The Appalachia Partnership Initiative’s Investments in Education, Workforce Development, and the Community

Technical Appendixes

Shelly Culbertson, Gabriella C. Gonzalez, Nupur Nanda

Prepared for the Chevron Corporation
Preface

Chevron North America Appalachian Mountain Business Unit’s Social Investment Team was established to meet several goals in the Pennsylvania, West Virginia, and Ohio region. Goals include strengthening science, technology, engineering, and mathematics (STEM) education in middle and high schools and improving pathways for high school graduates and adult learners to careers in the oil and gas industries and in advanced manufacturing. As part of these efforts, in 2014, Chevron’s Social Investment Team launched the Appalachia Partnership Initiative (API), a partnership of businesses, nonprofit organizations, and education institutions in the region. As of October 2017, the API consisted of representatives from Chevron, the Claude Worthington Benedum Foundation, the Grable Foundation, the Allegheny Conference for Community Development, and Catalyst Connection. The RAND Corporation serves as the independent research and analysis lead for the API. RAND is undertaking annual evaluations conducted from 2016 through 2019 to track the progress that API-sponsored programs are making in supporting the API’s goals over time.

These Technical Appendixes accompany the report, The Appalachia Partnership Initiative’s Investments in Education, Workforce Development, and the Community: Analysis of the First Stage, 2014–2016, which provides a baseline analysis of the first year and half of the API (October 2014 through July 2016). These appendixes provide more details on the methodology, data, and findings reported in the companion report.

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Organization of the Technical Appendixes

Appendix A summarizes the design of the overarching API monitoring and evaluation system, describes how the API logic models and indicators were developed, and lists the programs that are part of the API portfolio analysis. Appendix B details the methodology employed in RAND’s baseline portfolio analysis. Appendix C provides details on the analysis and findings of the alignment between strategies and goals of K–12 STEM education and workforce development programs and the strategic directions as defined by the logic models. Appendix D provides details of the analysis of beneficiaries of API-sponsored programs: who accessed the activities and services offered by the programs and where within the 27-county API region where programs were located. Appendix E provides more details on the analysis related to the sustainability and implementation of API programs to date. Appendix F describes how the
API worked toward its community catalyst goals and engaged with the growing community of entities at the regional, state, and federal levels involved in improving K–12 STEM education and workforce development. Appendix G includes the interview protocol asked of program administrators. Appendix H provides a sample data-collection template. Appendix I includes the API leader questionnaire.
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## Abbreviations

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<th>Description</th>
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<td>API</td>
<td>Appalachia Partnership Initiative</td>
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<td>ARC</td>
<td>Appalachian Regional Commission</td>
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<td>ASTC</td>
<td>Association of Science-Technology Centers</td>
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<tr>
<td>M&amp;E</td>
<td>monitoring and evaluation (system)</td>
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<tr>
<td>MEP</td>
<td>Manufacturing Extension Partnership</td>
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<tr>
<td>STEAM</td>
<td>science, technology, engineering, arts, and mathematics</td>
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<tr>
<td>STEM</td>
<td>science, technology, engineering, and mathematics</td>
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<tr>
<td>WIB</td>
<td>Workforce Investment Board</td>
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<td>WIOA</td>
<td>Workforce Innovation and Opportunity Act</td>
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Appendix A. Description of the API Monitoring and Evaluation System

In March 2016, the RAND Corporation presented a monitoring and evaluation system (hereafter referred to as the M&E system) for the Appalachia Partnership Initiative (API). In developing the M&E system, we drew on the API’s expertise and experience in program evaluations, reviewed the literature on relevant types of evaluations (including indicator systems, program evaluation, performance evaluation, and portfolio evaluation), reviewed API program documents, interviewed program administrators about each program’s goals and the data that programs collect, and conducted a series of workshops with API leadership about the evaluation process.

The API M&E system is a framework for conducting analyses to determine the extent to which the API portfolio of programs and initiatives as a whole is supporting the API’s goals, objectives, and desired impact through a performance measurement and a portfolio evaluation. The approach includes analyses of program data to create a descriptive portrait of how well each program is performing to date on key API goals, the extent to which the portfolio as a whole is meeting the API’s strategic goals, and any gaps or redundancies in API investments. The API M&E system does not include an approach to conduct individual program evaluations that assess each program’s independent goals.¹

The remainder of this appendix describes the characteristics of a strong M&E system and then outlines the characteristics of the API M&E system.

Characteristics of a Strong Monitoring and Evaluation System

A synthesis of previous research (Bamberger and Hewitt, 1986; Haims et al., 2011; McDavis and Hawthorn, 2006) indicates that a strong M&E system includes four key components:

1. clear statements of measurable objectives or outcomes and the mechanisms by which a program is designed to meet those objectives or outcomes

¹ A rigorous evaluation of each program would require an analysis of whether each program is effective in improving participants’ STEM knowledge, competence, or skills and subsequent employment in energy or advanced manufacturing occupations compared with a counterfactual (e.g., sociodemographically similar nonparticipants). This would require following participants and nonparticipants through time. While the API recognizes the value in conducting a more complex, rigorous analysis to determine each program’s effectiveness, it was beyond the scope of this study to do so. We are exploring the option with some API programs to conduct individual program evaluations.
2. a structured set of indicators covering outputs of goods and services generated by the program and the intended impact on program participants (they should include targets and benchmarks against which progress can be compared or measured)

3. a process for collecting data and managing records so that the data required for measuring indicators are compatible with existing statistics and are available at reasonable cost; includes institutional arrangements and structures for gathering, analyzing, and reporting individual program data, and for investing in capacity building for data collection and management

4. a process for using findings from monitoring efforts to inform decisionmaking and continuous improvements.

An M&E system typically includes both performance measurement and program evaluation. Both are systematic processes for understanding what a program, initiative, or reform does and how well it is doing it. Their aims are similar: to provide information that can help inform decisions, improve performance, and achieve planned results.

Performance measurement, also referred to as internal monitoring, is the “ongoing monitoring and reporting of program accomplishments, particularly progress toward pre-established goals” (U.S. Government Accountability Office, 2011). Program staff or managers can participate in performance measurement and data tracking while a program or portfolio of programs is implemented, with the aim of improving the programs’ design and functioning while in action (United Nations Evaluation Group, 2005; U.S. Government Accountability Office, 2011; U.S. Office of Management and Budget, 2013). Performance measurement is designed to provide constant and continual feedback on the progress of a program, the problems it is facing, and the efficiency with which it is being implemented (Bamberger and Hewitt, 1986, p. 1; World Bank Operations Evaluation Department, 1996; World Bank, 1994).

Program evaluation is a rigorous and independent assessment of either completed or ongoing activities to provide evidence about a program’s effectiveness (U.S. Government Accountability Office, 2011; U.S. Office of Management and Budget, 2013, p. 91). Evaluations are carried out independently, typically by an external body, to provide program or portfolio managers with an objective assessment of the extent to which a program or portfolio of programs produced the intended outcomes and impacts and examine the distribution of the benefits between different groups (Bamberger and Hewitt, 1986; U.S. Government Accountability Office, 2011, p. 2). Evaluations are also typically more rigorous in their procedures, design, or methodology, or may involve deeper or more-extensive analysis than internal monitoring (United Nations Evaluation Group, 2005; U.S. Government Accountability Office, 2011).2

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2 A high-quality and comprehensive program evaluation typically includes a process evaluation (sometimes referred to as an implementation analysis), which assesses whether and how well services are delivered as intended or planned; an outcomes evaluation, which assesses the extent to which goals are being met and whether a program is effective; and an impact evaluation, which assesses whether longer-term communitywide or social changes have occurred as a result of a program or a reform effort (U.S. Government Accountability Office, 2011; Wholey, Hatry, and Newcomer, 2010; Rossi, Lipsey, and Freeman, 2004).
Performance measurement and program evaluation are complementary tools for addressing the need for credible information, well-grounded decisionmaking, and transparency. Well-planned and well-conducted evaluations and performance measurement are an integral part of an ongoing cycle of program planning and development, implementation, and improvement (Patton, 2008).

Structure of the API Monitoring and Evaluation System

The API M&E system has five components that follow from the aforementioned characteristics of a strong system (we expand the fourth characteristic into two), as shown in Figure A.1.

1. **Description of the objectives of the API and the logic or theory of how API-sponsored programs are designed to meet API goals in the region.** The resulting logic model and theories of action provide a conceptual plan of program components, clear statements of potentially measurable objectives or outcomes, and the mechanisms by which each API-sponsored program is designed to meet API objectives or outcomes.
2. **Indicators** that measure the goals and objectives outlined in the logic model and theories of action. Each component of the logic model will have associated indicators.
3. **A data plan** to provide guidance on collecting, organizing, and managing data so that the data required for measuring indicators are compatible with data currently collected by each program and are least burdensome. This includes institutional arrangements and structures for gathering and reporting individual program data.
4. **An analysis plan** that outlines how to assess the extent to which the portfolio of programs is meeting the goals set out in the API strategic logic model, drawing on the indicators as well as other information.
5. **Visual presentation of findings** to synthesize main points into digestible formats to support API decisionmaking and continuous improvements to the portfolio of programs.

The goal is for the API to use the findings from the portfolio analysis to make strategic decisions about where to focus further investments or attention. The findings can also be used as a feedback mechanism to API-sponsored programs.
There are several limitations to the API M&E system. First, as discussed, the M&E system would include an analysis (in step 4 of 5) of the API portfolio as a collective whole, not in-depth evaluations of each program. Second, some desired indicators are not feasible because of the cost of data collection or other considerations. The evaluation would incorporate data from multiple sources, some of which are self-reported. Data may be incomplete, in particular in the first year when programs have been collecting systematic or quantifiable information for the first time. And third, while there are long-term generational goals set for the API portfolio, RAND’s interim evaluations would consider only the first few years of the API program investments: While API investment in these programs is a significant endeavor, it represents but the beginning of what would need to be a larger multifaceted set of efforts to achieve the API’s goals. These evaluations are therefore not intended to assess whether the next-generation goals have been achieved, but whether necessary steps toward those goals have been taken in the first few years.
Development of API Strategic Logic Models

As illustrated in Figure A.1, the first step of developing a M&E system is to develop a logic model. To identify the scope of the API-sponsored programs, the specific effects they are designed to produce, and how they are thought to achieve them, we met with the API partners over two days in June 2015 to design a logic model and accompanying theories of action. In that time, API leaders defined a set of steps that API leaders and their sponsored programs can take in partnership with local and state public, private, and nongovernmental actors in the tristate region to meet this vision. Figure A.2 shows the steps with which API leaders expect the initiatives and programs the API sponsors to work collectively to propel improvements in the region’s K–12 STEM education, workforce development, and collaborative networks.

A logic model is an illustrative diagram that articulates how programs’ resources or inputs, activities, and the direct products of activities (outputs) are designed to produce short-term outcomes, medium-term outcomes, and long-term impacts (Greenfield, Williams, and Eiseman, 2006; Williams et al., 2009; Knowlton and Phillips, 2013). The API Strategic Logic Model illustrates in broad terms how the API portfolio is intended to propel change in participants’ (e.g., children, young adults, dislocated workers, veterans) outcomes and, ultimately, how the portfolio of efforts can support desired impacts. The API is investing its inputs (e.g., funding, equipment, staff, or expertise). API partners (leaders, grantees, and program administrators) are undertaking activities in three areas: investments in K–12 STEM education, workforce development, and community catalyst efforts to influence the policy environment. These efforts are intended to support the API’s desired next-generational improvement in education and workforce development to undergird the regional economy.

The API Strategic Logic Model is grounded in key assumptions about the nature of the talent pool, workforce, and skills needs in the region, listed at the bottom of Figure A.2:

- **Reported lack of candidates to fill middle-skills jobs.** The labor market is dynamic and evolving. Therefore, there are continual potential mismatches in the skills demanded by energy and advanced manufacturing employers compared with those available in the supply of job candidates.
- **Aging workforce.** The energy and advanced manufacturing workforce in the region is nearing retirement at a faster rate than in other sectors or other regions.
- **Lack of awareness of STEM-related careers.** Youth, their parents, and staff at middle and secondary schools are not aware of the array of STEM-related careers that high school and college graduates can pursue in the region. Instead, many community stakeholders retain outdated perceptions that a STEM-related career is only available for those with advanced degrees (e.g., PhDs).
- **Underemployment for veterans and in rural areas.** The combined factors of the continued drawdown of troops, the relatively high unemployment rate of service members immediately upon separation, the recent closing of coal mines across the region, and the displacement of workers from those industries make it imperative for the region
to connect veterans and dislocated workers with employment opportunities in the energy and advanced manufacturing sectors.

The desired goals of API activities are the long-term outcomes (on the far right of Figure A.2), which would be measurable over the course of five to ten years after the launch of the API. These include improved STEM postsecondary education outcomes in the API region; increased employment in energy and manufacturing in the API region, filling job and skills in demand; and an active and sustainably funded workforce policy community. Eventually, over time, the region should see improvements in next-generation communitywide impacts: a sustainable regional energy and manufacturing education and employment ecosystem that supports broader economic development. In addition to the factors described in the logic model, there are also external factors, outside of the control of the API, that could affect outcomes. For example, the general economic condition of the state or local region could affect usage rates of API programs or job opportunities. As another example, federal policies could differentially affect the availability of jobs in different sectors. While no evaluation can account for the entire array of social and economic conditions or government policies that might affect K–12 education or employment opportunities, within this evaluation we highlight those factors that might be most relevant.
Figure A.2. API Strategic Logic Framework

API Strategic Framework

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Program Activities</th>
<th>Outputs (direct results from program)</th>
<th>Outcomes</th>
<th>Outcomes - Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>STEM Education Programs</td>
<td>Awareness, Skills acquisition, Professional development, Networks</td>
<td>Short-term (current) Understanding, Performance, Knowledgeable teachers, Career connections</td>
<td>Sustainable access to quality STEM education in targeted schools, More students prepared to enter and participate in STEM career pathways</td>
</tr>
<tr>
<td>Time</td>
<td>Workforce Development Programs</td>
<td>Awareness, Skills acquisition, Skills alignment, Industry engagement, Networks</td>
<td>Mid-term (3-5 years) Understanding, Hiring &amp; retention, Linked training &amp; Industry, Career connections</td>
<td>Sustainable access to quality workforce development and training, More workers prepared to enter energy and manufacturing career pathways</td>
</tr>
<tr>
<td>Money</td>
<td>Community Catalyst Programs</td>
<td>Contributions, Policy advocacy, Community involvement, Networks for change</td>
<td>Long-term (8-15 years)</td>
<td>Improved STEM K-12 and postsecondary education outcomes in the API region</td>
</tr>
<tr>
<td>Materials</td>
<td>Equipment &amp; Facilities</td>
<td>Technology</td>
<td>Next-Generation (10-20 years)</td>
<td>Increased employment in energy and manufacturing in the API region, filling job and skills demand</td>
</tr>
<tr>
<td>Advocacy</td>
<td>Networking</td>
<td>In-kind Contributions &amp; Expertise</td>
<td></td>
<td>Active and sustainably funded workforce policy community</td>
</tr>
</tbody>
</table>

Key issues and assumptions: Skills mismatch - Aging workforce - Employability - Lack of awareness of STEM-related careers - Underemployment (veterans, rural areas)
The API Strategic Logic Model describes four desired outputs for K–12 STEM education programs, shown in detail in Figure A.3: improved stakeholders’ awareness of STEM careers and career pathways, increased students’ STEM skills acquisition, increased opportunities for teachers’ professional development in STEM subjects, and stronger networks between students and industry leaders. We used the logic models to analyze the extent to which the API portfolio as a whole included programs and activities underway that could meet the four desired outputs. (Each individual program is not expected to work toward all of the four desired outputs.)

Figure A.3. API K–12 STEM Education Programs Logic Model

The API Strategic Logic Model describes five desired outputs for workforce development programs: workers’ awareness of STEM career pathways and training and development opportunities, workers’ skills acquisition in demand in the energy or advanced manufacturing sectors, skills alignment so transitioning workers such as veterans and displaced workers can translate current skills to those needed in the energy and advanced manufacturing sectors, active industry engagement in workforce development programs, and workers’ access to formal and informal job placement networks, as shown in Figure A.4.
Figure A.4. API Workforce Development Programs Logic Model

- **Outputs (direct results from program)**:
  - Awareness
  - Skills Acquisition
  - Skills Alignment
  - Industry Engagement
  - Networks

- **Outcomes**:
  - **Short-term (current)**:
    - Greater understanding, and improved interest in STEM careers
    - Improved hiring and retention of participants
    - Improved income level of participants
    - Links strengthened between training and industry career pathways
    - Participants have greater access to job placement networks
  - **Mid-term (3-5 years)**:
    - Access to quality workforce development and training programs
    - More workers prepared to enter energy and manufacturing career pathways

Directly Measurable API Results

API as One Contributing Actor
In addition to API investments in K–12 STEM education and workforce development, the API Strategic Logic Model includes activities to catalyze a community of education, workforce, private-sector, foundation, government, and nonprofit organization leaders to collaborate toward common goals. The API aims to reach its next-generation vision of improved K–12 STEM education and workforce development in the region, in part, through these community catalyst efforts. Figure A.5 shows the API Community Catalyst Logic Model.

**Figure A.5. API Community Catalyst Logic Model**

API Indicators

With the conceptual model of how API programs are expected to meet intended goals completed, the critical next step is to specify key indicators that will be used to measure implementation (inputs and activities) and progress toward goals (outputs and outcomes). An indicator is a quantitative or qualitative variable that provides the means to measure a particular phenomenon or attribute and specifies in words or numbers a level of objective achievement (Haims et al., 2011; U.S. Agency for International Development, 2009). It is important to note
that a single indicator is rarely a complete measure on its own and that multiple indicators are needed to measure a logic model’s components, implementation of activities, or progress toward goals. By using multiple indicators from various data sources, the API M&E system can produce a more comprehensive portrait of the portfolio of programs.

The API M&E system indicators were selected to meet SMART (specific, measurable, actionable [or appropriate], reliable, and time-bound) criteria (Doran, 1981). Each criterion should answer the following questions:

- **Specific**: Is the indicator clear? Does it measure what it is intended to measure (processes or progress toward the API’s goals and outcomes)?
- **Measurable**: Is it evident what data should be collected? Can the necessary information or data be obtained? Can changes in the indicator be verified?
- **Actionable or appropriate**: Does the indicator sufficiently capture progress and results? Are the time and cost requirements for data collection and analysis reasonable (i.e., do program staff have the capacity to collect and analyze the data)? Will the information measured with this indicator be useful to others outside of the API?
- **Reliable**: Is the indicator neutral and not distorted by value judgments (by the data collector)? Is the indicator able to reflect changing circumstances or situations? Is there agreement on how the indicator should be interpreted?
- **Time-bound**: Can the indicator be collected in a reasonably timely fashion?

In a set of meetings in June 2015, RAND and API leaders reviewed existing Chevron Social Investment M&E metrics, which Chevron asks programs funded over $150,000 to report on, as well as additional indicators suggested by RAND and API leaders. Meeting participants then considered the theories of action, particular evaluation questions to be considered in the evaluation, the availability of data from sponsored programs, measurability of desired indicators, and the data-collection burden on the sponsored programs. At the conclusion of the meeting, we compiled all suggested indicators. We then shared this broad list of indicators with all of the API-sponsored programs (both the programs included in the evaluations and programs not included in the evaluations) in a set of webinars in October 2015 and in telephone meetings conducted from October 2015 through January 2016. Program administrators provided written and oral feedback to us about how they viewed effective ways to measure progress of their programs, which indicators the program already collects data on, and the feasibility of collecting data on any indicators that are not already captured by the program. We reviewed each program’s input to determine which indicators were already collected by each API-sponsored program and identified which would need additional data-collection efforts. We shared the revised list of indicators with API partners in January 2016; these indicators were further winnowed in conversations with Chevron Corporation staff in February 2016. If other programs are funded through the API, we will assess the feasibility for program staff to collect and report on these indicators and modify the list, if warranted, on a case-by-case basis.
API Programs Included in Our Analysis

Table A.1 lists the slate of API-funded grantees and their programs included in the portfolio analysis. K–12 STEM education programs included are the Carnegie Science Center’s Chevron Center for STEM Education and Career Development (including the Student Energy Summit, Grand Slam Science on the Road, and Fab Lab), Children’s Museum of Pittsburgh Maker Initiative, the Education Alliance’s STEM Network Schools, Intermediate Unit 1’s Fab Lab, and Project Lead the Way. Workforce development organizations included are ShaleNET (which includes four colleges: Pennsylvania College of Technology, Westmoreland Community College, Stark College, and Pierpont College), Southwest Training Services, and Energy Innovation Center’s Safety Passport. Catalyst Connection and Natural Resources in Greene County grantees are categorized as both K–12 and workforce development.

In January 2016, Chevron Corporation determined that not all API-funded programs would be appropriate to include in the evaluation. Chevron determined that programs that occurred only at one point in time were dispersed activities rather than a structured program or were undergoing fundamental shifts in programming and would not be included at the time. Other programs may be added over time.
<table>
<thead>
<tr>
<th>Grantee</th>
<th>Program</th>
<th>Description</th>
<th>Target Beneficiaries</th>
<th>Geographic Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Science Center: Chevron Center for STEM Education and Career Development</td>
<td>Student Energy Summit</td>
<td>Annual two-day event that introduces middle and high school students to topics related to energy use and consumption. Now includes a professional presentation, a workshop, and an opportunity for students to create their own projects.</td>
<td>Middle and high school students (one day for each group)</td>
<td>Students schools in the local area around Carnegie Science Center</td>
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<td></td>
<td>Grand Slam Science, On the Road</td>
<td>Hands-on multimedia experience that teaches K–8 students concepts of physics through baseball. A session at a school includes a 45-minute assembly show followed by a 45-minute hands-on experience.</td>
<td>K–8 students and teachers, separate programs for different age groups</td>
<td>All API regions</td>
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<td></td>
<td>Fab Lab</td>
<td>Digital fabrication laboratory that provides K–12 students and adults a platform for innovation and a hands-on STEM learning experience. Chevron funded Carnegie Science Center to build both a stationary and a mobile Fab Lab.</td>
<td>Prekindergarten through 12th-grade students, parents, educators</td>
<td>Stationary Fab Lab: Carnegie Science Center Mobile Fab Lab: Sites throughout southwest Pennsylvania (Allegheny County, Butler County, Westmoreland County, Kanawha County)</td>
</tr>
<tr>
<td>Intermediate Unit 1</td>
<td>Fab Lab</td>
<td>Digital fabrication laboratory that provides K–12 students and adults a platform for innovation and a hands-on STEM learning experience. Chevron has funded Intermediate Unit 1 to build both a stationary and a mobile Fab Lab.</td>
<td>K–12 students and educators, adult education programs, community members, and organizations</td>
<td>Washington, Fayette, and Greene Counties. Planning to reach areas outside of the Intermediate Unit 1 region but in southwest Pennsylvania.</td>
</tr>
<tr>
<td>Children’s Museum of Pittsburgh</td>
<td>Explore Making</td>
<td>One-year, hands-on learning program designed to increase interest and engagement in making among first-grade students in 32 elementary schools within the API region. The program will also provide a professional development Maker Boot Camp for the teachers from the 32 schools.</td>
<td>1st-grade students and their teachers</td>
<td>Counties in Western Pennsylvania (Fayette County, Greene County, Washington County) and Marshall County in West Virginia</td>
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<tr>
<td>Building the West Virginia Network</td>
<td>Children’s Museum of Pittsburgh’s MAKESHOP team is aiding the development of seven new makerspaces across West Virginia by providing technical assistance, necessary supplies, and honoraria for participation.</td>
<td>Broad target audience across seven sites targeting both children and adults</td>
<td>Seven sites across counties in West Virginia: Cabell County, Mingo County, Jefferson County, Wayne County, Monongalia County, Marion County, and Marshall County</td>
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<tr>
<td>Grantee</td>
<td>Program</td>
<td>Description</td>
<td>Target Beneficiaries</td>
<td>Geographic Scope</td>
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<tr>
<td><strong>K–12 STEM Education Programs</strong></td>
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<tr>
<td>Education Alliance</td>
<td>STEM Network Schools</td>
<td>The Education Alliance selected eight West Virginia schools to receive assistance for three years to develop their own STEM programs. Education Alliance is using the six components of the Carnegie Science Center STEM Excellence Pathway to guide schools in the development process. Chevron funds are specifically directed to two of the schools: the Warwood School (Ohio County) and Sherrard Middle School (Marshall County).</td>
<td>Middle and high school students (Chevron funds are currently only available for middle school students)</td>
<td>Eight selected schools in West Virginia; Chevron’s funding is allocated to two middle schools in Marshall County and Ohio County</td>
</tr>
<tr>
<td>Project Lead the Way</td>
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<td>Nonprofit organization that provides K–12 STEM curricula to public, private, and charter schools throughout the United States. Project Lead the Way offers the following programs of study: Project Lead the Way Launch for kindergarten to 5th-grade students; Project Lead the Way Gateway for middle school students; Project Lead the Way Engineering, Project Lead the Way Biomedical Science, and Project Lead the Way Computer Science for high school students. Chevron is specifically funding Project Lead the Way Engineering pathway for grades K–12.</td>
<td>K–12 students and teachers</td>
<td>All API regions</td>
</tr>
<tr>
<td>Natural Resources at Central Greene School District</td>
<td></td>
<td>One-year high school course elective that prepares students for further education or occupations within the natural gas industry by providing them with hands-on technical training, courses that cover the scientific background for the industry, commercial driver’s license training, safety training and certificate.</td>
<td>11th- and 12th-grade high school students (planning to provide classes for adults in the future as well)</td>
<td>All five school districts in Greene County, Pennsylvania (course was initially piloted in Waynesburg Central High School of the Central Greene School District)</td>
</tr>
<tr>
<td><strong>Workforce Development Programs</strong></td>
<td></td>
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<td></td>
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<tr>
<td>ShaleNET</td>
<td></td>
<td>Public-private partnership between employers in the energy sector and community and technical colleges to provide training needed to develop a local workforce in the oil and natural gas industry in Pennsylvania, Ohio, Texas, and West Virginia. Chevron will annually donate $15,000 in merit-based scholarships to each of the four ShaleNET colleges within the API-covered region over the next four years.</td>
<td>Postsecondary students interested in careers in oil and gas</td>
<td>Ohio, Pennsylvania, West Virginia</td>
</tr>
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Table A.1—Continued
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<tr>
<th>Grantee</th>
<th>Program</th>
<th>Description</th>
<th>Target Beneficiaries</th>
<th>Geographic Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workforce Development Programs</strong></td>
<td><strong>Southwest Training Services</strong></td>
<td>Employment service that has two main components: (1) reemployment services, including the appropriate education and/or training, for dislocated workers and (2) career guidance for youth ages 14–24. Chevron’s funding is specifically used for dislocated workers from the energy and manufacturing industries within Washington, Greene, and Fayette Counties who have expressed interest in pursuing advanced technology and technical degrees. Training includes both classroom and on-the-job components. Each person can receive up to $8,000 in support.</td>
<td>Dislocated workers</td>
<td>Southwest Pennsylvania (Washington County, Greene County, and Fayette County). Three Pennsylvania career links—two in Washington County and one in Greene County; Southwest Training Services is colocated and integrated in each Pennsylvania Career Link in Washington and Greene counties.</td>
</tr>
<tr>
<td><strong>Catalyst Connection</strong></td>
<td>Middle school student video Contest</td>
<td>In 2015, the program matched manufacturing companies with ten schools. Student teams from each of the schools were supervised by trained teachers and given the opportunity to partner with their matched company to create a video about “what makes manufacturing cool.” The videos were publicly available online and a winner was chosen by vote. Catalyst Connection plans to expand this program to 20 schools.</td>
<td>Middle school to college students, teachers, and adults interested in attaining jobs in the manufacturing industry</td>
<td>Western Pennsylvania Counties, North West Pennsylvania counties, Northern Panhandle of West Virginia counties, Allegheny County (Pittsburgh and surrounding neighborhoods)</td>
</tr>
<tr>
<td></td>
<td>Adventures in Technology</td>
<td>Program matches middle and high school students with local industry (usually manufacturing companies) and provides funding for 15 research-based projects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturing Career Exploration Program with Girl Scouts</td>
<td>Involves an advisory committee of women in the manufacturing industry to develop initiatives to attract to and retain girls and women students in a STEM career.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pathways to apprenticeship</td>
<td>Pilot program to improve the awareness of career and apprenticeship opportunities in the manufacturing industries among teachers, parents, educators, and administrators in Fayette and Washington Counties.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional-development related activities</td>
<td>In 2014, Catalyst Connection collaborated with ASSET STEM education to develop a teacher professional development workshop for project-based learning. Chevron funded the participation of 100 teachers from southwest Pennsylvania and West Virginia in the workshop.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table A.1—Continued

<table>
<thead>
<tr>
<th>Grantee</th>
<th>Program</th>
<th>Description</th>
<th>Target Beneficiaries</th>
<th>Grantee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workforce Development Programs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internship and apprenticeship related activities</td>
<td>Catalyst Connection will develop toolkits and provide workshops to assist manufacturing companies in developing and implementing quality internship and apprenticeship programs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Innovation Center</td>
<td>Energy Safety Passport</td>
<td>Safety-training program for employees who are exposed to sites for oil or gas extraction. The program covers the rights and responsibilities of the employee and employer and the safety precautions that employees should take to protect themselves. Covered topics include chemical hazards, mobile equipment, vehicle safety, and other subjects.</td>
<td>Producers, service partners, contractors, and subcontractors</td>
<td>All API regions</td>
</tr>
</tbody>
</table>

**SOURCE:** Interviews with API program administrators; data provided by API program administrators.
Appendix B. Analytic Approach for Baseline Portfolio Analysis

Research Questions

The baseline portfolio analysis reported in the companion document to these Appendixes assessed the extent to which the API-sponsored K–12 STEM education and workforce development programs, in combination with community catalyst efforts of API leaders, are supporting the API’s goals, objectives, and desired impact to date. The time period of this evaluation is from the start of Chevron Corporation’s funding (2014) through July 2016.

Four questions guided our analyses:

- **Alignment.** To what extent were the API programs’ strategies and goals aligned with the API’s vision and strategy?
- **Beneficiaries.** What was the geographic scope of API programs and which beneficiaries did the programs reach?
- **Sustainability.** How sustainable did API program administrators report their programs were?
- **Community catalyst.** What steps had the API undertaken to catalyze a community of stakeholders to work toward similar goals?

Approach

To answer these questions, we took the following approach. First, between June and August 2016, we interviewed each of the API-sponsored program administrators about their goals, beneficiaries, challenges and opportunities related to sustainability, and interactions with regional and national policy communities. We analyzed the interview notes by first organizing administrators’ responses by evaluation research question, listing (1) activities, mission, goals, and strategies; (2) hoped-for impact and targeted beneficiaries; (3) implementation processes, financial sustainability plans, and any facilitators or hindrances to program sustainability; and (4) reported effectiveness to date and whether the programs collect any data or metrics to measure effectiveness. We then aggregated each interviewee’s responses by research question to describe cross-program similarities and differences. See Appendix G for a list of the interview questions.

Second, each program administrator submitted a data-collection template between August and October 2016, which asked about program beneficiaries, mission and vision, activities, policy interactions, awards, media, and more. All K–12 STEM education programs provided us with the data requested, and about one-half of the workforce development programs were able to provide us with the data requested. See Appendix H for sample data-collection templates for K–12 STEM education and workforce development programs. API leaders at Chevron, the Claude Worthington Benedum Foundation, the Grable Foundation, and the Allegheny Conference also
completed a questionnaire that inquired about the nature of their community relationships and connections. See Appendix I for this questionnaire.

Third, we conducted a review of API program documentation and a literature review of select topics, including logic-model analysis; program-evaluation methodology; museum-based informal education; activity-, problem-, and project-based instructional approaches; sector-based career pathways; promising models in workforce development programs; and network analysis in nonprofit settings.

Fourth, using the data provided by the programs, the Pittsburgh-based technology and design firm Informatics Studios developed an infographic map to graphically describe the geographic scope and key indicators to measure the progress of each program. The static map is included in Appendix D, and online interactive maps will be updated annually to correspond with our analysis. The materials are available on the API website: www.rand.org/appalachiapartnership .html.

Fifth, using data from the interviews, data-collection templates, and the API leader questionnaire, we produced network-analysis diagrams to analyze relationships among API programs, funders, and regional partners.
Appendix C. Data and Analysis of Alignment

Table C.1 summarizes activities of the API K–12 STEM education programs related to awareness, skills acquisition, professional development, and networks based on findings from interviews and documentation review. We note that, in some cases, we discuss Catalyst Connection; while it has been categorized as a workforce development grantee, it has some elements involving students in secondary education.
<table>
<thead>
<tr>
<th>Grantee and Programs</th>
<th>Awareness</th>
<th>Skills Acquisition</th>
<th>Professional Development</th>
<th>Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Science Center: Student Energy Summit, Grand Slam Science on the Road, Fab Lab</td>
<td>Conducting curiosity-focused events for students, such as the Student Energy Summit and the Grand Slam on the Road</td>
<td>Conducting mobile Fab Lab training at multiple schools</td>
<td>Training teachers through Fab Labs and Carnegie STEM Excellence Pathway</td>
<td>N/A</td>
</tr>
<tr>
<td>Children’s Museum of Pittsburgh: Explore Making and Building the West Virginia Network</td>
<td>Aiming to “inspire joy, creativity, and curiosity through museum experiences,” participating in the Maker Faire. Contributing to building the regional and national maker network.</td>
<td>Exposing children to STEM education in informal settings</td>
<td>Developing models for informal education and formal education to come together, conducting Educator Boot Camp, working with schools on professional development</td>
<td>N/A</td>
</tr>
<tr>
<td>Project Lead the Way</td>
<td>Emphasizing student engagement with science and discovery through classroom learning</td>
<td>Introducing a new curriculum in biology, engineering, and information technology</td>
<td>Providing in-service teacher training for Project Lead the Way teachers on curriculum, talking with teacher colleges about preservice teacher training</td>
<td>Collaborating nationally, promoting “local partnership teams” between PLTW schools, community, and businesses, coordinating with universities on program</td>
</tr>
<tr>
<td>Intermediate Unit 1 Fab Lab</td>
<td>Aiming to create a cultural shift in how STEM education, art, and fabrication are taught and viewed</td>
<td>Developing new curriculum with Fab Lab and expanding to main track, special needs, and gifted students</td>
<td>Training teachers in new approaches, hosting ongoing professional development meetings, and providing consultation to other schools</td>
<td>Involving industry in classroom, being approached by industry for prototyping, steering students toward both college and career readiness, and providing credits and badges</td>
</tr>
<tr>
<td>Education Alliance: STEM Network Schools</td>
<td>Aiming to change mindsets about STEM, with STEM as a thought process that shapes schools</td>
<td>Developing a new model and standards for a West Virginia STEM school</td>
<td>Developing individual school plans and providing technical assistance to schools</td>
<td>Involving local industry with STEM schools and collaborating with maker spaces networks</td>
</tr>
<tr>
<td>Catalyst Connection (multiple)</td>
<td>Aiming to create interest and awareness about manufacturing careers</td>
<td>Training students in project-based learning and manufacturing</td>
<td>Providing professional development for teachers in project-based learning</td>
<td>Creating a toolkit for employer apprenticeships, connecting students with employers</td>
</tr>
<tr>
<td>Natural Resources at Central Greene School District</td>
<td>Helping local students understand natural-resource jobs available through hands-on learning and site-visits</td>
<td>Developing a new curriculum linking secondary students with certifications and training students on skills for obtaining jobs in natural resources</td>
<td>Providing training for trainers</td>
<td>Linking students with skills and jobs and training counselors to link students with industry</td>
</tr>
</tbody>
</table>

**NOTE:** N/A = not applicable.
How API K–12 STEM Programs Aligned with the Logic Model

**Awareness**

API K–12 STEM programs are expected to improve awareness of STEM education opportunities and STEM career pathways, thereby generating greater understanding, interest, perception, and encouragement. Our analysis found that API-sponsored K–12 STEM education programs’ activities aligned with the API Strategic Logic Model in terms of *awareness* in two ways.

First, all of the API-supported K–12 STEM education programs had awareness components. The museum-based programs, those overseen by the Carnegie Science Center and the Children’s Museum of Pittsburgh, aimed to spark curiosity and interest in science through museum experiences. Indeed, informal science education (as opposed to formal classroom learning), such as through museum-based learning, has been found to increase engagement and interest in STEM subjects overall (McMeeking et al., 2016; National Research Council [NRC], 2015). In addition, informal science education programs can serve as models through which to better understand and account for the learning outcomes of participants, especially regarding the connection between interest in STEM and their individual inspiration to learn (McMeeking et al., 2016; Van Eijck and Roth, 2007; NRC, 2015). Such out-of-school experiences have also been linked to a decrease in the achievement gap between students of low- and high-income families and might be an avenue for reducing race- and gender-based gaps (NRC, 2015).

Second, in interviews and program materials, directors of the programs provided in formal classroom settings (e.g., Project Lead the Way, the Intermediate Unit 1 Fab Lab, Natural Resources, STEM Network Schools, and those overseen by Catalyst Connection) noted that these programs were aiming for a “cultural shift” or “mindset change” in how students view STEM education in schools and how teachers teach STEM subjects. Interviewees also reported that the programs aim to engage students in STEM education, provide hands-on learning experiences, make students aware of further education and career opportunities, and expose students to STEM-related career options. In particular, program administrators of Natural Resources and the programs overseen by Catalyst Connection reported that they work to create interest in students in manufacturing careers or careers in natural resources. These programs’ efforts to promote awareness at the middle and high school levels are in line with evidence that experiences students have with STEM education in middle school impact their decisions about whether they enroll in STEM courses in high school; lack of enrollment in middle school can curtail later STEM education (Boe et al., 2011). Middle school students who express a desire to have a STEM career and who see science as useful in the future are significantly more likely to pursue and finish a STEM degree (Maltese and Tai, 2011). And experiences in high school, such as enrollment in algebra and calculus courses, have been identified as a key determinant to later
pursuit of a STEM degree, such as engineering, and consequently a STEM career (Maltese and Tai, 2011; Hinojosa et al., 2016; Wang, 2013). Similarly, students who believe that high school math and science courses appropriately prepared them for college courses are also significantly more likely to pursue a STEM degree (Wang, 2013). Moreover, cultivating early interest in the relevance of science in K–12 students might be a key element in the growth of a new STEM workforce. One significant way to engage students is through hands-on learning, often linked to and categorized in the literature as inquiry- (NRC, 2015), project- (Kanter, 2010), and design-based learning (Crismond and Adams, 2012); tinkering (Bevan et al., 2015); or authentic practice (Roth et al., 2009; Charney et al., 2007). Hands-on STEM education helps students make the connection between what they learn in the classroom and a future career in STEM (Christensen, Knezek, and Wood, 2014).

Skills Acquisition

In the API Strategic Logic Model, skills-acquisition efforts are intended to improve students’ performance in STEM subjects.

The museum-based programs at Carnegie Science Center and the Children’s Museum aim to expose children to STEM education in informal settings, with the goal of improving or expanding upon STEM skills. Museum-based learning in the literature has been shown to provide hands-on learning opportunities that may not be available in the classroom (Phillips, Finkelstein, and Wever-Frerichs, 2007; Bevan and Dillon, 2010; NRC, 2015), thereby increasing youth’s exposure to STEM-related experiences. Additionally, museum-based learning can develop students’ skills through design-based methodology, practice, and STEM-based tinkering (Bevan et al., 2015). Out-of-classroom learning could enhance students’ learning through access to resources not typically available in the classroom, the opportunity to engage in authentic practice, and the experience of working collaboratively; it can also inspire further inquiry and promote greater understanding of key concepts (Braund and Reiss, 2006).

The API programs delivered in formal education settings concentrate on skills acquisition through experimentation with new models of curricula and collaboration with industry. Developing new models for skills acquisition in K–12 STEM education is a particularly strong area of the API portfolio. Program administrators of the Fab Labs at the Carnegie Science Center and Intermediate Unit 1 reported that the program aims to mix shop, computers, and art for students. Program administrators for Education Alliance’s STEM Network Schools reported that although the program just started at the time of the study, it seeks to create a new model and standards for a new type of STEM school in West Virginia. Project Lead the Way program administrators reported that it is introducing new project-, problem-, and activity-based instructional approaches for engineering, biology, and information technology in schools, with the goal that these new instructional models will improve students’ learning of STEM skills and content. Catalyst Connection and Natural Resources both aim to provide students with skills
(through apprenticeships or certifications) that will help them get jobs in manufacturing or natural resources.

Little is known about the number or strength of ties or collaborations among industries that are reliant on a talent pool with STEM skills and K–12 education systems (especially K–8). In contrast, informal learning environments such as science centers, museums, or botanical gardens have clear connections to K–12 education (e.g., through field trips or teacher professional development) (Phillips, Finkelstein, and Wever-Frerichs, 2007; Bevan and Dillon, 2010). Furthermore, high school career and technical or vocational education programs, in practice, have clear collaborations with industry. Therefore, this is a gap in research on promising tactics or models of collaboration between K–12 schools and industry that could prove effective. Stakeholders can better understand what could be effective if the API focuses on funding a diverse set of experimental K–12 educational models (itemized in Table C.1) that are meant to improve students’ skills that, if successful, could be scaled up. This is an experimental set of programs: Some may prove successful, and some may not meet expectations. To date, they have collectively provided new models of hands-on, practice-based learning toward goals of students’ acquisition of STEM skills.

**Professional development**

The third desired output in the API K–12 STEM Education Logic Model is professional development, which seeks to produce teachers more knowledgeable about STEM and links to careers. All of the K–12 STEM grantees included in this analysis had professional development components as part of their API-funded programs:

- The Carnegie Science Center provided training to teachers through Fab Labs and the Carnegie STEM Excellence Pathway.
- The Children’s Museum of Pittsburgh trained teachers on models for integrating informal and formal education, Educator Boot Camps, and working with schools on professional development.
- Project Lead the Way provided in-service teacher training on their project-, problem-, and activity-based instructional approaches.
- Intermediate Unit 1 trained teachers on teaching within the Fab Lab, hosts ongoing professional development meetings for teachers where teachers can compare experiences, and provides consultation to other schools.
- Education Alliance required individual school plans from the schools in its STEM Network and provides technical assistance to the schools on improving STEM education instructional practices.

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3 For example, see the list of resources and publications from the Association for Career and Technical Education (Association for Career and Technical Education, 2016).
• Catalyst Connection provided professional development for teachers in project-based learning.
• Natural Resources provided professional development for teachers to be able to certify students for commercial driver’s licenses and in other occupations needed in the natural gas industry.

However, most of the professional development was in-service training for teachers who were already working as teachers, as opposed to preservice training, which would take place while potential teachers are gaining a certification. Interviews with program managers revealed that teacher attrition is a common problem for their programs. When trained teachers leave a school or program, this creates a need to train additional teachers. Several program administrators noted that it would be useful if teachers coming out of teacher colleges had additional STEM education knowledge and skills, such as how to teach project-based learning, knowledge about connections to STEM careers, or the programs’ specific curriculum content. Project Lead the Way administrators have begun discussions with universities about incorporating these skills into education curricula for teachers.

**Networks**

The API K–12 STEM Education Logic Model targets networks between K–12 schooling and industry that strengthen mentoring and career connections. Several API programs aim to help schools connect their students to STEM careers:

• Education Alliance, Catalyst Connection, Intermediate Unit 1, and Natural Resources included components of their programs that help secondary students make connections with local industry for jobs that require a secondary degree through career guidance and industry partnerships.
• Project Lead the Way included a mentoring component to encourage students toward further STEM careers and STEM degrees in college.

While there is a long history in the United States of industry connecting with postsecondary education institutions, less is known about the potential effectiveness or what promising practices look like for collaborations between secondary schools and industry. There is some evidence that industry apprenticeships and internships for U.S. high schools students can encourage students to pursue STEM majors in college and, if they persist, careers in STEM (VanMeter-Adams et al., 2014). Further, hands-on practice through internships and scientific research has been shown to teach students lessons that they cannot learn from in-classroom work and can have long-term, sustainable effects on how students approach science and daily life such as time management (Van Eijck and Roth, 2007; Roth et al., 2009).

**How API Workforce Development Programs Aligned with the Logic Model**

Table C.2 summarizes activities of the API workforce development programs related to awareness, skills acquisition, skills alignment, industry engagement, and networks based on
findings from interviews and documentation review. The subsequent sections describe the findings in more detail.
<table>
<thead>
<tr>
<th>Grantee</th>
<th>Awareness</th>
<th>Skills Acquisition</th>
<th>Skills Alignment</th>
<th>Industry Engagement</th>
<th>Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShaleNET</td>
<td>Offers stackable-credential program to encourage students to know about noncredit and credit-bearing courses needed for various shale gas jobs</td>
<td>Offers range of stackable certificates and associate’s degrees in high-priority occupations in shale gas industry</td>
<td>Supports nontraditional students/part-time students, especially veterans, toward employment</td>
<td>Develops curriculum with industry leaders; equipment donation; advisory committee with industry membership providing input on skills in demand</td>
<td>Recruiting on campus by employers; career counselors available</td>
</tr>
<tr>
<td>SouthWest Training Services, Inc.</td>
<td>Provides services enabling employers and job seekers to make informed employment and training choices</td>
<td>Provides work-based learning experiences in advanced technology/technical degrees in high-priority occupations (as determined by Pennsylvania)</td>
<td>Provides dislocated workers education and retraining services needed to increase employment opportunities. CareerLink specifically focuses on dislocated workers from coal mining and manufacturing industries</td>
<td>Aims to be an effective partner with employers to provide innovative, high-quality, customer-focused workforce development services; on-the-job training opportunities</td>
<td>Providing job searches for dislocated workers</td>
</tr>
<tr>
<td>Catalyst Connection</td>
<td>Aims to create interest and awareness about manufacturing careers, with emphasis on apprenticeship opportunities</td>
<td>Trains adults in project-based learning and manufacturing</td>
<td>N/A</td>
<td>Provides training to employers on quality internships and apprenticeships</td>
<td>N/A</td>
</tr>
<tr>
<td>Natural Resources at Central Greene School District</td>
<td>Helps adult learners learn about natural resource jobs available through hands-on learning and site visits (in evening and/or weekend classes)</td>
<td>Provides students with scientific knowledge and skills and certifications in oil and gas industry</td>
<td>N/A</td>
<td>Incorporated guest speakers from industry and offering field trips; materials, equipment, and input on curriculum provided by companies</td>
<td>Offering exposure to companies and employers</td>
</tr>
<tr>
<td>Energy Innovation Center: Energy Safety Passport</td>
<td>Supports a culture of safety</td>
<td>Develops a standardized curriculum to support worker, environment, and community safety in energy-related jobs across employers</td>
<td>N/A</td>
<td>Develops training in collaboration with energy and safety experts to address best practices across the industry</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NOTE: N/A = not applicable.
**Awareness**

API-sponsored workforce development programs are expected to improve awareness, thereby generating greater understanding and improved interest in STEM careers. Our analysis of interviews with program administrators and review of documentation found that API workforce development programs did not specifically aim to improve trainees’ awareness of STEM careers but did so indirectly through the education and training provided. Each program sponsored by the API varied in its target population, certifications or degrees offered, and skills and knowledge taught. Participants in the programs were selecting to take the courses because they already had an interest in the specific degree or certification and therefore an understanding that the degree or certification would help them find an energy or manufacturing job. However, programs aimed to deepen participants’ understanding of expectations of the jobs they were training for. For example, ShaleNET is a consortium of five colleges (four are in Ohio, Pennsylvania, or West Virginia). ShaleNET program administrators at each of the four colleges reported that the college offers its own set of stackable degree- and nondegree-bearing courses for different types of jobs that are in high demand in the shale natural gas industry. A student could therefore complete a certification, enter the labor force, and then return to the program to receive further education and training. The stackable credential model therefore allows workers to move in and out of the labor force and provides a clear picture of the career pathway and the educational requirements to progress through that pathway. Catalyst Connection was the only program sponsored by the API that specifically aims to improve awareness about manufacturing jobs. While it did not provide specific training to adult workers, it aimed to amplify manufacturing companies’ efforts that were already underway by reaching out to stakeholders and creating awareness of job opportunities, career pathways, and internship or apprenticeship opportunities available in those companies.

**Skills Acquisition**

The API Workforce Development Logic Model specifies that the skills acquired through an API program will increase participants’ job opportunities, retention in that job, and income. By instilling skills and competencies in high demand, employers will seek graduates from these programs.

Our analyses found that each program had a specific aim to impart knowledge and skills to participants that aligned with the demands in the energy and manufacturing industry. Interviewees reported that, depending on the course offered, this often occurred through hands-on, activity-based learning approaches or on-the-job training and apprenticeships or internships, which would complement traditional classroom lecture formats. Examples of these approaches include:
Southwest Training Services provides courses in advanced technology and technical degrees in high-priority occupations, as determined by the state of Pennsylvania.

ShaleNET specifically focuses on the certificate and degrees in demand in high-priority occupations in the shale natural gas industry and provides opportunities for students to practice their skills on equipment provided by employers, on mock well pads, and in virtual workplaces. Certificates are available for jobs such as completion technician, floorhand, roustabout, or welder; one-year degrees are available for instrumentation and electronics technician, pipeline technician, process technician, or production technician; associate degrees are available for industrial maintenance technologist, mechatronics, and petroleum technologist. Coursework is transferable across the consortium colleges.

The Energy Safety Passport at the Energy Innovation Center provides a standardized curriculum that covers specific safety standards. It requires students to practice the safety procedures that are covered in the course before certification is provided.

At the time of this report, Natural Resources program administrators had plans to extend the high school programs to adults but had not yet done so. The program will provide adults with scientific knowledge and skills, and certifications in competencies and skills in demand in the oil and gas industry.

In addition to industry-specific technical skills needed to enter the workforce, additional skills are necessary to remain competitive and function effectively within the workplace. These workplace competencies, or “soft skills,” include oral and written communication skills, teamwork skills (e.g., respect for differing opinions and customs), problem-solving and critical-thinking skills, and professionalism (e.g., responsibility, accountability, and integrity) (U.S. Department of Labor, Office of Disability Employment Policy, 2013). All programs sponsored by the API included these soft skills as necessary components of the trainings offered or that will be offered.

Similar to the API-sponsored K–12 STEM education programs, the API is strategically funding workforce development programs that are either pilot efforts (that could be scaled up if deemed successful) or are employing potentially promising programming or instructional models meant to improve participants’ skills.

Skills Alignment

The third component of the API logic model for workforce development programs is skills alignment: supporting the transferability of skills of transitioning workers, such as veterans or dislocated workers, so that their current skills can be translated to those needed in the energy and advanced manufacturing sectors or providing reskilling so that their prior competencies and skills are incorporated in current employment. The expectation is that skills alignment will promote hiring, retention, and greater income for transitioning workers. By having their skills from a previous job recognized, workers may not have to start at an entry-level position, and therefore they may be more likely to maintain their current income.

To date, only two of the five workforce development programs explicitly mention transitioning workers as a target population or goal: ShaleNET and Southwest Training Services.
ShaleNET recruitment materials note that veterans and veteran spouses are encouraged to apply. Southwest Training Services’ program, CareerLink, is open to displaced coal miners who are looking for retraining for technology jobs.

Industry Engagement

Employer involvement in workforce development programs is critical to ensuring that graduates have received the technical knowledge and skills needed to meet occupational demands. Evaluations of workforce development programs across the United States found that, without frequent input and participation from local employers, training and education providers are unable to plan and develop programs that result in the knowledge, skills, and competencies needed to be competitive in the energy sector (Gonzalez et al., 2015). The API Workforce Development Logic Model specifies that programs that include employer involvement will strengthen links between training and industry careers.

Our analyses found that four of the five programs involved employers and industry leaders in three ways: (1) by providing technical expertise and advice in curriculum design and development to ensure that course requirements would meet on-the-job demands, (2) by providing equipment to ensure that students were practicing their skills using the most up-to-date materials, (3) by offering workplace experiences for students, whether through internships or field trips and guest lectureships. Catalyst Connection was the one outlier, as it provides consultation services to manufacturing companies to improve and facilitate those companies’ provision of internships and apprenticeships to potential workers.

Networks

Trainees’ access to formal and informal job placement networks is one approach to supporting their access to employment opportunities. Three of the programs (ShaleNET, Southwest Training Services, and Natural Resources) offer some kind of opportunity for trainees to access to job placement efforts, whether through career counseling, job databases, or exposure to companies with possible job openings through job fairs and meet and greets.
Appendix D. Data and Analysis of Beneficiaries

Geographic Scope and Reach of the API

Figure D.1 shows the county-level reach of the API programs. The darker shade of blue means that more programs were in the county. It is important to note that this map counts each grantee’s program itemized in Table A.2 in Appendix A. For example, Catalyst Connection operates six programs, each funded by the API and available in Allegheny County, Pennsylvania and in Brooke, Hancock, Marshall, Ohio, and Wetzel Counties in West Virginia.

There are two interesting findings from this map. First, in its early years of funding, the API portfolio reached across all counties in the API footprint. However, the concentration of programs was uneven: There was an unequal geographic distribution of API-funded programs across the states. Most API-funded programs appeared to be located or were available to people living in Southwestern Pennsylvania, with the heaviest concentration of API programs in Allegheny County, Pennsylvania, and in Marshall County, West Virginia. The only Ohio programs funded by the API at the time of the study were ShaleNET’s Stark College, the Project Lead the Way schools, and the Energy Safety Passport program (while located in Allegheny County, participants can come from any of the API counties). Yet, Ohio offered a number of potentially useful resources for API programs, including the Ohio STEM Hub Network, Ohio Career Pathways, “Choose Ohio First” scholarship, and Manufacturing Hub in Youngstown, Ohio. In addition to Project Lead the Way and Energy Safety Passport, West Virginia had only two API K–12 STEM programs: the Education Alliance and the Children Museum of Pittsburgh’s Building the West Virginia Maker Network.

4 These are: Adventures in Technology, various internship- and apprenticeship-related activities, Manufacturing Career Exploration Program with Girl Scouts, a Middle School Student Video Contest, Pathways to Apprenticeship, and various professional development-related activities.
Figure D.1. Geographic Distribution of Programs, by County in API Region

Heatmap of All Programs
1–3  4–6  7–9  10–12

COUNTY INVOLVEMENT IN API PROGRAMS

STEM EDUCATION PROGRAMS (K-12)

- Building the West Virginia Network
  - Boone, Marshall, Monongalia
- Explore Making
  - Fayette, Greene, Washington
- Fab Lab (Science center)
  - Allegheny, Butler, Westmoreland
- Fab Lab (III)
  - Fayette, Greene, Washington
- Grand Slam Science: On the Road
  - Allegheny, Armstrong, Beaver, Butler, Greene, Indiana, Lawrence, Mercer, Washington, Westmoreland, Belmont, Carroll, Columbiana, Hancock, Jefferson, Mahoning, Monroe, Stark, Trumbull, Warren, Ohio, Wetzel
- STEM Network Schools
  - Marshall, Ohio
- Student Energy Summit
  - Allegheny

Project Lead the Way
- Allegheny, Armstrong, Beaver, Butler, Greene, Indiana, Lawrence, Mercer, Washington, Westmoreland, Belmont, Carroll, Columbiana, Hancock, Jefferson, Mahoning, Monroe, Stark, Trumbull, Warren, Ohio, Wetzel

WORKFORCE DEVELOPMENT PROGRAMS

- Adventures in Technology
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- Energy Safety Passport
  - Allegheny, Armstrong, Beaver, Butler, Greene, Indiana, Lawrence, Mercer, Washington, Westmoreland, Belmont, Carroll, Columbiana, Hancock, Jefferson, Mahoning, Monroe, Stark, Trumbull, Warren, Ohio, Wetzel
- Internship and Apprenticeship
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- Manufacturing Career Exploration Program
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- Middle School Student Video Contest
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- ShadINet
  - Allegheny, Armstrong, Beaver, Butler, Greene, Indiana, Lawrence, Mercer, Washington, Westmoreland, Belmont, Carroll, Columbiana, Hancock, Jefferson, Mahoning, Monroe, Stark, Trumbull, Warren, Ohio, Wetzel
- Natural Resources at Grom County
  - Greene
- Pathways to Apprenticeship
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- Professional Development Related Activities
  - Allegheny, Brooke, Hancock, Marshall, Ohio, Wetzel
- Southwest Training Services
  - Fayette, Greene, Washington

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This uneven distribution of programs presents an opportunity for API leadership to consider how it wishes to balance its investments across the three states. On the one hand, the geographic spread of the programs seemed to align with the location of Chevron Corporation well pads and direct operations in Tuscarawas County, Ohio; Marshall County, West Virginia; and across Greene, Washington, Fayette, Westmoreland, and Allegheny Counties in Pennsylvania. Further, API leaders have focused funding on programs that reach rural counties that have relatively small populations of youth or working-age adults, thereby supporting communities that could be less connected to resources or do not have access to currently funded API programs. For context, Table D.1 itemizes the size of the working-age population (adults ages 18–64), the number of school-age children (youth ages 3–18), and the number of public schools in each of the API counties. Here, we see that, in the counties with fewer working-age and school-age populations (e.g., Harrison and Monroe Counties in Ohio, Greene County in Pennsylvania, or Wetzel County in West Virginia), the API has funded two to four K–12 STEM education and workforce development programs in each. The current concentration of programs seems to be well aligned with Chevron’s locations in the region and the API’s emphasis on rural communities.

On the other hand, API leaders could consider funding efforts in those counties with relatively larger populations. In Table D.1, we see that of the counties with relatively large working- and school-age populations (e.g., Mahoning and Stark Counties in Ohio; Allegheny, Beaver, Butler, Washington, and Westmoreland Counties in Pennsylvania; and Monongalia County in West Virginia) the API has funded two to four K–12 STEM programs, which is similar as the number of API programs available in the smaller counties, and one or two workforce development programs, which is fewer than the number of API programs available in the smaller counties.

<table>
<thead>
<tr>
<th>County</th>
<th>Size of Working-Age Population (Ages 16–64)</th>
<th>Number of School-Age Children in Households (Ages 3–17)</th>
<th>Number of Public Schools (2015–2016 Academic Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belmont County</td>
<td>43,056</td>
<td>11,235</td>
<td>23</td>
</tr>
<tr>
<td>Carroll County</td>
<td>16,682</td>
<td>5,492</td>
<td>8</td>
</tr>
<tr>
<td>Columbiana County</td>
<td>64,343</td>
<td>19,340</td>
<td>38</td>
</tr>
<tr>
<td>Harrison County</td>
<td>9,222</td>
<td>2,872</td>
<td>7</td>
</tr>
<tr>
<td>Jefferson County</td>
<td>41,237</td>
<td>11,826</td>
<td>43</td>
</tr>
<tr>
<td>Mahoning County</td>
<td>140,856</td>
<td>41,970</td>
<td>72</td>
</tr>
<tr>
<td>Monroe County</td>
<td>8,294</td>
<td>2,682</td>
<td>8</td>
</tr>
<tr>
<td>Stark County</td>
<td>226,858</td>
<td>71,321</td>
<td>140</td>
</tr>
<tr>
<td>Tuscarawas County</td>
<td>54,894</td>
<td>18,480</td>
<td>31</td>
</tr>
</tbody>
</table>
County | Size of Working-Age Population (Ages 16–64) | Number of School-Age Children in Households (Ages 3–17) | Number of Public Schools (2015–2016 Academic Year)
--- | --- | --- | ---
Pennsylvania | | | |
Allegheny County | 783,124 | 199,070 | 251
Armstrong County | 40,764 | 11,812 | 10
Beaver County | 102,718 | 29,036 | 49
Butler County | 115,665 | 34,128 | 31
Fayette County | 81,895 | 22,799 | 42
Greene County | 24,170 | 6,285 | 13
Indiana County | 56,590 | 13,830 | 20
Lawrence County | 52,887 | 15,580 | 25
Mercer County | 68,775 | 20,222 | 40
Washington County | 127,670 | 35,806 | 60
Westmoreland County | 217,393 | 60,395 | 86
West Virginia | | | |
Brooke County | 14,288 | 3,805 | 10
Hancock County | 18,082 | 5,077 | 11
Marion County | 35,202 | 9,495 | 21
Marshall County | 19,563 | 5,725 | 14
Monongalia County | 75,781 | 13,126 | 19
Ohio County | 26,555 | 7,017 | 14
Wetzel County | 9,361 | 2,817 | 6
TOTAL | 2,475,925 | 681,243 | 1094

SOURCES: Size of working-age population and number of school-age children are from U.S. Census Bureau’s American Community Survey 2009–2013 five-year estimates (U.S. Census Bureau, 2017); number of public schools in Ohio is from Great Schools (undated); number of public schools in Pennsylvania is from Pennsylvania Department of Education (undated); number of public schools in West Virginia is from West Virginia State Department of Education (undated).

Intended Beneficiaries

Table D.2 lists the types of populations the programs intended to serve (also see Table A.2 for this information) and the aggregated number of beneficiaries the API programs to date reached across the counties. Note that at the time of the study, some programs just started and were not yet able to provide numbers of participants.

Overall, the administrators of the K–12 STEM API-funded programs that were able to report the number of participants served between 2014 and 2016, documented that 48,056 prekindergarten through 12th-grade students had been touched by their programs. For those students that program administrators estimated or were able to determine the family’s income
level, about one-half were lower income, as defined by each program. Further, API-funded programs had reached 122 schools in that same year, and 777 teachers had gone through various in-service professional development opportunities.

Between 2014 and 2016, of the workforce development programs that were able to provide data, program administrators noted that 131 adults were trained or received API-funded service and seven instructors had received professional development. API leaders expect these numbers to increase in subsequent rounds of funding as more programs are able to report the number of beneficiaries.

**Table D.2. API Programs’ Intended and Served Beneficiaries**

<table>
<thead>
<tr>
<th>Program</th>
<th>Type of Beneficiaries</th>
<th>Number Served (October 2014–July 2016)</th>
<th>Numbers Served (October 2014–December 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K–12 STEM Education Programs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnegie Science Center:</td>
<td>Student Energy Summit</td>
<td>Number of students: 48,056</td>
<td>Number of students: 75,316</td>
</tr>
<tr>
<td>Chevron Center for STEM Education and Career Development</td>
<td>Grand Slam Science, On the Road</td>
<td>Number of schools: 122</td>
<td>Number of schools: 122</td>
</tr>
<tr>
<td></td>
<td>Fab Lab</td>
<td>Percentage of participants served defined as lower income: 48%</td>
<td>Percentage of participants served defined as lower income: 55%</td>
</tr>
<tr>
<td>Intermediate Unit 1</td>
<td>Fab Lab</td>
<td>Number of teachers trained in STEM-related instructional approaches: 777</td>
<td>Number of teachers trained in STEM-related instructional approaches: 961</td>
</tr>
<tr>
<td>Children’s Museum of Pittsburgh</td>
<td>Explore Making</td>
<td>Number of K–12 schools: 122</td>
<td>Number of K–12 schools: 122</td>
</tr>
<tr>
<td>Education Alliance</td>
<td>STEM Network Schools</td>
<td>Number of K–12 rural schools: 87</td>
<td></td>
</tr>
<tr>
<td>Project Lead the Way</td>
<td>K–12 students and teachers</td>
<td>Number of K–12 schools: 122</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As an organization, recently focusing more on girls and women and underserved populations</td>
<td>Number of K–12 schools: 122</td>
<td></td>
</tr>
<tr>
<td>Natural Resources at Central Greene School District</td>
<td>11th- and 12th-grade high school students (planning to provide classes for adults in the future as well)</td>
<td>Number of K–12 schools: 122</td>
<td></td>
</tr>
<tr>
<td><strong>Workforce Development Programs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ShaleNET</td>
<td>Postsecondary students interested in careers in oil and gas</td>
<td>Number of participants: 131</td>
<td>Number of participants: 383</td>
</tr>
<tr>
<td>Southwest Training Services</td>
<td>Dislocated workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Innovation Center</td>
<td>Energy Safety Passport</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Producers, service partners, contractors and subcontractors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catalyst Connection;</td>
<td>Middle school student video</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table D.1, the size of the working- and school-age populations and the number of schools in the 27-county API footprint is large. API leaders did not envision touching each adult, student, or school within the 27 counties, nor does the API have numeric targets for beneficiaries. Instead, the API endeavors to spearhead efforts to galvanize the community and other funders to reach students most in need (e.g., those living in rural communities) and adults that are interested in employment in middle-skill occupations in the energy and advanced manufacturing careers.

Moreover, given that this is the first year of the API portfolio, and many programs were not yet able to provide us with descriptions of the beneficiaries who had completed the programs, it is too early to determine whether the programs, as a whole, are reaching the types of populations that the API intends to support through its programming. We will continue to collect data from each program on the number of participants and their sociodemographic characteristics so that future analyses can track trends through time.
Appendix E. Data and Analysis of Sustainability

As noted in Appendix A, promoting long-term sustainable strategies and programs is central to the API. For the purposes of this evaluation, we defined sustainability as a program or activity that meets present and future needs of the tristate region’s STEM education and energy sector workforce ecosystem and the likelihood of programs and activities will continue beyond the API investment. Our analyses explored which factors program administrators reported facilitated or inhibited the programs’ ability to achieve desired results in the present and how financially sustainable the programs were at the time of the study.

Facilitators of Success

Our interviewees identified a number of factors that they believed facilitate their programs’ current and future success. These included a supportive government and policy community; networks, partnerships, and learning; and program, teacher, and school administrator motivation.

Supportive government and policy context: A number of program administrators identified supportive policy contexts in Pennsylvania and West Virginia at the state level and within specific local areas or cities:

- West Virginia has a Governor’s STEM Council, and the West Virginia Department of Education has designated grants for “Innovation Zones,” which emphasize STEM education and career pathways, among other priorities. Education Alliance, for example, is working toward developing a model and set of STEM standards for schools to be designated as a West Virginia STEM school. Education Alliance administrators reported that they relied on the strong supporting role of the school districts for this STEM school initiative.
- In Pennsylvania, the governor established a STEM Planning Committee whose members included the administrators from the Fab Lab programs in Intermediate Unit 1 and the Carnegie Science Center.
- In Pittsburgh, the Remake Learning community (discussed further in the companion report) has set goals for improving education in Pittsburgh, with collaboration among government, foundations, and education stakeholders. One of its three priorities is developing the Maker Movement, of which Pittsburgh has been particularly supportive.
- While most interviewees did not mention Ohio’s policy context (likely because most API programs to date are located in Pennsylvania and West Virginia), some noted that the Ohio State Department of Education initiative to create career pathways across a range of STEM occupations is viewed as a model for the region (Ohio Department of Education, undated). As another example, In September 2016, Ohio's Education Improvement Program provided Stark College with a $506,000 grant to support its ShaleNET programming, expanding funding provided in previous years from the federal government (CantonRep.com, 2016).
Workforce development program administrators reported that the federal government had been increasingly supportive of workforce development programs, especially those that are sector-based (which focus on education-business partnerships across a sector rather than one-off programs between one company and one education provider) and that include higher-education consortium and career-pathways models. For example, ShaleNET launched with two grants (one in 2010 and the second in 2012) from the U.S. Department of Labor Education and Training Administration totaling $19.9 million. Indeed, many workforce development programs based in higher-education institutions are closely tied to unpredictable state budgets that fluctuate depending on the funding decisionmakers in the government. Many workforce development programs therefore typically seek funding and support from the federal government.

**Networks, partnerships, and learning:** Several program administrators also identified networks with other programs and schools as important case studies for promising practices or about potential facilitators or obstacles to sustainability and how to surmount them. Some interviewees described networking among the schools in their programs or other programs approaching them for lessons learned. For example, among K–12 STEM efforts:

- Remake Learning and the Maker Movement offer networking opportunities among participating organizations.
- Principals of Education Alliance schools meet regularly to share experiences.
- Project Lead the Way has a hotline that schools can call for feedback and help.
- Many companies also have made efforts to get involved with these programs, providing in-kind staff time, equipment, or access to work sites. Intermediate Unit 1 Fab Lab noted that local businesses have begun approaching them for access to the Fab Lab for prototyping of their products.

The colleges in ShaleNET, Southwest Training Services, Natural Resources, and Catalyst Connection all pointed to their partnerships with employers, other colleges, and K–12 schools (where relevant) as pivotal in ensuring that their programs remained relevant and produced graduates who were employable by incorporating the most up-to-date instructional approaches, curriculum content, and attracting talent with an interest in middle-skilled jobs.

**Program, teacher and school administrator motivation:** Across the interviews, a common theme was the “enthusiasm,” “excitement,” and “commitment” of teachers and school administrators in participating schools about the new approaches to STEM K–12 education, in particular because of a perceived need for the programming. Many said that teachers were particularly supportive and “lined up” for training. One program leader described the provision of improved STEM K–12 education opportunities as a “social justice” issue in disadvantaged or rural communities. Incorporating new models and approaches to STEM learning and exposing students to STEM careers similar to what students in more-affluent school districts or in urban areas received served a broader community purpose and was seen as improving equity in opportunities. One program administrator added that teachers, students, and parents were
motivated to participate in that particular program because it would help the students obtain qualifications to find employment.

**Human resource capacity and institutional memory:** Interviewees from the workforce development programs noted that a key factor in supporting their programs’ sustainability in uncertain funding contexts was having consistent program administrators who had the capacity and knowledge to apply for funding from a variety of sources, and to make connections across a range of employers and community partners, and who had the institutional memory to leverage working relationships and strengthen collaborations.

**Challenges to Success**

Program leaders also identified a number of challenges to meeting their current and future goals.

**Perception gap:** Across programs, many interviewees noted making efforts to dispel notions that STEM education is too difficult and is only for the college-bound, as well as parental concerns that energy or manufacturing careers are not promising pathways. The *Work to Do* survey (Campos Research Strategy, 2014) found that parents, guidance counselors, and students in rural school districts in Pennsylvania whom they interviewed had low levels of awareness and understanding of STEM education; parents did not associate STEM education with noncollege degree jobs. For example, two K–12 STEM education programs administrators noted that they experienced challenges explaining that their STEM programs would be valuable to students with a wide range of postsecondary expectations. The perception gap is also a key challenge for workforce development programs. All interviewees noted that their programs were below capacity. They speculated that potential trainees either did not know about the program or the family-sustaining earnings one can make in the energy and manufacturing jobs currently available. In many instances, interviewees relayed anecdotes about recent high school graduates or transitioning workers who envisioned energy or manufacturing jobs as undesirable because they perceived them as dirty, dangerous, and about “pick axes and hard hats.”

**Leadership support:** While many program interviewees noted strong support from leaders at the state, district, or city levels, they also noted that leadership support at the school or district level for STEM K–12 education programs was uneven. They speculated that this lack of support might stem from a variety of sources such as competing priorities; the need to adhere to state testing requirements, which leave little flexibility in curricula and scheduling; constrained budgets; and principals or district superintendents who did not understand the potential effectiveness of new STEM learning approaches or informal learning models. For example, in some cases, school principals were not responsive to new programs likely because of their multiple competing demands or their school budgets lacked funding for such expenses as buses for field trips. Multiple program representatives noted that public schools systems’ emphasis on testing, resulting from state testing policies, had reduced flexibility for additional or experimental
programs. State standards (upon which the tests are based) do not stipulate a specific curriculum or instructional approach; program administrators noted that they would therefore expect that school leaders would be more open to project-based learning or learning occurring in informal settings. However, they reported the opposite: They found it difficult to convince schools that the new programs were valuable. This challenge has not been insurmountable, however, as many programs found collaborating schools to work with. At the city level, some interviewees perceived that manufacturing initiatives received less support from Pittsburgh than have the health care and information technology industries, as manufacturing may be viewed as part of the city’s past rather than its future. Likewise, interviewees from workforce development programs commented on how their budgets were often dependent on the whims of state politics and what efforts state legislatures or governors wanted to fund.

**Progression and links among pathways:** A number of program representatives noted that there was no clear pathway between K–12 education and the workplace; students, parents, school leaders, teachers, and guidance counselors did not understand and were not aware of which skills or courses accrued in middle or high school were particularly in demand in the workplace. Interviewees noted that to date there are no maps that articulate the coursework or skills that a high school graduate should have in order to meet requisites for entry into a postsecondary education or training program or to enter a middle-skill entry-level position. Indeed, our analysis of how API K–12 STEM programs aligned with the API Strategic Logic Model also found that K–12 STEM program administrators would like enhanced connections across API programs, so that programs could learn from one another or determine ways to link efforts.

**Impact measurement:** Many program representatives described measuring whether their program was effective as a particular challenge. There are a number of reasons for this. Data collection and longitudinal studies are expensive. Privacy laws limit access to student data. The nature of some of the programs, particularly informal learning through museums, makes measurement difficult because of the infrequent interaction of programs with students and the difficulty in demonstrating that particular results are attributable to particular programs. The literature also notes limitations in understanding the full effects of out-of-school informal programs. Because of the difficulty in collecting information from those who participate in out-of-classroom experiences after they have finished participating, it is hard to determine the extent to which these programs may lead to improved student achievement or careers in the STEM workforce (NRC, 2015).

Also cited as a challenge was the lack of understanding outcomes for graduates of workforce development programs. In addition to needing to protect students’ privacy, interviewees noted that tracking students into the future after they completed a program was often infeasible. Many programs track their completers for six months to one year after graduation and will be able to do so for the API-funded students once they graduate, but measuring longer-term employment was difficult: People moved without leaving forwarding information. However, especially for
workforce development programs, it is vital to track longer-term indicators, such as retention and salary gains, to determine a program’s effectiveness.

**Teacher qualifications and turnover:** Turnover of teachers and staff was described as a frequent problem for both the K–12 STEM education and workforce development programs. When K–12 teachers trained by or staffed in particular programs left, programs needed to train new teachers. Interviewees lamented that preservice teacher colleges do not educate their teachers in training with the skills needed for these programs, such as project-based instruction or particular subject-matter expertise not typically found in public schools (e.g., three-dimensional printing, additive manufacturing, occupational licensing for commercial driving). One STEM program manager believed that, although there were some teacher colleges that prepared teachers for technical education, spreading this practice to more preservice training programs could reduce some of the problems associated with teacher turnover. Finding teachers with the required state licenses for teaching STEM subjects is also a barrier for some programs. The workforce development program interviewees reported competing for quality instructors with the private sector. It is reportedly difficult for colleges and training programs to provide quality instruction when salaries in the private sector are much higher.

**Industry fluctuation:** Several program administrators noted the challenges in expanding given the industry slowdown. Programs that aim to provide certifications for students or adults to become employable in the manufacturing or energy sector found it difficult to attract participants because of the recent decline in the price of natural gas, which decreased employment in those sectors. Jobs were not as plentiful at the time of this study as during the initial shale gas boom between 2011 and 2015. The cyclical nature of the energy sector was a deep concern of the workforce development program interviewees: It was difficult to project future demand for jobs that the programs were training for, given the 2015 drawdown in employment. Many education and training programs’ budgets are dependent on how many students are in a course. If a course or program cannot draw sufficient attendance, it could close its doors. However, were demand to suddenly increase, there would not be qualified graduates available nor training programs in place. Not having longer-term strategies in place to deal with industry fluctuations was reported to be a key challenge to programs’ sustainability.

### Financial Sustainability

Program representatives also projected their ability to sustain their programs over time. While some of the programs believed that they had a financially sustainable model to continue their efforts, others noted that funding was unstable. Through our interviews, we identified ways that programs managed their financial sustainability. Table E.1 summarizes how each program acquired its funding.
### Table E.1. Sources of Funding for Programs

<table>
<thead>
<tr>
<th>Carnegie Science Center</th>
<th>Children’s Museum</th>
<th>IU1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation and corporate funding</td>
<td>Foundation and corporate funding</td>
<td>Start-up funding from Chevron</td>
</tr>
<tr>
<td>Fees from schools</td>
<td>Government funding</td>
<td>In-kind contributions from Intermediate Unit 1</td>
</tr>
<tr>
<td></td>
<td>School fundraisers</td>
<td>Fees from districts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Lead the Way</th>
<th>Education Alliance</th>
<th>Catalyst Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up implementation grants</td>
<td>Start-up grants</td>
<td>Foundation funding</td>
</tr>
<tr>
<td>Participation fees from schools</td>
<td>West Virginia Innovation Grants</td>
<td>Sponsorships</td>
</tr>
<tr>
<td>Donated equipment from business</td>
<td>VISTA (AmeriCorps Volunteers in Service to America) volunteers</td>
<td>Fees from manufacturers for equipment</td>
</tr>
<tr>
<td></td>
<td>In-kind contribution from schools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In-kind contribution from business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foundation and corporate funding</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Natural Resources</th>
<th>ShaleNET</th>
<th>Southwest Training Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up funding</td>
<td>Start-up funding (federal grant)</td>
<td>Government funding (e.g., Rapid Response Funds)</td>
</tr>
<tr>
<td>In-kind contribution from schools</td>
<td>In-kind contributions from businesses</td>
<td>Workforce Investment Boards (state funding)</td>
</tr>
<tr>
<td>Site access from companies</td>
<td>Financial contributions from businesses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tuition</td>
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<table>
<thead>
<tr>
<th>Energy Safety Passport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up funding</td>
</tr>
<tr>
<td>Tuition</td>
</tr>
</tbody>
</table>

**Start-up funding:** Programs require resources to launch and scale. Some of the STEM education programs have been able to scale up to include additional schools without external start-up funding. Other programs needed funding to start their efforts in new schools, with a vision that schools or programs would be independent after that initial infusion of funding. For example:

- Project Lead the Way and Education Alliance both planned for financial independence for their schools; funding is used upfront for training and equipment purchases, and then schools continue independently. Project Lead the Way noted that schools do not have to have start-up funding to join and that many participating schools do not. Education Alliance has a vision that their partner STEM schools will be independent after three years. In addition to the Chevron funding, Education Alliance has also received funding from grants and raised additional funds for schools starting up.
• Natural Resources relied on start-up funding, but then plans to develop financing for continuity.
• The Fab Labs at the Carnegie Science Center and Intermediate Unit 1 also relied on large grants for initial equipment and training. Intermediate Unit 1 received start-up funding from the API and in-kind contribution from the school districts and companies.
• Carnegie Science Center’s Grand Slam Science on the road relied on an initial grant to develop the programming.
• ShaleNET launched with a multimillion dollar grant from the U.S. Department of Labor.

Financial continuity: After start-up, a number of programs have developed models for financial continuity. These include charging fees, obtaining external funding for operations, or obtaining in-kind support.

• Project Lead the Way charges $3,000 in annual participation fees from schools for its curriculum, software, assessments, and teacher training. The project has found that the $3,000 annual fee has not deterred schools in continuing, and the funds have enabled Project Lead the Way to continue resourcing its development of materials.
• Carnegie Science Center interviewees reported that its sustainability model was “built in”; they charge schools operating costs and fees, while foundations cover costs for particular programming.
• Intermediate Unit 1 also charges districts fees to support its mobile Fab Lab.
• Natural Resources would like to charge companies fees for participation, but with the fall in prices of natural gas, companies are not hiring as much as before; they are concerned that fees, while they are still starting up, would deter participants.
• Catalyst Connection does not have a fee model. While program administrators reported having considered a fee model, they were concerned that fees might become a deterrent for some companies or schools.
• Workforce development programs rely on tuition from students to sustain them after the initial start-up funds are spent; some student tuition costs are covered by industry scholarships.

A number of program administrators reported relying on ongoing external funding for operations from federal or state governments, foundations, or corporations.

• The Children’s Museum has multiple sources of corporate, foundation, and government funding but notes that they can be unreliable from year to year.
• The Carnegie Science Center receives ongoing support from foundations and companies for its programming.
• Catalyst Connection relies on foundation funding, grants, and sponsorships for its operations; while this funding is year to year, they note that they have been operational for 23 years and their model has sustained itself. The workforce development program interviewees explained that searching for various federal, state, or local grants to support ongoing operations was commonplace and expected to ensure sustainability.

Multiple programs have benefited from in-kind contributions from schools or corporations. For example:
• PLTW administrators reported that their schools often receive donated equipment from local businesses.
• Parent-teacher associations at schools raise funds, such as through bake sales, to support bus transportation for students to the Children’s Museum.
• Natural Resources received in-kind contribution from schools (providing teachers and guidance counselors) and companies (providing access to well sites and other hands-on training).
• Project Lead the Way and Education Alliance received in-kind contributions from local industry, by sharing work sites, providing volunteers, and offering equipment. The workforce development programs all received industry in-kind support, often in the form of membership on advisory committees to provide input on job demands and to ensure that curricula were aligned to the demand.

Supporting financial sustainability: All program managers reported various challenges to their financial sustainability. One was the lack of consistency in state or federal education budgets, which created difficulties in their ability to plan for future programmatic spending or to know how much they would have to rely on external nongovernment funding sources. For example, several program representatives noted that the instability in the Pennsylvania state education budgets, which have not been passed consistently, was detrimental to their programs. Even if their programs did not rely on state funding, participating schools had to take loans to cover teacher salaries, preventing them from finding ways to cover costs for other programming. Education Alliance hired VISTA volunteers to work in its STEM schools; the VISTA volunteers wrote grant proposals, which brought in additional funding. Education Alliance also received West Virginia State Innovation Zone grants. In terms of federal funding, several expressed concern about its future, wondering about the direction of the next administration regarding their programs. A second was ongoing salary costs. One program administrator noted that being able to afford staffing costs was a particular issue; this program did not believe it had sufficient funding for full-time teachers, and they therefore hired (less expensive) consultants or student teachers (those in training) or volunteers to cover costs. They felt that if this practice continued, it could potentially compromise the integrity and quality of the program.

Leveraged funding was a sustainability strategy program administrators employed. Several program leaders described how, after one or two respected funders provided funding for a program, their name recognition made it easier to obtain other external funding. One described it as a “springboard process.” This was particularly the case for the workforce development program administrators who noted that while companies were often generous with in-kind support, they were less willing to provide financial support—especially if there was uncertainty around the connection between the program and fluctuating workforce demands. If one company financially supported a program, it was often perceived as a sign to other companies that they could also invest.
Appendix F. Data and Analysis of Community Catalyst

Policy Advocacy and Community Involvement

The tristate region hosts a number of regional, state, and national STEM and workforce development initiatives that relate to the API objectives. In this appendix, we describe the various STEM education and workforce development initiatives underway at the time of this study in Pennsylvania, West Virginia, and Ohio, discussed state by state. We review how these efforts relate to national initiatives and federal policy and how API initiatives relate to these activities. We also offer suggestions for how the API could further engage in policy discussions and community efforts underway to promote work toward common goals. The discussion here is based on a review of literature and media, interviews with API program administrators about their activities and collaborations, and data and documentation provided by API program administrators. We focus on examples of the main activities related to API initiatives underway, in particular those mentioned frequently in our interviews; we do not describe every initiative.

Pennsylvania

The API concentrates its efforts in 11 counties in southwestern Pennsylvania (see Figure 1): Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Mercer, Washington, and Westmoreland. Many API-sponsored activities are based in Pittsburgh in Allegheny County. Our review focused on activities in these counties, in addition to activities at the state level; it does not include activities elsewhere in the state unless they were linked to the counties considered here. However, we note that while West Virginia and Ohio have statewide initiatives, Pennsylvania did not have similar statewide initiatives; most STEM and workforce development initiatives are locally or regionally focused, and they were mostly led in Pittsburgh. The primary activities related to the API’s goals and involving API-sponsored organizations include the following.

Organizations in Pittsburgh have been undertaking initiatives toward defining and developing “the Maker Movement.” Here, we describe the main maker activities, how API programs have been involved with them, and how they relate to state and federal initiatives.

5 The nationwide Maker Movement gained traction through the launch of Make Magazine in 2005 by Maker Media in San Francisco. Maker Media hosted the first Maker Faire in 2006 in the Bay Area. Since then, numerous Maker Faires have been organized throughout the world, including Flagship Maker Faires (“Faires curated and produced by the Maker Media team”), Featured Maker Faires (“larger-scale regional events”), Mini Maker Faires (“community events”), and School Maker Faires (“K–12 Faires [closed to the general public]).” Maker Faires display successful
• **Pittsburgh as a “Maker City”**: Pittsburgh Mayor Bill Peduto committed to build Pittsburgh as a “Maker City” (a designation that includes supporting the creation of maker spaces, task forces, and collaborations) at the first National Maker Faire at the White House in 2014 (The White House, undated). About 100 other cities have also been designated as Maker Cities.

• **Remake learning network**: The Remake Learning Network—a coalition of more than 200 organizations in the greater Pittsburgh region stewarded by the Sprout Fund and the Remake Learning Council—has been investing in innovation in STEAM (science, technology, engineering, arts, and mathematics) learning, among other areas. *The Remake Learning Playbook*, which provides other communities resources to develop similar learning networks, was presented during the 2015 National Maker Faire in Washington, D.C. (*Pittsburgh Post-Gazette*, 2015). A number of API organizations have joined the Remake Learning Network, including Catalyst Connection, Children’s Museum of Pittsburgh, Intermediate Unit 1, the Carnegie Science Center, and Education Alliance. Chevron and the Education Alliance are also a part of the Remake Learning Council.

• **Fab Labs, MAKESHOPS, and Techshops**: Pennsylvania’s API region hosts a number of Fab Labs supported by the Fab Foundation, in addition to the API’s Intermediate Unit 1 and Carnegie Science Center Fab Labs. The Fab Foundation supports more than 500 Fab Labs in 30 countries and provides a platform for Fab Lab members to connect with other Fab Labs around the world. For example, Carnegie Science Center representatives presented on teacher professional development during the Fab12 conference in China. The Children’s Museum of Pittsburgh MAKESHOP is collaborating with the Institute of Museum and Library Services to develop evidence-based making and relevant professional-development resources. Pittsburgh is also one of nine U.S. cities that hosts the TechShop, which President Barack Obama visited prior to the 2014 White House Maker Faire (TechShop, 2016; Remake Learning, undated).

• **Maker Faires**: The Children’s Museum of Pittsburgh’s MAKESHOP has spearheaded many of the city’s maker efforts, including the organization of three Mini Maker Faires in 2011–2013 and two larger-scaled Featured Maker Faires in 2015–2016 (Maker Faire, 2016[a]; Maker Faire, 2016[b]).

• **Making in secondary curricula**: The Children’s Museum of Pittsburgh also partnered with Google and Maker Ed (a nonprofit organization that supports maker education) to develop a national strategy to add making to school curricula. The strategy involves ten participating hubs that will assist up to ten regional schools in implementing and sustaining making into their curricula; Children’s Museum of Pittsburgh is the hub for the Pittsburgh region (Maker Ed, 2016[a]; Maker Ed[b], 2016). Schools in the Pittsburgh region, such as Elizabeth Forward, South Fayette, Avonworth, and Blackhawk High Schools, are among the first in the United States to integrate making into their curriculum (The White House, undated); the Elizabeth Forward and the Avonworth schools house their own Fab Labs.

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do-it-yourself projects and innovations in any field (e.g., science, art, engineering, performance). For more information, see Maker Faire, 2016(a); Maker Media, 2016; Maker Faire, 2016(b).
In addition to the Maker Movement, there are a number of activities in the 27-county API region that aim to innovate in K–12 STEM education instruction and learning.

- **STEM school professional development**: The Carnegie Science Center in Pittsburgh is developing the STEM Excellence Pathway to provide schools and school districts with a standardized method to improve the quality of their STEM education practices, with a focus on school self-assessment (Stemiphere, 2013; Carnegie Science Center, undated[a]; Carnegie Science Center, undated[b]). The Education Alliance is using the STEM Excellence Pathway to implement the STEM Network Schools program in West Virginia.

- **STEM teacher training**: The Carnegie Science Center is also one of the 280 STEM organizations throughout the United States that have committed to the federal 100Kin10 initiative announced in President Obama’s 2011 State of the Union address, which sets goals to train an additional 100,000 STEM teachers in U.S. schools within ten years (100Kin10, undated). The Carnegie Science Center has committed to train 2,000 of the total 100,000 teachers within the next five years.

- **Recognition of nontraditional learning**: Pittsburgh is one of 12 LRNG cities that provide a public online platform to provide learners with badges that demonstrate nontraditional learning experiences, including for STEM subjects (LRNG, undated[a], undated[b], undated[c], undated[d]; MacArthur Foundation, undated). More than 40 Pittsburgh organizations have committed to provide learning opportunities and badges through the LRNG site (Open Badges in Higher Ed, undated; Remake Learning, 2016), including the Carnegie Science Center and Catalyst Connection.

The greater Pittsburgh region also has additional workforce development related institutions with activities related to API goals.

- **Connecting businesses and potential employees**: Both Natural Resources at Greene County and Southwest Training Services reported that they collaborate with the Tri-County Oil and Gas Expo to connect local businesses and potential employees from the Fayette, Greene, and Washington Counties of Southwestern Pennsylvania to opportunities associated with the Marcellus Shale (“Tri-County Oil and Gas Business to Business Expo,” undated). The Tri-County Oil and Gas Expo has served as a source of funding and assistance in developing curriculum materials for Natural Resources.

- **Spaces for interaction between industry and universities**: The Energy Innovation Center in Pittsburgh, which hosts the API Energy Safety Passport program, is a nonprofit institution that provides workforce development programs in STEAM career paths, a space for university-industry collaborations, and labs for green technology research. Local universities that have provided training at the center include Carnegie Mellon University, University of Pittsburgh, Duquesne University, and Robert Morris University (Energy Innovation Center, 2016[a], 2016[b], 2016[c]; Schooley, 2014; University of Pittsburgh, undated; Gagnier, 2015; NEXT Pittsburgh, 2015).

- **Widely available scholarships for tertiary education**: Pittsburgh provides higher education and workforce development opportunities to its students through the Pittsburgh Promise. The Pittsburgh Promise aims to reduce the education gap in Pittsburgh by providing all Pittsburgh Public Schools students scholarships to any postsecondary institution in Pennsylvania, including four-year public and private colleges and
universities, two-year college programs, or trade and technical schools (The Pittsburgh Promise, undated).

Pittsburgh and the greater Pittsburgh region have been recognized nationally for their STEM education and workforce development initiatives. For instance, the greater Pittsburgh region was selected by the STEM Funders Network, a national group of grantmakers for STEM education (STEM Ecosystems, undated[c]), as one of the U.S. STEM Ecosystem communities because of its network for delivery of prekindergarten to 16 (prekindergarten through four years of college) STEM education. STEM Ecosystems consist of “preK–16 schools; community settings such as afterschool and summer programs; institutions of higher education; STEM-expert organizations such as science centers, museums, corporations, intermediary and non-profit organizations or professional associations; businesses; funders; and informal experiences at home and in a variety of environments” (STEM Ecosystems, undated[b]). As a part of the STEM Ecosystem Initiative, the greater Pittsburgh region receives technical assistance and grants from the STEM Funders Network. Because of its ability to provide “connected learning” as a city through the Remake Learning Network and the LRNG portal, Pittsburgh was selected by the Mozilla Foundation to be one of the three Hive Network Cities in the United States (Hive Pittsburgh, undated[a]; undated[b]). Pittsburgh was also recognized as the Regional Spotlight for the fourth-year National STEM Video Game Challenge, part of the federal Educate to Innovate campaign (The White House, 2009; National STEM Video Game Challenge, 2016).

West Virginia

The API concentrates its efforts in seven counties in northern West Virginia: Brooke, Hancock, Marion, Marshall, Monongalia, Ohio, and Wetzel. The largest cities in these counties are Morgantown, Wheeling, and Weirton. Our review focused on activities in these counties, in addition to activities at the state level; it does not include activities elsewhere in West Virginia. West Virginia has a number of initiatives related to API goals at the state level, yet some interviewees noted that West Virginia lags behind Pennsylvania and Ohio in regional and national partnerships. One interviewee remarked that as a state, West Virginia is “not as plugged in as other states.”

There are a number of initiatives underway related to API goals in K–12 STEM education and workforce development in West Virginia.

• **West Virginia STEM Hubs:** In 2014, Governor Earl Ray Tomblin established the West Virginia Council on STEM to develop strategies to improve STEM education in the state. Council meetings were supported by the Benedum Foundation and consisted of representatives from K–12 and postsecondary education and multiple industries. The council recommended developing three to five STEM Hubs, modeled after STEM Hubs in Iowa, Tennessee, Oregon, Washington, and Ohio. STEM Hubs will coordinate activities among school districts, postsecondary institutions, STEM businesses, and community organizations to meet education and workforce needs of particular regions. Together, the Hubs will form a West Virginia STEM Network, which will receive annual
funding of $500,000 (West Virginia Council on STEM Report, 2014; West Virginia Department of Education and the Arts, 2016).

- **STEM model schools:** Education Alliance is working with the West Virginia state Board of Education and other policymakers to develop STEM school criteria for West Virginia using lessons learned from its STEM Network Schools program (The Education Alliance, 2016).

- **Advanced Manufacturing Technician Program:** West Virginia is one of seven states—along with Kentucky, Indiana, Mississippi, Texas, Tennessee, and Alabama—that hosts the Advanced Manufacturing Technician Program, supported by a partnership between Project Lead the Way and the Toyota Motor Engineering and Manufacturing, North America. Project Lead the Way students demonstrating math proficiency can apply to the program for an opportunity to receive a two-year associate degree, paid work experience, and education in business principles and best practices (Project Lead the Way, 2013).

**Ohio**

The API funded programs in nine counties in eastern Ohio: Belmont, Carroll, Columbiana, Harrison, Jefferson, Mahoning, Monroe, Stark, and Tuscarawas. The largest cities in these counties are Canton and Youngstown. Our review included activities in these counties and related efforts at the state and federal levels. While these areas in Ohio had a number of initiatives underway at the time of this study, API leaders interacted less with initiatives in Ohio than with initiatives in Pennsylvania and West Virginia.

Activities related to API efforts in K–12 STEM education and workforce development in Ohio included the following:

- **STEM Hubs:** Ohio has seven STEM Hubs established, which served as a model for the STEM Hubs underway in West Virginia. These STEM Hubs consist of a STEM platform school, which partners with other local schools, postsecondary institutions, businesses, and community organizations to share resources and coordinate STEM activities in the region. The hubs also have STEM training centers to provide up-to-date professional development courses. The Southeast Ohio STEM Hub is a part of the API region (Ohio STEM Learning Network, undated).

- **Career pathway mapping:** To further coordinate education and workforce development initiatives, the Governor’s Office of Workforce Transformation developed an online collection of typical career pathways for “In-Demand Occupations” in Ohio. These publicly available pathways are also used in determining effective policies to improve STEM education in the region (Ohio Department of Education, undated; Ohio Department of Job and Family Services, undated; OMJ, 2015; Ohio Means Jobs, undated[a]; Ohio Means Jobs, undated[b]). API leaders and programs viewed these career pathways as an important model for the region.

- **Scholarships for tertiary STEM education and workforce development:** The state of Ohio provides “Choose Ohio First” scholarships to undergraduate and graduate students of universities and colleges with an approved STEMM (science, technology, engineering, math, and medicine) education program (Ohio Higher Ed, undated). Students of some of the ShaleNET courses at Stark State College are eligible for Choose Ohio First scholarships.
• **Youngstown as a manufacturing hub and maker city:** Youngstown houses the first “Manufacturing hub” in the United States, launched as a pilot program for the National Network for Manufacturing Innovation, now known as Manufacturing USA. Manufacturing hubs are regions selected by the U.S. Department of Commerce because of their advanced manufacturing collaboration among local government, universities, and industry. These hubs receive federal grants that are matched by nonfederal and private funds (Manufacturing.Gov, undated[a]; The White House, 2012). Through the federally supported manufacturing hub, Youngstown was able to develop the resources to become another U.S. Maker City, along with Pittsburgh (The White House, undated; America Makes, undated; Fernback, 2016).

**Tristate Collaborations and Shared National Resources**

Pennsylvania, West Virginia, and Ohio share interests in developing STEM education and preparing workers for changing job demands in the region brought by recent shale discoveries, ongoing manufacturing, and the evolving information age. This has led to collaboration across the states to share resources and build the region as a center for the energy and manufacturing industries.

• **The Tri-State Regional Cooperation Agreement:** In an event sponsored by Chevron, the Benedum Foundation, and the Allegheny Conference, the governors of the three states signed the Tri-State Regional Cooperation Agreement in October 2015. The agreement promotes development of the tristate regional economy through initiatives that include energy and manufacturing workforce development programs (including ShaleNET) and collaborative research among academic institutions (“Regional Cooperation Agreement,” 2015).

• **Tri-State University Energy Alliance:** The energy institutes of four research universities in or near the API region—Case Western Reserve University in Ohio, West Virginia University in West Virginia, and Carnegie Mellon University and the University of Pittsburgh in Pennsylvania—formed the Tri-State University Energy Alliance. The institutes aim to collaborate to address pressing global and local energy challenges and bring the region to the forefront of energy research (Tri-State University Energy Alliance, undated; WVU Today, 2016; Conti, 2016). Many of the API programs collaborate with these universities as well.

• **Cross-state collaboration among API programs:** As mentioned earlier, Carnegie Science Center in Pittsburgh is providing guidance to Education Alliance West Virginia STEM Network Schools through its STEM Pathways toolkit. Catalyst Connection in Pittsburgh and Education Alliance are collaborating on an expansion of the Manufacturing Innovation challenge to West Virginia with the help of Eagles Manufacturing. Stark College in Ohio plans to become a Project Lead the Way accredited school.

• **ShaleNET:** The four ShaleNET colleges included in the API portfolio also provide connection among the federal government, the energy industry, and community or technical colleges across the three API states to produce workforce development programs that align with the occupational needs of the natural gas and oil industry within the three states. With the 2012 U.S. Department of Labor Education and Training
Administration grant, the ShaleNET training model was developed into a “stackable credential model,” offering four more certificates and two more associate programs (ShaleNET, undated).

The three states also shared connections to national initiatives and institutions, including the following:

- **STEMxNetwork**: Ohio, West Virginia, and Pennsylvania are three of 21 states that are members of the nationwide STEMx Network, which provides a platform for states to share resources on STEM education and professional development. ASSET STEM—a nonprofit organization that promotes good practice in professional development for STEM educators—is taking the lead in the Pennsylvania STEMx Network; Catalyst Connection is partnering with ASSET STEM to develop their professional development material for project-based learning (STEM Ecosystems, undated[a]).

- **Informal learning associations**: Museums and science centers throughout the United States connect through the Association of Science-Technology Centers (ASTC), which provides programmatic and professional guidance to member organizations and development of new science centers and policy advocacy for science centers. Children’s Museum of Pittsburgh and Carnegie Science Center are both members of the ASTC, while Ohio has ASTC members that are not API-sponsored but within the API region (Association of Science-Technology Centers, 2016).

- **Dream It. Do It.**: The three states have organizations participating in the Dream It. Do It. network, which was launched by the Manufacturing Institute to increase awareness of and interest in manufacturing career paths. Catalyst Connection is the regional leader for Southwestern Pennsylvania.

- **National After School Network**: Education Alliance is the West Virginia affiliate for the National After School Network, which provides out-of-school programs for students of all ages. Ohio and Pennsylvania each have an affiliate for the national afterschool network as well (Statewide Afterschool Networks, undated).

- **Manufacturing Extension Partnerships (MEPs)**: The three states have ongoing relationships with federal agencies to increase job opportunities. Sponsored by the U.S. Department of Commerce, MEPs are present in every state and together form a national network of agencies that support small- to medium-sized manufacturing companies aiming to collectively make the United States competitive in advanced manufacturing. MEPs connect small- and medium-sized enterprises with local, state, and federal governments and institutions to increase their ability to expand markets and develop innovative products (Manufacturing.gov, undated[b]). Catalyst Connection is an MEP in Southwestern Pennsylvania. Catalyst Connection also collaborates with MEPs in Ohio and West Virginia to exchange ideas.

- **Workforce Investment Boards (WIBs)**: Every U.S. state has WIBs, which operate under the 2014 Workforce Innovation and Opportunity Act (WIOA), implemented by the U.S. Department of Labor, U.S. Department of Education, and the U.S. Department of Health and Human Services. Its purpose is to improve federal workforce development
programs to make them more appropriate for 21st-century jobs. Southwest Training Services is affiliated with the local WIB through the Pennsylvania Career Link program. Carnegie Science Center and Catalyst Connection also collaborated with their local WIBs.

- **Appalachian Regional Commission (ARC):** The three API states are members of the federally funded ARC. Involving 13 Appalachian states, ARC is a regional economic development agency founded in the 1960s to improve the education, economic, and health care conditions of the mountainous portion of the Appalachian states that lagged behind the rest of the country. The agency fosters collaboration between the federal, state, and local governments and allows participating states to receive federal assistance and funding for a number of approved economic development projects (Appalachian Regional Commission, undated). In collaboration with Butler Community College and other regional partners, Allegheny Conference submitted a proposal to the ARC to support workforce development programs.

**Networks and Contributions**

API-sponsored entities formed networks to share ideas, collaborate on initiatives, facilitate pathways between education and jobs, and facilitate financial and in-kind contributions. Drawing on data provided by the API programs in interviews about their connections with other API programs, regional universities, funders, businesses, and government entities, we created network diagrams. We asked whether programs had met and shared promising practices with one another, whether they had partnerships with regional universities, businesses, government entities, or other external partners to collaborate on programing, and which entities had provided funding. Our questioning was intentionally open-ended to allow respondents to describe all the various partners, purposes of collaborations, and structures of those connections and collaborations.

Using the network visualization software Visone, we integrated individual API program responses about collaborations with descriptive information about API programs to create network diagrams and facilitate visual analytics (Brandes and Wagner, 2004). We created four network diagrams (shown in the companion report) illustrating the relationships among API programs and API leaders and other API programs; external partners (including mainly companies, along with several associations and government agencies); regional universities; and funders. The network diagrams represent a particular moment in time in July 2016, when the API program administrators completed the data collection template for us. Relationships may have developed or evolved since then or have been different in the past.

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6 WIBs, which were previously called Workforce Development Boards and were responsible for implementing the 1998 Workforce Investment Act, will now focus on the terms provided by WIOA (National Association of Workforce Boards, undated).
The purpose of these diagrams is to help API leaders understand their existing networks and consider forging or improving relationships with individual organizations or activating new networks of organizations that work together toward common goals. The network diagrams should enable API stakeholders to assess the extent to which network composition and the connections shown in the network can be leveraged to achieve API goals. This may result in API leaders’ considering how they can most effectively manage their individual and collective relationships. Relationship management is a concept explored in great detail by researchers whose specialization is evaluating interorganizational collaboration among public, private, and nonprofit organizations with the assumption that organizations have a limited amount of resources to spend on collaboration and that success is linked to effective and efficient use of those resources (DeLeon and Varda, 2009; Varda et. al., 2008; Paarlberg and Varda, 2009; Varda, 2010; Retrum et. al., 2013).
Appendix G. API Program Administrator Interview Questions

**Program Overview**

1. What is the geographic scope of your program?
2. Who are the intended beneficiaries?
3. What is the vision and desired impact of your program?
4. What do you consider to be the best ways to measure your impact?
5. The API’s goal is to “Improve the economic and education environment in Appalachia by investing in programs that increase job preparedness, access, and incomes.” How does your program’s vision align with these goals?
6. Are you aware of evidence from the literature or existing programs about impacts of similar endeavors elsewhere?

**Program Implementation**

1. What was the process for deciding budget use and priorities?
   - What role does the Chevron grant play in your overall organization’s mission?
   - What contribution do you receive from other organizations (funding, leadership, time, knowledge, in-kind)? From individuals?
   - Has being a Chevron-funded program enabled you to leverage additional funding?
2. How are operations and processes working?

**Outcomes**

1. What is the anticipated time line for impact?
2. What are your program’s defined targets or benchmarks for impact?
   - What changes can you document among beneficiaries?
   - Have you observed any measurable short-term changes among target groups?
3. What changes do you think are happening with anecdotal evidence?
4. How is your program meeting goals for target groups?

**Sustainability**

1. What factors facilitate the achievement of desired results?
2. What are the challenges in achieving desired results?
   - How are challenges being addressed?
   - Are new strategies needed to address challenges?
3. What are your biggest successes to date?
4. What are the gaps in meeting your goals?
5. How sustainable do you think the program is?
   - What are the factors that determine how sustainable the program is?
– Which factors bode well for sustainability, and which are challenges?
– How do you think that the challenges could be overcome?

6. What are the lessons learned about how to be more effective? How have your programs changed based on lessons learned?

**Community Engagement**

1. What other STEM education organizations or workforce development and training programs do you collaborate with most? In what way?
2. Do you collaborate with any of the other API-funded programs [show list]?
   – How so?
   – Did this partnership exist prior to the API or was it fostered by the initiative?
3. What higher education institutions do you collaborate with most? In what way?
   – Did this partnership exist prior to the API or was it fostered by the initiative?
4. How are your program’s efforts fitting into regional and national policy leadership on STEM education and workforce development?
   – What policy advocacy have you been engaged in?
   – What policy or government leadership interaction do you have?
   – How do you involve the wider community?
   – What other regional or national initiatives for these issues are you aware of, and how are you involved with them? Are you having dialogue with other regional or national leadership on these issues?

5. What are the most important regional or national policy issues that should be addressed in order to make your program more effective?
6. What organizations do work similar to your work, either in the tristate area or nationally?

**Closing**

1. Is there anything else that we should have asked you?
2. Is there anything that you would like to ask us?
## Appendix H. Sample Data Collection Template

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Currently (2015–2016)</th>
<th>Since Funding Started</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of public awards received</td>
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<tr>
<td>Please list the types of awards</td>
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<tr>
<td>Number of people who have attended public events associated with the project, if applicable</td>
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<tr>
<td>Number of career exploration events hosted by program</td>
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<td></td>
</tr>
<tr>
<td>Number of positive media mentions of program</td>
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</tr>
<tr>
<td>Number of direct project beneficiaries(^1) (number of participants)</td>
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<td></td>
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<tr>
<td>• American Indian or Alaska Native</td>
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<td>• Dislocated worker(^2)</td>
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<tr>
<td>• Veteran</td>
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<tr>
<td>Number of direct project beneficiaries(^1) (# of participants) residing in 27-county API footprint(^3)</td>
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<td>• American Indian or Alaska Native</td>
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<td>• Dislocated worker(^2)</td>
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<td>• Veteran</td>
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<tr>
<td>Number of direct project beneficiaries(^4) (# of participants) certified or accredited in a skilled trade as a</td>
<td></td>
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</tr>
</tbody>
</table>
result of project

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

Number of direct project beneficiaries (number of participants) completing the program

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

Number of direct project beneficiaries (number of participants) who dropped out of program (started, but did not complete)

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

Number of direct project beneficiaries (number of participants) who participated in job-related internship or co-op

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

Number of direct beneficiaries (number of participants) getting a job upon program completion

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

Please list the type of jobs attained and the number of individuals getting those jobs:

Number of direct project beneficiaries (number of participants) who remained in the same job for up to one year

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Hispanic or Latino
- Other race/ethnicity
- Rural residency
- Urban residency
- Suburban residency
- Male
- Female
- Dislocated worker
- Veteran

<table>
<thead>
<tr>
<th>Number of Chevron scholarship applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Chevron scholarships awarded</td>
</tr>
<tr>
<td>Number of instructors/vocational trainers trained in professional or occupational license</td>
</tr>
<tr>
<td>Number of hours in professional development related to courses supported instructor teach</td>
</tr>
<tr>
<td>Number of companies on job matching site</td>
</tr>
<tr>
<td>Number of on-the-job training opportunities (e.g., internships and co-ops, apprenticeships)</td>
</tr>
<tr>
<td>Number of companies collaborating for joint training for high-demand occupations across sectors.</td>
</tr>
</tbody>
</table>

Please list the companies and the type of collaborations

<table>
<thead>
<tr>
<th>Number of companies contributing in-kind expertise and time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please list the types of in-kind and amounts of contribution:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of companies collaborating with the program to develop curriculum relevant to advanced manufacturing and energy (e.g., work-based learning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please list the companies and describe the developed curriculums.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of job fairs (hosted by program)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of career counselors</td>
</tr>
</tbody>
</table>

NOTE: See next page for definition of items in superscript.
### Definitions

<table>
<thead>
<tr>
<th>No.</th>
<th>Metric</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Number of direct project beneficiaries</strong></td>
<td>The number of project beneficiaries is the number of people that are directly impacted by the project. It is the number of people who receive the direct outputs as a result of Chevron’s funding.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Dislocated worker</strong></td>
<td>A person who has recently been laid off from his/her previous job due to closing of the business for which he/she worked (e.g., coal miners laid off due to the closing of a mine).</td>
</tr>
<tr>
<td>3</td>
<td><strong>27-count API footprint</strong></td>
<td>Counties in Ohio, Pennsylvania, and West Virginia that encompass the Appalachia Partnership Initiative footprint:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Ohio</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Belmont, Carroll, Columbiana, Harrison, Jefferson, Mahoning, Monroe, Stark, Tusarawas</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Pennsylvania</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allegheny, Pennsylvania, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Mercer, Washington, Westmoreland</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>West Virginia</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brooke, Hancock, Marion, Marshall, Monongalia, Ohio, Wetzel</td>
</tr>
<tr>
<td>4</td>
<td><strong>Cash funds (in US$) contribution leveraged through partnership</strong></td>
<td>Leveraged funds are all funds that were contributed as a result of Chevron’s funding to the project. The additional funding must have come as a result Chevron’s investment; it is not simply other donations provided to the partner or project. Indicate their value, if known. Estimate if exact value is not known.</td>
</tr>
</tbody>
</table>
Appendix I. API Leader Questionnaire

Contributions

1. To the extent of your knowledge, how many institutions have provided financial support for API-funded activities?
   - List these institutions (e.g., foundations, companies, industry associations)
2. To the extent of your knowledge, how many companies are participating in API activities?
   - How many of these companies have their employees volunteer for API activities and/or events?
   - List these companies, the associated industries, and the number of volunteers provided.
3. How many of these companies have provided in-kind leadership, time and knowledge to the API initiative?
   - List these companies, the associated industries and their contributions.

Policy Advocacy

1. List and describe current discussions related to improving career and technology education, STEM education, or energy and advanced manufacturing workforce development policy between your organization and…
   - Federal government:
   - State government:
   - Local/city government:
2. List and describe initiatives currently in progress by your organization that are aligned with API policy priorities. (Please refer to “API Strategic Logic Model” in Chapter Two of Measuring Progress of the Appalachia Partnership Initiative: Proposed Monitoring and Evaluation System).
3. To the extent of your knowledge, what kind of impacts have these initiatives had on API policy priorities?

Community Involvement

1. How many community organizations are involved with the API?
   - List these community organizations and describe the nature of their involvement.
2. Are you aware of any partnerships between API programs and educational institutions?
– List the educational institutions by type (e.g., high school, college, etc.) and their contributions.

3. How many media interviews has your organization provided regarding the API?
4. How many media stories have been published about the API that your organization has directly contributed to?

Networks

1. List and describe all your outreach efforts your organization has undertaken on behalf of, or in partnership with, the API with industry and professional associations (e.g., board positions, speaking engagements, advisory roles, etc.).
2. List and describe all your API outreach efforts your organization has undertaken on behalf of, or in partnership with, the API with educational entities.
3. List and describe the conferences that your organization has participated in on behalf of, or in partnership with, the API.
4. List and describe all the cross-sector meetings and consortia your organization has facilitated or undertaken on behalf of, or in partnership with, the API.
5. To the extent of your knowledge, list and describe examples of industries facilitating or creating centers of excellence in the API region.
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