Second-Year Impact Evaluation of the U.S. DOE Energy I-Corps Program

Final Report

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research into action inc

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Acronyms and Abbreviations

ANL	Argonne National Laboratory
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
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
SNL	Sandia National Lab
TTO	Technology Transfer Office

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.

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 Cohort 1 is the group of lab scientists and engineers that participated in Fall 2015 Energy I-Corps training, and Cohort 2 is the group that received training in Spring 2016.
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).
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. Teams are challenged to conduct about 75 interviews during the course of the training.
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 instructors, designated as "core faculty" and "adjunct faculty."
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.
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 training teams, which augments 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, 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 developing a business model and testing or revising the model using interviews with customers and other market actors, such as supply chain actors. One such method is called the Lean LaunchPad method.

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 Energy I-Corps training, which trains university-affiliated innovators.
Node Lab	The National Renewable Energy Laboratory (NREL) serves as the principle implementer (node) for the Energy I-Corps program by designing the curriculum, leading program efforts, and supporting the participating labs and technology teams.
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.
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 a technology team's technical lead and overall project manager.
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.
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.
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.
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, one of a handful of U.S. Department of Energy (DOE) programs within the Technology-to-Market Program, is intended to accelerate the commercialization of clean energy technologies from DOE national laboratories (labs). The U.S. DOE's Office of Energy Efficiency and Renewable Energy (EERE) launched the Energy I-Corps pilot in August 14, 2014, with a request for lab participation.

This report, conducted by an independent evaluator, documents the program's second-year impact findings, and recaps findings from the first-year process and baseline research.[1] The second-year findings include outcomes and impacts for program Cohort 1—the group of lab researchers that participated in the first Energy I-Corps training in October 11 to November 19, 2015, and for Cohort 2—the group of researchers trained March 15 to May 5, 2016.

This report is based on findings from:

- Cohort 1 Year 2 data: from a follow-up survey with Cohort 1 lab researchers, which was fielded 18 months after training (Cohort 1 training took place from October 11 to November 19, 2015 and the survey conducted by the evaluation team took place from May 9, 2017 to June 14, 2017)
- Non-participant Year 2 data: the survey was conducted by the evaluation team from May 9, 2017 to June 14, 2017
- Cohort 2 Baseline data: The Cohort 2 Baseline survey was conducted from March 4 to 14, 2016, immediately before the training took place (March 15 to May 5, 2016)
- Cohort 2 Immediate post-training data: The Immediate Post-training survey was conducted from May 9 to June 22, 2016
- Cohort 2 Year 1 post-training data: the survey conducted by the evaluation team from February 22, 2017 to March 31, 2017

The study explores three domains of outcomes and impacts, which reflect the program objectives:

- Knowledge gain
- Commercialization outcomes

[1] *Evaluation of the Energy I-Corps Pilot,* November 28, 2016. 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. https://www.energy.gov/eere/analysis/downloads/energy-i-corps-program-year-1-process-and-impact-evaluation-0

This current report addresses one of the key recommendations of the first-year process and baseline report (to continue tracking Cohort 1 for an additional one or two years in order to assess the mid-term effects of the program that were not detectable after one year).

- Strengthened entrepreneurial spirit driving lab researchers, which we operationalized for this study as lab encouragement and support of entrepreneurial drive among researchers[2]

PROGRAM 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 program implementation contractor). The following national laboratories participated as Energy I-Corps Site Labs and assemble and support training teams for Cohort 1 and Cohort 2:

- Argonne National Laboratory (ANL)
- Fermi National Accelerator Laboratory (Fermi)
- Idaho National Laboratory (INL)
- Lawrence Berkeley National Laboratory (LBNL)
- Lawrence Livermore National Laboratory (LLNL)
- Los Alamos National Laboratory (LANL)
- NREL
- Oak Ridge National Laboratory (ORNL)
- Pacific Northwest National Laboratory (PNNL)
- Sandia National Laboratory-California (SNL)

Selected teams of lab researchers (including technology Principal Investigators [PIs]) participate in a training that guides them in developing and testing business models for their technologies by conducting research with relevant market actors to explore the models' key hypotheses. Throughout the training, which spans the better part of two months, teams engage an experiential customer discovery process, through which they test their hypotheses by interviewing relevant contacts within their target market. Relevant contacts may include potential customers, supply chain actors, possible partners, and so on, and discussions address such topics as customer pain-points with existing technologies, interest in the innovation, likely costs, and possible revenue

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[2] DOE revised the pilot's third objective toward the end of the Cohort 1 evaluation period. Initially, the third objective was to "transform national lab culture to value commercialization and entrepreneurial activities." DOE refined the third objective 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," which we operationalized for continuity between the Cohort 1 and Cohort 2 investigations as "lab encouragement and support of entrepreneurial drive among researchers.".

streams. The program design was 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.

Seven labs sent 14 teams of researchers to the first Energy I-Corps training, which was held October 11 to November 19, 2015 (Cohort 1); six labs sent another 14 teams to the second training, which was held March 15 to May 5, 2016 (Cohort 2). This evaluation assesses outcomes and impacts evident from the self-reports of Cohort 1 and 2 participants after the second full year of the program, as of Spring 2017.

KEY FINDINGS

The evaluation team developed performance metrics by which to gauge Energy I-Corps' progress in achieving its desired outcomes. The metric findings suggest that trainees are making positive progress towards commercializing their technologies. Trainees continue to build their knowledge, advance their technologies and reach a number of commercialization benchmarks. The evaluation of the pilot program (Year 1) focused on early outcomes, processes, and lessons learned. The previous report summarized results according to the outcomes assessment objectives: learning, commercialization, and lab entrepreneurial support. The findings from this Year 2 evaluation build on the results from the pilot evaluation and are organized according to the following objectives: knowledge gain, commercialization outcomes, and lab encouragement and support for entrepreneurial drive among researchers.

Knowledge Gains

Evaluation findings on knowledge gains suggest continued success. As evidenced by the findings below, the program is reaching its goal of increasing researcher understanding of the commercialization process and private sector needs. Cohort 1 trainees continue to build on their knowledge gains while Cohort 2 increased their knowledge and understanding because of the training.

- **At 18-months post-training, Cohort 1 trainees report that they are continuing to build upon their Energy I-Corps training and they are furthering their knowledge of the commercialization process.** When asked about the extent to which they have conducted investigations into various components of the Business Model Canvas (BMC), more than half of Cohort 1 trainees indicated that they had strategized about customer relationships (59%), investigated key partners (59%), investigated their customer segments (55%), and investigated value propositions (55%). Most areas where Cohort 1 trainees exhibited statistically significant gains in Year 1 are also areas where they reported further applying that knowledge in Year 2. For example, in Year 1 Cohort 1 trainees reported statistically significant improvement in their understanding of customer relationships, key partners, customer segments, and value propositions. In Year 2, at least half of all Cohort 1 trainees reported that they had applied their understanding of these concepts after the training.

   - A few Cohort 1 trainees have pursued a number of activities beyond BMC investigations to continue learning about the commercialization process, including participating in pitch competitions, working with the lab's commercialization department or managers, exploring potential business partnerships and investors, investigating competitors, and attending events for startups or connecting with incubators.

- **Cohort 2 trainees' understanding of all nine components of the BMC increased from baseline to post-training; four of these components showed statistically significant increases (key partners, channels, revenue streams, and cost structure).** Over half (54%) of the team PIs responding to the baseline survey said they had never heard of the BMC approach before the training, and an additional 38% said they had heard of the BMC but never really used it. Compared to Cohort 1, Cohort 2 trainees generally reported a higher level of understanding of the BMC components on their baseline surveys (possibly due to their labs' ongoing involvement in the program); therefore, their exhibited increases were not as strong as those reported by Cohort 1.[3]
- **Cohort 2 trainees' understanding of the technology commercialization process increased significantly as a result of the Energy I-Corps training.** More than three-quarters (79%) of respondents rated their understanding of the commercialization process ten-months post training as a "4" or "5" on a five-point scale, compared with 14% prior to the training (a statistically significant difference).[4] Although this increase is significant, it is not quite as large as the gain reported by Cohort 1 trainees (87% post-training versus 13% pre-training).
- **Training led to technology pivots.** Over one-third (36%) of Cohort 2 trainees reported that the greatest insights they achieved from the training was how to pivot to adapt to market needs, similar to the 35% of Cohort 1 trainees.
- **The Energy I-Corps training improved trainees' understanding of markets or market potential for their technologies.** Twelve out of 19 Cohort 1 trainees (63%) in the 18-month follow-up survey said that their understanding of the problem solved by their technology improved because of the Energy I-Corps

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[3] Though it is important to note that the difference might be due, in part, to survey question wording; the question for Cohort 1 used a 5-point scale while the Node-Lab implemented Cohort 2 survey used a 4-point scale.

[4] Percentage of respondents (n=15 baseline and 14 Year-1 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*. Statistically significantly different at the 95% confidence level.

program; 10 out of 22 (45%) Cohort 2 trainees said likewise in the post-training survey.

- **Cohort 1 Energy I-Corps trainees are producing scientific publications related to their technologies.** On average, Cohort 1 trainees submitted 2.67 scientific publications, and had 2 accepted since November 2015.
- **The Energy I-Corps trainees are sharing their knowledge.** Both Cohort 1 and 2 trainees (nine (41%), and three (38%) trainees, respectively) reported informing others in their lab about the BMC approach after completing the Energy I-Corps training (an outcome desired by the program).

Commercialization Outcomes

Findings suggest Energy I-Corps has very high potential to increase the commercialization of trained PIs' lab technologies. Cohort 1 trainees continued at 18-months post-training to make positive progress towards commercializing their Energy I-Corps technologies, including progressing in the stage of development of their technologies, to reaching commercialization benchmarks and for a small subset, reporting sales related to their technology.

Progress Toward Commercialization

- **Cohort 1 trainees demonstrated progress in the development of the pilot technologies, according to their self-reports**.[5] Half (50%) of the Cohort 1 trainees reported 18-months post-training that they had at least reached the stage of having a prototype of their technology and had validated it in a simulated operation environment (equivalent to a Technology Readiness Level (TRL) of 6 or 7. Prior to training, only 18% of Cohort 1 trainees reported having reached this stage of development. In addition, 86% of respondents reported that their technology had advanced at least one stage of development, and as a group the stage of development increased by an average of approximately 1.3 TRL levels since before their Energy I-Corps training.[6]
- **Cohort 1 trainees have met a number of commercialization benchmarks**. Scientific or technical publications were the most commonly reported activity by

[5] The evaluation team notes that the Departments of Energy and of Defense have developed "systematic, metric-based" approach to assessing TRL levels, a methodology that was outside the scope of this evaluation. See *Technology Readiness Assessment (TRA) / Technology Maturation Plan (TMP) Process Guide,* U.S. Department of Energy, March 2008.

[6] There is no "typical" progression of TRL over time. TRL progression of lab innovations is typically limited due to lab missions and funding focused on early research and development, the situation that Energy I-Corps was designed to ameliorate. Among entrepreneurs, TRL progression is highly dependent on such factors as (1) the complexity of the innovation (software may reach commercialization within a year or two, while some innovations can take more than a decade); (2) the characteristics of the market (e.g., How market-disruptive is the technology? Are there established supply chains? What is the competitive value of the innovation?); and (3) the interest of the initial target market in the innovation (How many change of direction ("pivots") are needed? How substantial are the changes needed?).

Cohort 1 trainees; they have submitted an average of 2.7 publications and an average of 2.0 have been published during the past year (related to their Energy I-Corps technology). Other commonly reported commercialization activities include submitting record(s) of invention, filing patents, and developing intellectual property (IP) in a CRADA, which refers to the IP rights belonging to each of the participants prior to the commencement of the arrangement.

  - On average, there does not appear to be a great difference in the behavior of trainees and non-participants when it comes to publishing work or applying for patents, copyrights, and other commercialization benchmarks. However, these numbers may be misleading due to the very small sample size of non-participants.

- **Cohort 2 trainees have go-to-market strategies.** Eighty-seven percent of Cohort 2 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."
- **Cohort 2 trainees are likely to continue conducting commercialization activities on their pilot technology following the Energy I-Corps training**. Eighty percent (80%) of Cohort 2 trainees reported they were *highly likely* (a rating of "5") or *moderately likely* (a rating of "4") to continue such activities in the next three months.
- **Trainees are making positive progress in their efforts to further fund their technologies**. Seven out of 14 (50%) Cohort 1 Year 2 trainees who responded to follow up questions regarding technologies noted that they were conducting discussions with funders, six trainees (43%) said they received funding, and four trainees (29%) indicated that they have presented a business idea to funders/investors. Comparing results with the previous Cohort 1 survey responses (Year 1) reveals statistically significantly increases in the proportion of respondents who have received funding (from 14% to 43%) and have presented a business idea to funders or investors (from 0% to 29%).
- **Cohort 2 trainees also reported efforts to further fund their technologies**. Seven of the 15 Cohort 2 (50%) trainees who reported they were likely to conduct commercialization in future years stated that they had received funding for further development or commercialization, and nine (60%) reported they were in discussion with potential funders. Three respondents (20%) said they were interested in pursuing funding, but were not in active discussions with funders. Combining data collected from the evaluation survey and collected by DOE internally found that Cohort 1 teams have received $6,014,000 and Cohort 2 teams have received $7,181,040 in follow-on funding.
- **The majority of Cohort 1 trainees do not think they would have pursued commercialization activities for their technologies without Energy I-Corps.**

When asked whether they would have undertaken commercialization activities in the absence of the Energy I-Corps training, 59% of Cohort 1 trainees reported they "probably" or "definitely" would not have done so.

Commercialization of Other Technologies

- **One-half of Cohort 1 trainees (11 out of 22 respondents) reported that they have worked on commercializing additional technologies besides their pilot technology since their Energy I-Corp training 18 months earlier.** The Cohort 1 trainees have investigated and/or conducted strategic planning on the BMC components for these other technologies and were most likely to report that they have investigated value propositions (90%) or have investigated customer segments (80%). In addition, 10 respondents said that they were *somewhat* or *highly likely* to conduct commercialization activities on other innovations like the activities conducted during Energy I-Corps training in future years (eight and two, respectively).
- **The majority of Cohort 2 trainees are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of *subsequent* innovations.** Three-fifths of Cohort 2 trainees (60%) rated themselves *highly likely* (a rating of "5"), and third (33%) rated themselves *likely* (a rating of "4") to continue commercialization activities for subsequent innovations. Cohort 2 trainee interest in technology commercialization activities such as licensing their technology to an existing company, starting a company, or getting a CRADA to do further work on a technology, increased dramatically because of the training, according to their attribution of training influence.

Lab Encouragement and Support of Entrepreneurial Drive Among Researchers

Trainees from Cohorts 1 and 2 reported that their labs offer a number of resources designed to help support them with commercialization efforts.

- **Trainees generally felt that their labs support them in their commercialization activities.** Around the same proportion of Cohort 1 and Cohort 2 trainees rated their lab's level of support a "4" or "5" on a five-point scale (69% from Cohort 1 in Year 1 and 60% in Cohort 2). The results from Cohort 1 in Year 2 are also similar to those in Year 1; the previous evaluation found that 69% of respondents gave a "4" or "5" rating.
- **Cohort 1 trainees noted they received direct assistance from their technology transfer office (82%), ongoing training on the commercialization process (64%), and mentoring and encouragement (59%).** In these cases, the proportion of trainee respondents who said that their Lab is supportive in these specific areas increased greatly compared to their perception of Lab support before their October 2015 training (up from 59%, 27%, and 43%, respectively),

which may, in part, be due to the Energy I-Corps program. The finding might also indicate that participation in Energy I-Corps raises trainees' awareness of available resources or their willingness to make use of available resources, as suggested by the next finding. It may also reflect overall changes in institutional policies in the DOE (see Appendix H).

- **Trainees were more likely than non-participants to report that their labs are supportive of specific commercialization activities.** Overall, a greater proportion of trainees said their Lab was "supportive" or "very supportive" (a 4 or 5 out of a 5-point scale) of the commercialization process than non-participants, especially in terms of commercialization training (64% compared to 0% for Cohort 1), assistance from the lab's technology transfer office, and mentoring (59%% compared to 17% for Cohort 1). This finding suggests that Energy I-Corps may be attaining, to some extent, its goal of strengthened entrepreneurial spirit among lab researchers; however, the outcome appears to be largely evident among researchers participating in the training, and with more limited dispersion among researchers at large.
- **Trainees offered a number of recommendations regarding labs' commercialization supports.** Trainees in Cohort 1 and Cohort 2 suggested an increase in financial resources available to directly support commercialization activities. Both Cohorts made suggestions related to wanting improved guidance and mechanisms for turning viable ideas into Laboratory Directed R&D (LDRD) projects, licenses, and new companies. Cohort 1 trainees also made suggestions related to improving education and entrepreneurial leave opportunities, and Cohort 2 trainees expressed a desire for labs to improve support for external fundraising activities related to commercialization.

Feedback on the Energy I-Corps Training

Cohort 2 trainees provided feedback and suggestions for continued improvement of the program, identifying the one-on-one feedback as a key strength of the training.

- **According to trainees, the one-on-one feedback provided by faculty mentors was a key strength of the Energy I-Corps training.** Respondents highly valued the one-on-one feedback and recommended offering more of it, especially during the early stages of the training. More formalized one-on-one feedback was a suggestion made by several respondents in both Cohort 1 and Cohort 2. In general, trainees value the faculty mentors and would appreciate even greater one-on-one attention from these mentors throughout the course of the training.
- **Trainees cited several areas for improvement related to the training's structure, length, organization, and content.** Cohort 2 trainees provided suggestions to improve the Energy I-Corps training, most commonly referring to

the structure, length, or organization (58%) and course content (25%). Suggestions regarding the curriculum indicated that more advanced warning of program workload would be helpful, as well as some reduction in the daily training schedule to minimize the likelihood that trainees burn out quickly. Several respondents mentioned that more tailored training and mentorship for teams suited for technology transfer was warranted (apart from training related to the formation of a small business). A common recommendation from Cohort 1 was that the course should be lengthened to 12 weeks; interestingly, no one from Cohort 2 recommended lengthening the course.

- **Trainees expressed a desire for more guidance or support for customer interviews.** While trainees in Cohort 2 did suggest more guidance or support for customer interviews, no one mentioned the interviews being unduly burdensome, which was a common complaint among Cohort 1 trainees.
- **Trainees in Cohorts 1 and 2 recommended more support for technology transfer be built into the program, to complement the training elements focused on starting small businesses.** Several respondents mentioned that more unique training parameters and mentorship for teams suited for technology transfer, as opposed to the formation of a small business, was warranted.

Section 1 Introduction

Energy I-Corps, one of a handful of U.S. DOE programs within the Technology-to-Market Program, is intended to accelerate the commercialization of clean energy technologies from DOE national laboratories (labs).[7] The U.S. DOE's 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. Energy I-Corps continues with annual funding.

This report, conducted by an independent evaluator, documents the program's second-year impact findings, and recaps findings from the first-year process and impact research. The second-year findings include outcomes and impacts for program Cohort 1—the group of lab researchers that participated in the first Energy I-Corps training in Fall 2015, and for Cohort 2—the group of researchers trained in Spring 2016.

This report is based on findings from:

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- Cohort 2 Baseline data: The Cohort 2 Baseline survey was conducted from March 4 to 14, 2016, immediately before the training took place (March 15 to May 5, 2016)
- Cohort 2 Immediate post-training data: The Immediate Post-training survey was conducted from May 9 to June 22, 2016
- Cohort 2 Year 1 post-training data: the survey conducted by the evaluation team from February 22, 2017 to March 31, 2017

Figure 1-1 provides a timeline summary of the data collection and of Cohort 1 and 2 Energy I-Corps Training.

The study explores three domains of outcomes and impacts, which reflect the program objectives:

- Knowledge gain
- Commercialization outcomes
- Lab encouragement and support of entrepreneurial drive among researchers[8]

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[7] https://energy.gov/eere/technology-to-market/about-technology-market-program

[8] DOE revised the pilot's third objective toward the end of the Cohort 1 evaluation period. Initially, the third objective was to "transform national lab culture to value commercialization and entrepreneurial activities." DOE refined the third objective 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," which we operationalized for continuity between the Cohort 1 and Cohort 2 investigations as "lab encouragement and support of entrepreneurial drive among researchers."

Figure 1-1: Timing of Cohort 1 and Cohort 2 Energy I-Corps Training and Evaluation Data Collection

	2015				2016												2017					
Study Group	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Cohort 1	B	B	I	I																	P	P
Cohort 2							B		I	I								P	P			
Year 1 non-participant sample		N						N														
Year 2 non-participant sample																					N	N

B = Baseline survey

I = Immediate Post-Training Survey

P = Post training survey

N = non-participant survey

I-Corps Training

1.1 ENERGY I-CORPS PROGRAM OVERVIEW

Energy I-Corps trains the selected lab scientists and engineers in techniques proven to accelerate technology commercialization. Training occurs in a group setting with extensive individual coaching and feedback provided by experienced entrepreneurs. EERE intends for the training to 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). EERE also intends to have participating teams know the next steps needed to move their technologies along the commercialization continuum, and lab encouragement and support of entrepreneurial drive among researchers.[9]

The Energy I-Corps Program comprises a Node Lab (which implements and manages the program, including responsibility for the curriculum), 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 recruit and support qualified teams and that EERE remains informed of Site Lab activity and progress.

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.[10] EERE selected the National Renewable Energy Laboratory (NREL) to serve as the Node Lab for the pilot, a role it continues to serve for the program. The program is open to all 17 labs. Through Cohort 2, the following national labs have participated in the program and assembled and supported training teams:

- Argonne National Laboratory (ANL)
- Fermi National Accelerator Laboratory (Fermi)
- Idaho National Laboratory (INL)
- Lawrence Berkeley National Laboratory (LBNL)
- Lawrence Livermore National Laboratory (LLNL)

[9] The logic model of the Energy I-Corps Pilot developed by the evaluation identified strengthened institutional support for commercialization as a key activity for pilot labs. See 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.

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

- Los Alamos National Laboratory (LANL)
- NREL
- Oak Ridge National Laboratory (ORNL)
- Pacific Northwest National Laboratory (PNNL)
- Sandia National Laboratory-California (SNL)

All training teams are composed of three team members:

- Principal Investigator (PI) – Serves as technical lead and overall project manager. The PI is always a lab employee.
- Entrepreneurial Lead (EL) – Leads the investigation, through interview research, into customer requirements and the commercial landscape, and assists in development of commercialization next steps. The EL is often, but not always, a lab employee.
- Industry Mentor (IM) – Provides business and commercialization guidance to the PI and EL.[11] The IM is rarely, if ever, a lab employee.

Selected teams participate in a training that guides the teams in developing and testing business models for their technologies by conducting research with relevant market actors to explore the models' key hypotheses. The training, which lasts the better part of two months, consists of a multi-day onsite opening session, weekly web-based sessions, and a multi-day onsite closing session. The onsite sessions included a mixture of lectures, workshops, team presentations, and group and individual feedback; the web-based sessions are 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.

Relevant contacts for the discovery process may include potential customers, supply chain actors, possible partners, and so on, and discussions address such topics as customer pain-points with existing technologies, interest in the innovation, likely costs, and possible revenue streams. The program design was 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.

[11] 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.

1.2 THE ENERGY I-CORPS TRAINING

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. 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.[12]

Energy I-Corps seeks to accelerate successful technology transfer by implementing a commercialization training model that modifies the respected Lean LaunchPad® entrepreneurship curriculum.[13] The Node Lab tailored 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 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.
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.

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

[13] 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.

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. 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.

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 COHORTS 1 AND 2

Fourteen teams participated from eight labs or lab partners in the Cohort 1 training (October 11 to November 19, 2015; see Table 1-1), and fourteen teams from six labs participated in the Cohort 2 training (March 15 to May 5, 2016; see Table 1-2). More detailed descriptions of the teams, their technologies and goals for the Energy I-Corps training are provided in Appendix D.

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

Lab	Team	Technology
ANL	Dynamic Aperture	Provides precise, real-time control of vapor deposition sources to improve the quality of thin films without stopping the manufacturing process to recalibrate sources.
ANL	SonicLQ	Software that uses sound waves to find and quantify air leaks to better estimate weatherization repairs and energy savings potential.
INL	ARAI	Advanced Renewable Aerial Inspection uses unmanned aircraft systems to inspect multiple types of wind turbines, including off-shore wind turbines, to collect data.

Lab	Team	Technology
INL	SPS	Switchable Polarity Solvent Forward Osmosis materials undergo a polarity shift when a chemical agent is detected. Applications include industrial water treatment and biomass fractionation.
LBNL	Ring Burner	Patented low-emission technology that uses premixed fuel and air and flame stabilization to evenly heat a surface.
LLNL/SNL	C-Best	Commercial Building Energy Saving Technology is an optimized control technology commercial HVAC systems.
NREL	Eco-AC	A modular air conditioning solution intended to replace current window air conditioners.
NREL	WISDEM	Wind Plant Integrated Systems Design and Engineering Model creates a “virtual,” vertically integrated wind plant to optimize wind turbine and plant design, control, and operation.
ORNL	CI-ReClad	Addresses air, vapor, and water-resistive barriers, while providing continuous thermal insulation with retrofit reclad application refinements so that a building can operate throughout recladding.
ORNL	Tunation	Zero touch audit software that enables energy service companies to identify buildings’ energy- and cost-saving potential quickly and cheaply.
PNNL	Co-culture Green	Captures fugitive methane and carbon dioxide gases and, with help from a co-culture, biologically converts them into products such as biofuel, feedstock, and fertilizer.
PNNL	HYDRA	A statistical framework to design an aggregate forecasting model with less variability, useful in a wide range of applications, including grid forecasting.
PNNL	STARS	Solar Thermochemical Advanced Reactor System uses sunlight to convert natural gas or biomethane feedstock into energy-rich gas for commercial use, such as hydrogen and on-site methanol production and electricity generation.
PNNL	Sub Lambda	A passively switchable dynamic window coating that reversibly blocks infrared radiation but not visible light.

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

Lab	Team	Technology
ANL	Nanoheatblock	Allows for the manufacturing of particulate (VO_2 nanorods) thermochromic films (thin-film window coatings).

Lab	Team	Technology
ANL	RW-EDI	Resin Wafer Electrodeionization – directly uses electricity to remove ions from aqueous streams.
ANL	SCA	Smart Charge Adapter – provides communication, control, and monitoring capabilities for the electric vehicle charging session.
INL	High-Moisture Pelleting Process	Decreases the drying cost and manages the feedstock moisture more efficiently.
INL	Quake	Advanced seismic methods and tools for the nuclear industry.
LBNL	Bioalchemy, Inc.	Merges microfluidics with mass spectrometry to provide fully automated enzyme processing and assay for cellulose degrading enzymes.
LBNL	Evodia	Developing engineered microbes to convert inexpensive, renewable sugars into high-value specialty chemicals.
LBNL	TOUGH	A suite of codes for complex subsurface simulations, such as how valuable resources can be extracted from or wastes safely stored in the subsurface.
LLNL	Micro Miners	Biotechnologies to sequester and recover rare earths from low-grade sources (e.g., mine tailings, geothermal fluids, and recyclable materials).
LLNL	Saline Solutions	Novel desalination method that removes ions from water electrostatically.
NREL	Biolyst Renewables	Technologies to produce adipic acid (a primary component of nylon) renewably from biomass at a competitive cost and lower environmental footprint than petroleum-derived adipic acid.
NREL	Solguard	Integrated photovoltaic safety and performance solution provides remote shut-off capability of solar systems while giving owners automatic alerts of potential safety and energy-production problems
PNNL	Volttron	An open-source platform for distributed sensing and control funded by DOE's Building Technologies Office
PNNL	Polymer Membranes	Membranes tailored to allow conduction of specific ionic species between the negative and positive electrodes in an electrochemical system.

1.4 PROGRAM LOGIC MODEL

For the first-year process and impact evaluation of Energy I-Corps, the research team developed a program logic model. Appendix C provides the model graphics and description.

Section 2 Methods

This report extends the initial Energy I-Corps research, which reported on Year 1 outcomes of Cohort 1 training (which took place from October 11 to November 19, 2015), to include an assessment of Year 2 outcomes and impacts for Cohort 1 and Year 1 outcomes for Cohort 2 (trained March 15 to May 5, 2016).[14]

The study explores three domains of outcomes and impacts, reflecting the program objectives.

- Knowledge gain
- Commercialization outcomes
- Lab encouragement and support of entrepreneurial drive among researchers

A companion report conducted case study analysis of four technologies that participated in Energy I-Corps and the commercial advances they made since participation. The case study analysis explores influences of technology, team, and target market characteristics on the advances made.[15]

This current report is based on findings from:

- **Cohort 1 Year 2 data:** from a follow-up survey with Cohort 1 lab researchers, which was fielded 18 months after training (Cohort 1 training took place from October 11 to November 19, 2015 and the survey conducted by the evaluation team took place from May 9, 2017 to June 14, 2017). All participants from Cohort 1 were invited to take the survey.
- **Year 2 Non-participant data:** from a web survey of non-participants identified by lab program managers as appropriate comparisons to the Cohort 1 participants (survey conducted by the evaluation team from May 9, 2017 to June 14, 2017).[16]
- **Cohort 2 Baseline data**: from a web survey conducted prior to the Cohort 2 training by the Node lab (NREL) with which DOE contracts to implement Energy I-Corps (The Cohort 2 training took place from March 15 to May 5, 2016 and the Baseline survey was conducted from March 4 to 14, 2016). All participants from Cohort 2 were invited to take the survey.

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[14] The evaluation team notes that there was no overlap in PIs among the Cohort 1 and Cohort 2 teams or among the nonparticipants for Cohort 1 and Cohort 2. In addition, Cohort 2 teams do not include any Cohort 1 nonparticipants. Among the Cohort 2 nonparticipants, one applied to Cohort 1 (but was not selected) and two applied for Cohort 5 (but were not selected),

[15] Energy I-Corps Program: 2017 Case Studies, Final Report. February 2018. Submitted to U.S. DOE EERE by RIA, NMR Group Inc., and Gretchen Jordan. https://www.energy.gov/eere/analysis/downloads/energy-i-corps-program-2017-case-studies

[16] The evaluation team worked with the participating labs to identify and recruit non-participants. The evaluation team asked the lab pilot managers from Cohort 1 to identify their labs' senior manager(s) with oversight for applied EERE research, to enlist these managers' support of the research, and to ask them to identify their most entrepreneurial PIs conducting applied EERE research who were not participating in the Energy I-Corps program.

- **Cohort 2 Immediate Post-training data:** web survey conducted post-training by the Node lab, which collected data on a limited number of immediate knowledge gain and commercialization outcome metrics (The Cohort 2 training took place from March 15 to May 5, 2016 and the Post-training survey was conducted from May 9 to June 22, 2016). All participants from Cohort 2 were invited to take the survey.
- **Cohort 2 Year 1 data:** from a follow-up web survey with Cohort 2 lab researchers roughly 10 months after training (Survey conducted by the evaluation team from February 22, 2017 to March 31, 2017.). All participants from Cohort 2 were invited to take the survey.

The survey research seeks to identify the impacts of Energy I-Corps training on researchers' commercialization understanding, activities and accomplishments, and, to a lesser extent, to examine the barriers to commercialization the participants faced and the approaches they took to reduce the barriers.

The evaluation methodology employs a treatment/comparison group approach—that is, training cohorts and non-participants. Surveying both the training cohort and non-participants make it possible to better assess the effects of the training and more deeply understand how participating labs can foster commercialization within their communities of scientists.

The analysis examines the impacts of the Energy I-Corps training in the following ways:

- Cohort 1 outcomes, including comparisons across years
- Cohort 2 outcomes, including comparisons with Cohort 1
- Comparisons of both cohorts with the non-participants.

Appendix E provides a discussion of the methods that the evaluation team used to assure the research design quality. It also discusses study limitations. Because we did not require a response to every survey item, there are several instances where respondents chose not to answer a question or a set of follow-up questions. We have reported the maximum number responses for each item, which varies within each survey.

2.1 OUTCOME METRICS

The peer-reviewed technical evaluation plan established performance metrics for assessing Energy I-Corps early outcomes in the areas of learning, commercialization, and lab encouragement and support of entrepreneurial drive among researchers.[17, 18] The Year 2 evaluation extended the initial Lab-Corps effectiveness research, which reported on Year 1 outcomes through training Cohort 1 to include an assessment of Year 2 outcomes and impacts for both Cohorts 1 and 2. (Table 2-1).[19]

Table 2-1: Outcome Metrics

Outcome	Metric
Knowledge gain	Information added to BMC
	Refinements/pivots made to BMC
	Sharing information with non-participants
	Increased understanding of commercialization process and market needs
	Increased quality/viability of BMC
	Application of BMC to other technologies
Commercialization	Commercialization activities engaged in and outcomes
	Stage of commercialization (TRL)
	Commercialization benchmarks (scientific or technical publications, CRADAs, patents, trademarks, sales, etc.)
	Funding received and efforts to receive further funding
	Entrepreneurial leave taken
Lab encouragement and support of entrepreneurial drive among researchers *	Researcher assessment of lab support
	Changes in lab support for commercialization since the program began
	Non-program support provided to teams due to labs' Energy I-Corps participation
	Intra-lab learning opportunities

[17] *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.

[18] DOE revised the pilot's third objective toward the end of the Cohort 1 evaluation period. Initially, the third objective was to "transform national lab culture to value commercialization and entrepreneurial activities." DOE refined the third objective 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," which we operationalized as "lab encouragement and support of entrepreneurial drive among researchers." For continuity between the Cohort 1 and Cohort 2 investigations, we did not revise the evaluation metrics associated with this goal. *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.

[19] This current report addresses one of the key recommendations of the first-year process and impact report (to continue tracking Cohort 1 for an additional one or two years in order to assess the mid-term effects of the program that were not detectable after one year).

**As discussed in footnote 18, DOE's revised its phrasing of the third pilot objective toward the end of the Cohort 1 evaluation period. For continuity between the Cohort 1 and Cohort 2 investigations, we did not revise the evaluation metrics associated with this goal.*

DOE scoped this investigation to comprise surveys of researchers participating in Cohorts 1 and 2, as well as surveys with an equivalent-sized sample of nonparticipants to serve as a comparison group. These methods preclude a full investigation of the third program goal, which broadly addresses all lab researchers.

2.2 EVALUATION DATA SOURCES

As noted above, our team administered surveys to three groups: Cohort 1 (to assess Year 2 impacts), Cohort 2 (which includes baseline, post-training, and Year 1 impacts), and Year 2 non-participants.

2.2.1 Cohort 1 (Year 2) Survey and Response Rate

We invited 29 Cohort 1 trainees, representing 14 project teams, to participate in a follow-up survey eighteen months after their Energy I-Corps training (Year 2 survey). We surveyed Cohort 1 trainees from May 9, 2017 to June 14, 2017, and sent up to five reminder emails soliciting their feedback. Twenty-Two Cohort 1 trainees completed the survey, including at least one individual from 13 of the 14 training teams (Table 2-2).

Table 2-2: Number of Cohort 1 (Year 2) Respondents by Lab

Organization	Total number of trainees at labs	Year 2 Follow-up Survey
	Total	Total
ANL	4	4
INL	4	2
LBNL	3	3
LLNL	1	1
NREL	4	4
ORNL	5	4
PNNL	8	4
Total	**29**	**22**

2.2.2 Cohort 2 Survey and Response Rate

As noted in the introduction, 45 Cohort 2 trainees, representing 14 project teams, participated in the Cohort 2 training from March 15 to May 5, 2016. The training lab (Node), NREL, implemented a pre-training survey and a post-training survey immediately after the conclusion of the training. These surveys collected baseline data on some of the knowledge gain and commercialization outcome metrics. We conducted a one-year follow-up survey with the Cohort 2 trainees from February 22, 2017 to March 31, 2017, and sent up to five reminder emails soliciting their feedback. This survey also obtained, retrospectively, some additional baseline data. Twenty-Two Cohort 2 trainees completed the survey, including at least one individual from 13 of the 14 training teams. Overall, 15 team members responded to the baseline and both follow-up surveys (Table 2-3 and Table 2-4).

Table 2-3: Number of Cohort 2 Trainee Respondents by Role and Survey Wave

Role	All Surveys	NREL Baseline Survey	NREL Immediate Post-training Survey	Year 1 Follow-up Survey
Principal Investigator (PI) or Co-PI	8	13	12	9
Entrepreneurial Lead (EL)	6	16	14	8
Industry Mentor	1	6	4	5
Total	**15**	**35**	**30**	**22**

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

Lab	Baseline and Follow-up surveys	NREL Baseline Survey	NREL Post-training Survey	Year 1 Follow-up Survey
ANL	5	8	6	6
INL	2	6	4	3
LBNL	2	6	8	2
LLNL	3	4	4	4
NREL	3	6	6	4
ORNL	-	-	-	-
PNNL	-	2	2	1
SNL	2	3	-	2
Total	**15**	**35**	**30**	**22**

2.2.3 Non-participants (Year 2), Survey and Response Rate

The initial Energy I-Corps pilot report (Evaluation of the Energy I-Corps Pilot, Final Report, November 28, 2016) included surveys of non-participants who were considered by the labs for Cohort 1 training.[20] This approach to identifying a non-participant group yielded a group much smaller (about one-third the size) than the cohort group due to the unavailability of the PI for a variety of reasons. In addition to the small sample size, the Year 1 nonparticipant group was exposed to training concepts during the application process, and thus likely had somewhat greater knowledge of the commercialization endeavor than typical among lab researchers.

For the current evaluation, the evaluation team worked with the participating labs to identify and recruit non-participants. The evaluation team asked the lab pilot managers from Cohort 1 to identify their labs' senior manager(s) with oversight for applied EERE research, to enlist these managers' support of the research, and to ask them to identify their most entrepreneurial PIs conducting applied EERE research who were not participating in the Energy I-Corps program.

[20] The Energy I-Corps Pilot report included surveys of Cohort 1 non-participants. The Node Lab administered pre- and post-training web-based surveys to the proposed principal investigators and/entrepreneurial leads of non-participating teams that the labs had considered but not selected for Cohort 1 participation. The non-participant sample for these initial surveys was restricted to those candidate teams most similar to the participating teams and were generally considered to be the "runners up" and comprised candidate teams from four of the seven labs that fielded participating teams. https://energy.gov/sites/prod/files/2016/12/f34/Evaluation%20of%20Lab-Corps%20Pilot%20-%20Final%20Report%2011-25-2016.pdf

Thus, both the Year 1 and Year 2 non-participant groups were comparable to the Cohort participants in entrepreneurial interest, as judged for Year 1 by application to the pilot and for Year 2 by recommendation of their senior managers. Year 1 non-participants had more direct exposure to Energy I-Corps concepts than Year 2 non-participants during the process of applying for training. Both Year 1 and Year 2 non-participants had opportunities to learn Energy I-Corps principals of commercialization from their participating peers, as participants reported they shared their learning with their colleagues. Year 2 non-participants may therefore have received information from both Cohort 1 and Cohort 2 participants.

Five of the seven participating labs provided 23 non-participant contacts. We surveyed the non-participants from May 9, 2017 to June 14, 2017, and sent up to five reminder emails soliciting their feedback, in addition to an advance email alerting the non-participants of the survey. Ultimately, this additional effort yielded the same number of Year 2 non-participants as in Year 1. The nine Year 2 non-participant respondents were from four different labs.

Table 2-5: Year 2 Non-participant Respondents by Lab

Organization	Year 2 Follow-up Survey
	Total
INL	3
LBNL	1
LLNL	2
NREL	3
Total	**9**

Table 2-6 provides a summary of the populations, sample sizes, and response rates. Appendix I provides our survey instruments.

Table 2-6: Population and Sample Sizes

Group	Population	Sample	Response Rate
Cohort 1 Year 2	14 teams, 29 trainees	22	76%
Year 2 Non-participants	23 lab scientists	9	39%
Cohort 2 Baseline from NREL	14 teams, 45 trainees	35	78%
Cohort 2 Immediate post-training from NREL	14 teams, 45 trainees	30	67%
Cohort 2 Year 1 post-training	14 teams, 45 trainees	22	49%

2.2.4 Study Limitations

It is important to note that there are several limitations to this study and therefore the findings should be interpreted and applied with caution. For example, there are many variations among the trainees, their technologies, the technologies' technical readiness, and their labs, and all are factors that influence pilot outcomes. This study does not attempt to trace the influence of these variations on early pilot outcomes. As mentioned, a companion report conducted case study analysis of four technologies that participated in Energy I-Corps. [21] The case study analysis explores influences of technology, team, and target market characteristics in the post-training commercialization advances made by these technologies.

The small sample sizes of the Cohort trainees, and especially of the nonparticipants, provides further limits and cautions in interpreting results. For example, comparing commercialization outcomes between trainees and nonparticipants should be interpreted cautiously because of the extremely small sample of nonparticipants (fewer than 10 respondents). Identifying and recruiting a comparison group of nonparticipants proved to be difficult.

In addition, interpreting the difference in understanding of the BMC components between Cohort 1 and 2 trainees is difficult because of the use of different scales in the survey questions (the question for Cohort 1 used a 5-point scale while the survey for Cohort 2 used a 4-point scale)

In addition, the program objective of lab encouragement and support of entrepreneurial drive among researchers creates a confounding factor because positive evidence of the catalyzing change and sharing knowledge, particularly with non-participants, inhibits the ability to demonstrate the effectiveness of the training through differences between trainees and non-participants.

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[21] Energy I-Corps Program: 2017 Case Studies, Final Report. February 2018. Submitted to U.S. DOE EERE by RIA, NMR Group Inc., and Gretchen Jordan. https://www.energy.gov/eere/analysis/downloads/energy-i-corps-program-2017-case-studies

Section 3 Cohort 1 Outcomes and Impacts

This section reviews survey findings from 22 Cohort 1 Energy I-Corps trainees 18 months after their training (Cohort 1 training took place from October 11 to November 19, 2015). These results focus primarily on the most recent survey (referred to as the (Cohort 1 Year 2 survey), with comparisons to Cohort 1 Year 1 results as appropriate. The Cohort 1 Year 1 survey results are obtained from the previous first year Energy I-Corps study.[22] The findings include an assessment of Cohort 1 trainees' knowledge and understanding of key commercialization concepts, and how they are reportedly applying these concepts. This section also provides an update on Cohort 1 trainees' commercialization outcomes, including their progress towards commercialization and lab encouragement and support of entrepreneurial drive among researchers. Section 4 provides Cohort 2 Year 1 findings and compares with Cohort 1 Year 1 findings. Section 5 compares the Cohort 1 Year 2 follow-up respondents and Cohort 2 Year 1 follow-up respondents to a comparison group of Year 2 non-participants.

3.1 KNOWLEDGE GAIN

The Cohort 1 survey asked trainees to report on how they are applying their knowledge of key commercialization concepts. The results indicate that they are building upon their Energy I-Corps training by applying these concepts to their work and by furthering their knowledge in related areas.

3.1.1 Understanding of the Commercialization Process

A key feature of the Energy I-Corps training is the instruction regarding the business model canvas (BMC), which trains participants to examine the nine components of a business model that are considered necessary to commercialize a new technology (section 1.2 The Energy I-Corps Training details the nine components). Results from the Cohort 1 Year 2 survey indicate that Energy I-Corps trainees continue to apply their learning related to the BMC to enhance their understanding of the commercialization process (Figure 3-1). When asked about the extent to which they have conducted investigations into various components of the BMC, more than half of Cohort 1 trainees indicated that they had strategized about customer relationships (59%), investigated key partners (59%), investigated their customer segments (55%), and investigated value propositions (55%). Furthermore, most areas where Cohort 1 trainees reported applying knowledge in Year 2 are also areas where the results showed statistically significant gains from baseline in the Year 1 survey responses—noted with two asterisks (**) in Figure 3-1.

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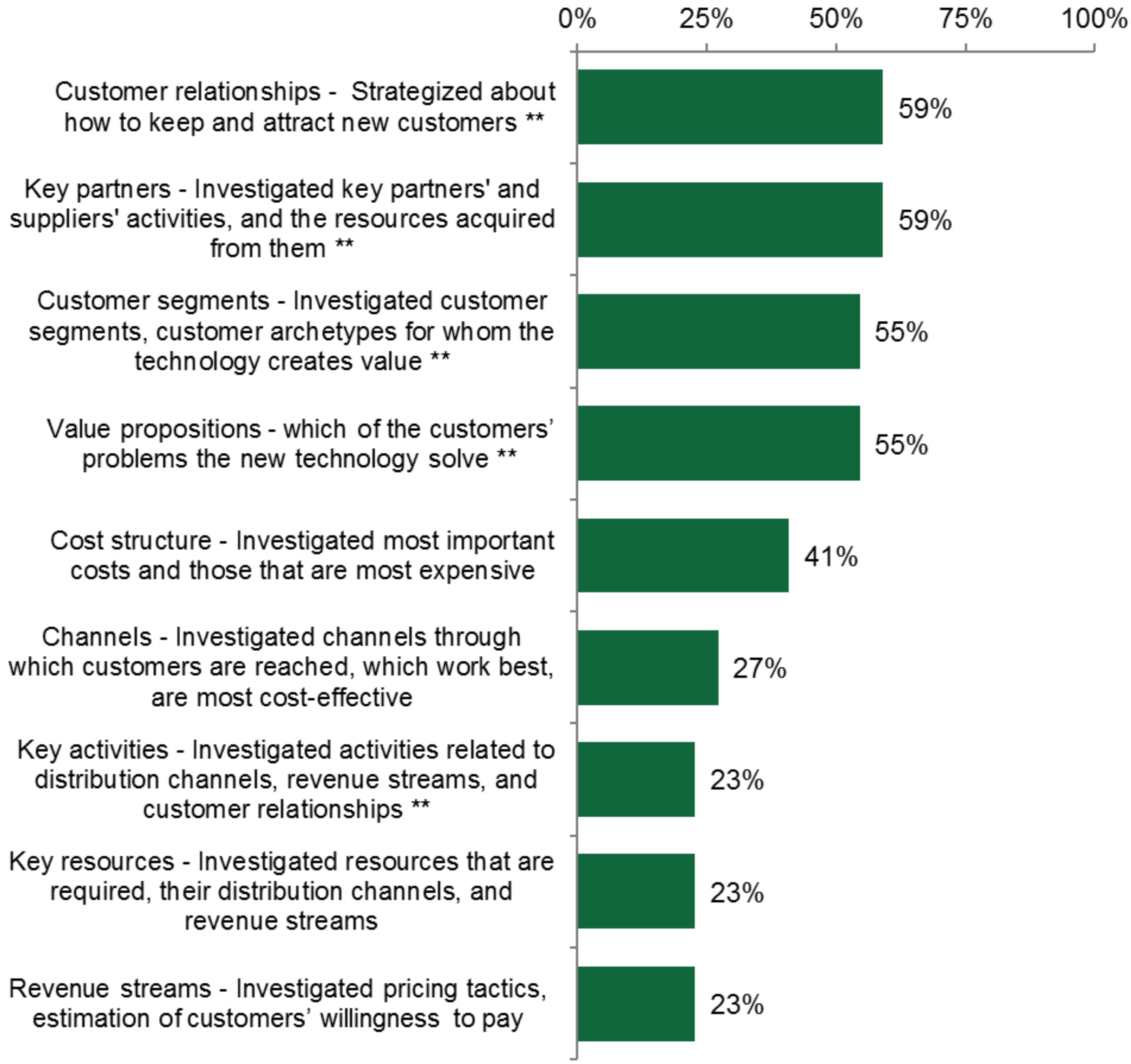
[22] *Evaluation of the Energy I-Corps Pilot,* November 28, 2016. Submitted to U.S. DOE EERE by NMR Group, Inc., Research Into Action, Inc., Gretchen Jordan, Ph.D., Albert Link, Ph.D., and East Mountain IP.

Figure 3-1: Business Model Canvas Components that Trainees Investigated Following their Training (n=22)*



* Percentage of respondents said "somewhat" or "a lot."
** Items where Cohort 1 respondents reported statistically significant knowledge gains from baseline in Year 1.

The Cohort 1 Year 2 survey asked trainees to describe what they had done to continue learning about the commercialization process. Respondents provided a range of answers, including participating in pitch competitions, working with the lab's commercialization department or managers, exploring potential business partnerships and investors, investigating competitors, and attending events for startups or connecting with incubators. Two Cohort 1 trainees noted that they have received financial support through the Technology Commercialization Fund (TCF) to further the commercialization of their technologies.

Another area of knowledge gain pertains to scientific publications associated with their technologies. Cohort 1 trainees reported the number of scientific publications they submitted or had published since November 2015 related to their Energy I-Corps technology. On average, Cohort 1 trainees submitted 2.67 scientific publications, and had 2 accepted in that time frame.

Table 3-1: Number of Scientific Publications Submitted/Accepted (n=12)

Status of Scientific Journal Articles	n	Mean	Range
Submitted*	12	2.67	0-10
Accepted	11	2.00	0-6

* Omits one respondent who reported submitting 35 articles for publication

3.2 COMMERCIALIZATION OUTCOMES

The Cohort 1 Year 2 survey asked trainees to report on several commercialization-related activities and outcomes, including the stage of development and commercialization of their technologies, their status on various commercialization benchmarks, their efforts to further fund their technologies, and their commercialization of other technologies. Trainees also assessed the likelihood of achieving commercialization without the Energy I-Corps training.

3.2.1 Stage of Commercialization

The Cohort 1 Year 2 survey asked trainees to assess the differences over time of development and commercialization of their technologies. The survey asked trainees to assess the stage of development of their technology ‘now’ (eighteen months after the training) and to assess the stage retrospectively at the time they started the training (October 2015). The Year 2 survey included a seven-stage scale (similar to Technology Readiness Levels).[23] According to their self-reports , trainees appear to have demonstrated progress in the development of the pilot technologies for Cohort 1.[24] Fifty

[23] For ease of web-survey administration, the question regarding technology advancement paraphrased DOE’s TRL descriptions for brevity and simplicity. See Appendix G for a comparison of the stages of commercialization used in this survey and TRLs.

[24] The evaluation team notes that the Departments of Energy and of Defense have developed “systematic, metric-based” approach to assessing TRL levels, a methodology that was outside the scope of this evaluation. See *Technology Readiness Assessment (TRA) / Technology Maturation Plan (TMP) Process Guide,* U.S. Department of Energy, March 2008.

percent of trainees reported 18 months post-training that they had at least reached the stage of having a prototype of their technology and had validated it in a simulated operation environment (the survey phrasing of stage 5, which is equivalent to a Technology Readiness Level (TRL) 6 or 7). The six respondents who reported that they had validation in commercial operational environment or that they were in the final design stage include representatives from four teams. Prior to training, only 18% of Cohort 1 trainees reported having reached this stage of development (Table 3-2). In addition, 86% of respondents reported that their technology had advanced at least one stage of development, and, as a group, the stage of development increased by an average of approximately 1.3 TRL levels since before their Energy I-Corps training [25]

Table 3-2: Commercialization Stage of Development, Before and After Training (n=22)

Stage of Development	Pre-Training (October 2015)			Eighteen Months Post-Training		
	Trainee Respondents	Percent	Teams*	Trainee Respondents	Percent	Teams*
1. Concept exploration/preliminary investigation	2	9%	2	0	0%	0
2. Concept definition/initial investigation	7	32%	7	2	9%	2
3. Proof of concept/detailed investigation	6	27%	4	5	23%	5
4. Proof of application/initial development and verification	3	14%	3	4	18%	2
5. Validation in simulated operation environment/prototype project	2	9%	2	5	23%	4
6. Validation in commercial	1	5%	1	4	18%	4

[25] There is no "typical" progression of TRL over time. TRL progression of lab innovations is typically limited due to lab missions and funding focused on early research and development, the situation that Energy I-Corps was designed to ameliorate. Among entrepreneurs, TRL progression is highly dependent on such factors as (1) the complexity of the innovation (software may reach commercialization within a year or two, while some innovations can take more than a decade); (2) the characteristics of the market (e.g,, How market-disruptive is the technology? Are there established supply chains? What is the competitive value of the innovation?); and (3) the interest of the initial target market in the innovation (How many change of direction ("pivots") are needed? How substantial are the changes needed?).

operational environment/commercial scale						
7. Final design/commercial production	1	5%	1	2	9%	2
Total	**22**	**100%**	**--**	**22**	**100%**	**--**

* A "team" is counted when at least one member of that team selected a given response.

Nearly all teams (11 of 13) and nearly all (19 of 22) respondents reported progress in commercialization (see Figure 3-2, Table 3-3, and Table 3-4). Not all members of the teams assessed the stage or progress identically, but in general specified the same amount of progress over time (Figure 3-2).

Figure 3-2: Stage of Commercialization Identified by Teams

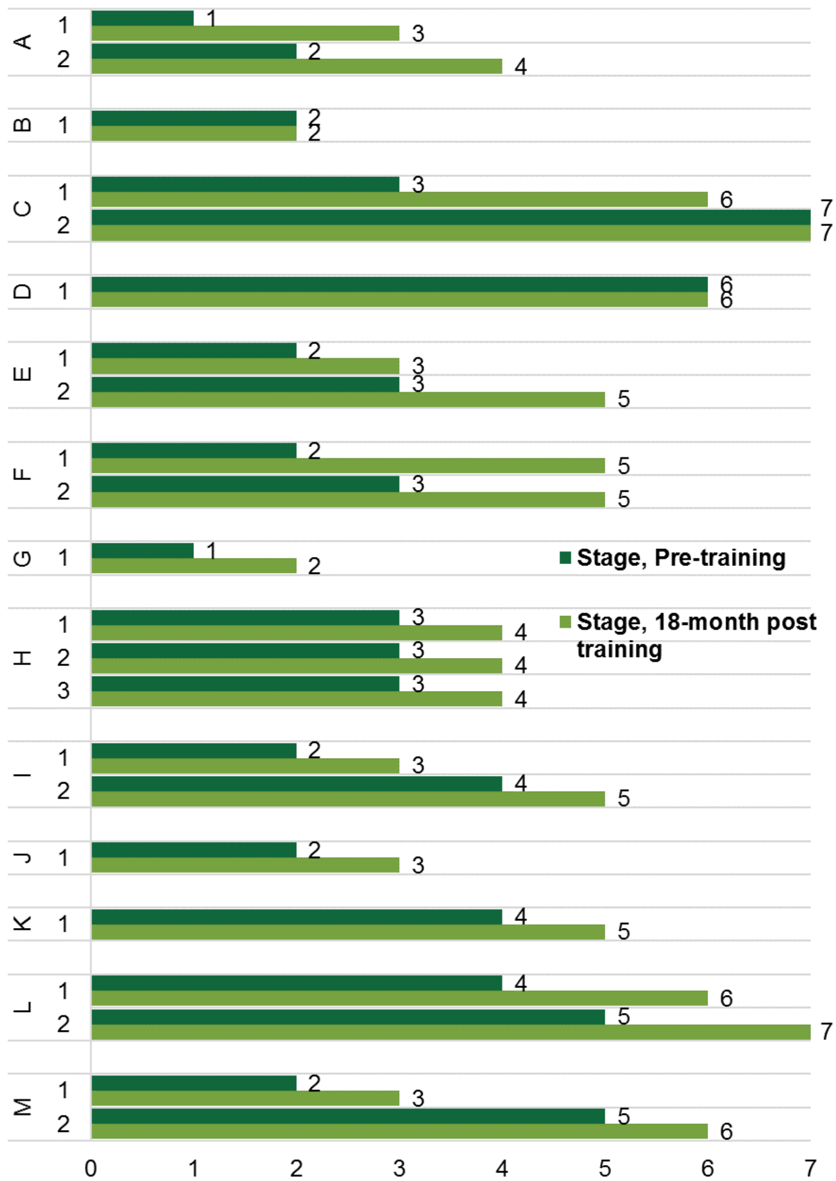


Table 3-3: Change in Commercialization Stage of Development from Before and After Training (n=22)

Statement	Trainee Respondents	Percent	Teams*
No change in commercialization stage of development	3	14%	3
One level increase in commercialization stage of development	12	55%	8
Two level increase in commercialization stage of development	4	18%	3
Three level increase in commercialization stage of development	3	14%	3

* A "team" is counted when at least one member of that team selected a given response.

Table 3-4: Average Change in Commercialization Stage of Development from Before and After Training by Team (n=22)

Average Change in Stage of Development	Number of Teams
0-1 level(s)	8
1-2 levels	5

Eighteen months after undergoing the Energy I-Corps training, the majority of Cohort 1 trainees had reached a "go" decision for their pilot technology (16 of the 22 respondents or 73%). Four trainees said that they had reached a "no-go" decision, and two trainees reported that they did not know.[26] Among trainees who reached a "no-go" decision on their technology (four respondents), the reasons they gave were well-considered. Two trainees expressed dissatisfaction with some aspect of their technology's investment market, such as their value proposition or the return on investment they estimated for their technology. Two other trainee respondents who reached "no-go" decisions on their pilot technologies had concerns with management; one trainee said that they were particularly concerned with how the Lab was handling their IP. One trainee who reached a "no-go" decision for their pilot technology added that they would apply what they learned in Energy I-Corps in subsequent commercialization activities:

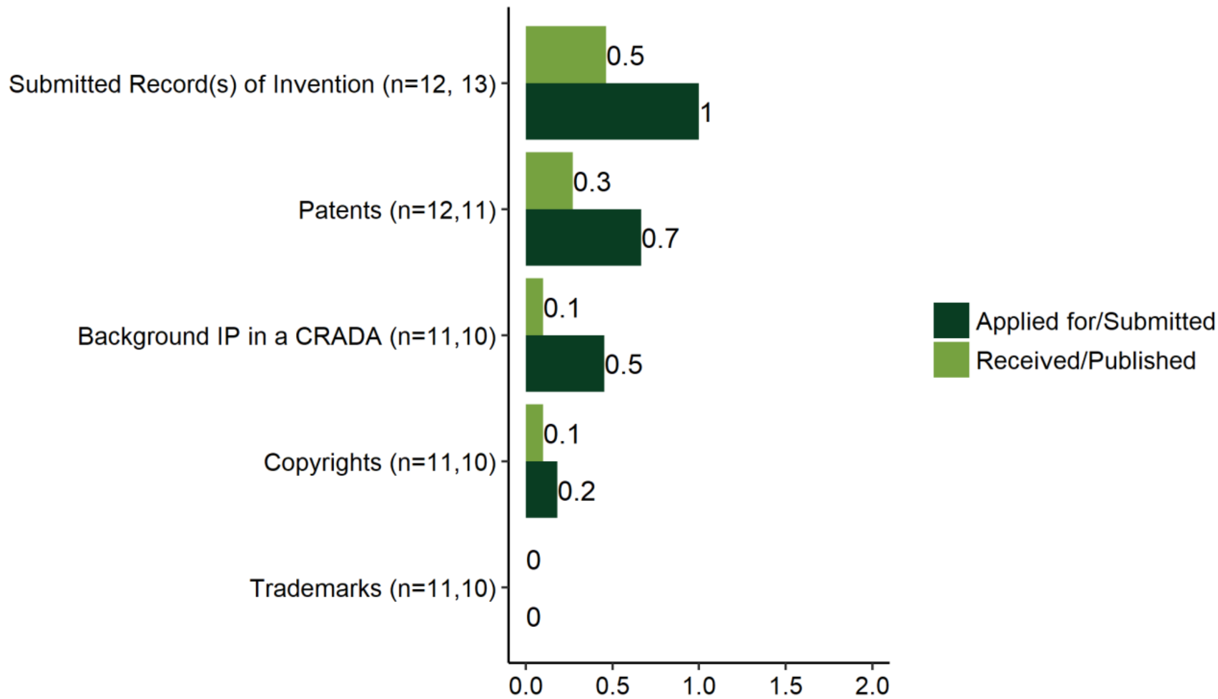
> *Our processes, as designed, will not have an attractive enough ROI for initial investment. We are now developing new technology to expand the bio-product portfolio and hope to re-boot the process that we learned in Lab-Corps [now Energy I-Corps].*

[26] In the Year 1 survey, six months following the pilot training, just one respondent (4%) reported reaching a "no-go" decision.

3.2.2 Progress Towards Commercialization

The Cohort 1 Year 2 survey asked trainees to report on their progress towards commercialization benchmarks (Figure 3-3). Overall, ten trainees (45%) reported completing one of several commercialization benchmarks. Commonly reported commercialization activities include submitting record(s) of invention, filing patents, and developing background intellectual property in a CRADA.[27,28] None of the Cohort 1 trainees reported applying for or a receiving trademark.

Figure 3-3: Average Number of Commercialization Benchmarks Applied for/Submitted and Received/Published (n=12)



When asked about their efforts to fund further work on their technology during the past year (18 months after the completion of the Energy I-Corps pilot), seven out of 14 trainees (50%) noted that they were conducting discussions with funders, six trainees (43%) said they received funding, and four trainees (29%) indicated that they have presented a business idea to funders/investors (Figure 3-4). Note that much of the funding received came from DOE sources (Table 3-6).

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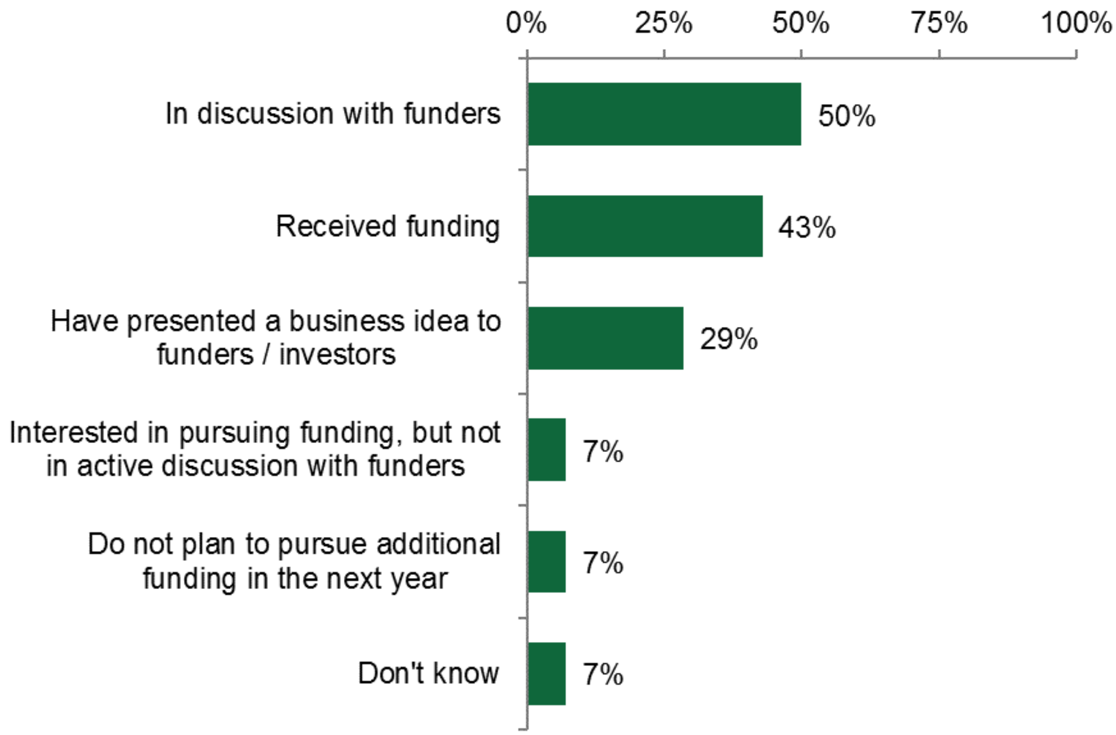
[27] Background IP refers to the IP rights belonging to each of the participants prior to the commencement of the arrangement.

[28] We were able to verify two out of the three respondents who said that a patent was received, as well as an additional two respondents who said they had submitted patents, by searching their names at USPTO.gov.

Figure 3-4: Efforts to Further Fund their Technology (n=14)



Compared to the results from the Year 1 survey, Cohort 1 has made substantial progress. Examining results from Years 1 and 2 shows statistically significant increases in the proportion of respondents and teams who have received funding (from 14% to 43% of respondents) and have presented a business idea to funders or investors (from 0% to 29% of respondents). The results reveal statistically significant decreases in the percentage of those who are not in active discussion, but who are interested in pursuing funding (from 41% to 7% of respondents). These findings indicate that the Cohort 1 participants are making positive progress in their efforts to further fund their technologies.

Table 3-5: Efforts to Further Fund their Technology, Years 1 and 2 (n=22)

Response	Year 1			Year 2			Significance**
	Trainee Respondents	Percent	Teams+	Trainee Respondents	Percent	Teams+	
In discussion with funders	6	27%	5	7	50%	6	n.s.
Received funding	3	14%	3	6	43%	4	$p < 0.05$
Have presented a business idea to funders / investors	0	0%	0	4	29%	4	$p < 0.01$
Other	0	0%	0	2	14%	2	n.s.
Interested in pursuing funding, but not in active discussion with funders	9	41%	7	1	7%	1	$p < 0.01$
Do not plan to pursue additional funding in the next year	1	5%	1	1	7%	1	n.s.
Don't know	0	0%	0	1	7%	1	n.s.
Looking for more funding from DOE (LDRD, CRADA, etc.)*	4	18%	3	-	-	-	--

* LDRD = Laboratory Directed Research and Development.

** Column describes the statistical significance between Year 1 and Year 2 responses. "n.s." indicates no statistically significant difference.

+ A "team" is counted when at least one member of that team selected a given response.

Using data collected from the evaluation survey and from data collected by DOE internally, the team found that, 18 months after their training, Cohort 1 trainees reported that the source of much of the funding was internal DOE Lab grants, but some respondents were able to secure other, non-DOE government funding or private investment (Table 3-6). Cohort 1 trainees also indicated that they were conducting ongoing discussions with potential funders, such as DOE (3), private companies and investors (2), state government (1), business partners (1), and manufacturers (1).

Table 3-6: Funding Received (n=5; Multiple Responses Permitted)

Response	Trainee Respondents	Teams (4 total)*	Detail	Amount (as reported)
DOE or Internal Lab grants	9	5	EERE	2 separate grants of \$285,000^ and \$800,000
			CRADA	2 separate grants of \$500,000^ and \$1,500,000+
			GTO	Unspecified
			BETO	Unspecified
			SBIR IIB	Unspecified
			LDRD	Unspecified
Other government funding	2	3	DoD	Grant of \$1,100,000
			State government	2 Separate grants of \$161,000+ and \$150,000+
Private funding	1	1	LaunchTN and other private funding	Grant of \$500,000^ and \$4,000^

* A "team" is counted when at least one member of that team selected a given response or provided funding information directly to the DOE

+ Only reported to DOE, not in survey

^ Verified by DOE reporting

Three out of 10 Cohort 1 trainees reported that their research led to unanticipated uses for their technologies. Of these three, two provided detailed responses, including one who stated that other groups are adapting the technology to their fields, and another who noted that they received interest from a company in India that wants to apply the technology (building energy models) and publish their results.

Two respondents indicated that their technology includes an open-source software application that is available for free download (Table 3-7).

Table 3-7: Actual Sales of Products, Processes, or Services (n=14; Multiple Responses Permitted)

Response	Trainee Respondents	Percent	Teams*
No sales to date, nor are any sales expected	3	21%	3
No sales to date, but sales are expected	4	29%	4
Sales of product(s)*	0	7%	0
Sales of process(es)	0	0%	0
Sales of service(s)**	0	0%	0
Other sales (e.g. licenses)	2	14%	2

+ A "team" is counted where at least one member of that team selected a given response.

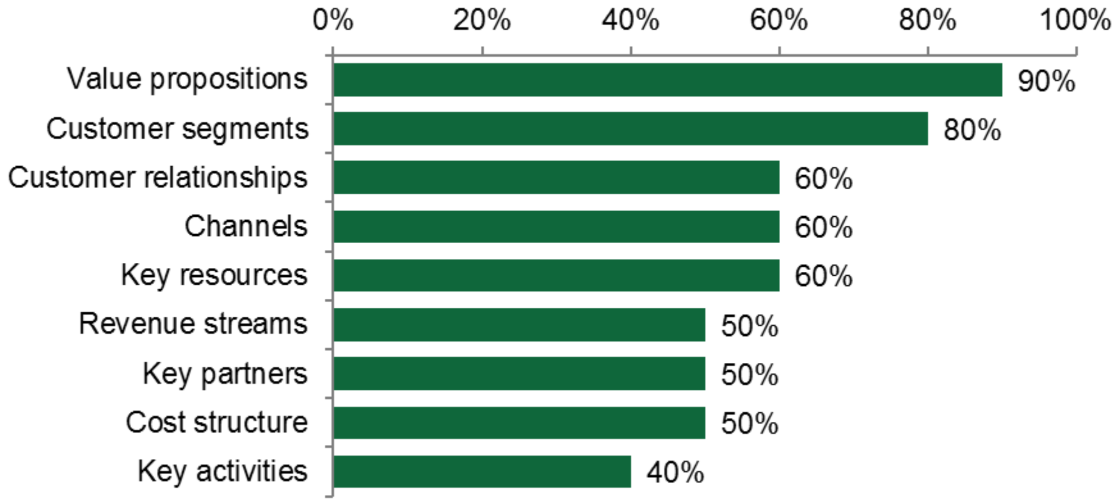
* The evaluation team followed-up with the team reporting sales and confirmed that there were no sales but instead open-source downloads of software.

** The evaluation team was unable to confirm the sales of services for two trainees.

3.2.3 Commercialization of other Technologies

Exactly one-half (50%) of Cohort 1 trainees surveyed said that they have worked on commercializing additional technologies besides their pilot technology since the Energy I-Corp pilot training. Ten of those 11 trainees responded to follow up questions regarding the extent to which they have investigated and/or conducted strategic planning on the BMC components for these other technologies. Trainees who have done so were most likely to report that they have investigated value propositions (90%) or have investigated customer segments (80%). Figure 3-5 shows the full range of responses. In addition, eight out of ten said they were *highly likely* (5 out of 5 on a 5-point scale) to conduct commercialization activities in future years on innovations similar to the activities they conducted during Energy I-Corps training, and the remaining two said they were "somewhat likely" (4 out of 5 on a 5-point scale).

Figure 3-5: Extent to which Participants Conducted Investigation or Strategic Planning on BMC Components for Technologies Other than Pilot Technology (n=10)*

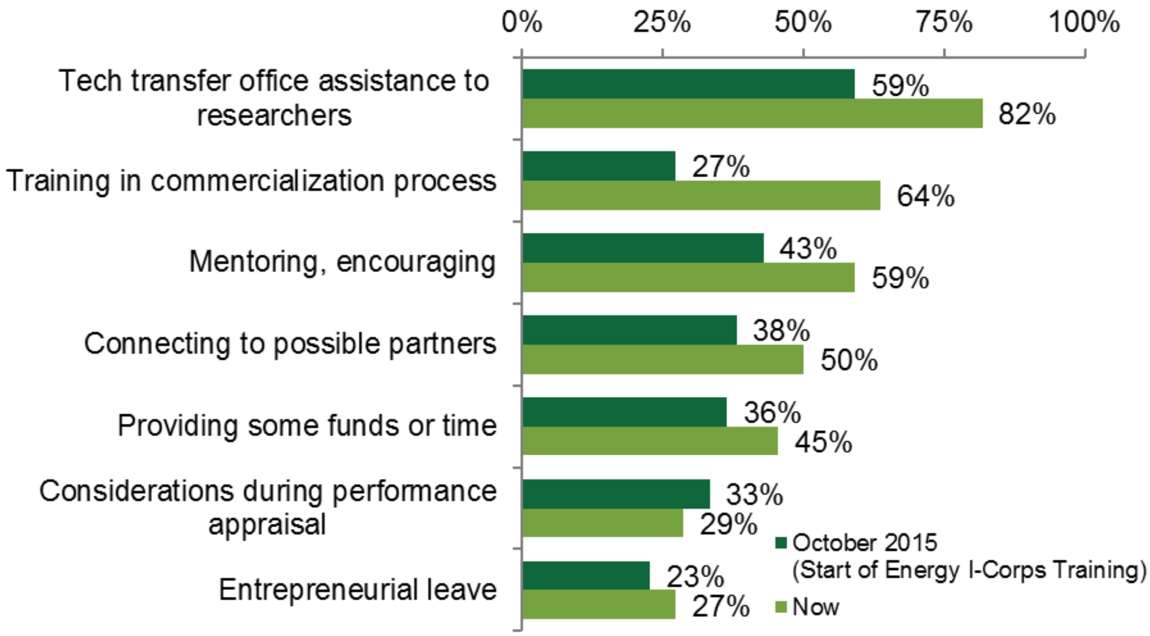


* Percentage of respondents who said "somewhat" or "a lot."

3.3 LAB ENCOURAGEMENT AND SUPPORT OF ENTREPRENEURIAL DRIVE AMONG RESEARCHERS

The Cohort 1 Year 2 survey asked trainees to evaluate how supportive of activities related to the commercialization process their Labs were 18 months after the training, and to think back and evaluate Lab support before the start of the training (before October 2015). As Figure 3-6 shows, the areas that Cohort 1 trainees felt they received the greatest support include assistance from their technology transfer offices (82% versus 59% prior to the Energy I-Corps training), training in the commercialization process (64% versus 27% prior to training), and mentoring and encouragement (59% versus 43% prior to the training). In some cases, the proportion of trainee respondents who said that their Lab is supportive increased greatly compared to their perception of Lab support from before October 2015, as evidenced by the length of the second bar for each item exceeding the length of the first.

Figure 3-6: Resources Labs Provide to Support the Commercialization Process (n=22)



In the Year 1 evaluation, Cohort 1 trainees mentioned that many of these resources were not readily available or offered by their labs. The commonly cited recommendations from respondents to both the baseline and follow-up surveys related to 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. It appears that the labs have improved in many of these areas, which may, in part, be due to the Energy I-Corps program. It may also be that participation in Energy I-Corps raises trainee awareness of available resources or willingness to make use of available resources.

3.4 OTHER FINDINGS

3.4.1 Commercialization without the Energy I-Corps Training

Cohort 1 trainees were asked a series of questions to assess the impact of the Energy I-Corps training on the commercialization process of their technology. First, they were asked to assess whether they would have undertaken commercialization in the absence of the Energy I-Corps training. Six of the 22 Cohort 1 respondents said they would “definitely not” have undertaken the commercialization process for their technology in the absence of the Energy I-Corps pilot, and seven more said they would “probably not” have done so, for a total of 59% of respondents who would “probably” or “definitely” not undertaken the process. In comparison, only two of the total 22 (9%) said they “probably” or “definitely” would have undertaken the commercialization process. Of those that would have done so, one said that that their commercialization efforts would have been narrower in scope, and that commercialization might have been delayed by six months, and the other said that the outcomes would have been the same without the program. The remaining seven participant respondents (32%) were uncertain whether they would have undertaking the commercialization process in the absence of the pilot.

Table 3-8: In the Absence of the Energy I-Corps pilot, Would you Have Undertaken the Commercialization Process for this Technology? (n=22)

Response	Trainee Respondents	Percent
Definitely yes	1	5%
Probably yes	1	5%
Uncertain	7	32%
Probably not	7	32%
Definitely not	6	27%

Section 4 Cohort 2 Outcomes and Impacts

Section 4 provides Cohort 2 Year 1 findings, and compares Cohort 2 Year 1 with Cohort 1 Year 1 findings where possible. This section reviews survey findings from 22 Cohort 2 Energy I-Corps trainees. The findings include an assessment of Cohort 2 Year 1 trainees' knowledge and understanding of key commercialization concepts and how they are reportedly applying these concepts. These results focus primarily on Cohort 2 Year 1, with comparisons to baseline survey results as appropriate. This section also provides a comparison to Cohort 1 Year 1 trainees' commercialization outcomes, including their progress toward commercialization, and lab encouragement and support of entrepreneurial drive among researchers. To provide a consistent assessment, comparisons to Cohort 1 results generally draw on survey responses following the Energy I-Corps training in Year 1, obtained from the first evaluation study in 2016 (Evaluation of the Energy I-Corps Pilot, Final Report, November 28, 2016[29]). Section 5 compares the Cohort 1 Year 2 follow-up respondents and Cohort 2 Year 1 follow-up respondents to a comparison group of year 2 non-participants.

4.1 KNOWLEDGE GAIN

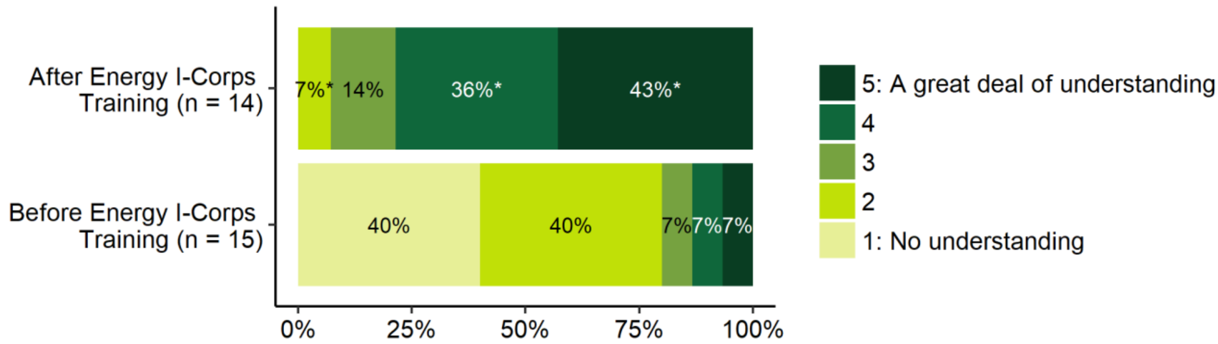
Cohort 2 trainees' understanding of the technology commercialization process increased after the training. Prior to the Energy I-Corps training, 14% rated their understanding as a "4" or "5" on a 5-point scale, compared with 79% who rated their understanding as a "4" or a "5" ten months post-training (a statistically significant difference).[30, 31] Although this increase is statistically significant, it is not quite as large as the gain reported by Cohort 1 trainees in Year 1. Cohort 1 trainees' understanding of the technology commercialization process rose from 13% in the baseline survey to 87% in the follow-up survey.

[29] *https://energy.gov/sites/prod/files/2016/12/f34/Evaluation%20of%20Lab-Corps%20Pilot%20-%20Final%20Report%2011-25-2016.pdf*

[30] Percentage of respondents (n=15 baseline and 14 Year-1 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*. Statistically significantly different at the 95% confidence level.

[31] Two Cohort 2 trainees (out of 15) said they were involved in an initiative or program other than Energy I-Corps to develop their entrepreneurial skills prior to March 2016.

Figure 4-1: Understanding of Technology Commercialization Process (n=15)



*Statistically significant difference at the 90% confidence interval

On the follow-up survey, Cohort 2 trainees described the greatest insights they achieved through the training (Table 4-1). Their understanding of how to pivot to adapt to market needs was most commonly cited; five of the 14 Cohort 2 trainees (36%) reported this insight. This is consistent with the percentage reported by Cohort 1 trainees (8 out of 23 or 35%) following their training. However, compared to Cohort 2, the Cohort 1 trainees were more likely to report, without prompting, a better understanding of the market and market opportunities (61% vs 21%), as well as an improved understanding of the customer discovery process (52% vs 21%).

Table 4-1: Greatest Insights from Energy I-Corps Training (Cohort 1 n=23, Cohort 2 n=14) (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Cohort 1 (n=23)		Cohort 2 (n=14)	
	Trainee Respondents	Percent	Trainee Respondents	Percent
Understanding of how to pivot to adapt to market needs	8	35%	5	36%
Understanding of how to solicit early stage investment and partnerships	-	-	3	21%
Understanding of the value of the customer discovery process	12	52%	3	21%
Better understanding of the value of the technology and associated services	7	30%	3	21%

Response	Cohort 1 (n=23)		Cohort 2 (n=14)	
	Trainee Respondents	Percent	Trainee Respondents	Percent
Better understanding of the market and market opportunities	14	61%	3	21%
Better understanding of effort required to successfully take a technology to market	2	9%	2	14%
Understanding of the benefits and versatility of the business model canvas	1	4%	1	7%
Better understanding of approaches to commercialization	2	9%	-	-
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**	**--**	**14**	**--**

Before completing the Energy I-Corps training, Cohort 2 trainees most often identified increased market awareness as a desired outcome from the training (75%, Table 4-2). This finding is strongly aligned with the most common insight Cohort 2 trainees had as a result of the training, which was an improved understanding of how to pivot to adapt to market needs, and how to better understand various elements of the market, such as customer discovery, the value of the technology and services, and the overall market and market opportunities (Table 4-1).

Table 4-2: Cohort 2 Ideal Outcome Trainees Identified Before Participation in the Program (n=28) (Multiple Responses Permitted)

Response	Trainee Respondents	Percent
Increase in market awareness	21	75%
Additional funding or investment to develop this technology	20	71%
A start-up company	12	44%
A commercial license for my technology	12	43%
A new partnership agreement (CRADA or other)	10	36%
Total	**22**	--

Cohort 2's Team PI's understanding of all nine components of the BMC increased from baseline to follow-up survey; four of these components showed statistically significant increases (key partners, channels, revenue streams, and cost structure; Table 4-3). Over half (54%) of the team PIs responding to the baseline survey said they had never heard of the BMC approach before this program, and an additional 38% said they had heard of the BMC but never really used it. Compared to Cohort 1 results in Year 1, the Cohort 2 trainees generally reported a higher level of understanding of the BMC components on their baseline surveys (possibly due to their labs' ongoing involvement in the program), and, therefore, they did not exhibit as strong increases as those reported by Cohort 1 (see Figure 4-2).

Table 4-3: Cohort 2 Trainee Understanding of Business Model Canvas Components, Baseline and Follow-up (n=13)*

Item	Percent "3" or "4"		Statistical Significance**
	Baseline (n=13)	Follow-up (n=12)	
Customer segments, customer archetypes	69%	92%	n.s.
Customer relationships	54%	83%	n.s.
Key partners, suppliers	46%	92%	$p < 0.05$
Value propositions	85%	92%	n.s.
Key activities, such as identifying distribution channels	62%	83%	n.s.

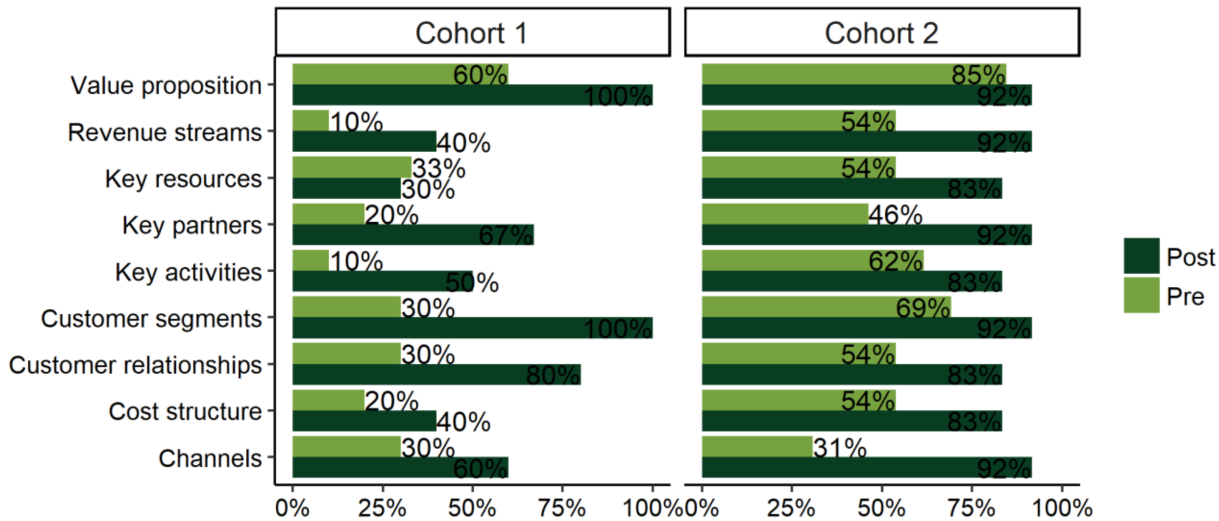
Item	Percent "3" or "4" Baseline (n=13)	Percent "3" or "4" Follow-up (n=12)	Statistical Significance**
Channels through which customers are reached	31%	92%	$p < 0.05$
Revenue streams	54%	92%	$p < 0.05$
Cost structure	54%	83%	$p < 0.05$
Key resources	54%	83%	n.s.

* Percentage of respondents providing a “3” or “4” rating on a 4-point scale, where 1 equals *none* and 4 equals *a great deal*. Table reports one respondent per team (the PIs) so that the teams are the unit of analysis, not the individuals.
**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 4-2 compares the change in understanding of the BMC components between Cohort 1 and Cohort 2 following their trainings. As evidenced by a comparison of Cohort 1 and 2 post-training understanding (the second bar for each item) and the relative lengths of the pre-/post-bars for the two cohorts, Cohort 2 attained greater understanding of the BMC components than Cohort 1 did. However, for nearly every component, Cohort 1 reported a higher change in understanding from the baseline to the follow-up survey due to higher baseline Cohort 2 familiarity. This is possibly the result of their labs’ ongoing involvement in the program.[32]

[32] Though it is important to note, as explained in the study limitations, that the difference might be due, in part, to survey question wording; the question for Cohort 1 used a 5-point scale while the survey for Cohort 2, implemented by the lead lab, used a 4-point scale.

Figure 4-2: Trainee Understanding of Business Model Canvas Components Comparing Cohort 1 and Cohort 2 Baseline and Follow-up (Cohort 1 n=10, Cohort 2 n=11)*

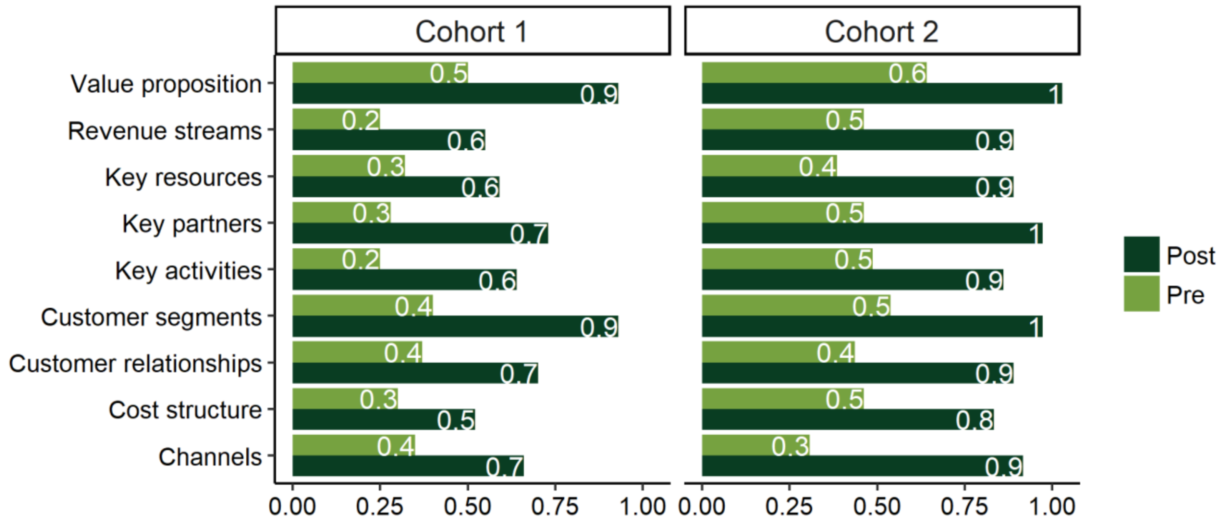


* Cohort 1 displays the percentage of respondents providing a "4" or "5" rating on a 5-point scale, where 1 equals *not at all knowledgeable* and 5 equals *very knowledgeable*. Cohort 2 displays the percentage of respondents providing a "3" or a "4" on a 4-point scale, where 1 equals *no understanding* and 4 equals *a great deal* of understanding.

Figure 4-3 illustrates the same trainee information in another way, showing the mean understanding ratings on each of the nine BMC components for baseline and Year 1 follow-up.[33] In this analysis, Cohort 1 does not appear to consistently report higher changes in understanding.

[33] Because the surveys used two different scales (5-point and 4-point), we converted the scores from an interval scale to percentages based on a range from 0% to 100%. The 4-point scale converted to values of 0%, 33%, 66% and 100% while the 5-point scale converted to values of 0%, 25%, 50%, 75% and 100%.

Figure 4-3: Mean Cohort 1 and Cohort 2 Trainee Baseline and Year 1 Follow-up Understanding of Business Model Canvas Components (Cohort 1 n=10; Cohort 2 n=11)*



* Scores were converted from an interval scale to percentages based on a range from 0% to 100%. The 4-point scale converted to values of 0%, 33%, 66% and 100% while the 5-point scale converted to values of 0%, 25%, 50%, 75% and 100%

In the Cohort 2 post-training survey, trainees were asked to rate their understanding of the market needs related to their technology. on a scale of 1 to 10 (1 being "not at all" and 10 being "extremely well") Respondent understanding was about 4.8 out of ten on average, with 55% rating their understanding 5 or greater.

Ten months after completing their training, twelve out of 19 Cohort 2 trainees (63%) reported improved understanding of the problem solved by their technology due to the Energy I-Corps training; twelve out of 16 Cohort 2 trainees (75%) had similar responses in the post-training survey. Sixty-three percent of the trainees who said their understanding of the problem changed in either survey said the training improved their understanding of the market or market potential for their technology.

Table 4-4: How Understanding of the Problem Solved by Technology Changed as a Result of the Energy I-Corps Training (n=19) (Coded from Open-ended Survey Responses; Multiple Responses)*

Response	Trainee Respondents	Percent
Improved understanding of markets or market potential	12	63%
Improved understanding of customers	7	37%
New or improved technological focus of commercialization	6	32%
Total Respondents	**19**	**--**

Response	Trainee Respondents	Percent

*Data from both Year-1 and post-training follow-up surveys

4.1.1 Shared Knowledge

Cohort 2 trainees reported that they informed others in their lab about the BMC approach after completing the Energy I-Corps training. Three of the eight respondents (38%) who answered this question reported sharing the ideas with interested colleagues, and two respondents (25%) had already conducted presentations for other groups in the lab (Table 4-5). The responses from Cohort 2 trainees regarding how they informed others about the BMC approach are generally similar with those from Cohort 1.

Table 4-5: Trainee Activities to Promote Business Model Canvas Approach (n=8) (Coded from Open-ended Survey Responses; Multiple Responses)

	Cohort 1		Cohort 2	
Response	Trainee Respondents	Percent	Trainee Respondents	Percent
Discussion with colleagues who are interested (fellow researchers, managers, etc.)	9	41%	3	38%
Kept supervisor and lab directors apprised of Energy I-Corps activities	1	5%	2	25%
Presentations for other lab groups	2	9%	2	25%
Advocated for similar training for all Principal Investigators	1	5%	1	13%
Planning a lab-wide presentation for the near future	5	23%	1	13%
Nothing yet; not yet but plan to inform others in my lab	6	27%	-	-
Total Respondents	**22**	**--%**	**8**	**--%**

4.2 COMMERCIALIZATION OUTCOMES

4.2.1 Progress Towards Commercialization

Most (87%) of Cohort 2 trainee Year 1 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."[34] This is similar to the results from Cohort 1, of which 83% of trainees *somewhat* or *completely* agreed with the statement.

Following the training, none of the Cohort 2 trainees said that they had reached a "no-go" decision for the commercialization of their pilot technology (only one team from Cohort 1 indicated the team had reached a "no-go" decision in Year 1). When asked to assess the likelihood that they would continue conducting commercialization activities on their pilot technology during the next three months, 80% percent of Cohort 2 trainees reported they were *highly likely* (a rating of "5") or *moderately likely* (a rating of "4") to continue (Table 4-6). In comparison, 89% of Cohort 1 Year 1 reported they were *highly likely* or *moderately likely* to continue, and none rated their likelihood less than 3. One Cohort 2 trainee provided a "3" rating and explained that potential businesses had expressed interest in licensing the technology, but expected additional DOE commercialization funding did not materialize, thus limiting options with potential partners.[35]

Table 4-6: Cohort 2 Likelihood that Commercialization Activities will Continue on Pilot Technology (n=15)

Response	Trainee Respondents	Percent
Highly likely	8	53%
Moderately likely	4	27%
Neither likely nor unlikely	1	7%
Moderately unlikely	1	7%
Not at all likely	1	7%
Total Respondents	**15**	**100%**

Trainees who, in the Year 1 follow-up survey, stated that they were likely to conduct commercialization activities in future years were asked about their efforts to further fund

[34] The average rating was 4.3, on a 5-point scale where 1 equals completely disagree and 5 equals completely agree.

[35] One respondent stated they were "neither likely nor unlikely" to continue commercialization activities, pointing to a lack of time; another said they were "not at all likely" due to the fact that they were not the party responsible for R&D.

their work on their Energy I-Corps technology. Seven of the 15 Cohort 2 trainees (47%), representing seven teams, reported they had received funding for further development or commercialization, and nine trainees (60%), representing six teams, reported they were in discussion with potential funders (Table 4-7). Three respondents, representing three teams, said they were interested in pursuing funding, but were not in active discussions with funders. Those who said that they had received additional funding most often reported that the source was DOE, including DOE Laboratory Directed Research and Development funds, DOE Office of Energy Efficiency and Renewable Energy funds, and funds from ARPA-E. One respondent received funding from the California Energy Commission EPIC program, and one received private investment. The respondents in discussion with funders reported a variety of sources, such as additional funding from DOE programs (two respondents), private industry funding (four respondents), venture capitalists (four respondents), energy companies (one respondent), and hospitals (one respondent). In addition, one Cohort 2 trainee said that a company or other entity made a commitment to fund late stage development or commercialize this technology prior to March 2016 (Energy I-Corps training), but that respondent did not specify when that commitment was made.

Cohort 1 Year 1 trainees, on the other hand, were much more likely to say they were interested in pursuing funding but not in discussion with funders (40%), and only three (12%) said they had received funding. This might suggest that the Energy I-Corp training received by Cohort 2 trainees better equipped them to pursue funding than the training received by Cohort 1 trainees; however, other external variables or team characteristics may account for this difference.

Table 4-7: Efforts to Fund Further Work on Pilot Technology (n=15) (Coded from Open-ended Survey Responses; Multiple Responses)

Response	Cohort 1			Cohort 2		
	Trainee Respondents	Percent	Teams*	Trainee Respondents	Percent	Teams*
In discussion with funders	6	24%	5	9	60%	6
Received funding	3	12%	3	7	47%	7
Interested in pursuing funding, but not in active discussion with funders	9	40%	7	3	20%	3
Looking for more funding from DOE (LDRD, CRADA, etc.)	4	12%	3	-	-	-
Do not plan to pursue additional funding in the next year	1	4%	1	-	-	-
Other	-	-		1	7%	1
Total	**22**	**--**		**15**	**--**	**--**

+ A "team" is counted when at least one member of that team selected a given response.

Using data collected from the evaluation survey and from data collected by DOE internally, Table 4-8 compares the amount of funding received by teams from both cohorts.

Table 4-8: Funding Received (Multiple Responses Permitted)

Source	Cohort	Number of Teams	Total*
DOE	1	4	$4,099,000
	2	4	$6,050,000
Other Government	1	1	$1,100,000
	2	0	--
State Government	1	2	$311,000
	2	1	$999,040
Private	1	2	$504,000
	2	3	$132,000
Total	1	7	$6,014,000
	2		$7,181,040

*The Cohort 2 survey did not ask respondents to specify the amount of funding received. Cohort 2 totals reflect information provided to DOE separately. All totals are as-reported.

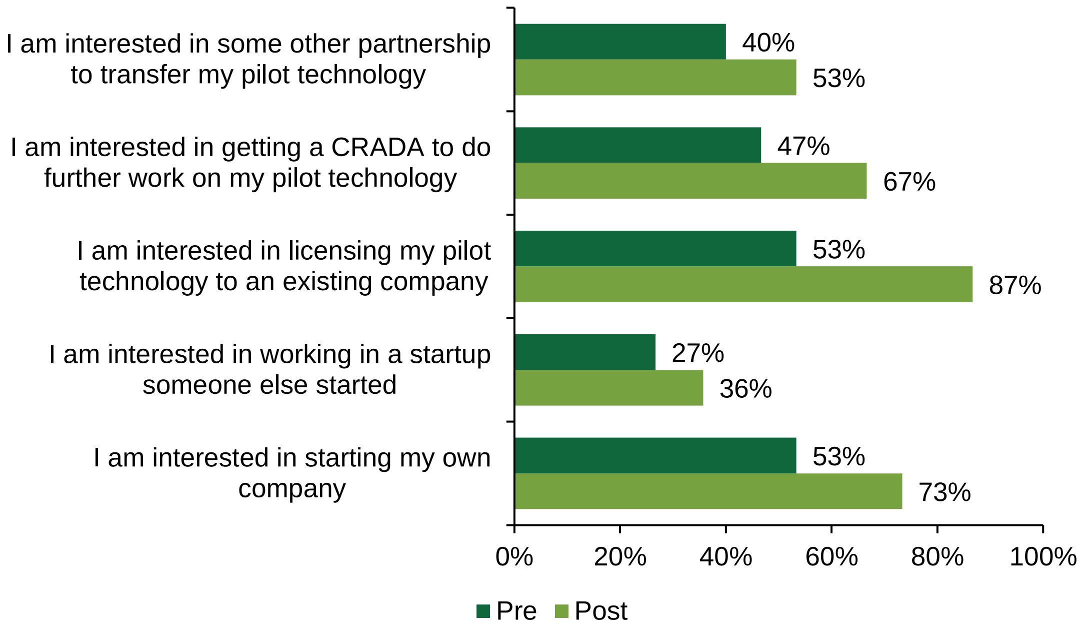
4.2.2 Commercialization of other Technologies

More than 93% of the Cohort 2 trainees are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of *subsequent* innovations, which is similar to the 87% reported by Cohort 1 trainees. In the Year 1 follow-up survey, 60% and 33% of Cohort 2 trainees rated themselves *highly likely* (a rating of “5”) and *likely* (a rating of “4”) to apply what they learned to subsequent innovations, respectively. Following their training, 75% and 13% of Cohort 1 trainees rated themselves *highly likely* and *likely* to apply what they learned to subsequent innovations, respectively.[36]

Cohort 2 trainee interest in technology commercialization activities, such as licensing pilot technology to an existing company, starting a company, or getting a CRADA to do further work on a technology, increased dramatically because of the training (Figure 4-4).

[36] The sum of the individually reported percentages (75% and 13%) differ from the total of 87% due to rounding.

Figure 4-4: Percent of Cohort 2 Trainees that "Completely" or "Somewhat" Agreed with the Commercialization Concepts as They Apply to Their Pilot Technologies, Before and After the Training (n=15)



4.3 LAB ENCOURAGEMENT AND SUPPORT OF ENTREPRENEURIAL DRIVE AMONG RESEARCHERS

Cohort 2 trainees rated their lab's level of support of commercialization slightly lower than Cohort 1 trainees following their training. Sixty-nine percent of Cohort 1 trainees 60% of Cohort 2 trainees rated their labs as *supportive* or *very supportive* (four or five on a scale of one to five, where one equals "not at all supportive" and five equals "very supportive"), which, given small sample sizes in both cases, suggests that the results might be considered quite similar. The average score for Cohort 2 respondents was 3.9 out of 5.

Table 4-9: Cohort 2 - Lab Supportiveness of Commercialization Activities (n=15)

Response	Trainee Respondents	Percent
5 – very supportive	6	40%
4	3	20%
3	5	33%
2	1	7%
1 – not at all supportive	0	0%
Total Respondents	**15**	**100%**
Mean	**3.9**	

Cohort 2 trainee Year 1 follow-up survey respondents provided suggestions to improve the Energy I-Corps training. Their suggestions most commonly referred to the structure, length, or organization (58%) and course content (25%; Table 4-10). Suggestions regarding the curriculum indicated that more advanced warning of program workload would be helpful. They also suggested a reduction in the daily training schedule to help prevent trainees from becoming burnt out too quickly. Respondents really valued the one-on-one feedback and recommended offering more of it, especially during the early stages of the training. Several respondents mentioned that more unique training parameters and mentorship for teams suited for technology transfer, as opposed to the formation of a small business, was warranted.

Following their training, a common recommendation from Cohort 1 was that the course should be lengthened to 12 weeks; interestingly, no one from Cohort 2 recommended lengthening the timing of thecourse. However, at least one individual from both cohorts recommended shortening the days of the session. More formalized one-on-one feedback was a suggestion made by several respondents in both Cohort 1 and Cohort 2; in general, trainees value the faculty mentors and would appreciate even greater one-on-one attention from these mentors throughout the course of the project. While trainees in Cohort 2 did suggest more guidance or support for customer interviews, no one mentioned the interviews being unduly burdensome, which was a common complaint among Cohort 1 trainees. Both Cohort 1 and Cohort 2 trainees recommended more support for technology transfer be built into the program, as opposed to a singular focus on starting small businesses.

Table 4-10: Cohort 2 Trainees' Suggested Improvements to Energy I-Corps Training (n=12) (Coded from Open-ended Survey Responses; Multiple Responses)

	Cohort 2	
Response	Trainee Respondents	Suggestion
Structure, length, organization	7	• Length of course ▪ Break up team presentations into several sessions ▪ Reduce evening activities ▪ More time during kickoff to shape initial business model and prepare for customer discovery ▪ Shorten course to 8 weeks or less to prevent burnout • Advance preparation ▪ Provide more notice of the program workload before the training begins so participants can plan accordingly • Other restructuring ▪ More structured time for one-on-one feedback, especially during early stages of the program (3) ▪ Scoring structure for presentations should be distinct for technology transfer technologies as opposed to technologies appropriate for a scalable business ▪ Both faculty and other program participants should have an opportunity to provide feedback on presentations
Content	3	• Tighter content, deeper dive ▪ Delve deeper into the business model canvas ▪ Less focus on startups ▪ Include technology transfer staff from the laboratories in the training to help explain lab resources during and after the program • Increase examples and discussion ▪ Provide ▪ Other content suggestions ▪ Include more discussion or an exercise dealing with cash flow and making operational trade-offs
Interviewing	2	• Provide more guidance on interview questions and techniques

Response	Cohort 2	
	Trainee Respondents	Suggestion
		• Have teams record an interview for a faculty member to critique, or have a faculty member call in to an interview call to provide feedback on technique
Faculty/ team composition	3	• Faculty composition ▪ Balance faculty expertise to better represent technology transfer issues ▪ Make sure faculty members are careful to explain business jargon • Team composition ▪ Group teams with similar technology areas so teams can learn from each other
Tools	2	• Tools ▪ Provide a way to see and manage all hypotheses in one place on LaunchPad Central ▪ Maintaining contemporaneous versions of business model canvas in LaunchPad Central and the presentation was difficult
Follow-up	2	• Provide mechanisms to keep teams connected after the training, such as social media • Conduct a case study of one team to document any obstacles they encounter after the training and investigate what steps can be taken to help alleviate these obstacles in the future.

The Year 1 follow-up surveys for both Cohorts 1 and 2 solicited suggested changes respondents' labs could undertake that might increase commercialization activity among lab researchers (Table 4-11). Trainees in Cohort 1 and Cohort 2 suggested an increase in financial resources available to directly support commercialization activities. Both cohorts made suggestions on the topic of easing the transition of the commercial enterprise from the laboratory to the public sector, such as providing clear mechanisms for turning good ideas into Laboratory Directed R&D (LDRD) projects, licenses, and new companies. Cohort 1 trainees also made suggestions related to improving education and leave of absence opportunities, while Cohort 2 trainees would like better accommodation of external fundraising activities related to commercialization.

Table 4-11: Trainee Suggestions for Lab Changes to Support Commercialization (Coded from Open-ended Survey Responses; Multiple Responses)

Suggestions	Cohort 1 Year-1 Follow-Up (n=20)	Cohort 2 Year-1 Follow-up (n=14)
Increase financial resources available to directly support commercialization activities	4	3
Better accommodate external fundraising activities related to commercialization	-	2
Provide clear mechanisms for turning good ideas into Laboratory Directed R&D (LDRD) projects, licenses, and new companies/Ease transition of the commercial enterprise from the laboratory to the public sector	3	2
Add commercialization milestones as DOE evaluation metrics to further incentivize and motivate continued commercialization activities	-	1
Offer more education and training opportunities	3	-
Offer or improve leave of absence policy to work on commercialization activities.	3	-

Cohort 2 trainees indicated their labs offered several additional resources, including educational and mentorship opportunities, financial incentives, and partnership opportunities (Table 4-12). Cohort 1 trainees identified similar resources and support.

Table 4-12: Support for commercialization provided by National Laboratory besides what is provided through Energy I-Corps

	Cohort 1		Cohort 2		
Statement	**Count "Yes"**	**Percent "Yes"**	**Count "Yes"**	**Percent "Yes"**	**Elucidation**
Education, mentorship, or opportunities to interact with peers (n=27,14)	19	70%	12	87%	• Mentorship opportunities (3) • Support and education from technology transfer staff (4) • Entrepreneurship classes (2)
Financial incentives (for example, returning a portion of royalties to researchers or offering entrepreneurial leave) (n=27,12)	17	63%	10	83%	• Return of royalties (7) • Opportunities to take entrepreneurial leave (3) • Bonus for patent applications (2)
Financial resources (n=27,13)	11	41%	7	54%	• Opportunities to apply for internal funding (5)
Time resources (n=27,14)	11	41%	5	38%	• Support from technology transfer staff (2)
Partnership with individuals or organizations outside the laboratory (n=26,14)	14	54%	11	79%	• CRADAs are encouraged (4) • Support for collaboration with industry and academia (1) • Help finding potential partners, mentors, and investors (2)

Section 5 Comparing Cohort 1 Year 2 and Cohort 2 Trainees to Year 2 Non-participants

Where possible, this section compares the Cohort 1 Year 2 follow-up respondents and Cohort 2 Year 1 follow-up respondents to a comparison group of Year 2 non-participants. The comparison group consists of similar individuals engaged in commercialization who did not participate in Energy I-Corps training program (see Section 2 for description of the non-participant sample). This section also compares these Year 2 non-participant survey respondents to trainee respondents in the areas of commercialization knowledge gain, commercialization outcomes, and lab encouragement and support of entrepreneurial drive among researchers. The purpose of this comparison is to observe whether the Energy I-Corps program produces commercialization outcomes beyond those achieved by other similar researchers pursing technology commercialization in the Labs without the benefit of the training.

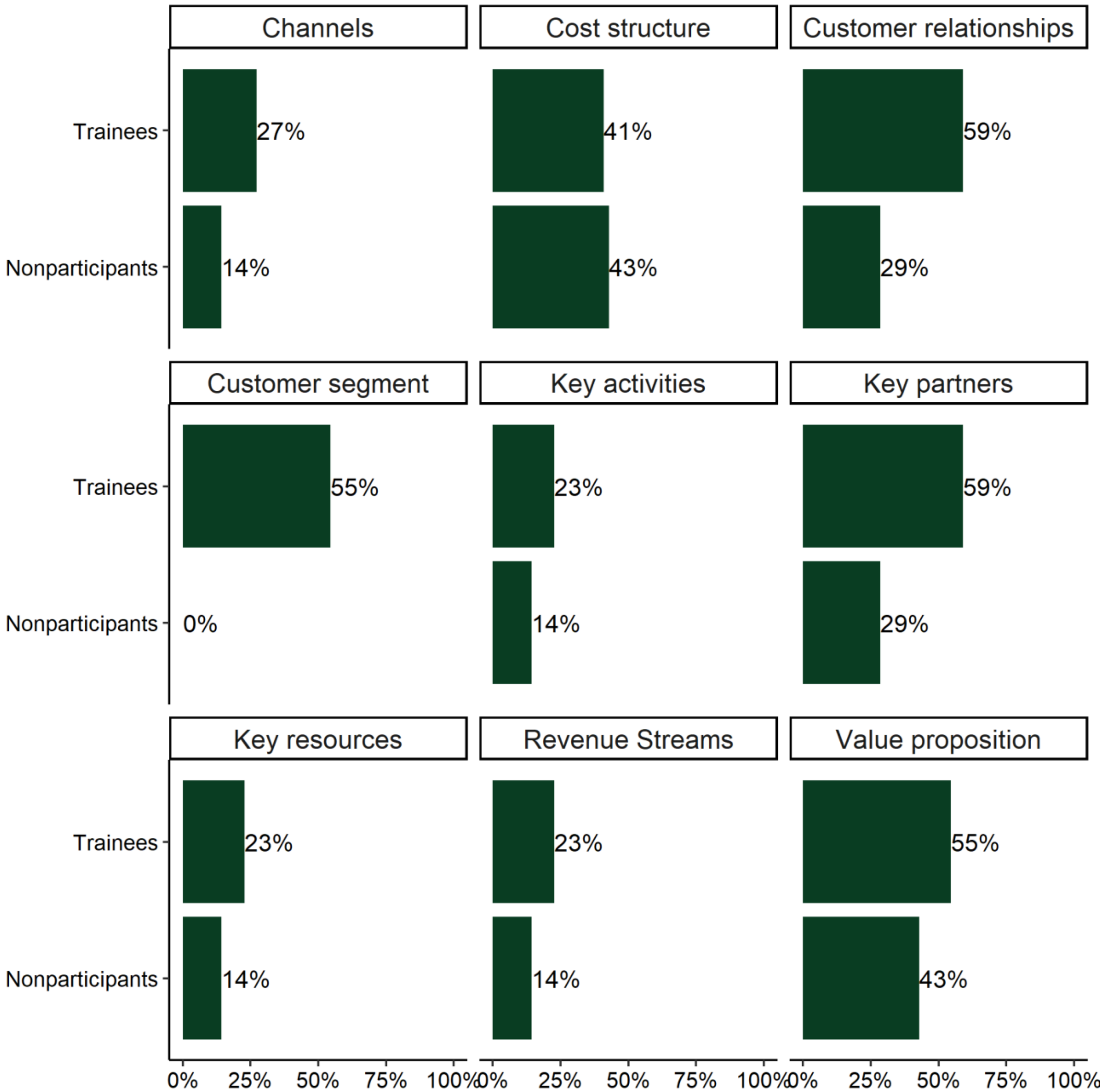
5.1 KNOWLEDGE GAIN

5.1.1 Business Model Canvas

Comparing Cohort 1 Year 2 trainees to non-participants on their level of investigation of elements of the BMC found many substantial differences. Cohort 1 Year 2 trainees were more likely to report that they had conducted *some* or *a lot* of investigation into many of the elements of the BMC (Figure 5-1). The greatest difference observed between Cohort 1 Year 2 trainees and non-participant responses was in their investigation into customer segments (identification of customer archetypes and for whom the technology creates value); none of the non-participants said that they did *some* or *a lot* of investigation into customer segments, while 55% of trainees said they did. On the other hand, trainees and non-participants had relative parity in the proportion of respondents who said they did *some* or *a lot* of investigation into cost structure (identification of most important costs and which key resources and activities are most expensive). However, due to the small number of non-participant respondents, none of these differences are statistically significant (Figure 5-1). Cohort 2 trainees were asked a similar but slightly different question on the Energy I-Corps post-training survey and therefore are not compared to the Year 2 non-participants.[37]

[37] Cohort 2 trainees were asked to rate their understanding of the BMC components rather than the extent to which they have conducted investigation into components of the BMC.

Figure 5-1: Investigation Conducted Into Business Model Canvas Components (Cohort 1 Year Two Follow-up Trainee Survey n=22, Year 2 Non-participant survey n=7)*



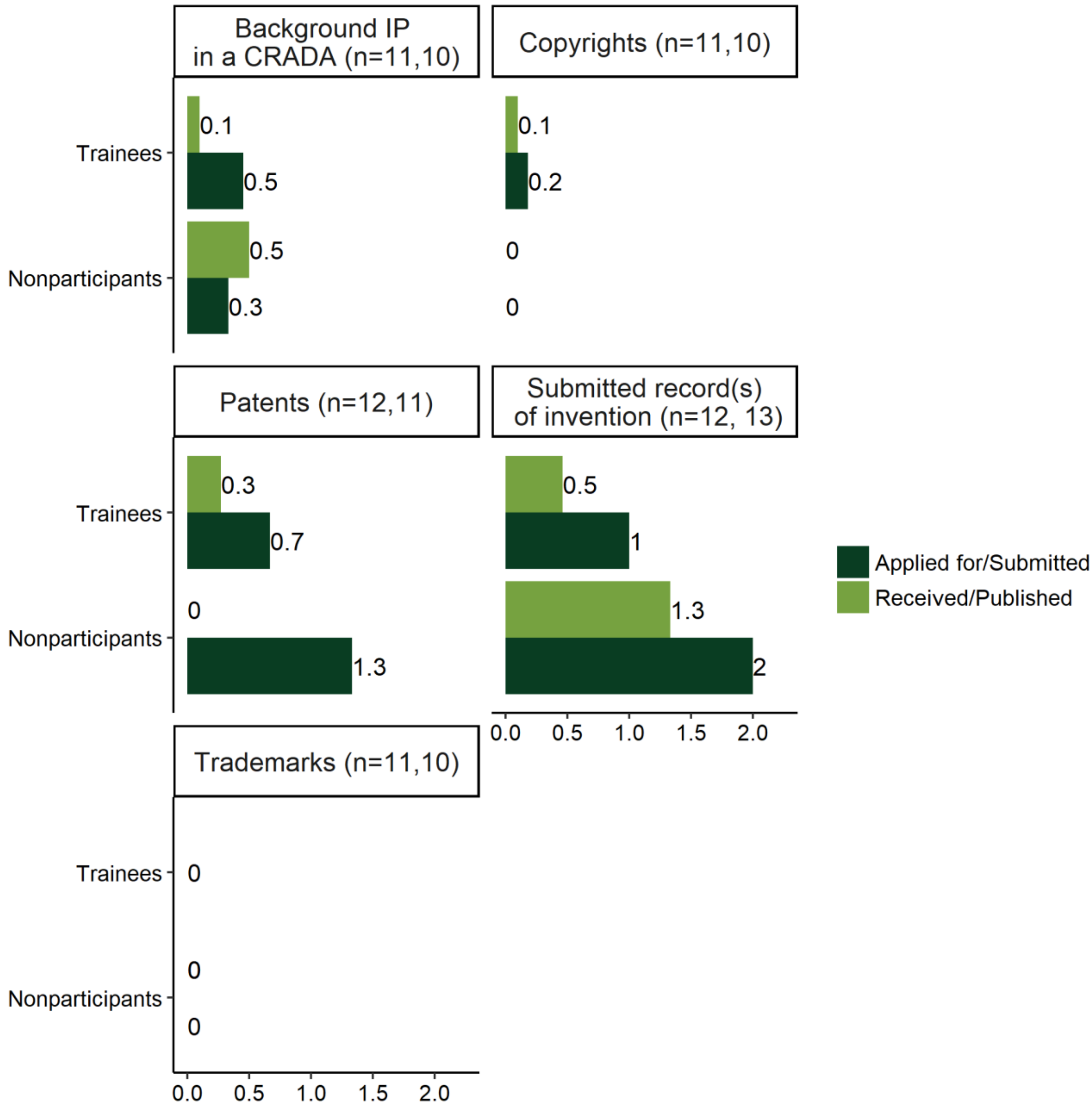
*Percentage of respondents providing a “3” or “4” rating on a 4-point scale, where 1 means respondents have not conducted any investigation at all into the concept and 4 means the respondent has conducted a lot of investigation into the concept.

5.2 COMMERCIALIZATION OUTCOMES

5.2.1 Progress Towards Commercialization

On average, when it comes to publishing work or applying for patents, copyrights, and other commercialization benchmarks there does not appear to be a great difference in the behavior of Cohort 1 trainees compared to non-participants; if anything, it appears non-participants are doing equally well if not better than Cohort 1 Year 2 Energy I-Corp trainees. However, these numbers may be misleading due to the very small sample size of non-participants.

Figure 5-2: Mean Number of Commercialization Benchmarks Applied for/Submitted or Received/Published by Participants and Non-participants, mean (Cohort 1 n=12, Non-participant n=5) *



The majority of both Cohort 1 Year 2 trainees and non-participants reached a "go" decision for their pilot technology; however, a larger proportion of Cohort 1 Year 2 trainees reached this decision. In addition, none of the Cohort 2 Year 1 trainees said they reached a "no-go" decision (Table 5-1). Among Cohort 1 Year 2 trainees who reached a "no-go" decision on their technology, the reasons they gave were well-considered, including two respondents who were unsatisfied with some aspect of their technology's investment market, such as their value proposition estimation or the return on investment they derived for their technology. Two other trainee respondents who reached a "no-go" decision on their pilot technologies had concerns with management, one saying that they were particularly concerned with how the Lab was handling their IP. One participant who reached a "no-go" decision for their pilot technology added that they would apply what they learned in Energy I-Corps in subsequent commercialization activities:

> *Our processes, as designed, will not have an attractive enough ROI for initial investment. We are now developing new technology to expand the bio-product portfolio and hope to re-boot the process that we learned in Lab Corps.*

The one non-participant who reached a "no-go" decision about their technology said that their technology was not yet mature enough to pursue commercialization.

Table 5-1: Reached a No-Go Decision for Pilot Technology

Response	Cohort 1 Year 2 Trainees (n=22)		Cohort 2 Year 1 Trainees (n=13)		Non-participants (n=8)	
	Trainee Respondents	Percent	Trainee Respondents	Percent	Count	Percent
Yes	4	18%	0	0%	1	13%
No	16	73%	13	100%	5	63%
Don't know	2	9%	0	0%	2	25%

When asked about their efforts to fund further work on their technology eighteen months after the completion of the Energy I-Corps training, seven out of 14 (50%) Cohort 1 Year 2 trainees noted that they were conducting discussions with funders, and six out of 14 (43%) said they received funding. These ratios are similar to Cohort 2 Year 1 trainees, 60% of whom reported being in discussion with funders and 47% receiving funding.

A larger proportion of the Year 2 non-participants said that they had received funding than both the Cohort 1 Year 2 trainees and the Cohort 2 Year 1 trainees; however, the number of Year 2 non-participants who answered the question in the follow-up survey was very small, and the difference is not statistically significant. In addition, larger percentages of trainees from Cohorts 1 and 2 are in discussions with funders than non-participants (Table 5-2).

Table 5-2: Efforts to Further Fund their Technology

	Cohort 1 Follow-Up Year 2 Survey (n=14)		Cohort 2 Follow-up Year 1 Survey (n=15)		Year 2 Non-participants (n=5)	
Response	Trainee Respondents	Percent	Trainee Respondents	Percent	Count	Percent
Received funding	6	43%	7	47%	3	60%
In discussion with funders	7	50%	9	60%	1	20%
Interested in pursuing funding, but not in active discussion with funders	1	7%	3	20%	2	40%
Do not plan to pursue additional funding in the next year	1	7%	0	0%	0	0%
Don't know	1	7%	-	-	1	20%

The source of much of the funding that both trainees and non-participants reported receiving came from internal DOE Lab grants, but some respondents were able to secure other, non-DOE government funding or private investment (Table 5-3).

Table 5-3: Funding Received (multiple responses permitted)

Response	Cohort 1 Year 2 Trainees (n=6)		Cohort 2 Year 1 Trainees (n=7)		Non-participants (n=3)	
	Trainee Resp.	Detail	Trainee Resp.	Detail	Count	Detail
Internal Lab grants	9	DOE EERE grants worth $250,000, $285,000, $800,000 (3); DOE GTO grant (1); DOE BETO grant (1); DOE SBIR IIB grant (1); LDRD funding (1) CRADA worth $25,000 and $250,000 (2)	5	DOE EERE (2); LDRD funding (1); Unspecified DOE funding (2).	4	Unspecified internal Lab funding, worth $50,000 and $500,000 (2); DOE STTRE grant worth $50,000 (1); DOE BETO grant (1) CRADA worth $1,000,000 and $10,000 (2)
Other government funding	2	State government grant worth $4,000 (1); DoD grant worth $1,000,000 (1).	1	State Energy Commission funding (1).	0	
Private industry funding	1	CRADA worth $25,000 and $250,000 (2); Grant worth $4,000	1	Unspecified private investment into start-up company (1).	0	

Only one non-participant specified that they had made any sales of their technology, while three Cohort 1 Year 2 trainees reported making sales (Table 5-4). Apart from commercial sales, two non-participants and two Cohort 1 Year 2 trainees said their technology includes an open-source software application that is available for free download.

Table 5-4: Actual Sales of Products, Processes, or Services (multiple responses permitted)

Response	Trainees (n=14)		Non-participants (n=7)	
	Trainee Respondents	Percent	Count	Percent
No sales to date nor are any sales expected	3	21%	4	6%
No sales to date, but sales are expected	4	29%	1	14%
Sales of product(s)*	0	0%	0	0%
Sales of process(es)	0	0%	1	14%
Sales of service(s)**	0	0%	0	0%
Other sales (e.g. rights to technology, licensing, etc.)	2	14%	0	0%

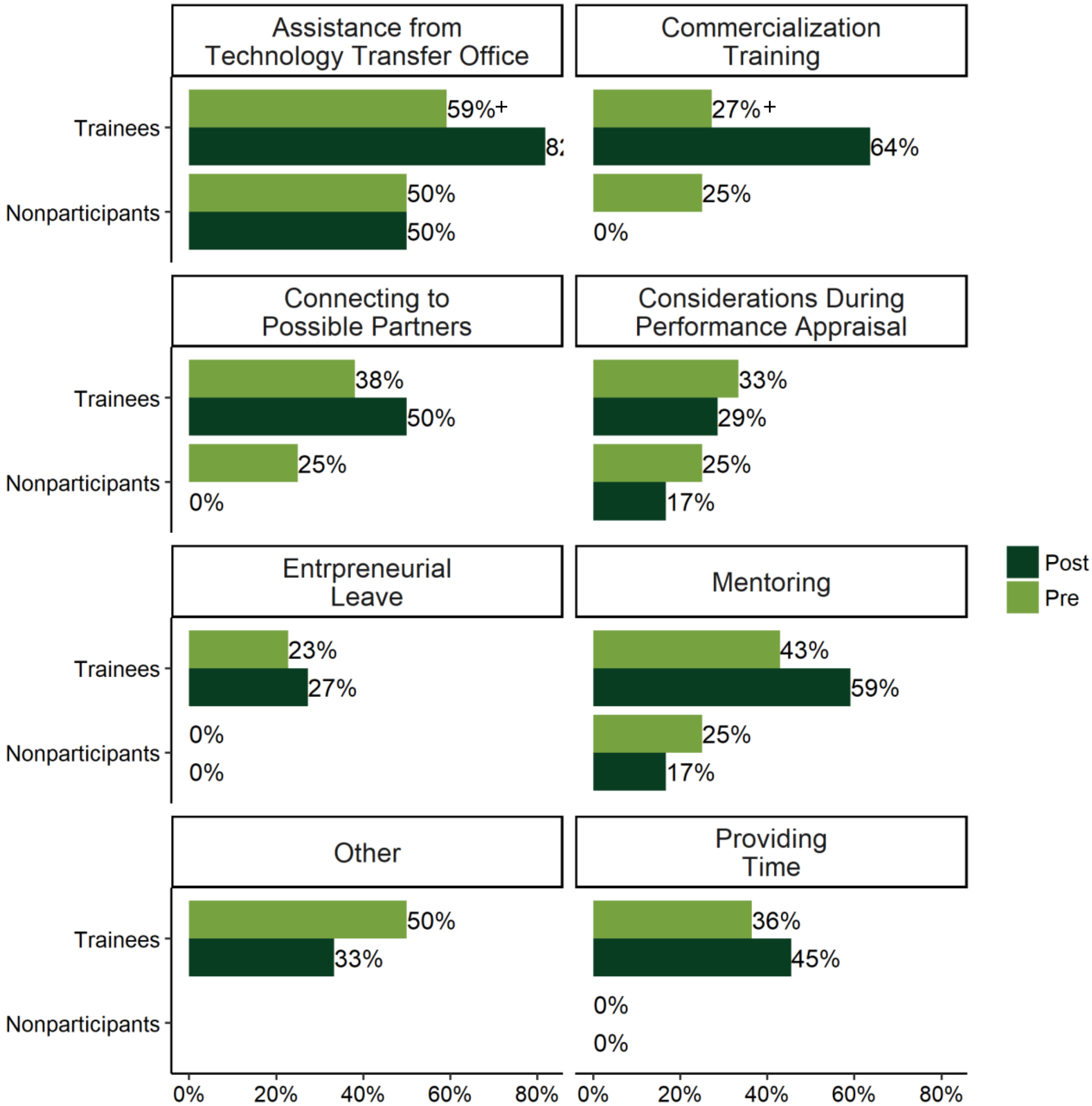
* The evaluation team followed-up with the team reporting sales and confirmed that there were no sales but instead open-source downloads of software.

** The evaluation team was unable to confirm the sales of services for two trainees.

5.3 LAB ENCOURAGEMENT AND SUPPORT OF ENTREPRENEURIAL DRIVE AMONG RESEARCHERS

The Cohort 1 Year 2 follow-up survey asked trainees and non-participants to evaluate how supportive of activities related to the commercialization process their Labs were 18 months after the training, and to think back and evaluate Lab support before the start of the training (before October 2015). A greater proportion of trainees said their Lab was *supportive* or *very supportive* (a 4 or 5 out of a 5-point scale) of the commercialization process than non-participants. This was especially true in terms of commercialization training, assistance from the lab's technology transfer office, and mentoring. In some cases, the proportion of trainee respondents who said that their Lab is supportive increased greatly compared to their perception of Lab support from before October 2015 (Figure 5-3).

Figure 5-3: Resources Labs Provide to Support the Commercialization Process (Cohort 1 Year 2 n=22; Non-participant n=6)*



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

+Statistically significantly different from post proportion at the 90% confidence interval.

Section 6 Conclusions and Recommendations

The evaluation team developed performance metrics by which to gauge Energy I-Corps' progress in achieving its desired outcomes. The evaluation of the pilot program (Year 1) focused on early outcomes, processes, and lessons learned. The findings from the Year 2 evaluation build on the results from the pilot evaluation and are organized according to the following objectives: knowledge gain, commercialization outcomes, and lab encouragement and support of entrepreneurial drive among researchers.

6.1 CONCLUSIONS

The metric findings suggest that trainees are making positive progress towards commercializing their technologies, including a small subset of trainees who have reported sales related to their technology. Trainees continue to build their knowledge, advance their technologies and reach a number of commercialization benchmarks.

Knowledge Gains. Evaluation findings suggest continued pilot success, increasing researcher understanding of the commercialization process and private sector needs for their technologies. Cohort 1 trainees continue to build on their knowledge gains, and Cohort 2 trainees reported increased knowledge and understanding due to the training. For example, Cohort 1 trainees continue to conduct investigations into components of the BMC and Cohort 2 understanding of the technology commercialization process increased significantly as a result of the Energy I-Corps training. Further, over a third of both cohorts reported that the greatest insights they achieved from the training was how to pivot to adapt to market needs while even larger percentages reported that their understanding of the problem solved by their technology improved because of the Energy I-Corps program. On average, when it comes to applying for patents, copyrights, and other commercialization benchmarks there does not appear to be a great difference in the behavior of Cohort 1 trainees compared to non-participants, but the small sample size of non-participants makes it difficult to draw definitive conclusions about non-participant knowledge gain.

Commercialization Outcomes. Findings suggest Energy I-Corps has very high potential to increase the commercialization of trained PIs' lab technologies. Cohort 1 trainees continued, at 18-months post-training, to make positive progress towards commercializing their technologies, including progressing in the stage of development of their technologies, reaching commercialization benchmarks and for a small subset, reporting sales related to their technology. For example, three Cohort 1 trainees representing three teams reported making sales related to their technology, and only one non-participant reported doing so. Further, half (50%) of the Cohort 1 trainees reported that they had at least reached the stage of having a prototype of their technology and had validated it in a simulated operation environment (equivalent to a Technology Readiness Level (TRL) of 6 or 7). Cohort 1 trainees have met several commercialization benchmarks, including scientific or technical publications related to their Energy I-Corps technology, submitting record(s) of invention, filing patents, and developing intellectual property (IP) in a CRADA. Trainees are also making positive progress in their efforts to further fund their technologies, with seven Cohort 1 trainees noting that they were conducting discussions with funders, six reported they received funding, and four trainees indicated that they have presented a business idea to funders/investors, Half of Cohort 1 trainees are working on commercializing *additional* technologies and the majority of Cohort 1 trainees do not think they would have pursued commercialization activities for their technologies without Energy I-Corps. In addition, seven Cohort 2 trainees reported that they had received funding for further development or commercialization, nine reported they were in discussion with potential funders, and the majority of Cohort 2 trainees are likely to apply what they learned through Energy I-Corps and engage in similar activities in support of *subsequent* innovations.

Lab Support of Entrepreneurial Drive among Researchers. Trainees from Cohorts 1 and 2 reported that their labs offer a number of resources designed to help support them with commercialization efforts. For example, trainees identified direct assistance from their technology transfer office, ongoing training on the commercialization process, and mentoring and encouragement. In addition, trainees were more likely than non-participants to report that their labs are supportive of specific commercialization activities. These findings suggests that Energy I-Corps may be attaining, to some extent, its goal of strengthened entrepreneurial spirit among lab researchers; however, the outcome appears to be largely evident among researchers participating in the training, and with more limited dispersion among researchers at large. Trainees suggested a number of recommendations regarding labs' commercialization supports, including an increase in financial resources available to directly support commercialization activities, improved guidance and mechanisms for turning viable ideas into Laboratory Directed R&D, and improved education and entrepreneurial leave opportunities.

6.2 RECOMMENDATIONS

Continue to investigate Energy I-Corps outcomes. Early outcomes appear promising, yet it is too soon to detect evidence of increased technology commercialization. DOE might conduct a longitudinal study of Energy I-Corps participants to monitor commercialization of participating technologies, influence of training concepts on participants' ongoing research activities, and interest in commercialization among lab researchers. Should DOE undertake such a study, it would be important to explore the role played in commercialization by the availability of funding for research that advances technology readiness levels.

Investigate the roles played by the various DOE commercialization initiatives in fostering commercialization of lab technologies; assess complementarities; assess relative effectiveness of comparable initiative strategies. DOE uses a variety of strategies to foster commercialization of lab technologies, some facets of which are complementary and others that are similar. Given the inevitability of limited funding for these initiatives, DOE might conduct a comparative investigation to identify a portfolio of initiatives that appears to offer the greatest effectiveness.

Conduct a fuller investigation of Energy I-Corps outcomes with respect to the third program objective. The methodology used for the current evaluation had limited ability to assess program outcomes with respect to strengthened entrepreneurial spirit driving lab researchers, the third objective. If DOE is interested in better understanding the extent to which the program has achieved this objective, a more comprehensive methodology that includes expanded investigation of non-participants and interviews with lab management is likely necessary.

Examine strengths and weaknesses of program variations across labs. Cohort selection processes, pre-training orientation, and other facets of the program vary across the labs. With sufficient number of cohorts, DOE might examine the relative strengths and weaknesses of program variations across the labs, and attempt to identify the strongest practices.

Compare the impacts of Energy I-Corps and NSF I-Corps. Because Energy I-Corps was based on the NSF's I-Corps program, comparing the outcomes may provide valuable lessons to both programs.

Appendix A Context for the Energy I-Corps Program and Recap of Cohort 1 Study Findings

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 Technology-to-Market effort, under which the Energy I-Corps program is being conducted. Through that effort, EERE aims to accelerate the transfer of federally funded research and innovation to the private sector and thereby generate a greater return on taxpayer investment.[38,39]

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; and
- Lab policies facilitating entrepreneurship
- The degree to which lab staff perceive a sense of urgency about commercial impact.[40]

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[38] 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*.

[39] 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*

[40] 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.

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 program.

A.1 RECAP OF COHORT 1 FIRST-YEAR IMPACT AND PROCESS FINDINGS

This section was previously published as part of the Executive Summary to the first-year program process and impact report (Evaluation of the Energy I-Corps Pilot, Final Report, November 28, 2016[41]).

To guide the first-year impact and process evaluation of Energy I-Corps, the evaluation team, in its peer-reviewed technical evaluation plan, developed performance metrics to gauge the pilot's progress in achieving its desired outcomes. The metric findings suggested the pilot had met with first-year success. This recap of first-year 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.

A.1.1 Learning Outcomes Findings

Evaluation findings on learning outcomes suggest early pilot success. As evidenced by the findings below, the pilot for the Cohort 1 participants was determined to be 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. In addition, 83% reported increases in their understanding of the various potential commercialization routes, which is substantially higher than the gains reported by comparison non-participants (33% and 33%, respectively). The proportion of trainees indicating that they understood the technology commercialization process increased to 87% following the training, from 13% prior to the training (a statistically significant increase and substantially different from changes reported by non-participants over the period). The Cohort 1 findings indicate that the Energy I-Corps training

[41] *Evaluation of the Energy I-Corps Pilot,* November 28, 2016. 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. *https://energy.gov/sites/prod/files/2016/12/f34/Evaluation%20of%20Lab-Corps%20Pilot%20-%20Final%20Report%2011-25-2016.pdf*

is highly effective in substantially increasing the 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 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. **Non-participants 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 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 non-participants.** The two groups' baseline understanding was similar, ruling out (although not definitively) a rival explanation that the trainees' own characteristics, rather than the training, 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 and 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 that 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.**

A.1.2 Commercialization Findings

Findings suggest Energy I-Corps has very high potential to increase the commercialization of a trained PI's lab technologies. However, we were limited in our ability to access the extent of trainee's commercialization activities because research was at an early stage (data collection ended one month after training). 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 that 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 that it was likely they would continue commercialization activities on their pilot technology during the three months following the pilot. About half (56%)

of non-participants 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 five of the 17 teams trained in 2015 (14 Cohort 1 Energy I-Corps teams, plus three NSF I-Corps teams) were well positioned to begin launching their technologies in the next year.**

3a. **There was 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. This was because trainees indicated that 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 non-participants**. PI trainees were statistically more likely than non-participants 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%).

A.1.3 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 non-participants.** Two-fifths (41%) of respondents reported that they shared the ideas from the Energy I-Corps experience with groups and individuals in their labs by the end of the pilot. Ninety percent of non-participants 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, 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 including a TTO staff person on subsequent technology teams by the end of Cohort training 1.

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:
   - 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)

   However, only 13% of trainee respondents believed lab staff commonly take advantage of the commercialization-support resources their labs offer.
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 non-participants 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.

A.1.4 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 non-participants, trainees were more likely to report statistically significant increases in their understanding of Energy I-Corps concepts. Trainees were also statistically more likely than non-participants 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. This 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 the 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. Their suggestions most commonly referred 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. These were developed 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.

A.1.5 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, which is 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. **Teams' performance, especially during the first half of the training, might be improved by more targeted lab-provided training preceding the onsite training. In addition, teams might benefit were the program to shift some material from the initial onsite training into the lab-provided training that proceeds the onsite 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 the following: 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 they appreciated 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 that they believed their labs were not interested in or supportive of commercialization, and so it was not worth it for 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 teams' 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, 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, and policies)**.

Appendix B Additional Survey Findings

B.1 COMPARING COHORT 1 AND COHORT 2 RESPONSE RATES

As part of its pilot management activities, the Node Lab administered web-based baseline and immediate post-training surveys to the members of participating Cohort 1 teams.[42] A total of 51 unique PIs and ELs employed by the Site Labs responded to the surveys (Table B-6-1). (Survey respondents also included other technology team respondents that we do not report on. The evaluation team excluded responses from Industry mentors [IMs] and team members not employed by the lab, as neither are the target group for the training.)[43]

Fifteen Cohort 2 Principal Investigators (PIs) and Entrepreneurial Leads (Els) responded to the each of the baseline, immediate post-training, and Year 1 follow-up surveys, twenty-three PIs and ELs responded to both the baseline and post-training surveys, and 19 PIs and ELs responded to both the baseline and Year 1 follow-up surveys conducted by NMR Group, Inc. (Table B-6-1).

[42] 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 non-respondents. The Node fielded one 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 non-respondents, and NMR Group, Inc. fielded a second follow-up survey from February 22, 2017 to March 31, 2017, with an initial distribution and weekly follow-up emails.

[43] 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).

Table B-6-1: Number of Trainee Respondents by Role and Survey Wave

	Cohort 1			Cohort 2			
Team	Baseline and Follow-up survey	Baseline Survey	Year 2 Follow-up Survey	Baseline and Follow-up surveys	NREL Baseline Survey	NREL Immediate Post-training Survey	Year 1 Follow-up Survey
Principal Investigator (PI) or Co-PI	12	16	12	8	13	12	9
Entrepreneurial Lead (EL)	10	11	11	6	16	14	8
Industry Mentor	1	1	1	1	6	4	5
Total	**23**	**28**	**24**	**15**	**35**	**30**	**22**

Team members from every Site Lab (except for SNL-California, a partner to LLNL) responded to the baseline or follow-up surveys in Cohort 1, and from every Site Lab in Cohort 2 (Table B-6-2). There were no project teams from ORNL in Cohort 2.

Table B-6-2-3: Number of Trainee Respondents by Lab and Survey Wave

	Cohort 1			Cohort 2			
Organization	Baseline and Follow-up survey	Baseline Survey	Year 2 Follow-up Survey	Baseline and Follow-up surveys	NREL Baseline Survey	NREL Post-training Survey	Year 1 Follow-up Survey
ANL	3	4	3	5	8	6	6
INL	4	4	4	2	6	4	3
LBNL	3	3	3	2	6	8	2
LLNL	-	1	-	3	4	4	4
NREL	4	4	4	3	6	6	4
ORNL	5	5	5	-	-	-	-
PNNL	4	7	5	-	2	2	1
SNL	-	-	-	2	3	-	2
Total	**23**	**28**	**24**	**15**	**35**	**30**	**22**

B.2 COMPARING YEAR 1 AND YEAR 2 NON-PARTICIPANT RESPONSE RATES AND SURVEY FINDINGS

To create a non-participant sample in 2016, the Node Lab administered pre- and post-training web-based surveys to the proposed PIs and/or EIs of non-participating teams that the labs had considered but not selected for Cohort 1 participation. This non-participant sample for surveys was restricted to candidate teams most similar to the participating teams. These were generally considered to be the “runners up” and comprised candidate teams from four of the seven labs that fielded participating teams (Table B-6-4). NMR administered a survey with a separate sample of Energy I-Corps non-participants two years after the Cohort 1 Energy I-Corp training, in 2017.[44] For the current evaluation, the evaluation team worked with the participating labs to identify and recruit non-participants. The evaluation team asked all the lab pilot managers to identify their labs’ senior manager(s) with oversight for applied EERE research, to enlist these managers’ support of the research, and to identify their most entrepreneurial PIs conducting applied EERE research who are not participating in the Energy I-Corps pilot.

The non-participant sample size was similar in Year 2 to the Year 1 non-participant sample sizes. The Year 2 follow-up survey non-participant respondent population includes respondents from four different labs.

Table B-6-4: Number of Non-participant Respondents by Lab and Survey Wave

Organization	Year 1 Pre- and Post-Training Survey	Year 1 Non-participant Pre-Training Survey	Year 1 Non-participant Post-Training Survey	Year 2 Non-participant Follow-up Survey
ANL	1	2	3	0
INL	2	2	2	3
LBNL	0	0	0	1
LLNL	3	3	3	2
NREL	0	0	0	3
SNL	1	2	1	0
Total	**7**	**9**	**9**	**9**

[44] The Node fielded the web-based non-participant pre-training survey from October 2 to October 23, 2015, with an initial distribution and four follow-up emails to nudge non-respondents. The Node fielded the web-based non-participant post-training survey from April 4 to April 13, 2016, with an initial distribution and weekly follow-up emails to non-respondents. Because these surveys parallel the participant surveys, we refer to them as pre- and post-training surveys, or pre- and post-surveys. The terms “pre” and “post” are in relation to the *date* of the training, not to the *experience* of training. The non-participants did not receive the Cohort 1 training. NMR Group fielded the Year 2 follow-up survey from May 9 to June 7, 2017, with an initial distribution and weekly follow-up emails to non-respondents.

In some respects, the Year 2 non-participant sample provides a comparison to the Cohort 2 Year 2 participant sample to contribute to the interpretation of Energy I-Corps impacts. Yet because we specifically sought non-participants that were known to be comparable to the participants, some non-participants have had exposure to, and thus may have been influenced by, Energy I-Corps. Indeed, one pilot goal is knowledge transfer from participants to their colleagues (see 4.1.1). However, the Year 2 sample of non-participants may be thought of as less influenced by their exposure to Energy I-Corps because the sample is not drawn exclusively from individuals who have already applied to the program.

B.2.1 Comparing I-Corps Influence on Year 1 and Year 2 Non-participants

Of the nine Year 2 non-participants, seven had not applied to the Energy I-Corps program. When asked about the various ways in which they may have been influenced by Energy I-Corps, Year 2 non-participants most commonly reported that they had discussed the training with participating Lab teams (56%) and studied or reviewed commercialization books or other resources (33%). Only one Year 2 non-participant reported reviewing any of the Energy I-Corps training materials. None of the Year 2 non-participant survey respondents completed any commercialization training. The Energy I-Corps exposure of the Year 2 non-participant sample may be more reflective of the general diffusion of the program among the Labs, as almost none of the non-participants in this sample had applied to the program.

Table B-6-5-6: Energy I-Corps Impacts on Non-participants

Response	Year 1 Non-participant Sample (n=9)		Year 2 Non-participant sample (n=9)	
	Count	Percent	Count	Percent
Discussed the Lab-Corps/Energy I-Corps training with participating Lab teams	8	89%	5	56%
Reviewed Lab-Corps/Energy I-Corps training materials	7	78%	1	11%
Studied or reviewed commercialization books or other resources	5	56%	3	33%
Completed any commercialization training	2	22%	0	0%
Found another source of funding to pursue commercialization activities	2	22%	-	-

Non-participants generally reported that they intended to continue to conduct commercialization activities. Seven out of eight non-participants who responded to this item on the Year 2 follow-up survey said they would conduct such activities on subsequent innovations in future years. Six of nine non-participants who completed the Year 1 post-training survey responded likewise (Table B-6-7).

Table B-6-7-8: Likelihood of Continuing Commercialization Activities

Likelihood of conducting:	Year 1 Post Survey: “4” or “5” Rating (n=9)		Year 2 Follow-up Survey: "4" or "5" Rating (n=8)	
	Trainee Respondents	Percent	Trainee Respondents	Percent
Commercialization activities on *subsequent innovations* in *future years*	6	67%	7	88%

Year 1 and Year 2 non-participants were asked somewhat different questions about the components of the BMC; in the former case, Year 1 non-participants were asked to rate their understanding of the BMC components out of 5. In the latter case, Year 2 non-participants were asked to rate how much investigation they had done into the aspect of the BMC (using a 4-point scale). However, we can see that some Year 2 non-participants do report doing some or a lot of investigation into the concepts, whereas Year 1 non-participants on the whole did not rate their understanding of the concepts very highly.

Table B-6-9-10: Knowledge of/Investigation into Components of the BMC by Non-participants

Response	Year 1 Non-participant Sample (n=9)		Year 2 Non-participant sample (n=7)	
	Count	Percent “4” or “5”	Count	Percent “3” or “4”
Customer segments, customer archetypes	0	0%	0	0%
Customer relationships	0	0%	2	29%
Value propositions	1	11%	3	43%
Key activities	0	0%	1	14%
Key partners, suppliers	0	0%	2	29%

* Year 1 non-participants displays the 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*. Year 2 non-participants displays the percentage of respondents providing a “3” or a “4” on a 4-point scale, where 3 equals *some* and 4 equals *a lot* of investigation into the concept.

A larger proportion of Year 2 non-participants reported receiving funding than Year 1 non-participants, who were more likely to report being in discussion with funders.

Table B-6-11-12: Efforts by Non-participants to Fund Commercialization of Pilot Technology

Response	Year 1 Non-participant Sample (n=9)		Year 2 Non-participant sample (n=5)	
	Count	Percent	Count	Percent
Received funding	0	0%	3	60%
Currently in discussion with funders	5	56%	1	20%
Interested in pursuing funding, but not in active discussion with funders	2	22%	2	40%
Do not plan to pursue additional funding in the next year	1	11%	0	0%
Don’t know	1	11%	1	20%

Appendix C Program Logic Models

C.1 HIGH-LEVEL LOGIC

The evaluation team developed a high-level logic model of the Energy I-Corps Program (Figure C-6-1-2) from its inception through implementation, illustrating how the program's activities will achieve its one year and broad goals. The logic modeling was performed for the earlier first Energy I-Corps evaluation study and its description is repeated here.[45]

The three principal Energy I-Corps goals are seen in the bottom row of the high-level logic model shown in Figure C-6-1-2.

The activities of EERE and the Node Lab (top row of Figure C-6-1-2) comprise four areas:

- EERE staff design the program with input from the national labs and NSF I-Corps program managers. Program design includes funding for lab management of their program 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 C-6-1-2) 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 C-6-1-2) 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.

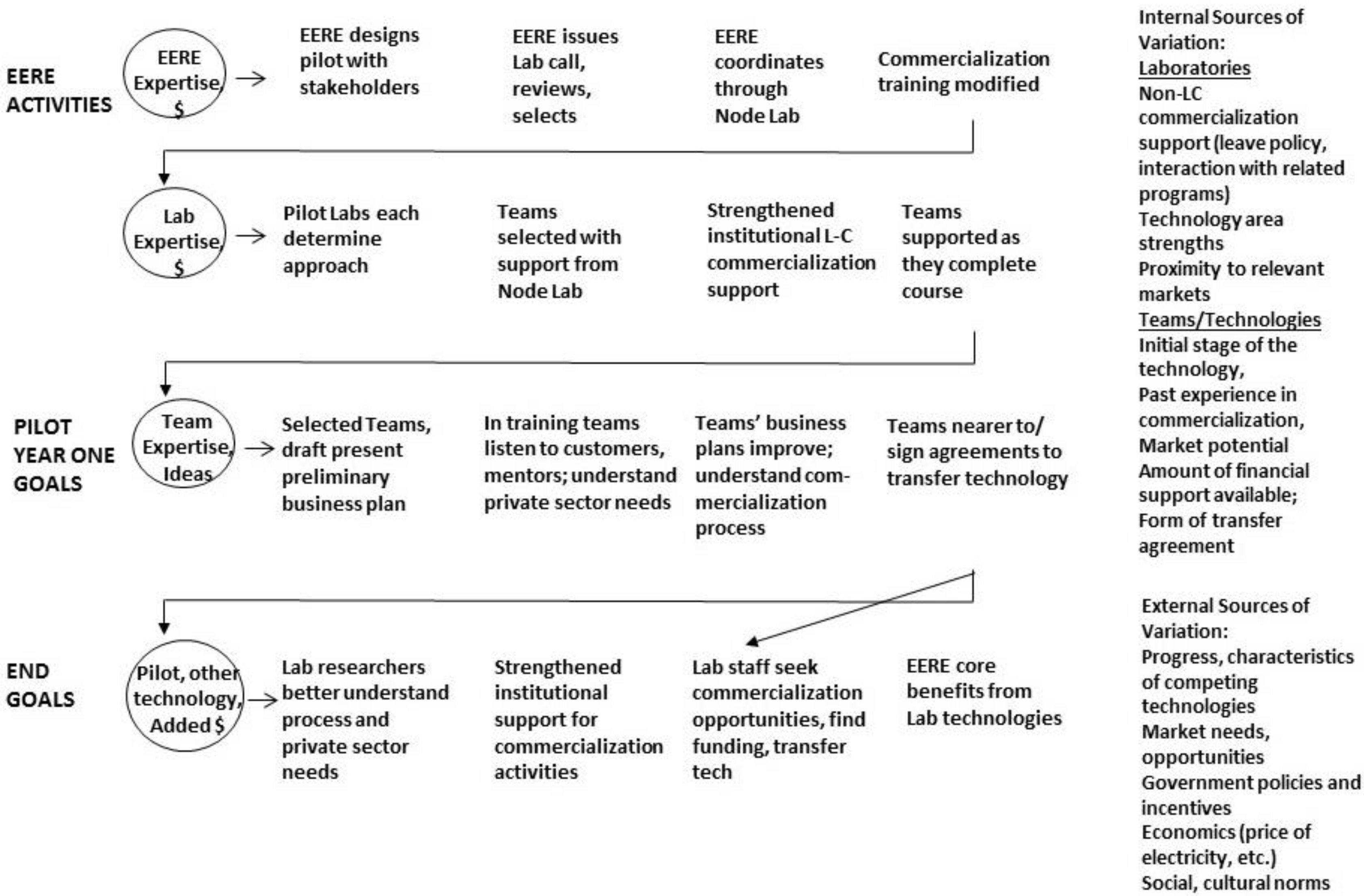
[45] Lab-Corps Pilot Technical Evaluation Plan, July 31, 2015. Submitted to U.S. DOE EERE by NMR Group, Inc., Research Into Action, Inc., Gretchen Jordan, Ph.D., Albert Link, Ph.D., and East Mountain IP. Peer-reviewed by Donald Siegel, Ph.D., Irwin Feller, Ph.D., Brian Zuckerman, Ph.D., Maryann Feldman,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

- 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.[46]
- Teams engage in technology transfer activities.[47] 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).

[46] 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.

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

Figure C-6-1-2: High Level Logic Model for Energy I-Corps Program



C.2 INTERNAL AND EXTERNAL INFLUENCES ON PROGRAM SUCCESS

There are influences both internal and external to the Energy I-Corps program that may drive or constrain success of the program 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 E has additional detail).[48]

Internal to the program, 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 G 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 program 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).

[48] 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.

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.

External to the program 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 program outcomes explored in this study.

C.3 DETAILED LOGIC MODELS

Figures C-2 to C-4 provide the detailed project logic.

Figure C-6-3-4: Energy I-Corps Program 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 C-6-5-6: Energy I-Corps Program Logic Model for the Training Teams

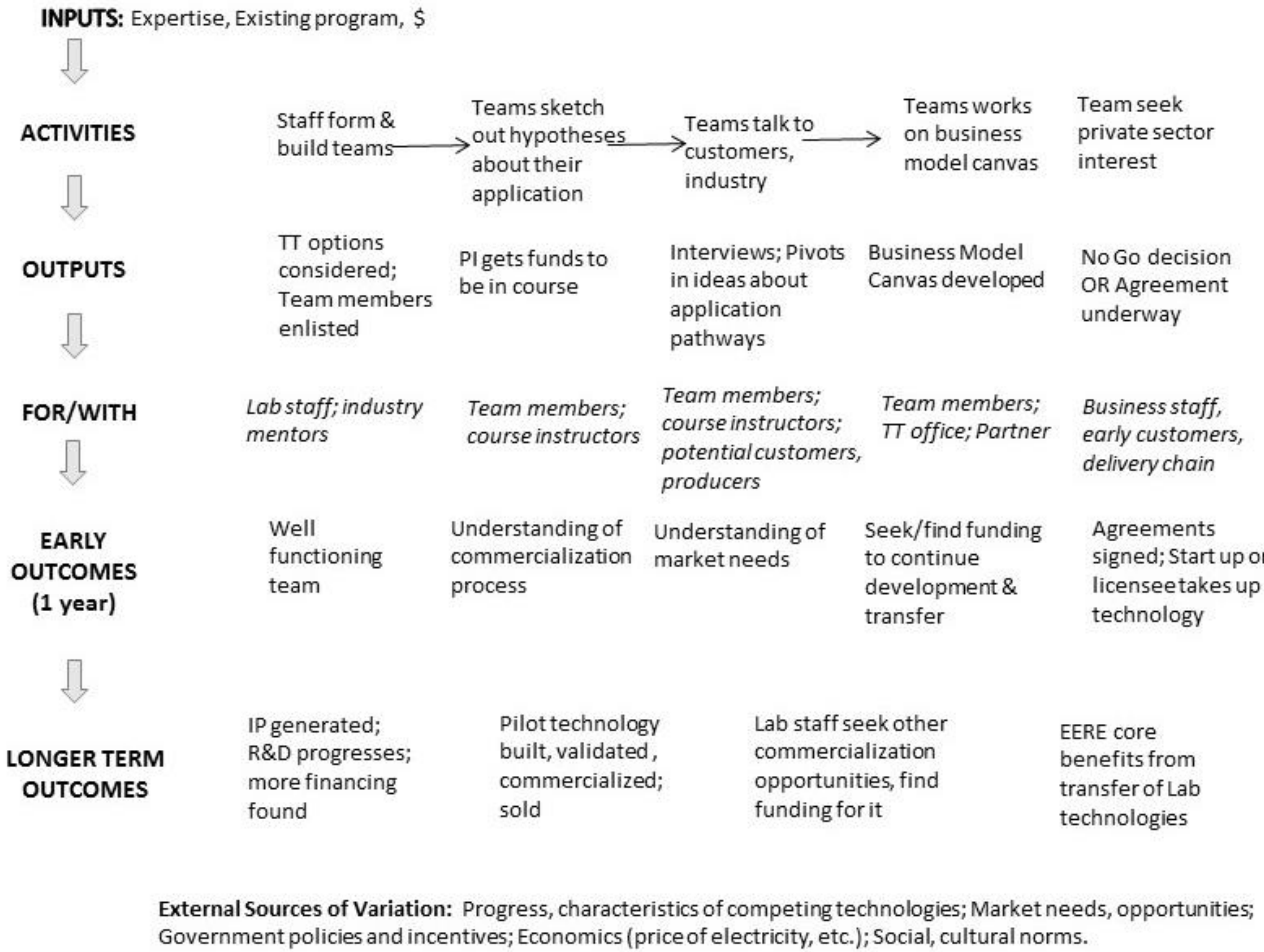


Figure C-6-7-8: Energy I-Corps Logic Model for Processes at the Site Laboratories

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 D Cohort 1 and 2 Team and Technology Descriptions

Provided below are descriptions of the technologies being developed by the two cohorts of teams involved in this evaluation of the Energy I-Corps Program. The descriptions below are derived from the Energy I-Corps Website, paraphrased and lightly edited for clarity. Links to each of the Energy I-Corps cohorts are provided below, and the main page for the program can be found here.

Cohort 1

Dynamic Aperture

- The Dynamic Aperture team developed a device that allows precise, real-time control of vapor deposition sources, which improves the quality of thin films without the need to stop the manufacturing process to recalibrate sources. The resulting films can enhance device yield, improve the performance of optics, and increase efficiency while reducing manufacturing costs. Possible applications have the potential to increase solar cell efficiency, improve performance of x-ray telescopes, and increase extreme ultraviolet lithography throughput. Engagement with Energy I-Corps will help the team identify potential customers, gain insight through the evaluation of market analysis, and make decisions regarding how best to pursue commercialization of the technology.

SonicLQ

- The SonicLQ software uses commercially available equipment to create a non-invasive solution using sound waves to both find and quantify air leaking through enclosed spaces to improve estimates for weatherization repairs and energy savings potential. Distinct from current air leakage testing procedures, SonicLQ tests can occur in occupied buildings and during all phases of construction, giving energy service companies new opportunities to sell more testing contracts. Energy I-Corps will help the team explore SonicLQ's potential, develop a business plan, and then decide between licensing the technology or starting a new business.

ARAI

- The Advanced Renewable Aerial Inspections (ARAI) technology utilizes unmanned aircraft systems (UAS) to perform safer, less costly inspections on multiple types of wind turbines, including off-shore wind turbines, to collect data. The UAS data can be used to help ascertain maintenance requirements and detect issues and trends to help wind farm operators, public utilities, turbine manufacturers, and maintenance companies make rapid, informed decisions in how they manufacture, build, deploy, and maintain their products. Through its participation in Energy I-Corps, the team hopes to better understand the challenges of taking innovative ideas from concept to commercialization.

Switchable Polarity Solvent Forward Osmosis

- Switchable polarity solvents (SPSs) are a new class of materials that undergo a polarity shift when exposed to a chemical agent. The switch leads to major changes in solubility and phase behavior, and SPSs display many of the beneficial characteristics of room temperature ionic liquids without the cost or difficulty of recycling. The team sees a range of possible applications for this technology, but their initial target areas will be industrial water treatment and biomass fractionation. The use of SPSs in water treatment processes has the potential to cost-effectively obtain high water recoveries from high-salinity and high-fouling industrial waters. The team's biomass project will use SPSs to fractionate biomass such that it can be merchandized, allowing the biomass industry to compete with the petrochemical infrastructure. With the help of Energy I-Corps the team hopes to explore various paths forward, demonstrate the processes, and bring the technology to market.

Ring Burner

- Ring Burner is based on Lawrence Berkeley National Laboratory's (LBNL's) patented low-emission technology that utilizes premixed fuel and air supply, as well as a simple flame stabilizing mechanism, to evenly heat a surface with minimal pollutant formation. The team is aiming to use the technology to enhance the cooking experience in residential and commercial kitchens. Energy I-Corps will help the team develop other value propositions in response to market feedback.

C-Best

- The Commercial Building Energy Saving Technology (C-BEST) is an optimized control technology for heating, ventilating, and air conditioning systems in commercial buildings such as office, retail, and computer centers. C-BEST provides an online, real-time, deep learning, self-modeling, and advanced non-linear optimization solver technology. The technology is a risk-free, low-cost, capital-free investment in energy efficiency that is being describes as having the potential to reduce a commercial building's energy bill by anywhere from 10% - 30%. Through Energy I-Corps, the C-BEST team expects to learn business skills and find potential customers while piloting market-ready applications for their technology.

Eco-AC

- Eco-AC is a modular air conditioning solution intended to replace window air conditioners. Units are installed by drilling one or two small holes in an exterior wall and connecting the evaporator and condenser through them, eliminating the eyesore of traditional window air conditioner units while maintaining a simple installation. The technology also reduces air leakage while improving operating efficiency and comfort. Eco-AC includes multiple patent-pending components developed at the National Renewable Energy Laboratory (NREL). The team is collaborating with Energy I-Corps in the hope they can help them capitalize on the poor aesthetics of window air conditioners, lack of differentiation between current products, and lack of brand-awareness/loyalty while targeting homeowners, property managers, and rental tenants.

WISDEM

- The NREL WISDEM research tool is being developed to address the complexity of current by wind plant systems, which are often coupled systems where occurrences in one part of the plant affects other areas. The team believes that commercialization of the WISDEM tool can help with this issue by creating a “virtual” and vertically integrated wind plant that can enable stakeholder collaboration for optimizing wind turbine and plant design, control, and operation. With the help of Energy I-Corps, the team aims to create a business model for a full graphical interface with database support, turning WISDEM into a commercially viable tool that will help industry design and develop improved wind energy systems.

CI-ReClad

- This product updates an existing Dow Chemical Company product, THERMAX Wall System (TWS), which combines the components of air, vapor, and water-resistive barriers while providing continuous thermal insulation with practical retrofit reclad application refinements. The product aims to allow cost-effective retrofitting of building envelopes while addressing unique project requirements and allowing the building to maintain its normal operations throughout recladding. The integration and constructible details of these components would benefit architects, contractors, and owners by making retrofits less costly, time consuming, and complex. Engagement with Energy I-Corps is designed to help the team evaluate the commercialization potential of the updated system, TWS – ReClad.

Tunation

- Tunation is a software product that is designed to help energy companies identify the energy and cost-savings potential for both commercial and residential buildings with greater ease and cost savings. Through using new “zero touch” audit and simulation technology, the software can learn and adapt a building model in real time while keeping costs low. Tunation has the potential to help medium and small business afford these services by keeping costs low, expanding the energy modeling market and reducing building energy use.

Co-culture Green

- The team uses binary culture technology that can reduce greenhouse gas emissions and also generate value-adding products and biomass. The technology capture fugitive methane and carbon dioxide gasses and biologically converts them into products such as biofuel, feedstock, and fertilizer with the assistance of a co-culture. Oil and gas drilling companies are viewed as potential partners, and Energy I-Corps is helping to gauge interest in the industry by providing interviews, while also helping to explore other avenues to use the technology.

HYDRA

- HYDRA is a statistical framework for designing an aggregate forecasting model that is less susceptible to variability. It iteratively tunes, augments, and then combines the strengths from multiple competing methods to generate a single model that is more accurate and reliable than any single approach. HYDRA's potential applications range from predicting short- and long-term energy needs in the power grid (one industry collaborator reduced forecasting errors by 65% and is estimated to save up to $100 million annually) to detecting early indications of disease in cattle (reducing the typical $5 billion annual loss). Energy I-Corps will help the team clearly define and demonstrate HYDRA's potential applications and increase the impact the tool can have in the wider world.

STARS

- The Solar Thermochemical Advanced Reactor System (STARS) uses the sun's energy to convert natural gas or biomethane feedstock into chemical energy, creating an energy-rich gas that is suitable for commercial use, including hydrogen production, methanol production for on-site use, and electrical generation. Energy I-Corps will help the team understand and characterize the potential market uses for STARS, develop a more efficient prototype suitable for manufacturing, and use industry input to illuminate a path for commercializing the technology.

Sub Lambda

- The technology being developed is a potentially low-cost, passively switchable dynamic coating for windows that is based in part on subwavelength materials. When window temperature increases beyond a specified point, the coating will reversibly block infrared radiation, without blocking visible light. This technology will allow dynamic solar heating of a building while also providing natural daylight. If successful, this technology has the potential to provide significant energy savings for commercial and residential buildings. Through Energy I-Corps, the team hopes to better understand and characterize potential market uses for its technology.

Cohort 2

Nanoheatblock

- NanoHeatBlock is an advanced processing technology that supports the manufacturing of particulate thermochromic films, improving the performance of smart windows. Instead of using bulk VO_2 film, Argonne has synthesized thin-film window coatings containing VO_2 nanorods. The nanorods greatly enhance the optical and infrared blocking performance of the window coating. In addition, the technology is scalable, with the capacity of finely tuning material properties, producing high-quality window films at a low cost. If successful, it could result in a technical potential energy savings up to $2.64 \times 10_{17}$ J/year for new and existing commercial and residential markets combined. With the help of Energy I-Corps, the team hopes to explore various paths forward, demonstrate the processes, and bring the technology to market.

RW-EDI

- Ion-exchange resin wafer electrodeionization (RW-EDI) is a low-energy, low-cost separation technology that uses electricity to remove ions from aqueous streams. It integrates commercially available components of ion-exchange resin material, membranes, and electrically driven separation devices to increase the energy efficiency and reduce the cost of processing aqueous streams. The technology provides enhanced fluid and flow distribution; higher conductivity; superior pH control; ease of materials handling and system assembly; and a porous solid support for incorporation of catalysts; biocatalysts; and other adjuvants. RW-EDI is a near commercial technology that won 2001 and 2006 R&D 100 Awards for chemicals/water purification and bio-based chemical/biofuel production.

Smart Charge Adapter (Patent Pending)

- The smart charge adapter (SCA - Patent Pending) is a handheld, internet of things (IoT) device that can connect any charging station with a plug-in electric vehicle (PEV). The SCA is PEV/charge station agnostic. The SCA provides communication, control, and monitoring capabilities during the time the vehicle is charging, providing advantages to the owner of the SCA and utility/grid operator. Potential applications include PEV sub-metering, demand response, frequency regulation, charge scheduling, and PEV charging data analytics. Energy I-Corps will help the team determine if there is a market for the SCA technology, identify the best initial customer segment, and determine the best path to pursue commercialization.

High-Moisture Pelleting Process

- Idaho National Laboratory has developed a high-moisture pelleting procedure that lowers the cost of drying and manages the feedstock moisture more efficiently. Using this process, biomass is pelleted at moisture contents greater than 25 percent. The pellets are partially dried during production by the frictional heat developed in the pellet die during compression and extrusion. Also, a short preheating stage replaces the usual energy-intensive steam conditioning. This step helps reduce feedstock moisture content as well as activate biomass components, like lignin. Techno-economic analysis indicated the process reduces energy and production costs by about 40 to 50 percent compared to a conventional pelleting method. Currently, work is underway to scale-up the high moisture pelleting process from lab to pilot and commercial scale.

Quake

- Currently, DOE and the nuclear industry perform seismic analysis using equivalent-linear numerical analysis tools. For large levels of shaking, where soil strains are high, these tools are likely inaccurate for seismic and flooding probabilistic risk assessment (PRA) calculations. As proposed, this technology will use advanced seismic methods and tools will minimize uncertainty and reduce quantified safety margins and costs required to mitigate seismic risks.

Bioalchemy, Inc.

- The BioAlchemy team has developed a new microfluidic technology (microNIMS) for high-throughput screening of cellulose degrading enzymes. The technology merges microfluidics with mass spectrometry, allowing fully automated enzyme processing and assay. Unlike traditional microfluidic detection systems, microNIMS can be used on many different enzymes and substrates; and to solve multiple enzyme challenges across a broad range of pretreatment conditions and substrate options. The fabrication conditions can be altered to target different enzyme/substrate systems. They can also be fabricated in patterned arrays, allowing multiple assays to be run simultaneously. The combined versatility, throughput, and reduced sample consumption make microNIMS an enabling technology for commercial enzyme assay.

Evodia

- Evodia is developing engineered microbes that can convert inexpensive, renewable sugars into high-value specialty chemicals. Its platform technology will provide novel biosynthetic routes to compounds that have established markets, and can be extended to produce novel compounds through simple genetic alterations in the host cell, all from a single inexpensive feedstock. Evodia's technology will therefore provide "greener" routes to established and novel products while lowering production costs.

TOUGH

- TOUGH is a software too that simulates how valuable resources—such as water, oil, gas, and heat—can be extracted from the pore space of soils and rocks, or how harmful materials—such as chemical and radioactive wastes, or carbon dioxide—can be safely stored in the deep earth or tracked as they move through the subsurface. The team has developed, customized, and tested the simulation software and provided the expertise to address a variety of challenging environmental and energy problems. With the help of Energy I-Corps, the goal is for the TOUGH suite of codes to be positioned as the tool of choice for complex subsurface simulations across sectors.

Micro Miners

- The Micro Miners team creates and utilizes innovative biotechnologies to recover rare earths from low-grade sources (e.g., mine tailings, geothermal fluids, and recyclable materials) to expand the global rare earth supply chain. It focuses on research and development of affordbale and eco-friendly approaches that use environmentally safe microorganisms. To increase efficiency and specificity of rare earth extraction, it employs both native microbial features as well as advanced bioengineering technologies. With the development of an extraction pipeline that promises the delivery of rare earth materials with high efficiency and purity, it addresses the vulnerability and criticality of rare earths to emerging clean energy technologies.

Saline Solutions

- Flow-through electrode capacitive desalination (FTE-CD) is an innovative desalination method that removes ions from water electrostatically and is best suited for low concentrations of salt (15 g/L or less). The technology has many potential uses, but it would most benefit the production of ultrapure water. Ultrapure water is required for the production of advanced electronics and pharmaceuticals, and as a working fluid for power plant turbines. Producing ultrapure water usually takes several steps, which includes using reverse osmosis (RO) membranes to remove most of the salt. FTE-CD can remove salt much faster at low concentrations than RO can, saving money and energy. The overall savings are expected to be 30 percent. Upon success, the technology could expand into additional markets, such as brackish water desalination for municipal or agricultural use.

Biolyst Renewables

- The team at Biolyst Renewables has developed technologies that produce adipic acid renewably at a competitive cost and lower environmental footprint than petroleum-derived adipic acid. Adipic acid is a primary component of nylon, and its production from petroleum releases significant quantities of the potent greenhouse gas nitrous oxide. Biolyst Renewables' approach overcomes this issue by producing adipic acid renewably from biomass at low cost without the release of nitrous oxide, resulting in one-tenth of the greenhouse gas footprint. With the help of Energy I-Corps, the team hopes to understand barriers to entry for the rapidly growing bioplastics market and how to compete with petroleum in an environmentally sustainable manner.

Solguard

- SolGuard's integrated photovoltaic (PV) safety and performance solution will provide remote shut-off capability of solar systems while giving owners automatic alerts of potential safety and energy-production problems. Electrical safety can discourage firefighters from intervening during a fire, and faults in the system can pose a fire risk. For module and inverter manufacturers, the technology enables sales of existing products into rooftop markets, which are rapidly closing due to National Electric Code (NEC) regulations. For owners, it offers compliance with upcoming NEC regulations and improved actionable information about system performance and problems associated with fire risk. Finally, for insurers and firefighters, it decreases the risk of PV system-started fires and improves firefighting response if a fire does occur.

Volttron

- VOLTTRON is an open-source platform for distributed sensing and control funded by DOE's Building Technologies Office. VOLTTRON enables rapid development and deployment of Smart Building solutions by allowing applications to easily communicate with physical devices and other resources.

Polymer Membranes

- Polymer membranes are vital to many energy and water technologies, including energy storage, water electrolysis and purification, and stationary and transportation power systems. The membranes are tailored to allow conduction of specific ionic species between the negative and positive electrodes in an electrochemical system. For example, polymer membranes can be optimized for transport of protons (H+) or hydroxyl ions (OH-), depending on the acidic or alkaline environment of the energy-water system. The prototype poly (phenylene)-based hydrocarbon membrane separators developed at Sandia National Laboratories show exceptional performance in real-world application tests by system customers and partner research institutions.

Appendix E 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 F Research Design Quality Assurance and Limitations

F.1 ASSURING RESEARCH DESIGN QUALITY

The initial Energy I-Corps pilot report (Evaluation of the Energy I-Corps Pilot, Final Report, November 28, 2016) provided an overview of our research design for assessing early outcomes of the pilot is a quasi-experimental design using a carefully chosen comparison group;[49] an updated overview is provided here.

Our research design for assessing early outcomes of the program is a limited 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 program supports *evidenced-based* policy decisions. Our approach is designed to produce research that yields meaningful findings and conclusions that support an assessment of the generalizability of the program experience and decisions regarding program scale up, with appropriate cautions. Additionally, the evaluation plan that governed the first-year research and specified the metrics pursued in both the first- and second-year survey research was reviewed by a high-level team of external experts, from private industry and universities.

To meet the goals of the research design, we have, among other things, identified factors that might confound the interpretation of the program results by suggesting either the program 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 program's contribution to commercialization planning process changes and product advancements.

Confounding factors include the internal influences on the program identified by the logic model: initial stage of the technology, technology sector, past commercialization experience, non-Energy I-Corps resources and support, form of transfer agreements, and Laboratory proximity to customers and markets.

[49] The Energy I-Corps Pilot report included surveys of Cohort 1 non-participants. The Node Lab administered pre- and post-training web-based surveys to the proposed principal investigators and/entrepreneurial leads of non-participating teams that the labs had considered but not selected for Cohort 1 participation. The non-participant sample for these initial surveys was restricted to those candidate teams most similar to the participating teams and were generally considered to be the "runners up" and comprised candidate teams from four of the seven labs that fielded participating teams. https://energy.gov/sites/prod/files/2016/12/f34/Evaluation%20of%20Lab-Corps%20Pilot%20-%20Final%20Report%2011-25-2016.pdf

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

Our approach minimizes *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).

STUDY LIMITATIONS

As described, 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. The limitations of this 2nd year impact report are detailed in the body of the report in section 2.2.4.

Appendix G Technology Readiness Level

G.1 TECHNOLOGY READINESS DEFINITIONS

Technology Readiness Level, or "TRL" is a widely used indicator of degree of development of a technology toward deployment, typically on a scale of 1-9, with 9 being fully deployment ready. EERE has at times included TRL 10 to indicate commercial production.

- **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. TRL 9 can be as few as one unit produced.
- **TRL 10 production and sales**. (EERE has used this added TRL)

Cohort 1 trainees assessed the stage of development and commercialization of their technologies. The Year 2 survey used a seven-stage scale that paraphrased DOE's TRL descriptions for brevity and simplicity.[50] Table 6-1314 compares the commercialization stages used in the Year 2 survey to TRLs.

[50] The team used a Minnesota Department of Commerce memo on commercialization milestones to develop the 7-point scale used in the survey; the memo was based on US DOE and DOD commercialization metrics. http://mn.gov/commerce-stat/pdfs/commercialization-milest-success.pdf

Table 6-1314: Comparing Cohort 1 Year 2 Survey Commercialization Stage to TRLs

Cohort 1 Year 2 Survey Commercialization Stage	TRL
1. Concept exploration/preliminary investigation	• **TRL 1 Basic Research:** Initial scientific research has been conducted. Principles are qualitatively postulated and observed. Focus is on new discovery rather than applications.
2. Concept definition/initial investigation	• **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
3. Proof of concept/detailed investigation	• **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.
4. Proof of application/initial development and verification	• **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.
5. Validation in simulated operation environment/ prototype project	• **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).
6. Validation in commercial operational environment/ commercial scale	• **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. TRL 9 can be as few as one unit produced
7. Final design/commercial production	• **TRL 10 production and sales.** (EERE has used this added TRL)

Appendix H National Laboratory Initiatives and Technology Commercialization Initiatives Having Some Indirect Lab Involvement

In addition to the Energy I-Corps program – 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. As of November 2016, the following are National Laboratory initiatives and technology commercialization Initiatives having some indirect lab involvement.

H.1 LAB INITIATIVES

H.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.

H.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.

H.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.

H.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.

H.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.

H.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*.

H.2 COMMERCIALIZATION INITIATIVES INDIRECTLY INVOLVING LABS

H.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.

H.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.

H.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.

H.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.

H.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 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.

H.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.

H.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 a Memorandum of Understanding (MOU) between DOE and the participating research institution.

Appendix I Survey Instruments

I.1 COHORT 1 YEAR 2 SURVEY

I.1.1 Instrument Information

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	10-15 minutes
Population Description	Cohort 1 participants in DOE Lab-Corps training
Contact Sought	National Lab staff participating in cohort 1 training teams
Fielding Firm	NMR on behalf of pilot labs

[PROGRAMMING] Programming instructions are in bracketed CAPS.

I.1.2 Introduction

Thank you for taking this survey that follows-up about one year after your Lab-Corps participation. Your responses will contribute to the development and refinement of the Lab-Corps pilot and perhaps Laboratory support for commercialization support.

I.1.3 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE] {LC POST-SURVEY, Q1}

1. ANL
2. INL
3. LBNL
4. LLNL
5. PNNL
6. SNL
7. NREL
8. ORNL
9. Other (please name): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q2. Which technology team do you represent? [REQUESTED RESPONSE] {LC POST-SURVEY, Q2}

1. ARAI
2. Battery Health Management
3. C-BEST
4. CI-ReClad
5. Co-culture Green
6. Dynamic Aperture
7. Eco-AC
8. HYDRA
9. Ring Burner
10. SonicLQ
11. STARS
12. Sub Lambda
13. Switchable Polarity Solvents Forward Osmosis
14. Tunation
15. WISDEM

96. Other (please name): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q3. Please enter your name here: {LC POST-SURVEY, Q3}

1. [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). The first set of questions addresses your pilot technology.

[ASK ALL]

Q4. Please indicate the stage of development/commercialization that best describes your pilot technology today and at the time you started your Lab Corps training. [CONSTRAIN TO A SINGLE RESPONSE] {SBV, PARTICIPANT, Q18}

Stage of development / commercialization	Today	At the time you started your Lab Corps training (October 2015)
1. Concept exploration/preliminary investigation		
2. Concept definition/initial investigation		
3. Proof of concept/detailed investigation		
4. Proof of application/initial development and verification		
5. Validation in simulated operation environment/ prototype project		
6. Validation in commercial operational environment/ commercial scale		
7. Final design/commercial production		

[ASK ALL]

Q5. During the past year, after the Lab-Corps training ended, to what extent have you conducted any investigation into the following components of the business model for your pilot technology? {SIMILAR TO LC POST-SURVEY, Q11}

[MATRIX QUESTION: SCALE]

Business Model Component	Not at all	A little	Somewhat	A lot
Investigated your customer segments, customer archetypes - for whom the technology creates value				
Strategized about customer relationships - to keep and attract new customers, how costly the relationships are				
Investigated channels - through which customers are reached, which work best, are most cost-effective				
Investigated key resources - that are required, their distribution channels, and revenue streams				
Investigated value propositions - which of the customers' problems the new technology solve and the bundles of products and services being offered				
Investigated key activities - related to distribution channels, revenue streams, and customer relationships				
Investigated revenue streams - pricing tactics, estimation of customers' willingness to pay				
Investigated key partners, suppliers - their activities, and the resources acquired from them				
Investigated cost structure - most important costs and those that are most expensive				

[ASK ALL]

Q6. What have you done during the past year to continue learning about the commercialization process? [OPEN-ENDED] {SIMILAR TO ITEM IN LC POST-SURVEY, Q16}

[ASK ALL]

Q7. Since completing the Lab Corps training, have you reached a No Go decision for the commercialization of your pilot technology? {LC POST-SURVEY, Q30}

[SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[IF Q7 = 1. YES (NO GO)]

Q8. What led to the No Go decision? {LC POST-SURVEY, Q31}

1. [OPEN-ENDED RESPONSE]

[IF Q7 = 1. YES (NO GO), SKIP TO Q18 (ATTRIBUTION); ELSE, CONTINUE]

Q9. Please give the number of records of inventions, cases of background IP in a CRADA, patents, copyrights, trademarks, and / or scientific publications that have occurred during the past year related to the pilot technology. Enter numbers. If none, enter 0 (zero). [SBIR39]

	Number Applied For/ Submitted	Number Received/ Published
Submitted record(s) of invention		
Background IP (intellectual property) in a CRADA (cooperative research and development agreement)		
Patents		
Copyrights		
Trademarks		
Scientific/ Technical Publications		

Q10. Which of the following describe your efforts during the past year to fund further work on your pilot technology? {SIMILAR TO LC POST-SURVEY, Q38}

[MULTIPLE RESPONSE]

1. Received funding

2. Currently in discussion with funders
3. Have presented a business idea to funders / investors
4. Interested in pursuing funding, but not in active discussion with funders
5. Do not plan to pursue additional funding in the next year
96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know

[IF Q10 = 1. RECEIVED FUNDING]

Q11. What type and amount of funding have you received during the past year (i.e., internal Lab funding, EERE or other governmental, private, NGO, etc.)? Please use the table below to report type of funding, source of funding and total amount of funding received. {SIMILAR TO LC POST-SURVEY, Q39}

[OPEN-ENDED RESPONSE]

Type (grant, CRADA, etc.)	Source (internal Lab funding, EERE or other governmental, private, NGO, etc.)	Amount (total $)

[IF Q10 = “2. IN DISCUSSION WITH FUNDERS…”]

Q12. What types of funders are you in discussions with? {LC POST-SURVEY, Q40}

1. [OPEN-ENDED RESPONSE]

Q13. Related to your pilot technology, have you…

	Yes	No	Don’t Know / Refused
Founded venture(s) to develop and sell products			
Taken entrepreneurial leave			

Q14. Has your work on the pilot technology led to unanticipated uses of the technology? This might include new applications or markets, or perhaps another group is now conducting R&D on the technology to adapt it to needs in their field. [NEW QUESTION]

Q15. Have you or your team had any actual sales of products, processes, services or other sales incorporating the pilot technology? [SBIR35]

Item	1.YES	2.NO	97 DK	98 RF
a. No sales to date nor are sales expected				
b. No sales to date, but sales are expected				
c. Sales of product(s)				
d. Sales of process(es)				
e. Sales of services(s)				
f. Other sales (e.g. rights to technology, licensing, etc.) [PLEASE SPECIFY]				

[IF Q15a=Y or Q15b=Y, SKIP TO Q21 [ATTRIBUTION]]

Q16. When did the first sale occur resulting from products, processes, services or other sales incorporating the pilot technology [RESPONSE INCLUDES MONTH AND YEAR FIELDS] [SBIR36a]

Q17. What is the approximate amount of total sales dollars of product(s), process(es) or services to date resulting from the pilot technology? [SBIR36b]

[PULLDOWN WITH CHOICES: 0, <$100,000, $100,000-$499,999, $500,000-$999,999, $1,000,000-$4,999,999, $5,000,000-$9,999,999, $10,000,000-$19,999,999, $20,000,000-$49,999,999, $50,000,000+]

Q18. What is the approximate amount of other total sales dollars (e.g. rights to technology, sale of spin-off company, etc.) to date resulting from the pilot technology? [SBIR36c]

[PULLDOWN WITH CHOICES: 0, <$100,000, $100,000-$499,999, $500,000-$999,999, $1,000,000-$4,999,999, $5,000,000-$9,999,999, $10,000,000-$19,999,999, $20,000,000-$49,999,999, $50,000,000+]

Q19. Does your pilot technology include an open-source software application that is available for free download? [NEW]

Q20. [IF YES] How many times has your software been downloaded? [NEW]

[ATTRIBUTION]

[ASK ALL]

Q21. In your opinion, in the absence of the Lab Corps pilot, would you have undertaken the commercialization process for this technology? [SELECT ONE] [SBIR24]

1. Definitely yes
2. Probably yes
3. Uncertain
4. Probably not
5. Definitely not

[PROGRAMMER: IF Q21 = 1 or 2, GO TO Q22. IF Q21 = 3, 4, or 5 GO TO Q24]

Q22. If you had undertaken the commercialization process for this technology in the absence of the Lab Corps pilot, this project would have been… [SELECT ONE] [SBIR25]

1. Broader in scope
2. Similar in scope
3. Narrower in scope

Q23. Please provide your best estimates of what would have occurred in the absence of the Lab Corps pilot. [SBIR26]

a. How long would the start of this work been delayed? [TEXT BOX – MONTHS; ENTER 0 IF NO DELAY]

b. The expected duration/time to reach the same stage of completion would have been… [SELECT ONE]
1) longer
2) the same
3) shorter

c. In achieving similar goals and milestones, the project would be… [SELECT ONE]
1) ahead
2) the same place
3) behind

The next set of questions relate to your research on technologies other than the pilot technology

Q24. Since completing the Lab-Corps pilot, have you worked on commercializing any additional technologies, other than your Lab-Corps pilot technology? {NEW}

1. Yes
2. No

[IF NO, SKIP TO Q27]

Q25. To what extent have you conducted any investigation or strategic planning for any of the following business planning components for any technologies other than your pilot technology? {SIMILAR TO LC POST-SURVEY, Q11}

[MATRIX QUESTION: SCALE]

Business planning components	Not at all	A little	Somewhat	A lot
Your customer segments, customer archetypes - for whom the technology creates value				
Customer relationships - 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 - that 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				

Q26. Please rate how likely is it that *in future years* you will conduct commercialization activities *on other innovations* like the activities you conducted during your Lab Corps training one year ago? { LC POST-SURVEY, Q36}

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely

I.1.4 Lab Support for Commercialization

The final questions explore your Lab's support for the commercialization process

Q27. 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 now? And how supportive was your Lab at the start of your Lab Corps training? {NEW}

	Now						October 2015 (Start of Lab-Corps Training)				
Item	**1 Not at all supportive**	**2**	**3**	**4**	**5 Very supportive**		**1 Not at all supportive**	**2**	**3**	**4**	**5 Very supportive**
Training in commercialization process											
Tech transfer office assistance to researchers											
Mentoring, encouraging											
Entrepreneurial leave											
Considerations during performance appraisal											
Connecting to possible partners											
Providing some funds or time											
Other (please specify)											
Overall											

I.1.5 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!

I.2 NON-PARTICIPANT YEAR 2 SURVEY

I.2.1 Instrument Information

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	<7 minutes
Population Description	Non-participants in DOE Lab-Corps training
Contact Sought	National Lab staff candidates for Cohort 1 training
Fielding Firm	NMR on behalf of pilot labs

I.2.2 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.2.3 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE]

1. ANL
2. INL
3. LLNL
4. SNL
5. Etc.

Other (please name): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q2. Please describe the energy efficiency or renewable energy technology that has been the primary focus of your recent research. Please limit your responses to a technology that you have worked on since before October of 2015. [OPEN-ENDED RESPONSE]

Q2A. What is the name of this technology? [OPEN-ENDED RESPONSE]

Q3. Please enter your name here:

1. [OPEN-ENDED RESPONSE]

Q4. Have you applied to be considered for any of the Lab Corps training cohorts? [y/n response]

Q5. [IF YES] What cohort(s)? [INCLUDE PRECODES FOR EACH COHORT AND DATES - https://energy.gov/eere/technology-to-market/lab-corps-teams]

Q6. [IF NO] Why have you not applied to be considered for any of the Lab Corps training cohorts?

[ASK ALL]
Q4A. Since the first cohort of Lab Corps training, which was conducted in October and November of 2015, 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?		

[ASK IF Q4A_c (COMMERCIALIZATION TRAINING0 = 1]

Q4B. PLEASE DESCRIBE THE TRAINING, INCLUDING THE SPONSOR OF THE TRAINING.

[ASK IF Q4 (YES, APPLIED TO LC)

Q7. 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						

Q8. Please indicate the stage of development/commercialization that best describes your technology today and at the time that the first Lab Corps cohort training began (October 2015). [CONSTRAIN TO A SINGLE RESPONSE] {SBV, PARTICIPANT, Q18}

Stage of development / commercialization	Today	October 2015 (first Lab Corps training)
8. Concept exploration/preliminary investigation		
9. Concept definition/initial investigation		
10. Proof of concept/detailed investigation		
11. Proof of application/initial development and verification		
12. Validation in simulated operation environment/ prototype project		
13. Validation in commercial operational environment/ commercial scale		
14. Final design/commercial production		

[ASK ALL]

Q9. Since November of 2015, to what extent have you conducted any investigation into the following components of the business model for your technology? {SIMILAR TO LC POST-SURVEY, Q11}

[MATRIX QUESTION: SCALE]

Business Model Component	Not at all	A little	Somewhat	A lot
Investigated your customer segments, customer archetypes - for whom the technology creates value				
Strategized about customer relationships - to keep and attract new customers, how costly the relationships are				
Investigated channels - through which customers are reached, which work best, are most cost-effective				
Investigated key resources - that are required, their distribution channels, and revenue streams				
Investigated value propositions - which of the customers' problems the new technology solve and the bundles of products and services being offered				
Investigated key activities - related to distribution channels, revenue streams, and customer relationships				
Investigated revenue streams - pricing tactics, estimation of customers' willingness to pay				
Investigated key partners, suppliers - their activities, and the resources acquired from them				
Investigated cost structure - most important costs and those that are most expensive				

Q10. Since November of 2015, have you reached a No Go decision for the commercialization of your technology? {LC POST-SURVEY, Q30}

[SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[IF Q7 = 1. YES (NO GO)]

Q11. What led to the No Go decision? {LC POST-SURVEY, Q31}

1. [OPEN-ENDED RESPONSE]

[IF Q7 = 1. YES (NO GO), SKIP TO Q18 (ATTRIBUTION); ELSE, CONTINUE]

Q12. Please give the number of records of inventions, cases of background IP in a CRADA, patents, copyrights, trademarks, and / or scientific publications that have occurred since November 2015 related to your technology. Enter numbers. If none, enter 0 (zero). [SBIR39]

	Number Applied For/ Submitted	Number Received/ Published
Submitted record(s) of invention		
Background IP (intellectual property) in a CRADA (cooperative research and development agreement)		
Patents		
Copyrights		
Trademarks		
Scientific/ Technical Publications		

Q13. Which of the following describe your efforts since November 2015 to fund further work on your pilot technology? {SIMILAR TO LC POST-SURVEY, Q38}

[MULTIPLE RESPONSE]

1. Received funding
2. Currently in discussion with funders
3. Have presented a business idea to funders / investors
4. Interested in pursuing funding, but not in active discussion with funders
5. Do not plan to pursue additional funding in the next year
96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know

[IF Q10 = 1. RECEIVED FUNDING]

Q14. What type and amount of funding have you received during the past year (i.e., internal Lab funding, EERE or other governmental, private, NGO, etc.)? Please use the table below to report type of funding, source of funding and total amount of funding received. {SIMILAR TO LC POST-SURVEY, Q39}

[OPEN-ENDED RESPONSE]

Type (grant, CRADA, etc.)	Source (internal Lab funding, EERE or other governmental, private, NGO, etc.)	Amount (total $)

[IF Q10 = "2. IN DISCUSSION WITH FUNDERS…"]

Q15. What types of funders are you in discussions with? {LC POST-SURVEY, Q40}

1. [OPEN-ENDED RESPONSE]

Q16. Related to your technology, have you…

	Yes	No	Don't Know / Refused
Founded venture(s) to develop and sell products			
Taken entrepreneurial leave			

Q17. Has your work on your technology led to unanticipated uses of the technology? This might include new applications or markets, or perhaps another group is now conducting R&D on the technology to adapt it to needs in their field. [NEW QUESTION]

Q18. Have you or your team had any actual sales of products, processes, services or other sales incorporating your technology? [SBIR35]

Item	1.YES	2.NO	97 DK	98 RF
a. No sales to date nor are sales expected				
b. No sales to date, but sales are expected				
c. Sales of product(s)				
d. Sales of process(es)				
e. Sales of services(s)				
f. Other sales (e.g. rights to technology, licensing, etc.) [PLEASE SPECIFY]				

[IF Q18a=Y or Q18b=Y, SKIP TO Q21 [ATTRIBUTION]]

Q19. When did the first sale occur resulting from products, processes, services or other sales incorporating your technology [RESPONSE INCLUDES MONTH AND YEAR FIELDS] [SBIR36a]

Q20. What is the approximate amount of total sales dollars of product(s), process(es) or services to date resulting from your technology? [SBIR36b]

[PULLDOWN WITH CHOICES: 0, <$100,000, $100,000-$499,999, $500,000-$999,999, $1,000,000-$4,999,999, $5,000,000-$9,999,999, $10,000,000-$19,999,999, $20,000,000-$49,999,999, $50,000,000+]

Q21. What is the approximate amount of other total sales dollars (e.g. rights to technology, sale of spin-off company, etc.) to date resulting from your technology? [SBIR36c]

[PULLDOWN WITH CHOICES: 0, <$100,000, $100,000-$499,999, $500,000-$999,999, $1,000,000-$4,999,999, $5,000,000-$9,999,999, $10,000,000-$19,999,999, $20,000,000-$49,999,999, $50,000,000+]

Q22. Does your technology include an open-source software application that is available for free download? [NEW]

Q23. [IF YES] How many times has your software been downloaded? [NEW]

Q24. Please rate how likely is it that *in future years* you will conduct commercialization activities *on other innovations*? { LC POST-SURVEY, Q36}

[SINGLE RESPONSE]

1. Not at all likely

2.
3.
4.
5. Highly likely

- Lab Support for Commercialization

The final questions explore your Lab's support for the commercialization process

Q25. 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 now? And how supportive was your Lab at the start of the Lab Corps training of the first cohort (October 2015)? {NEW}

	Now						October 2015 (Start of Cohort 1 Lab-Corps Training)				
Item	1 Not at all supportive	2	3	4	5 Very supportive		1 Not at all supportive	2	3	4	5 Very supportive
Training in commercialization process											
Tech transfer office assistance to researchers											
Mentoring, encouraging											
Entrepreneurial leave											
Considerations during performance appraisal											
Connecting to possible partners											

Providing some funds or time											
Other (please specify)											
Overall											

I.2.4 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.4 COHORT 2 YEAR 1 SURVEY

I.4.1 Instrument Information

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	<30 minutes
Population Description	Cohort 2 DOE Lab-Corps training Participants (NOTE: Cohort 2 graduated on May 5, 2016)
Contact Sought	National Lab staff and other team members participating in training
Fielding Firm	NMR on behalf of pilot labs

[PROGRAMMING] Programming instructions are in bracketed CAPS.

I.4.2 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.4.3 Characteristics of Team

[ASK ALL]

Q1. Please identify your organization. [REQUESTED RESPONSE]{Q1 PRE AND POST}

1. Argonne National Laboratory (ANL)
2. Brookhaven National Lab (BNL)
3. Fermi National Accelerator (FANL)
4. Idaho National Laboratory (INL)
5. Lawrence Berkeley National Laboratory (LBNL)
6. Lawrence Livermore National Laboratory (LLNL)
7. National Renewable Energy Laboratory (NREL)
8. Oak Ridge National Laboratory (ORNL)
9. Pacific Northwest National Laboratory (PNNL)
10. Sandia National Laboratories (SNL)
11. Other National Lab[SPECIFY:________]
12. Other Organization [SPECIFY:________]

Q2. Which technology team do you represent? [REQUESTED RESPONSE] {Q2 PRE AND POST}

1. BioAlchemy
2. Biolyst Renewables
3. Evodia
4. High-Moisture Pelleting Process (HMPP)
5. Micro Miners
6. Resin Wafer Electrodeionization
7. NanoHeatBlock
8. Polymer Membranes
9. Quake
10. Saline Solutions
11. Smart Charge Adapter
12. SolGuard
13. TOUGH
14. VOLTTRON
15. Other [SPECIFY: __________]

[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 cohort 2 pilot (March – May, 2016).

[ASK ALL]
Q3. Please enter your name here: {Q5 PRE; Q3 POST}

1. [OPEN-ENDED RESPONSE]

[ASK ALL]

Q4. What is your role on your Lab-Corps team? {Q10 PRE; Q6 POST}

[SINGLE RESPONSE]

1. Principal Investigator (PI)
2. Entrepreneurial Lead (EL)
3. Industry Mentor (IM)
96. Other role (lab rep, observer, etc.) (please describe): [OPEN-ENDED RESPONSE]

[ASK ALL]

Q5. Prior to March 2016, had a company (new or established) or other entity already made a commitment to fund late stage development or commercialize this technology? {Q6 PRE}

[SINGLE RESPONSE]
Yes
No
98. Don't know

[IF Q5 = YES]

Q6. What is the approximate month and year that company or entity made that commitment? {Q7 PRE}

[OPEN-ENDED RESPONSE]

Q7. Prior to March 2016, have you been involved in any initiatives (other than Lab-Corps) to develop entrepreneurial skills? The initiative could have been lab-sponsored or something you pursued on your own. [SINGLE RESPONSE] {Q8 PRE (added the clarifying 2nd sentence to this version)}

1 Yes
2 No
98. Don't know

[ASK IF Q5= 1, YES]

Q8. Please name or describe the (other than Lab-Corps) initiative(s) you have been involved in to develop entrepreneurial skills? [OPEN-ENDED RESPONSE] {Q9 PRE}

Q9. SINCE THE LAB CORPS TRAINING, HAS YOUR UNDERSTANDING OF THE PROBLEM THAT YOUR TECHNOLOGY SOLVED CHANGED? {MODIFIED VERSION OF NREL POST SURVEY, Q6}

1. YES
2. NO
3. NOT SURE YET

Q10. IF YES, PLEASE EXPLAIN {NREL POST SURVEY, Q7}

I.4.4 Lab-Corps Training [ASK ALL]

[ASK ALL]

Q11. Thinking back to March 2016, before the Lab-Corps training, how well did you understand the technology commercialization process and the elements needed for success? And how well do you understand it now? {Q12 PRE; Q10 POST}

[SINGLE RESPONSE]

		Prior to Lab-Corps Training	Now
1.	1 – No understanding		
2.	2		
3.	3		
4.	4		
5.	5 – A great deal of understanding		

[ASK ALL]

Q12. 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. {Q14 POST}

[OPEN-ENDED RESPONSE]

I.4.5 Status of Commercialization Effort [ASK ALL]

[ASK ALL]

Q13. We would like to understand the progression of any commercialization activities you've engaged. Please use the table to indicate which of the following statements were true before you attended Lab-Corps (pre-March 2016), and which statements are true for just the period after training (subsequent to May 2016) **AND** related to your pilot technology. {modified version of Q13 PRE; Q29 POST}

[MULTIPLE RESPONSE]

Commercialization processes	Before Lab-Corps (pre-March 2016)	Post Lab-Corps, with Pilot Technology (subsequent to May 2016).
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]

Q14. Have your pilot activities resulted in a No Go decision for the commercialization of your pilot technology? {Q30 POST}

[SINGLE RESPONSE]

1. Yes
2. No
98. Don't know

[IF Q14= 1. YES (NO GO)]

Q15. What led to the No Go decision? {Q31 POST}

1. [OPEN-ENDED RESPONSE]

[IF Q14≠ 1 YES (NO GO)]

Q16. 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? {Q34 POST}

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely
98. Don't know

[IF Q16= 1 OR 2 OR 3]

Q17. Please describe the reasons why you do not think it's likely you will conduct such activities in the next three months? {Q35 POST}

[OPEN-ENDED RESPONSE]

[ASK ALL]

Q18. Thinking back to March 2016, before the Lab-Corps training, how would you rate the extent of your agreement with the following concepts as they apply to your **pilot** technology? And how would you rate the extent of your agreement now? {Q8 PRE; Q 32 POST}

[MATRIX QUESTION: SCALE]

	March 2016 (Prior to Lab-Corps Training)						Now					
Item	1 Completely	2 Somewhat	3 Neither agree nor	4 Somewhat agree	5 Completely agree	6 I had already done	1 Completely	2 Somewhat	3 Neither agree nor	4 Somewhat agree	5 Completely agree	6 I had already done
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 Q18= 1 OR 2]
Q18a. Why do you have little interest in…
[MATRIX QUESTION]
[OPEN ENDED RESPONSE]
[DISPLAY ITEMS RATED 1 OR 2 IN Q18]

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?

[ASK ALL]
Q19. Based on the activities you have done in conjunction with Lab-Corps, to what extent do you agree with the following statements? {Q33 POST}

[MATRIX QUESTION: SCALE]

Item	1 Completely disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Completely agree	6 Done prior Lab-Corps involveme
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						

[ASK ALL]

Q20. 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? {Q36 POST}

[SINGLE RESPONSE]

1. Not at all likely
2.
3.
4.
5. Highly likely
98. Don't know

[IF Q20= 1 OR 2 OR 3]

Q21. Please describe the reasons why you do not think it's likely you will conduct such activities in the coming years? {Q37 POST}

[OPEN-ENDED RESPONSE]

[IF Q20≠ 1]

Q22. Which of the following describe your efforts to fund further work on your technology? {Q38 POST}

[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 Q22 = 1. RECEIVED FUNDING]

Q23. What type of funding have you received? {Q39 POST}

1. [OPEN-ENDED RESPONSE]

[IF Q22 = "2. IN DISCUSSION WITH FUNDERS…"]

Q24. What types of funders are you in discussions with? {Q40 POST}

1. [OPEN-ENDED RESPONSE]

[IF Q1 = 1 - 11 work for a national lab; IF Q1 = 12, "Other Organization" SKIP TO CLOSING]

I.4.6 Lab Support for Commercialization

[ASK IF Q1 = 1 – 11, EMPLOYED BY LAB; ELSE SKIP TO CLOSING]

Q25. 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? {Q17 PRE}

[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

Q26. 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? {Q18 PRE}

[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)			

Q27. Please briefly describe the resources or support for the commercialization process your Lab provides. (Please address each item you checked "Yes" to above.) {Q19 PRE}

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)	

[ASK ALL (Q1 = 1 - 9)]

Q28. What, if anything, have you done to inform others in your lab about the Business Model Canvas approach? {Q41 POST}

1. [OPEN-ENDED RESPONSE]

[ASK ALL (Q1 = 1 – 9)]

Q29. What other activities, if any, have taken place in your lab to raise awareness of the Business Model Canvas approach? {Q42 POST}

1. [OPEN-ENDED RESPONSE]

[ASK ALL (Q1 = 1 – 9)

Q30. What changes at your Laboratory, if any, would help to increase commercialization activity? {Q43 POST}

1. [OPEN-ENDED RESPONSE]

I.4.7 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.5 COHORT 2 BASELINE SURVEY (TRAINING LAB ADMINISTERED)

1. First Name

2. Last Name

3. With which laboratory are you affiliated?

- Argonne National Laboratory (ANL)
- Fermi National Accelerator (FANL)
- Idaho National Laboratory (INL)
- Lawrence Berkeley National Laboratory (LBNL)
- Lawrence Livermore National Laboratory (LLNL)
- National Renewable Energy Laboratory (NREL)
- Oak Ridge National Laboratory (ORNL)
- Pacific Northwest National Laboratory (PNNL)
- Sandia National Laboratories (SNL)

4. Team Name

5. Team Member Role

- Principal Investigator (PI)
- Entrepreneurial Lead (EL)
- Industry Mentor (IM)

6. Please describe the problem that your technology solves (1-2 sentences).

7. Today, how well do you feel you understand the Business Model Canvas?

- I've never heard of it before this program
- I've heard of it, but never really used it
- I've taken classes/seminars where it was used
- Other (please specify)

8. Please rate your knowledge on the individual components of the Business Model Canvas

(None), (Very little), (Some), (A great deal), (Not sure)

- Customer Segments

- Value Proposition
- Channels
- Key Partners
- Customer
- Relationships
- Key Resources
- Revenue Streams
- Cost Structure
- Key Activities

9. Do you have any experience with the Customer Discovery Process?

10. On a scale of 1 to 10 (1 being "not at all" and 10 being "extremely well"), how well do you understand the market needs related to your technology?

11. What is your level of Technology Transfer/Commercialization experience? (Select all that apply)

- I've submitted record(s) of invention
- A patent has been filed on my invention(s)
- A patent has been issued on my invention(s)
- My invention has been listed as background IP in a CRADA or other partnership agreement
- I've successfully licensed my invention to a commercial entity
- I've launched a start-up with a DOE lab technology
- Other (please specify)

12. Do you have relationships outside of the laboratory that could potentially help your commercialization process?

- Yes
- No
- Not sure

13. Today, what is the ideal outcome from your participation in the Lab-Corps program? (Select all that apply)

- A commercial license for my technology

- A new partnership agreement (CRADA or other)
- A start-up company
- Additional funding or investment to develop this technology
- Increase in market awareness
- Other (please specify)

15. In your own words, please share your expectations for this program

I.6 COHORT 2 POST-TRAINING SURVEY (TRAINING LAB ADMINISTERED)

First Name

2. Last Name

3. With which laboratory are you affiliated?

- Argonne National Laboratory (ANL)
- Brookhaven National Lab (BNL)
- Fermi National Accelerator (FANL)
- Idaho National Laboratory (INL)
- Lawrence Berkeley National Laboratory (LBNL)
- Lawrence Livermore National Laboratory (LLNL)
- National Renewable Energy Laboratory (NREL)
- Oak Ridge National Laboratory (ORNL)
- Pacific Northwest National Laboratory (PNNL)
- Sandia National Laboratories (SNL)
- None of the above

4. Team Name.

- Team 1 - BioAlchemy
- Team 2 - Biolyst Renewables
- Team 3 - Evodia
- Team 4 - HMPP
- Team 5 - Micro Miners
- Team 6 - Resin Water Electrodeionization
- Team 7 - NanoHeatBlock
- Team 8 - Polymer Membranes
- Team 9 - Quake
- Team 10 - Saline Solutions
- Team 11 - Smart Charge Adapter

- Team 12 - SolGuard
- Team 13 - TOUGH
- Team 14 - VOLTTRON
- Team 1 - Hydro Scanner
- Team 2 - MAIforBldgs
- Team 3 - Monolith
- Team 4 - Fermians
- Team 5 - DLR
- Team 6 - WasteNot
- Team 7 - FiberSAS
- Team 8 - SwitchGlaze

5. Team Member Role.

- Principal Investigator (PI)
- Entrepreneurial Lead (EL)
- Industry Mentor (IM)
- Other (Lab rep, observer, etc.)

6. In the initial survey you took, you were asked to describe the problem that your technology solved. Now that you have completed the training, has this changed?

- Yes
- No
- Not Sure Yet

7. If yes, please explain.

8. Did you make any pivots over the course of the program (market, customer segment, etc.)?

- Yes
- No
- Not Sure

9. If yes, please explain.

10. Now that you have completed training on the Business Model Canvas, please rate your understanding of the individual components.

(None), (Very little), (Some), (A great deal), (Not sure)

- Customer Segments
- Value Proposition
- Channels
- Key Partners
- Customer
- Relationships
- Key Resources
- Revenue Streams
- Cost Structure
- Key Activities

11. Now that you have completed the program, on a scale of 1 to 10 (1 being "not at all" and 10 being "extremely well"), how well do you feel you understand the market needs related to your technology?

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

12. Over the course of the program, did you build any new relationships that could potentially help with the commercialization of your technology?

- Yes
- No
- Not Sure

13. Through your experience with the Lab-Corps Program, do you feel you have identified a viable path to commercialization for your technology?

- Yes
- No
- Not Sure Yet

14. If yes, briefly explain your next steps and what is needed to get there (resources, additional training, etc.).

15. Overall, did the program meet, exceed, or fall short of your expectations? Please elaborate.

16. Which subjects would you like to have learned more about?

17. Are there any sessions you would recommend dropping or changing? Why?

18. Do you feel you had sufficient support from your management to devote the time needed for this program? (Please provide comments as necessary; specific responses will be kept confidential)

19. Do you have any feedback on the choice of venues for this training (Table Mountain Inn and Denver West Marriot)?

20. Do you have any additional comments/feedback you'd like to share on any aspects of the program (faculty, program length, associated technology, etc.)?

21. Would you recommend this program to others?

- Yes
- No
- Not Sure

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