

# The Economic and Programmatic Impacts of the Maryland Technology Development Corporation on the Maryland Economy



Prepared for:  
The Maryland Technology  
Development Corporation  
(TEDCO)

Prepared by:  
Battelle  
Technology Partnership  
Practice

December 2015



Battelle does not engage in research for advertising, sales promotion, or endorsement of our clients' interests including raising investment capital or recommending investments decisions, or other publicity purposes, or for any use in litigation. Battelle endeavors at all times to produce work of the highest quality, consistent with our contract commitments. However, because of the research and/or experimental nature of this work the client undertakes the sole responsibility for the consequence of any use or misuse of, or inability to use, any information, apparatus, process or result obtained from Battelle, and Battelle, its employees, officers, or Trustees have no legal liability for the accuracy, adequacy, or efficacy thereof.

## TABLE OF CONTENTS

	Page
<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
Approach to Measuring TEDCO’s Record of Achievement .....	3
Sizable Economic Impacts Found from TEDCO’s Core Research and Technology Deployment Programs .....	4
Functional and Strategic Impacts of TEDCO’s Operations .....	6
<b>INTRODUCTION .....</b>	<b>7</b>
TEDCO’s Mission and Selected Performance Metrics .....	7
The Battelle Assessment Approach: Going Beyond Standard Economic Multiplier Analysis to Consider Broader Catalytic or Functional Impacts of TEDCO’s Programs .....	9
<b>ECONOMIC MULTIPLIER IMPACTS OF TEDCO’S FIVE CORE PROGRAMS .....</b>	<b>12</b>
Methodology .....	12
Aggregated Direct Impacts: TEDCO’s Five Largest Programs .....	13
TEDCO’s Overall Estimated Impacts – TEDCO’s Five Largest Programs in Aggregate .....	14
Total Estimated Economic Impacts – Program-Specific .....	15
Economic Impacts of the Technology Commercialization Fund .....	15
Economic Impacts of the Maryland Innovation Initiative .....	16
Economic Impacts of the Maryland Stem Cell Research Fund .....	16
Economic Impacts of the Maryland Cyber Security Investment Fund .....	17
Economic Impacts of the Propel Baltimore Fund .....	17
Projected 2020 Impacts of TEDCO’s Five Largest Programs .....	18
Summary and Conclusion – Economic Impact Analysis .....	19
<b>FUNCTIONAL IMPACTS OF TEDCO’S OVERALL OPERATIONS .....</b>	<b>21</b>
The Role of TEDCO in Maryland’s Entrepreneurial and Technology Development Ecosystem .....	22
Descriptions and Outcome Measures for TEDCO’s Key Programs .....	28
Entrepreneurial Support Programs .....	34
<b>SUMMARY AND CONCLUSION – TEDCO’S ROLE IN MARYLAND TECHNOLOGY GENERATION, TRANSFER, AND COMMERCIALIZATION .....</b>	<b>37</b>

## LIST OF TABLES

	<b>Page</b>
<i>Table ES-1. FY2015 Economic Contribution of TEDCO’s Five Largest Programs on the Maryland Economy .....</i>	<i>5</i>
<i>Table ES-2. FY2015 Economic Contribution of TEDCO’s Five Core Programs on the Maryland Economy by Program.....</i>	<i>6</i>
<i>Table 1. Direct Impacts of TEDCO’s Five Core Programs – FY2015.....</i>	<i>14</i>
<i>Table 2. Economic Impact of TEDCO’s Five Largest Programs on Maryland – In Aggregate, FY 2015... </i>	<i>15</i>
<i>Table 3. Economic Impact of the Technology Commercialization Fund on Maryland, FY 2015 .....</i>	<i>16</i>
<i>Table 4. Economic Impact of the Maryland Innovation Initiative on Maryland, FY 2015.....</i>	<i>16</i>
<i>Table 5. Economic Impact of the Maryland Stem Cell Research Fund on Maryland, FY 2015 .....</i>	<i>17</i>
<i>Table 6. Economic Impact of the Maryland Cyber Security Investment Fund on Maryland, FY 2015.....</i>	<i>17</i>
<i>Table 7. Economic Impact of the Maryland Propel Baltimore Fund on Maryland, FY 2015.....</i>	<i>18</i>
<i>Table 8. Projected 2020 Economic Impact of TEDCO’s Five Largest Programs on Maryland .....</i>	<i>19</i>
<i>Table 9. Alignment of TEDCO Programs with the Stages of the Commercialization Process .....</i>	<i>24</i>
<i>Table 10. Total Venture Capital Investment, 2009-15 .....</i>	<i>27</i>
<i>Table 11. Venture Capital Investment Normalized by R&amp;D, 2011 .....</i>	<i>27</i>
<i>Table 12. MSCRF Applications and Awards.....</i>	<i>30</i>
<i>Table 13. Maryland Innovation Initiative Applications and Awards.....</i>	<i>32</i>
<i>Table 14. Technology Commercialization Fund Applications and Awards.....</i>	<i>33</i>

## LIST OF FIGURES

<i>Figure 1. TEDCO in the Maryland Technology and Entrepreneurial Development Ecosystem .....</i>	<i>23</i>
<i>Figure 2. Risk Capital and Technology Commercialization – The “Valley of Death” .....</i>	<i>25</i>
<i>Figure 3. TEDCO’s Role in the Commercialization-based Entrepreneurship Process.....</i>	<i>26</i>

## ABBREVIATIONS

Abbreviation	Definition
CIF	Cyber Security Investment Fund
FDA	US Food and Drug Administration
GDP	gross domestic product
I/O	input/output
ICE	Innovation, Corporate Excellence and Entrepreneurship
mdPACE	medical device Product Acceleration and Commercialization by Executives
MERL	Maryland Entrepreneurs Resource List
MII	Maryland Innovation Initiative
MSCRF	Maryland Stem Cell Research Fund
MVF	Maryland Venture Fund
NIST	National Institute of Standards and Technology
N-STEP	NIST – Science and Technology Entrepreneurship Program
PBF	Propel Baltimore Fund
R&D	Research and Development
RBI2	Rural Business Innovation Initiative
SBIR	Small Business Innovation Research
TBED	Technology-based Economic Development
TCF	Technology Commercialization Fund
TCP	TEDCO Capital Partners
TEDCO	Technology Development Corporation (State of Maryland)
TPP	Technology Partnership Practice (Battelle)

## EXECUTIVE SUMMARY

**Innovation is the key determinant of international competitiveness.** According to a report by Deloitte and the Council on Competitiveness Manufacturing Competitiveness Initiative, “the competitiveness of a nation ultimately depends upon how successful is its national innovation ecosystem. An innovation ecosystem is composed of people, resources, policies, and institutions that promote the translation of new ideas into tangible products, technologies, and services. Hence, a successful innovation ecosystem efficiently links resources invested in the knowledge economy to increased profits by creating new products, processes, and services.”<sup>1</sup>

**Policies to support the innovation ecosystem are at the forefront of state economic development policy.** According to a 2013 National Research Council Report, Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century, “In recent decades, however, innovation-related initiatives have moved to the center of state and local development efforts, featuring initiatives such as the upgrading of university research infrastructure, faculty recruiting, the promotion of systematic and professionalized university-industry technology transfer, the fostering of start-ups, and the development of research and innovation-based industrial clusters.”<sup>2</sup>

**Maryland is still not fully capitalizing on its significant innovation and technology assets.** Maryland is a recognized international leader in research and development—with major research universities and the nation’s most advanced complex of federal laboratories. But Maryland has been less successful in terms of the transformation of its research and development strengths into new products, high-growth companies, and jobs. According to the Maryland Economic Development and Business Climate Commission, “Our principal finding is that Maryland has not nearly reached its potential in growing business and creating jobs. Although operating in a high-tech economy and ranking first in the nation in the monetary value of research conducted within its borders, Maryland, during the past decade, ranks thirty-seventh in percentage job growth and twenty-sixth in the growth rate of creating university-based start-ups.”<sup>3</sup>

**TEDCO’s Programmatic Offerings are expanding.** In 2015, TEDCO assumed management of the Maryland Venture Fund (MVF), Maryland’s seed and early stage investing program and the Maryland Life Sciences Investment Fund, and received federal funding for the mdPACE program to support the development of medical device companies and the N-STEP program to facilitate the commercialization of NIST technologies.

**TEDCO is viewed as a key and highly successful element of Maryland’s Entrepreneurial and Technology Commercialization Ecosystem.** According to the Maryland Economic Development and Business Climate Commission, “TEDCO is regarded as being a highly effective facilitator of early stage business development and entrepreneurship.” The Commission goes on to recommend that TEDCO’s role be expanded and that “As the State’s financial conditions improve, [Maryland should] increase TEDCO’s investment budget to more nearly match those of high-performing states.” With the transfer of the

---

<sup>1</sup> Deloitte, Advanced Technologies Initiative Manufacturing & Innovation, 2015 [http://www.compete.org/storage/documents/Deloitte\\_and\\_Council\\_on\\_Competitiveness\\_Advanced\\_Tech\\_Report\\_11-17-15.pdf](http://www.compete.org/storage/documents/Deloitte_and_Council_on_Competitiveness_Advanced_Tech_Report_11-17-15.pdf), page 22.

<sup>2</sup> Charles W. Wessner ED. “Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century.” 2013, The National Academies Press, Washington, DC., page 28.

<sup>3</sup> “Report of the Maryland Economic Development and Business Climate Commission.” 2015. Department of Legislative Services Office of Policy Analysis Annapolis, Maryland page iii.

Maryland Venture Fund and the Life Sciences Investment Fund to TEDCO in 2015, the State is beginning to implement these recommendations.

**TEDCO's efforts are generating a strong and growing economic impact.** According to this independent assessment by the Battelle Technology Partnership Practice, the economic development consulting group of the world's largest independent research and development non-profit, TEDCO's operations generate significant and growing economic impacts:

- *The economic contribution to the Maryland economy of TEDCO's five core research, technology transfer, and commercialization programs totaled almost \$1.0 billion in 2015, generating a total of 4,358 jobs;*
- *TEDCO's efforts are also generating high quality jobs with average labor income per job created estimated at \$74,700 compared to statewide average labor income per worker of \$63,700; and*
- *The economic activity associated with TEDCO's core programs increased by 70 percent and the jobs created have increased by more than 50 percent since the 2013 assessment of TEDCO's economic impact. While part of these gains can be attributed to the inclusion of two new programs, TEDCO's core commercialization programs – the Technology Commercialization Fund and Maryland Innovation Initiative (TCF and MII) – experienced significant gains in their estimated impacts.*

**TEDCO is a good investment for Maryland.** Estimated state and local government revenues from the economic activity attributable to TEDCO activities reached \$35.8 million in 2015, with \$20.4 million in estimated State of Maryland revenues and \$15.5 million in estimated local government revenues, and:

- *The estimated 2015 State of Maryland revenues of \$20.4 million attributable to the five core programs analyzed exceeds TEDCO's FY2015 appropriation of \$17.6 million;*
- *Excluding the Maryland Stem Cell Research Fund (MSCRF), Battelle calculated an estimated 29 percent return on investment for 2015 on the State of Maryland's investment in TEDCO's four core commercialization programs; and*
- *Even when the MSCRF is included, TEDCO generated a still respectable 11 percent return on investment for 2015.*

**Most importantly, the impact of TEDCO's existing efforts is projected to grow substantially over the next decade.** Battelle estimates that the economic impacts associated with TEDCO's five core programs will grow to \$1.4 billion in 2020, supporting a total of 6,520 jobs earning \$487.4 million in labor income, and generate state and local government revenues of \$53.3 million, an almost 50 percent increase over TEDCO's current economic impact, based on current funding and outcomes levels. These ever-rising impacts from TEDCO's investments are not surprising, and reflect the fact that TEDCO's efforts play a key role in early-stage venture development, which will continue to have a positive economic impact for as long as those new ventures continue to operate. This type of activity generates a significant pay-off in sustaining future economic growth.

## Approach to Measuring TEDCO's Record of Achievement

TEDCO plays the lead role in Maryland's efforts to expand commercialization and is involved in all stages of the commercialization process, from supporting research, to facilitating technology transfer, to supporting entrepreneurship, to investing in companies. TEDCO's mission of supporting technology development and commercialization gives the corporation a clear and vitally important role in Maryland's economic development efforts and the state's entrepreneurial ecosystem. In order to describe its important contributions to Maryland, TEDCO retained the Battelle Technology Partnership Practice (TPP) to update its 2013 *Economic and Programmatic Impacts of the Maryland Technology Development Corporation on the Maryland Economy* report.

Battelle is the world's largest non-profit independent R&D institution, and the Battelle TPP is a leading national provider of advanced impact analysis and economic development consulting services for state governments, regional economic development organizations, and major research universities and institutions. The program staff at the TPP has considerable experience in evaluating the impact of investments in technology-based economic development (TBED) at the national, state, and regional levels.

As in the 2013 report, the Battelle TPP's approach in analyzing the economic and functional benefits of TEDCO's operations combined a **quantitative analysis** of the economic and fiscal impacts of TEDCO's five core research, commercialization, and investment programs, with a **qualitative assessment** of the role and contribution of TEDCO's overall operations to Maryland's technology and entrepreneurial ecosystem. The analysis prepared by Battelle for TEDCO consists of the following two components:

- Input/output (I/O) analysis to measure the direct, indirect, and induced economic impacts of TEDCO's five core programs on the Maryland economy. This updated analysis added two additional TEDCO programs, the CIF and the PBF, to its 2013 analysis of the TCF, MII, and MSCRF. This quantitative analysis estimates the economic contribution of these five programs on Maryland employment, labor income, business volume (economic output), and state and local government revenues; and
- A qualitative assessment of the functional impact of the role and importance of these five programs as well as TEDCO's mentoring and other technology and business support programs to enhancing Maryland's technology and entrepreneurial ecosystem.

## **Sizable Economic Impacts Found from TEDCO's Core Research and Technology Deployment Programs**

TEDCO provides a broad range of programs to meet the needs of Maryland's technology commercialization and entrepreneurial system. Battelle prepared an economic impact analysis of TEDCO's five core programs to assess their economic impact on the Maryland economy. Battelle analyzes the economic contribution of such TBED programs in terms of their impact in two core areas:

- **Research and Development (R&D) Expenditures** – TBED programs support university, business, and other types of research and development expenditures. These expenditures have economic impacts as they are circulated in a regional economy; and
- **Business Activities** – TBED organizations provide programs to: 1) foster entrepreneurship and the commercialization of new technologies; and 2) meet the capital needs of entrepreneurial and technology-based businesses. These programs create a “portfolio” of businesses assisted by state or local TBED programs. The operations of these businesses created or assisted and the product sales related to technologies commercialized represent the core economic impacts associated with TBED programs.

The research expenditures and business activity supported by TEDCO's TBED programs have multiplier effects across Maryland's economy. In order to conduct research, universities, federal laboratories, and business R&D facilities purchase goods and services from local suppliers and employ local residents. Similarly, technology-based businesses purchase goods and services from local suppliers and pay salaries to local workers. These purchases and wages are circulated in the regional economy to other businesses and workers who in turn purchase goods and services from other local companies, who employ and pay wages and salaries to other workers through successive cycles of revenues and purchases. As a result, the total economic activity supported by TBED programs is greater than their simple R&D expenditures or portfolio company revenues, expenditures and jobs created. This additional increment of economic activity is called the “multiplier effect.”

As presented in Table ES-1, the economic contribution to the Maryland economy of the research and business activities associated with TEDCO's five largest programs totaled almost \$1 billion in FY2015, supporting a total of 4,358 jobs earning \$325.6 million in labor income, and generating estimated state and local government revenues of \$35.8 million. Battelle estimates that the economic activity generated or supported by TEDCO's five largest programs generates an estimated \$20.3 million in State of Maryland revenues, an amount that exceeds its FY2015 appropriation of \$17.6 million.

**Table ES-1. FY2015 Economic Contribution of TEDCO's Five Largest Programs on the Maryland Economy**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$572,308,790	\$183,472,572	1,916	\$14,079,757	\$42,215,311
Indirect Impacts	\$199,399,838	\$76,901,341	1,110	\$9,723,214	\$17,557,030
Induced Impacts	\$188,537,383	\$65,266,751	1,332	\$12,040,670	\$15,827,631
<b>Total Impact</b>	<b>\$960,246,011</b>	<b>\$325,640,664</b>	<b>4,358</b>	<b>\$35,843,641</b>	<b>\$75,599,972</b>
State Impact Multiplier	1.68	1.77	2.27		

Source: Battelle calculations using IMPLAN I/O modeling

The estimated impacts associated with each of TEDCO's five programs are presented in Table ES-2, with the contribution of each program as follows:

- The portfolio of 239 TCF companies analyzed<sup>4</sup> generates \$884.3 million in economic activity, supports 3,883 jobs earning \$292.9 million in labor income, and generates \$32.7 million in combined state and local government revenues. The economic activity associated with the TCF program has increased by more than 60 percent and the job impacts by almost 50 percent since the 2013 report;
- The portfolio of 11 MII companies analyzed generates \$13.3 million in economic activity, supports 74 jobs earning \$4.9 million in labor income, and generates \$0.5 million in combined state and local government revenues;
- The \$9 million in MSCRF research funding generates \$18.0 million in economic activity, supports 98 jobs earning \$7.2 million in labor income, and generates \$0.7 million in combined state and local government revenues;
- The portfolio of 4 CIF companies analyzed generates \$13.0 million in economic activity, supports 63 jobs earning \$5.0 million in labor income, and generates \$0.5 million in combined state and local government revenues; and
- The portfolio of 4 PBF companies analyzed generates \$31.7 million in economic activity, supports 240 jobs earning \$15.6 million in labor income, and generates \$1.4 million in combined state and local government revenues.

<sup>4</sup> As described above, Battelle analyzed the impact of each company in the program that it first participated in. Thus, the number of companies in the economic impact analysis described below differ from the total number of companies that participated in each program.

**Table ES-2. FY2015 Economic Contribution of TEDCO's Five Core Programs on the Maryland Economy by Program**

Program <sup>1</sup>	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Technology Commercialization Fund	\$884,281,937	\$292,877,897	3,883	\$32,771,582	\$69,434,802
Maryland Innovation Initiative	\$13,262,943	\$4,944,034	74	\$499,735	\$1,067,751
Maryland Stem Cell Research Fund	\$17,979,817	\$7,182,805	98	\$679,963	\$800,959
Cyber Security Investment Fund	\$13,007,311	\$5,026,446	63	\$481,916	\$1,142,129
Propel Baltimore Fund	\$31,714,003	\$15,609,482	240	\$1,410,445	\$3,154,331
<b>Total Impact</b>	<b>\$960,246,011</b>	<b>\$325,640,664</b>	<b>4,358</b>	<b>\$35,843,641</b>	<b>\$75,599,972</b>
(1) Note in order to avoid double counting, eight firms that participated in 2 different programs were allocated to the first program in which they participated.					

Source: Battelle calculations using IMPLAN I/O modeling

## Functional and Strategic Impacts of TEDCO's Operations

Since its founding, TEDCO has deployed \$190 million to support the development and growth of Maryland's entrepreneurial and innovation ecosystem. Its accomplishments through FY2015 include the following:

- TEDCO has supported the development of a portfolio of more than 329 entrepreneurial and technology-based businesses;
- TEDCO has supported over \$137 million in research;
- TEDCO has funded more than 648 research projects across the State;
- Since TEDCO initiated the MII in November 2012 it has funded 141 projects at five Maryland universities, providing a total of \$13.5 million in research and commercialization funding, with a total of 22 companies formed based on MII supported technologies;
- The MSCRF has awarded \$128 million in 383 translational research grants; and
- Since 2010, TEDCO's RBI programs have mentored 794 companies and provided \$465,594 in funding to 74 projects.

**While TEDCO's economic and functional impacts to date are impressive, there is strong evidence of unmet needs across Maryland's entrepreneurial and innovation ecosystem.** While TEDCO's budget grew in FY2013 with the creation of the MII program, its budget has been largely flat over the past three years and well below the levels of the end of the last decade, while awareness of and participation in the Corporation's programs has increased. In FY2015, TEDCO was able to fund only 17 percent of MSCRF, 39 percent of MII, and 25 percent of TCF applications received, an acceptance level lower than most previous years for each of these programs.

**Through its diverse programs and efforts, TEDCO makes a clear and important contribution to improving the technology and entrepreneurial development ecosystem in Maryland. TEDCO's contribution to Maryland's economic development efforts has been recognized by the Maryland Economic Development and Business Climate Commission, which recommends expanding the Corporation's funding and mission.**

## INTRODUCTION

### TEDCO's Mission and Selected Performance Metrics

TEDCO was created by the Maryland State Legislature in 1998 to facilitate the transfer and commercialization of technology from Maryland's research universities and federal labs into the marketplace and to assist in the creation and growth of technology-based businesses in all regions of the state. TEDCO serves as the hub of Maryland's entrepreneurial network where start-ups find mentors, organizational assistance, facilities for daily operations, and a roadmap for success. TEDCO:

- Establishes and manages programs that support innovation;
- Establishes and manages programs that promote entrepreneurship;
- Provides funding for technology transfer development; and
- Provides funding for business formation, growth, and expansion.

Since its founding, TEDCO has deployed \$190 million to support the development and growth of Maryland's entrepreneurial and innovation ecosystem. Its accomplishments through FY2015 include the following:

- TEDCO has supported the development of a portfolio of more than 329 entrepreneurial and technology-based businesses;
- TEDCO supported companies have attracted more than \$670 million in follow on funding;
- TEDCO has supported over \$137 million in research;
- TEDCO has funded more than 648 research projects across the State;
- In FY2014, TEDCO reported a record 373 applications for its programs and supported 121 projects;
- Since TEDCO initiated the Maryland Innovation Initiative (MII) in November 2012, it has funded 141 projects at five Maryland universities, providing a total of \$13.5 million in research and commercialization funding, with a total of 22 companies formed based on MII supported technologies;
- The Maryland Stem Cell Research Fund (MSCRF) has awarded \$128 million in 383 translational research grants; and
- Since 2010, TEDCO's RBI programs have mentored 794 companies and provided \$465,594 in funding to 74 projects.

As a result of its success in supporting entrepreneurial and technology-based economic development in Maryland, TEDCO has attracted additional support from both the federal and state governments to expand its mission and program offerings. In the past year, TEDCO has assumed management of Maryland's principal venture capital program and its Life Sciences Investment Fund and attracted federal funding to support the growth and development of Maryland's medical devices sector and the commercialization of technologies developed at the National Institute of Standards and Technology. TEDCO's four newest programs include the following.

**1) The Maryland Venture Capital Fund** – TEDCO assumed management of the Maryland Venture Fund (MVF) from the Maryland Department of Commerce in October 2015. MVF is a regionally recognized leader in seed and early stage investing and a national model for state supported investment programs. With nearly two decades of experience and numerous successful investments, MVF invests in Maryland-based, highly innovative technology companies across the full range of industry sectors, including software, communications, cybersecurity, and life sciences companies in the areas of healthcare information technology (IT), medical devices, and diagnostics. The fund has total assets of approximately \$100 million. Approximately \$80 million is currently invested and \$15 million is available for new investments. Additionally, approximately \$45 million is in a designated evergreen fund, whose returns will be available for future new and follow on investments. The MVF has invested in over 150 companies that have created or retained more than 5,000 jobs.

**2) The Maryland Life Sciences Investment Fund** – Makes investments in companies developing products in human healthcare that require FDA approval.

**3) mdPACE** – In 2015, TEDCO received a \$500,000 grant from the U.S. Economic Development Administration (EDA) Office of Innovation and Entrepreneurship, to create the mdPACE (medical device Product Acceleration and Commercialization by Executives) Program. The goal of mdPACE is to accelerate the development of a medical device cluster in Maryland by providing entrepreneurs and early stage medical device companies with hands-on assistance from experienced medical device executives to facilitate U.S. Food and Drug Administration (FDA) clearance of new technologies. The mdPACE Program will operate like a virtual commercialization center, serving projects across the state, including in many of the region’s incubators. The goal for the program is to work with 5 to 7 medical device start-ups that are candidates for the FDA 510(k) regulatory pathway in the first year of the program.

**4) N-STEP** – In 2015, TEDCO developed the N-STEP (NIST – Science and Technology Entrepreneurship Program) is to facilitate the commercialization of technologies from NIST (National Institute of Standards and Technology). N-STEP is focused on the commercialization of NIST research and forming companies to independently pursue further translational research and development of technologies. N-STEP offers grants of up to \$112,000 to support projects that continue or initiate translational research and development activities specifically related to NIST’s mission.

***TEDCO’s success in promoting research, entrepreneurship, and technology commercialization is evident in the program highlights and outcome measures described above as well as in its success in attracting new funding and programs to expand and enhance its mission.*** In order to more rigorously document the impacts of TEDCO’s activities, TEDCO retained the Battelle Technology Partnership Practice (TPP) to update its 2013 report titled: Economic and Programmatic Impacts of the Maryland Technology Development Corporation on the Maryland Economy. Battelle is the world’s largest independent non-profit R&D organization, and TPP is Battelle’s technology-based economic development (TBED) consulting group, with a national standing in evaluating the impact of state and regional TBED programs.

## **The Battelle Assessment Approach: Going Beyond Standard Economic Multiplier Analysis to Consider Broader Catalytic or Functional Impacts of TEDCO's Programs**

Technology-Based Economic Development (TBED) efforts, such as the research, entrepreneurial support, technology commercialization, and financing/venture capital programs now being implemented by TEDCO, are increasingly important components of state-level economic development strategies. The goal of TBED programs is to create high quality jobs and support economic growth and development by coordinating, enhancing, and facilitating the deployment of the innovation, research, and technology assets residing within a state. Maryland, with its substantial base of academic and federal research facilities and innovation and technology-based businesses, is well positioned to benefit from TBED efforts. Indeed, according to the Milken Institute's *2014 State Tech and Science Index*, Maryland is ranked 2<sup>nd</sup> nationally in terms of its technology development capacity, with considerable strength in Research and Development Inputs, Human Capital Investment, Technology and Science Workforce, and Technology Concentration and Dynamism.<sup>5</sup>

***TBED efforts have broad and substantial impacts on regional economies.*** Their most tangible impact is the jobs and economic activity generated and supported by these programs. These are often measured in terms of their ***economic and fiscal impact*** on the regional economy. These impacts are estimated for this report through the use of economic modeling in order to assess the ***multiplier effects*** of the jobs created and research supported. However, economic modeling does not provide a complete picture of the overall importance and impact of TBED efforts. The core goal of TBED efforts is to enhance and support the entrepreneurial and technology development ecosystem existing in a state or region. TBED programs are designed specifically to strengthen the development, commercialization, and deployment of new innovations and technologies by addressing gaps in and facilitating the strength of the regional entrepreneurial and innovation ecosystem. These systemic ***functional impacts*** are at least equally important to the economic impact measures because by strengthening the entrepreneurial and innovation ecosystem, TBED programs establish a foundation to support future economic growth and development. While these systemic impacts are difficult to quantify, describing the need for, the importance of, and the role of TBED efforts is vital to assessing the overall impact of an organization such as TEDCO.

In this report, Battelle's approach is to combine an analysis of the ***economic and fiscal impacts*** with a description of the ***functional impacts*** of TEDCO's programs in order to provide a complete assessment of the value of TEDCO's program activities to advancing TBED in Maryland.

The Battelle TPP approach considers the ***economic and fiscal impacts*** of TEDCO's programs in terms of their impact in two core areas:

- Research and Development (R&D) Expenditures – TBED organizations support university, business, and other types of R&D expenditures, which have economic impacts as they are circulated in a regional economy; and
- Business Activities – TBED organizations provide programs to foster entrepreneurship, support the commercialization of new technologies, and meet the capital needs of entrepreneurial and technology-based businesses. These programs create a “portfolio” of businesses assisted by state

---

<sup>5</sup> <http://assets1b.milkeninstitute.org/assets/Publication/ResearchReport/PDF/StateTechScienceReport4Web.pdf>.

or local TBED programs. The operations of businesses created or assisted, and the product sales related to technologies commercialized, represent the economic impacts associated with TBED programs.

One standard technique for measuring the economic impact of this activity is to consider the successive cycles of revenues and purchases made based on the direct expenditures associated with the activity, event, or industry being studied. These purchases and wages are circulated in the regional economy in the form of purchases made from other businesses and wages paid to workers, who in turn purchase other goods and services from other local companies, who employ and pay wages and salaries to other workers through successive cycles of revenues and purchases. As a result, the total economic activity supported by these purchases is greater than their simple expenditures, and includes these additional rounds of spending, which are called multiplier effects. In essence, this traditional method for analyzing economic impact focuses on the backward linkages that spending has across the economy.

But TBED goes beyond simply having traditional economic impact multiplier effects. By its very nature, TBED programs serve as catalysts for further economic growth. As the State Science and Technology Institute explains in its *Resource Guide for Technology-based Economic Development*, the three major outputs from TBED are the advancement of a state's or region's (1) intellectual infrastructure, (2) capital, and (3) entrepreneurial culture.<sup>6</sup> The catalytic nature of TBED is demonstrated by the fact that spending on research activities and business activities are highly interrelated, with research expenditures helping to generate the technology breakthroughs that business activity spending then helps to commercialize.

To capture these broader catalytic aspects of TEDCO's programs, *functional impacts* from the following activities are also considered:

- **Investing in R&D and Technology Deployment:** generating technology through R&D and deploying that technology through technology commercialization efforts;
- **Fostering Entrepreneurship:** supporting the efforts of individual entrepreneurs, reducing barriers to entrepreneurial activity in general, and expanding the business and entrepreneurial skills available to new ventures; and
- **Increasing Capital Access:** working to expand the level of financial investment and business lending available to local technology businesses.

These functional impacts, also known to economists as forward linkage impacts, are the critically important impacts generated by the technology development and deployment programs provided by TEDCO. These include the role and importance of TEDCO's programs in Maryland's economic development efforts and the contribution of these programs to improving Maryland's technology and entrepreneurial development ecosystem. It is the delivery of these programs and services that are at the core of TEDCO's mission. As will be shown later in this report, the forward linkage functional/strategic impacts of TEDCO are many and have a substantial impact on Maryland's economic development and technology and entrepreneurial development ecosystem. Functional impacts are a challenge to quantify. Some aspects such as research volume, companies mentored, and technologies licensed or patented can be quantified. However, assigning an economic value to these programs, projects, or interventions is difficult, if not impossible. As a result, Battelle has focused its efforts on describing the need for the TEDCO programs offered along with any available performance metrics.

---

<sup>6</sup> [http://www.ssti.org/Publications/Onlinepubs/resource\\_guide.pdf](http://www.ssti.org/Publications/Onlinepubs/resource_guide.pdf).

Bringing together the economic multiplier impacts and functional impacts allows a complete assessment of the value of TEDCO's program activities in advancing Maryland's TBED.

In the following sections, Battelle sets out its full analysis of the economic and functional impacts generated by TEDCO in Maryland. The analyses provided by Battelle incorporate the following:

- The use of input/output (I/O) analysis to measure the direct, indirect, and induced economic impacts of five of TEDCO's core programs on the Maryland economy;
- Projections of economic future impacts based on TEDCO's recent experience; and
- An analysis of the functional impact and strategic importance of TEDCO's overall programmatic offerings in supporting technology commercialization and economic development in Maryland.

## ECONOMIC MULTIPLIER IMPACTS OF TEDCO'S FIVE CORE PROGRAMS

### Methodology

The economic activity generated in a city, county, region, or state is greater than the simple total of spending associated with the event or activity being studied. This is because as this money is earned it is, in turn, spent, earned, and re-spent by other businesses and workers in the local economy through successive cycles of spending, earning, and spending. However, the spending in each successive cycle is less than in the preceding cycle because a certain portion of spending “leaks” out of the economy in each round of spending. Leakages occur through purchases of goods or services from outside of the region and through federal taxation. The IMPLAN multipliers used in this analysis capture the effects of these multiple rounds of spending. This analysis focuses on five measures of economic impact:

- **Output.** The total value of production or sales in all industries;
- **Employment.** The total number of full and part time jobs in all industries;
- **Labor Income.** The wages and salaries, including benefits, and other labor income earned by the workers holding the jobs created;
- **State and Local Government Revenues.** The fiscal benefits accruing to both state and local governments in Maryland as a result of the direct and multiplier impacts associated with TEDCO's five core programs; and
- **Federal Government Revenues.** The fiscal benefits accruing to the federal government as a result of the direct and multiplier impacts associated with TEDCO's five core programs.

Four measures of the economic impacts and fiscal impacts of TEDCO's five core programs are presented in this report:<sup>7</sup>

- **Direct Impacts** – The change in economic activity being analyzed—in this case the research and portfolio company activity generated by TEDCO's five core programs;
- **Indirect Impacts** – The changes in inter-industry purchases, for example the purchase of research supplies;
- **Induced Impacts** – The changes in spending from households as income and population increase due to changes in production; and
- **Total Impacts** – The combined total of direct, indirect, and induced effects.

The economic impact analysis focusses on five of TEDCO's core programs because these programs represent the largest programs implemented by the corporation and because both spending and impact data are collected for each.

---

<sup>7</sup> Throughout this report dollar values are expressed in current dollars.

## **Aggregated Direct Impacts: TEDCO's Five Largest Programs**

The inputs to the economic and fiscal impact analysis are the research activities funded by and employment and business activities of the portfolio of companies that received support from TEDCO's five core programs. The direct impacts of these programs are presented in Table 1, and were defined as follows:

- The direct impacts of the **Technology Commercialization Fund (TCF)**, **Maryland Innovation Initiative (MII)**, **Cyber Security Investment Fund (CIF)**, and **Propel Baltimore Fund (PBF)** were the company-specific outcomes reported to TEDCO by each of the companies participating in the programs. The TCF program provides seed funding for companies to commercialize new products based on technology created in Maryland's universities and federal laboratories. The MII program funds efforts that promote commercialization of research conducted in five partnership universities. The CIF and PBF invest in companies to support commercialization and expansion. For each of these four programs, companies are required to report the level of employment, expenditures, revenues, and other impact figures, such as additional funding, resulting from the technology being commercialized or products developed.<sup>8</sup> These company operational revenues and expenses represent the estimated direct impact of the TCF, MII, CIF, and PBF programs.
- The direct impacts of the **Maryland Stem Cell Research Fund** were the research expenditures associated with the program, which were analyzed as occurring in the R&D sector of the Maryland economy.

***TEDCO is generating an expanding base of economic activities in Maryland.*** The direct Maryland economic activity generated by its five largest programs analyzed totals \$572.3 million in economic activity and 1,916 jobs in 2015, an increase of more than 70 percent in terms of revenues and expenditures and 56 percent growth in employment since the 2013 report. While some of this growth is attributable to the addition of two new programs (CIF and PBF) to the economic impact analysis, a significant portion of this growth is based on the growth of the core TCF and MII programs. The TCF remains the largest program in terms of direct impacts, generating 88 percent of direct jobs.

---

<sup>8</sup> TEDCO provided a database of 257 companies that received assistance from these five core programs. In order to avoid double counting of impacts, the eight firms that participated in more than one TEDCO program were allocated to the first program that each company participated in. TEDCO was able to provide recent employment data for 115 of these companies. In order to identify the industry of the portfolio of TEDCO assisted companies and verify the self-reported employment data, the Battelle-TPP purchased company records from the Hoovers database for the 152 of the 257 companies for which data were available. Between these two databases, employment data were available for 178 companies – 70 percent of the total. Data on type industry, by NAICs code, were available for 152 of these companies, 59 percent of the total. Data for the companies where employment or industry (NAICs code) were unavailable were identified by Battelle based on available company information. For the companies where no employment data were available, the median employment figure for the firms where employment data were available was used.

**Table 1. Direct Impacts of TEDCO’s Five Core Programs – FY2015**

	Revenues or Expenditures	Employment
Five Core TEDCO Programs <sup>1</sup>	\$572,308,790	1,916
Technology Commercialization Fund <sup>2</sup>	\$532,010,540	1,679
Maryland Innovation Initiative <sup>2</sup>	\$7,228,997	35
Maryland Stem Cell Research Fund <sup>3</sup>	\$9,093,590	41
Cyber Security Investment Fund <sup>2</sup>	\$7,315,534	25
Propel Baltimore Fund <sup>2</sup>	\$16,660,129	136
(1) In order to avoid double counting, companies were allocated into the program that they first participated in.		
(2) Employment - as reported by TEDCO. Revenues estimated by Battelle using IMPLAN.		
(3) MSCRF Research Spending.		

Source: TEDCO, FY 2015 Data and Battelle

It is important to note how the direct economic impacts associated with TEDCO differ from those of other state government entities. TEDCO’s core commercialization programs, TCF, MII, CIF and PBF, fund the commercialization of technologies. MSCRF represents an investment in translational stem cell research. These TEDCO programs can be viewed as an investment in a portfolio of companies and research that, unlike many other state government efforts, leverage the initial state funding with additional private capital (in the case of TCF, MII, CIF, and PBF), and with additional federal or private research funding (in the case of MSCRF). Furthermore, the portfolio of companies created, and in many cases the stem cell research projects initiated, remains active in Maryland even after the period of state funding ends, and, as a result, Maryland continues to capture the benefits associated with the growth of its companies supported and with the technologies commercialized from the funded stem cell research.

## TEDCO’s Overall Estimated Impacts – TEDCO’s Five Largest Programs in Aggregate

This section presents the results of the economic impact analyses for the five largest programs in aggregate, with the individual program by program results presented below that. For each analysis, Battelle provides the direct effect values driving the model (based upon the operational data provided by TEDCO), the additional estimated indirect and induced multiplier impacts, and a summation of the total impacts (direct, indirect, and induced). An impact multiplier is also provided for the three model drivers (employment, personal income, and output)—for every one (job or dollar) of direct effect, the multiplier number will equal the total (including the direct effect) number of jobs or dollars created in the regional economy. The following impact data are provided for each analysis: output, labor income (including both wages and benefits), employment, state and local tax revenue, and federal tax revenue.<sup>9</sup>

As presented in Table 2, the economic contribution to the Maryland economy of the five largest TEDCO programs totaled \$960 million in 2015, with a total of 4,358 jobs earning \$325.6 million in labor income and supporting estimated state and local government revenues of \$35.8 million. Total direct research expenditures and portfolio company revenues of \$572.3 million and employment of 1,916 are augmented with an additional \$199.4 million and 1,110 jobs from *Indirect Impacts* through the local purchases made to support this activity and by \$188.5 million and 1,332 jobs from *Induced Impacts* resulting from the

<sup>9</sup> The estimation of tax revenue is subject to significant variability due to ever-changing rate structures, the use of available exemptions, and the accounting of potential income, if any, subject to taxation. These figures should be viewed with some measure of caution throughout this analysis.

increase in local incomes attributable to TEDCO’s five core programs. These core program impacts have increased by 70 percent in terms of revenue and 54 percent in terms of employment since the 2013 report, supported by both growth in the impacts associated with the TCF and MII programs as well as from the addition of two new programs, CIF and PBF, to the impact analysis. The \$960.2 million in estimated TEDCO-supported impacts results in an output multiplier of 1.68, or \$1.68 in economic activity supported for each \$1 in research expenditures and portfolio company revenues.

**Table 2. Economic Impact of TEDCO’s Five Largest Programs on Maryland – In Aggregate, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$572,308,790	\$183,472,572	1,916	\$14,079,757	\$42,215,311
Indirect Impacts	\$199,399,838	\$76,901,341	1,110	\$9,723,214	\$17,557,030
Induced Impacts	\$188,537,383	\$65,266,751	1,332	\$12,040,670	\$15,827,631
<b>Total Impact</b>	<b>\$960,246,011</b>	<b>\$325,640,664</b>	<b>4,358</b>	<b>\$35,843,641</b>	<b>\$75,599,972</b>
State Impact Multiplier	1.68	1.77	2.27		

Source: Battelle calculations using IMPLAN I/O model of the State.

## Total Estimated Economic Impacts – Program-Specific

### *Economic Impacts of the Technology Commercialization Fund*

The portfolio of companies associated with TEDCO’s largest commercialization program – the Technology Commercialization Fund and its predecessor, the Maryland Technology Transfer and Commercialization Fund – had total direct employment of 1,679 and estimated direct impacts of \$532.0 million.<sup>10</sup> As presented in Table 3, the \$532.0 million in estimated portfolio company direct impacts generate \$884.3 million in economic activity in Maryland, support 3,883 jobs earning \$292.9 million, and have an associated \$32.8 million in estimated state and local government revenues. Total direct TCF portfolio operating impacts of \$532.0 million and employment of 1,679 jobs are augmented with an additional \$182.7 million and 1,005 jobs in *Indirect Impacts* through the local purchases made to support the operations of these companies and by \$169.6 million and 1,198 jobs in *Induced Impacts* from the increase in local incomes attributable to portfolio and supplier company operations. The \$884.3 million in estimated TCF-supported impacts results in an output multiplier of 1.66, or \$1.66 in economic activity supported for each \$1 in portfolio company revenues.

<sup>10</sup> Few companies reported revenues, which were estimated based on reported employment by the IMPLAN model. See note 7 for the derivation of the inputs to the analysis.

**Table 3. Economic Impact of the Technology Commercialization Fund on Maryland, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$532,010,540	\$163,755,539	1,679	\$12,947,684	\$38,825,742
Indirect Impacts	\$182,693,663	\$70,419,583	1,005	\$8,994,228	\$16,238,339
Induced Impacts	\$169,577,734	\$58,702,775	1,198	\$10,829,670	\$14,370,721
<b>Total Impact</b>	<b>\$884,281,937</b>	<b>\$292,877,897</b>	<b>3,883</b>	<b>\$32,771,582</b>	<b>\$69,434,802</b>
State Impact Multiplier	1.66	1.79	2.31		

Source: Battelle calculations using IMPLAN I/O model of the State.

### **Economic Impacts of the Maryland Innovation Initiative**

As presented in Table 4, the 11 companies that have been started as a result of the Maryland Innovation Initiative directly generate an estimated \$7.2 million in economic activity in Maryland and employ 35 workers earning \$2.7 million in labor income. Total direct impacts are augmented with an additional \$3.2 million and 19 jobs in *Indirect Impacts* through the local purchases made to support company activities and by \$2.9 million and 20 jobs in *Induced Impacts* from the increase in local incomes attributable to these company-related expenditures, for a total impact of \$13.3 million, supporting 74 jobs earning \$4.9 million and supporting \$500,000 in state and local government revenues. The \$13.3 million in MII-supported impacts results in an output multiplier of 1.83, or \$1.83 in economic activity supported for each \$1 in company revenues.

**Table 4. Economic Impact of the Maryland Innovation Initiative on Maryland, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$7,228,997	\$2,745,365	35	\$165,870	\$544,026
Indirect Impacts	\$3,171,345	\$1,207,721	19	\$151,051	\$281,136
Induced Impacts	\$2,862,601	\$990,948	20	\$182,814	\$242,589
<b>Total Impact</b>	<b>\$13,262,943</b>	<b>\$4,944,034</b>	<b>74</b>	<b>\$499,735</b>	<b>\$1,067,751</b>
State Impact Multiplier	1.83	1.80	2.12		

Source: Battelle calculations using IMPLAN I/O model of the State

### **Economic Impacts of the Maryland Stem Cell Research Fund**

As presented in Table 5, the R&D activities associated with the Maryland Stem Cell Research Fund generate \$18.0 million in economic activity in Maryland, support 98 jobs earning \$7.2 million, and have an associated \$0.7 million in estimated state and local government revenues. Total direct research expenditures of \$9.1 million and direct employment of 41 research jobs are augmented with an additional \$4.7 million and 28 jobs in *Indirect Impacts* through the local purchases made to support this research activity and by \$4.2 million and 29 jobs in *Induced Impacts* from the increase in local incomes attributable to these research expenditures. The \$18.0 million in estimated MSCRF-supported impacts results in an output multiplier of 1.98, or \$1.98 in economic activity supported for each \$1 in research expenditures.

**Table 5. Economic Impact of the Maryland Stem Cell Research Fund on Maryland, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$9,093,590	\$3,965,391	41	\$208,574	353,367
Indirect Impacts	\$4,728,089	\$1,777,939	28	\$205,826	245,090
Induced Impacts	\$4,158,138	\$1,439,475	29	\$265,563	202,502
<b>Total Impact</b>	<b>\$17,979,817</b>	<b>\$7,182,805</b>	<b>98</b>	<b>\$679,963</b>	<b>\$800,959</b>
State Impact Multiplier	1.98	1.81	2.40		

Source: Battelle calculations using IMPLAN I/O model of the State

### **Economic Impacts of the Maryland Cyber Security Investment Fund**

As presented in Table 6, the three companies for which data were available that received funding from the Maryland Cyber Security Investment Fund directly generate an estimated \$7.3 million in economic activity in Maryland and employ 25 workers earning \$2.9 million in labor income. Total direct impacts are augmented with an additional \$2.8 million and 17 jobs in *Indirect Impacts* through the local purchases made to support company activities and by \$2.9 million and 21 jobs in *Induced Impacts* from the increase in local incomes attributable to these company-related expenditures, for a total impact of \$13.0 million, supporting 63 jobs earning \$5.0 million and supporting \$500,000 in state and local government revenues. The \$13.0 million in CIF-supported impacts results in an output multiplier of 1.78, or \$1.78 in economic activity supported for each \$1 in company revenues.

**Table 6. Economic Impact of the Maryland Cyber Security Investment Fund on Maryland, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$7,315,534	\$2,890,886	25	\$171,840	\$643,124
Indirect Impacts	\$2,783,324	\$1,128,608	17	\$124,299	\$252,518
Induced Impacts	\$2,908,453	\$1,006,952	21	\$185,777	\$246,487
<b>Total Impact</b>	<b>\$13,007,311</b>	<b>\$5,026,446</b>	<b>63</b>	<b>\$481,916</b>	<b>\$1,142,129</b>
State Impact Multiplier	1.78	1.74	2.50		

Source: Battelle calculations using IMPLAN I/O model of the State

### **Economic Impacts of the Propel Baltimore Fund**

As presented in Table 7, the four companies that received funding from the Propel Baltimore Fund and for which data were available<sup>11</sup> directly generate an estimated \$16.6 million in economic activity in Maryland and employ 136 workers earning \$10.1 million in labor income. Total direct impacts are augmented with an additional \$6.0 million and 41 jobs in *Indirect Impacts* through the local purchases made to support company activities and by \$9.0 million and 64 jobs in *Induced Impacts* from the increase in local incomes attributable to these company-related expenditures, for a total impact of \$31.7 million, supporting 240 jobs earning \$15.6 million in labor income and supporting \$1.4 million in state and local

<sup>11</sup> TEDCO reported 11 companies for the PBF, but 7 of these companies participated in other TEDCO programs (5 in TCF and 2 in CIF) before receiving PBF funding and were allocated to these other two programs.

government revenues. The \$13.0 million in PBF-supported impacts results in an output multiplier of 1.90, or \$1.90 in economic activity supported for each \$1 in company revenues.

**Table 7. Economic Impact of the Maryland Propel Baltimore Fund on Maryland, FY 2015**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$16,660,129	\$10,115,391	136	\$585,789	\$1,849,052
Indirect Impacts	\$6,023,417	\$2,367,490	41	\$247,810	\$539,947
Induced Impacts	\$9,030,457	\$3,126,601	64	\$576,846	\$765,332
<b>Total Impact</b>	<b>\$31,714,003</b>	<b>\$15,609,482</b>	<b>240</b>	<b>\$1,410,445</b>	<b>\$3,154,331</b>
State Impact Multiplier	1.90	1.54	1.77		

Source: Battelle calculations using IMPLAN I/O model of the State

## Projected 2020 Impacts of TEDCO’s Five Largest Programs

TEDCO’s operations generate an expanding portfolio of research and companies assisted. The impacts associated with TEDCO’s operations increase as the portfolio of TEDCO-assisted companies grows through two mechanisms: 1) employment growth of the existing portfolio companies; and 2) the addition of new companies assisted by TEDCO’s programs. Battelle projected the five-year growth in the economic impacts associated with TEDCO’s five core programs and their resultant research and commercialization activities based on the following assumptions:

- The existing portfolio of companies will experience 4 percent annual growth in employment. This rate of growth was based on an analysis of the average growth of the portfolio of TEDCO supported companies prepared for the 2013 economic impact report, prepared using five-year on longitudinal data from the National Establishment Time-Series (NETS) database;<sup>12</sup>
- A total of 19 new companies will be assisted by TCF each year;
- A total of 7 new companies will be formed based on the MII and CIF programs;<sup>13</sup> and
- Each of the new companies formed will have three employees, based on the 2013 report.

As presented in Table 8, the economic contribution to the Maryland economy of TEDCO’s five core programs is projected to grow to \$1.4 billion in 2020, supporting a total of 6,520 jobs earning \$487.4 million in Labor Income, and generate state and local government revenues of \$53.3 million.

<sup>12</sup> NETS was developed by Walls & Associates in partnership with Dun and Bradstreet (D&B). NETS converts D&B archival establishment data into a time series database of establishments that contains data on employment by establishment over time. NETS provides the ability to follow an establishment over time as it was formed, grew, contracted or changed corporate form. Annual rates of growth for the existing portfolio of companies were calculated for each of the past five years based on the year of company formation. Given that the past five year period used included the recent “Great Recession,” a period of considerable economic dislocation, these estimates can be viewed as conservative.

<sup>13</sup> This estimate was developed in cooperation with TEDCO based on the recent performance of both programs.

**Table 8. Projected 2020 Economic Impact of TEDCO's Five Largest Programs on Maryland**

	Output (\$s)	Labor Income (\$s)	Employment	State/Local Tax Revenue (\$s)	Federal Tax Revenue (\$s)
Direct Effect	\$848,917,523	\$274,544,371	2,858	\$20,786,291	\$63,116,943
Indirect Impacts	\$298,133,834	\$115,183,376	1,669	\$14,495,181	\$14,534,445
Induced Impacts	\$282,196,060	\$97,689,347	1,994	\$18,022,148	\$23,764,733
<b>Total Impact</b>	<b>\$1,429,247,417</b>	<b>\$487,417,093</b>	<b>6,520</b>	<b>\$53,303,620</b>	<b>\$113,237,326</b>
State Impact Multiplier	1.68	1.78	2.28		

Source: Battelle calculations using IMPLAN I/O model of the State.

The projected five-year growth in the economic impacts associated with TEDCO's five core programs from \$960 million in economic activity and 4,358 jobs currently to \$1.4 billion and 6,520 jobs in 2020 represents a nearly 50 percent increase in TEDCO-supported economic activity and employment. This analysis is based on current levels of state support and funding.

## Summary and Conclusion – Economic Impact Analysis

*TEDCO makes a significant economic contribution to the Maryland economy.* TEDCO's economic impact was not analyzed as a simple source of expenditures. Its investment in technology transfer, commercialization, and product development activity through TCF, MII, CIF and PBF has created, and continues to grow, a portfolio of companies that are key drivers of Maryland's high technology business community. This activity capitalizes on Maryland's existing research assets to create an expanding portfolio of companies, many of which might not exist except for the early-stage funding that TEDCO provided when those companies were at their most critical stage of development. Similarly, the MSCRF is an investment that is keeping Maryland competitive in the area of stem cell science, which will lead to future economic activities as this promising science matures and leads to a variety of new products. This investment ensures that Maryland will be well-positioned to take advantage of the economic opportunities that new products in this sector will generate. Overall in 2015, the portfolio of TCF, MII CIF and PBF, companies and the core research program (MSCRF) directly supported \$572.3 million in economic activity and 1,916 jobs in Maryland. When multiplier effects are included, their economic contribution totaled \$960.3 million, with a total of 4,358 jobs earning \$325.6 million in labor income, and estimated state and local government revenues of \$35.8 million.

Based on the IMPLAN estimated 2015 combined state and local government revenues of \$35.8 million, Battelle estimates the total Maryland state government portion to be \$20.4 million<sup>14</sup> in 2015. These estimated state tax revenues exceed TEDCO's FY2015 state appropriation of \$17.6 million. Approximately \$19.8 million of those state tax revenues are attributable to TCF, MII, CIF, and PBF, TEDCO's core commercialization and technology support and investment programs. As of FY2015, Maryland has invested a total of \$190 million in TEDCO. Just over one-third of that state funding, \$68.8 million, has supported TEDCO's TCF, MII, CIF, and PBF programs, with the remaining 64 percent going to the MSCRF.

<sup>14</sup> The IMPLAN model used estimates of total **combined** state and local revenues from a variety of major revenue sources, including income, property and sales taxes, and other revenues. Battelle distributed these IMPLAN estimated combined state and local revenues into their separate state and local revenue components estimates based on the distribution of state versus local revenues derived by each major revenue source from the U.S. Bureau of the Census *State and Local Government Finances Summary: 2013* report.

Battelle calculated an estimated 2015 return on investment of the State of Maryland's investment in TEDCO's four core programs, TCF, MII, CIF, and PBF. This return on investment analysis excludes the MSCRF because that is an investment in early-stage, translational research and thus cannot be expected to generate immediate economic and fiscal returns to the state. Economic and fiscal returns from MSCRF can be expected in the future as the stem cell sector grows and matures and research results are commercialized. **Focusing narrowly on the estimated state tax revenues associated with TCF, MII, CIF, and PBF, the 2015 return on TEDCO's investment totals 29 percent.**<sup>15</sup>

---

<sup>15</sup> Calculated by dividing \$19.8 million in estimated state government revenues from TEDCO's TCF, MII, CIF, and PBF programs by total state investment to date in those programs of \$68.8 million.

## FUNCTIONAL IMPACTS OF TEDCO'S OVERALL OPERATIONS

TEDCO was created by the Maryland State Legislature in 1998 to facilitate the transfer and commercialization of technology from Maryland's research universities and federal labs into the marketplace and to assist in the creation and growth of technology-based businesses in all regions of the state.

TEDCO's Mission is *to facilitate the creation and growth of businesses throughout all regions of the state by supporting entrepreneurship and innovative technologies.*

TEDCO's Vision is that *Maryland will be internationally recognized as a premier location for innovation, entrepreneurship and company formation with:*

- *Multiple innovation clusters;*
- *A large, established entrepreneurial community; and*
- *A thriving venture capital community.*

**Maryland is well positioned to capitalize on the investments made by TEDCO in research, technology commercialization, and entrepreneurial support.** Maryland's national prominence in technology development is evident in the following data from the Maryland Department of Commerce:

- Johns Hopkins University ranks first among academic institutions in the nation in research and development expenditures, totaling \$2.17 billion in FY 2013. The university also ranks first in federally funded research (\$1.90 billion).
- Maryland ranks first in National Institutes of Health research and development contract awards.
- Maryland ranks second in federal obligations for research and development (\$15.6 billion). On a per capita basis, Maryland ranks first among the states in federal R&D obligations.
- Maryland ranks third in research and development intensity, which is the ratio of R&D expenditures to gross domestic product (GDP) by state. Maryland ranks fourth in total R&D performance, first in federal intramural R&D, and fourth in R&D performed at universities and colleges.
- Maryland ranks fifth in R&D expenditures at universities and colleges, totaling \$3.45 billion in FY 2013. Further, Maryland ranks third in federal government R&D spending at universities and colleges with \$2.72 billion.
- Maryland ranks third per capita and fourth overall in Small Business Innovation Research Program (SBIR) awards for 2014.
- Maryland is ranked first among U.S. states in the percentage of professional and technical workers in the workforce.
- Maryland is ranked second in the Milken Institute State Technology and Science index 2014.
- Maryland is home to 400 ground-breaking research centers.<sup>16</sup>

Despite these many research and development, workforce, and technology business assets, Maryland is viewed by many as not fully capitalizing on its significant base of research and innovation assets. As home to major public and private universities, such as Johns Hopkins and the University System of

---

<sup>16</sup> See <http://commerce.maryland.gov/about/rankings-and-statistics>.

Maryland, and federal research facilities, ranging from the Beltsville Agricultural Research Center, the largest agricultural research center in the world, to the National Institutes of Health, the largest biomedical research facility in the world, to major federal defense and space research facilities, Maryland is at the forefront of research and development in a number of critical fields. However, Maryland has not fully capitalized on the economic development potential generated by these research assets. TEDCO was created to address this gap specifically.

The need to more fully capitalize on the many entrepreneurial, innovation, and research assets in the State was explicitly recognized by the Maryland Economic Development and Business Climate Commission, which reported that:

*“Our principal finding is that Maryland has not nearly reached its potential in growing business and creating jobs. Although operating in a high-tech economy and ranking first in the nation in the monetary value of research conducted within its borders, Maryland, during the past decade, ranks thirty-seventh in percentage job growth and twenty-sixth in the growth rate of creating university-based start-ups.”<sup>17</sup>*

TEDCO is recognized in the Commission report as a critical asset to support the efforts required for Maryland to meet its potential in capitalizing on its significant research and innovation base. The Commission found that “TEDCO is regarded as being a highly effective facilitator of early stage business development and entrepreneurship” and goes on to recommend that TEDCO’s role be expanded: “As the State’s financial conditions improve, increase TEDCO’s investment budget to more nearly match those of high-performing states.” With the transfer of the Maryland Venture Fund and the Life Sciences Investment Fund to TEDCO in 2015, the State is beginning to implement these recommendations.

This section of the report will first describe TEDCO’s role in Maryland’s technology and entrepreneurial development ecosystem and go on to describe both the need for and utilization of TEDCO’s key programs.

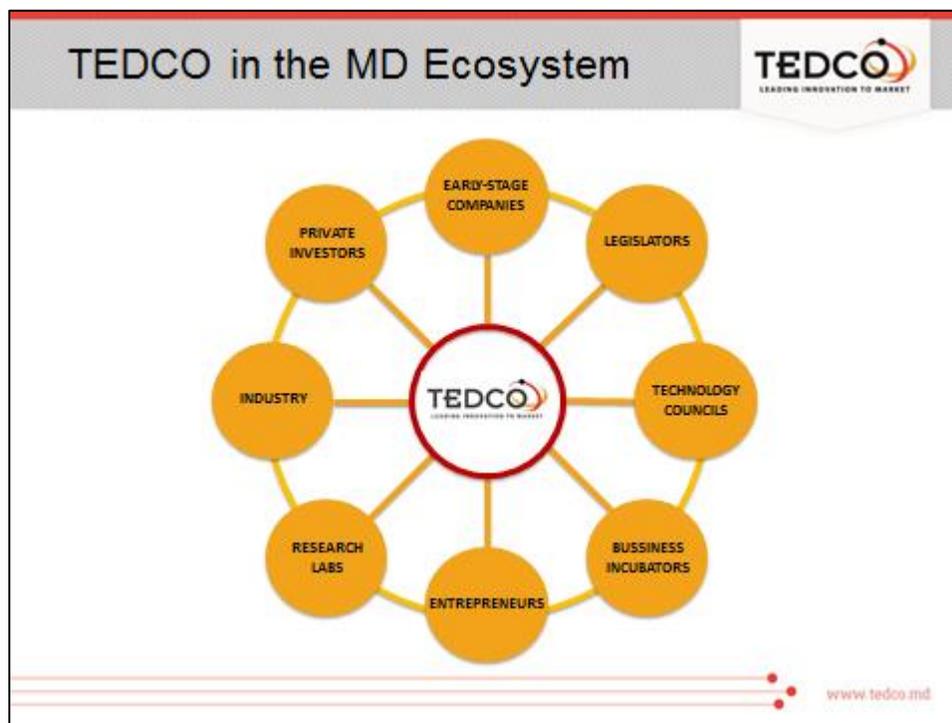
## **The Role of TEDCO in Maryland’s Entrepreneurial and Technology Development Ecosystem**

Economic development is not easy to achieve in general, and entrepreneurially driven and technology-based economic development represents an even greater challenge. The successful development of technology-based business sectors depends on a chain of factors that is particularly complex and challenging to manage. Success in entrepreneurial development is strongly influenced by a combination of local business, cultural, networking, and support assets. The states and regions in the U.S. that have achieved success in combining entrepreneurial and technology-based economic development, such as California and Massachusetts, have mature technology development ecosystems in place and early-established entrepreneurial cultures. Some successful technology centers developed organically over time (as occurred in Silicon Valley and Boston); while others result from the dedicated activities of states, regions, and key stakeholders to connect and build the ecosystem to ensure that such development happened (as occurred in the Research Triangle area). As presented in Figure 1, TEDCO operates the center of Maryland’s technology and entrepreneurial development ecosystem, working with and

---

<sup>17</sup> See <http://msa.maryland.gov/megafile/msa/speccol/sc5300/sc5339/000113/020000/020859/unrestricted/20150235e.pdf>. – Page 5.

providing services to the key institutions (universities/research labs), service providers (incubators/technology councils), investors, government, entrepreneurs, and the technology-based business community, all of whom drive the ecosystem.



**Figure 1. TEDCO in the Maryland Technology and Entrepreneurial Development Ecosystem**

Within Maryland’s entrepreneurial and technology development ecosystem, TEDCO provides a continuum of services across the three stages of the process of accelerating entrepreneurial innovation and advancing ideas to economic success, as follows:

**Idea Stage:** Generating research innovations and advancing technology that is being transferred from research labs to commercial business entities.

**Start-up Stage:** Providing startups and early stage ventures the knowledge, funding, and resources necessary to launch a new business.

**Expansion Stage:** Assisting existing companies that are in position to advance to the next stage of commercial viability but need outside capital investment and guidance to move forward.

An overview of the functional impacts of TEDCO’s overall programmatic offerings, including the five core programs analyzed above—and their alignment to the stages of accelerating entrepreneurial innovation and advancing ideas to economic success—is presented in Table 9.

**Table 9. Alignment of TEDCO Programs with the Stages of the Commercialization Process**

Program	Description	Idea Stage	Start-up Stage	Expansion Stage
Advanced Technology Innovation Partnership	Facilitates the commercialization of USDA Agricultural Research Service and other federal research	✓		
Maryland Stem Cell Research Fund	Funds stem cell research and medical treatments through grants to public and private entities in the State	✓		
Maryland Innovation Initiative	Supports the commercialization of research conducted in five research universities	✓	✓	
Technology Validation Program	Funding to validate a technology for a specific application and/or to validate the market opportunity for a technology	✓	✓	
N-Step	Facilitates the commercialization NIST research.	✓	✓	
mdPACE	Facilitates the testing and development of new medical devices	✓	✓	
Incubator Assistance Program	Support for Maryland’s incubators to provide additional services to their client companies		✓	
Cyber Security Investment Fund	Targeted investments in to cyber-security projects that advance a technology toward commercialization		✓	✓
Maryland Entrepreneurs Resource List	Mentoring or providing leadership to early stage companies		✓	✓
Rural Business Innovation Initiative	Provides technical and business assistance to small companies and early-stage technology-based companies in rural Maryland		✓	✓
Technology Commercialization Fund	Invests in projects that advance a technology toward commercialization		✓	✓
Propel Baltimore Fund	Invests in high-growth, early-stage companies willing to establish headquarters in Baltimore City		✓	✓
Maryland Venture Fund	Evergreen startup funding to early-stage companies in software, cybersecurity, life sciences, health IT and diagnostics.		✓	✓
Life Sciences Investment Fund	Makes investments in companies developing products in human healthcare that require FDA approval.		✓	✓

**Successful TBED efforts link the generators of new innovations through research with the entrepreneurial or management talent and risk capital required to develop new products and new companies.** This is the core goal and mission of TEDCO. Through its diverse and comprehensive programs, TEDCO:

- Supports, identifies, and links the new innovations and technologies being developed by Maryland’s federal, university and other research institutions into the entrepreneurial and technology development ecosystem;
- Facilitates and supports project and company access to entrepreneurial or management talent; and

- Provides access to capital to support early-stage product development and business start-up and expansion.

In an innovation rich environment like Maryland, the process of commercializing technology and supporting entrepreneurial development in general has a critical need for *access to entrepreneurial/management talent and capital*. Translating new research discoveries and innovations into firms and products with sales in the marketplace depends on not only the ability of firms to access the entrepreneurial/managerial talent to oversee the creation of new products or services, but also the risk capital to finance this creation. The financial aspects of technology commercialization have been called the “Valley of Death,” with financial cash flow elements and sources of capital varying by stage (Figure 2). Research has demonstrated that gaps within the “Valley of Death” impede the commercialization-based entrepreneurial process.

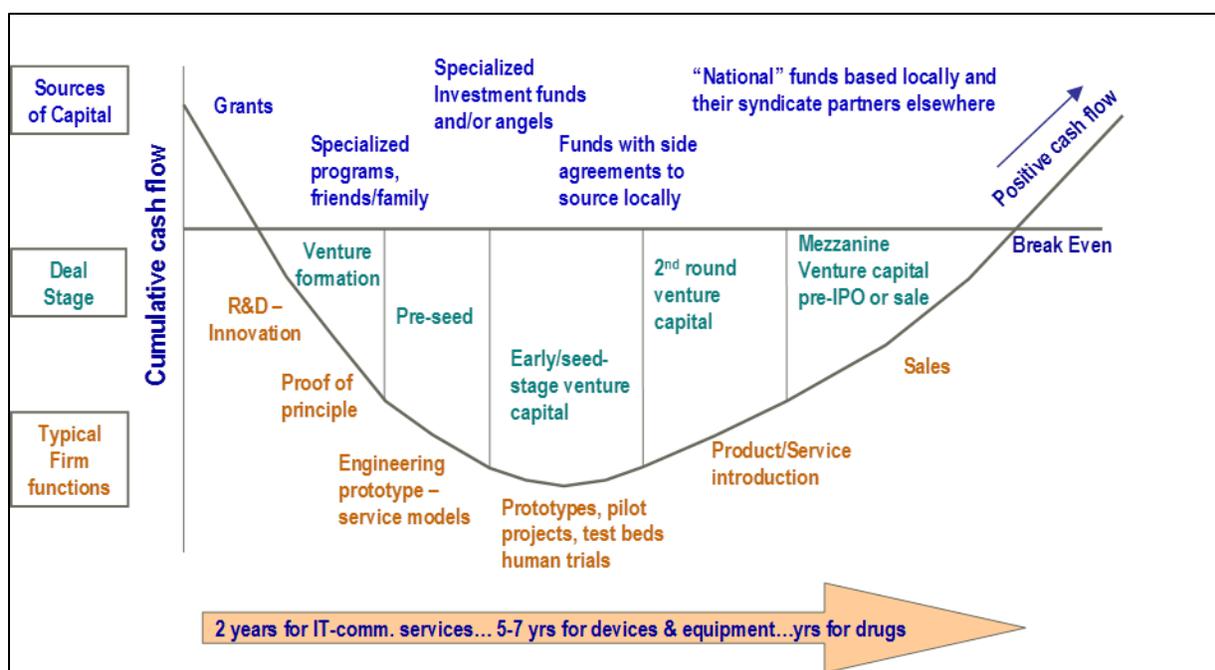
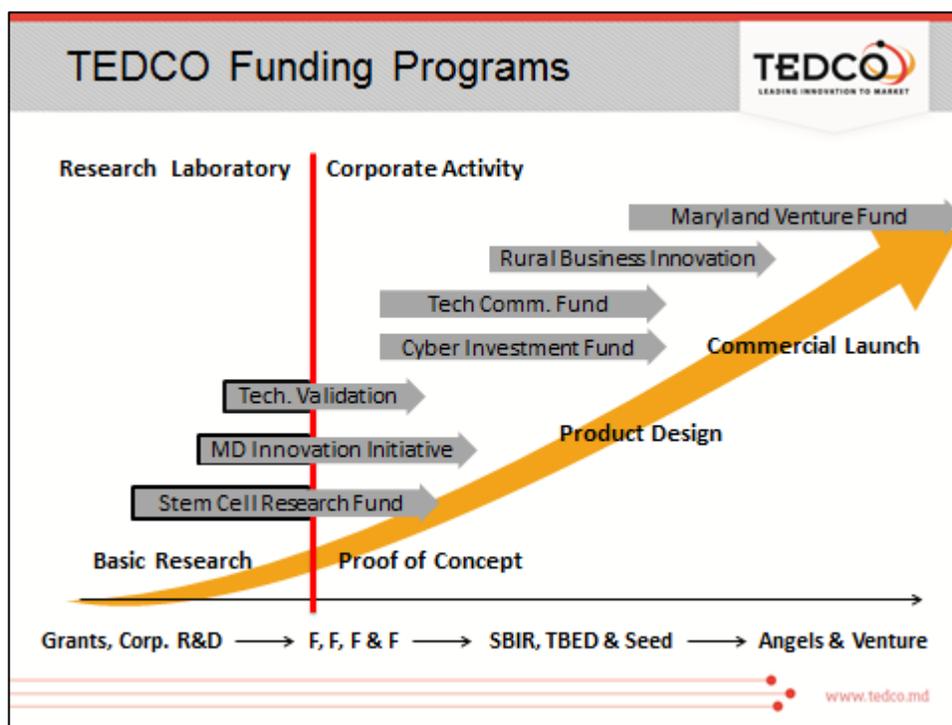


Figure 2. Risk Capital and Technology Commercialization – The “Valley of Death”

**TEDCO is playing an increasingly important role in providing both assistance and capital to Maryland’s entrepreneurial and technology commercialization ecosystem.** The “Valley of Death” illustration demonstrates the need for a continuum of support, services, and assistance from the private and public sectors throughout the commercialization process as a technology enterprise is conceived, developed, formed, grown, and brought to maturity. Companies need tools such as due diligence, proof of concept, engineering optimization in developing the technology and identifying the product, managerial and entrepreneurial support, and access to risk capital. In addition to its role in providing mentoring and other support services, TEDCO has traditionally played a critical role in providing access to early stage capital to support the venture formation, pre-seed, and early/seed stage phases of entrepreneurial development through the TCF and MII programs. The CIF and PBF provide capital to support later stage development, and with its assumption of management of the MVF, TEDCO is now playing a central role across the spectrum of entrepreneurial and technology company capital needs. The full spectrum of

TEDCO funding and services provided across the continuum of the commercialization-based entrepreneurship process is presented in Figure 3.



**Figure 3. TEDCO's Role in the Commercialization-based Entrepreneurship Process**

TEDCO's financing programs address what is considered a critical gap in Maryland's entrepreneurial and technology commercialization ecosystem. Maryland lags benchmark states in terms of venture capital investment, both when examined in total and when the amount of venture capital is normalized by the level of R&D activity in each state. As presented in Table 10, Maryland had 702 venture capital deals and \$3.5 billion of venture capital investment over the 2009-15 period, ranked eighth out of the nine benchmark states. In terms of supporting technology commercialization, seed and early-stage venture capital investment are the most important types of investments to support the development of new, entrepreneurially driven, technology-based start-up companies. Over this period, Maryland had 234 early-stage venture capital deals and associated investment of \$1.0 billion, ranked sixth out of the benchmark states. As presented in Table 11, Maryland lags the nation and most of the benchmark states in terms of both total venture capital deals and investment per \$10 million in research,<sup>18</sup> with less than half the national number of deals per \$10 million, and just over one-quarter of the level of investment per \$10 million. Similarly, in terms of seed and early-stage venture capital investment per \$10 million in research, Maryland lags the nation and most benchmark states.

<sup>18</sup> Data are for 2011 because this is the most recent year for which total state R&D figures were available.

**Table 10. Total Venture Capital Investment, 2009-15**

State	Total Venture Capital Deals		Seed and Early Stage Venture Capital Deals	
	Deals	Millions of \$s	Deals	Millions of \$s
Maryland	702	\$3,539	234	\$1,015
California	13,598	\$148,924	6,006	\$41,663
Colorado	859	\$5,259	313	\$1,534
Massachusetts	3,486	\$27,512	1,440	\$11,603
North Carolina	506	\$3,573	137	\$806
Ohio	550	\$1,799	239	\$534
Pennsylvania	1,608	\$4,692	693	\$1,279
Texas	1,528	\$14,837	492	\$2,039
Virginia	643	\$4,548	223	\$610
<b>United States</b>	35,064	\$302,576	14,178	\$80,279
(1) Time period is 2009-11/9/2015				

Source: Thomson Reuters ThomsonOne venture capital database

**Table 11. Venture Capital Investment Normalized by R&D, 2011**

State	Total Venture Capital Deals		Seed and Early-Stage Venture Capital Deals	
	Deals per \$10 Mil. in R&D	\$s per \$10 Mil. in R&D	Deals per \$10 Mil. in R&D	\$s per \$10 Mil. in R&D
Maryland	0.05	\$0.26	0.02	\$0.03
California	0.23	\$2.17	0.10	\$0.57
Colorado	0.20	\$1.23	0.10	\$0.54
Massachusetts	0.24	\$1.61	0.10	\$0.73
North Carolina	0.08	\$0.56	0.02	\$0.13
Ohio	0.07	\$0.17	0.04	\$0.09
Pennsylvania	0.14	\$0.43	0.06	\$0.14
Texas	0.12	\$1.93	0.03	\$0.14
Virginia	0.09	\$0.62	0.03	\$0.03
<b>United States</b>	0.12	\$0.97	0.05	\$0.24

Source: Battelle calculations using NSF State R&D figures and Thomson Reuters ThomsonOne venture capital database

**Significant progress is being made in expanding access to venture and start-up capital in Maryland.**

Maryland not only maintained its second best ranking nationally in the Milken Institute’s 2014 State Tech and Science Index, it improved its score for the third Index Report in a row, signifying not only a strong, but an improving climate for entrepreneurially driven, technology-based economic development.

According to the Milken State Tech and Science Index report, “Maryland’s rising score is largely due to a rebound in Risk Capital and Entrepreneurial Infrastructure, up from 13th in 2012 to fifth in 2014.” The State Tech and Science Index report goes on to report that:

“In Risk Capital and Entrepreneurial Infrastructure, Maryland made spectacular gains, climbing eight spots to fifth in 2014 (from 13th in 2012). In 2010, it had fallen to an all-time low at 14th. The improvements show that the state is succeeding in its efforts to attract funding and streamline the commercialization of university research through InvestMaryland and the Maryland Venture Fund. InvestMaryland has raised close to \$84 million by auctioning premium tax credits to

insurance companies. This money is used to fund startups and help fill the existing gap in venture capital. Similarly, Innovate Maryland seeks to move discoveries from academia (Johns Hopkins University, Morgan State University, University of Maryland College Park, University of Maryland Baltimore, and University of Maryland Baltimore County) into the marketplace promoting the commercialization of research. Support is provided through TEDCO, Maryland's state-run technology transfer organization."<sup>19</sup>

It is clear from the Milken Index report that Maryland's investment in TBED is paying off and that TEDCO plays a central role in this success.

## **Descriptions and Outcome Measures for TEDCO's Key Programs**

**TEDCO plays a central role in supporting Maryland's entrepreneurial and technology commercialization ecosystem.** It does this by providing a full menu of programs designed to support and facilitate the generation, transfer, and commercialization of technology in Maryland. TEDCO was created to assist Maryland in enhancing and capturing the economic benefits from the substantial base of academic and federal research being conducted in the state. A brief description of TEDCO's main programs and available outcome measures is presented below.

TEDCO's mission is to support the advancement of TBED in Maryland. With Maryland's strong base of academic and federal research, the state has only limited need to invest in basic research outside of the university system. However, Maryland has joined with several other states, notably California, New York, and Ohio, in supporting stem cell research. Maryland has focused on stem cell research because it is one of the most important emerging areas of health and life sciences research, and it has the potential to transform health care by curing or alleviating many of the world's most devastating diseases. The use of stem cells has facilitated the creation of a new medical field – regenerative medicine – with huge potential impacts on the treatment of disease. Unlike other areas of technology development where federal or private research spending funded the initial stages of basic research, federal restrictions were placed on stem cell research. State governments have become a major source for stem cell research along with renewed federal and rapidly growing private sector research. States like Maryland are investing in stem cell research because of the tremendous growth opportunities in the field. According to the 2014 BCC research report, *The Global Market for Stem Cells*, the global stem cell products market totaled \$5.6 billion in 2013 and could exceed \$10.5 billion in 2018, making it one of the most rapidly growing areas of pharmaceutical/medical products.

The **Maryland Stem Cell Research Fund (MSCRF)** was established by the Maryland Stem Cell Research Act of 2006 to promote state-funded stem cell research and cures through grants and loans to public and private entities in Maryland, and is perpetuated through an appropriation in the governor's annual budget. TEDCO's MSCRF is one of six state stem cell research programs identified nationwide by the National Institutes of Health.<sup>20</sup>

MSCRF has four main programs:

- **1) Pre-Clinical & Clinical Research Grants**, awarded for the first time in Fi 2013, are designed for biotech companies interested in conducting pre-clinical and clinical human stem cell research

---

<sup>19</sup> Op Cit., page 8.

<sup>20</sup> <http://stemcells.nih.gov/research/pages/stateResearch.aspx>.

in Maryland. For clinical applications, the company does not have to be based in Maryland, but at least one clinical site must be in Maryland in order to increase clinical trial activities at state universities and hospitals. Currently the MSCRF's largest award, each Pre-Clinical grant provides up to \$500,000/year for up to three years, and each Clinical Research grant provides up to \$750,000/year for up to three years.

- **2) Investigator-Initiated Research Grants** are designed for established researchers who have preliminary data to support their proposals. Each Investigator-Initiated Research Grant currently provides up to \$600,000/year in direct costs to be budgeted over a period of up to three years. To date, the MSCRF has funded 72 Investigator-Initiated Research Grants.
- **3) Exploratory Research Grants** are designed for investigators exploring new hypotheses, approaches, mechanisms, or models. Little or no preliminary data are required to support these applications. This program provides the opportunity for young investigators and established investigators from other fields to initiate or advance their careers by doing stem cell research. Each Exploratory Research Grant provides up to \$100,000/year in direct costs, for up to two years. This funding mechanism frequently leads to future larger grant awards. To date, the MSCRF has funded 168 Exploratory Research Grants.
- **4) Post-Doctoral Fellowship Grants**, initiated in FY2008, are designed to recruit and train the best and brightest scholars early in their research careers, and to grow Maryland's stem cell research community. Each Post-Doctoral Fellowship Grant provides up to \$55,000/year for research and salary, for up to two years. To date, the MSCRF has funded 111 Post-Doctoral Fellowship Grants.

The MSCRF's applications and awards are summarized in Table 12. The total number of applications has increased from 85 applications in FY2007 to 173 in FY2015. The percentage of projects funded has fallen from a high of 51 percent in FY2008 to only 17 percent in FY2015. Since the creation of the program, TEDCO has received 1,351 applications for \$535.8 million in research, but was able to fund only 354 projects for \$119.0 million. The fact that the MSCRF has been able to fund only 26 percent of applications, representing 22 percent of requested funding, indicates there is potentially substantial unmet need for funding of stem cell research projects.

**Table 12. MSCRF Applications and Awards**

MSCRF Program Activity	2007	2008	2009	2010	2011	2012	2013	2014	2015
Applications	85	122	148	141	180	180	171	151	173
Investigated Initiated	41	33	38	20	42	31	32	36	44
Exploratory	44	65	70	77	97	105	92	70	85
Post-Doctoral	-	24	40	44	41	44	42	42	42
Pre-Clinical	-	-	-	-	-	-	5	3	2
Awards	24	62	59	42	36	40	31	31	29
Investigated Initiated	7	11	6	5	9	9	10	7	8
Exploratory	17	34	32	19	13	17	10	15	11
Post-Doctoral	-	17	21	18	14	14	10	8	9
Pre-Clinical	-	-	-	-	-	-	1	1	1
Percent of Projects Funded	28%	51%	40%	30%	20%	22%	18%	21%	17%
Investigated Initiated	17%	33%	16%	25%	21%	29%	31%	19%	18%
Exploratory	39%	52%	46%	25%	13%	16%	11%	21%	13%
Post-Doctoral	-	71%	53%	41%	34%	32%	24%	19%	21%
Pre-Clinical	-	-	-	-	-	-	20%	33%	50%
Funding Applied For	<u>\$80,845,000</u>	<u>\$62,076,562</u>	<u>\$86,050,000</u>	<u>\$52,550,000</u>	<u>\$55,800,000</u>	<u>\$50,380,000</u>	<u>\$48,268,212</u>	<u>\$44,606,249</u>	<u>\$55,205,123</u>
Investigated Initiated	\$70,725,000	\$44,838,714	\$65,550,000	\$30,000,000	\$28,980,000	\$21,390,000	\$20,010,000	\$22,811,174	\$30,104,977
Exploratory	\$10,120,000	\$14,597,848	\$16,100,000	\$17,710,000	\$22,310,000	\$24,150,000	\$20,930,000	\$15,429,498	\$19,480,146
Post-Doctoral	-	\$2,640,000	\$4,400,000	\$4,840,000	\$4,510,000	\$4,840,000	\$4,620,000	\$4,620,000	\$4,620,000
Pre-Clinical	-	-	-	-	-	-	\$2,708,212	\$1,745,577	\$1,000,000
Funding Awarded	<u>\$13,997,810</u>	<u>\$22,905,651</u>	<u>\$18,938,685</u>	<u>\$11,736,252</u>	<u>\$10,682,833</u>	<u>\$11,561,038</u>	<u>\$10,705,723</u>	<u>\$9,395,990</u>	<u>\$9,093,590</u>
Investigated Initiated	\$9,430,157	\$13,286,553	\$9,328,970	\$5,454,751	\$6,182,833	\$6,113,822	\$6,812,268	\$4,829,743	\$5,243,853
Exploratory	\$4,567,653	\$7,749,098	\$7,299,715	\$4,301,501	\$2,960,000	\$3,907,216	\$2,234,455	\$3,279,958	\$2,384,737
Post-Doctoral	-	\$1,870,000	\$2,310,000	\$1,980,000	\$1,540,000	\$1,540,000	\$1,100,000	\$879,858	\$990,000
Pre-Clinical	-	-	-	-	-	-	\$559,000	\$406,431	\$475,000
Percent of Projects Funded	17%	37%	22%	22%	19%	23%	22%	21%	16%
Investigated Initiated	13%	30%	14%	18%	21%	29%	34%	21%	17%
Exploratory	45%	53%	45%	24%	13%	16%	11%	21%	12%
Post-Doctoral	-	71%	53%	41%	34%	32%	24%	19%	21%
Pre-Clinical	-	-	-	-	-	-	21%	23%	48%

Source: TEDCO

TEDCO's core mission is to support the generation, transfer, and commercialization of technology. As described above, TEDCO's core technology transfer and commercialization programs seek to address the commercialization gap in Maryland by providing needed funding and technical assistance at each stage of the commercialization process.

The **Maryland Innovation Initiative** (MII) was started in FY2012 as a partnership between the State of Maryland and five Maryland academic research institutions – Johns Hopkins University, Morgan State University, University of Maryland College Park, University of Maryland Baltimore, and University of Maryland Baltimore County – to promote commercialization of university discoveries. The goal of the MII program is to foster the commercialization of university innovations through technology validation, market assessment, and the creation of start-up companies in Maryland. MII provides three phases of funding:

- **Phase I: Pre-commercial Research** – provides \$100,000 (or \$150,000 for a joint application between two universities) in funding for proof of concept and other studies on intellectual property that demonstrate the utility of a technology for a specific commercial application;
- **Phase II: Commercialization Planning** – provides \$15,000 (or \$20,000 for a joint application between two universities) in funding for commercialization planning such as the costs for purchasing a market analysis, for conducting market surveys, for contracting with industry experts, or for other costs associated with gathering and assembling the information required for the development of a proper commercialization plan; and
- **Phase III: Early-stage Development** – provides \$100,000 (or \$150,000 for a joint application between two universities) for corporate product development expenses to prepare for a product launch or the advancement of a product technology to achieve a commercial milestone that significantly increases the company's value and better positions the company for follow-on investment from angels or venture capitalists.

The MII also established Site Miners, individuals supported by the MII program to assist start-ups and faculty in the process of submitting a strong business-oriented application that is focused on commercialization. These individuals work as liaisons between the applicant and the MII program, providing valuable input and feedback prior to submission of an MII application. The MII program's applications and awards are presented in Table 13. Since the inception of the program, TEDCO has funded a total of 141 MII projects, with an associated \$13.5 million in project support. Over the past three fiscal years, TEDCO was able to fund a total of only 141 MII projects out of a total of 332 applications, or 42 percent of total requested projects, potentially indicating unmet technology commercialization needs at the five participating universities. MII companies have gone on to receive \$11.7 million in downstream funding to further develop their technologies.

**Table 13. Maryland Innovation Initiative Applications and Awards**

MII Program Activity	FY2013	FY2014	FY2015
MII Applications	88	125	119
MII Awards	33	62	46
Percentage Funded	38%	50%	39%
MII Amount Requested	\$8,847,052	\$12,375,572	\$12,026,967
MII Amount Funded	\$3,356,109	\$5,900,260	\$4,233,197
Percentage Funded	38%	48%	35%

Source: TEDCO

The Maryland **Technology Commercialization Fund** (TCF) provides up to \$225,000 to support projects that advance a technology toward commercialization. TCF helps companies to reach a critical milestone in their product (or service) development that will move their technology further along the commercialization pathway, increase the company’s valuation, and lead to follow-on investment for further growth and sustainability. TCF funding is provided in two distinct investments. The “First Investment” of up to \$100,000 provides funds for critical product development that enables companies to achieve significant product development/technical milestones. The “Second Investment” of up to \$125,000, which is subject to a concurrent third party investment requirement and TEDCO’s approval, supports further product development and better prepares a company for later-stage investments or product launch and revenue generation. In order to qualify for TCF investment, a company must meet two criteria:

- 1) The company must be a for-profit entity located in Maryland with fewer than 16 employees; and
- 2) The company is pre-revenue OR has received less than an aggregate of \$500,000 in equity investments from sophisticated investors.

TEDCO uses the TCF program to make investments in these organizations, enabling them to reach a critical milestone in their product or service development efforts that will move technologies further along the commercialization pathway, increase a company’s valuation, and lead to follow-on investment and job creation. Investments through the TCF program are made in the form of a five-year, convertible note to the company. As presented in Table 14, TEDCO invested in 21 TCF projects in FY2015. TEDCO invested in a high of 61 percent of the companies that applied in FY2005, falling to a low of 22 percent in FY2012, and increasing to 25 percent in FY2015. Since 2004, TEDCO has received 781 TCF applications and has had sufficient resources to fund 269 projects, or 34 percent of applications, and the number of applications has increased from 22 in FY2004 to more than 80 for three of the past four years. The steady growth in TCF applications is indicative of greater awareness of the program within Maryland entrepreneurial and technology development ecosystem, while the declining approval rate may be indicative of unmet need for commercialization financing in Maryland. TCF has been a vitally important source of capital to address the “Valley of Death” that hinders commercialization in Maryland. ***The TCF program has supported the creation of a portfolio of 239 successful technology companies based on new technologies generated in Maryland that have gone on to receive \$749 million in downstream funding to further support the development of TCF companies, more than ten times the level of state TEDCO funding for the program.***

**Table 14. Technology Commercialization Fund Applications and Awards**

TCF Program Activity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Applications	22	44	52	88	70	68	67	59	82	58	87	84
Awards	13	27	27	34	27	22	21	17	18	22	20	21
% Awarded	59%	61%	52%	39%	39%	32%	31%	29%	22%	38%	23%	25%

Source: TEDCO

In addition to the TCF, TEDCO offers the **Technology Validation Program (TVP)**, which provides funding to validate a technology for a specific application and/or to validate the market opportunity for a technology. The goal of the TVP is to foster the creation of more start-up companies based on technologies developed at Maryland’s universities, not-for-profit research institutions, and federal laboratories. The program is focused on universities and federal laboratories that are not part of the MII program. The validation of a technology for a specific application generally involves a small proof of concept study to demonstrate that the technology works as intended. The validation of a market opportunity generally involves a market analysis that demonstrates that products based on the technology will have a clear competitive advantage and meet a clear need in a significant market.

The TVP includes two distinct phases – the Technical Assessment Phase and the Market Assessment Phase. The Technical Assessment Phase consists of awards of up to \$40,000 for proof of concept studies at a Maryland university. The Market Assessment Phase consists of awards of up to \$10,000 for a market analysis for a technology and for the development of a commercialization plan. Since its creation in 2013, the TVP has received 18 applications, and has approved five projects with three projects completed.

Universities and not-for-profit research institutions in Maryland are eligible to apply for both phases of the TVP provided that they are not active Qualifying Universities as defined in the Maryland Innovation Initiative statute. Entrepreneurs considering the creation of a Maryland-based start-up company relying on a technology from an eligible university, a not-for-profit research institution in Maryland, or a federal lab in Maryland for its formation are eligible to apply directly for the Market Assessment Phase of the TVP.

In addition to providing early stage venture funding through MII, TCF, and TVP, TEDCO works to address the shortage of commercialization funding and venture capital investment in Maryland through several investment funds targeted on specific geographic, demographic, or technology-based investment areas. In this update of the 2013 report, Battelle added two of TEDCO’s programs, the Cyber Security Investment Fund (CIF) and the Propel Baltimore Fund (PBF), to its economic and fiscal impact analysis.

The **Cyber Security Investment Fund (CIF)**, initiated in FY2015, provides up to \$225,000 to support projects that advance a technology toward commercialization. CIF helps companies to reach a critical milestone in their product or service development that will move their technology further along the commercialization pathway, increase the company’s valuation, and lead to follow-on investment for further growth and sustainability.

CIF funding is provided in two distinct investments. The “First Investment” of up to \$100,000 provides funds for critical product development that enables companies to achieve significant technical milestones. The “Second Investment” of up to \$125,000, which is subject to a concurrent third party investment (a “Qualified Investment” – defined below) and TEDCO’s approval, supports further product development

and better prepares a company for later-stage investments or product launch and revenue generation. In its first year of operation, CIF received 23 applications for funding from 17 companies and made 6 awards totaling \$600,000.

The **Propel Baltimore Fund** (PBF) addresses the critical need for more early-stage capital in Baltimore City. PBF is available to companies with new technology ideas or innovation-focused business plans that are currently based in or are willing to relocate to Baltimore City. The fund will lead investments into these companies and will require matching funds from other investors to go along with the Propel Baltimore Fund capital. The initial investment into each company will be up to \$250,000. The Propel Baltimore Fund is focused on start-ups and early-stage companies that can provide returns to investors in five to seven years. Since its inception, the PBF has received 141 proposals and has invested \$2.56 million in 10 projects with four projects in due diligence. PBF received 81 applications for funding in FY 2015, up from 17 applications in FY2014 and 30 applications in FY 2013, indicating increased awareness of the fund and potentially unmet needs for funding to support companies willing to locate in Baltimore City. Propel Baltimore companies have gone on to raise \$80.7 million in additional capital.

### ***Entrepreneurial Support Programs***

The technology commercialization process does not end once a technology is transferred to a start-up or existing company. Successful technology commercialization requires a technological innovation as well as the entrepreneurial/managerial talent to manage—and the risk capital to finance—the creation of the new company, product, or service. TEDCO provides assistance in these areas as well.

Maryland's technology commercialization asserts are not located solely along the I-95 Corridor that links the state's major public and private research universities and federal laboratories. Maryland possesses strong research and technology generation opportunities across the state, not just in its colleges and universities but also in its technology-oriented businesses base. In order to tap this potential, TEDCO established the **Rural Business Innovation Initiative** (RBI2) to provide technical and business assistance to start-up and small technology-based businesses in the rural areas of Maryland, as defined by the Rural Maryland Council. The goal of the program is to help companies overcome business and technical hurdles and advance to the next growth level. There is no cost to the company to receive assistance.

Assistance to companies is provided by a regional RBI2 mentor. Each region has a local RBI2 business mentor, whose job is to evaluate potential clients and to provide resources, consulting services, and technical management assistance. Mentors work closely with company clients at their business. The types of business assistance provided include:

- Business model or strategy;
- Market strategy/analysis and competitive analysis;
- Funding opportunities and introductions;
- Financial analysis;
- Business plan or grant review;
- Intellectual property;
- Prototype development; and
- Manufacturing problem solving.

In order to be eligible for the RBI2 program, businesses must (1) be involved in developing new technologies/products or utilizing technology to create or expand their businesses, (2) have fewer than 16 employees, and (3) have annual revenues of \$1 million or less.

Since 2013, the RBI2 program has mentored 591 companies and funded 33 technical assistance projects with 30 different rural companies, providing \$200,766 in project funding. Some examples of RBI2 successes are as follows:

RBI2 Performance Metrics (FY2013-15)	
Companies Mentored	591
Hours of Mentoring	7,210
Number of Projects Funded	33
Number of Companies Served	30
Amount of Project Funding	\$200,766

- **Glycopure, Inc.**, in Dorchester County, was successful in utilizing the MdBio biotechnology tax credit program to raise \$700,000 in new capital investment after receiving assistance from the RBI2 program;
- **Spessard Mfg.** (Valley Industrial Plastics), one of the most successful RBI2 companies, has received a \$100K Phase II Maryland Industrial Partners (MIPs) award for home plate testing and a \$500,000 loan from the Maryland Department of Business and Economic Development for a new building and working capital;
- **TimberRock Energy Solutions** won a \$500K award from the Maryland Energy Administration;
- **Enterprise 101 d.b.a. PaverGuide** and **Crab Machinery, LLC** have gone on to receive follow up funding from the Maryland MIPs program; and
- The RBI2 Program has assisted several companies to participate in other TEDCO programs; for example **Glycopure**, **i-lighting**, **Imagilin**, **TimberRock**, and **Solar Fruits BioFuels** have all participated in both the RBI2 and TCF programs.

TEDCO also links Maryland technology companies with local entrepreneurial talent through the **Maryland Entrepreneurs Resource List** (MERL) program, which connects a list of 115 seasoned entrepreneurs who have experience in venture capital finance and technology commercialization. The MERL entrepreneurs also assist TEDCO in its other programs, serving as reviewers for applications to the MII and TCF programs and assisting portfolio companies in seeking venture capital investment. The number of companies receiving assistance from MERL has increased steadily, from 12 in Fiscal FY2012 to 72 in FY2015.

In addition to the MERL program, in FY2015 TEDCO launched the **Executive Exchange** program to assist its portfolio companies. This is a multi-tiered initiative designed to cut across all TEDCO funding programs by offering supplemental stage-appropriate assistance to TCF and MII portfolio company entrepreneurs. The Executive Exchange Program consists of six elements:

- Loaned Executives will be provided to lead a start-up team through a critical inflection point
- Executive Coaching will help entrepreneurs mature alongside their ventures
- CEO Roundtables will facilitate peer-to-peer support among entrepreneurs
- Portfolio Workshops will address topics of interest to groups of entrepreneurs
- Maryland Entrepreneurs Resource List (MERL) members will continue to coach and mentor entrepreneurs
- TEDCO Staff & Rural Business Initiative (RBI2) representatives will continue to coach and mentor entrepreneurs.

In 2015, the Executive Exchange program is on track to provide 2,520 hours of assistance to TEDCO portfolio companies, costing an estimated \$336,000, and the program has provided loaned executives to eight and executive coaching to two portfolio companies.

TEDCO has also played a critical role in developing and assisting the tenants of Maryland’s business incubator network. Over its history, TEDCO has provided planning grants and assistance in obtaining capital funding to incubators in Maryland. It also provides assistance through the **Incubator Business Assistance Fund** to assist incubators and their tenants in obtaining consulting and/or training resources to foster the development of tenant companies. TEDCO provides funding to qualified incubators to help them implement best practices for their tenant/affiliate companies.

Not only does TEDCO provide financial and technical support to promote entrepreneurial development in Maryland, it promotes and publicizes entrepreneurship in general through its **Innovation, Corporate Excellence and Entrepreneurship** (ICE) awards program. The ICE program recognizes outstanding businesses and individuals from TEDCO’s diverse portfolio of seed and early-stage companies. The most recent ICE Awards celebration, held at the Sheraton Columbia Town Center, was attended by more than 200 representatives from TEDCO’s portfolio companies and partnering organizations.

TEDCO Innovation, Corporate Excellence and Entrepreneurship (ICE) Award Winners 2013-15	
Round	Award
<b><u>2013 ICE Award Winners</u></b>	
Remedium	Innovation
TRX Systems	Company
Robert Rashford, Genesis Engineering	Entrepreneur
<b><u>2014 ICE Award Winners.</u></b>	
Woofound/Traitify	Innovation
CSA Medical	Company
Casey Eitner	Entrepreneur
<b><u>2015 ICE Award Winners</u></b>	
Analytical Informatics	Innovation
Lookingglass	Company
Tom Popomaronis	Entrepreneur

## **SUMMARY AND CONCLUSION – TEDCO’S ROLE IN MARYLAND TECHNOLOGY GENERATION, TRANSFER, AND COMMERCIALIZATION**

**Through its programs and efforts, TEDCO makes a clear and important contribution to improving the technology and entrepreneurial development ecosystem in Maryland. TEDCO’s mission and programs are central to the State of Maryland’s economic development strategy and consistent with national and state technology-based development best practices commercialization activity.** The need to expand commercialization activity has been recognized by the Maryland Economic Development and Business Climate Commission, which recommends expanding TEDCO’s funding and programs.

As described above, TEDCO’s five core programs generate substantial economic returns to Maryland, as follows:

- The direct Maryland economic activity generated by the five core programs analyzed totals \$572.3 million in economic activity and 1,916 jobs in 2015, an increase of more than 70 percent in terms of revenues and expenditures and 56 percent growth in employment since the 2013 report;
- The total economic contribution to the Maryland economy, including multiplier effects, of the five core TEDCO programs totaled \$960 million in 2015, with a total of 4,358 jobs earning \$325.6 million in labor income and supporting estimated state and local government revenues of \$35.8 million; and
- Focusing on the four core TEDCO commercialization programs analyzed, the 2015 return on the State of Maryland’s investment in TEDCO’s core technology commercialization programs (excluding MSCRF) totals 29 percent.

While these economic contributions are clearly impressive, they represent only a part of TEDCO’s overall contribution to the Maryland economy. At least as important to the economic and fiscal contributions of TEDCO’s five core programs is its central role in facilitating, supporting, and enhancing the generation, transfer, and commercialization of technologies across Maryland. TEDCO provides vitally needed funding and technical assistance to Maryland’s entrepreneurial and technology commercialization ecosystem.

TEDCO’s programs are an important source of both the capital and technical assistance required to support the entrepreneurially driven commercialization of new technologies in a state that, despite its clear strength in research, lags its peers in venture capital investment, commercialization, and technology business activity. TEDCO has funded 354 MSCRF, 269 TCF, 141 MII, 6 CIF and 14 PBF projects, yet there remains substantial unmet demand for its core programs, with only 26 percent of MSCRF, 34 percent of TCF, 42 percent of MII, 26 percent of CIF and 10 percent of PBF applications funded over the entire history of each program.