tunation
16. WISDEM (Wind Plant Integrated Systems Design and Engineering Model)
96. Other (please name): [OPEN-ENDED RESPONSE]

[TELL ALL]

Please note that this survey uses the term “pilot technology” to refer to the technology that your team has focused on during the Lab-Corps pilot (October – November, 2015).

[ASK ALL]

Q3. Please enter your name here:

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q4. Has the composition or roles of your Lab-Corps team members changed since your Lab-Corps training began?

1. Yes
2. No

[ASK IF Q4 = 1, YES; ELSE SKIP TO Q6]

Q5. Please describe any changes in your Lab-Corps team composition or roles.

1. [OPEN-ENDED RESPONSE]

Q6. What is your role on your Lab-Corps team?

[SINGLE RESPONSE]

1. Principal Investigator (PI)
2. Entrepreneurial Lead (EL)
3. Industry Mentor (IM)
4. Researcher working under PI’s direction
96. Other role (please describe): [OPEN-ENDED RESPONSE]

I.6.2.3 Lab-Corps Training

[ASK ALL]

Q7. Overall, how did the Lab-Corps training compare to your expectations?

[SINGLE RESPONSE]

1. Greatly exceed

2. Exceeded
3. Met
4. Partially met
5. Did not meet at all

96. Other, please specify: [OPEN-ENDED RESPONSE]

[IF Q7 = 1, “EXCEEDED”]

Q8. In what ways did the Lab-Corps training exceed your expectations?

1. [OPEN-ENDED RESPONSE]

[IF Q7 = 3, “DID NOT MEET”]

Q9. In what ways did the Lab-Corps training fall short of your expectations?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q10. On a scale from 1 to 5, with 1 meaning “no understanding” and 5 meaning “a great deal of understanding,” how well do you understand the technology commercialization process and the elements needed for success?

[SINGLE RESPONSE]

1. 1 – No understanding
2. 2
3. 3
4. 4
5. 5 – A great deal of understanding

[ASK ALL]

Q11. How knowledgeable are you about each component of the Business Model Canvas (BMC) as it applies to your Lab-Corps pilot technology?

[MATRIX QUESTION: SCALE]

[Logic] Item	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable
Customer segments, customer archetypes - for whom the technology creates value					

[Logic] Item	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable
Customer relationships - how to keep and attract new customers, how costly the relationships are					
Channels - through which customers are reached, which work best, are most cost-effective					
Key resources - what are required, their distribution channels, and revenue streams					
Value propositions - which of the customers' problems the new technology solves and the bundles of products and services being offered					
Key activities - related to distribution channels, revenue streams, and customer relationships					
Revenue streams - pricing tactics, estimation of customers' willingness to pay					
Key partners, suppliers - their activities, and the resources acquired from them					
Cost structure - most important costs and those that are most expensive					

[ASK ALL]

Q12. Please rate the extent to which your understanding of the market needs related to your technology has increased during the Lab-Corps training (from and including the October training until now)?

[SINGLE RESPONSE]

1. 1 – Not at all
2. 2
3. 3

4. 4
5. 5 – A great deal

[ASK ALL]

Q13. Please rate the extent to which your understanding of the various potential lab-to-market commercialization routes has increased during the Lab-Corps training?

[SINGLE RESPONSE]

1. 1 – Not at all
2. 2
3. 3
4. 4
5. 5 – A great deal

[ASK ALL]

Q14. Please briefly describe the greatest insights relating to the possible commercialization of your pilot technology that emerged during the Lab-Corps training? For example, you might describe technology decisions or pivots, or insights about your own interest in conducting commercialization activities as taught by Lab-Corps.

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q15. To what extent do you agree with the following statements?

[MATRIX QUESTION: SCALE]

Randomize All Items	1 Completely Disagree	2 Somewhat Disagree	3 Neither Agree nor Disagree	4 Somewhat Agree	5 Completely Agree
Overall, activities were well suited to the learning objectives of the course					
The teaching team provided relevant critique/feedback to participants					

Randomize All Items	1 Completely Disagree	2 Somewhat Disagree	3 Neither Agree nor Disagree	4 Somewhat Agree	5 Completely Agree
The teaching team encouraged appropriate levels of participation by participants					
The teaching team motivated us to do our best work					
The education climate was conducive to learning					
Participation in Lab-Corps broadened my understanding of the commercialization process					
Lab-Corps gave me new skills that will be useful in my commercialization activities					

[FOR EACH ITEM IN Q15=1 OR 2 (“COMPLETELY DISAGREE” OR “SOMEWHAT DISAGREE”)]

Q16. How could Lab-Corps have more effectively:

[MATRIX QUESTION]

[Display Items Rated “Completely Disagree” Or “Somewhat Disagree in Q15] Item	[Open-Ended Response]
Connected activities to the learning objectives of the course?	
Provided relevant critique/feedback to participants?	
Encouraged appropriate levels of participation?	

Motivated you to do your best work?	
Provided an education climate conducive to learning	
Broadened your understanding of the commercialization process?	
Given you skills that will be useful in your commercialization activities?	

[ASK ALL]

Q17. In hindsight, to what extent do you agree with the following statement?

[MATRIX QUESTION: SCALE]

Randomize All Items	1 Completely Disagree	2 Somewhat Disagree	3 Neither Agree nor Disagree	4 Somewhat Agree	5 Completely Agree
The Lab-Corps commercialization activities are better suited to technologies more developed than my team's pilot technology					

[ASK ALL]

Q18. Please rate the value to you of the various types of Lab-Corps training activities?

[Logic] Item	1 No value	2	3	4	5 High value	97 NA	98 DK
Lectures							
Networking (workshop, reception)							
Office hours (one-on-ones)							
Team presentations							
Industry engagement							
Weekly web-based sessions							

[ASK ALL]

Q19. What improvements do you suggest for future Lab-Corps courses? Please describe specific activities, lectures, exercises, or selection of faculty that could be refined or improved.

1. [OPEN-ENDED RESPONSE]

I.6.2.4 Lab-Corps Activities

[ASK ALL]

Q20. About how many people (of any type: customers, suppliers, etc.) did your team interview about your pilot technology during the Lab-Corps training (from and including the October training until now)? Please provide a numerical response (do not use ranges; instead use mid-point of range).

[MATRIX QUESTION]

Item	Numerical response (do not use ranges; instead use mid-point of range)
Number of interviews completed:	
Number of interviews scheduled (to be completed):	

[ASK ALL]

Q21. Which of the following types of people did your team interview during the Lab-Corps training?

[MATRIX QUESTION]

Item	1 Interviewed	2 Scheduled or upcoming	3 Did not interview	97 NA	98 DK
Potential customers					
Potential customers in multiple segments (different industries, different user groups, etc.)					
Potential suppliers					
Potential distributors					

Item	1 Interviewed	2 Scheduled or upcoming	3 Did not interview	97 NA	98 DK
Potential investors					
Firms potentially interested in acquiring the technology					
Potential partners					
Other					

[ASK ALL]

Q22. About how many hours did you personally spend per week (on average) on your Lab-Corps project since the October training?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q23. During the past six weeks, to what extent – if at all – did your Lab-Corps related work negatively impact your ability to meet your ongoing lab responsibilities?

[SINGLE RESPONSE]

1. Not at all
2. Somewhat
3. Significantly

96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know

[ASK ALL]

Q24. During the past six weeks, to what extent – if at all – did meeting your ongoing lab responsibilities negatively impact your ability to accomplish your planned Lab-Corps related activities?

[SINGLE RESPONSE]

1. Not at all
2. Somewhat
3. Significantly

96. Other, please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[ASK ALL]

Q25. Which response best describes how your workload during the past six weeks compared with your typical workload during the three months preceding the October training?

[SINGLE RESPONSE]

1. Workload remained about the same; Lab-Corps activities displaced my ongoing activities
2. Workload increased somewhat; Lab-Corps activities displaced some but not all of my ongoing activities
3. Workload increased substantially; Lab-Corps activities largely were in addition to my ongoing activities

96. Other, please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[ASK ALL]

Q26. Was the Lab-Corps funding you were awarded sufficient to cover the accomplishment of your planned Lab-Corps related activities?

[SINGLE RESPONSE]

1. Yes
2. No

96. Other, please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[IF Q26=2 NO]

Q27. About how much additional funding would you likely have needed to cover the accomplishment of your planned Lab-Corps related activities?

[SINGLE RESPONSE]

1. Up to about 10% more funding
2. Up to about 20% more funding
3. Up to about 30% more funding
4. More than 30% more funding

96. Other, please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[ASK ALL]

Q28. Rate the extent of your agreement or disagreement with the following:

The activities I learned through Lab-Corps are a good fit with…

[MATRIX QUESTION: SCALE]

Randomize All Items	1 Completely Disagree	2 Somewhat Disagree	3 Neither Agree nor Disagree	4 Somewhat Agree	5 Completely Agree
My professional goals					
How Lab management assesses my performance					
My understanding of the professional goals of many of my Lab's established researchers					
Post-doc positions					
The role of my Lab's technology transfer office					

I.6.2.5 Status of Commercialization Effort

[ASK ALL]

Q29. Which of the following activities in the commercialization process have you done since September 2015 related to your pilot technology?

[MULTIPLE RESPONSE]

1. I have interviewed potential customers about a product, service, or technology
2. I have presented a business idea to investors
3. I have licensed a technology to a commercial entity
4. I have received a patent on an invention(s) or submitted record(s) of invention

5. I have founded venture(s) to develop and sell products, or taken entrepreneurial leave
6. An invention of mine has been listed as background IP (intellectual property) in a CRADA (cooperative research and development agreement)
7. Other, please specify: [OPEN-ENDED RESPONSE]
8. None of the above

[ASK ALL]

Q30. Have your pilot activities resulted in a No-Go decision for the commercialization of your pilot technology?

[SINGLE RESPONSE]

1. Yes
2. No

98. Don't know

[IF Q30= 1. YES (NO-GO)]

Q31. What led to the No-Go decision?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q32. To what extent do you agree with the following statements?

[MATRIX QUESTION: SCALE]

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	6 I have already done this
I am interested in starting my own company						
I am interested in working in a startup someone else started						
I am interested in licensing my						

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	6 I have already done this
technology to an existing company						
I am interested in getting a CRADA to do further work on my technology						
I am interested in some other partnership to transfer my technology						

[ASK ALL]

Q33. Based on the activities you have done in conjunction with Lab-Corps, to what extent do you agree with the following statements?

[MATRIX QUESTION: SCALE]

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	6 Done prior to Lab-Corps involvement
I understand my technologies' value proposition, i.e., the potential for my technology to provide value to a specific customer						
I have a clear understanding of who makes the buy decision for my technology, and the attributes they consider in buying						
I have a go-to-market strategy for my technology that includes target customer segments, channels, and pricing tactics and/or the						

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	6 Done prior to Lab-Corps involvement
appropriate licensing partner to get to market						
I have a clear understanding of the next 3 things I need to do to continue to commercialize my technology						

[IF Q30≠ 1 YES (NO-GO)]

Q34. Please rate how likely is it that during the *next three months* you will continue to conduct commercialization activities *on your pilot technology* like the activities you conducted during the past six weeks?

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely

98. Don't know

[IF Q34= 1 OR 2 OR 3]

Q35. Please describe the reasons why you do not think it’s likely you will conduct such activities in the next three months?

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q36. Please rate how likely is it that *in future years* you will conduct commercialization activities *on subsequent innovations* like the activities you conducted during the past six weeks?

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely

98. Don't know

[IF Q36= 1 OR 2 OR 3]

Q37. Please describe the reasons why you do not think it's likely you will conduct such activities in the coming years?

1. [OPEN-ENDED RESPONSE]

[IF Q36≠ 1]

Q38. Which of the following describe your efforts to fund further work on your technology?

[MULTIPLE RESPONSE]

1. Received funding
2. In discussion with funders
3. Interested in pursuing funding, but not in active discussion with funders
4. Do not plan to pursue additional funding in the next year

96. Other, please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[IF Q37 = 1. RECEIVED FUNDING]

Q39. What type of funding have you received?

1. [OPEN-ENDED RESPONSE]

[IF Q38 = "2. IN DISCUSSION WITH FUNDERS…"]

Q40. What types of funders are you in discussions with?

1. [OPEN-ENDED RESPONSE]

[IF Q1 = 1 - 9 work for a national lab; IF Q1 = 8, "Other" SKIP TO CLOSING]

I.6.2.6 Lab Support for Commercialization

[ASK IF Q1 = 1 – 9, EMPLOYED BY LAB; ELSE SKIP TO CLOSING]

[ASK ALL (Q1 = 1 - 9)]

Q41. What, if anything, have you done to inform others in your lab about the Business Model Canvas approach?

1. [OPEN-ENDED RESPONSE]

[ASK ALL (Q1 = 1 – 9)]

Q42. What other activities, if any, have taken place in your lab to raise awareness of the Business Model Canvas approach?

1. [OPEN-ENDED RESPONSE]

[ASK ALL (Q1 = 1 – 9)

Q43. What changes at your Laboratory, if any, would help to increase commercialization activity?

1. [OPEN-ENDED RESPONSE]

I.6.2.7 Closing

Thank you very much for all of your valuable time. We know it was a significant investment, and we appreciate it.

CLICK "SUBMIT" IF YOU ARE FINISHED WITH YOUR SURVEY QUESTIONS.

THANKS AGAIN!

I.7 LAB-CORPS NONPARTICIPANT FOLLOW-UP COURSE SURVEY

I.7.1 Instrument Information

I.7.1.1 Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	<7 minutes
Population Description	Nonparticipants in DOE Lab-Corps training
Contact Sought	National Lab staff candidates for Cohort 1 training
Fielding Firm	NMR on behalf of Node Lab

I.7.2 Instrument

I.7.2.1 Introduction

Thank you for taking this survey. Your responses will contribute to the development and refinement of the Lab-Corps pilot and related efforts.

I.7.2.2 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE]

1. ANL
2. INL
3. LLNL
4. SNL

Other (please name:) __________

[ASK ALL]

Q2. Which technology do you represent? (The following questions will refer to this as "your technology") [REQUESTED RESPONSE]

1. AD Up
2. CO2 Geostorage Energy Systems
3. Evolution Transportation

4. Impedance Measurement Box
5. Laser-Less Time-Resolved Depth-of-Field Controlled Particle Image Velocimetry
6. Novel Continuous-Flow Microreactor
7. Sea-going Algae Biorefinery
8. Water Sampler Concentrator
9. Other (please name): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q3. Please enter your name here:

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q4. Since being considered for the Fall 2015 Lab-Corps training, have you:

[MATRIX QUESTION]

Item		Yes (1)	No (2)
a.	Reviewed any of the Lab-Corps training materials?		
b.	Discussed the Lab-Corps training with any of the participating Lab teams?		
c.	Completed any commercialization training?		
d.	Studied or reviewed commercialization books or other resources?		
e.	Found another source of funding to pursue commercialization activities?		

[ASK IF Q4c (COMMERCIALIZATION TRAINING) OR Q4d (STUDIED) OR Q4e (FUNDING) = 1]

Q4. Please rate the extent to which applying for the Lab-Corps pilot contributed to your decision to learn more about commercialization?

[MATRIX QUESTION]

	1 – Not at all	2	3	4	5 – A great deal	9 – Don't know
Extent Lab-Corps contributed to your decision to pursue commercialization						

[ASK ALL]

Q5. Thinking back to October 2015, how would you rate your knowledge of the following concepts as they apply to your technology? And how would you rate your knowledge now?

[MATRIX QUESTION: SCALE]

[LOGIC] Item	As of October 2015					Now				
	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable
Customer segments, customer archetypes - for whom the technology creates value										
Customer relationships - how to keep and attract new customers, how costly the relationships are										

[LOGIC] Item	As of October 2015					Now				
	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable	1 Not at all knowledgeable	2	3	4	5 Very knowledgeable
Value propositions - which of the customers' problems the new technology solves and the bundles of products and services being offered										
Key activities - related to distribution channels, revenue streams, and customer relationships										
Key partners, suppliers - their activities, and the resources acquired from them										

[ASK ALL]

Q6. Please rate the extent to which your understanding of the following has increased since October 2015?

[MATRIX QUESTION]

Extent of increase in understanding of:		1 – Not at all	2	3	4	5 – A great deal	9 – Don't know
a.	Market needs related to your technology						
b.	Market commercialization routes						

[ASK IF Q6a (MARKET NEEDS) OR Q6b (COMMERCIALIZATION ROUTES) >2]

Q7. Please rate the extent to which applying for the Lab-Corps pilot contributed to your decision to undertake activities that led to your increased understanding?

[MATRIX QUESTION]

Extent Lab-Corps contributed to increase in your understanding of:	1 – Not at all	2	3	4	5 – A great deal	9 – Don't know
[ASK IF 6a (MARKET NEEDS) >2] Market needs related to your technology						
[ASK IF 6b (COMMERCIALIZATION ROUTES) >2] Market commercialization routes						

[ASK ALL]

Q8. About how many people (of any type: customers, suppliers, etc.) have you interviewed about your technology since October 2015? Please provide a numerical response (do not use ranges; instead use mid-point of range).

[MATRIX QUESTION]

Item	Numerical response (do not use ranges; instead use mid-point of range)
Number of interviews completed:	
Number of interviews scheduled (to be completed):	

[ASK IF Q8a (CONDUCTED INTERVIEWS) >0 OR Q8b (SCHEDULED INTERVIEWS) >0]]

Q9. Please rate the extent to which applying for the Lab-Corps pilot contributed to your decision to conduct these interviews?

	1 – Not at all	2	3	4	5 – A great deal	9 – Don't know
[ASK IF Q8a (CONDUCTED INTERVIEWS) >0 OR Q8b (SCHEDULED INTERVIEWS) >0] Extent Lab-Corps contributed to your decision to conduct interviews						

[ASK IF Q8a>0]

Q10. Which of the following types of people have you interviewed since October 2015?

[MATRIX QUESTION]

Item	1 Interviewed	2 Scheduled or upcoming	3 Did not interview	97 NA	98 DK
Potential customers					
Potential customers in multiple segments (different industries, different user groups, etc.)					
Potential suppliers					
Potential distributors					
Potential investors					
Firms potentially interested in acquiring the technology					
Potential partners					
Other					

[ASK ALL]

Q11. Since October 2015, about how many hours did you personally spend engaged in activities – such as conducting interviews or clarifying the value proposition – to advance the commercialization prospects of your technology?

1. [OPEN-ENDED RESPONSE]

I.7.2.3 Status of Commercialization Effort [Ask All]

[ASK ALL]

Q12. Since October 2015, which of the following activities in the commercialization process have you done related to your technology?

[MULTIPLE RESPONSE]

1. I have presented a business idea to investors
2. I have founded venture(s) to develop and sell products, or taken entrepreneurial leave
3. An invention of mine has been listed as background IP (intellectual property) in a CRADA (cooperative research and development agreement)

None of the above

Q13. [ASK FOR ALL Q12 ACTIVITIES WITH RESPONSE OF 'YES'] Please rate the extent to which applying for the Lab-Corps pilot contributed to your decision to conduct these activities?

	1 Not at all	2	3	4	5 A great deal
Presenting a business idea to investors					
Founded venture(s) to develop and sell products, or taken entrepreneurial leave					
An invention of mine has been listed as background IP (intellectual property) in a CRADA (cooperative research and development agreement)					

[ASK ALL]

Q14. Please rate how likely is it that during the *next three months* you will conduct commercialization activities *on your technology* (such as those activities listed in the preceding question)?

[SINGLE RESPONSE]

1. Not at all likely
2.
3.

4.
5. Highly likely
98. Don't know

[ASK ALL]

Q15. Please rate how likely is it that *in future years* you will conduct commercialization activities *on subsequent innovations* like the activities you have conducted since October 2015?

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely
98. Don't know

Q16. Which of the following describe your efforts to fund further work on your technology?

[MULTIPLE RESPONSE]

1. Received funding
2. In discussion with funders
3. Interested in pursuing funding, but not in active discussion with funders
4. Do not plan to pursue additional funding in the next year
96. Other, please specify: [Open-ended response]
98. Don't know

[ASK ALL]

Q17. Thinking back to October 2015, how would you rate the extent of your agreement with the following concepts as they apply to your technology? And how would you rate the extent of your agreement now?

[MATRIX QUESTION: SCALE]

Item	As of October 2015					Now				
	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree
I understand my technologies' value proposition, i.e., the potential for my technology to provide value to a specific customer										
I have a clear understanding of who makes the buy decision for my technology, and the attributes they consider in buying										
I have a go-to-market strategy for my technology that includes target customer segments, channels, and pricing tactics and/or the appropriate licensing partner to get to market										
I have a clear understanding of the next 3 things I need to do to continue to commercialize my technology										

I.7.2.4 Lab Support for Commercialization

[ASK ALL]

Q18. What changes at your Laboratory, if any, would help to increase commercialization activity?

1. [Open-ended response]

I.7.2.5 Closing

Thank you very much for all of your valuable time. We know it was a significant investment, and we appreciate it.

CLICK "SUBMIT" IF YOU ARE FINISHED WITH YOUR SURVEY QUESTIONS.

THANKS AGAIN!

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