Supporting a 21st Century Workforce in Puerto Rico

Challenges and Options for Improving Puerto Rico’s Workforce System Following Hurricanes Irma and Maria in 2017

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Preface

On August 8, 2018, the government of Puerto Rico submitted to Congress an economic and disaster recovery plan, as required by the Bipartisan Budget Act of 2018. Under contract with the Federal Emergency Management Agency (FEMA), the Homeland Security Operational Analysis Center (HSOAC) provided substantial support in developing the plan by soliciting and integrating inputs from a wide variety of stakeholders, contributing analysis where needed, and assisting drafting the plan. The plan included an overview of damage and needs, courses of action (COAs) to meet those needs, costs of the COAs, and potential funding mechanisms for those costs.

To support federal agencies evaluating and funding recovery actions, HSOAC is releasing this detailed volume for the economic sector, which is one of 12 HSOAC research sectors that helped develop the recovery plan. HSOAC developed supporting information for each sector engaged as part of recovery planning. While the other sector reports describe conditions and actions that contribute to economic outcomes, the Economics Sector volumes are focused on the preexisting conditions and policies that contributed to the economic contraction before Hurricanes Irma and Maria and the potential actions that could be taken to promote economic growth in the poststorm period.

The purpose of this document is to give decisionmakers more detail on the workforce challenges confronting Puerto Rico prior to the 2017 hurricane season, and directly afterward, and to offer suggested strategies to design and implement workforce development programs and an overarching system that will help meet short-term and long-term workforce needs and support the government of Puerto Rico in meeting its strategic objective to develop a 21st-century workforce. Data collection and analysis for this report occurred from January through June 2018. This report is a companion document to another Economics Sector report, Challenges and Opportunities for the Puerto Rico Economy: A Review of Evidence and Options Following Hurricanes Irma and Maria in 2017 (forthcoming), which summarizes the sector’s courses of action described in the recovery plan and provides more details on how the government of Puerto Rico can develop its economy in the wake of the 2017 hurricanes.

More information about HSOAC’s contribution to recovery planning in Puerto Rico, along with links to other reports being published as part of this series, can be found at www.rand.org/hsoac/puerto-rico-recovery.

This document will likely be of interest to other stakeholders funding or implementing recovery activities in Puerto Rico, including local municipality agencies, nongovernmental organizations, and the private sector. Furthermore, this body of material contributes to the larger literature about disaster recovery and resilience and may be of interest to other communities planning for recovering from similar disasters.
This research was sponsored by FEMA and conducted within the Strategy, Policy, and Operations Program of the HSOAC’s federally funded research and development center (FFRDC).

About the Homeland Security Operational Analysis Center

The Homeland Security Act of 2002 (Section 305 of Public Law 107-296, as codified at 6 U.S.C. § 185), authorizes the Secretary of Homeland Security, acting through the Under Secretary for Science and Technology, to establish one or more FFRDCs to provide independent analysis of homeland security issues. The RAND Corporation operates the HSOAC as an FFRDC for the U.S. Department of Homeland Security (DHS) under contract HSHQDC-16-D-00007.

The HSOAC FFRDC provides the government with independent and objective analyses and advice in core areas important to the department in support of policy development, decisionmaking, alternative approaches, and new ideas on issues of significance. The HSOAC FFRDC also works with and supports other federal, state, local, tribal, and public- and private-sector organizations that make up the homeland security enterprise. The HSOAC FFRDC’s research is undertaken by mutual consent with DHS and is organized as a set of discrete tasks.

This report presents the results of research and analysis conducted under 70FBR218F00000032, “Puerto Rico Economic and Disaster Recovery Plan: Integration and Analytic Support.”

The results presented in this report do not necessarily reflect official DHS opinion or policy.

For more information on HSOAC, see www.rand.org/hsoac. For more information on this publication, visit www.rand.org/t/RR2856.
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Summary

In September 2017, Puerto Rico experienced two major hurricanes within two weeks of one another. The two storms, Hurricane Maria in particular, caused catastrophic damage to buildings and infrastructure throughout Puerto Rico as well as a significant number of injuries and deaths. In light of the severe damage caused by Hurricanes Irma and Maria, the Federal Emergency Management Agency (FEMA) contracted with the Homeland Security Operational Analysis Center (HSOAC), a federally funded research and development center operated by the RAND Corporation under contract with the Department of Homeland Security, to provide support in developing the Governor of Puerto Rico’s economic and disaster recovery plan (herein, the Recovery Plan), as required by the Bipartisan Budget Act of 2018 (Pub. L. 115-123). HSOAC solicited and integrated inputs from a wide variety of stakeholders, contributed analysis where needed, and supported the writing of the draft plan.¹ The plan includes an overview of damage and needs, courses of action (COAs) to meet those needs, costs of the COAs, and potential funding mechanisms for those costs. The effort was organized around “sectors” of recovery planning to mirror the FEMA sectors that are based on the National Disaster Recovery Framework, including teams related to Energy, Water, Transportation, Communications/IT, Health and Social Services, Education, Natural and Cultural Resources, Housing, Public Buildings, Community Planning and Capacity Building, Municipalities, and Economics.

Objectives of the Report

The purpose of this report is to provide decisionmakers greater detail on the workforce challenges in Puerto Rico prior to the 2017 hurricane season, acute workforce needs resulting from Hurricanes Irma and Maria, and strategies that were identified to help the economic sector (and, more broadly, Puerto Rico) meet the goals of the recovery plan’s strategic initiative to Build a 21st-Century Workforce. The government of Puerto Rico defines this workforce as a “modern workforce imbued with 21st-century skills” that “requires a world-class K–12 and higher education system that is equitable, efficient, and better integrated with the demands of the labor market and needs of businesses.”² The goals of this strategic initiative are to (1) develop and protect human capital to establish a world-class workforce; (2) increase labor force flexibility; and (3) create high-quality employment opportunities aligned with economic growth.

¹ More information about HSOAC’s contribution to planning for recovery in Puerto Rico, along with links to other reports being published as part of this series, can be found at www.rand.org/hsoac/puerto-rico-recovery.

strategies. The 21st-Century Workforce strategic initiative is just one of eight set forth in the recovery plan.

As part of the Recovery Plan, the Economics Team developed principles for investing in economic growth and a list of over 120 detailed recovery actions, grouped into 40 COAs for consideration by the government of Puerto Rico. The overarching philosophy underpinning these COAs was to define potential actions that were broadly consistent with Puerto Rico’s past actions and plans, were likely feasible (in that plans or proposals for specific actions existed, could reasonably be developed fairly rapidly, or appeared in the literature), could be linked to issues highlighted by the review of Puerto Rico’s economy and estimates of damage, and spanned the relevant policy and investment space, thus providing a menu of possible options. As they emerged, various independent plans and recommendations were cross-referenced for consistency with the developed set of COAs. All 40 COAs were incorporated into the recovery plan published by the government of Puerto Rico on August 8, 2018.

This report documents the background research conducted to craft the COA most closely aligned with the recovery plan’s strategic initiative for building a 21st-century workforce that is included with the economic sector COAs; namely ECN 2, Implement Workforce Development Programs. This HSOAC recovery plan supplemental report provides greater detail for a focused topic in contrast with the other reports in this collection that provide an overview of a recovery sector. The report illuminates the research that is distilled into only a brief description within the recovery plan and short summary in the companion Economics Sector report. This greater detail here is motivated by the importance of Puerto Rico’s workforce in sustaining recovery and building resilience against potential future disasters. The HSOAC analysis supplements U.S. federal agency analysis conducted on behalf of the economic recovery in Puerto Rico. In addition to presenting the analysis conducted to create this COA, this report also provides guidance on how to approach implementing the strategies and actions suggested in the COA. The research was undertaken between January and June 2018. Supplemental discussions with representatives of the government of Puerto Rico and FEMA occurred in December 2018, after the publication of the recovery plan.

**Key Findings**

In explaining the report’s major findings, we first summarize the economic context in Puerto Rico prior to the hurricanes in 2017. These analyses used existing publicly available data sources. We then summarize the analyses we conducted on historical and acute workforce challenges confronting Puerto Rico. These analyses were derived through a review of primarily secondary data sources and literature reviews, augmented by interviews with on-the-ground

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3 The Economics Team is defined as HSOAC Economics sector personnel and recovery support function (RSF) personnel on the ground in Puerto Rico before, during, and after the development of the Recovery Plan.

4 For detailed information about the Economics sector planning and COA development, see RAND Corporation, “Supporting Puerto Rico’s Disaster-Recovery Planning,” undated.
partners. We then present the analyses HSOAC undertook in developing strategies to strengthen Puerto Rico’s workforce in light of the acute short-term and longer-term workforce shortages and needs, with the aim to support the government of Puerto Rico in building a 21st-century workforce. We relied on reviews of the literature on promising practices in the field of workforce development, a review of evidence-based workforce development programs in regions of the continental United States (CONUS) that were recovering from natural disasters, interviews with workforce development program administrators and key personnel from the government of Puerto Rico, and the recommendations and insights from a panel of experts in economics, development, and workforce development.

**Economic Development Context of Puerto Rico**

Economic growth in Puerto Rico was generally negative between 2006 and 2016, with low labor force participation and high unemployment relative to the CONUS. In conjunction with the contraction of the economy, a variety of factors—lower revenues, high rates of expenditure, and heavy borrowing—resulted in high and unsustainable levels of debt. Puerto Rico’s credit rating dropped to below investment grade in early 2014, followed by a series of defaults on debt payments (U.S. Government Accountability Office, 2018). The financial crisis ultimately resulted in the passage of H.R. 5272, the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) in 2016, which established the Financial Oversight and Management Board (FOMB) and provided the framework for restructuring the government of Puerto Rico’s debt.

Just before Hurricanes Irma and Maria, between 3.3 million and 3.5 million people resided in Puerto Rico. As compared with the CONUS, per capita economic activity was low, with a gross national income (GNI) per capita at $19,430 for Puerto Rico for 2016, while the comparable figure for the CONUS was $56,810. Gross domestic product (GDP), which includes production of non–Puerto Rico firms operating in Puerto Rico, was composed of about 47 percent manufacturing (with large concentrations of biopharma, chemicals, and computer and electronics) and 20 percent finance, insurance, and real estate. Agriculture accounted for approximately 1 percent of GDP.\(^5\)

Total employment in June 2017 was about 853,000, with the largest sectors including public administration (15 percent), retail trade (15 percent), and health care and social assistance (11 percent). Relative to the CONUS, Puerto Rico just prior to the storms was characterized by high unemployment (10.4 percent) and a low labor force participation rate (near 40 percent overall). Relatedly, Puerto Rico has a considerably large informal economic sector, estimated in size at between 20 to 25 percent of formal economic activity. Outmigration has been significant over the past decade, largely driven by differences in economic opportunity between Puerto Rico

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and the CONUS, complemented by low transaction costs (since the people of Puerto Rico are U.S. citizens).

**Historical and Acute Workforce Challenges in Puerto Rico**

Puerto Rico’s economy has a variety of structural problems that have contributed to a lack of growth over the past decade or so. Each of these challenges has multiple root causes that may be under the aegis of multiple actors, including the government of Puerto Rico, U.S. federal agencies, and Congress.\(^6\) Before the hurricanes, Puerto Rico was already experiencing major challenges to its workforce.

1. **Low labor force participation.** Puerto Rico’s labor force had been declining in the ten years before Hurricanes Irma and Maria. At every age level and education level, participation is lower in Puerto Rico than in the CONUS, and lower participation rate appears to be driven by younger workers and less educated workers: Puerto Rico has high rates of low educational attainment and few low-wage employment opportunities. The existence of a large informal labor-force sector is also a challenge to workforce strategy planning and workforce development, as it weakens or entirely does away with traditional policy levers.

2. **Outmigration of working-age population.** Outmigration is the primary reason for the declining labor force participation and a key explainer of why labor force participation is so low among less-educated workers. From the perspective of the overall labor force of Puerto Rico, the takeaway is that Puerto Rico is losing working-age individuals who typically drive the economy.

3. **A fragmented postsecondary education system.** Puerto Rico’s postsecondary education system is fragmented across private and public institutions that appear to operate independently of one another, providing variable programs and credentials and creating inefficiencies in workforce development. (An example of inefficiency is in the mismatch between the supply of graduates with personal care service and auto repair certificates relative to the number of personal care service and auto repair jobs available.) Moreover, highly subsidized four-year postsecondary institutions remain unaffordable to a broad swath of Puerto Rico’s population, even as increases in tuition are set to take effect in the near future.

4. **There is not a clear alignment between education and training opportunities available and the occupations most in demand.** HSOAC analysis found a wide range of key occupations across educational categories. At each education level, from post-master’s (which includes Ph.D.’s, J.D.’s, D.D.S.’s, and M.D.’s) to certificates (which may or may not require an associate’s degree or even a high school diploma), there are numerous occupations that we identify as in high-demand by employers in Puerto Rico. This suggests that any long-term workforce development policies or strategies in Puerto Rico must encompass training and

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\(^6\) See the challenges and opportunities for the Puerto Rico economy at RAND Corporation, “Supporting Puerto Rico’s Disaster Recovery Planning,” webpage, undated.
education across the spectrum of education levels (low-, middle-, and high-skill levels). This lack of clarity jeopardizes the value of the credential and could be a challenge to Puerto Rico’s planning workforce development.

Strategies to Support Workforce Development as Puerto Rico Rebuilds

Taking into consideration the economic context of Puerto Rico and the historical and acute workforce challenges, the Economics Team developed a set of strategies to strengthen Puerto Rico’s workforce as it endeavors to build a 21st-century workforce. This set of strategies became part of the recovery plan’s Economics Sector COA titled ECN 2, Implement Workforce Development Programs. These strategies are ordered in terms of intensive investments (from less to more), external and internal to the government of Puerto Rico. These strategies are intended to provide a range of possible responses from the government of Puerto Rico and are thus not an exhaustive list of all the options Puerto Rico could undertake. Four strategies are intended to meet the short-term acute workforce challenges facing the island. The fifth strategy outlines a systems approach for workforce development that the government of Puerto Rico could implement to meet the ambitious goals set out in the Recovery Plan to build a 21st-century workforce. In developing these archetype strategies on behalf of the government of Puerto Rico, we relied on reviews of the literature on promising practices in the field of workforce development, a review of evidence-based workforce development programs in regions of the CONUS that were recovering from natural disasters, interviews with workforce development program administrators and key personnel from the government of Puerto Rico, and the recommendations and insights from a panel of experts in economics, international development, and workforce development which we convened in April 2018.

Below, the five strategies are briefly summarized. These strategies are scalable and can be enacted concurrently. They are not mutually exclusive.

Strategy 1. Let the Market Guide Workforce Development

This strategy allows an unguided, emergent (or market-based) response to deliver some of the needed additional workers in Puerto Rico’s post-hurricane recovery. This approach relies on a variety of private businesses and private nonprofit, nongovernmental organizations (NGOs) to facilitate the reconstruction of Puerto Rico. In this way, normal labor market signals, primarily job openings and wage levels, will guide individuals toward their optimal training and

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7 One rough estimate suggests that as many as 300,000 residential units on the island have severe damage from Hurricane Maria. Approximately 30 percent of those units will have been completely destroyed; see Andres Viglucci, “Half of Puerto Rico’s Housing Was Built Illegally. Then Came Hurricane Maria,” Miami Herald, February 14, 2018. A 2,000-square-foot home in the CONUS takes approximately 300 person-hours to complete. Assuming that a home in Puerto Rico requires approximately 200-person hours, residential reconstruction efforts alone will require approximately 7,000 construction workers working full-time for 24 months. There are approximately 20,000 to 33,000 construction workers presently in the formal labor market in Puerto Rico.
employment outcomes. Where necessary and possible, new employers will train their workforce to undertake the required tasks. The strategy requires little to no local government capacity to implement. The strategy assumes, however, that local and nonlocal firms will react to overall market conditions (e.g., with the hiring of additional construction labor) and that such conditions will emerge independently. The U.S. federal government might play a particular role in this strategy by designing federal policies, contracts, and grants to shape a market-based response in ways that benefit Puerto Rico in the short and long term.

**Strategy 2. Temporarily Contracting a Skilled and Experienced Workforce from the Continental United States**

Skilled and experienced workers in the United States may represent a critical resource in rebuilding Puerto Rico. By contracting with experienced construction firms in the CONUS, the government of Puerto Rico and other construction employers might address immediate needs while avoiding in the short to medium term the potentially greater uncertainty and intensive investments required in a more intensive strategy aimed at directly developing a local construction workforce. To help ensure medium- to long-term benefits for Puerto Rico, contracts with CONUS firms might incentivize local hiring whenever possible to ensure Puerto Rico construction labor benefits from government construction contracts. This approach would ensure investments in local labor and workforce development while not requiring the necessary free market conditions (e.g., local investments, growth in construction hiring) assumed or required by strategy 1. Such incentives would be in addition to fewer room and board and travel costs for local construction workers. There are potential weaknesses in this strategy, however. First, malfeasance and graft could plague these sorts of external contracts. Second, research suggests that temporary contract workers from a stronger economy typically do not permanently relocate to a given contract site in instances in which the contract site has a less robust economy—as is the case when comparing Puerto Rico’s economy to that of the CONUS and temporary contracts may result in few to no resulting resources (e.g., new and/or larger local firms, more skilled construction labor) to develop and support the local construction workforce. This means that the medium- to long-term prospects of a strong construction labor supply in Puerto Rico with experience in residential hurricane reconstruction likely diminishes under this strategy. Finally, this strategy assumes that the costs created by the transactional frictions and economic inefficiencies in importing an external workforce will be absorbed by the acute demand for labor.

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Strategy 3. Training Puerto Rico Workers Remotely in the Continental United States

A third strategy that the government of Puerto Rico could undertake is to coordinate with a remote, tuition-based training program in which interested residents of Puerto Rico could apply to travel to and train under and then, with assistance from the government of Puerto Rico or the training provider, find and complete an apprenticeship in Puerto Rico. This strategy could be coordinated in a number of ways and would therefore require some management and coordination from the government of Puerto Rico. One strength of this strategy is that it requires fewer direct government investments in Puerto Rico’s workforce development infrastructure at a time when existing programs in Puerto Rico remain closed following the hurricanes (e.g., Job Corps training centers in Arecibo and Barranquitas) and when there are numerous economic, health, and other exigencies on the island. This strategy is also appealing since it leverages existing expertise in the CONUS, including expertise in hurricane reconstruction and recovery in Texas, Louisiana, Florida, and elsewhere. This strategy could thus provide a skilled (re)construction workforce in the short term with less coordination and support from the government of Puerto Rico. Additionally, returning workers who have been trained represent a newly (up)skilled workforce in support of Puerto Rico’s medium- to long-term reconstruction and development efforts. However, this strategy presents two main challenges. First, individuals who select into the program are more likely to have established English fluency and other advantages, while youth from more vulnerable and disadvantaged populations are less likely to participate in this program. Generally, outmigration from Puerto Rico to the CONUS and circular migration between the CONUS and Puerto Rico remain a concern in this strategy since remote training likely increases the probability of such migration, given that many migrants have postsecondary training. To incentivize trainees to return to and remain in Puerto Rico, residency requirements under the programs and/or paid internships using disaster relief and other federal funds will likely be necessary.

Strategy 4. Implement Short-Term Career and Technical Training Opportunities in Puerto Rico

Relative to other countries in the Organisation for Economic Cooperation and Development (OECD), the United States has a smaller and arguably underdeveloped vocational system at the K–12 and postsecondary levels. Short-duration or “micro” training and education therefore

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10 Primary interview data from expert sources indicate that language skills often present a key barrier to participation in Job Corps programs in the CONUS.


represents a plausible strategy for the government of Puerto Rico to develop its labor force in high-demand occupations. So-called micro-credentials, combining these short-duration training and education programs into certifications and two- and even four-year postsecondary degrees (with demonstrated labor market returns in some instances), might provide viable career paths for Puerto Rico residents. Importantly, micro-credentials need not occur solely in the confines of a formal classroom or other instructional setting. Competency assessments based on prior training and experience would formalize knowledge and skills that individuals develop while working. Given the extent of informal training and labor market employment in Puerto Rico, competency-based assessments and credentialing represent a particular advantage of this strategy. The short duration of training and courses in a standard micro-credentialing approach also means that this sort of strategy can accommodate a large number of students overall, with rolling cohorts of students across myriad and multiple training and course opportunities. This strategy would leverage existing workforce development resources to create and/or strengthen industry-postsecondary education partnerships, which would help to speed up critical project-based training for students as well as address Puerto Rico’s immediate reconstruction needs.

A main weakness of this strategy is potentially large inefficiencies given differences in institutional approaches and culture across local partners—particularly postsecondary institutions and employers—and resulting limitations to implement this strategy in a cost-effective manner. Though there is evidence of existing relationships among technical and vocational programs and local employers in Puerto Rico, the depth and functionality of these relationships is unclear. These relationships are critical, however, for providing relevant, up-to-date training that meets the needs of employers and Puerto Rico’s reconstruction and other needs as Puerto Rico seeks to rebuild, post-hurricanes. This strategy also assumes that local employers understand their workforce needs, which is not always the case, particularly in the context of changing technologies and an economic landscape. Given an ongoing financial crisis in Puerto Rico, it is

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15 In primary data collection, several expert interviewees noted the importance of project-based learning generally and the short amount of time and training an unskilled student requires for performing basic construction tasks such as residential roofing. Roofing and other basic residential construction needs remain acute in Puerto Rico. See the summary of the damage and needs assessment following the hurricanes in RAND Corporation, “Supporting Puerto Rico’s Disaster-Recovery Planning.”

also likely that limited capacity to implement this strategy in a cost-effective manner could be a key barrier.

**Strategy 5. Develop and Implement a Comprehensive Workforce Development System to Meet Longer-Term Workforce Needs**

This strategy recommends that the government of Puerto Rico incorporate policies and activities that will meet both short-term programming and longer-term capacity building for the island’s workforce needs. Such a strategy would need to be comprehensive and systemic so that planning and prioritization of each element of the system are carefully considered. Moreover, implementation of individual activities would also facilitate capacity building. While the government of Puerto Rico might incrementally introduce any number of workforce development strategies separately or together, such an approach might create a fragmented and less effective response to the island’s workforce and economic development needs in the medium to long term. Figure S.1 illustrates a workforce development system framework that aims to address and ameliorate short- and long-term workforce challenges while meeting the ambitious goals of the government of Puerto Rico to build a 21st-century workforce in Puerto Rico.

The key challenges to implementing a comprehensive workforce development system is coordination among key stakeholders; designing and implementing a workforce and education policy framework to support multiple training programs to meet various sectors’ needs; conducting skills-gap analyses and finding instructional staff to fill positions; finding sufficient funds to stand up brick-and-mortar facilities alongside online programming; instituting on-the-job experiences; and pursuing collaborations among education and industry to develop curriculum and find materials. In addition, there is not a robust community college system or public postsecondary education system that can stand up the workforce development programs that will be required to fulfill the short-term and longer-term demand. Limited resources, competition for skilled workers, and a lack of alignment across industries are other challenges.
Figure S.1. Proposed Workforce Development System Framework for Puerto Rico’s Recovery

<table>
<thead>
<tr>
<th>Inputs: Planning, Policies, Investments</th>
<th>Activities: Services delivered</th>
<th>Outputs: Direct products of services</th>
<th>Short term: Knowledge and skills</th>
<th>Medium-term: Actions and behaviors</th>
<th>Longer term: Changes</th>
<th>FINAL IMPACT</th>
</tr>
</thead>
</table>
| • Policies to support structures and incentives for system | • Sector based models | • Institutions - Build employer partnerships | • Institutions - Development of a world-class workforce development system that is:  
- Equitable  
- Efficient  
- Agile  
- Resilient  
- *Individuals* | | | |
| • Cross-sector (government-industry-education) planning | | | | | | |
| • Design of industry specific blueprint | • K-14 standards and curricula | • Individuals - Aware of labor market demands  
• Individuals - Aware of labor market trends and opportunities | • Individuals - Seek training in career pathway of choice at CTE center | | | |
| • Analysis of skills and career pipeline alignment | • Occupational credentials and licenses | • Individuals - Identify pathways that fit their career and employment goals  
• Individuals - Improve job search and application skills  
• Individuals - Improve technical skills and abilities  
• Individuals - Improve content knowledge  
• Individuals - Strengthen workplace competencies and soft skills | • Individuals - Utilize job portal to apply for jobs  
• Individuals - Become lifelong learners | | | |
| • Data infrastructure for integrated job opportunities by municipality, occupation, industry | • Degrees and certifications | • Community - Advertise formal employment benefits in short and long term  
• Community - Increase job match quality  
• Community - Attract high quality instructional staff | | | | |
| • Materials, equipment, and facilities for educational and training institutions (both online and brick and mortar) | • Comprehensive information job portal | • Community - Develop and protect human capital  
• Community - Establish a world-class workforce  
• Community - Increase labor force flexibility  
• Community - Create high quality employment opportunities aligned with economic growth strategies | | | | |

NOTE: K–14 is Kindergarten through the second year of postsecondary education.

**Suggested Process to Support the Government of Puerto Rico in Prioritizing Strategies and Tactics**

The policy options and activities outlined in the five strategies of Puerto Rico’s recovery plan COA ECN 2, Implement Workforce Development, are wide-ranging and varied. The suggested options offered in this report may seem daunting or difficult to discern among. In the case of the Puerto Rico, we expect that leadership for implementing these strategies will come from several ministries and government offices such as the Governor’s Office and the Department of Labor and Human Resources, with various involved actors and stakeholder groups such as employers, the Department of Education, the University of Puerto Rico, or municipality governments. For all of the strategies HSOAC outlines in this report, effective implementation will require careful planning, with clearly articulated goals, well-defined tasks, metrics to measure progress, and timelines.

The government of Puerto Rico could prioritize and then implement whichever strategies and policies it selects to stem acute workforce shortages and to build its 21st-century workforce in the longer-term using two approaches.

1. **Discern Priorities by Creating an Implementation “Roadmap”**

When confronted with a wide range of policy options, strategies, or recommendations, governments and organization often use a “roadmap” to support decisionmaking and to aid
implementation. The goal of an implementation roadmap is to itemize and organize recommendations in a way that reflects decisionmakers’ priorities and takes into consideration factors that could facilitate or hinder implementation. A roadmap organized in such a way could help the government of Puerto Rico in determining its priorities and which strategies to implement in the near and longer term. A “high priority” strategy needs to be determined by decisionmakers as a foundational strategy. Given the lack of capacity of the government of Puerto Rico, its education institutions, and the physical infrastructure of the island recovering from the 2017 hurricanes, it is important to identify those recommendations that need to be implemented earlier than others to address crucial bottlenecks and facilitate further development of the workforce. An “easier to implement” strategy would be one that involves fewer government agencies or partners because tasks are simple, clear, and easy to monitor and processes or institutions to support implementation are already in place. Focusing on an “easier to implement” strategy could provide crucial momentum to the process of building the workforce and mitigate the acute workforce shortages Puerto Rico is experiencing. An implementation roadmap should also include a description of the processes that would aid implementation.\textsuperscript{17} An implementation roadmap should also articulate how to build capacity within government, municipality, and education institutions to implement whichever recommended strategies the government of Puerto Rico determines are actionable.

2. Implement Strategies in Phases

So as not to overload a government and its education institutions that are already under capacity because of the 2017 hurricanes and to also manage the scale of the effort involved, a second approach the government of Puerto Rico can undertake is to phase in the implementation of the strategies prioritized and selected through the use of an implementation roadmap. Studies of change in large organizations have shown that implementation is most successful when done in phases.\textsuperscript{18} We suggest five phases for the government of Puerto Rico.\textsuperscript{19}

- **Phase I. Design policies and procedures.** Once strategies have been prioritized and selected, it is incumbent on the government of Puerto Rico to develop and promulgate the

\textsuperscript{17} Sandra H. Berry et al., *Designing a System for Collecting Policy-Relevant Data for the Kurdistan Region—Iraq*, Santa Monica, Calif.: RAND Corporation, MG-1184-1-KRG, 2014.


\textsuperscript{19} These phases are modified to fit the needs of the government of Puerto Rico from the suggested phases for the Kurdistan region in Iraq to implement education policy and program changes. See Georges Vernez, Shelly Culbertson, and Louay Constant, *Strategic Priorities for Improving Access to Quality Education in the Kurdistan Region—Iraq*, Santa Monica, Calif.: RAND Corporation, MG-1140-1-KRG, 2014.
policies, program designs, and functions or responsibilities of staff that will be in charge of implementing the selected strategies or activities.

- **Phase II. Craft an implementation plan.** The government of Puerto Rico could develop detailed plans that itemize specific tasks and the person(s) responsible for accomplishing each task and timelines for completion. The plan must also include potential challenges, barriers, or risks to implementing the task so that any unintended or extenuating circumstances that could hinder implementation can be addressed as far in advance as necessary.

- **Phase III. Create a communication plan and announce decisions.** A communication plan that explains the rationale for decisions can help the government of Puerto Rico engender support and buy-in from the broader stakeholder community.

- **Phase IV. Begin implementation, monitor and evaluate to continuously improve strategies, and adapt.** It is at this point that implementation of specific strategies can begin. Strategies could be implemented on a small scale (with a pilot program) where desirable or at full-scale (across the island) to collect data and monitor progress; create a culture of learning from experience; evaluate how to improve; and make changes to plans, targets, policies, and procedures based on lessons learned. At the same time, it will be important to balance improvements and innovation with maintaining consistency of policy for a set period of time.

- **Phase V. Sustain strategies that are deemed successful.** In this phase, the government of Puerto Rico could expand implementation of programs and strategies according to the implementation plan devised in phase II. This last phase should also include methods to support the sustainability of programs deemed successful so that they can continue to have an impact over time. Sustainability management will include determining longer-term budgetary needs, ensuring that management and staff are fully trained over time, stabilizing policies, and establishing and maintaining communications with stakeholders.
Acknowledgments

We acknowledge the steadfast support and encouragement of our project sponsor Michael Byrne, the Acting Caribbean Area Division Director of the Federal Emergency Management Agency (FEMA) and the federal coordinating officer and federal disaster-recovery coordinator for Hurricane Irma and Maria response and recovery in Puerto Rico. We also appreciate the contributions of other key FEMA partners, including Gerilee Bennett, Kevin Snyder, Patrick Tuohy, Hope Thompson, and Jose Gil Montanez. From Puerto Rico, we are particularly grateful for the input of Omar Marrero Diaz and Laura Femenias Jove, the director and associate director, respectively, of the Central Office for Recovery, Reconstruction, and Resilience.

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- David Santiago-Rosado, subcontractor, EDA, DoC

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### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACS</td>
<td>American Community Survey</td>
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<tr>
<td>BEA</td>
<td>Bureau of Economic Analysis</td>
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<tr>
<td>BLS</td>
<td>Bureau of Labor Statistics</td>
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<td>CIP</td>
<td>Classification of Instructional Programs</td>
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<tr>
<td>COA</td>
<td>course of action</td>
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<tr>
<td>CONUS</td>
<td>continental United States; in this report, referring to 50 states plus Washington, D.C.</td>
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<tr>
<td>CTE</td>
<td>career and technology education</td>
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<tr>
<td>DoC</td>
<td>U.S. Department of Commerce</td>
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<tr>
<td>EITC</td>
<td>earned income tax credit</td>
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<td>EP</td>
<td>employment projections</td>
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<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
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<tr>
<td>FFRDC</td>
<td>federally funded research and development center</td>
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<tr>
<td>FOMB</td>
<td>Financial Oversight and Management Board</td>
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<tr>
<td>GAO</td>
<td>General Accounting Office/Government Accountability Office</td>
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<tr>
<td>GDP</td>
<td>gross domestic product</td>
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<tr>
<td>GED</td>
<td>general equivalency diploma</td>
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<tr>
<td>GNI</td>
<td>gross national income</td>
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<tr>
<td>GNP</td>
<td>gross national product</td>
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<tr>
<td>HRSA</td>
<td>Health Resources and Services Administration</td>
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<tr>
<td>HSOAC</td>
<td>Homeland Security Operational Analysis Center</td>
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<tr>
<td>HUD</td>
<td>U.S. Department of Housing and Urban Development</td>
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<tr>
<td>IA</td>
<td>individual assistance</td>
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<tr>
<td>IPEDS</td>
<td>Integrated Postsecondary Education Data System</td>
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<tr>
<td>ISA</td>
<td>income share agreement</td>
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<tr>
<td>NAICS</td>
<td>North American Industrial Classification System</td>
</tr>
<tr>
<td>NGO</td>
<td>nongovernmental organization</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>---------</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
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<tr>
<td>OES</td>
<td>Occupational Employment Statistics</td>
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<tr>
<td>PA</td>
<td>physician assistant</td>
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<tr>
<td>PREPA</td>
<td>Puerto Rico Electric Power Authority</td>
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<tr>
<td>PROMESA</td>
<td>Puerto Rico Oversight, Management, and Economic Stability Act</td>
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<tr>
<td>QCEW</td>
<td>Quarterly Census of Employment and Wages</td>
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<td>RSF</td>
<td>recovery support function</td>
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<tr>
<td>SOC</td>
<td>Standard Occupational Classification</td>
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<tr>
<td>UPR</td>
<td>University of Puerto Rico</td>
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<tr>
<td>WIA</td>
<td>Workforce Investment Act of 1998</td>
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<tr>
<td>WIOA</td>
<td>Workforce Innovation and Opportunity Act of 2014</td>
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1. Introduction

In September 2017, Puerto Rico was ravaged by two hurricanes within ten days: Hurricane Irma, a Category 5 storm, on September 6, and Hurricane Maria, a Category 4 storm, on September 20. Irma skirted Puerto Rico with sustained winds of 58 miles per hour (mph); at which point nine *municipios* (municipalities) were declared eligible for individual assistance (IA) from the Federal Emergency Management Agency (FEMA). Maria made landfall in Puerto Rico with sustained winds of up to 155 mph (averaging 123 mph), taking a course over a 12-hour period that bisected Puerto Rico from southeast to northwest particularly concentrated on Puerto Rico’s smaller islands of Culebra and Vieques (see Figure 1.1), resulting in an additional Major Disaster Declaration, DR-4339-PR. As a result of Hurricane Maria, all 78 of Puerto Rico’s municipalities were declared eligible for both individual and public assistance.

*Figure 1.1. Course and Strength of Hurricane Maria*  

![Course and Strength of Hurricane Maria](source: Applied Research Associates, 2017.)

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20 We refer to the hurricane damage for ease, but it is more accurate to say damage from multiple hurricanes.
The losses from the storms were large, with hundreds of thousands of residents depending on external help for an extended period of time to meet basic needs.\textsuperscript{21} FEMA reported more than 335,000 homes and more than 22,000 rental units incurred damage.\textsuperscript{22} Puerto Rico’s building code requires buildings to be able to withstand winds of up to 145 mph,\textsuperscript{23} but many buildings, particularly residences, were not built to this code.\textsuperscript{24} An assessment of flood insurance coverage indicated that only 7,646 of Puerto Rico’s 1.6 million housing units have coverage from the U.S. National Flood Insurance Program, with only $6.2 million of insurance in force.\textsuperscript{25} Furthermore, many of FEMA’s emergency supplies in San Juan had been relocated to the U.S. Virgin Islands, which were devastated by Irma.\textsuperscript{26}

The high windspeeds and rain brought by Maria caused widespread destruction, particularly to Puerto Rico’s electrical grid. Maria caused the largest blackout in U.S. history and the second-largest in the world.\textsuperscript{27} Parts of Puerto Rico went nearly a year without electricity,\textsuperscript{28} and where power had been restored earlier, a single incident darkened the island.\textsuperscript{29} Hurricane Maria essentially destroyed Puerto Rico’s already-fragile electric grid, and all of Puerto Rico was without power for the first eight days after Hurricane Maria. Because of numerous issues, power restoration after Hurricane Maria has moved substantially slower than normal, which has resulted in additional economic hardships for surviving small and large businesses. Nine days after the disaster, only 4 percent of power to customers had been restored (see Figure 1.2).\textsuperscript{30} As of February 15, 2018, 148 days after the event, only 76.4 percent of the power had been restored, according to senior leadership briefings shared with the authors. The calculation of the power restoration was measured by the number of meters of the electric grid that had been restored. (By contrast, 83 percent of the power disrupted by Hurricane Harvey in southeast Texas had been restored to customers after nine days—an indication of the lack of power infrastructure on the island prior to the hurricanes, but also possibly of the severity of the storm and either difficult or slow power restoration.)

\textsuperscript{21} Almost 80 days after Hurricane Maria, FEMA was still in a response mode, delivering over 300,000 meals.
\textsuperscript{22} Jennifer Hinojosa and Edwin Meléndez, “The Housing Crisis in Puerto Rico and the Impact of Hurricane Maria,” Center for Puerto Rican Studies, City University of New York, Hunter College Centro, RB2018-04, June 2018.
\textsuperscript{24} Viglucci, February 14, 2018.
\textsuperscript{26} Steven Schmidt, “FEMA Wasn’t Ready for Hurricane Maria, Destruction in Puerto Rico,” \textit{Living on Earth}, August 5, 2018.
\textsuperscript{30} Some of the data in Figure 1.2 (with respect to Puerto Rico) is based on the amount of power generated as opposed to power restored to customers.
inadequate recovery efforts in Puerto Rico). The interruptions in power provision meant many residents lacked running water, and sewage treatment failures polluted many alternative sources of drinking water.\textsuperscript{31}

![Figure 1.2. Percentage of Power Restored Following Hurricane Maria](image)

**Figure 1.2. Percentage of Power Restored Following Hurricane Maria**

Damage to both public and private capital was extensive, severely disrupting economic activity in the short to medium runs—across the island as well as within individual municipalities. An estimated 5,000 to 8,000 small businesses were permanently closed.\textsuperscript{32} According to the second quarter 2017 Quarterly Census of Employment and Wages (QCEW)\textsuperscript{33} from the U.S. Bureau of Labor Statistics (BLS), there were 45,099 private entities or business units and 1,849 public administration units operating in Puerto Rico.\textsuperscript{34} Communications (internet, cellular, and landlines) were also severely disrupted, resulting in substantial commercial issues. Some of the larger multinational corporations with operations in Puerto Rico reported significant hurricane-related losses.\textsuperscript{35} At the municipal level, many of the 78 municipalities also have very limited resources and


\textsuperscript{32} Nick Leiber, “Puerto Rico’s Small Businesses Are Still Hurting from Hurricane Maria,” *Bloomberg Businessweek*, September 11, 2018.

\textsuperscript{33} QCEW data are the product of a federal-state cooperative program. The data come from summaries of employment and total wages of workers covered by state and federal unemployment insurance. State Workforce Agencies provide this information to BLS.

\textsuperscript{34} Because Hurricanes Irma and Maria struck Puerto Rico in September, the June 30, 2017, data give the best picture of the number of businesses and entities at the time.

\textsuperscript{35} Q3 and Q4 2017 earnings call transcripts and publicly filed financial statements.
capacity to wage an effective recovery.\textsuperscript{36} Furthermore, as of March 2019, 32 municipalities had expired hazard mitigation plans, which are intended to identify risks and vulnerabilities associated with natural disasters and develop long-term strategies for protecting people and property from future hazard events. States and municipalities with an approved hazard mitigation plan are eligible for certain nonemergency FEMA grants, which could supplement emergency recovery funds, thus putting those 32 municipalities at a disadvantage in securing needed support for recovery.\textsuperscript{37}

**Objectives of This Report**

In light of the severe damage caused by the storms, FEMA contracted with the Homeland Security Operational Analysis Center (HSOAC) to provide substantial support in developing the government of Puerto Rico’s economic and disaster recovery plan (herein, the Recovery Plan),\textsuperscript{38} as required by the Bipartisan Budget Act of 2018. HSOAC solicited and integrated inputs from a wide variety of stakeholders and contributed analysis where needed.\textsuperscript{39} The Recovery Plan included an overview of damage and needs, courses of action (COAs) to meet those needs, the estimated costs of the COAs, and potential funding mechanisms for those costs. The Recovery Plan and supporting efforts were organized around “sectors” of recovery planning to mirror the FEMA effort, including teams related to Energy, Water, Transportation, Communications/IT, Health and Social Services, Education, Natural and Cultural Resources, Housing, Public Buildings, Community Planning and Capacity Building, Municipalities, and Economics.

While the government of Puerto Rico’s Recovery Plan included specific COAs to rebuild the infrastructure and economy of the island, it also included eight *strategic initiatives* that reflected aspirational directions for Puerto Rico’s future. One strategic initiative, *Build a 21st-Century Workforce*, states that a “modern workforce imbued with 21st-century skills requires a world-class K–12 and higher education system that is equitable, efficient, and better integrated with the demands of the labor market and needs of businesses.”\textsuperscript{40} The goals of this strategic initiative are to (1) develop and protect human capital to establish a world-class workforce; (2) increase labor force flexibility; and (3) create high-quality employment opportunities aligned with economic growth strategies. Box 1.1 describes the strategic initiative as it is presented in the 2018 Recovery Plan.

\textsuperscript{36} For more information about capacity at the municipal level, see RAND Corporation, undated.
\textsuperscript{37} FEMA requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of nonemergency disaster assistance, including funding for mitigation projects. Jurisdictions must update their hazard mitigation plans and resubmit them for FEMA approval every five years to maintain eligibility. For a searchable map of which municipalities have FEMA-approved or expired hazard mitigation plans, see FEMA, Hazard Migration Plan Status, website, undated.
\textsuperscript{38} Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
\textsuperscript{39} RAND Corporation (undated) has more information online about HSOAC’s contribution to planning for recovery in Puerto Rico, along with links to other reports being published as part of this series.
\textsuperscript{40} Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
Box 1.1. Developing a 21st-Century Workforce in Puerto Rico

A workforce system, which builds on the capital investments in education, will be needed to address the short-term employment needs of the currently unemployed and underemployed in Puerto Rico, especially those living in the most vulnerable circumstances (e.g., youth, women, veterans) and “middle skill” workers with some postsecondary training, to fill positions in high-demand industries (e.g., health care, construction, energy, and information technology). Furthermore, the government will build on these short-term strategies to develop and refine a more sustainable, longer-term workforce system. Individuals with transferable 21st-century skills will have the ability to navigate an evolving labor market, improve their employment status and wages, and enhance their resilience to industry-specific shocks. Communities’ economic development will be improved by the resulting expansion of the formal economy, high employment and labor force participation rates, and a growing tax base. Greater economic opportunities are also likely to (1) reduce the number of potential workers who choose to leave Puerto Rico, and (2) help spur former residents to return and new migrants to arrive.

To date, the structure of most education and training programs has not evolved apace, and most programs operate under the notion that workers will linearly progress through their careers within a single industry, which requires a narrower set of more-or-less static skills to start. This strategic initiative envisions K–12 and higher education institutions, along with employers, keeping pace with changes in technology, innovation, and evolving workplace and contemporaneously adapting curricula and training programs.

Specific activities will support increasing the number, diversity, and quality of educational, vocational, and training opportunities, with a focus on sector-based models. Activities include developing flexible and worker-centered career pathways; flexible training approaches, such as online, brick-and-mortar, and hybrid classrooms; curriculum and standards that incorporate hands-on, project-based, student-centered learning; public-private partnerships; job portals to match openings with workers; career and technical education centers to complement vocational education; stackable credential models; and on-the-job learning opportunities. This initiative takes advantage of the global trend toward jobs that are geographically independent (e.g., the “Human Cloud”) to encourage people to relocate to Puerto Rico and to bring the advantages of a global economy to Puerto Rico to support a better quality of life for residents. It will provide the needed components to enhance the required Workforce Innovation and Opportunity Act State Plan being crafted by the Department of Economic Development and Commerce.


This report documents the analysis conducted by the Economics (ECN) Team to produce the recovery course of action most closely aligned with the 21st-Century Workforce strategic initiative, namely ECN 2, Implement Workforce Development Programs. The Economics Team is defined as the partnership between HSOAC Economics Sector personnel and Economics recovery support function (RSF) personnel on the ground in Puerto Rico before, during, and after the development of the Recovery Plan. HSOAC Economics personnel worked closely with the FEMA-led Economics RSF, which contributed significant content to this volume. The data collection and analysis to inform this COA were undertaken from January through June 2018. Supplemental discussions with Puerto Rico government and FEMA representatives occurred in December 2018.

The Economics Sector COA titled ECN 2, Implement Workforce Development Programs, outlines strategies the government of Puerto Rico can undertake to support human capital development on the island to meet both short-term workforce shortages in the wake of the hurricanes as well as build longer-term capacity of the people of Puerto Rico as the government aims to meet the goals of the strategic initiative to develop a 21st-century workforce. The Economics team crafted the workforce development COA to match the ambitious goals the
government of Puerto Rico, as described in Box 1.1, and this COA was incorporated into the Recovery Plan.

Box 1.2 summarizes the COA. Appendix A provides further details of this COA, in a summary comparable to all the COAs described in the HSOAC sector-specific supplemental reports. This report describes the underlying analysis that resulted in the short summary description that appears in Appendix A.

**Box 1.2. Economics Team Course of Action: Implement Workforce Development Programs**

<table>
<thead>
<tr>
<th>Implement policies and activities such as the creation of regional training centers to support education and training of the workforce, especially the unemployed, underemployed, and those in training for employment, with a focus on persons disproportionately affected by disaster who are in high-need occupations.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potential benefits:</strong> Improves labor force participation rates, engages those not currently or not gainfully employed, and increases the labor force’s years of education, which should benefit both individuals and the economy.</td>
</tr>
<tr>
<td><strong>Potential costs:</strong> $68 million in total estimated costs</td>
</tr>
<tr>
<td><strong>Potential funder(s):</strong> CDBG-DR [Community Development Block Grant–Disaster Recovery], Department of Labor, U.S. Department of Education, FEMA Dislocated Workers program, nongovernment sources</td>
</tr>
<tr>
<td><strong>Potential implementer(s):</strong> P3 [Puerto Rico Public-Private Partnerships Authority], Puerto Rico Department of Labor and Human Resources</td>
</tr>
</tbody>
</table>

**NOTE:** Cost-benefit and feasibility analyses for each course of action were not possible. When developing courses of action, the teams considered their responsiveness to needs, level of innovation, and alignment with the evidence base (e.g., based on best or promising practices). Further, the approach to estimating the rough-order-of-magnitude cost of each individual COA was based on the specific nature of the action and the available sources of information robust enough to inform the estimate. Total estimated costs include both upfront and annual costs, where applicable. Cost figures in the Recovery Plan should thus be regarded as preliminary pending greater detail about specific implementation activities and the completion of ongoing damage assessments. Analyses of funding sources for the courses of action identified included U.S. government aid and nongovernmental funding sources. In addition, eligibility requirements for many supplemental funding elements are still unspecified. Therefore, funding sources identified are notional at this time. Suggestions about possible implementers are also preliminary because details about how the courses of action will be put into effect will not be known until there is additional clarity about available funding and associated criteria.


This COA thus provides a set of innovative and inspiring activities and policies that could potentially propel the island’s workforce into the 21st century, which the government of Puerto could strive toward. The set of strategies within this COA was thus intended to be a first stage to inform the Recovery Plan; it was outside the scope of the project to map a specific implementation plan. Thus, implementation details and priority-setting would occur at a second stage.

In light of these objectives, this report provides

- a summary of historical workforce challenges in Puerto Rico
- a description of the short-term workforce challenges facing Puerto Rico given the destruction from the hurricanes
• detailed strategies that comprise the COA ECN 2, Implement Workforce Development Programs
• suggested processes for the government of Puerto Rico to prioritize and thus implement the strategies outlined in the COA and meet its strategic initiative to develop a 21st-century workforce during and after the recovery effort.

Data Sources

To inform the analyses summarized within this report, we relied on a number of secondary data sources: literature reviews of peer-reviewed rigorous scientific analysis on Puerto Rico’s damage, the economic history of Puerto Rico, workforce, workforce development, logic model design and development, and workforce program best practices; interviews with program administrators at exemplar workforce training programs in the continental United States (CONUS) in recovery zones or in storm areas and with union leaders in key occupations in spring 2018; interviews with HSOAC sector leads and reviews of each sector volume to determine workforce issues for each sector in summer 2018; the input of an expert panel of experts with deep knowledge in workforce development, international development, and labor economics in spring 2018; and discussions with Puerto Rico government and FEMA representatives in December 2018. Details on specific data sources and methodological approaches are available within their respective chapters and in Appendix B.

Challenges to Workforce Recovery in Puerto Rico

Economic Development in Puerto Rico: Historical Context

While Hurricanes Irma and Maria were extremely damaging to the economy of Puerto Rico, they struck when the economy was already in a precarious position. Puerto Rico has been in a deep economic recession since 2006, influenced by the full phaseout of Section 936 tax treatments for corporations and relatively high costs of doing business. The recession brought with it low labor force participation, high unemployment, weakened institutions, considerable debt, and resultant outmigration, all of which hamper economic growth.

During the last two decades of the 20th century, following completion of the phaseout of Section 936 tax treatments in 2006, economic growth has generally been negative, with low labor force participation and high unemployment relative to the CONUS. While the phaseout of the tax incentives was

41 The Tax Reform Act of 1976 created Section 936 of the Internal Revenue Code (IRC) of the United States, also known as the “Possession Tax Credit,” granted U.S. corporations a tax exemption on income originating from U.S. territories. The largest beneficiary of this policy appeared to be the pharmaceutical industry, which tended to develop a product in the CONUS then transfer the patent to a subsidiary in Puerto Rico, which produced the drug and claimed the income under Section 976. See H. J. Toro, “Economic Change and Occupational Stasis: Puerto Rico as a Case Study of Stratification and Development,” Research in Social Stratification and Development, Vol. 36, 2014.
42 See the challenges and opportunities for the Puerto Rico economy at RAND Corporation, undated.
certainly a contributing factor, recessionary pressure in the United States in 2001 and during the Great Recession (late 2007 to 2009) combined with high fuel prices and high costs of doing business, among other factors, also contributed. At least partially in response, this contraction has corresponded with net outmigration and corresponding population losses. Before 2006, Puerto Rico experienced relatively modest growth in gross domestic product and a decline in its unemployment rate from 1985 to 2000 (see Figure 1.3).

Figure 1.3. Gross Domestic Product, Unemployment, and Net Position of Puerto Rico over Time

In conjunction with the contraction of the economy, Puerto Rico also experienced high and unsustainable levels of debt and the government shut down for 13 days in May 2006. Puerto Rico’s credit rating dropped to below investment grade in early 2014, followed by a series of

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defaults on debt payments. The financial crisis ultimately resulted in the passage of H.R. 5272, the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) in 2016, which established the Financial Oversight and Management Board (FOMB) and the framework for restructuring Puerto Rico’s debt. Given these historical challenges, a careful balancing act between fiscal stimulus, policy reform, and careful choices regarding spending will likely be needed in order to promote longer-term economic growth as Puerto Rico recovers from the hurricane damage.

Below we summarize a few key facts about Puerto Rico’s economic contraction before the destruction from the hurricanes.\textsuperscript{46}

**Gross National Product (GNP) and Gross Domestic Product (GDP).** Puerto Rico’s official statistics for 2016 report GNP at $70.1 billion and GDP of $105 billion, suggesting a considerable presence of non–Puerto Rico firm activity operating on the island. Although GDP and GNP have grown in nominal terms, real GDP/GNP has generally been declining since 2005, suggesting a contraction of overall economic activity over the past decade. Before Hurricanes Irma and Maria, the two largest private sectors of the Puerto Rico economy were the manufacturing sector (47.3 percent of GDP) and finance, insurance, and real estate (19.8 percent). The past decade resulted in small changes in economic structure, with some growth in the share of manufacturing, agriculture, administrative services and support, and health care and social services and declines in the share of mining, construction, and management of companies and services. Puerto Rico’s per capita income has averaged between 48 and 59 percent lower than the CONUS between 1990 and 2016, with real per capita income remaining relatively constant at $27,000 (2010 dollars) since 2005.

**The Economic Activity Index.** This index, which is an alternative statistic strongly correlated to GNP/GDP and associated growth rates, shows the general decline in overall economic activity over the past decade, with a contraction of over 22 percent from 2005 to prestorm 2017. This broadly corresponds to formal measures of GNP and GDP declines over a similar period, which is indicative of economic contraction.

**Establishments.** Before Hurricanes Irma and Maria, there were just over 45,000 private entities or business units and 1,849 public administration units with employees operating in Puerto Rico, with the number of private establishments remaining relatively constant over the past decade. About 55 percent of firms had five or fewer employees, employing about 80 percent of all private workers. Just under 40 percent of small businesses have been operating for less than six years. Start-up and exit rates were roughly equal before the storms, with start-up rates generally declining since 2005.

\textsuperscript{46} See the challenges and opportunities for the Puerto Rico economy at RAND Corporation, undated.
Employment and Unemployment. Total employment in Puerto Rico before the hurricanes was approximately 852,700, with an unemployment rate of 10.4 percent, or more than twice that of the CONUS. The three largest sectors in terms of employment were public administration (15 percent), retail trade (15 percent), and health care and social assistance (11 percent), while manufacturing employment totaled 9 percent (as opposed to over 40 percent of GDP). Total employment declined by approximately 16.5 percent since 2005, with double-digit unemployment rates. Manufacturing and construction employment declined (by 38 and 68 percent, respectively) over this period, while health care and social assistance and accommodation and food services added jobs.

Figure 1.3 illustrates the trends in economic development in Puerto Rico from 1960 through 2016 by depicting GDP, unemployment, and net position (assets less liabilities).

Population. The population of Puerto Rico peaked in 2004 and has since been steadily declining in concert with economic contraction, with best estimates of 3.2 million to 3.4 million just before Hurricanes Irma and Maria. According to the World Bank, Puerto Rico’s population in 2004 was 3.83 million and has decreased every year since then. Puerto Rico’s population in 2016 was 3.41 million (see Figure 1.4).

Figure 1.4. Puerto Rico Population, in Millions

Puerto Rico’s population has declined almost 10 percent between 2000 and 2015, with the majority of this decline taking place between 2010 and 2015. Puerto Rico’s recent population losses present a host of difficulties for the island. A smaller population translates into a smaller tax base to support government programs. Relative to the CONUS, the elderly population is slightly greater, the poverty rate is about twice that of the poorest state (Mississippi), educational attainment is lower, and the labor force participation rate is over 20 percentage points lower (about 40 percent compared to 63 percent). It is unclear if the low participation rate is the result of substitution into the informal economy and unreported employment or if potential workers are not participating in either the formal or informal economies.

Corresponding to the economic contraction of the past decade, there has been continuing outmigration from Puerto Rico (mainly to the CONUS), impacting labor supply. Similarly, the lack of economic opportunity can be seen in personal income statistics, which show that per capita incomes are lower than the poorest U.S. state.

Revenue and Public Debt. Following rapid escalation of borrowing and expenditures in the mid-to-late 2000s (corresponding to the end of the phaseout of Section 936 tax incentives), Puerto Rico declared a fiscal state of emergency in 2009. Despite stabilization efforts, Puerto Rico’s bond rating continued to be downgraded and the territory defaulted on bond payments several times during 2014 and 2015. In response, the U.S. House of Representatives introduced PROMESA, which became law in 2016. In May 2017, four months before Hurricanes Irma and Maria made landfall, Puerto Rico filed for protection under Title III of PROMESA, resulting in the largest municipal bankruptcy in U.S. history. The makings of the debt crisis predate the hurricanes; however, the pressure of debt payments will act as a major headwind against disaster recovery and prolonged growth.

Social Benefit Programs. People in Puerto Rico are eligible for many federal entitlement programs and pay Social Security and Medicare taxes, but they do not pay federal income taxes unless they work for the federal government, and formula funding may differ from states in some cases. Federal benefit programs can directly support vulnerable populations, but also may distort incentives, especially those related to work.

The yearlong blackout in parts of Puerto Rico is symbolic of its overall hurricane experience—undermaintained or out-of-date systems struggling with day-to-day operations were exposed by the hurricanes. The large reconstruction needs in the wake of Irma and Maria present Puerto Rico with an opportunity to not only rebuild, but also newly build a strong pipeline between training and the workforce to fill both short- and long-term gaps in available human capital.
Organization of Report

The volume is reported in two parts and several appendices. Part I, which includes Chapters 2 through Chapter 4, provides a detailed portrait of the labor force, occupation, and training landscape in Puerto Rico (and context for the recovery effort) and identifies the major stressors affecting workforce and labor supply in the prestorm period and immediately after the storms. Chapter 2 describes the labor force context in Puerto Rico leading up to the hurricanes and through 2018. This includes the occupational composition of Puerto Rico, key occupations, the training landscape in Puerto Rico, and the industrial composition of Puerto Rico. It broadly identifies long-term workforce needs in Puerto Rico and problems prior to the hurricanes that could exacerbate recovery efforts for its workforce. Chapter 3 provides a descriptive portrait of Puerto Rico’s short-term acute workforce shortages and needs, addressing the anticipated direct workforce needs related to hurricane reconstruction and recovery. Chapter 4 examines the potential labor market impacts of a large injection of capital into a small island economy, providing a nuanced understanding of the workforce challenges facing the island as it moves toward recovery.

Part II builds off the workforce challenges confronting Puerto Rico described in Part I to offer suggestions to improve the workforce system on the island and best meet the Recovery Plan goal to build a 21st-century workforce in Puerto Rico. Chapter 5 describes five workforce development strategies the government of Puerto Rico could implement to meet short-term and long-term labor shortages that were considered when devising the Economics course of action ECN 2, Implement Workforce Development Programs. Chapter 6 delves deeply into how the government of Puerto Rico could implement this COA, focusing on the policies, infrastructure, resources, and activities the government could consider. Chapter 7 concludes the report.

The appendices furnish additional information to supplement the main text. Appendix A is a detailed description of the COA, as documented in the Recovery Plan. Appendix B explains the protocols used in our interviews. Appendix C is a list of all postsecondary education and training institutions in Puerto Rico, as of December 2018. Appendix D details suggested activities and recommendations the government of Puerto Rico could undertake to address specific workforce needs in various industries.
Part I.

Historical and Acute Workforce Challenges Facing Puerto Rico
2. Historical Context and Current Challenges for the Workforce System in Puerto Rico

In this chapter, we describe the labor force in Puerto Rico, the occupational and industrial composition of the current labor force, and the current education and training system that produces that labor force. We then develop a framework using select occupations to understand where Puerto Rico’s current labor force and occupational composition could be potentially misallocated and, subsequently, where Puerto Rico’s training and postsecondary education system could be falling short in producing trained workers most in need on the island. Our goal is to not only understand the historical context of the Puerto Rico labor force, but the key challenges in developing a 21st-century workforce.

The Current Workforce and Labor Force in Puerto Rico

The concept of a workforce does not have a single definition; instead, it is context-dependent. For example, companies can refer to their employees as their workforce, states and local governments have workforce agencies that often handle issues of unemployment and out-of-work training, and governments of all levels use workforce development to describe the strategic planning of worker education and training. In the context of this report, we use workforce to refer to the pool of available workers in Puerto Rico and their human capital or skills. It encompasses not only the skills and experience of current workers, but the skills and experience of future and potential workers. We use workforce system to refer to education, training, and other programs that support the skill and experience accumulation of the workforce.

The labor force, on the other hand, has an unvarying definition. According to the BLS, the labor force comprises individuals who are either currently employed or those who are actively seeking employment (have applied for a job in the past four weeks). The labor force participation rate is the total number of individuals in the labor force divided by the noninstitutionalized population.47 Note that the labor force is a civilian measure, meaning that it excludes the military. Both the count of the labor force and the labor force participation rate are clearly defined measures that provide a point-in-time description of civilian workers.

The labor force in Puerto Rico averaged 1.09 million people in 2018. Figure 2.1 shows the monthly labor force level in Puerto Rico since January of 2000, as calculated by the Local Area Unemployment Statistics of the BLS.48

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47 This is according to the Bureau of Labor Statistics, “Current Population Survey,” April 10, 2018. An example of an institution with an institutionalized population is a jail or prison.

Through the early 2000s, Puerto Rico’s labor force was increasing steadily, starting from 1.29 million in 2000 and increasing until its peak at 1.43 million in mid-2006. Concurrent with the prolonged economic decline beginning in 2006, the labor force has been declining since, reaching a 20-year low in 2018. As explained in Chapter 1, Puerto Rico’s economy was already in decline before, and separate from, the Great Recession, thus explaining the drop in the labor force beginning in 2006.49

Abstracting from the recent decline, one persistent issue regarding the labor force in Puerto Rico is that participation as a share of the working-age population is generally low. The level shown in Figure 2.1 is a count of all labor force participants in the civilian population. Expressed as a share of the population, the labor force participation rate in Puerto Rico fell slightly from 47.6 percent in 2006 to 43.4 percent in 2017. That is significantly lower than in the United States

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49 Since the labor force is the count of employed plus unemployed, jobseekers who become discouraged (particularly likely during a recession) and stop looking for work would be excluded from a count of the labor force.
overall, which includes data on Puerto Rico, though the pattern is consistent.\textsuperscript{50} The U.S. labor force participation rate fell from 65 percent in 2006 to 63.2 percent in 2017.\textsuperscript{51} Labor force participation is not equal across every population group; some parts of the population are more likely to work than others. As we will show, though, within each population group, Puerto Rico has lower labor force participation than the United States overall.

\textit{Labor Force Participation by Age, Educational Attainment, and Gender}

Figure 2.2 shows the distribution of the populations of Puerto Rico and the United States overall (including Puerto Rico) by age group. Both have relatively even profiles of their working-age populations (those aged 16 to 64); each ten-year age window accounts for roughly 20 percent of the population.

\textbf{Figure 2.2. Age Distribution of Population in Puerto Rico and United States Overall}

\begin{center}
\includegraphics[width=\textwidth]{age_distribution.png}
\end{center}

\textit{SOURCE: Puerto Rican Community Survey, 5-Year Files (2012–2016).}
\textit{NOTE: Overall United States includes data from Puerto Rico.}

\footnotesize
\begin{itemize}
\item \textsuperscript{50} All references to the “overall” United States include data from Puerto Rico.
\end{itemize}
Figure 2.3 shows the average labor force participation within those age groups. At every age level, Puerto Rico’s labor force attachment is much lower than CONUS levels. The starkest difference is for both the very young and very old. Only 35 percent of 16- to 24-year-olds in Puerto Rico participate in the labor force, compared with 58 percent of same-age youth in the CONUS. At prime working ages (i.e., from age 25–34 and 35–44), people in Puerto Rico have 73 percent and 72 percent labor force participation, respectively, both ten points below the CONUS share of 82 percent. By age 45, Puerto Rico’s labor force participation drops while participation in the CONUS remains more or less constant. CONUS labor force participation between age 45 and 54 is 80 percent, but Puerto Rico’s participation level drops to 61 percent. Only 34 percent of those aged 55 to 64 are in the labor force in Puerto Rico, compared with 64 percent of same-age individuals in the CONUS. Prior research has found that workers in Puerto Rico retire much earlier than workers on the CONUS.

**Figure 2.3. Labor Force Participation Rate, by Age**

![Bar chart showing labor force participation rates by age group for Puerto Rico and CONUS.]

**SOURCE:** Puerto Rican Community Survey, 5-Year Files (2012–2016).

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52 Full-time enrolled students are not considered part of the labor force; even so, educational attainment is slightly higher in the United States overall.

Similarly, Figure 2.4 shows the educational attainment of the population ages 25 to 64 for both Puerto Rico and the United States overall. A much higher share of the population in Puerto Rico has less than a high school degree (18 percent) and exactly a high school degree (28 percent) than the CONUS (12 percent and 26 percent, respectively). In total, 46 percent did not go to college. Puerto Rico also has a higher share of high school dropouts than any of the states in the CONUS.

**Figure 2.4. Educational Attainment of the Working-Age Population**

![Bar chart showing educational attainment in Puerto Rico and the CONUS](chart-image)

**SOURCE:** Puerto Rican Community Survey, 5-Year files (2012–2016).

The large share of high school dropouts contributes to lower overall levels of labor force participation in Puerto Rico, as this group generally has lower labor force attachment. Figure 2.5 shows the labor force participation by educational attainment, comparing Puerto Rico and the CONUS. Fewer years of education is associated with low rates of labor force participation. Differences between labor force participation in the CONUS and Puerto Rico exist at all education levels but are largest among individuals with a high school education or less. Only 34 percent of the individuals 25 to 64 years of age with less than a high school diploma participate in the labor force in Puerto Rico, compared with 61 percent of their CONUS counterparts. Even among individuals with a high school diploma, labor force participation in
Puerto Rico is low (53 percent) compared with the CONUS (73 percent). Participation increases at high levels of educational attainment in Puerto Rico, with 66 percent for those with some college or an associate’s degree and 79 percent for those with a bachelor’s or higher degree.

**Figure 2.5. Labor Force Participation Rate, by Educational Attainment**

![Bar chart showing labor force participation rates by educational attainment in Puerto Rico and the CONUS](chart)

**Source:** Puerto Rican Community Survey, 5-Year files (2012–2016).

Finally, differences in labor force participation exist between the genders. In the CONUS, 82 percent of men and 72 percent of women participate in the labor force; in Puerto Rico, the rates are 65 and 54 percent, respectively. Note that the difference in participation between men and women is similar, though the levels are not.

**Potential Explanations for Low Labor Force Participation Rates in Puerto Rico**

One driver of lower labor force participation in Puerto Rico, as presented in the previous section, is a larger baseline share of groups with low labor force participation, such as high school dropouts. But this does not explain why, compared with the CONUS, labor force participation is lower within each age and education group and within both genders. These
statistics suggest the presence of broader, economy-wide factors that also contribute to lower labor force participation.

There are many potential explanations. As noted previously, Puerto Rico has experienced a sustained economic decline since 2006. Labor force participation typically declines during downturns, as workers lose their jobs or workers seeking employment grow discouraged and stop looking. Figure 2.1 illustrates this decline. This is not unique to Puerto Rico; the decline in labor force participation was acute in the United States overall during the Great Recession.54

But there are additional factors that are unique to Puerto Rico. The Bipartisan Congressional Task Force on Economic Growth in Puerto Rico created under PROMESA, the federal legislation, noted in its final report that public benefits in Puerto Rico are comparatively more generous than they are in the CONUS. Incomes are lower in Puerto Rico—$19,343 was the median income in 2017 as compared with $60,336 in the United States—and eligibility cutoffs do not vary between the CONUS and Puerto Rico, so a larger share of people in Puerto Rico qualify. In addition, the cost of living in Puerto Rico is about 70 percent of that in the CONUS. Not only do more people in Puerto Rico qualify for an income-based benefit, but the benefits go farther. Because it is a territory whose residents generally do not pay federal income taxes,55 Puerto Rico does not have access to the full suite of state-administered and federal public cash and in-kind assistance programs. However, the Task Force’s assessment concluded that in Puerto Rico, federal public program benefits induced earlier retirement and also disincentivize work among lower-income individuals, who would lose benefits with positive earnings.56 The latter conclusion is supported by academic research.57

Moreover, compared with the CONUS, Puerto Rico has a large informal economy, estimated in size to be 25 percent of GNP.58 The definition of an informal economy varies, often with the context or country being discussed, but typically comprises firms and business activities that do not register as businesses, pay taxes, comply with public regulations, or some combination therein.59 Although the estimated size of the informal economy in Puerto Rico is below the international average (about 35 percent) as well as the average in Latin American and Caribbean countries (about 40 percent), it is well above the estimated average (17 percent) across countries

55 Federal employees in Puerto Rico pay federal income taxes.
58 A full discussion on the variety of methodologies used to define and estimate the informal labor force in Puerto Rico is available in RAND Corporation, undated.
in the Organisation for Economic Cooperation and Development (OECD) and in the CONUS (9 percent).\(^6^0\)

An individual can be employed in the informal economy if their employer is part of the informal sector. In addition, an individual can be employed in the informal economy if their employer is part of the formal sector, in that they follow most tax and regulation standards but do not report all of their employees and have some “under the table” workers. There remain disincentives to employers’ hiring workers formally: avoiding the payment of Social Security contributions; avoiding income taxes; evading labor market regulations such as minimum wages, safety standards, and number of working hours; avoiding compliance with “administrative procedures” such as questionnaires demanded of formal businesses or compliance with other production standards, such as proper permitting or adhering to building codes.\(^6^1\) Note that these incentives operate on the employer; there may be separate incentives to the worker, such as the income-based public benefits described above.\(^6^2\)

Regardless of type of informal employment, the informal economy should not technically reduce the size of the labor force. Labor force estimates are based on a survey of individuals in which they are asked if they are receiving compensation for work; they are not asked about the formality or informality of their earnings.\(^6^3\) They may be undercounted, but the official statistics are meant to include all paid workers, regardless of formality.\(^6^4\) To the extent that workers in informal work arrangements do not report that they are employed, the informal sector reduces the size of the Puerto Rico labor force. However, this is only the case if a worker does not have both arrangements; a worker could have both formal and informal employment. Unfortunately, given that informal work is by definition not reported by employers and that household surveys do not differentiate between formal and informal earnings, it is difficult to measure how many workers maintain both formal and informal employment and how many workers report employment to surveys.

Another potential explanation for low labor force participation rates in Puerto Rico is selective outmigration. The people of Puerto Rico became citizens of the United States in 1917, granting them free movement to live and work anywhere in the United States. Rates of migration

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\(^6^2\) The International Labor Organization also includes in informal employment unpaid family workers and unpaid domestic workers.


into and out of Puerto Rico have varied considerably since then, often dependent on the economic conditions in Puerto Rico. Since 1941, Puerto Rico has experienced net outmigration to the United States, meaning that more individuals leave Puerto Rico for the CONUS than leave the CONUS for Puerto Rico. The largest spike in outmigration occurred after World War II as Puerto Rico was transitioning away from a primarily agricultural economy toward a more manufacturing-based economy. Over this period, Puerto Rico’s rural-to-urban migration spanned the territory and the CONUS. With the development of a more robust manufacturing industry from the 1970s to 2000, outmigration from Puerto Rico was much lower.\textsuperscript{65}

Since 2005, the rate of outmigration increased, and Puerto Rico has since experienced a large and sustained outmigration. In Figure 2.6, we reproduce a Census Bureau estimate of migration levels between 2005 and 2015.\textsuperscript{66} In 2005 a similar level of Puerto Rico–born adults would migrate between Puerto Rico and the CONUS, but the gap in migration levels grew afterward. By 2015, an estimated 46,975 adults left Puerto Rico, and only 15,366 returned, a difference of 30,000. One estimate of the sustained outmigration over this period is as high as 375,000, about 10 percent of the island’s 2017 population.\textsuperscript{67}

\textbf{Figure 2.6. Estimated Migration Between Puerto Rico and Continental United States for the Population Age 16 and Older, Born in Puerto Rico, 2005–2015}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{migration_graph.png}
\caption{Estimated Migration Between Puerto Rico and Continental United States for the Population Age 16 and Older, Born in Puerto Rico, 2005–2015}
\end{figure}


\textsuperscript{67} Meléndez and Hinojosa, October 2017.
It is important to put Puerto Rico’s migration in the context of typical, or expected, migration levels. A recent analysis by Lyman Stone, for example, found that Puerto Rico’s rate of gross outmigration (expressed as a level in the blue line in Figure 2.6) is actually in line with most U.S. states—on par with Oregon, New York, and Pennsylvania—and significantly lower than that of states in the U.S. mountain region. However, few people choose to relocate to Puerto Rico from the CONUS (the red line in Figure 2.6), so the overall net outmigration—the difference—is much higher for the island.

Outmigration, whether gross or net, is not necessarily a problem for labor force participation if the individuals who stay, leave, or return are all equally likely to participate in the labor force. However, if those who leave are more likely to work—or in other words, if there is selection in who migrates—then outmigration can contribute to reduced labor force participation. For nearly every occupation, wages are higher in the CONUS than they are in Puerto Rico. And though the cost of living is lower in Puerto Rico, the gain in wages is often higher than the increased cost of living. Logically, higher wages in the CONUS could induce workers or individuals more likely to work to leave Puerto Rico, while the lower cost of living on the island could induce nonworkers or individuals less likely to work to stay. Given the differences in earnings between the CONUS and Puerto Rico, this seems a plausible factor in explaining the lower labor force participation. However, wages and cost of living are but one aspect of an individual’s decision about whether to remain or migrate.

Outmigration presents an additional concern for the labor force. To the extent that outmigrants are not random cross-sections of the population but a set from specific occupations or with a specific skill or set of skills (e.g., induced by higher wages or better employment prospects in their particular occupation), then outmigration not only reduces the labor force participation rate but key parts of the labor force itself. That is very difficult to measure directly; no existing data include necessary information about the characteristics, behaviors, and outcomes (including occupation) of individuals in the origin location and follows them as they leave the origin location. We will discuss later in the chapter specific occupations and industries for which there is evidence of this form of concentrated outmigration.

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69 Indeed, it is also not a problem for the individuals choosing to leave. Our focus in this report is on the economic vitality of Puerto Rico overall; therefore, we consider the potential negative impacts of outmigration on the tax base and the ability to provide and receive essential services.
70 The American Community Survey and the Puerto Rican Community Survey are the best sources of information on migration to and from Puerto Rico. The surveys collect detailed information on individuals where they currently live, as well as if they lived in Puerto Rico (or in the CONUS) in the year prior. However, it is does not collect information on their behavior or outcomes in both places; hence, the data can show that people who left Puerto Rico work, but not that workers left Puerto Rico.
Occupational Context for the Puerto Rico Workforce

Puerto Rico has a labor force of approximately 1.09 million workers. In Table 2.1, we summarize the occupational distribution of those workers by the jobs held. These data are from the BLS Occupational Employment Statistics (OES), an annually published summary of wages and employment in over 800 occupations in the United States and in each state, in the most recent year available, 2017. The table gives a snapshot of the types of jobs in Puerto Rico before the hurricanes. In the first column of Table 2.1, we provide the two-digit occupation group based on the Standard Occupational Classification (SOC). In the second column, we show the share of jobs in the OES that are in that occupation. The second column sums to 100 percent. In the third column, we show the location quotient with the United States; the location quotient is a measure of job concentration relative to the U.S. average. A quotient greater than 1 means that there are more jobs in that occupation per 1,000 jobs in Puerto Rico than there are in the United States. In the final column, we show the location quotient for the same industries in Hawaii, which is also a U.S. island economy.

Before the hurricanes, the highest-share occupation in Puerto Rico was the office and administrative support occupations group, comprising 18 percent of jobs. At 1.20, this is a higher quotient than the CONUS, meaning that there are more office and administrative support jobs in Puerto Rico, relative to population size. This is also higher than Hawaii’s location quotient (1.08), though both island economies have more office workers relative to the CONUS. The next largest category of occupations is sales and related occupations, at 12 percent, and also with a higher quotient than the CONUS at 1.20. This could possibly reflect the importance and size of tourism through retail sales in Puerto Rico. However, in Hawaii, where one would also expect a large role for tourism, the location quotient is less than 1, at 0.82, meaning that Puerto Rico has more sales workers than the CONUS, but Hawaii has fewer.

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71 Note that occupation is not synonymous with industry: Occupation describes the worker and industry describes the employer. For example, office and administrative support occupations can span multiple industries.
73 The Standard Occupational Classification is a six-digit code identifying the 836 occupations in the United States. Each successive digit is a subgroup within the larger. Hence, the two-digit codes are the “major” occupation groups.
74 The Economics sector report assessment provides similar analysis of the industries and businesses; see RAND Corporation, undated.
Table 2.1. Occupational Share of Jobs and Location Quotient with the Continental United States, 2017

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Share of Jobs (Puerto Rico) (Percentage)</th>
<th>Location Quotient (Puerto Rico)</th>
<th>Location Quotient (Hawaii)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office and administrative support</td>
<td>18</td>
<td>1.20</td>
<td>1.08</td>
</tr>
<tr>
<td>Sales and related</td>
<td>12</td>
<td>1.20</td>
<td>0.82</td>
</tr>
<tr>
<td>Food preparation and serving related</td>
<td>8</td>
<td>0.88</td>
<td>0.53</td>
</tr>
<tr>
<td>Education, training, and library</td>
<td>8</td>
<td>1.23</td>
<td>0.83</td>
</tr>
<tr>
<td>Production</td>
<td>7</td>
<td>1.03</td>
<td>1.21</td>
</tr>
<tr>
<td>Protective service</td>
<td>6</td>
<td>2.58</td>
<td>1.11</td>
</tr>
<tr>
<td>Health care practitioners and technical</td>
<td>6</td>
<td>1.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Transportation and material moving</td>
<td>5</td>
<td>0.70</td>
<td>1.11</td>
</tr>
<tr>
<td>Business and financial operations</td>
<td>5</td>
<td>0.92</td>
<td>1.10</td>
</tr>
<tr>
<td>Building and grounds cleaning and maintenance</td>
<td>5</td>
<td>1.48</td>
<td>0.82</td>
</tr>
<tr>
<td>Management</td>
<td>4</td>
<td>0.85</td>
<td>1.09</td>
</tr>
<tr>
<td>Installation, maintenance, and repair</td>
<td>3</td>
<td>0.86</td>
<td>1.34</td>
</tr>
<tr>
<td>Construction and extraction</td>
<td>3</td>
<td>0.78</td>
<td>1.40</td>
</tr>
<tr>
<td>Personal care and service</td>
<td>2</td>
<td>0.51</td>
<td>1.85</td>
</tr>
<tr>
<td>Community and social service</td>
<td>2</td>
<td>1.22</td>
<td>0.97</td>
</tr>
<tr>
<td>Architecture and engineering</td>
<td>2</td>
<td>0.89</td>
<td>0.96</td>
</tr>
<tr>
<td>Computer and mathematical</td>
<td>1</td>
<td>0.41</td>
<td>0.92</td>
</tr>
<tr>
<td>Health care support</td>
<td>1</td>
<td>0.39</td>
<td>0.37</td>
</tr>
<tr>
<td>Arts, design, entertainment, sports, and media</td>
<td>1</td>
<td>0.62</td>
<td>1.28</td>
</tr>
<tr>
<td>Life, physical, and social science occupations</td>
<td>1</td>
<td>0.80</td>
<td>1.04</td>
</tr>
<tr>
<td>Legal</td>
<td>1</td>
<td>0.70</td>
<td>0.38</td>
</tr>
<tr>
<td>Farming, fishing, and forestry</td>
<td>0</td>
<td>0.65</td>
<td>0.92</td>
</tr>
</tbody>
</table>


The remaining occupations are less than 10 percent each. Several have quotients that suggest a large difference with the CONUS: For example, protective service occupations are 6 percent of Puerto Rico’s jobs; at 2.58 quotient, this is very large relative to the United States. Hawaii also has a higher concentration of protective workers, at 1.11, but this is much less than Puerto Rico’s. But certain occupations, some of which are likely to be instrumental to recovery efforts, are smaller in the Puerto Rico economy relative to the CONUS, such as transportation and material moving (0.70); installation, maintenance, and repair (0.86); construction and extraction (0.78); and architecture and engineering (0.89). This further breaks with Hawaii, in which all of these occupations, save architecture and engineering, are larger in the economy instead of smaller.

The composition of the labor force and the relative size of occupation groups do not necessarily mean that Puerto Rico has too many or too few jobs in any given occupation. The economy of Puerto Rico, an island territory, is not necessarily similar to the continental U.S.
economy as a whole. It is likely more similar to Hawaii, a former territory that is also an island economy. However, as is evident in Table 2.1, Puerto Rico’s occupational composition also deviates considerably from Hawaii’s composition.

Industry Context for the Puerto Rico Workforce

In Table 2.2, we list each of the major industries and their share of Puerto Rico employment. The largest industry by employment in Puerto Rico is government, which includes federal, state (government of Puerto Rico), and municipal workers, at 25 percent. This is likely the case in part because most utility workers in Puerto Rico are public employees; transportation and utilities have fewer than 2 percent of employment by comparison. In addition, recall from Table 2.1 that Puerto Rico also has a high share of protective service occupations, which includes police. The next largest sectors, measured by employment, are retail trade (14.4 percent), education and health services (13.8 percent), and professional and business services (13.1 percent).

<table>
<thead>
<tr>
<th>Industry</th>
<th>2017 Employment (thousands)</th>
<th>Share (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and logging</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Construction</td>
<td>20.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Durable goods manufacturing</td>
<td>29.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Nondurable goods manufacturing</td>
<td>41.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>28.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Retail trade</td>
<td>125.2</td>
<td>14.4</td>
</tr>
<tr>
<td>Transportation and utilities</td>
<td>15.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Information</td>
<td>17.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Financial activities</td>
<td>42.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Professional and business services</td>
<td>114.0</td>
<td>13.1</td>
</tr>
<tr>
<td>Education and health services</td>
<td>120.2</td>
<td>13.8</td>
</tr>
<tr>
<td>Leisure and hospitality</td>
<td>79.0</td>
<td>9.1</td>
</tr>
<tr>
<td>Other services</td>
<td>17.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Government</td>
<td>217.1</td>
<td>25.0</td>
</tr>
</tbody>
</table>


Certain industries have specific issues or needs regarding their labor force. For these sectors, we discuss the current state of the labor force and the issues present, or those that may arise in the future, which may require targeted workforce policy.
Labor Force Context of the Construction Industry

In April 2018, the Associated Press reported that Puerto Rico had an outstanding recovery need of about $50 billion in construction and repair.\(^75\) One rough estimate suggests that as many as 300,000 residential units on the island will have severe damage from Hurricane Maria. Approximately 30 percent of those units will have been completely destroyed. A 2,000-square-foot home in the CONUS requires approximately 300 person-hours to complete. Assuming that a home in Puerto Rico requires approximately 200 person-hours, residential reconstruction efforts alone will require approximately 7,000 construction workers working full-time for 24 months. There are approximately 20,000 to 33,000 construction workers presently in the formal labor market in Puerto Rico. Policies regarding the employment of foreign workers reportedly also exacerbated the shortages.\(^76\) Furthermore, the increased construction demand in Texas and Florida has pulled in displaced workers from Puerto Rico, potentially amplifying the shortage of workers there.\(^77\) The staffing firm Good Labor, Inc. specifically recruits construction workers from Puerto Rico for jobs in the CONUS. Compared to Hawaii and the United States at large, Puerto Rico has a larger proportion of its construction workforce made up of “construction laborers” and a smaller proportion in skilled trades such as electricians, carpenters, and plumbers, positions which are often licensed or certified.

The destruction of housing and roads and infrastructure has heightened the demand for workers in the construction industry. Before the hurricanes, Puerto Rico officially contained 1.57 million housing units (including apartments).\(^78\) However, as much as half of Puerto Rico’s residential housing was built “informally”—not up to the relatively strict building code standards—leaving a possible one million homes built illegally.\(^79\) These homes were no match for hurricane-force winds. According to FEMA inspections, more than 335,000 homes and more than 22,000 rental units sustained hurricane damage.\(^80\) The president of the Puerto Rico Builders’ Association estimates the housing demand to be 60,000 to 90,000 new dwellings over the next five years based on the hurricane destruction.\(^81\) Additionally, some of the recoverable housing stock was built without clear title or in prohibited flood areas,\(^82\) so increased code enforcement

\(^{79}\) Viglucci, February 14, 2018.
\(^{80}\) Hinojosa and Meléndez, June 2018.
\(^{81}\) Viglucci, February 14, 2018.
\(^{82}\) Viglucci, February 14, 2018.
may create additional demand for housing. Finally, many homeowners are behind on their mortgage payments, and only half of those delinquencies are a result of the hurricane. The moratorium on missed payments and foreclosures has expired, and so former homeowners may need to seek rental housing because of financial constraints.

Roads and bridges are the primary infrastructure for transportation within Puerto Rico, as there is no long-distance rail service and limited public transit. Of the nearly 17,000 miles of road in Puerto Rico, only 3,500 miles (20 percent) are funded by federal dollars (in contrast, between 2005 and 2014, the U.S. government funded close to 40 percent of roads in the CONUS). The remainder is primarily owned by individual municipalities, with Puerto Rico’s Department of Transportation—Departamento de Transportación y Obras Públicas—claiming responsibility for the rest. This complex bureaucracy is often a challenge to determining responsibility for road maintenance: Tired of waiting for government action, some residents have taken local pothole repair into their own hands. The vast majority of the rated federally funded roads in Puerto Rico are rated as poor or fair. Puerto Rico’s bridges are rated structurally deficient or poor at higher rates than in the CONUS. Finally, Puerto Rico’s fatality-per-vehicle-miles-traveled ratio is nearly double that of the CONUS (excluding Puerto Rico). Thus, even before the hurricanes, Puerto Rico’s system of transportation was unimodal, dangerous, and poorly maintained. Hence, Puerto Rico has long-deferred transportation infrastructure maintenance issues that must be met by a skilled workforce deployed to both rural and urban areas under federal and municipal governments.

**Labor Force Context of the Health Industry**

In general, careers in medical fields are lucrative and consistently in high demand. The health sector comprises doctors, nurses, technicians, and the array of medical professions. Puerto Rico exceeds the CONUS state median for physicians per 100,000 residents (289 in Puerto Rico versus 258 median among U.S. states). However, an outsized proportion of Puerto Rico’s

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84 While there is some intracity transit, there is no public intercity transportation. For additional information, see Liisa Ecola, et al., *Rebuilding Surface, Maritime, and Air Transportation in Puerto Rico After Hurricanes Irma and Maria: Supporting Documentation for the Puerto Rico Recovery Plan*, Santa Monica, Calif.: RAND Corporation, forthcoming.
87 For more information on the transportation sector, see Ecola et al., forthcoming.
physicians are age 60 or older, suggesting a shortfall may occur in the future as they retire. In addition, health professionals tend to concentrate in urban rather than rural areas. Before the hurricanes of 2017, 72 of Puerto Rico’s 78 municipalities had been designated by the Health Resources and Services Administration (HRSA) as medically underserved areas.\(^{90}\)

Outmigration has compounded the potential for health care worker shortfall: The American Association of Medical Colleges estimates that more than 2,000 health professionals emigrated to the CONUS in 2014,\(^{91}\) and other sources estimate that Puerto Rico loses 400 to 500 physicians each year to emigration.\(^{92}\) About 20 percent of physicians completing medical school in Puerto Rico find employment outside Puerto Rico, with the plurality moving to New York.\(^{93}\) Puerto Rico’s nurses are also in demand from the CONUS. For example, before the hurricanes, Advent Health (previously known as Florida Hospital) sourced about 3 percent of its nurses from Puerto Rico, and the company expects that number to potentially double with additional hurricane-based migration.\(^{94}\)

While doctors and nurses are leaving Puerto Rico, the medical needs of the island’s population are not decreasing. Puerto Rico’s population is considerably older than in most U.S. states, increasing the need for medical services. There is also evidence that suggests unmet demand, difficulty in delivering services, or different norms of health care consumption—rates of preventive care in Puerto Rico are much lower than in the CONUS despite comparatively high rates of having insurance.\(^{95}\) Proposed increases in Medicare and Medicaid reimbursement rates\(^{96}\) could substantially increase the demand for health care services and thus the health care workforce.

Furthermore, there are important differences in labor force supply and workforce needs by specialty. For example, emergency medicine is in high need, yet there is only one emergency medicine residency program on the island and it has a capped number of students and 30 percent of its graduates leave to work in the United States. As a result, Puerto Rico confers only seven new emergency practitioners each year. Researchers have calculated the island needs 317 EPs,


\(^{95}\) Department of Health and Human Services, January 12, 2017.

and this shortage could persist through 2044. The combination of limited training opportunities, increased need, and outmigration of trained workers contribute to a dearth of workers in a particular health profession. Unlike the continental U.S. states, Puerto Rico does not allow physician assistants (PAs) to practice medicine unless they are affiliated with a federal facility like a Veterans Administration hospital. An increased role for advanced clinical practice occupations, as proposed in the Recovery Plan for Puerto Rico, could greatly increase both access to care and the demand for nonphysicians.

Labor Force Context of the Energy Industry

Power production and distribution in Puerto Rico is performed by Puerto Rico Electric Power Authority (PREPA), a public corporation. PREPA’s performance during the hurricane was widely regarded as poor. When Hurricane Maria hit the island, it affected 70 percent of PREPA’s transmission system and left the entire island in the dark. Because the Puerto Rico Aqueduct and Sewer Authority, the public water utility, relies on PREPA to power the water, sewage, and wastewater collection system, over 50 percent of the population also lost potable water. PREPA is intended to be fully funded by rate-paying customers, but in recent years, PREPA accrued significant debt via its bond issuance. As of February 2017, five months before the hurricanes, it was estimated by the FOMB created by PROMESA that PREPA accounted for nearly 20 percent of Puerto Rico’s total debt. PREPA also consistently failed to meet its own goals for service interruption frequency and duration, goals that were lower than those of continental U.S. utilities. PREPA’s highest production capacity is in the south, while the majority of the population lives in the north, meaning electrification of the entire island is very dependent on transmission and distribution lines. Finally, the political structure of PREPA, in which managers changed with each administration and rate increases were strongly opposed, created administrative issues that compounded the problems of what PREPA employees referred to as the “ailing grid.”

Yet despite the lack of rate increases, Puerto Rico residents face comparatively high prices for electricity, with only Alaska and Hawaii having higher rates. Puerto Rico has no petroleum production and thus imports fuel for use in motor vehicles and power production. While PREPA

98 See American Academy of PAs, “Puerto Rico: The Final Frontier for PA Licensure,” AAPA, undated.
99 Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
had planned to convert many plants to natural gas, the drop in the price of crude oil and the limitations of PREPA’s uncertain financial future disincentivized these efforts.\textsuperscript{104} Approximately half of the island’s electricity is produced from petroleum products, one-third from natural gas, one-sixth from coal, and the rest from renewables.\textsuperscript{105} PREPA also failed to meet a legislatively mandated target for the 2015 proportion of energy from renewable resources.\textsuperscript{106}

PREPA also has significant personnel issues among its over 6,000 employees. To start, PREPA lost 30 percent of its employees between 2012 and 2017, mainly to retirement, and 86 percent of those who left were in operations. PREPA acknowledges that it is understaffed in various high-skilled functions.\textsuperscript{107} A FOMB report found, specifically, the “sheer number of governor-appointed empleados de confianza [political appointees] predisposed PREPA to massive turnover, loss of institutional knowledge, and decisionmaking that was unresponsive to market forces.”\textsuperscript{108} This was true not only at upper levels, such as the PREPA Board, but also at lower level positions that were also filled by empleados de confianza for technician or operational roles. Moreover, the investigative report found that employees would switch between career job and political appointments frequently. This left PREPA with inefficient management and a very high number of employees who are political appointments rather than trained, occupation-specific workers.

By PREPA’s own admission, it is facing a shortfall of skilled workers and the power authority is attempting to reorient energy sources away from petroleum and toward renewables. For workforce policy, this indicates the need for additional training opportunities. However, the investigative report suggests that hiring practices and the high number of appointments of empleados de confianza could deter individual investment in skills in this area. It is unclear which forms of energy production will require new workers and which might be overstaffed in the future.

\section*{Education and Training Landscape in Puerto Rico}

In the previous section, we discussed the Puerto Rico labor force, a point-in-time estimate of who is working, or wants to work, in the Puerto Rico economy. In this section, we transition from labor force to workforce, broadening our scope beyond current workers to future and potential workers. To start, we discuss various components of Puerto Rico’s secondary and postsecondary education and training landscape, the first and critical input of workforce strategy.

As a U.S. territory, Puerto Rico is allocated federal block grants that comprise the national investment in worker training. The primary funding vehicle is the Workforce Innovation and

\begin{footnotes}
\item[107] Puerto Rico Electric Power Authority, \textit{Amended and Restated Fiscal Plan—Draft}, San Juan: PREPA, April 2018.
\end{footnotes}
Opportunity Act of 2014 (WIOA), which updates the previous Workforce Investment Act of 1998 (WIA). WIOA funds a core set of training programs: the Adult Services program, the Dislocated Workers program, the Youth Services program, the Wagner-Peyser program, the Adult Education and Literacy program, and the Rehabilitation Services program. WIOA also requires a state to have a strategic workforce plan, which includes coordinating WIOA with numerous other programs that are funded through separate legislation, such as Trade Adjustment Assistance, Jobs for Veterans, Job Corps, and YouthBuild.\footnote{Donna Counts, “Federal Funding for State Employment and Training Programs Covered by the WIOA,” The Council of State Governments, April 14, 2017; Workforce Innovation and Opportunity Act, WIOA State Plan for the Commonwealth of Puerto Rico, FY-2018, 2018.} For the most part, we will not discuss WIOA’s programs; because they are federally required, they are not unique to the training landscape in Puerto Rico. Moreover, it is outside the scope of this report to assess the extent to which Puerto Rico utilizes WIOA funding or complies with its federal mandates. However, we will discuss some of WIOA’s partner programs, as necessary, as they relate to particular aspects of Puerto Rico’s workforce training.

**Secondary Education**

For the vast majority of jobs, a high school diploma is a fundamental component of the necessary qualification. In many cases, the high school diploma forms the first part of the training pipeline, in which each successive step requires some credential or certificate. As noted previously, Puerto Rico’s secondary education system has the lowest graduation rate of any state or territory in the United States. Earlier research has noted that Puerto Rico’s dropout rate has declined considerably since the 1990s\footnote{Neil Allison and Arthur MacEwan, “Students Dropping Out of Puerto Rico Public Schools Measuring the Problem and Examining the Implications,” undated.} and that Puerto Rico dropouts have a high rate of high school equivalency (or GED) attainment,\footnote{Helen F. Ladd and Francisco L. Rivera-Batiz, “Education and Economic Development,” in *The Economy of Puerto Rico: Restoring Growth*, Susan M. Collins, Barry P. Bosworth, and Miguel A. Soto-Class, eds., Washington, D.C.: Brookings Institution Press, 2006, pp. 189–254.} which is sufficient as a credential in future education or training as it is accepted as a substitute for a high school diploma. Nonetheless, a high dropout rate, historically, indicates that there is a large pool of older, unskilled workers in Puerto Rico.

Puerto Rico students participated in CTE differs from the national average, as shown in Figure 2.7.

Figure 2.7. Share of 2017 CTE Enrollment in Puerto Rico and U.S. Overall, by Career Cluster

Puerto Rico has a much higher share of students in the business career cluster (28 percent) than the United States overall (11 percent), with no students in education and training, finance, government and public administration, or law, public safety, corrections, and security. It has higher shares of students in architecture and construction (11 percent), tourism (9 percent), and transportation, distribution, and logistics (9 percent), but a lower share in science, technology, engineering, and math (3 percent) and health science (7 percent). There is no correct percentage allocation across careers, and given the differences in their economies, Puerto Rico should not
necessarily be identical in early training investments to the United States overall. Yet, CTE is intended as career- and college-readiness preparation for future workers and, as such, reflects state investment in key sectors.

**Apprenticeships**

Apprenticeships are a key part of a broader training landscape (see Box 2.1). They have been shown to be very effective training tools and are associated with higher wages. In addition, they are on the rise; the Department of Labor notes that the number of apprenticeships has increased 43 percent in the United States overall since 2013, with a total of 534,000 U.S. residents actively apprenticing in 2017. At least in part, this is likely reflective of increases in available funding; the Department of Labor has increased the number of discretionary grants to states and industry partnerships in recent years to support apprenticeships and expand their role. Industries vary in their use and prevalence of apprenticeships. Table 2.3 lists the industries with the most federally registered apprenticeships with the Department of Labor; we provide this list to illustrate the fields that make use of apprenticeship training. There were a total of 175,195 registered apprenticeships in the construction industry in 2017, compared with 89,301 in military, 23,004 in public administration, 17,559 in manufacturing, 15,895 in transportation, and 9,019 in utilities. The remaining industries in the United States have fewer than 2,500 each.

<table>
<thead>
<tr>
<th>Box 2.1. Apprenticeships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprenticeships combine on-the-job training with classroom instruction to prepare workers for highly skilled careers. An individual employer, group of employers, labor organization, education institution, or an industry association can sponsor an apprenticeship program. In a typical apprenticeship, individuals earn lower wages than are expected for the occupation or even the task they are performing, but their wages increase as they progress through the training, the classroom, and various benchmarks of certification. Apprenticeships are registered with the U.S. Department of Labor or State Apprenticeship Agency.</td>
</tr>
</tbody>
</table>

Within the construction industry, the occupations with the largest number of apprenticeships are electrician, carpenter, craft laborer, plumber, pipe fitter, drywall applicator, roofer, millwright, painter, boilermaker, heating and air-conditioner install/servicer, cement mason, floor layer, and glazier.

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### Table 2.3. Top Federally Registered Apprenticeship Programs in United States (FY 2017)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of Registered Apprentices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>175,195</td>
</tr>
<tr>
<td>Military (USMAP)</td>
<td>89,301</td>
</tr>
<tr>
<td>Public administration</td>
<td>23,004</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>17,559</td>
</tr>
<tr>
<td>Transportation</td>
<td>15,895</td>
</tr>
<tr>
<td>Utilities</td>
<td>9,019</td>
</tr>
<tr>
<td>Health care and social assistance</td>
<td>2,549</td>
</tr>
<tr>
<td>Retail trade</td>
<td>2,435</td>
</tr>
<tr>
<td>Education</td>
<td>2,303</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>2,256</td>
</tr>
<tr>
<td>Warehousing</td>
<td>1,690</td>
</tr>
<tr>
<td>Other services, except public administration, administrative and support, and waste management and remediation services</td>
<td>1,116</td>
</tr>
<tr>
<td>Agriculture, forestry, fishing and hunting</td>
<td>819</td>
</tr>
<tr>
<td>Information</td>
<td>607</td>
</tr>
<tr>
<td>Accommodation and food services</td>
<td>542</td>
</tr>
<tr>
<td>Mining, quarrying, and oil and gas extraction</td>
<td>470</td>
</tr>
<tr>
<td>Professional, scientific, and technical services</td>
<td>357</td>
</tr>
<tr>
<td>Finance and insurance</td>
<td>161</td>
</tr>
<tr>
<td>Arts, entertainment, and recreation</td>
<td>62</td>
</tr>
<tr>
<td>Real estate and rental and leasing</td>
<td>46</td>
</tr>
</tbody>
</table>


At time of writing Puerto Rico currently has only one registered apprenticeship (through Mercedes-Benz in Carolina), though in 2016, Puerto Rico’s Department of Labor and Human Resources won $200,000 from the U.S. Department of Labor as part of the ApprenticeshipUSA accelerator grants to help integrate apprenticeships into their education and workforce systems; engage industry and other partners to expand apprenticeships to new sectors and new populations at scale; conduct outreach and work with employers to start new programs; promote greater inclusion and diversity in apprenticeships and implement state incentives and system reforms.\(^{117}\)

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Furthermore, in late 2018 officials in Puerto Rico announced the launch of an apprenticeship program, and interviews with officials at the Governor’s Office of Workforce Development in the December of 2018 revealed that the government of Puerto Rico was reenergizing its efforts to launch apprenticeship programs among the private-sector community. (Further details of the program have yet to be announced at the time of writing this report.)

One reason apprenticeships were not historically active in Puerto Rico is likely related to funding. Unlike other funds from the Department of Labor, support for apprenticeships is not given as part of a block grant that is allocated via a formula, but instead as a discretionary grant in which states compete for funds. We found no evidence that Puerto Rico had applied for these funds—which typically involve significant cost-sharing with the state (territorial) government and the employer or industry sponsoring the apprenticeships—before 2016.

Postsecondary Education

Puerto Rico’s postsecondary education system spans two- and four-year degrees, public and private universities, and career-technical education programs. Table 2.4 lists the number of institutions granting postsecondary degrees, by level and status. At the baccalaureate and post-baccalaureate level, Puerto Rico has few public institutions relative to the number of private ones—a pattern that is typical among states in the CONUS. The largest university is the University of Puerto Rico (UPR), which has nine campuses throughout the island. UPR grants bachelor’s, master’s, professional, and doctoral degrees. Several of the campuses specialize in one academic field (e.g., University of Puerto Rico, Medical Sciences Campus). In addition to UPR, Puerto Rico has two public arts universities (a music conservatory, Conservatorio de Musica de Puerto Rico, and an arts school, Escuela de Artes Plasticas y Diseno de Puerto Rico); the University College of San Juan, a public university offering both two-year and four-year degrees; and the Instituto Tecnologico, which has four campuses and grants two-year degrees and technical certificates.

Tuition is relatively low for public postsecondary schools, though the PROMESA Fiscal Control Board recently recommended substantial increases to public tuition as a method to generate revenue. This may discourage students from pursuing higher education; while public tuition in Puerto Rico was lower than that of any U.S. state, it is still a significant portion of the average family’s income. Yet, given the high dropout rate and patterns of postsecondary enrollment in Puerto Rico and in the CONUS, college students do not represent the average

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119 The Economics sector report assessment provides a discussion of the business climate and labor market regulation in Puerto Rico, which could also make starting an apprenticeship program more difficult; see RAND Corporation, undated.
family. Indeed, despite their highly subsidized tuition rates, four-year postsecondary institutions remain unaffordable to a broad swath of Puerto Rico’s population, particularly as increases in tuition are set to take effect in the near future.

### Table 2.4. Number of Postsecondary Institutions in Puerto Rico, 2017

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Number of Institutions</th>
<th>Number Public</th>
<th>Number Private, Nonprofit</th>
<th>Number Private, For-Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master’s or higher</td>
<td>27</td>
<td>2</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>30</td>
<td>4</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Associate’s degree</td>
<td>36</td>
<td>3</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Technical certificate</td>
<td>68</td>
<td>1</td>
<td>16</td>
<td>51</td>
</tr>
</tbody>
</table>


NOTE: There are 90 total institutions in Puerto Rico, but the numbers in the first column do not sum as institutions may offer degrees at multiple levels.

The remaining postsecondary institutions are private, offering bachelor’s and associate’s degrees and certificate training across 90 institutions, some with a handful of campus locations and others with ten or more. Indeed, at the sub-baccalaureate level, Puerto Rico has few public institutions relative to private ones, though this is atypical among U.S. states. Especially atypical is the incredibly high number of sub-baccalaureate schools that are for-profit—62, more than 60 percent of the total. In comparison, the island state of Hawaii has 22 certificate- or associate’s-granting schools, seven public, six private nonprofit, and nine private for-profit (about 40 percent). Or, 1.5 percent of sub-baccalaureate schools are public in Puerto Rico and 81.3 percent are private for-profit, compared with 35 percent public in Hawaii and 10 percent private for-profit. In the United States at large, there are approximately 5,600 sub-baccalaureate institutions, with a little over 2,100—38 percent—categorized as private for-profit. Appendix C provides a complete list of postsecondary institutions located in Puerto Rico.

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121 It is worth noting that Puerto Rico’s postsecondary education system most likely educates mainly advantaged students, given that (1) Puerto Rico’s high school dropout rate is high and (2) even the already relatively low tuition at UPR is still a significant portion of average and even median income. These students and their families more than likely will continue to attend postsecondary school in Puerto Rico since those schools remain a relatively good bargain relative to tuition rates for higher education institutions in the CONUS and given the critical importance of a college education for economic well-being and social status. If all that holds, then the impacts of increased tuition on enrollments might be fairly minimal.

122 Data compiled from U.S. Department of Education, Integrated Postsecondary Education Data System, National Center for Education Statistics.

123 Of the 1,987 institutions in the United States classified as two-year schools by the Integrated Postsecondary Education Data System (IPEDS), 851 are private for-profit.
For-profit colleges are a driver of student debt, and critically, student debt default.\textsuperscript{124} In addition, for-profit colleges have been associated with fraud, deceptive marketing, falsified student outcomes, and recruiting practices that the Government Accountability Office (GAO) found close to harassment.\textsuperscript{125} The GAO further found that the cost difference for identical certificates could be as much as 26 times more at the for-profit college than a community college nearby, suggesting that for-profit colleges rely on marketing and information asymmetry in recruiting students and driving profits. Students who enroll at for-profit colleges experienced a slight bump in earnings of 4 percent to 7 percent, but this is lower than the returns to public community college.\textsuperscript{126}

However, it is not clear that public and for-profit institutions are necessarily drawing from the same pool of students. For-profit colleges are more likely to enroll high school dropouts or general equivalency diploma (GED) holders than public community colleges.\textsuperscript{127} Earlier research has found that when a new for-profit college opens, it does not decrease attendance at a nearby community college, though these results may not apply to Puerto Rico, where there are no nearby colleges.\textsuperscript{128} Other researchers found that public community colleges that are full result in for-profit enrollment, suggesting a preference for public colleges and a constrained choice.\textsuperscript{129} Again, given that Puerto Rico has only a single, public certificate-granting school, the research on preferences between public and for-profit colleges may not apply.

Moreover, a disparate system of private, certificate-offering schools could be more difficult to strategically coordinate to meet Puerto Rico–wide workforce goals than a centralized public system and may instead respond more to the demands of the potential students rather than demands of employers. Although consumers (in this case, students) may have a better read on labor market needs and move faster than a more centrally organized system, they may also be susceptible to individual institutional marketing that is not reflective of labor market demand.

Indeed, Table 2.5 illustrates the concern that the two-year training landscape is not reflective of workforce needs. It shows the number of sub-baccalaureate certificate programs, number of institutions offering those programs, and three years of certificate conferral (awards) total, by

\begin{itemize}
  \item Deming, Goldin, and Katz, 2013.
\end{itemize}
two-digit Classification of Instructional Programs (CIP) categories.\textsuperscript{130} The dominant certificate program in Puerto Rico is for personal or culinary services, with 193 certificate-granting programs across 55 institutions producing a combined 7,661 conferrals a year, on average, between the 2014–2015, 2015–2016, and 2016–2017 school years. Personal and culinary services include cosmetologists, barbers, cooks, and food handlers, among others. Among the largest certificate categories is mechanic and repair technologies, with 89 programs at 35 institutions producing 2,760 mechanics a year. Indeed, these two categories—personal and culinary services and mechanic and repair—comprise 40.6 percent of all certificate programs and 49.9 percent of all conferrals. Recall from Table 2.2 that total employment in the Other Services industry, which includes all personal care services and auto repair, has only 17,700 employees. Or, if we assume that half of the conferrals in the CIP category of personal care and culinary services were for the former, then each year Puerto Rico grants a third as many new certificates as there are total jobs in those areas.

Hence, although it is a popular conferral, cosmetology and auto repair certificates do not necessarily result in employment within Puerto Rico.\textsuperscript{131} Of course, given that Puerto Rico has an informal sector, it could be that the number of jobs is not indicative of the number of workers earning money in that area. Recall from Table 2.1 that personal care and services comprise 2 percent of all employment in Puerto Rico, and installation, maintenance, and repair only 3 percent. Again, these household summaries do not distinguish between formal and informal employment.

It is important to note that not every occupation requires a certificate, and the importance of certificates in being qualified to work also varies. Many construction trades have long been associated with apprenticeships. For example, transportation occupations may require a specific license but no certificate. Some trades require a certificate, such as cosmetology, while others do not require a certificate, though it is attainable. Moreover, among the largest certificate categories are health professions and related occupations, which would include medical technicians and nurse assistants, with 184 programs at 64 institutions producing 5,768 conferrals a year, and engineering technologies and related fields, with 42 programs and 28 institutions producing 1,203 certificates a year. In comparison, the construction trades have 32 programs at 22 institutions producing just 717 conferrals a year, and transportation and materials moving have zero programs.

\textsuperscript{130} This table does not include many of the CIP codes that have no sub-baccalaureate certificates but instead are areas that are associated with bachelor’s degrees, such as mathematics or English literature.

\textsuperscript{131} Alternatively, some individuals may seek this training while planning to find employment outside of Puerto Rico.
Table 2.5. The Number of Sub-Baccalaureate Certificate Programs in Puerto Rico and Average Certificate Conferrals, 2015–2017, by CIP

<table>
<thead>
<tr>
<th>CIP Category</th>
<th>Number of Certificate Programs</th>
<th>Number of Institutes Offering Programs</th>
<th>Average Annual Conferrals (2015–2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, agriculture operations, and related sciences</td>
<td>4</td>
<td>4</td>
<td>51</td>
</tr>
<tr>
<td>Business, management, marketing, and related support services</td>
<td>36</td>
<td>25</td>
<td>531</td>
</tr>
<tr>
<td>Communications technologies/technicians and support services</td>
<td>3</td>
<td>2</td>
<td>162</td>
</tr>
<tr>
<td>Computer and information sciences and support services</td>
<td>19</td>
<td>15</td>
<td>223</td>
</tr>
<tr>
<td>Construction trades</td>
<td>32</td>
<td>22</td>
<td>717</td>
</tr>
<tr>
<td>Education</td>
<td>10</td>
<td>9</td>
<td>194</td>
</tr>
<tr>
<td>Engineering</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Engineering technologies and engineering-related fields</td>
<td>42</td>
<td>28</td>
<td>1,203</td>
</tr>
<tr>
<td>Family and consumer sciences/human sciences</td>
<td>31</td>
<td>24</td>
<td>394</td>
</tr>
<tr>
<td>Foreign languages, literatures, and linguistics</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Health professions and related programs</td>
<td>184</td>
<td>64</td>
<td>5,768</td>
</tr>
<tr>
<td>Homeland security, law enforcement, firefighting, and related protective service</td>
<td>12</td>
<td>8</td>
<td>191</td>
</tr>
<tr>
<td>Legal professions and studies</td>
<td>3</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>Mechanic and repair technologies/technicians</td>
<td>89</td>
<td>35</td>
<td>2,760</td>
</tr>
<tr>
<td>Parks, recreation, leisure, and fitness studies</td>
<td>9</td>
<td>9</td>
<td>154</td>
</tr>
<tr>
<td>Personal and culinary services</td>
<td>193</td>
<td>55</td>
<td>7,661</td>
</tr>
<tr>
<td>Precision production</td>
<td>8</td>
<td>7</td>
<td>575</td>
</tr>
<tr>
<td>Theology and religious vocations</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Transportation and materials moving</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual and performing arts</td>
<td>13</td>
<td>8</td>
<td>270</td>
</tr>
</tbody>
</table>

NOTE: “Conferrals” is defined as certifications earned or conferred. CIP = Classification of Instructional Programs.

The concern for a workforce system is that individuals are investing time and money into training, both of which can be quite costly, without realizing significant labor market gains. We point out the mismatch between the demand for personal care service and auto repair certificates relative to the number of personal care service and auto repair jobs to show an example of how this may occur. Public community colleges, with lower costs and demonstrable returns to income and employment above for-profit colleges, are a key part of many workforce development systems but a much smaller part of Puerto Rico’s portfolio.

An Analysis of Puerto Rico’s Workforce System

Maintaining a high-quality workforce, and meeting occupational demands, depends on (1) the quality of and access to appropriate education and training and (2) the harmonization of that training with existing labor market opportunities. In the previous sections of this chapter, we have discussed the current labor force of Puerto Rico, its occupational and industrial mix, and the training and education programs in place. We have outlined several issues at each level—low
labor force participation, occupation and industry concentrations, underperforming secondary schools, and fragmented postsecondary schooling. However, we need a lens from which to view and evaluate system operations and components. Once we establish a representative framework for diagnosing strengths and shortfalls, we can identify and discuss appropriate policy options.

In the final section of the chapter, we identify a set of occupations, which we refer to as the “key occupations,” that we determine are likely important to long-term economic vitality in Puerto Rico. We then examine the workforce pipeline and labor market outcomes of those occupations to understand and diagnose where the current workforce system fails to align in producing these workers and why. We do not claim that this set of occupations is exhaustive; rather, it is illustrative, permitting us to discuss training pipelines at various credential levels with tangible examples.

**Key Occupations**

To begin, we think broadly about long-term workforce needs and identify a set of key occupations in Puerto Rico from which to view the workforce system. There are over 800 occupations to choose from, and to produce a narrower and more manageable list we established a set of features that “key” occupations would have. We then used these features to build a set of ranking criteria.

The first feature of the key occupations is that they have to be increasing in size. In this way, we can see the workforce infrastructure in Puerto Rico for jobs we expect to be in higher demand in the future. For this, we used the Employment Projections (EP) from the BLS. The BLS produces ten-year, national projections of job growth or decline by occupation. These are not predictions but projections, given current trends. We formed three ranking criteria for each occupation based on these projections, starting with

1. the projected national growth in jobs (number)
2. the projected national growth in jobs (percentage).

We measure job growth in both absolute numbers as well as percentage growth to balance the fact that absolute number increases often favor larger occupations, while percentage growth favors smaller occupations.

The second feature of key occupations is that they are relevant and reflective of the broader functioning of the workforce system. Rather than place value judgments on particular occupations and rank them by what we think is more important, we measure relevance by size. Our additional ranking criterion is thus

3. the total number of projected jobs in ten years.

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132 The projections are extrapolations rather than based on models of multiple factors. While these projections are based on national data, there are no equivalent measures available for Puerto Rico, and applying some sort of industry composition conversion would introduce additional error.
For example, if there are two occupations that both increase by 1,000 jobs, one from 0 to 1,000 and one from 9,000 to 10,000, this criterion ranks the second job higher. This weights the key occupations to be those which would likely require more coordination from the workforce system.

One drawback to the EP data is that they are not specific to Puerto Rico. Ideally, these key occupations would reflect that certain conditions in Puerto Rico make workforce development more challenging. In particular, given what we noted about outmigration, workers in a specific occupation may be drawn to leave Puerto Rico if compensation is significantly higher in the CONUS. Thus, our fourth criterion uses the OES to measure, on average, the difference in wages between Puerto Rico and likely U.S. outmigration targets within an occupation. We looked at

4. the gap in annual earnings between workers in Puerto Rico and workers in six states with a large number of Puerto Rico migrants (Florida, New York, New Jersey, Pennsylvania, Massachusetts, Connecticut).

Occupations with a larger gap—those in which the earnings in Puerto Rico were lower relative to the six U.S. states—are more likely to be key occupations. This is on the assumption that, first, they may be more vulnerable to outmigration, and second, if there is more outmigration, there may be a lower supply in Puerto Rico, or the workforce system may need to take outmigration into account. We only look at wages in states that have a large Puerto Rico population base, since the U.S. labor market and presence of Puerto Ricans varies considerably across states.

So far, our key occupations are ones that have been growing, relevant, and comparatively underpaid. For our final feature, we also think the key occupations should have some measure of supply. The employment projections give a sense of demand, the inverse of which is whether Puerto Rico already produces those workers apace with demand. Hence, our final ranking criterion is

5. the difference in location quotients between Puerto Rico and the six migration states.

For example, police officer could be an occupation that is growing, is a sufficiently large occupation, and is one in which workers in Puerto Rico make much less than similar workers in the CONUS, but as we noted earlier, Puerto Rico has a very high concentration of protective service officers already. It is not a key occupation from the workforce development perspective.

For each of these enumerated criteria, we rank all of the occupations and divide them into five equal-sized groups (quantiles). We then assign a numeric score from 1 to 5 to all the occupations within the quantiles, where 1 is “most key, and 5 is “least key.” We then sum the score over the five criteria; the lowest possible score (most in need) is a 5, the highest possible

133 There were no occupations in which Puerto Rico median annual wages were higher than in the six migration states.
score is 25 (where need is closest to being met). The key occupations are those that have a lower total score.

The result of this ranking criteria is a set of occupations that we use to frame our discussion of Puerto Rico’s education and training systems. Our criteria were based on the features of key occupations that we deemed important for a long-term assessment of a workforce development system in Puerto Rico. There are countless other ways to think about workforce development or to rank occupations. For example, this method does not take into account acute workforce requirements of hurricane reconstruction and recovery projects; we discuss the short-term workforce needs specific to the recovery in Chapter 3. Or, we could have based our analysis on occupations that require the most training investment in terms of time or monetary costs, or only those that require some time of certificate or licensing. The features that we highlight are oriented to be broad and long term.

Table 2.6 shows all those occupations with a score of 10 or lower, sorted by categories of postsecondary credentials. In certain occupations we combined more detailed occupational categories into larger groups. In this instance, the range is shown. The final column in Table 2.6 is the wage difference: Puerto Rico’s average earnings in that occupation as a fraction of the average earnings in that occupation in the six states with the highest population of Puerto Rico outmigrants: New York, New Jersey, Connecticut, Pennsylvania, Massachusetts, and Florida.

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Key Occupation</th>
<th>Score</th>
<th>PR Wage as Percentage of M6* Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-MA</td>
<td>Dentists, general</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Physical therapists</td>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Medical scientists, except epidemiologists</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Clinical, counseling, and school psychologists</td>
<td>8</td>
<td>56</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Physicians and surgeons</td>
<td>9</td>
<td>36–65</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Lawyers</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>Post-MA</td>
<td>Postsecondary teachers, all</td>
<td>10</td>
<td>44–52</td>
</tr>
<tr>
<td>MA</td>
<td>Physician assistants</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>MA</td>
<td>Counselors and social workers</td>
<td>7–8</td>
<td>45–68</td>
</tr>
<tr>
<td>MA</td>
<td>Nurse practitioners</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>MA</td>
<td>Occupational therapists</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>MA</td>
<td>Speech-language pathologists</td>
<td>8</td>
<td>50</td>
</tr>
</tbody>
</table>

An occupation’s placement in these education categories is based on the OES study of the workers in that occupation and standards within the context of the CONUS. The categories are not necessarily fixed, especially in the Associate’s Degree (AA)/Certificate categories. Some AA programs include occupational certificates, some certificates require an AA in addition, while some only require a high school diploma or equivalent. However, the OES identifies the typical postsecondary credential required.
<table>
<thead>
<tr>
<th>Education Level</th>
<th>Key Occupation</th>
<th>Score</th>
<th>PR Wage as Percentage of M6* Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>Statisticians and computer/information scientists</td>
<td>9</td>
<td>40</td>
</tr>
<tr>
<td>MA</td>
<td>Education administrators</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>MA</td>
<td>Urban and regional planners</td>
<td>10</td>
<td>46</td>
</tr>
<tr>
<td>BA</td>
<td>Personal financial advisers</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>BA</td>
<td>Finance, business, insurance, and marketing workers, including analysts</td>
<td>6–8</td>
<td>28–59</td>
</tr>
<tr>
<td>BA</td>
<td>Managers, all industries</td>
<td>6–10</td>
<td>46–62</td>
</tr>
<tr>
<td>BA</td>
<td>Primary and secondary instructors and librarians</td>
<td>7–9</td>
<td>32–40</td>
</tr>
<tr>
<td>BA</td>
<td>Computer, information security, software, and network workers</td>
<td>7–9</td>
<td>42–69</td>
</tr>
<tr>
<td>BA</td>
<td>Human resources workers, including compensation and training experts</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td>BA</td>
<td>Operations research analysts</td>
<td>8</td>
<td>63</td>
</tr>
<tr>
<td>BA</td>
<td>Public relations, fundraisers, and related workers</td>
<td>9–10</td>
<td>42–48</td>
</tr>
<tr>
<td>BA</td>
<td>Network and computer systems administrators</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>BA</td>
<td>Mechanical and civil engineers</td>
<td>10</td>
<td>61</td>
</tr>
<tr>
<td>BA</td>
<td>Appraisers and assessors of real estate</td>
<td>10</td>
<td>47</td>
</tr>
<tr>
<td>AA</td>
<td>Paralegals and legal assistants</td>
<td>7</td>
<td>62</td>
</tr>
<tr>
<td>AA</td>
<td>Web developers</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td>AA</td>
<td>Respiratory therapists</td>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td>AA</td>
<td>Occupational therapy assistants</td>
<td>8</td>
<td>38</td>
</tr>
<tr>
<td>AA</td>
<td>Radiologic technologists</td>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td>AA</td>
<td>Dental hygienists</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td>AA</td>
<td>Diagnostic medical sonographers</td>
<td>9</td>
<td>32</td>
</tr>
<tr>
<td>AA</td>
<td>Physical therapist assistants</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>AA</td>
<td>Veterinary technologists and technicians</td>
<td>10</td>
<td>79</td>
</tr>
<tr>
<td>AA</td>
<td>Preschool teachers, except special education</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Certificate</td>
<td>Medical assistants</td>
<td>7</td>
<td>57</td>
</tr>
<tr>
<td>Certificate</td>
<td>Heating, air conditioning, and refrigeration mechanics and installers</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>Certificate</td>
<td>Licensed practical and licensed vocational nurses</td>
<td>8</td>
<td>46</td>
</tr>
<tr>
<td>Certificate</td>
<td>Phlebotomists</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>Certificate</td>
<td>Hairdressers, hairstylists, and cosmetologists</td>
<td>9</td>
<td>74</td>
</tr>
<tr>
<td>Certificate</td>
<td>Dental assistants</td>
<td>9</td>
<td>49</td>
</tr>
<tr>
<td>Certificate</td>
<td>Automotive service technicians and mechanics</td>
<td>9</td>
<td>46</td>
</tr>
<tr>
<td>Certificate</td>
<td>Firefighters</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>Certificate</td>
<td>Health technologists and technicians, all other</td>
<td>9</td>
<td>68</td>
</tr>
<tr>
<td>Certificate</td>
<td>Medical records and health information technicians</td>
<td>10</td>
<td>49</td>
</tr>
</tbody>
</table>
For most of the occupations identified as key, workers in Puerto Rico tend to make half or less of what they would in the CONUS, with the exception of veterinary technologists and technicians, hairdressers, hairstylists and cosmetologists, and manicurists and pedicurists. We refer to the difference in wages within an occupation between Puerto Rico and the six migration states as the wage disparity: the lower the percentage, the higher the disparity. The disparity is problematic for workforce policy; once a worker has the appropriate training or education for the job, they can make about twice as much money working in the CONUS.\textsuperscript{135} Again, the cost of living in Puerto Rico is roughly on the order of 70 percent of the U.S. average.\textsuperscript{136} Thus, a portion of the wage disparity is eroded in the lower cost of living, but the effect is not complete.

The wage disparity is particularly acute among the health professions. On average, dentists in Puerto Rico earn 36 percent of what their counterparts in the six migration states earn. Other health occupations, such as PAs (28 percent), nurse practitioners (19 percent), respiratory therapists (35 percent), sonographers (32 percent), and physical and occupational therapy assistants (38 percent), are also among those with the largest pay disparities for key postsecondary occupations. The disparity is also acute among financial professionals, encompassing financial advisers, analysts, and managers, averaging 24 percent and 28 percent among the lowest-paid occupations.

Table 2.7 presents the results of the same methodology applied to occupations that require a high school degree or less. These occupations still require training but not necessarily through the postsecondary education system. We denote with superscript letter “a” those occupations associated with the construction industry; across these occupations, the wage disparity with the six migration states averages 38 percent. The next largest field represented among key occupations is transportation—bus and truck mechanics and diesel engine specialists, and automotive body and repairs—as well as the lower skilled financial occupations such as clerks in insurance or loan-making.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Education Level & Key Occupation & Score & PR Wage as Percentage of M6a Wage \\
\hline
Certificate & Manicurists and pedicurists & 10 & 97 \\
Certificate & Emergency medical technicians and paramedics & 10 & 57 \\
\hline
\end{tabular}
\caption{Table 2.7: Wage Disparity for Occupations Requiring a High School Degree or Less}
\end{table}

\textsuperscript{135} One might expect wages to rise in Puerto Rico to attract and retain talent if these occupations are truly in-demand; however, the health care industry is constrained by reimbursement rates, artificially capping wages.

\textsuperscript{136} Numbeo, “Cost of Living Comparisons Between Puerto Rico and the United States,” webpage, undated.
Table 2.7. Key Occupations, Quantitative Score, and Wage Difference with Migration States, High School Credential or Less

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Key Occupation</th>
<th>Score</th>
<th>PR Wage as Percentage of M6* Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS</td>
<td>Plumbers, pipefitters, and steamfitters(^a)</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>HS</td>
<td>Self-enrichment education teachers (e.g., ceramics, martial arts, piano)</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>HS</td>
<td>First-line supervisors of construction trades and extraction workers(^a)</td>
<td>7</td>
<td>38</td>
</tr>
<tr>
<td>HS</td>
<td>Operating engineers and other construction equipment operators(^a)</td>
<td>7</td>
<td>37</td>
</tr>
<tr>
<td>HS</td>
<td>Insurance claims, processing clerks, and sales</td>
<td>8</td>
<td>40–57</td>
</tr>
<tr>
<td>HS</td>
<td>Bus and truck mechanics and diesel engine specialists</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td>HS</td>
<td>Electricians(^a)</td>
<td>8</td>
<td>45</td>
</tr>
<tr>
<td>HS</td>
<td>First-line supervisors of personal service workers</td>
<td>8</td>
<td>61</td>
</tr>
<tr>
<td>HS</td>
<td>Brickmasons and blockmasons(^a)</td>
<td>9</td>
<td>48</td>
</tr>
<tr>
<td>HS</td>
<td>Automotive body and related repairers</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>HS</td>
<td>Structural iron and steel workers(^a)</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>HS</td>
<td>Hazardous materials removal workers(^a)</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>HS</td>
<td>Solar photovoltaic installers</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>HS</td>
<td>Loan interviewers and clerks</td>
<td>9</td>
<td>56</td>
</tr>
<tr>
<td>HS</td>
<td>Construction and building inspectors(^a)</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>HS</td>
<td>Sheet metal workers(^a)</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>HS</td>
<td>First-line supervisors of housekeeping and janitorial workers</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td>HS</td>
<td>Paving, surfacing, and tamping equipment operators(^a)</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>HS</td>
<td>Property, real estate, and community association managers; first-line supervisors of landscaping, lawn service, and groundskeeping workers</td>
<td>10</td>
<td>55</td>
</tr>
<tr>
<td>HS</td>
<td>Police, fire, and ambulance dispatchers</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>HS</td>
<td>Security and fire alarm systems installers</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>HS</td>
<td>Billing and posting clerks</td>
<td>10</td>
<td>53</td>
</tr>
<tr>
<td>HS or less</td>
<td>Cement masons and concrete finishers(^a)</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>HS or less</td>
<td>Food servers, nonrestaurant</td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>HS or less</td>
<td>Roofer(^a)</td>
<td>9</td>
<td>37</td>
</tr>
</tbody>
</table>


\(^a\) Occupations associated with the construction industry.

An important finding from Tables 2.6 and 2.7 is the breadth of the key occupations across educational categories. At each education level, from post–master’s degree (which includes Ph.D.’s, J.D.’s, D.D.S.’s, and M.D.’s) to certificates that may or may not require an associate’s degree or even a high school diploma, there are numerous occupations that we identify as key occupations in Puerto Rico. Recall that key occupations, as we defined them, were those occupations that were growing in size, relevant, with large pay differences, and that were not as prevalent in Puerto Rico. Occupations within each education level demonstrate these features.
This suggests that any long-term workforce development policies or strategies in Puerto Rico must encompass training and education across the spectrum of education levels (low-, middle-, and high-skill levels).

**Training Pipelines for Key Occupations in Puerto Rico**

Next, we describe the training pipeline in Puerto Rico for each of the occupations that we identified in the previous section. In this way, these occupations serve as a means by which to measure the performance of the current training landscape in Puerto Rico. In Tables 2.8 through 2.11, we summarize each occupation according to whether the occupation is associated in the CONUS with an apprenticeship (this does not mean that an apprenticeship is required, but that in some states or localities, apprenticeships are used); the number of completed credentials in the four-digit CIP code at that degree level; the number of institutions that grant those conferrals; and finally, the required credentials to work in that occupation and whether those credentials are accepted in labor markets in the CONUS. In most cases, the acceptance of a license or occupational certificate varies by state.

**Table 2.8. Summary of Key Occupation Training and Credentialing, Post-M.A. Level**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Apprenticeship in CONUS?</th>
<th>Conferrals in 2017</th>
<th>Number of Education Institutes</th>
<th>Credential Required (Puerto Rico)</th>
<th>Degree/License Communicability with CONUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentists</td>
<td>52</td>
<td>1</td>
<td></td>
<td>DDS + exam-based license</td>
<td>Full: degree and license reciprocity in CONUS</td>
</tr>
<tr>
<td>Doctors</td>
<td>428</td>
<td>6</td>
<td></td>
<td>MD + exam-based license</td>
<td>Partial: some medical school and exams not recognized</td>
</tr>
<tr>
<td>Lawyers</td>
<td>502</td>
<td>3</td>
<td></td>
<td>JD + exam-based license</td>
<td>Partial: Puerto Rico Bar has no reciprocity</td>
</tr>
<tr>
<td>Clinical, counseling, and school psychologists</td>
<td>208</td>
<td>7</td>
<td></td>
<td>MA/MSW degree + exam-based license; PhD + exam-based license</td>
<td>Partial: licenses do not have reciprocity</td>
</tr>
<tr>
<td>Physical therapists¹</td>
<td>0</td>
<td>0</td>
<td></td>
<td>DPT + exam-based license</td>
<td>NA</td>
</tr>
<tr>
<td>Postsecondary instructors</td>
<td>(varies)</td>
<td></td>
<td></td>
<td>PhD</td>
<td>Full: degree recognized</td>
</tr>
</tbody>
</table>

**Sources:** CONUS apprenticeship information is from the U.S. Department of Labor. Conferrals and conferral-granting institutions are from IPEDS; conferrals are summarized on the two-digit level. Credential, certificate, and licensing requirements and the communicability between Puerto Rico and CONUS are based on authors’ analysis of the BLS Occupational Outlook Handbook professional association literature.

¹ We could not find any information on institutes that grant physical therapy degrees or licenses in Puerto Rico.
Occupations associated with degree requirements beyond the master’s level are summarized in Table 2.8. All degrees from accredited institutions in Puerto Rico are recognized in the rest of the United States. Communicability with the CONUS for these occupations is thus dependent on whether the license to practice is accepted across states. For dentists, an occupation associated with shortages in Puerto Rico, there is only one school that confers a doctor of dental surgery (D.D.S.) degree, which graduated 52 students in 2017, compared with six medical schools and three law schools. It is not uncommon for a state to have only one or no dental school. Each of these occupations requires an exam-based license to practice, but only dental licenses have full portability. Counselors and psychologists can be licensed at the master’s or doctorate level; there are seven schools that grant conferrals in counseling and psychology. However, there is no institution that grants physical therapist degrees in Puerto Rico that we could identify. Finally, the number of institutions graduating postsecondary instructors will vary by field, but typically this occupation requires a Ph.D. (and no additional certification), meaning that it is fully portable to the CONUS.

In terms of training pipelines, most of the key occupations at this (post-master’s) level, with the exception of physical therapists, have established programs. Responding to changes in demand could be accomplished by changing the size of the programs, which, although not trivial, is less difficult than creating new training pipelines. In terms of workforce strategy, however, trained workers in these occupations may require incentives to stay in Puerto Rico. In general, the occupations associated with the most education have similar degree and license requirements with the CONUS, even if the license itself is not accepted everywhere.

Occupations with degree requirements at the master’s level are summarized in Table 2.9. For these and the remaining occupations, a discussion of training programs must note that the total training requirements for the occupation can vary from Puerto Rico to the CONUS and among other states. In addition, the occupation can also be associated with multiple tiers of trained workers, some with higher credentials and some not. Counselors and social workers, for example, comprise school counselors, substance abuse counselors, rehabilitation counselors, and marriage counselors, among others. Puerto Rico has nine institutes granting 393 master’s-level conferrals in 2017. However, the occupation itself does not technically require a master’s degree and also does not require a license or certificate, though a master’s and certificates are held by certain workers.

Puerto Rico has a large number of institutions granting nursing degrees that produce just over a thousand nurse practitioner degree holders a year. However, PAs, the highest medical

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137 Not included in Table 2.8 that was included in Table 2.6 is medical scientist. Information regarding the occupation in Puerto Rico was insufficient to be included.

138 Health Resources and Services Administration (HRSA) estimates suggest that less than 20 percent of the dental need in Puerto Rico is met by the current supply. See Kaiser Family Foundation, “State Health Facts: Dental Care Health Professional Shortage Areas (HPSAs),” December 31, 2018.

practitioner under M.D.’s, are not allowed to practice in Puerto Rico, and for that reason Puerto Rico does not have a training pipeline to produce them. There are a handful of PAs that work in federal hospitals, such as the Veterans Administration, who were trained in the CONUS. Should regulations change to allow PAs to practice in Puerto Rico, the last state or territory to allow it, then training programs would need to be established, likely within some nursing or medical schools, to produce these workers.

Table 2.9. Summary of Key Occupation Training and Credentialing, M.A. Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Apprenticeship in CONUS?</th>
<th>Conferrals in 2017</th>
<th>Number of Education Institutes Offering Degree</th>
<th>Credential Required: Puerto Rico</th>
<th>Degree/License Communicability with CONUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counselors and social workers</td>
<td>393</td>
<td>9</td>
<td>MA/MSW and/or experience</td>
<td>Partial: most states require license</td>
<td></td>
</tr>
<tr>
<td>Education administrators</td>
<td>978</td>
<td>18</td>
<td>MA + exam-based license</td>
<td>Partial: licenses do not have reciprocity</td>
<td></td>
</tr>
<tr>
<td>Nurse practitioners</td>
<td>1,075&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24</td>
<td>MSN + exam-based license</td>
<td>Partial: licenses do not have reciprocity</td>
<td></td>
</tr>
<tr>
<td>Physician’s assistants</td>
<td>0</td>
<td>0</td>
<td>Not allowed to practice in Puerto Rico</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statisticians and computer/information scientists</td>
<td>16</td>
<td>3</td>
<td>MS</td>
<td>Full: degree recognized</td>
<td></td>
</tr>
<tr>
<td>Urban and regional planning</td>
<td>282</td>
<td>18</td>
<td>MA + exam-based license</td>
<td>Full: no license required in CONUS</td>
<td></td>
</tr>
</tbody>
</table>

SOURCES: CONUS apprenticeship information is from the U.S. Department of Labor. Conferrals and conferral-granting institutions are from IPEDS; conferrals are summarized on the two-digit level. Credential, certificate, and licensing requirements and the communicability between Puerto Rico and CONUS are based on authors’ analysis of the BLS Occupational Outlook Handbook professional association literature.

<sup>a</sup> For these fields, conferrals are at the two-digit level and comprise more than one occupation.

Although there are three institutions that grant master’s degrees for statisticians, computer scientists, and information scientists, there are a very low number of conferrals each year, just over a dozen. Finally, there are 18 schools that grant urban planning master’s degrees. This is a licensed occupation in Puerto Rico, but not in the CONUS. Recall that each of these occupations was identified as growing, significant in size, but with steep pay disparities between Puerto Rico and the CONUS and with a lower concentration in Puerto Rico.

<sup>140</sup> American Academy of PAs, “PAs for Puerto Rico and AAPA Meet with Puerto Rico’s New Congresswoman,” AAPA, July 17, 2017.
Occupations with degree requirements at the bachelor’s level are summarized in Table 2.10. Degrees from accredited institutions are accepted anywhere in the CONUS, hence, most of the occupations have full communicability, except for those that require a license, which is typically not transferable. Looking at sectors across Tables 2.9 and 2.10, we see the large variation in conferrals across fields. Combining M.A. and B.A. conferrals, there are 6,496 conferrals in nursing; 3,976 in business and finance; 2,228 in education; and 1,091 in counseling and social work. In comparison, there are only 798 in the computer science fields and 1,028 in engineers and operations research. Again, the educational institutions are in place to support these growing and important occupations, but not enough students are graduating in the pipeline for those occupations. We do not know if this reflects lack of student enrollment, constraints or caps in certain programs, or a combination of both.

Finally, in Table 2.11, we summarized the key occupations that are associated with a postsecondary credential less than a B.A., comprising associate’s degrees, certificates, or a combination of both. For many occupations in this table, we had difficulty in determining the credential requirement or training institution in Puerto Rico—this applies to science technicians, web developers, and paralegals. In the case of science technicians and web developers, we have a record of conferrals in those subject areas but could not confirm that a license or certificate was not required. In the CONUS, science technicians have a B.A. and a certification specific to the machine they are working on. But in the case of paralegals, there is no training institution that produces paralegals, and we could not find a certificate program. Continental U.S. requirements for paralegals is much more dependent on the certificate, and paralegals can have B.A.’s, associate’s degrees, or even high school diplomas. Separately, though we know firefighters are trained in Puerto Rico and serve in the Firefighter Corps, we could not find information about their training academy, though we could for emergency medical technicians and paramedics.

In most of the occupations, the communicability with the CONUS is also unclear. Most of the occupations require certificates, but the degree to which we could identify reciprocity varied. Indeed, it was easier to identify cases in which there was no communicability. In the case of medical technologists and technicians (radiologic technicians, dental hygienists, medical sonographers, veterinary technicians, or other health technicians), the CONUS requires a higher educational degree, similar to non–health science technicians. In contrast, medical assistants in the CONUS (e.g., respiratory therapists, occupational therapy assistants, physical therapy assistants, phlebotomists, and dental assistants) require only a high school degree. Finally, cosmetology certificates are not transferrable.
Table 2.10. Summary of Key Occupation Training and Credentialing, B.A. Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Apprenticeship in CONUS?</th>
<th>Conferrals in 2017</th>
<th>Number Education Institutes</th>
<th>Credential Required: Puerto Rico</th>
<th>Degree/License Communicability with CONUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance, business, insurance, and marketing workers, including analysts</td>
<td>✓</td>
<td>3,976a</td>
<td>45</td>
<td>BA</td>
<td>Full: degree accepted</td>
</tr>
<tr>
<td>Personal financial advisers</td>
<td></td>
<td>3,976a</td>
<td>45</td>
<td>BA</td>
<td>Unclear</td>
</tr>
<tr>
<td>Public relations, fundraisers, and related workers</td>
<td>✓</td>
<td>3,976a</td>
<td>45</td>
<td>BA</td>
<td>Full: degree accepted</td>
</tr>
<tr>
<td>Counselors and social workers</td>
<td>✓</td>
<td>698</td>
<td>17</td>
<td>BA + exam-based license</td>
<td>Partial: no license reciprocity</td>
</tr>
<tr>
<td>Nurses (RNs from BSN)</td>
<td>✓</td>
<td>5,421</td>
<td>45</td>
<td>BSN + exam-based license</td>
<td>Partial: no license reciprocity</td>
</tr>
<tr>
<td>Primary and secondary instructors and librarians</td>
<td>✓</td>
<td>1,250</td>
<td>37</td>
<td>BA + occupational certification</td>
<td>Partial: little certificate reciprocity</td>
</tr>
<tr>
<td>Computer, information security, software, and network workers and network and computer systems administrators</td>
<td>✓</td>
<td>782</td>
<td>28</td>
<td>BS</td>
<td>Full: degree accepted</td>
</tr>
<tr>
<td>Mechanical and civil engineers</td>
<td>✓</td>
<td>1,028a</td>
<td>6</td>
<td>BS + exam-based license</td>
<td>Partial: no license reciprocity</td>
</tr>
<tr>
<td>Operations research analyst</td>
<td></td>
<td>1,028a</td>
<td>6</td>
<td>BS</td>
<td>Full: degree accepted</td>
</tr>
<tr>
<td>Appraisers and assessors of real estate</td>
<td>✓</td>
<td>Unknown</td>
<td>Unknown</td>
<td>(Unclear)</td>
<td>Partial: CONUS has licensing requirements</td>
</tr>
</tbody>
</table>

 SOURCES: CONUS apprenticeship information is from the U.S. Department of Labor. Conferrals and conferral-granting institutions are from IPEDS; conferrals are summarized on the two-digit level. Credential, certificate, and licensing requirements and the communicability between Puerto Rico and CONUS are based on authors’ analysis of the BLS Occupational Outlook Handbook professional association literature.

a For these fields, conferrals are at the two-digit level and comprise more than one occupation.

The final education category is those occupations that require a high school diploma but are not necessarily required to have a certificate, though they can, and often incorporate on-the-job training or apprenticeships. These occupations include the construction trades, the energy trades, and certain finance and insurance occupations, such as loan interviewers, tax preparers, or insurance claim processing clerks. Even within the CONUS, these occupations have varying certificate requirements. We do not summarize these occupations; the lack of uniformity in credential, especially given how many are associated with apprenticeships in the CONUS, makes summarizing difficult.
Table 2.11. Summary of Key Occupation Training and Credentialing, Sub-B.A. Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Apprenticeship in CONUS</th>
<th>Conferrals in 2017</th>
<th>Number Education Institutes</th>
<th>Credential Required: Puerto Rico</th>
<th>Degree/License Communicability with CONUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical technologists and technicians</td>
<td>✓</td>
<td>5,443</td>
<td>60</td>
<td>AA + exam-based license</td>
<td>None: CONUS requires BA</td>
</tr>
<tr>
<td>Medical assistants</td>
<td>✓</td>
<td>5,443</td>
<td>60</td>
<td>AA + certification</td>
<td>Partial: CONUS requires HS diploma, varying license reciprocity</td>
</tr>
<tr>
<td>Science technicians</td>
<td>✓</td>
<td>17</td>
<td>3</td>
<td>Unclear</td>
<td>None: CONUS requires BA + machine-specific certification</td>
</tr>
<tr>
<td>Web developers</td>
<td>✓</td>
<td>218</td>
<td>37</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
<tr>
<td>Paralegals</td>
<td>✓</td>
<td>0</td>
<td>0</td>
<td>Unclear</td>
<td>None: CONUS requires AA/BA + certification</td>
</tr>
<tr>
<td>Firefighters</td>
<td>✓</td>
<td>Unclear</td>
<td>Unclear</td>
<td>Certificate</td>
<td>Unclear: CONUS requires certificate</td>
</tr>
<tr>
<td>Emergency medical technicians and paramedics</td>
<td>✓</td>
<td>5,543</td>
<td>60</td>
<td>Certificate</td>
<td>Unclear: CONUS requires certificate</td>
</tr>
<tr>
<td>Heating, air conditioning, and refrigeration mechanics and installers</td>
<td>✓</td>
<td>2,724</td>
<td>31</td>
<td>Certificate + License</td>
<td>Unclear: CONUS requires certificate</td>
</tr>
<tr>
<td>Automotive service technicians and mechanics</td>
<td>✓</td>
<td>2,724</td>
<td>31</td>
<td>Certificate</td>
<td>Unclear: CONUS requires certificate</td>
</tr>
<tr>
<td>Cosmetologists/beauticians</td>
<td>✓</td>
<td>7,439</td>
<td>51</td>
<td>Certificate</td>
<td>None: no reciprocity with CONUS</td>
</tr>
</tbody>
</table>

SOURCES: CONUS apprenticeship information is from the U.S. Department of Labor. Conferrals and conferral-granting institutions are from IPEDS; conferrals are summarized on the two-digit level. Credential, certificate, and licensing requirements and the communicability between Puerto Rico and CONUS are based on authors' analysis of the BLS Occupational Outlook Handbook professional association literature.

For these fields, conferrals are at the two-digit level and comprise more than one occupation.

Lessons from Key Occupations

We use a set of key occupations and their training pathways as a framework to critically examine the workforce development system in Puerto Rico. Our main findings are, first, for occupations associated with the most education, the training institutions and infrastructure to support occupational growth are in place in Puerto Rico; further expansion can be facilitated by increasing program slots at extant institutions or creating satellite campuses to increase the geographic accessibility of training. There are programs for dentistry, medicine, law, and research scientists. However, training workers does not mean that Puerto Rico can retain them. The large wage disparities between Puerto Rico and the United States overall means that in addition to training workers, the workforce development system may need to incorporate some kind of incentive program to encourage skilled workers to remain in Puerto Rico.
Second, though we recognize that it is difficult to say precisely how many conferrals are sufficient or what size programs should be, conferrals for certain occupations appear very low. Combined M.A. and B.A. conferrals were high for nursing and business and finance, but much lower in the computer science fields, engineering, and operations research. This could be a function of the number of institutes offering programs. For example, only six institutes offer undergraduate engineering degrees, compared with 45 for nursing. It could also be a function of student interest in those programs. Although there are 28 institutions offering Bachelor of Science degrees for the computer sciences fields, there are only 782 graduates. Occupations that are currently supported with comparatively fewer programs or lower enrollment may require more extensive workforce coordination, employer partnerships, education recruiting, or career exposure.

Third, in many cases, especially for occupations requiring a sub-baccalaureate education, occupational requirements in Puerto Rico were difficult to determine; it was therefore hard to assess if a certificate was necessary or in what instances. This lack of clarity and uniformity jeopardizes the value of the credential, which can in turn make it difficult to gauge the returns to a human capital investment, such as enrolling in a technical certificate program. As we noted in the previous section, the enrollment choices of students do not always align with employment prospects. Schools, especially for-profit schools, can rely on marketing to recruit students rather than labor market returns.

Conclusion

Puerto Rico faces numerous long-term challenges to its workforce development system. In this chapter, we discussed low labor force participation and its potential causes, including competing public benefits, outmigration of workers, and the presence of a large informal sector; the occupational and industrial mix of the current labor force; and the education and training landscape at the secondary and postsecondary level. Using a set of key occupations, we further discussed if necessary postsecondary training programs were extant and producing sufficient qualified workers. This was not an evaluation; particular programs or occupations would require a more in-depth analysis. However, our findings offer insight into some system-wide issues, such as instances in which there were or were not enough training programs or where the value and necessity of a credential was not evident.

With this understanding of the labor market and workforce development system in Puerto Rico, the chapters that follow will discuss how the hurricane and recovery effort exacerbate long-term issues or present new sources of difficulty, policies to support short-term recovery, and policies to ensure long-term workforce vitality.
3. Acute Workforce Needs as Puerto Rico Recovers from Hurricanes Irma and Maria

Chapter 2 outlined the prehurricane recovery workforce issues within Puerto Rico, both in terms of labor force participation and training pathways. This chapter discusses the unique, acute workforce needs created or highlighted by the hurricane recovery effort. No matter where a natural disaster strikes, short-term demand for labor will be difficult to meet, complicated by a potentially partially relocated workforce. Reconstruction needs alone will increase the demand for labor, and if physical capital was damaged, employers may seek to substitute machinery with additional labor. Evidence of this can be seen in news articles depicting hurricane-induced worker shortages that spurred relocation across the CONUS after Hurricanes Katrina, Harvey, and Irma. Any region struck by natural disasters faces an intense, short-term spike in labor demand, particularly in construction occupations, and with the isolation of an island, workers from the CONUS cannot flow as easily to Puerto Rico as they can, for example, to Texas and Louisiana. Continued outmigration will only compound this issue. This chapter is organized by the training requirements of recovery-relevant occupations: uncredentialed, trade skills, and bachelor’s degree or beyond. Where possible, we make labor supply comparisons to not only the United States overall, but also to Hawaii and New Zealand to capture the differential workforce needs of a small island.

Labor Market Demands

The hurricanes created two direct forms of labor demand in Puerto Rico: building construction, reconstruction, and repair; and infrastructure construction, reconstruction, and repair. Approximately 90 percent of Puerto Rico’s nearly 1.23 million households applied for immediate relief and housing assistance from FEMA, with 78 percent of these indicating damage to their structure or personal property. As of May 2018, FEMA IA inspections indicated that approximately 7,000 homes were either substantially damaged or destroyed. Figure 3.1 maps residential damage from the hurricanes, and Figure 3.2 indicates those residences registering for FEMA IA. However, buildings beyond residences were also damaged by the hurricanes. Three

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144 For additional information about the damage to the housing sector after the hurricanes, see RAND Corporation, undated.
in four public buildings owned by the Puerto Rico Industrial Development Company reported hurricane damage. More than 90 percent of the public buildings owned by the Puerto Rico Public Buildings Authority requested assistance with debris removal, and 65 percent of these buildings sustained hurricane damage. Eighty-five percent of schools reported damage.\textsuperscript{145} The ongoing recovery will require inventorying, prioritizing, and repairing these buildings.

\textbf{Figure 3.1. Housing Impacts from Hurricanes Irma and Maria, Puerto Rico}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure_3_1.png}
\caption{Housing Impacts from Hurricanes Irma and Maria, Puerto Rico}
\end{figure}

\begin{center}
\textbf{SOURCE: HSOAC analysis of data provided by CBCP RSF, January 2018.}
\end{center}

Meanwhile, municipal leaders surveyed as part of HSOAC’s analysis of municipal needs revealed that road restoration was their number-one infrastructure priority,\textsuperscript{146} and the rebuilding of roads presents a unique opportunity to bury previously vulnerable, above-ground power lines.\textsuperscript{147} Other recovery priorities include developing and maintaining asset management systems and prioritizing safety and utility when embarking on repair and new transit projects.\textsuperscript{148} In April 2018, the Governor announced a plan to invest $652 million in Puerto Rico’s roads, with the first portion going toward roads currently in critical condition, the second toward federal highways, and the third to develop improved infrastructure.\textsuperscript{149}

\begin{flushright}
\textsuperscript{145} Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
\textsuperscript{146} See Ecola et al., forthcoming.
\textsuperscript{147} Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
\textsuperscript{148} For more information on the transportation sector, see Ecola et al., forthcoming.
\end{flushright}
Thus, the anticipated labor market demand for reconstruction is strong. However, as highlighted in Chapter 1, Puerto Rico has been in a period of economic decline at least since 2006, and construction opportunities have been limited. Therefore, the extant construction workforce is considerably undersized: Puerto Rico has fewer than 10 employees in the construction industry per 1,000 residents, compared with 24 per 1,000 in the United States overall, and 31 per 1,000 in Hawaii.\textsuperscript{150} While it is possible that the informal market discussed previously supplies enough labor to make up this difference, the proposed emphasis on moving away from informal construction to code-compliant construction will require trained and credentialed tradespeople.

As shown in Figure 3.3, the construction workforce in Puerto Rico has been generally declining since the early 2000s, and the rate of decline accelerated at the beginning of Puerto Rico’s recession in 2006. While the overall U.S. construction workforce saw steady growth after emerging from the 2009 recession, Puerto Rico’s 2011 to 2013 increase appears to have been only temporary; construction employment steadily declined from 2013 to 2017.

Our analyses estimate that for $1 billion of recovery spending, 4,600 new jobs in construction will be created and thus need to be filled. If $10 billion for the government of Puerto Rico’s Recovery Plan is spent in Puerto Rico, Puerto Rico’s construction employment will need to more than double (see Chapter 4 for more detail). To meet reconstruction demands, then, Puerto Rico will need to import or else increase the number of workers at a variety of credential levels, and this growth may not be evenly spread across occupations. This chapter discusses the specific occupations most likely to be needed and their current supply in Puerto Rico.

Identifying Recovery Occupations

Table 3.1 lists recovery-relevant occupations to illustrate the possible training needs to support the Recovery Plan. In the first column, we denote in green those occupations that are relevant to the long-term recovery. In the remaining columns, we denote in gray the range of credentials required for each occupation. Dark gray cells denote the most frequently reported credential for that occupation.
Table 3.1. Sample Occupations by Credential(s) Required

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction laborers</td>
<td></td>
</tr>
<tr>
<td>Line installation/repair</td>
<td></td>
</tr>
<tr>
<td>Road/bridge maintenance workers</td>
<td></td>
</tr>
<tr>
<td>Cement/concrete workers</td>
<td></td>
</tr>
<tr>
<td>Construction supervisors</td>
<td></td>
</tr>
<tr>
<td>Carpenters</td>
<td></td>
</tr>
<tr>
<td>Electricians</td>
<td></td>
</tr>
<tr>
<td>Plumbers</td>
<td></td>
</tr>
<tr>
<td>Roofers</td>
<td></td>
</tr>
<tr>
<td>Equipment operators</td>
<td></td>
</tr>
<tr>
<td>Building inspectors</td>
<td></td>
</tr>
<tr>
<td>Architects/drafters</td>
<td></td>
</tr>
<tr>
<td>Civil engineers</td>
<td></td>
</tr>
<tr>
<td>Construction managers</td>
<td></td>
</tr>
<tr>
<td>Logistics engineers</td>
<td></td>
</tr>
<tr>
<td>Asset management</td>
<td></td>
</tr>
<tr>
<td>Cybersecurity</td>
<td></td>
</tr>
<tr>
<td>Data management</td>
<td></td>
</tr>
<tr>
<td>Management analysts</td>
<td></td>
</tr>
<tr>
<td>Photovoltaic installation workers</td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td></td>
</tr>
<tr>
<td>Physician assistants</td>
<td></td>
</tr>
<tr>
<td>Solar energy systems engineers</td>
<td></td>
</tr>
<tr>
<td>System planning</td>
<td></td>
</tr>
</tbody>
</table>

SOURCES: Occupations selected from Economics, Housing and Social Services, Transportation, Housing, and Energy Sector research to support Recovery Plan; credentials sourced from O*NET.

NOTE: Gray shading indicates credentials reported for an occupation; the darkest shading indicates the most commonly reported credential level. “Plan” green shading denotes an occupation needed if the Recovery Plan for Puerto Rico reaches full implementation; remaining occupations are more directly recovery-focused.

We relied on three sources of information to create this table. One, we reviewed the Economics, Health and Social Services, Transportation, Housing, and Energy Sector research that supports the Recovery Plan, scanning materials for workforce-relevant terms (keywords: workforce, worker, training, trained, skill, employ) to determine which occupations would likely have substantial increases in demand from the recovery effort, which occupations had currently insufficient training pipelines, and what mechanisms or structural changes could address these
workforce needs. Two, we consulted peer-reviewed\textsuperscript{151} and media reports of damage estimates for the hurricanes in Puerto Rico, as well as previous hurricanes in other parts of the United States. Three, we used the U.S. Department of Labor’s Occupational Information Network (O*NET)\textsuperscript{152} to identify specific occupations and typical credentials based on key skills and tasks identified in our review of sector research.

As shown in Table 3.1, the recovery workforce needs a range of skills and training, and it will need to be large. The occupations are discussed in more detail by the training and credentials required in the sections that follow.

**Occupations Requiring (at Most) a High School Diploma (Uncredentialed)**

With extensive damage to infrastructure of all kinds (roads, bridges, waterways), there is a substantial need for physical laborers to remove debris and rebuild. While Puerto Rico has a comparatively large number of highway maintenance workers and general construction laborers, the reconstruction demand will likely require additional workers. Fortunately, many of these occupations have quick training pipelines with the ability to provide Puerto Rico with additional road/bridge maintenance workers, construction laborers, and power line installers in a short time frame suited to the recovery effort.

To secure the future of Puerto Rico’s energy supply, the territory needs to attract, train, and retain a skilled energy workforce. As part of its power restoration efforts, the Army Corps of Engineers brought in more than 2,500 workers from the CONUS.\textsuperscript{153} Furthermore, as Figure 3.4 shows, Puerto Rico’s workforce of power line installers/repairers is actually proportionately larger than that of Hawaii. However, the above-ground nature and long transmission distances of Puerto Rico’s power lines necessitate frequent repair. Thus, the workforce needs to grow in specific areas to match Puerto Rico’s investments in energy diversification and system resilience, which may involve retraining or honing the skills of those previously involved in other areas of energy work. PREPA may be a potential source for these workers, if they are reskilled. A 2018 report from the U.S. Department of Energy noted that PREPA could have an oversupply of administrative personnel, given that “PREPA’s officials and consultants describe an inefficient bureaucracy with high absenteeism, overly staffed with non-value-added administrative personnel.”\textsuperscript{154}

\textsuperscript{151} For details on the damage and needs assessment performed in support of the recovery plan, see RAND Corporation, undated.

\textsuperscript{152} O*NET OnLine, www.onetonline.org, is a database of occupational information sponsored by the U.S. Department of Labor’s Employment and Training Administration.

\textsuperscript{153} See RAND Corporation, undated, for further details about the economic effects of the response effort and a summary of the economic recovery analysis supporting the recovery plan.

As the government of Puerto Rico’s Recovery Plan is implemented, Puerto Rico will diversify its energy sources for residential and commercial electricity, supplementing natural gas and coal with solar energy. This will require the recruitment and training of photovoltaic cell installation workers, as according to BLS figures, Puerto Rico currently has fewer than the reporting threshold.

As shown in Figure 3.4, Puerto Rico has comparatively fewer cement/concrete workers, construction supervisors, and solar installers, all of which will be important occupations in the recovery effort.\(^{155}\)

**Occupations Requiring a Trade Skill**

Previous hurricanes can be instructive as to which occupations are needed for reconstruction. News articles after Hurricanes Harvey and Irma suggest excess demand for skilled tradespeople such as carpenters, roofers, electricians, and plumbers—occupations that are already

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\(^{155}\) While the figures in this chapter present per capita comparisons of occupational supply, the authors have additionally conducted an analysis using GDP as the means of comparison, potentially a preferable metric if one believes that (1) commercial construction demand outpaces residential construction demand and (2) commercial construction correlates more strongly or differently with GDP than population. The conclusions of the GDP-indexed comparisons are identical to those of the population comparisons presented here (i.e., that Puerto Rico is understaffed in recovery-relevant occupations), with the exception of equipment operators (now on par with the CONUS but below Hawaii), logistics engineers (comparable to CONUS and Hawaii), electrical engineers (on par with CONUS but below Hawaii), and environmental engineers (on par with Hawaii and above the CONUS proportion).
underrepresented in Puerto Rico’s workforce. The magnitude of this underrepresentation can be seen in Figure 3.5.

**Figure 3.5. Professionals per 1,000 Residents, Trade Skills for Hawaii, Puerto Rico, New Zealand, and United States Overall**

![Figure 3.5](image)


NOTE: No data were available for the number of building inspectors in New Zealand. U.S. overall includes data from Hawaii and Puerto Rico.

While Puerto Rico has about half as many construction industry employees per resident as the United States overall, the differences are even starker by title for trade skill occupations. If Puerto Rico were to match Hawaii’s trade professional per 1,000 resident ratio in the six trades depicted in Figure 3.5, Puerto Rico would need to add approximately 5,000 carpenters, 5,000 electricians, 4,000 plumbers, 1,000 roofers, 3,500 equipment operators, and 1,500 building inspectors. Note that Hawaii’s construction workforce is comparably smaller than that of the United States overall, and likely also could not support a reconstruction effort without significant increasing labor or importing off-island labor. Regardless, when compared with other island economies, Puerto Rico has a clear shortage of skilled trade construction workers.

However, there are many ways in which a comparison economy may not be the proper benchmark for thinking about shortages. In an alternative method, we examine how Puerto Rico’s current trade workforce stacks up against potential demand, using residential reconstruction as an example. Table 3.2 gives estimates of the number of tradespeople required to reconstruct 100,000 houses\textsuperscript{156} in Puerto Rico. In the first column, we show the number of

\textsuperscript{156} Viglucci, February 14, 2018.
hours a worker in that trade is estimated to spend on a 1,600-square-foot house with no garage, fireplace, or interior finishes. In the next column, it scales the worker-hours per house to the number of workers for 100,000 houses, assuming that each individual worker works 2,000 hours per year. In the final two columns, we contrast the estimated workers needed with the number of workers formally employed in these occupations and the number of residents in Puerto Rico reporting these occupations, regardless of employment status. Occupational estimates include individuals classified as “helpers” who generally lack formal credentials and may not be perfect substitutes for trade labor.

Table 3.2. Tradespeople Required and Available for Residential Reconstruction (100,000 Houses)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Estimated Hours per House</th>
<th>Req. supply (2k Hours/Year)</th>
<th>Formally Employed (BLS)</th>
<th>Occupation (ACS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpenter</td>
<td>128</td>
<td>6,400</td>
<td>2,540</td>
<td>8,517</td>
</tr>
<tr>
<td>Plumber</td>
<td>120</td>
<td>6,000</td>
<td>980</td>
<td>3,378</td>
</tr>
<tr>
<td>Roofer</td>
<td>80</td>
<td>4,000</td>
<td>340</td>
<td>993</td>
</tr>
<tr>
<td>Electrician</td>
<td>80</td>
<td>4,000</td>
<td>2,550</td>
<td>6,571</td>
</tr>
<tr>
<td>Cement mason</td>
<td>168</td>
<td>8,400</td>
<td>770</td>
<td>n/a</td>
</tr>
<tr>
<td>HVAC</td>
<td>80</td>
<td>4,000</td>
<td>1,290</td>
<td>3,180</td>
</tr>
</tbody>
</table>


a No cement/concrete masons were identified in the ACS sample.

While the number of individuals formally employed in an occupation is almost certainly an underestimate of the potential talent pool, the number of individuals reporting the occupation is almost certainly an overestimate. Puerto Rico needs at least 10,000 more skilled tradespeople to accomplish residential building reconstruction alone, and that is assuming the resulting demand is evenly spread throughout the year. If the reconstruction needs to happen in a shorter time frame, the shortfall is even more profound. Moreover, this 10,000-worker shortfall does not include commercial building reconstruction, which will only amplify the shortfall.

The recovery represents an increase in the demand for construction labor, but it is difficult to gauge how much of that increase is short term or temporary. Moreover, the goal of the recovery is not just to rebuild but also to bring buildings, particularly housing, up to building codes, suggesting sustained need for skilled construction workers. Finally, the ongoing development

158 The universe for reporting occupations in the American Community Survey is all individuals who have been employed at some point in the last five years. Furthermore, the question asks for the “kind of work” the respondent or reference person was doing, rather than the title. Given the degree of credentialing within the construction industry, one who has been paid for plumbing work in the last five years is not necessarily interchangeable with a licensed plumber. “Plumbing helper” is not a valid occupation in the ACS.
and economic gain associated with the size of the recovery investment and overall economic recovery could support a sustained, larger construction workforce.

A need for skilled trade workers in Puerto Rico presents training challenges. Puerto Rico plans to increase the number of code enforcers/building inspectors twentyfold, but inspectors must be recertified every three years, meaning there are both upfront and ongoing training hurdles. Carpenters, plumbers, and electricians typically start as apprentices or journeypersons or pursue an associate’s degree, with a likely minimum two-year lead time from entry to qualification. Table 3.3 outlines construction occupations by their apprenticeship and certificate program availability in the CONUS. Note that many of the critical construction occupations typically use apprenticeship as a pathway. However, as noted in Chapter 2, Puerto Rico currently has only one registered apprenticeship program, and it is for automotive technology.

### Table 3.3. Construction Occupations Training and Credentialing Pathways in the United States

<table>
<thead>
<tr>
<th>Construction Occupation</th>
<th>Apprenticeships</th>
<th>Certificate Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-line supervisors of construction trades and extraction workers</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Brickmasons and blockmasons</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Carpenters</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tile and marble setters</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cement masons and concrete finishers</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Construction laborers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Paving, surfacing, and tamping equipment operators</td>
<td>Yes</td>
<td>Unknown</td>
</tr>
<tr>
<td>Operating engineers and other construction equipment operators</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Drywall and ceiling tile installers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Electricians</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Glaziers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Insulation workers, floor, ceiling, and wall</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Painters, construction and maintenance</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pipelayers</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Plumbers, pipefitters, and steamfitters</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Reinforcing iron and rebar workers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Roofers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sheet metal workers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Structural iron and steel workers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Construction and building inspectors</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Elevator installers and repairers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Highway maintenance workers</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**SOURCES:** O*NET OnLine and BLS, Occupational Outlook Handbook.

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Solutions to overcome the challenges of training pipelines for these occupations, both in terms of short-term bottlenecks and long-term limitations, are discussed in Chapters 5 and 6.

**Occupations Requiring a Bachelor’s Degree**

Along with the increased demand for physical labor comes increased demand for those who organize and plan that labor, as well as its output. The reconstruction effort will require the design of systems and buildings, skilled positions that generally are filled by workers with bachelor’s degrees. Our review of the research undertaken to inform the Recovery Plan identified transportation engineers and logistics engineers as key to improving system design for public goods (e.g., roads, utilities). The reconstruction effort will additionally need architects and drafters to design and draw plans for new buildings or substantial renovations, as well as construction managers\(^{161}\) to scope and delegate new jobs.

Construction workforce differences are particularly stark in these baccalaureate occupations: As shown in Figure 3.6, there are ten times as many construction managers per 1,000 residents in Hawaii than in Puerto Rico, and Puerto Rico also lacks a representative supply of civil engineers and architects/drafters. Given the post-hurricane emphasis on code-compliant construction, these occupations will be critical to the rebuilding effort.

If the systems improvements proposed in the Recovery Plan for Puerto Rico are carried out, Puerto Rico will additionally need a technical workforce capable of implementing, securing, and using asset management systems to coordinate public resources. Thus, there will be increased demand for workers with technical expertise in cybersecurity, asset and data management, management analysis, and system planning. Yet, as illustrated in Figure 3.7, Puerto Rico proportionately has fewer professionals in these fields than have Hawaii and the U.S. overall. Additionally, the energy diversification efforts will necessitate an increase in solar energy systems engineers. However, as shown in Table 3.1, the Puerto Rico workforce is underrepresented in those skills.

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\(^{161}\) Note that construction managers are distinct from construction supervisors: The manager scopes, budgets, schedules, and coordinates a job, while the supervisor is an on-site overseer. Managers typically have a bachelor’s degree, whereas supervisors generally have no more than a certificate and often only a high school diploma.
Figure 3.6. Professionals per 1,000 Residents, Occupations Requiring a Bachelor’s Degree for Hawaii, Puerto Rico, New Zealand, and United States Overall

NOTE: No data were available for logistics engineers in New Zealand, and the definition of construction managers differs too greatly to compare. United States overall includes data from Puerto Rico and Hawaii.

Figure 3.7. Professional per 1,000 Residents, Technical Occupations Requiring a Bachelor’s Degree for Hawaii, Puerto Rico, and United States Overall

NOTE: United States overall includes data from Puerto Rico and Hawaii.
While Puerto Rico has a highly ranked program\textsuperscript{162} for training engineers at the University of Puerto Rico, Mayagüez campus, retention challenges leave Puerto Rico potentially understaffed in key technical occupations. Although contractors from outside of Puerto Rico might address staffing gaps in the short run, to implement and maintain robust technical systems across public goods and utilities Puerto Rico will need to increase either the number of entrants to or number of retained graduates from the training pipeline. In addition to occupations specific to rebuilding the infrastructure, a crucial component to Puerto Rico’s recovery is the rebuilding of the quality of life. Thus, Puerto Rico will also need to increase a skilled workforce of teachers, professors, doctors, nurses, and physicians, strategically located throughout Puerto Rico, to enhance quality of life in both urban and rural areas. While Puerto Rico has an adequate supply of teachers given the anticipated future number of schools,\textsuperscript{163} potential changes to Medicare and Medicaid reimbursement policies\textsuperscript{164} along with the continued aging of Puerto Rico’s population will likely increase the demand for medical care. A skilled workforce in these sectors is itself an amenity that can help attract and retain a broader workforce.

Conclusion

Rebuilding Puerto Rico is about more than just the physical capital. One of the key drivers of Puerto Rico’s shortage of skilled workers was and is outmigration, particularly among families with children.\textsuperscript{165} While reconstructing the physical infrastructure of Puerto Rico can be accomplished with the occupations listed within this chapter, high-quality and accessible education and health care are important features in retaining skilled workers with families. Furthermore, as evident from Table 3.1, the forthcoming job openings require a range of training and credentials, some of which naturally nest together. Workforce development systems and employers could take advantage of this structure in attracting and retaining employees new to a sector or new to employment overall. For example, someone with a high school diploma might start working on a team of photovoltaic installers and then decide to pursue a certificate to be able to do this kind of work unsupervised. After a few years, she might get interested in solar more broadly, going back to school to get an undergraduate degree in solar energy systems engineering, allowing her to design photovoltaic or solar thermal systems, conduct engineering site audits, and make recommendations about improving existing solar infrastructure.\textsuperscript{166} (The

\begin{thebibliography}{99}
\bibitem{162} Pedro Bosque Pérez, “UPR Mayagüez está entre las mejores universidades en ingeniería” [UPR Mayaguez Is Among the Best Universities in Engineering], ElNuevodia.com, January 29, 2015.
\bibitem{163} Nicole Chavez, “Puerto Rico Closing 283 Schools over Sharp Drop in Enrollment,” CNN.com, April 6, 2018.
\bibitem{164} See the Health and Social Services sector report at RAND Corporation, undated.
\end{thebibliography}
application of this form of stackable credential model to in-demand occupations and training pipelines is discussed further in Chapter 6.)

Finally, note that this chapter addresses only the anticipated direct workforce needs related to hurricane reconstruction and recovery. Importing any sizable construction workforce from the CONUS would consequently increase demand for temporary housing, retail, and restaurants. Chapter 4 examines the potential labor market impacts of a large injection of capital into a small island economy, incorporating this form of secondary effect.

This chapter assesses the role of the workforce capacity and labor mobility that could operate as constraints or challenges in Puerto Rico’s recovery process. Given the relative isolation of Puerto Rico, mobility of the labor available to work there could play a major role in the recovery process in terms of either cost or timing. Within the CONUS, labor mobility provided a stable market environment where fiscal resources were efficient in delivering recovery efforts. In the case of Puerto Rico, the lower labor mobility could have a detrimental impact on the recovery process.

Through the use of an input-output model, we estimate expenditures by sector with a series of scenarios to assess the potential impact of the Recovery Plan in terms of output, value added, employment, and labor income. Implementing the plan has direct effects on the values we estimate. In turn, the additional output uses inputs, causing indirect effects. Likewise, the additional labor income and profit creates economic activity, known as the induced effects. When combined, these impacts provide an estimate of the scale and composition of new economic activity and how the local economy would react to recovery efforts.

HSOAC estimated the employment required to implement the Recovery Plan, giving consideration to the occupational distribution in Puerto Rico. Additionally, we considered two pieces to the labor mobility question. First, we used wage disparities to analyze the incentives for different occupations to stay within Puerto Rico versus moving to the CONUS. Second, we provided context for how foreign nationals may be used to supplement the labor force on a temporary basis. Our last step was to consider the composition of occupations as temporary positions versus permanent positions. This dynamic is important to recognize, given that the recovery effort must be understood as a transitory increase in economic output for Puerto Rico and not a sustained, permanent increase. Labor demands that are permanent positions contribute more significant impacts to long-run economic development. Contrastingly, the economic benefits of temporary employment is likely to decline and expire with the cessation of project funds.

Our goal with this work is to offer empirically based estimates that can provide FEMA leadership and officials from the government of Puerto Rico with key insights into the time path

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167 Recovery spending for Hurricane Katrina was estimated to cost $160 billion, with approximately $115 billion in funds coming from federal sources. Hurricane Sandy resulted in approximately $70 billion in total spending with $56 billion coming from federal sources. For more information, see Ryan Struyk, “What Past Federal Hurricane Aid Tells Us About Money for Harvey Recovery,” CNN.com, September 13, 2017.

168 Note that the investments selected by the Governor as part of the Recovery Plan are designed to improve the economy and that this may mean that there are jobs after the recovery investments are complete.
of investment on the island. These estimates are based on historical data specific to Puerto Rico and relevant U.S. aggregate sources. As such, we performed a sensitivity analysis to offer a range of potential outcomes. Given the large-scale nature of the recovery effort relative to the size of the economy, HSOAC predictions regarding expenditures and employment are outside of what have occurred historically and thus are inherently uncertain.

Modeling Approach

Our modeling approach entails a four-step process. In our first step, we matched each COA described in the Recovery Plan to one of four different two-digit North American Industry Classification System (NAICS) codes, based on keywords with the COA descriptions. These four sectors are (1) Construction, (2) Administrative Services, (3) Management of Companies, and (4) Educational Services. Using these keywords as categories, we determined a breakdown of the plan costs based on the cost estimates embedded within the plan. Table 4.1 provides the rough mapping from COA to sector.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Keywords</th>
<th>Plan Cost Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Built, build, repair, replace</td>
<td>48</td>
</tr>
<tr>
<td>Administrative</td>
<td>Incentivize, plan, study, task force, steering committee</td>
<td>39</td>
</tr>
<tr>
<td>Management of companies</td>
<td>Business consulting, assist, manage, compensate, improve, implement</td>
<td>12</td>
</tr>
<tr>
<td>Educational services</td>
<td>Training, schooling, education</td>
<td>1</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis of the Recovery Plan.

The second step estimated the economic impacts of a set of scenarios based on potential implementation approaches. HSOAC researchers opted to apply an input-output model of the economic conditions of Puerto Rico, using 2016 data provided by IMPLAN. Input-output analysis is a standard technique that has been used for decades to estimate the regional economic

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169 We categorized the COAs based on all of the two-digit NAICS codes matching keywords in the COA to keywords in the NAICS description. These were the four industries that had any representation within the categorization. Note that the health services category is not directly provided in any of the COAs, although administrative and construction services are out of the Human and Social Services sector.

170 We have done a sensitivity analysis of the categorization and relative contribution. Importantly, Administrative, Management of Companies, and Educational Services have similar economic multiplier impacts so that a misspecification across these three categories is likely not to have a significant impact. There is a large difference in the economic impacts between these three categories and Construction. We feel confident in the distinction between construction-related activities and the other three categories.

171 IMPLAN is an input-output modeling platform that downscales Bureau of Economic Analysis national-level data to local-level data. For further information about IMPLAN data and models, see implan.com.
impact of shocks to the supply chain. Given that input-output models are linear in design, these results can be scaled to reflect any level of spending.\textsuperscript{172}

While the time lag of IMPLAN dataset is not ideal, the data in this model represent the best available estimates on sector-level production functions for Puerto Rico. We aggregated the industries in the input-output model to the two-digit NAICS code sectors to maintain consistency between our allocation of COAs and the macroeconomic impact estimation and our eventual occupational analysis. Our outcome scenarios were built to analyze five annual spending levels: $1 billion, $2 billion, $5 billion, $10 billion, and $25 billion. This approach is appropriate as the recovery effort is likely to have significant variance in yearly expenditures. As upfront spending could be much greater than expenditures in future years, we sought to understand how a nonconstant path of funding would impact labor demand in Puerto Rico.

Input-output models are used to estimate the impacts of spending injections or reductions for an entire economy. In the case of an isolated market like Puerto Rico, it is important to consider the local purchasing ability of the economy. Demands not met by local production will “leak” out of the economy, reducing the economic impact to Puerto Rico. Significant portions of spending go to paying workers for labor and buying material inputs from both local market and nonlocal locations. By tracking these spending and inputs, we can estimate how much of the spending leaves the market or is used to purchase goods from local industries. We assume that the proportion of imported goods in each sector before and after the injection is the same. The local expansion is the indirect effect of the injection. Contrastingly, worker wages, proprietor profit, and other payments to capital increase the demand for all goods as a result of the increases in income. This process is known as the \textit{induced effect}. The combined effects of indirect and induced increases to production represent the total economic impact of the initial injection.

We measure these economic impacts in four different dimensions: \textit{output}, \textit{value added}, \textit{employee compensation}, and \textit{employment}. Output is the value of all goods and services that result from the increased spending, including all intermediate inputs. For example, if the economy produces $1 million worth of roads and uses $500,000 worth of locally produced concrete, the total output for the economy would be $1.5 million. However, the exchange and product do not add $1.5 million worth of real value. As such, we focus our attention on the value added: the value of the good produced minus the cost of intermediate good and service inputs. Value added consists of factors such as proprietor income, employee compensation, payments to land, and taxes on production. This value estimate is similar to measures of GDP for countries or gross regional product for sub-country regions. Additionally, we separately reported analysis of employee compensation to gain a better understanding of how workers in Puerto Rico will fare.

\textsuperscript{172} Input-output models assume that all inputs to production are perfect complements and consumption goods are also perfect complements in household demand. Thus, in order to double output, we have to double every input. Though this assumption is convenient it may not be valid in practice; nonetheless, it provides us with a first-order estimate of the likely impacts.
from recovery spending. Finally, we reported changes in employment as obtained from both aggregate and sector data.

Our third step was to translate the increases in employment into increases in demand for specific occupations. Even though Puerto Rico has willing and able workers, the island market may not have the number of workers of specific occupations that will be needed for the recovery. To better understand these critical occupations, we used BLS occupations-by-industry breakdowns.\textsuperscript{173} These data are based on national-level data and are not specific to Puerto Rico, but they do provide a suitable representation of occupations by industry. We provide these occupational demands at the two-digit and six-digit SOC system codes. With an understanding of these occupational needs, we compared the demands induced by the recovery spending to the current distribution of occupations in Puerto Rico. Leveraging BLS data, we further calculated the wage disparity by occupation between Puerto Rico and the CONUS, focusing on the six most common states of residence for outmigrants from Puerto Rico.

Finally, we have provided a qualitative discussion for how these occupational demands could be met and the resulting implications for the recovery process. This discussion will center around the following key areas of interest: the role of training and incentive programs in Puerto Rico, the impacts of foreign workers temporarily relocating to Puerto Rico, and the effect of U.S. workers who temporarily or permanently relocate to Puerto Rico.

\textbf{Input-Output Model to Estimate Aggregate Demand from Recovery Spending}

We first consider a $1 billion annual recovery expenditure. Table 4.2 provides the aggregate results for this new spending. This suggests that a $1 billion expenditure based on the proportional allocation in the Recovery Plan would add approximately $1.2 billion to Puerto Rico’s value added (GDP) and result in approximately 21,000 new jobs. Importantly, though, since the IMPLAN data is normally based on Bureau of Economic Analysis (BEA) data, these are not full-time equivalents but full- and part-time jobs based on the industry averages estimated by BEA.

Using this same approach, we estimate the impacts for four additional expenditure levels: $2 billion, $5 billion, $10 billion, and $25 billion. Table 4.3 displays only the total effect for each of the scenarios. Given the input-output model’s linearity, these are simply linear expansions of the initial case. As such, any of the results in Table 4.2 can be scaled to gain additional detail.

Table 4.2. Aggregate Economic Impact of $1 Billion Recovery Expenditure in Puerto Rico

<table>
<thead>
<tr>
<th>Impact Type</th>
<th>Employment</th>
<th>Labor Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct effect</td>
<td>15,000</td>
<td>$484,000,000</td>
<td>$692,000,000</td>
<td>$1,016,000,000</td>
</tr>
<tr>
<td>Indirect effect</td>
<td>2,000</td>
<td>$66,000,000</td>
<td>$170,000,000</td>
<td>$250,000,000</td>
</tr>
<tr>
<td>Induced effect</td>
<td>4,000</td>
<td>$135,000,000</td>
<td>$329,000,000</td>
<td>$483,000,000</td>
</tr>
<tr>
<td>Total effect</td>
<td>21,000</td>
<td>$686,000,000</td>
<td>$1,192,000,000</td>
<td>$1,751,000,000</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using IMPLAN.
NOTE: Total may not be sum of the parts because of rounding.

Table 4.3. Total Effects of Alternative Recovery Expenditures

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Employment</th>
<th>Labor Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1 billion</td>
<td>21,000</td>
<td>$686,000,000</td>
<td>1,192,000,000</td>
<td>1,751,000,000</td>
</tr>
<tr>
<td>$2 billion</td>
<td>42,000</td>
<td>1,373,000,000</td>
<td>2,385,000,000</td>
<td>3,502,000,000</td>
</tr>
<tr>
<td>$5 billion</td>
<td>105,000</td>
<td>3,432,000,000</td>
<td>5,962,000,000</td>
<td>8,755,000,000</td>
</tr>
<tr>
<td>$10 billion</td>
<td>210,000</td>
<td>6,864,000,000</td>
<td>11,925,000,000</td>
<td>17,509,000,000</td>
</tr>
<tr>
<td>$25 billion</td>
<td>524,900</td>
<td>17,161,000,000</td>
<td>29,811,000,000</td>
<td>43,773,000,000</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using IMPLAN.

To gain additional insight into these results, Table 4.4 displays the employment increases by industry sector for each of the recovery expenditures. To put these numbers into perspective, Puerto Rico has approximately 1 million participants in the labor force in an economy of approximately $100 billion in annual output.

It is important to note that the June 2018 estimate from BLS for the size of the labor force of Puerto Rico is approximately 1.1 million workers. Thus, in the larger expenditure scenarios, there would be considerable wage increases that would need to take place to incentivize residents of Puerto Rico not currently working to take these jobs. For example, in the $10 billion expenditure case, Puerto Rico would need to add an additional 46,000 construction workers when there are currently only approximately 27,000 construction workers in Puerto Rico.\footnote{174} Thus, there may not be capacity within Puerto Rico to fill these jobs and incentive structures will need to be drastically changed to have the appropriate mix of workers for the recovery efforts. We will return to this topic in the next section.

One of the difficulties that arises when estimating the economic and employment impacts of recovery efforts in Puerto Rico is that both the electric and water utilities are government entities. Accordingly, the input-output data from IMPLAN and BEA will report these as government production rather than utilities. Thus, our models underestimate the impact of any of the government activities that have a private-sector analog. Our model undercounts the effects of these large Puerto Rico government sectors because, in the case of Puerto Rico, these normally private outputs are embedded within government activities.

Table 4.4. Employment by Industry for Recovery Expenditures

<table>
<thead>
<tr>
<th>Industry with NAICS Code</th>
<th>$1 Billion</th>
<th>$2 Billion</th>
<th>$5 Billion</th>
<th>$10 Billion</th>
<th>$25 Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>21,000</td>
<td>42,000</td>
<td>105,000</td>
<td>210,000</td>
<td>525,000</td>
</tr>
<tr>
<td>11 Ag, forestry, fish, and hunting</td>
<td>200</td>
<td>300</td>
<td>800</td>
<td>1,500</td>
<td>5000</td>
</tr>
<tr>
<td>21 Mining</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22 Utilities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>23 Construction</td>
<td>4,600</td>
<td>9,100</td>
<td>22,800</td>
<td>45,700</td>
<td>115,000</td>
</tr>
<tr>
<td>31–33 Manufacturing</td>
<td>600</td>
<td>1,200</td>
<td>3,000</td>
<td>6,000</td>
<td>15,000</td>
</tr>
<tr>
<td>42 Wholesale trade</td>
<td>200</td>
<td>500</td>
<td>1,200</td>
<td>2,400</td>
<td>5,000</td>
</tr>
<tr>
<td>44–45 Retail trade</td>
<td>1,100</td>
<td>2,200</td>
<td>5,400</td>
<td>10,900</td>
<td>27,500</td>
</tr>
<tr>
<td>48–49 Transportation and warehousing</td>
<td>200</td>
<td>300</td>
<td>800</td>
<td>1,600</td>
<td>5,000</td>
</tr>
<tr>
<td>51 Information</td>
<td>100</td>
<td>100</td>
<td>400</td>
<td>700</td>
<td>2,500</td>
</tr>
<tr>
<td>52 Finance and insurance</td>
<td>100</td>
<td>100</td>
<td>400</td>
<td>700</td>
<td>2,500</td>
</tr>
<tr>
<td>53 Real estate and rental</td>
<td>100</td>
<td>300</td>
<td>700</td>
<td>1,400</td>
<td>2,500</td>
</tr>
<tr>
<td>54 Professional scientific and tech services</td>
<td>300</td>
<td>600</td>
<td>1,600</td>
<td>3,200</td>
<td>7,500</td>
</tr>
<tr>
<td>55 Management of companies</td>
<td>500</td>
<td>1,100</td>
<td>2,700</td>
<td>5,400</td>
<td>12,500</td>
</tr>
<tr>
<td>56 Administrative and waste services</td>
<td>10,800</td>
<td>21,500</td>
<td>53,800</td>
<td>107,600</td>
<td>270,000</td>
</tr>
<tr>
<td>61 Educational services</td>
<td>300</td>
<td>600</td>
<td>1,500</td>
<td>3,000</td>
<td>7,500</td>
</tr>
<tr>
<td>62 Health and social services</td>
<td>800</td>
<td>1,600</td>
<td>4,100</td>
<td>8,200</td>
<td>20,000</td>
</tr>
<tr>
<td>71 Arts, entertainment, and recreation</td>
<td>0</td>
<td>100</td>
<td>200</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>72 Accommodation and food services</td>
<td>700</td>
<td>1,400</td>
<td>3,500</td>
<td>6,900</td>
<td>17,500</td>
</tr>
<tr>
<td>81 Other services</td>
<td>100</td>
<td>300</td>
<td>700</td>
<td>1,500</td>
<td>2,500</td>
</tr>
<tr>
<td>92 Government</td>
<td>300</td>
<td>600</td>
<td>1,500</td>
<td>2,900</td>
<td>7,500</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using IMPLAN.
NOTE: Numbers may not sum to total because of rounding.

Translation of Employment to Occupation

To explore these results further, we focus on the $10 billion recovery expenditure scenario and use the occupations-by-industry data to estimate the occupation-specific employment quantity demand increases. There are over 1,000 occupational codes available in the BLS occupations-by-industry database for the United States. As a starting point, we consider only the two-digit SOC codes to reduce the number for exposition purposes.

Table 4.5 provides the total employment by occupation for the $10 billion recovery effort. Not surprisingly, there is considerable increased demand for office and administrative support, construction, and construction-support occupations based on the expenditure in administrative, business management, and construction that are directly impacted by the recovery expenditures. The next set of occupations such as production, sales, and protection-related occupations are largely driven by the indirect and induced effects of the recovery effort.
To further understand the occupational impacts of recovery expenditures, Table 4.6 presents the occupational demand at the six-digit SOC for the 30 highest demanded occupations. The fourth column of Table 4.6 presents employment in 2017 in Puerto Rico from the BLS Occupational Employment Survey. For most of these top 30 occupations, these are demand increases of between 5 percent and nearly 250 percent, suggesting that considerable expansion across occupations would need to occur to absorb the recovery efforts into the economy.
<table>
<thead>
<tr>
<th>SOC code</th>
<th>Title</th>
<th>Plan Effect</th>
<th>Employment 2017</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>37-2011</td>
<td>Janitors and cleaners, except maids and housekeeping cleaners</td>
<td>11,701</td>
<td>28,640</td>
<td>41</td>
</tr>
<tr>
<td>33-9032</td>
<td>Security guards</td>
<td>8,311</td>
<td>25,110</td>
<td>33</td>
</tr>
<tr>
<td>53-7062</td>
<td>Laborers and freight, stock, and material movers, hand</td>
<td>8,139</td>
<td>10,000</td>
<td>81</td>
</tr>
<tr>
<td>43-4051</td>
<td>Customer service representatives</td>
<td>7,059</td>
<td>14,240</td>
<td>50</td>
</tr>
<tr>
<td>37-3011</td>
<td>Landscaping and groundskeeping workers</td>
<td>6,694</td>
<td>6,420</td>
<td>104</td>
</tr>
<tr>
<td>47-2061</td>
<td>Construction laborers</td>
<td>6,063</td>
<td>6,680</td>
<td>91</td>
</tr>
<tr>
<td>43-9061</td>
<td>Office clerks, general</td>
<td>5,845</td>
<td>22,530</td>
<td>26</td>
</tr>
<tr>
<td>47-2031</td>
<td>Carpenters</td>
<td>4,205</td>
<td>2,080</td>
<td>202</td>
</tr>
<tr>
<td>43-6014</td>
<td>Secretaries and administrative assistants, except legal, medical, and executive</td>
<td>3,968</td>
<td>21,110</td>
<td>19</td>
</tr>
<tr>
<td>11-1021</td>
<td>General and operations managers</td>
<td>3,648</td>
<td>5,850</td>
<td>62</td>
</tr>
<tr>
<td>47-2111</td>
<td>Electricians</td>
<td>3,418</td>
<td>1,420</td>
<td>241</td>
</tr>
<tr>
<td>41-2031</td>
<td>Retail salespersons</td>
<td>3,404</td>
<td>38,690</td>
<td>9</td>
</tr>
<tr>
<td>47-1011</td>
<td>First-line supervisors of construction trades and extraction workers</td>
<td>2,997</td>
<td>2,910</td>
<td>103</td>
</tr>
<tr>
<td>43-3031</td>
<td>Bookkeeping, accounting, and auditing clerks</td>
<td>2,660</td>
<td>7,950</td>
<td>33</td>
</tr>
<tr>
<td>41-3099</td>
<td>Sales representatives, services, all other</td>
<td>2,629</td>
<td>2,860</td>
<td>92</td>
</tr>
<tr>
<td>41-2011</td>
<td>Cashiers</td>
<td>2,521</td>
<td>31,960</td>
<td>8</td>
</tr>
<tr>
<td>47-2152</td>
<td>Plumbers, pipefitters, and steamfitters</td>
<td>2,506</td>
<td>540</td>
<td>464</td>
</tr>
<tr>
<td>51-2092</td>
<td>Team assemblers</td>
<td>2,443</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>53-3032</td>
<td>Heavy and tractor-trailer truck drivers</td>
<td>2,354</td>
<td>8,130</td>
<td>29</td>
</tr>
<tr>
<td>37-2012</td>
<td>Maids and housekeeping cleaners</td>
<td>2,196</td>
<td>2,700</td>
<td>81</td>
</tr>
<tr>
<td>43-5081</td>
<td>Stock clerks and order fillers</td>
<td>2,190</td>
<td>17,730</td>
<td>12</td>
</tr>
<tr>
<td>53-7064</td>
<td>Packers and packagers, hand</td>
<td>2,168</td>
<td>3,560</td>
<td>61</td>
</tr>
<tr>
<td>43-1011</td>
<td>First-line supervisors of office and administrative support workers</td>
<td>1,954</td>
<td>15,840</td>
<td>12</td>
</tr>
<tr>
<td>35-3021</td>
<td>Combined food preparation and serving workers, including fast food</td>
<td>1,869</td>
<td>15,200</td>
<td>12</td>
</tr>
<tr>
<td>51-9198</td>
<td>Helpers—production workers</td>
<td>1,805</td>
<td>1,450</td>
<td>125</td>
</tr>
<tr>
<td>29-1141</td>
<td>Registered nurses</td>
<td>1,746</td>
<td>19,090</td>
<td>9</td>
</tr>
<tr>
<td>47-2073</td>
<td>Operating engineers and other construction equipment operators</td>
<td>1,690</td>
<td>1,690</td>
<td>100</td>
</tr>
<tr>
<td>41-9041</td>
<td>Telemarketers</td>
<td>1,686</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>49-9021</td>
<td>Heating, air conditioning, and refrigeration mechanics and installers</td>
<td>1,606</td>
<td>1,630</td>
<td>99</td>
</tr>
<tr>
<td>49-9071</td>
<td>Maintenance and repair workers, general</td>
<td>1,555</td>
<td>6,850</td>
<td>23</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using BLS data.
To put this into perspective with respect to the construction industry, we re-create Table 4.6 for just the construction-related industries. Table 4.7 presents these results for the top 10 construction occupations affected by the plan. The resulting occupation list is consistent with the list identified from the more descriptive approach summarized in Chapter 3. The first line is the total construction-related jobs. There is cause for concern in that construction-related occupations are likely to double with a $10 billion effort of which approximately $5 billion is in construction. In particular, there is considerable demand for highly skilled occupations such as electricians, plumbers and pipefitters, carpenters, and steel workers.

Table 4.7. Construction Employment for $10 Billion Recovery Effort

<table>
<thead>
<tr>
<th>SOC Code</th>
<th>Title</th>
<th>Plan Effect</th>
<th>Employment 2017</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>47-0000</td>
<td>Total Construction</td>
<td>31,700</td>
<td>27,410</td>
<td>116</td>
</tr>
<tr>
<td>47-2061</td>
<td>Construction laborers</td>
<td>6,063</td>
<td>6,680</td>
<td>91</td>
</tr>
<tr>
<td>47-2031</td>
<td>Carpenters</td>
<td>4,205</td>
<td>2,080</td>
<td>202</td>
</tr>
<tr>
<td>47-2111</td>
<td>Electricians</td>
<td>3,418</td>
<td>1,420</td>
<td>241</td>
</tr>
<tr>
<td>47-1011</td>
<td>First-line supervisors of construction trades and extraction workers</td>
<td>2,997</td>
<td>2,910</td>
<td>103</td>
</tr>
<tr>
<td>47-2152</td>
<td>Plumbers, pipefitters, and steamfitters</td>
<td>2,506</td>
<td>540</td>
<td>464</td>
</tr>
<tr>
<td>47-2073</td>
<td>Operating engineers and other construction equipment operators</td>
<td>1,690</td>
<td>1,690</td>
<td>100</td>
</tr>
<tr>
<td>47-2141</td>
<td>Painters, construction and maintenance</td>
<td>1,288</td>
<td>530</td>
<td>243</td>
</tr>
<tr>
<td>47-2051</td>
<td>Cement masons and concrete finishers</td>
<td>1,163</td>
<td>620</td>
<td>188</td>
</tr>
<tr>
<td>47-2181</td>
<td>Roofers</td>
<td>786</td>
<td>340</td>
<td>231</td>
</tr>
<tr>
<td>47-2211</td>
<td>Sheet metal workers</td>
<td>669</td>
<td>130</td>
<td>515</td>
</tr>
<tr>
<td>47-2061</td>
<td>Construction laborers</td>
<td>6063</td>
<td>6680</td>
<td>91</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using BLS data.
NOTE: For hazardous materials removal workers, there are no data for Puerto Rico available, supposedly for proprietary reasons.

Wage Disparity Between Puerto Rico and the Continental United States

To consider both the likelihood of additional migration of skilled workers from Puerto Rico to the CONUS and the likelihood of inducing workers to migrate to Puerto Rico for newly created jobs, we evaluated wage disparity as an issue. We use the wage by occupation by area data available from the BLS to construct two measures of the wage disparity by occupation between locations in the CONUS and Puerto Rico. The first is to simply compare Puerto Rico occupation-specific mean annual wages to U.S. occupation-specific wages. The second is to use the wages in the six states with the largest influx of people from Puerto Rico to the CONUS:
Florida, New York, Pennsylvania, Connecticut, Massachusetts, and New Jersey. That is, we construct the ratio of the wage in Puerto Rico to the two different areas. The results for the same 30 occupations listed in Table 4.6 appear in Table 4.8. For most of the construction occupations, workers in Puerto Rico make about half of what they would if they were in the CONUS. This suggests that for most occupations, once a worker has the appropriate training or education for the job, they can make about twice as much money if they moved to the CONUS. Thus, training local residents may not be enough to develop a workforce necessary to implement the recovery efforts and additional incentives may be required to sustain a sufficient workforce for the duration, though it should be noted that the cost of living in Puerto Rico is roughly on the order of 70 percent of the U.S. average. Thus, a portion of the wage disparity is eroded in the lower cost of living, but the effect is not complete.

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176 Numbeo, undated.
Table 4.8. Wage Disparity Between Puerto Rico and Continental United States and Top Six States

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Wage Disparity U.S.</th>
<th>Wage Disparity Six States</th>
</tr>
</thead>
<tbody>
<tr>
<td>37-2011</td>
<td>Janitors and cleaners, except maids and housekeeping cleaners</td>
<td>0.73</td>
<td>0.64</td>
</tr>
<tr>
<td>33-9032</td>
<td>Security guards</td>
<td>0.60</td>
<td>0.59</td>
</tr>
<tr>
<td>53-7062</td>
<td>Laborers and freight, stock, and material movers, hand</td>
<td>0.77</td>
<td>0.74</td>
</tr>
<tr>
<td>43-4051</td>
<td>Customer service representatives</td>
<td>0.65</td>
<td>0.59</td>
</tr>
<tr>
<td>37-3011</td>
<td>Landscaping and groundskeeping workers</td>
<td>0.69</td>
<td>0.64</td>
</tr>
<tr>
<td>43-9061</td>
<td>Office clerks, general</td>
<td>0.66</td>
<td>0.61</td>
</tr>
<tr>
<td>43-6014</td>
<td>Secretaries and administrative assistants, except legal, medical, and executive</td>
<td>0.60</td>
<td>0.54</td>
</tr>
<tr>
<td>11-1021</td>
<td>General and operations managers</td>
<td>0.72</td>
<td>0.59</td>
</tr>
<tr>
<td>47-2061</td>
<td>Construction laborers</td>
<td>0.50</td>
<td>0.41</td>
</tr>
<tr>
<td>41-2031</td>
<td>Retail salespersons</td>
<td>0.69</td>
<td>0.68</td>
</tr>
<tr>
<td>51-2092</td>
<td>Team assemblers</td>
<td>0.61</td>
<td>0.61</td>
</tr>
<tr>
<td>41-3099</td>
<td>Sales representatives, services, all other</td>
<td>0.55</td>
<td>0.47</td>
</tr>
<tr>
<td>37-2012</td>
<td>Maids and housekeeping cleaners</td>
<td>0.80</td>
<td>0.70</td>
</tr>
<tr>
<td>53-7064</td>
<td>Packers and packagers, hand</td>
<td>0.71</td>
<td>0.67</td>
</tr>
<tr>
<td>43-3031</td>
<td>Bookkeeping, accounting, and auditing clerks</td>
<td>0.58</td>
<td>0.53</td>
</tr>
<tr>
<td>51-9198</td>
<td>Helpers—production workers</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td>53-3032</td>
<td>Heavy and tractor-trailer truck drivers</td>
<td>0.44</td>
<td>0.42</td>
</tr>
<tr>
<td>41-2011</td>
<td>Cashiers</td>
<td>0.81</td>
<td>0.78</td>
</tr>
<tr>
<td>43-5081</td>
<td>Stock clerks and order fillers</td>
<td>0.72</td>
<td>0.71</td>
</tr>
<tr>
<td>41-9041</td>
<td>Telemarketers</td>
<td>0.65</td>
<td>0.60</td>
</tr>
<tr>
<td>43-1011</td>
<td>First-line supervisors of office and administrative support workers</td>
<td>0.64</td>
<td>0.58</td>
</tr>
<tr>
<td>47-2031</td>
<td>Carpenters</td>
<td>0.42</td>
<td>0.35</td>
</tr>
<tr>
<td>13-1071</td>
<td>Human resources specialists</td>
<td>0.57</td>
<td>0.51</td>
</tr>
<tr>
<td>29-1141</td>
<td>Registered nurses</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>35-3021</td>
<td>Combined food preparation and serving workers, including fast food</td>
<td>0.82</td>
<td>0.77</td>
</tr>
<tr>
<td>43-3011</td>
<td>Bill and account collectors</td>
<td>0.62</td>
<td>0.56</td>
</tr>
<tr>
<td>47-2111</td>
<td>Electricians</td>
<td>0.51</td>
<td>0.45</td>
</tr>
<tr>
<td>49-9071</td>
<td>Maintenance and repair workers, general</td>
<td>0.56</td>
<td>0.51</td>
</tr>
<tr>
<td>51-9199</td>
<td>Production workers, all other</td>
<td>0.61</td>
<td>0.62</td>
</tr>
<tr>
<td>35-3031</td>
<td>Waiters and waitresses</td>
<td>0.74</td>
<td>0.66</td>
</tr>
</tbody>
</table>

SOURCE: Authors’ analysis using BLS data.

NOTE: Wage disparity is the ratio of the wage in Puerto Rico to either the wage in the CONUS or the wage in the six states that receive the most Puerto Rico residents.
Finally, we use the BLS estimates of the levels of education and on-the-job training by occupation to gain a better picture of the types of training necessary for all occupations. Table 4.9 provides the BLS estimates for the top 30 occupations from Table 4.6. For most of these occupations in demand for the recovery, only a high school diploma or less is required and most require only short-term on-the-job training. The construction trades are an exception and usually require an apprenticeship or long-term on-the-job training. This suggests that much of the effort in training programs for the recovery effort should focus on construction trades, of particular importance for the Recovery Plan’s longer-term recovery proposals.

### Table 4.9. Education and On-the-Job Training for Top 30 Occupations

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Education</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>37-2011</td>
<td>Janitors and cleaners, except maids and housekeeping cleaners</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>33-9032</td>
<td>Security guards</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>53-7062</td>
<td>Laborers and freight, stock, and material movers, hand</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-4051</td>
<td>Customer service representatives</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>37-3011</td>
<td>Landscaping and groundskeeping workers</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-9061</td>
<td>Office clerks, general</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-6014</td>
<td>Secretaries and administrative assistants, except legal, medical, and executive</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>11-1021</td>
<td>General and operations managers</td>
<td>Bachelor’s degree</td>
<td>None</td>
</tr>
<tr>
<td>47-2061</td>
<td>Construction laborers</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>41-2031</td>
<td>Retail salespersons</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>51-2092</td>
<td>Team assemblers</td>
<td>High school diploma or equivalent</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>41-3099</td>
<td>Sales representatives, services, all other</td>
<td>High school diploma or equivalent</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>37-2012</td>
<td>Maids and housekeeping cleaners</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>53-7064</td>
<td>Packers and packagers, hand</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-3031</td>
<td>Bookkeeping, accounting, and auditing clerks</td>
<td>Some college, no degree</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>Code</td>
<td>Title</td>
<td>Education</td>
<td>Training</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>51-9198</td>
<td>Helpers—production workers</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>53-3032</td>
<td>Heavy and tractor-trailer truck drivers</td>
<td>Postsecondary nondegree award</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>41-2011</td>
<td>Cashiers</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-5081</td>
<td>Stock clerks and order fillers</td>
<td>High school diploma or equivalent</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>41-9041</td>
<td>Telemarketers</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-1011</td>
<td>First-line supervisors of office and administrative support workers</td>
<td>High school diploma or equivalent</td>
<td>None</td>
</tr>
<tr>
<td>47-2031</td>
<td>Carpenters</td>
<td>High school diploma or equivalent</td>
<td>Apprenticeship</td>
</tr>
<tr>
<td>13-1071</td>
<td>Human resources specialists</td>
<td>Bachelor's degree</td>
<td>None</td>
</tr>
<tr>
<td>29-1141</td>
<td>Registered nurses</td>
<td>Bachelor's degree</td>
<td>None</td>
</tr>
<tr>
<td>35-3021</td>
<td>Combined food preparation and serving workers, including fast food</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
<tr>
<td>43-3011</td>
<td>Bill and account collectors</td>
<td>High school diploma or equivalent</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>47-2111</td>
<td>Electricians</td>
<td>High school diploma or equivalent</td>
<td>Apprenticeship</td>
</tr>
<tr>
<td>49-9071</td>
<td>Maintenance and repair workers, general</td>
<td>High school diploma or equivalent</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>51-9199</td>
<td>Production workers, all other</td>
<td>High school diploma or equivalent</td>
<td>Moderate-term on-the-job training</td>
</tr>
<tr>
<td>35-3031</td>
<td>Waiters and waitresses</td>
<td>No formal educational credential</td>
<td>Short-term on-the-job training</td>
</tr>
</tbody>
</table>

**SOURCE:** Authors’ analysis using BLS data.

**Conclusion**

As the recovery efforts in Puerto Rico increase with additional appropriations and investment, we should expect a concomitant increase in the demand for workers. Since December 2017, the unemployment rate has been falling in Puerto Rico, dropping from 11 percent to 9.3 percent in June 2018, while the size of the labor force has remained roughly constant over this period.\(^{177}\) This suggests that the recovery efforts currently taking place are having a positive economic effect and those workers looking for employment are more likely to find it. As the recovery efforts increase, we should expect this trend to continue. There are three potential sources for the workers: (1) residents of Puerto Rico who are unemployed or currently

not participating in the labor force; (2) residents of Puerto Rico who are currently employed and who could change occupations in order to fill demands; and (3) the diaspora of people from Puerto Rico who are residing in the CONUS or outside of the United States altogether.

There were approximately 100,000 unemployed people residing in Puerto Rico in June 2018. If Puerto Rico were able to reach the U.S. unemployment level of approximately 4 percent without a commensurate increase in labor supply, there would be an additional 60,000 workers available. It seems likely that there will be a skills mismatch between labor demand and labor supply as the distribution of occupations at present will not exactly mirror that of the recovery effort. However, given that most of the occupations in demand have minimal educational and training requirements, these currently unemployed workers could likely find work. For those jobs that have educational or training requirements, programs should be developed to train those workers if a goal is to employ residents of Puerto Rico over nonresidents. Importantly, the construction trades necessary for approximately 50 percent of the Recovery Plan may require training programs that are currently not available.

Although there will be considerable demand for all workers, the skilled labor force that receives either formal or on-the-job training will have an incentive to move to the CONUS once these skills are acquired, given the wage disparities. Thus, if formal training is provided, incentives need to be provided as well to induce these workers to stay within Puerto Rico in order to stem the tide of outmigration. A 2018 executive order by the Governor of Puerto Rico promises to pay construction workers a minimum wage of $15 per hour as opposed to the minimum wage of $7.25 per hour for all projects funded by the government.\textsuperscript{178} At present, according to the BLS data, the mean hourly wage in construction is $10.34 and $24.01 in the United States.\textsuperscript{179} Thus, even with this executive order, wages must still go higher for construction workers to have an incentive to stay in Puerto Rico as the wage incentives still favor movement to the CONUS even though the wage disparity would decline.

As recovery efforts increase and the unemployment rate continues to decline, we would expect wage pressures to begin to increase wages owing to the increased demand. This should induce some of the individuals currently not in the labor force to participate, expanding labor supply and slowing the rate of increase. If the scale of the recovery effort is sufficiently large, we would expect these labor demand pressures to increase wages across Puerto Rico and potentially erase historical wage disparity. This would encourage a return migration from the CONUS back to Puerto Rico from previous outmigrants along with other U.S. citizens seeking opportunities in Puerto Rico.

If these internal labor dynamics are not sufficient to induce U.S. citizens living in the CONUS to pursue endeavors in Puerto Rico, temporary foreign workers may be an opportunity. The major problem to outsourcing the labor demands to foreign workers is that within the U.S.


immigration system only one type of visa (the H2B visa) would allow for a temporary seasonal work permits. However, only 66,000 H2B visas are available within the entire U.S. system. Thus, foreign workers should not be relied on as a source to satisfy the recovery’s labor demand.

The most realistic solution for ensuring available labor for recovery remains to be found in targeting the workforces available in Puerto Rico and in the CONUS. Workers from Puerto Rico will require training programs with incentives to keep these workers on the island until project completion. In contrast, while workers with relevant skill sets would be in high supply on the CONUS, the incentive structures for CONUS residents will likely be expensive. To induce skilled workers to move to Puerto Rico, wages and cost of living would have to be better than they currently are. A caveat of these conclusions is that the increased labor demand will require a significant amount of low skilled work that could be filled by either currently unemployed individuals or those that decide to join the local labor market. The skill mix among workers in Puerto Rico may not be sufficient, given existing and potential Puerto Rico labor supply. As such, it is highly likely that there will be a significant proportion of construction labor supply derived from the CONUS. To induce workers from CONUS to work in Puerto Rico, wage premiums, per diem, and lodging costs will need to be paid. This will generate a comparative trade-off between the speed of recovery and the cost of recovery. These types of incentives and options for Puerto Rico are discussed in more detail in Part II of this report.
Part II.

Options for Supporting a 21st-Century Workforce in Puerto Rico
5. Strategies for Developing a Workforce in Puerto Rico to Meet Short- and Long-Term Needs

As we have described previously in this report, Puerto Rico has workforce needs that are structurally not being met, which could hamper the island’s recovery from Hurricanes Irma and Maria. The chapters in Part I outlined the prehurricane recovery workforce issues within Puerto Rico, both in terms of pipelines and occupational shortages and the unique, acute workforce needs the island experienced at the time of this study. Hurricane recovery spending has heightened and will continue to heighten the short-term demand for labor; moreover, if the reforms suggested in the Recovery Plan are implemented and support a more business-friendly environment, Puerto Rico will need a workforce appropriate to labor demand in the 21st century. Thus, while fulfilling these short-term needs is important, the government of Puerto Rico also needs to concurrently build the knowledge, skills, and abilities of the talent pool to meet longer-term economic demands and the government’s strategic objective (described in Chapter 1) to develop a workforce for the 21st century. This section offers suggested activities and initiatives that the government of Puerto Rico can undertake to meet short- and long-term needs.

To support the government of Puerto Rico in its recovery efforts to develop a modern workforce, the Economics Team devised a collection of activities and policy levers that support the education and training of the workforce (unemployed, underemployed, and talent in the pipeline toward employment), particularly targeting underemployed populations (e.g., youth, women, veterans, and workers who recently lost employment) in high-needs occupations across multiple industries. This chapter summarizes the background research and analysis HSOAC conducted to devise COA ECN 2, Implement Workforce Development Programs, to support the government of Puerto Rico’s decisionmaking. Within, we outline five suggested strategies and activities that comprised this COA. Four of the strategies support meeting short-term acute workforce needs and one outlines a more comprehensive strategy to building a workforce development system that will meet longer-term capacity needs as they arise. This list of strategies was developed from a review in the literature, discussions between the RSF Economics and HSOAC Economics CONUS team, and COAs in other sectors as itemized in the Recovery Plan.

Chapter 6 provides guidance on how the government of Puerto Rico can adjudicate among the options presented in this chapter in order to prioritize and implement efforts given the capacity of the government, education and training institutions, employers and businesses, and the infrastructure and physical capital as the island recovers from the 2017 hurricanes. Chapter 7 concludes the report with a summary of key findings and recommendations.
Characteristics of a Well-Functioning Workforce Development System to Meet 21st-Century Workplace Demands

In light of the labor and employment challenges facing Puerto Rico in its recovery, detailed in Part I of this report, clear efforts need to be made quickly to generate qualified candidates to fill open positions across various high-needs sectors with jobs that are in demand, as well as build Puerto Rico’s capacity to manage longer-term employment needs. Puerto Rico would benefit from developing an effective system for recruiting, training, and educating the local talent pool to fill the job and skills needs of employers in the short and long term—namely, a comprehensive and well-functioning workforce development system. A workforce development system consists of a variety of interconnected components: potential talent, education and training providers, and employers embedded within a local, regional, state, and federal policy context.

Figure 5.1 illustrates a typical pipeline for a workforce development system. At the top of the pipeline is the pool of potential talent—youth who have recently graduated from high school or have passed the GED test for a high school diploma equivalent, adult learners with insufficient credentials (whether novices entering a new industry or experienced workers who need to be retrained), or current employees who are seeking advancement. Typically, individuals within this pool flow through the pipeline, gaining admittance to training courses and educational programs that will provide them with the skills needed to meet the demands in available jobs. Education and training programs can be available at two-year degree-granting public institutions like community colleges, at private technical certification programs, through Workforce Development Boards, or through registered apprenticeship programs required for specific certifications or licenses. Two key factors can impede or facilitate the flow of talent through the pipeline: (1) the policy environment created by local, state, and federal education, labor, and commerce policies and (2) economic activity within a state or region.

As suggested by Figure 5.1, workforce development is a system of interrelated components within which employment training is just one part of a larger whole. For the system to function adequately so that talent is prepared appropriately and is therefore employable in any sector and for employers to recruit, hire, and retain workers who meet the skills needs of job opportunities, the components need to operate in a cohesive way. This requires deep employer engagement in all aspects of the pipeline, career advancement opportunities for talent-, industry-, or job-driven education and training, and connectivity across all components.180

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We approached the development of the strategies suggested in the COA ECN 2, Implement Workforce Development Programs, with the workforce pipeline, the short- and long-term workforce needs of Puerto Rico, and the interrelated components of a well-functioning workforce development system in mind. In the following sections we describe the analytic approach we undertook to develop this COA and outline the strategies within the COA.

Approach to Devising Strategies Suggested Within COA ECN 2, Implement Workforce Development Programs

To support the Recovery Plan effort, the Economics Team developed a list of over 120 recovery activities and policies spanning the intersection of the demand and supply of labor to support the economic development of Puerto Rico. The Economics Team identified four primary areas of policy that could be addressed to incentivize economic development in Puerto Rico.
Rico and upon which the COAs were organized. While not all directly related to workforce development, investments in the continuing economic development of Puerto Rico will have consequences for its workforce; thus, we outline the targeted policy areas of the Recovery Plan here.

- Increase the attractiveness of doing business in Puerto Rico by lowering the costs of doing business, including both financial and nonfinancial costs, and stemming the flow of outmigration.
- Increase the formal labor force participation rate by reducing or removing disincentives for formal work.
- Broaden the tax base and increase the fiscal and economic resiliency of Puerto Rico through a flattening of the tax structure and lower dependence on particular tax exemptions.
- Increase fiscal discipline to ensure a sustainable and rightsized public sector.

To facilitate decision support, these activities were aggregated into 40 broader COAs for consideration by the government of Puerto Rico. The overarching philosophy was to define potential actions that were broadly consistent with the government’s revealed preferences, were likely feasible (in that plans or proposals for specific actions existed or could reasonably be developed fairly rapidly, or appeared in the literature), could be linked to issues raised in damage assessment reports and spanned the relevant policy and investment space. As they emerged, various independent plans and recommendations were cross-referenced for consistency with the developed set of COAs. The COAs outlined in the Recovery Plan were either changes to policy, development of new programs to help fill perceived challenges, or strategic initiatives and projects designed for reconstruction or repurposing of assets or development of key economic subsectors. Each COA included the following information: (1) which sectors within Puerto Rico that could be impacted (e.g., health, education, energy), (2) issues or problems the COA aimed to solve, (3) short description of the COA, (4) the COA’s potential benefits, (5) potential spillover impacts (both positive or negative) to other sectors, (5) potential costs and funding mechanisms, (6) potential pitfalls, (7) likely precursors, (8) and detailed policies that would need to be implemented for the COA to operate as designed.

To devise the strategies incorporated within the COA ECN 2, Implement Workforce Development Programs, the Economics Team used a top-down approach: We first started with the strategic initiative of a 21st-century workforce and then identified logical approaches to meeting the strategic initiative and where the existing pool of COAs could be sufficient to meet

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181 See RAND Corporation, undated, for more discussion of the policy areas and the broader COA development process for the economic sector.
182 Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.
183 RAND Corporation, undated.
184 For example, The Puerto Rico Disaster Recovery Action Plan, Plan for Puerto Rico, Build Back Better, the various New Fiscal Plan(s) for Puerto Rico (and its agencies), and the National Disaster Recovery Framework.
its objectives and where there may be important gaps. The initial focus was on a construction workforce in devising these strategies, but these strategies are applicable to any sector or industry in high demand in Puerto Rico.

As with any approach to a complex problem, such as systematically developing approaches to stem workforce shortages in the short term and to craft a broader, ambitious workforce development system, we relied on a wide range of sources of information.

- We conducted a review of the peer-reviewed literature on the workforce in storm-heavy regions, workforce development promising practices, and the unique Puerto Rico workforce needs.
- We characterized workforce training programs that had some evidence base (whether through quasi-experimental or case study analyses) and the potential to be successful in meeting workforce challenges. The full list is available in Appendix C. To be included, the training programs had to meet our selection criteria, which meant
  - being located in a storm-heavy region or recovery zone in the United States (e.g., Gulf Coast or the eastern seaboard such as New Jersey) or on an island (e.g., Guam or Hawaii)
  - providing on-the-job training opportunities
  - considering impediments to trainees’ attendance
  - focusing on vulnerable populations or upskilling displaced workers.
- We conducted interviews with program administrators at the exemplar programs in the United States in recovery zones or in storm areas, leaders of unions in construction fields, and government of Puerto Rico officials. Protocols for these discussions are available in Appendix B.
- We convened an expert panel at RAND on April 26, 2018, to review strategies and tactics suggested for the workforce development COA. Three attendees with expertise in workforce development, economic development, labor economics, and international development attended and provided feedback.
- In June 2018, we used the information elicited from the above sources to conduct a logic modeling exercise to develop the workforce development system framework. The exercise consisted of three steps.
  - Step 1. Define the guiding principles and goals of a 21st-century workforce system.
    - Develop and protect human capital.
    - Establish a world-class workforce.
    - Increase labor force flexibility.
    - Support the emergence of high-quality employment opportunities aligned with economic growth strategies.
  - Step 2. Review literature on characteristics of workforce development systems, including
    - policies and inputs
    - structures and institutions
    - processes
    - stakeholders.
  - Step 3. Undertake visioning of components of a workforce development system in Puerto Rico that would meet 21st-century demands and develop the five core
components of a logic model (described in more detail later in the chapter)—inputs, activities, outputs, outcomes, and final impact/next-generation change.

Research Questions

Throughout the process to develop the strategies and to inform the crafting of the COA ECN 2, Implement Workforce Development Programs, our work was loosely guided by a set of research questions on what a well-functioning workforce system could entail.

- Any workforce development effort needs to be demand-driven. What is driving this effort? Is the primary employer Puerto Rico or a construction company/set of companies?
  - What types of buildings, and therefore occupations, will be most in need of new construction or reconstruction (e.g., public housing, mixed-used, schools, retail space, office buildings)?
- What is the geographic dispersion of the talent who would most likely undertake the training and therefore fill the jobs (are they primarily in San Juan or in rural areas)? Where would jobs be located? (This will help us determine the extent to which there might be a geographic mismatch between talent, training providers/apprenticeship opportunities, and job opportunities.) And is this necessarily an issue on an island of Puerto Rico’s size (although the quality of transportation and infrastructure would need to be considered)?
- Which indirect, external factors could impede the uptake of talent participating in training programs/apprenticeships (e.g., child care needs, transportation)?
- What are the real skills needed for which occupations (e.g., technical skills, applied/hands-on skills, content knowledge, as well as behavioral competencies/soft skills)?
- Who would train the talent pool (e.g., private training providers, unions)?
- What is the evidence base for successful apprenticeship programs, which could be used as models for Puerto Rico or tailored to the Puerto Rico context?
- Where are viable sources of funding for a training program/apprenticeship (e.g., Department of Labor; Rockefeller Foundation)?
  - Who are other players in Puerto Rico that could be viable partners or potential funders?
- How can we determine whether a “graduate” of a program/apprenticeship has the requisite skills needed to be successful on a construction site (i.e., should we consider some kind of pre- and post-assessment)?
- What would be the long-term plan for ensuring sustainability so that the trained local talent pool can find career-enhancing construction jobs or can transfer their skills to other types of employment on Puerto Rico?
- What are the external factors any workforce development system in Puerto Rico will need to consider?
  - Migration/circular migration
    o Size and availability of potential talent pool
    o Infrastructure needs
  - Informal economy/informal construction
    o Attracting potential talent pool to program
• Reskilling workers already embedded in informal economy
  – Material markets and disposal
  – Building codes and permits
  – Contractor licensing
  – Alternative housing
  – Work incentives
• What are the facilitators/barriers to the workforce development system?
  – Transportation
  – Child care
  – Housing/facilities for trainees
  – Attracting talent to program
    – Opportunity costs (if already employed)
    – Awareness
  – Placement of program (geographic mismatch considerations)
    – Deciding where to locate training center(s) based on rebuilding need or talent availability.

In the remainder of this chapter, we outline four strategies focused on short-term workforce development, as well as a fifth strategy targeting the reimagining of Puerto Rico’s overarching workforce development system for the government of Puerto Rico.

While we discuss the strategies individually, they are not mutually exclusive and could be phased in over time or as capacity of the government and physical infrastructure on the island builds. Likewise, the longer-term strategy to build a comprehensive workforce development system is not intended to operate outside of the realm of the four short-term strategies, but rather it could be implemented in tandem with any of the short-term strategies the government of Puerto Rico decides to implement. Within each strategy we describe its characteristics, advantages and challenges to its implementation, and potential funding mechanisms.

**Strategy 1. Let the Market Guide Workforce Development**

One potential strategy to meet short-term workforce needs is to rely on an emergent (or market-based) response. This approach relies on a variety of private businesses and nonprofit NGOs to facilitate the reconstruction of Puerto Rico. Private businesses and nonprofit agencies are motivated to respond to shortages in the supply of workers given both economic and noneconomic considerations. This strategy is not directly implemented by any one actor; a variety of small-scale organizations will work independently and perhaps collaboratively within their respective domains and with minimal government coordination. The free market response to post-hurricane workforce development needs could be supplemented by local government efforts to mobilize skilled tradespeople and coordinate across private and nonprofit actors. However, given reduced capacity of the government in the wake of the hurricanes, one would expect that supplemental support would be limited.
The on-the-ground response to the immediate post-disaster needs of Puerto Rico was met with this strategy. For example, in 2017 and 2018, nonprofits such as Habitat for Humanity and the postsecondary education systems at State University of New York/City University of New York (SUNY/CUNY) were working to train construction workers to support residential rebuilding on the island, and private companies such as Tesla, Sonnen, and ReVision Energy had constructed and donated batteries and microgrids to repair and modernize Puerto Rico’s aging electrical grid.\textsuperscript{185}

\textbf{Advantages and Challenges}

There are number of potential benefits to this strategy. First, this approach requires minimal government oversight and coordination and therefore has the lowest initial costs. Additionally, there may be secondary benefits from industry and nonprofit response to workforce development needs—namely, a potential influx of personnel who need short- to long-term room and board and related services. As a result, there may be economic and employment growth in related sectors such as hospitality. Formal partnerships between Puerto Rico and CONUS and international partners in the private and nonprofit sector may further strengthen useful initiatives in human capital development and trade in Puerto Rico. For example, a collaboration between Boston Scientific and its Puerto Rico partners maintained Boston Scientific’s campus in Puerto Rico and may have helped speed restoration of that campus.\textsuperscript{186} To the extent that demand for construction workers drives wage increases, individual construction workers in Puerto Rico working mainly in other industries and/or in the informal labor market may also return to formal work in the construction industry. The movement of workers from lower-paying jobs in other sectors, such as the service sector, to the construction industry may create additional tax revenue. Similarly, worker mobility from the informal labor market to formal work in the construction industry could also create additional tax revenue.

Potential secondary benefits extend to noneconomic outcomes as well. Depending on the scale and quality of the reconstruction, new housing could improve health and environmental outcomes. The flexibility and experience of outside private and nonprofit agencies may bring with them efficiencies that would be passed on to individual Puerto Rico residents in the form of reduced construction costs. For example, Habitat for Humanity’s operational model specifically emphasizes affordable individual home mortgages given low-cost labor. This sort of operational model and savings pass-through to Puerto Rico residents may alleviate financial stress. Habitat for Humanity is among several nonprofits with specific expertise in post-hurricane construction


and an emphasis on alleviating affordable housing shortage. Finally, this strategy is not exclusive of any others; Puerto Rico may continue to accept assistance from private and nonprofit organizations while implementing the other strategies outlined in this chapter. In fact, this strategy is the likely “default” immediately after any disaster while waiting for more centrally organized assistance.

Of course, there are potential negative impacts of this approach. Economic theory and empirical research show that markets often fail to operate as expected after natural disasters. Medium- to long-term costs may therefore offset lower costs in the short term of exclusively using an emergent response to workforce development needs based on private and nonprofit actors. This strategy could be employed in tandem with government strategies to help encourage investments with efficient but longer-term payoffs. Additionally, a large influx of disaster relief dollars represents a market distortion that may induce corruption and graft. Outcomes of corruption, graft, and unmonitored spending directly related to workforce development may include continued and perhaps increased use of the informal labor market workforce and subsequent loss of tax and other government revenue, as well as further risk to residential and commercial buildings from potentially lower-quality construction. The travel time and distance between the CONUS and Puerto Rico increase monitoring costs and thus the possibility of graft and corruption and may weaken nongovernmental agencies’ resolve to provide assistance. Changes in the tax treatment of Puerto Rico could also threaten the private-sector response to workforce development needs in Puerto Rico. The lack of strategic coordination among parties trying to help Puerto Rico may result in duplicate or inefficient efforts; where possible, the government of Puerto Rico could serve as an informational intermediary. Finally, the Jones Act, a U.S. law about ocean shipping to U.S. ports, including Puerto Rico, hinders the ability of foreign companies and governments to aid Puerto Rico while conducting business with the CONUS, adding extra costs to outside assistance.

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188 For example, public outcry against surge pricing has often led to inefficient price controls; see Steven Suranovic, “Surge Pricing and Price Gouging: Public Misunderstanding as a Market Imperfection,” George Washington University, IIEP-WP-2015-20, December 2015.
190 See the damage and needs assessment following the hurricanes at RAND Corporation, undated.
191 Note that a centralized approach’s success rests on the ability of the coordinating agency to efficiently and effectively identify problems and distribute resources. Centralization likely entails a coordinated plan, which increases the likelihood that all efforts succeed or fail together (rather than the probable individual successes under a distributed system).
192 Foreign-flagged or foreign-crewed ships may not stop in Puerto Rico if they plan to also stop in the contiguous United States; thus, foreign companies or governments providing aid to Puerto Rico would need to send a ship only to Puerto Rico, rather than splitting the journey’s costs with commerce in the United States.
Potential Funding Mechanisms

This strategy requires no direct public funding sources, relying on the independent mobilization and coordination of firms and organizations in the private and nonprofit sectors, respectively. As mentioned previously, strategy 1 is not mutually exclusive of other strategies; in fact, the lack of an upfront investment requirement actually facilitates the pursuit of this strategy as a supplement to others.

Strategy 2. Temporarily Contract a Skilled and Experienced Workforce from the Continental United States

According to the BLS, there were some 11.2 million construction workers in the United States in 2018, accounting for about 7 percent of the U.S. workforce. And, in spite of a relatively tight labor market, some economic metrics indicate that the U.S. economy may be slowing.\(^{193}\) Certainly wage growth among U.S. construction workers has yet to return to the levels seen before the Great Recession.\(^{194}\) As a result, skilled and experienced construction workers in the CONUS may represent a critical resource in rebuilding Puerto Rico following the destruction of the 2017 hurricane season. By temporarily importing skilled and experienced workers, the government of Puerto Rico and other construction employers may more efficiently address their resident construction needs. Overall, importing a skilled and experienced construction workforce from the CONUS could likely accelerate recovery and rebuilding in Puerto Rico. If successful, this strategy can also be used to address other occupational shortages through program expansion.

Advantages and Challenges

Construction workers in the CONUS represent a pool of relatively skilled and experienced labor in all trades. These workers present an advantage by offering a labor force ready to work from day one, and those from hurricane- and flood-prone states such as Texas, Louisiana, and Florida may possess specialized knowledge relevant to Puerto Rico’s reconstruction efforts. Such a labor force may require less intensive training than new entrants to the Puerto Rico construction workforce, particularly since the latter group may have little formal training or less technical knowledge vis-à-vis residential building codes. Additionally, importing a workforce to meet immediate disaster relief response is an approach already tested in post–Hurricane Maria Puerto Rico. FEMA used such an approach in working to repair the electricity grid and restore power on


the island. This suggests that the organizational wherewithal and knowledge to move and manage thousands of workers to the island could be applied to the construction industry and coordinated by the government of Puerto Rico in tandem with private employers. Thus, by contracting with experienced construction firms in the CONUS, the government of Puerto Rico and other stakeholders might address immediate construction needs while avoiding the potentially greater uncertainty and intensive investments in the short to medium term required in a more intensive strategy aimed at directly developing a local construction workforce. To help ensure medium- to long-term benefits for Puerto Rico, the government of Puerto Rico could include incentives for CONUS firms to hire the local workforce, after the initial short-term influx of workers from the CONUS, in order to support investments in local labor and workforce development while not requiring the necessary free market conditions (e.g., local investments, growth in construction hiring) assumed or required by strategy 1.

On the negative side, the U.S. labor market overall is rather tight with historically low rates of unemployment in 2019. Economic theory generally predicts a marked increase in wages in such circumstances, although that has not necessarily been the case even in the recent labor market with rather unusually low unemployment.\textsuperscript{195} Still, the special case of importing labor for hurricane disaster reconstruction and relief seems likely to increase reconstruction costs, unlike a case where sufficient skilled labor could be sourced on-island. For example, median household income in Puerto Rico is just about $20,000.\textsuperscript{196} A construction worker in the United States overall typically earns about $33,500 in a year. This means that construction workers from the CONUS will likely require a premium hourly wage relative to construction workers resident on Puerto Rico. Additionally, relying on an imported workforce to reconstruct the island’s infrastructure may lead to wages higher than the wages a construction worker typically enjoys even in the CONUS, especially if wages must also cover travel to and from Puerto Rico, lodging, and a per diem. Indeed, higher wages may be a potential necessity to induce workers to temporarily locate to Puerto Rico.\textsuperscript{197}

If pursued in isolation, this strategy fails to establish a more permanent workforce in Puerto Rico and any secondary benefits of a standing pool of skilled and experienced construction workers. For example, a lack of a (re)skilled construction workforce will likely lead to (continued) deferred maintenance and additional construction costs in the long term. Importing an external workforce may introduce unforeseen transactional frictions and economic inefficiencies. For example, imported workers may not be fluent in Spanish and thus would be unable to collaborate with local laborers. They may also possess inadequate knowledge of the older and informal construction methods common in Puerto Rico, creating challenges for repair and reconstruction

\textsuperscript{195} Sprague, 2017; Tedeschi, 2018.
\textsuperscript{196} U.S. Census Bureau, “Quick Facts: Puerto Rico,” July 1, 2018.
\textsuperscript{197} Mazzei and Armendariz, February 6, 2018; Newkirk, November 3, 2017.
work. Moreover, malfeasance and graft could plague these sorts of external contracts.\textsuperscript{198} Also, research conducted by HSOAC during recovery plan development suggests that temporary contract workers from a stronger economy typically do not permanently relocate to a given contract site when the contract site has a less robust economy—as is the case comparing Puerto Rico’s economy to that of the CONUS,\textsuperscript{199} and temporary contracts may result in few if any resulting resources (e.g., new and/or larger local firms, more skilled construction labor) to develop and support the local construction workforce. The medium- to long-term prospects of establishing a strong construction labor supply in Puerto Rico, with experience in residential hurricane reconstruction, likely diminish under this strategy.

However, the increased costs of bringing in construction workers from outside of Puerto Rico is likely to increase wages for the (currently) scarce skilled construction workers already in Puerto Rico. If this persists in the longer term (i.e., if economic development encourages continued construction), this would incentivize more individuals in Puerto Rico to receive appropriate training for construction employment, provided sufficient training opportunities exist or crop up. Thus, this strategy may fit well as an interim solution, filling the gap after the local skilled labor pool has been exhausted and the latent labor pool (those seeking skills) has not yet been realized.

\textit{Potential Funding Mechanisms}

FEMA, U.S. Department of Housing and Urban Development (HUD), U.S. Department of Education, and industry partners remain funding options for this strategy.

\textbf{Strategy 3. Train Puerto Rico Workers Remotely in the Continental United States}

A third possible strategy to meet acute workforce shortages in Puerto Rico is for the government of Puerto Rico to pay for workers to attend a remote, tuition-based training program in which those interested in developing a certain skill will be sent to extant training sites and programs in the CONUS. The remote training strategy aims to grow and sustain a construction workforce in Puerto Rico via accessible, affordable training and incentivizing long-term residence in Puerto Rico. The remote training model leverages extant programs in the CONUS under the assumption that hurricane damage, construction workforce shortages, technical expertise, and fiscal constraints on the island make a local training program prohibitively expensive. To ensure newly skilled workers return to Puerto Rico, the program could include

\textsuperscript{198} As one example, see Frances Robles and Deborah Acosta, “Puerto Rico Cancels Whitefish Energy Contract to Rebuild Power Lines,” \textit{New York Times}, October 29, 2017.

\textsuperscript{199} RAND Corporation, undated; Cadena and Kovak, 2016.
mortgage, tax, and career incentives to encourage long-term residence in Puerto Rico and participation in the formal labor markets.

Programs will ideally include a pre-apprenticeship component in which students learn basic construction skills, which will then lead to a full apprenticeship or training program to graduate with specified licenses or certifications. We suggest that this strategy be competitive for attendees, requiring candidate applications and interviews for a limited number of slots, potentially increasing the prestige of the program and the quality of the applicant pool. Tuition and room and board will be subsidized generally via FEMA and HUD disaster relief funds; scholarships (including room and board) will also be available based on FEMA and HUD disaster relief funds. Additional subsidies and scholarships may be available for targeted construction occupations, such as solar panel installation, given the Recovery Plan’s inclusion of COAs related to a modernized power grid and other, related infrastructure projects.

Students would travel to the remote site for an eight- to ten-week stay for on-site training under master tradespersons, ideally with experience in hurricane or natural disaster reconstruction, and other experts. Texas, Florida, and Louisiana are likely locations for this program given hurricane activity and reconstruction efforts in those states. Upon completion of the program, a graduate would become eligible for a paid internship in a construction trade in Puerto Rico. Paid internships would be subsidized in the first few months of the proposed program using disaster relief and other federal funds. Program graduates would receive a monthly income supplement for attending local chapter meetings where professional networking, support, and formal seminars will be made available. Program graduates would also qualify for tax credits and/or subsidized home or business loans or (first-time) homebuyer tax credits.\textsuperscript{200,201} Tax credits could last a maximum 24 months, following program completion; extant or new construction homes in Puerto Rico could qualify for homebuyer tax credits but should meet construction codes; subsidized loans could convert to the market rate should the graduate violate the program’s residency requirements.\textsuperscript{202} Other penalties related to program costs and direct benefits to the

\textsuperscript{200} Tax credits may be modeled after the federal earned income tax credit (EITC), which phases out at higher income levels. This credit program should be structured so as to discourage informal residential construction, if possible.\textsuperscript{201} Median home price in Puerto Rico is approximately $110,000. A 30-year fixed-interest mortgage for $150,000 (4.0 percent APR; 3.33 percent or $5,000 down payment) incurs about $104,000 in interest payments over the life of the loan. Interest payments total $48,000 at 2.0 percent APR. Subsidized loans can be structured to discourage building in hurricane-prone areas and/or require building-code-compliant construction and materials. To encourage (re)construction and formal home ownership in Puerto Rico, we do not recommend subsidized mortgage benefits phase out at higher income levels. However, the subsidized mortgage cannot be transferred to another loan or home. It is likely the case that the initial down payment for a secured mortgage is the larger barrier to titled or formal home ownership for individuals and their families. In that case, a first-time homebuyer credit is likely a better policy. Residency requirements would remain the same. Not incidentally, a homebuyer tax credit will have lower total program costs than a subsidized mortgage loan.

\textsuperscript{202} It is worth noting that time-sensitive benefits will likely lead to an influx of trained construction workers into the informal labor market once the benefits expire. This remains a problem in any workforce training program, given the large size of Puerto Rico’s informal labor market.
graduate, post-program, may apply based on graduates’ behavior and residential mobility upon completion of the program.

Circular and outmigration opportunities created by Puerto Ricans’ citizenship status, in combination with the experience any graduate attains while in a remote program in the CONUS, could increase the likelihood of further outmigration. For this reason, any remote training program would need to be coupled with benefits that would target homeownership, along with other incentives (discussed in more detail below).

Advantages and Challenges

The strengths of this strategy are manifold. First, this strategy requires fewer direct government investments in Puerto Rico’s workforce development infrastructure at a time when existing programs in Puerto Rico remain closed following the hurricanes (e.g., Job Corps training centers in Arecibo and Barranquitas) and when there are numerous economic, health, and other exigencies on the island. This strategy is also appealing since it leverages existing expertise in the CONUS, including expertise in hurricane reconstruction and recovery in Texas, Louisiana, Florida, and elsewhere. These two strengths of the present strategy mean that this strategy will provide a skilled (re)construction workforce in the short term with less coordination and support from the government of Puerto Rico. Additionally, returning, trained workers represent a newly (up)skilled workforce in support of Puerto Rico’s medium- to long-term reconstruction and development efforts.

Though there are no facilities start-up costs associated with a remote workforce training program, costs for instruction (including instructional materials), facilities maintenance, and any program subsidies remain. These costs may be less in the CONUS than in Puerto Rico, given remaining storm damage on the island and fixed costs associated with importing instructional materials and perhaps even instructors. Additionally, even if the financial costs would be lower, the logistics of creating new programs in Puerto Rico would be challenging in the midst of hurricane recovery.

However, extant training programs and centers in the CONUS will pass through at least some fixed costs associated with leasing a building and other basic facilities operation, undermining the primary benefit of no start-up costs. Additionally, cost-of-living and wage differences between the CONUS and Puerto Rico may also make the cost of a remote training program prohibitive. Additionally, these programs propose to train construction workers based on standard practices that, even in a program with instructors from hurricane-prone U.S. states, may be insufficient and/or irrelevant for the Puerto Rico context. For example, illegal residential construction in Puerto Rico is relatively common. Remote training programs and instructors from the CONUS may be ill-equipped to deal with these sorts of on-the-ground realities in Puerto Rico. If this were the case, it means that much of the training in a remote program would be of little to no value in reconstruction efforts in Puerto Rico.
Overall, prohibitive costs associated with a medium to large remote general training program may make a hybrid model with intense, remote instructor training more logical. This program could be offered for a smaller number of individuals with extant construction skills along with a general program in Puerto Rico using CONUS instructors and newly trained Puerto Rico instructors, an online curriculum, and other instructional supports. Such a hybrid approach could leverage the shorter start-up timeline of a CONUS-based program with the potentially reduced costs of hosting a program within Puerto Rico and could require less coordination and oversight by the government of Puerto Rico.

Two other problems would need to be considered before implementing this strategy. First, individuals who select the program are more likely to have established English fluency and other advantages, while youth from more vulnerable and disadvantaged populations are less likely to participate in this program. If this strategy is implemented, careful attention must be paid to these sorts of barriers to participation among disadvantaged populations since they are most likely to need formal training and to remain in Puerto Rico in the long term and therefore to contribute to Puerto Rico’s long-term recovery following formal job training. Generally, outmigration from Puerto Rico to the CONUS and circular migration between them remain a concern in this strategy since remote training likely increases the probability of such migration, given that individuals with postsecondary training are more likely to immigrate. To incentivize Puerto Rico trainees to return to and remain in Puerto Rico, residency requirements under the programs and/or paid internships using disaster relief and other federal funds will likely be necessary. Program graduates would receive a monthly income supplement for attending local program meetings where professional networking, support, and formal seminars would be made available. Program graduates could also qualify for tax credits and/or subsidized home or business loans to further incentivize trainees to remain in Puerto Rico in the longer term. Other incentives, such as college tuition subsidies for children, may further blunt outmigration and circular migration between Puerto Rico and the CONUS that is induced by re- or upskilled workers under a remote training model.

Potential Funding Mechanisms

FEMA, HUD, U.S. Department of Education, and industry partners remain funding options for this strategy.

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203 Primary interview data from expert sources indicate that language skills often present a key barrier to participation in Job Corps programs in the CONUS.

Strategy 4. Implement Local Short-Term Career and Technical Training in Puerto Rico

Relative to other OECD countries, the United States has a smaller and arguably underdeveloped vocational system at the K–12 and postsecondary levels. Puerto Rico’s vocational education opportunities more or less mimic the CONUS and could be developed further. Expanding and strengthening Puerto Rico’s postsecondary vocational training through project-based, short-duration (four to six weeks) “micro-credentialing,” training, and education that incorporates industry-postsecondary education partnerships could be a viable strategy for Puerto Rico. This strategy follows long-standing models in Germany, Switzerland, and other OECD countries and builds on Puerto Rico’s existing vocational programs. These programs could follow the model of the Building Minnesota Apprenticeship Program or the Minnesota Trades Academy, both of which are entry- and mid-level short-duration programs targeting those new to construction occupations and those seeking to build expertise or management skills.

Implementing “micro-credential” programs could be a plausible strategy for the government of Puerto Rico to develop its labor force in high-demand occupations: Short-duration training and education could provide occupation-specific certifications for participants, which could also be parlayed in a two- or a four-year postsecondary degree if the participant chooses to continue with their education. Research has demonstrated labor market returns in some instances, which could create important linkages across short-duration trainings and provide viable career paths for Puerto Rico residents. Importantly, micro-credentials need not occur solely in the confines of a formal classroom or other instructional setting. Competency assessments based on prior training and experience would formalize knowledge and skills that individuals develop while working.

Industry-postsecondary education partnerships undertaken as part of this strategy would follow Puerto Rico’s state plan under the 2014 federal Workforce Innovation and Opportunity Act, which reauthorizes the Workforce Investment Act of 1998 and aims to promote workforce development programs that are directly tied to skills demands and the coordinating local boards. This can be achieved through several models of implementation: (1) Program instructors are trained by employers in immersion and nonimmersion periods; (2) students are instructed at existing postsecondary institutions in Puerto Rico; and (3) students are trained on-site at the relevant local employer(s). To address shortages in vocational instructors and to

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205 Shavit and Muller, 1998; Hoffman and Schwartz, 2015; Jacob, October 5, 2017.
207 Dadgar and Trimble, 2015; these returns appear to vary by labor market context and across the working career, however. See Liu, Belfield, and Trimble, 2015; Jepsen, Trosk, and Coomes, 2014; Hanushek et al., 2017.
provide instructors with the requisite knowledge of employers’ needs and expectations, several programs and policies in the CONUS now require vocational instructors to be trained at the relevant local employer(s).210 The government of Puerto Rico could implement a similar model at the postsecondary level, targeting key employers. It may also be possible and desirable to train instructors from the CONUS with targeted key Puerto Rico employers. Given changing employer needs and economic context, we anticipate that instructors’ own training at local employers will be critical to ensuring that this construction training remains relevant and up-to-date.

The second key component of locally determined micro-credentialing training programs leverages existing postsecondary training programs in Puerto Rico and existing facilities, instructors, and materials. Students would also obtain hand-on experience through work-based learning. Such training can be organized under the supervision of the postsecondary institution in which a student is enrolled, the local employer, and the appropriate local workforce board. Overall, student training at the postsecondary institution and relevant employer(s) is intended to be intense and short in duration. A short-duration micro-credential program lends itself to repeated training as necessary to meet local employer and economic need. This approach is common in vocation training across a variety of fields under the guise of “stacking” credentials.211 For example, information technology workers often pursue short course and certifications in software and other technologies because these fields rapidly change. Such rapid and related training is intended to support Puerto Rico’s vision of an agile 21st-century workforce (e.g., Puerto Rico’s “human cloud”).

**Advantages and Challenges**

One advantage of this strategy is that it builds on existing workforce development resources such as state and local boards under WIOA and existing vocational programs and postsecondary institutions in Puerto Rico. Relative to other potential strategies, local worker training programs also present an opportunity to invest in Puerto Rico’s education system and strengthen existing programs and infrastructure in Puerto Rico. Given the extent of informal training and labor market employment in Puerto Rico, as detailed in Part I of this report, competency-based assessments and credentialing represent a particular advantage of this strategy. The short duration of trainings and courses in a standard micro-credentialing approach also means that this sort of strategy can accommodate a large number of students overall, with rolling cohorts of students across myriad and multiple training and course opportunities. This strategy would leverage existing workforce development resources to create and/or strengthen industry-postsecondary education partnerships in order to provide critical project-based training that will

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speed student training as well as help address Puerto Rico’s immediate reconstruction needs.\textsuperscript{212} For example, technical colleges located throughout the island already offer many technical and vocational programs. These programs have established relationships with local employers and place many of their students and graduates with employers in on-the-job training opportunities and jobs, respectively.

Second, program requirements specifically include mechanisms for maintaining and strengthening industry-postsecondary education relationships. Many vocational instructors are recruited for their present skills and perhaps industry relationships. Over time, however, those skills and relationships may wane. Requirements for instructor training at local employers ensures that instructors’ skills and relationships remain up-to-date. These relationships in particular ensure that employers’ skills needs are included in workforce training. Third, this strategy relies on local determinants to address Puerto Rico’s training needs. In this way, this strategy offers an emergent and flexible model with local actors (local postsecondary institutions, employers, and workforce boards) serving as the primary coordinators.

One main weakness of this strategy is potentially large inefficiencies given differences in the institutional approach and culture across local actors—particularly postsecondary institutions and employers. This strategy provides a sustainable, qualified, and rightsized pipeline of talent only if training institutions and employers are in close communication about skill and staffing needs and residents are well informed about training opportunities and job prospects. Though there is evidence of existing relationships among technical and vocational programs and local employers in Puerto Rico, the depth and functionality of these relationships is unclear. These relationships are critical, however, for providing relevant, up-to-date training that meets employer and Puerto Rico’s reconstruction needs for rebuilding post-hurricanes.\textsuperscript{213} This strategy also assumes that local employers understand their workforce needs, which is not always the case, particularly in the context of changing technologies and an economic landscape. Given the ongoing financial challenges faced by Puerto Rico, it is also likely that limited capacity to implement this strategy in a cost-effective manner could be a key barrier. Moreover, this strategy assumes that individual local actors can more or less independently identify and absorb new technologies and innovations in a potentially quickly changing field, such as green construction techniques that are compliant with Leadership in Energy and Environmental Design standards. While remote instructor training in this strategy is intended to address problems arising from limited local knowledge, this strategic mechanism requires ongoing financial support and other resources. Finally, this strategy provides workers with skills that may have general relevance, inducing migration and

\textsuperscript{212} In primary data collection, several expert interviewees noted the importance of project-based learning generally and the short amount of time and training an unskilled student requires for performing basic construction tasks such as residential roofing. Roofing and other basic residential construction needs remain acute in Puerto Rico. See the damage and needs assessment summary in RAND Corporation, “Supporting Puerto Rico’s Disaster-Recovery Planning.”

\textsuperscript{213} Carnevale, Garcia, and Gulish, 2017.
associated problems as noted in previous strategies.\(^{214}\) We anticipate that localized professional and social networks will limit workers’ geographic mobility; thus, this strategy does not have any formal mechanisms to reduce worker emigration.

**Potential Funding Mechanisms**

U.S. Department of Labor, Department of Education, and industry partners remain funding options for this strategy.

**Strategy 5. Develop and Implement a Comprehensive Workforce Development System to Meet Longer-Term Workforce Needs**

This strategy recommends that the government of Puerto Rico incorporate policies and activities that will meet both short-term programming and longer-term capacity building for the island’s workforce needs. This strategy thus complements the four suggested short-term strategies discussed previously in this chapter and can be implemented concurrently or separately from any of the other four strategies suggested in this report. Such a strategy is comprehensive and systemic, though implementation of individual sub-strategies would also facilitate capacity building. While the government of Puerto Rico might incrementally introduce any number of workforce development strategies separately or together, such an approach might create a fragmented and less effective response to the island’s workforce and economic development needs in the medium to long term. Research demonstrates that relatively intensive investments in education and training are positively associated with economic growth and development, and much of the research on educational reform and workforce development emphasizes the importance of systemic and comprehensive policies that span the educational and labor market career, given positive individual and economic impacts of such policies.\(^{215}\)

There are four core areas that a workforce development system will need to establish. They include

1. aligning the skills and content knowledge required in the evolving labor market for high-demand occupations with the supply of talent on the island
2. standing up workforce training centers (“centers of excellence”) that traverse secondary and postsecondary education levels in strategically selected geographic areas across the island

\(^{214}\) While likely beneficial for the worker electing to move, upskilling a likely-to-migrate-workforce does little to address the construction workforce shortages within Puerto Rico.

3. instituting policies to encourage industry and education sectors to collaborate in the development of career pathway models, curriculum development for training programs, and supply-demand analyses

4. strategically designing an education system (elementary, secondary, and postsecondary) to develop a pipeline of talent by supporting vocational education/career and technical education and on-the-job experiences for youth and jobseekers (e.g., through internships or apprenticeships).

The process by which workforce development can propel the island’s economic development and well-being is presented in Figure 5.2, which details the ways in which a comprehensive workforce development system can have positive outcomes for individuals, institutions, and the community. Our first step in devising the structure of a comprehensive and well-functioning workforce development system was to identify the goals or impacts such a system intends to produce and then articulate or map out which initiatives or activities can best allow the system to achieve those goals. This strategy is often achieved through the design of a *logic model*. A workforce development system logic model as shown in Figure 5.2 aims to address and ameliorate the short- and long-term workforce challenges facing Puerto Rico, as detailed in Part I of this report. We crafted the logic model by reviewing the literature on promising practices and characteristics of workforce development programs and systems; drawing on discussions with the RSF in Puerto Rico and considering the economic, social, and political context in Puerto Rico; and incorporating the government of Puerto Rico’s Recovery Plan’s strategic objective to develop a 21st-century workforce. Our model illustrates in broad terms how various workforce development initiatives could work together to propel change in outcomes for individuals, institutions (e.g., businesses, government entities, and education or training providers), and the broader community and, ultimately, how the initiatives can help Puerto Rico cultivate its ambitions to build a modern workforce. Figure 5.2 is intended to be a model to help the government meet its strategic goals and thus could serve as a framework that the government of

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Puerto Rico could use to create and build on workforce development efforts already underway. It can also be used as a guide to assess the degree to which these initiatives are achieving intended goals and to measure progress through time. (We offer a process by with the government of Puerto Rico could operationalize this framework in Chapter 6.)

**Figure 5.2. Proposed Workforce Development System Framework for Puerto Rico’s Recovery**

<table>
<thead>
<tr>
<th>Inputs: Planning, policies, investments</th>
<th>Activities: Services conducted</th>
<th>Outputs: Direct products of services</th>
<th>Short-term: Knowledge and skills</th>
<th>Medium-term: Actions and behaviors</th>
<th>Long-term: Changes</th>
<th>FINAL IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Policies to support structures and incentives for system</td>
<td>• Sector-based models</td>
<td>• K-14 standards and curricula</td>
<td>• Institutions • Awareness of labor market demands • Awareness of labor market trends and opportunities</td>
<td>• Institutions • Build employer partnerships • Align training programs with labor market expectations • Establish person-centered education</td>
<td>• Institutions • Development of a world-class workforce development system that is: - Equitable - Efficient - Agile - Resilient</td>
<td></td>
</tr>
<tr>
<td>• Cross-sector (government-industry-education) planning</td>
<td>• Public-private partnerships</td>
<td>• Occupational credentials and licenses</td>
<td>• Occupational credentials and licenses</td>
<td>• Individuals • Aware of returns to formal labor market over informal • Identify pathways that fit their career and employment goals • Improve job search and application skills • Improve technical skills and abilities • Improve content knowledge • Strengthen workplace competencies and soft skills</td>
<td>• Individuals • Improved educational attainment • Improved employment • Reduction in unemployment • Reduction in reliance on informal economy • Increase in income • Increase in social status • Greater civic engagement</td>
<td></td>
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<tr>
<td>• Design of industry specific blueprint</td>
<td>• Comprehensive information job portal</td>
<td>• Degrees and certifications</td>
<td>• Community • Advertise formal employment benefits in short and long term • Increase job match quality • Attract high quality instructional staff</td>
<td>• Community • Increase in tax base • Increase in formal labor force participation • Reduction in outmigration/brain drain</td>
<td></td>
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</tr>
<tr>
<td>• Analysis of skills and career pipeline alignment</td>
<td>• K-14 career and technical education (CTE) centers</td>
<td>• Training pipelines</td>
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<tr>
<td>• Data infrastructure for integrated job opportunities by municipality, occupation, industry</td>
<td>• Centers of excellence</td>
<td>• On-the-job training • Apprenticeships • Internships • Cooperatives • Work-based learning</td>
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<tr>
<td>• Materials, equipment, and facilities for educational and training institutions (both online and brick and mortar)</td>
<td>• International training centers</td>
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In this logic model, the **inputs** are the planning efforts, government policies, and investments needed for a comprehensive and well-functioning workforce development system. These inputs include

- **policies** of the government to support the structure and incentives for the system to operate
- **planning** among the government, industry and business leaders and (K–12 and postsecondary) education providers
- **blueprints** for industry- or sector-specific workforce development programs, activities, and collaborations
- **data infrastructure** development and maintenance, which is necessary to link job opportunities to job seekers by municipio, occupation, and industry
- **materials, equipment, and facilities** for educational and training institutions (online and brick-and-mortar)—whether rebuilt or anew.
Activities are the initiatives that form the backbone of any strong workforce development system, as outlined earlier in this chapter. Activities include

- sector-based models
- public-private partnerships
- a comprehensive information node/job portal that incorporates individuals’ interests and needs as well as employer-driven requirements
- facilities where preparation can occur, such as K–12 and higher education career and technical education centers, regional centers of excellence, or sector-specific international or national training centers.

The inputs and activities are designed to eventually lead to desired impacts on Puerto Rico, depicted on the far-right of Figure 5.2, which are the goals in the Recovery Plan: develop and protect human capital, establish a world-class workforce, increase labor force flexibility, and create high-quality employment opportunities aligned with economic growth.

The logic model illustrates five measurable components of the effectiveness of the workforce development system activities. The first is the outputs, which are the products that each workforce development initiative or activity provides. These outputs include career pathway models, K–14 (K–12 and two years postsecondary education) standards and curricula, occupational credentials and licenses, degrees and certifications, training pipelines, and on-the-job training opportunities (i.e., apprenticeships, internships, cooperatives, and work-based learning). One can think of outputs as direct results of the activities.\(^\text{217}\)

The second indicator of the effectiveness of activities is short-term outcomes. These are outcomes that one would expect the activities to affect immediately (within one to three years). These include improvements in specific knowledge or skills that institutions and individuals involved in the workforce development system obtain. As illustrated in the logic model in Figure 5.2, one would expect that through time, government, businesses, and education institutions would have an improved awareness of the skill demands of the labor market as well as trends and job opportunities in the labor market. Concurrently, individuals would have improved their awareness of returns to the formal labor market; they would be able to identify education and employment pathways that fit their career and employment goals and their job search and application-writing skills, content knowledge, and workplace competencies would also have improved and strengthened.

The third component is medium-term outcomes. These are any changes in actions or behavior one would expect to result from the increase in awareness, knowledge, and skills produced from the short-term outcomes. The time frame for achieving these outcomes could vary, even within an initiative. In the logic model (Figure 5.2), we list medium-term outcomes for institutions, individuals, and the community. We expect that government, business, and

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education institutions would build partnerships, training programs would be aligned with labor market expectations, and instruction would be person-centered, meeting individuals’ education and employment needs. We would expect that individuals would seek training in career pathway(s) of their choice at whichever career and technical education center or training center best meets their employment needs, and that they would use the job portal to apply for jobs and become lifelong learners—so they are facile at moving in and out of the education system in order to best meet their career goals. The fourth component is long-term outcomes, which we organize by hoped-for benefits to individuals, institutions, and the community.

The key to the logic model is the dynamic flow of the relationships between and among the inputs, outputs, and outcomes. Understanding the expected connections among these components of the model will allow for systematic monitoring and evaluation so that the initiatives can undertake continuous improvements.218

Advantages and Challenges

Establishing a comprehensive workforce development system could allow industry leaders/businesses across multiple sectors (e.g., energy, education, health and social services, agriculture, tourism) to pull from a strong pool of talent on the island (thereby attracting more businesses to the island without the need for tax breaks or other incentives), support retention of talent, and enhance the education system so that it keeps pace with evolving skills needs of industry. This would affect labor availability, and potentially wages, and improve efficiencies in the delivery of education and training. Furthermore, developing and enhancing a comprehensive workforce development system in Puerto Rico could (1) improve the labor force participation rate (by engaging heretofore dislocated and disengaged workers who otherwise would not be gainfully employed) and (2) increase individuals’ education levels and skill sets. This could have numerous benefits to individuals and to the island’s economy and community well-being. For example, individuals could experience greater earnings potential219 and increased job satisfaction.220 They


would be able to make more informed decisions about health, marriage, and parenting\textsuperscript{221} and become more goal-oriented and less likely to engage in risky behavior.\textsuperscript{222} They can expect positive effects on their children’s education and employment outcomes and health and well-being\textsuperscript{223} and improved trust and social interactions.\textsuperscript{224} These relationships hold even when analyses consider a variety of individual family backgrounds or other characteristics.\textsuperscript{225} For the island’s economic development and community well-being, improvements in the average years of education and increased workforce training have been associated with a community’s higher levels of volunteering and voting,\textsuperscript{226} better birth outcomes and higher levels of school readiness in the next generation,\textsuperscript{227} lower levels of criminal behavior,\textsuperscript{228} and higher levels of economic growth.\textsuperscript{229} 

There are many challenges to implementing a comprehensive workforce development system that require coordination among key stakeholders. The effort entails designing and implementing a workforce and education policy framework to support multiple training programs to meet various sectors’ needs; conducting skills-gap analyses; finding instructional staff to fill positions; finding sufficient funds to stand up brick-and-mortar facilities alongside online programming; instituting on-the-job experiences; and collaborations among education and industry to develop curriculum and find materials. In addition, as detailed in Chapter 2, there is not a robust community college system or public postsecondary education system for establishing the workforce development programs that will be required to fulfill the short-term and longer-term

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demand. Limited resources, competition for skilled workers, and a lack of alignment across industries also pose challenges.

**Potential Funding Mechanisms**

Depending on the range of policies and levers employed and the timeline for activities, costs can vary. Policies to enhance workforce development on the island are ostensibly no cost, whereas a large, comprehensive workforce development system that includes various career and technical centers, incorporates the K–12 education and higher education systems on the island, and meets the needs of all sectors could require long-term funding and a high monetary investment—and could still have a high risk of failure. Possible funding sources for workforce development programs include (1) U.S. Department of Labor Employment and Training Administration grants for apprenticeship programs and other workforce development programs targeted to high-needs occupations, (2) FEMA’s Dislocated Workers program, (3) HUD, (4) Department of Education career and technical education/postsecondary education grants, (5) the U.S. Economic Development Administration; and (6) consortia of private-industry businesses and philanthropic foundations (e.g., Annie E. Casey Foundation).

**Conclusion**

This chapter introduced the various strategies that comprised the Economics Team’s COA ECN 2, Implement Workforce Development Programs. Within that COA, we suggested five strategies—four to meet short-term workforce shortages, and a fifth that is intended to be an aspirational plan to support the government of Puerto Rico in meeting its ambitious goal of building a 21st-century workforce. However, there are a number of challenges to developing such a system. One way to overcome these obstacles is for the government of Puerto Rico to build a broad coalition of partners that traverses public, private, and education sectors. Chapter 6 provides suggested tactics for the government of Puerto Rico to move forward in the Recovery Plan and offers guidance on how to prioritize the strategies outlined in this chapter and how to implement any selected strategies, given potential challenges and capacity issues.

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6. Implementing the Workforce Development System Framework to Support a 21st-Century Workforce in Puerto Rico

To meet the ambitious goals set forth in the recovery plan’s strategic objective to build a 21st-century workforce, Puerto Rico needs to alter the composition of its training institutions and the policy structure in which workforce training takes place. To support the creation and sustainability of a comprehensive workforce development system to meet short- and longer-term workforce needs, the government of Puerto Rico could start with a policy framework that supports multiple training programs, objective and evolving information and research about skill gaps, instructional staff in training programs, and collaboration between educational professionals and the private sector, such as the framework we provide in Chapter 5. Implementing a multipronged effort could help propel Puerto Rico on to a path to building a strong and flexible workforce development system that meets the goal of supporting a 21st-century workforce. In this chapter, we first offer specific strategies the government of Puerto Rico can employ to implement the various planning, policies, and investments (inputs) and activities outlined in Figure 5.2, Proposed Workforce Development System Framework for Puerto Rico’s Recovery. We then apply these efforts to specific industries in Puerto Rico. We conclude with a suggested process the government of Puerto Rico can undertake to prioritize among the various inputs and activities.

Planning, Policies, and Investments Needed to Launch a Successful Workforce Development System in Puerto Rico

First, we describe the policies, planning efforts, and investments (inputs) the government of Puerto Rico could undertake to support a comprehensive workforce development system in Puerto Rico. These inputs are

- government policies to support the structure of a workforce development system and that incentivize employment
- cross-industry planning (government-industry-education)
- industry-specific blueprints
- skills and career pipeline analyses
- data infrastructure for integrated job opportunities by municipio, occupation, and industry
- materials, equipment, and facilities for educational and training institutions.
Establish Government Policies to Support Structures and Incentives for the Workforce Development System

**Incentivize work in the formal labor market and for talent to remain in Puerto Rico for employment.** As discussed in Part I of this report, Puerto Rico faces the unique challenge of having a large informal labor force and heavy migration of working-age people out of Puerto Rico. To ensure that Puerto Rico’s workforce development system is agile and meets the needs of the potential talent pool, we suggest that the government of Puerto Rico promulgate policies to incentivize working-age adults to enter jobs in the formal labor market that are in high demand and for graduates from education and training institutions to remain in Puerto Rico for employment.

Two Economics courses of action listed in the Recovery Plan support these policies. The first is ECN 31, Change Social Welfare and Benefits Policy, which proposes altering the structure of social welfare benefits and individual income tax policy, which could remove the disincentives for work created by the current structure. By reducing the overall level of benefits and/or changing the eligibility structure of certain benefits (e.g., establishing work requirements or using an income tax credits to change hard thresholds for benefits eligibility and thus the incentive to work), beneficiaries would be incentivized to enter the labor force. Lowering individual tax rates would stimulate consumption spending or saving. There may also be fiscal benefits on the expenditure side, depending on the policy (e.g., if benefits are lowered). Additional economic activity and associated tax collections may partially or fully offset reduced marginal tax rates over time. There may also be increased participation in the formal financial system as workers transition to the formal economy. COA ECN 5, Improve Retention of Educated Workforce Through Policy Change, suggests that the government of Puerto Rico create incentives for UPR graduates to remain in Puerto Rico.

Two other possible strategies for the government of Puerto Rico to consider are income share agreements (ISAs) and loan forgiveness. ISAs are contracts between a student and a tuition funder (either an educational or financial institution) in which student borrowers sign a contract to repay a fixed fraction of their future income for a set term, rather than agreeing to a fixed payment amount, in exchange for payment of current tuition. Payment terms (rate and length of payment period) are a function of the school attended and the major pursued. Many small institutions in the CONUS, such as coding bootcamps, started using ISAs as a way to defray the upfront costs for nontraditional students. As ISAs have gained in popularity, Vemo Education has partnered with a range of colleges and universities to offer ISAs to a broader population of students, including students at Purdue, Clarkson, Messiah College, Lackawanna College, and

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Norwich University. The state of California intends to fund ISA pilot programs at a University of California and a CalState campus to explore their potential for increasing college affordability. The flexibility of an ISA gives it unique applicability to the graduate-retention problem faced by Puerto Rico. While changing loan payments to a proportion of income will already improve the comparative attractiveness of being employed in Puerto Rico, the payment rate and period could additionally be conditioned on remaining in Puerto Rico, such that those who emigrate to the CONUS after being trained in Puerto Rico must pay a higher percentage of their (already higher) income.

A second financing model that could incentivize graduates to stay in Puerto Rico after graduation while also increasing access to training opportunities is the loan forgiveness model. Whereas an ISA replaces an educational loan, loan forgiveness has been used in the United States primarily to recruit and retain teachers and physicians into rural and underserved communities. While those employed in public service in Puerto Rico are eligible for the federal Public Student Loan Forgiveness program, the vast majority of applicants (independent of geography) were denied loan forgiveness, reportedly because of loan or employment ineligibility or incomplete paperwork. Occupation-specific programs have found that rightsized loan forgiveness programs result in recruits generally completing their term of service and survey results indicate that loan forgiveness programs increase the willingness to work in underserved communities. Thus, the government of Puerto Rico could consider loan forgiveness as a mechanism for increasing retention in hard-to-fill occupations and underserved communities. Loan forgiveness for physicians, for example, could be contingent on working in one of the 72 municipios designated as underserved by HRSA, and the forgiveness could be gradual to ensure long-term retention. Similar incentives could be used to defray educational expenses for other medical occupations.

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Update WIOA State Plan. Congress passed on July 9, 2014 (and the President then signed on July 11) the Workforce Innovation and Opportunity Act of 2014. This Act reauthorizes the Workforce Investment Act of 1998 and ties federal workforce training money to local and regional employers who will help customize training programs at high schools and community colleges. It also consolidates programs and provides more local flexibility in how they are run. The aim is to promote workforce development programs that are directly tied to skills demands. The WIOA requires states to develop unified plans across all WIOA-authorized programs and encourages them to incorporate demand-driven and job-driven efforts into their new plans. It also mandates that states encourage and sustain sector-based partnerships that aid in skills and training alignment at the local level between colleges, labor unions, workforce agencies, and other stakeholders; however, to date, little to no funding has been dedicated to carrying out this mandate within Puerto Rico. We suggest that the government of Puerto Rico update the WIOA State Plan to focus its programs and incentives on high-priority sectors and capabilities (e.g., aerospace, software development, construction, and creative services).

Reduce burdens to obtain occupational licensing. To create a more open labor market and further incentivize talent to enter the formal labor force, we suggest that the government of Puerto Rico take inventory of all occupational licensing requirements and undertake reforms to reduce unnecessary regulations, creating a more open labor market. This effort was also suggested in the New Fiscal Plan for Puerto Rico.

Invest in research and partnerships. Research partnerships leverage the intellectual capital of Puerto Rico, which might increase overall levels of productivity or develop marketable solutions and products to increase economic growth. This policy suggestion is also mentioned in the Puerto Rico Recovery Plan under ECN 7, Create Research Centers and Partnerships.

Incentivize entrepreneurship. Two courses of action in the Puerto Rico Recovery Plan suggest that the government of Puerto Rico train and support entrepreneurs who can start businesses in Puerto Rico, where they create new products and services that Puerto Rico can then export. The COAs also promote public-private partnerships. Ultimately, if successful, the new businesses will generate local job opportunities. The COAs are ECN 12, Provide Innovation and Entrepreneurial Training, and ECN 28, Implement Initiative to Promote Entrepreneurship.

Institute job creation efforts. Two courses of action in the Recovery Plan—ECN 25, Assist Dislocated Workers Through the Use of Existing Grants, and ECN 23, Implement Job Creation Initiative—suggest and outline plans for the government of Puerto Rico to create jobs within communities, especially jobs targeted at women and young adults. Individuals could work in or near their communities in physical and social reconstruction projects. These COAs were also

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suggested in the *Build Back Better Puerto Rico* plan. Disaster Dislocated Worker Grants, which were also included in the *Build Back Better* plan, provide funding to create temporary employment opportunities to assist with cleanup and recovery efforts when an area impacted by disaster is declared eligible for public assistance by FEMA or other federal agencies.

**Plan Cross-Sector (Government-Industry-Education) Initiatives**

**Define geographic economic zones.** This collection of policy levers defines particular geographic economic zones or districts with varying levels of benefits, including tax advantages and waivers of certain regulations, and state-chartered private-lending institutions offering help to businesses that conventional lenders consider too risky but that do not have the high-growth potential required by venture capitalists. These plans and policies are derived from COA ECN 8, Define and Develop Economic Development Zones, and ECN 33, Establish Business and Industrial Development Corporations (BIDCOs).

**Build industry-based public-private partnerships.** Industry-based models are partnerships between public agencies and the economic stakeholders in a targeted industry, cluster of industries, or occupations. The partnership plans and implements customized education and training programs to upgrade the skills of the workforce and improve the economic performance of the region. Thus, rather than one employer working with an education or training program to fill jobs, industry-based programs involve multiple employers in a region or industry sector that articulate their workforce and skills demands and numerous education and training institutions—both private and public—working collectively to meet the needs of employers. Because the industry approach targets an entire industry rather than a single company, an industry-based program may involve the government or public sector to help an entire industry become more competitive.

Industry-based partnerships are often organically created by a group of employers that identify a common workforce need. Industry-based partnerships usually involve employers in a region cooperating with each other and with education institutions to train prospective workers, using applied classroom training or training that includes career pathways. Long-term industry partnerships increase efficiency by building a network of trust in which employers share information about business needs, share time and monetary investment in initiatives, and rely on

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244 Brown, 2018.

the program for hiring and training. These partnerships have benefits beyond hiring and training efficiency for the employers involved. Educators, working in collaboration with employers, have a better understanding of a region’s needs. Potential trainees and employees have greater access to career-advancing training, of particular importance for disadvantaged populations. Regions with such partnerships benefit from increased economic development and an improved ability to retain skilled populations.

Employer buy-in increases the ability to reorganize and redesign existing positions to create a more sustainable skills ecosystem, of particular importance for retention-plagued sectors and regions like health care in Puerto Rico.

Implementing the industry-based approach is often more successful with an intermediary (e.g., nonprofit, public agency, union) that can bolster and maintain relationships between stakeholders, including institutions of higher learning and other training providers, local industry, and local government. Intermediaries oftentimes will coordinate activities, staff partnerships, and communicate strategies; although employers are important members of these partnerships, they generally do not serve as intermediaries. The intermediary facilitates partnerships with employers, links employers and potential employees, or encourages employers to develop curriculum, evaluation and assessment tools, and on-the-job experiences for training participants or to commit to interviewing graduates of training programs. The organizations most likely to act as intermediaries are Workforce Development Boards and community-based organizations. Other types of organizations play a role in industry-based programs such as community colleges, economic development agencies or community development corporations, employers and employer associations, unions, and research or advocacy organizations.

Examples of industry-based partnerships include the Center for Energy Workforce Development, a partnership of electric, natural gas, and nuclear utilities, unions, and their associations; the Aerospace Joint Apprenticeship Committee, a partnership between Boeing and the International Association of Machinists and Aerospace workers; and Kaiser Permanente and a coalition of its unions. Industry-based partnerships are discussed in more detail later in this chapter.

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248 Kochan, Finegold, and Osterman, 2012; Conway and Giloth, 2014.
Design Industry-Specific Blueprints

A third input to the Puerto Rico workforce development system is the planning and design for industry-specific training systems. Although each industry within Puerto Rico has unique needs and specific employer partnerships that could be developed, it is important that industry-based partnerships and programming be devised in a coherent manner so that there are no duplications of efforts and so that individual programming can be developed in tandem. Example types of blueprints to meet industry-specific workforce needs are listed here (and elaborated in more details later in this chapter).

- **Construction.** Design and stand up national training centers for construction that incorporate secondary school programs, vocational training programs, and business training programs.

- **K–12 Education.** Expand and update secondary vocational programs in Puerto Rico to align with changing workforce needs. Develop and implement new professional development and talent management systems for K–12 teachers and administrators. These efforts are articulated in more depth in Education sector COAs itemized in the Recovery Plan: EDU 6, Expand and Update K–12 Vocational Program; EDU 8, Strengthen School Leadership Pipeline; and EDU 9, Develop and Implement Teacher Pipeline Program.

- **Energy.** Train a workforce capable of installing, operating, and maintaining Puerto Rico’s future energy system (especially in asset management, system planning, and data management) and quickly responding to and repairing damage to the electric system. This is elaborate on in more depth in the Energy sector COA ENR 18, Rightsize and Train the Future Energy Workforce, in the Recovery Plan.

- **Health.** Expand incentives to retain and train the health care and public health workforce to mitigate shortages in some health specialties and outmigration of the health care workforce. Initiatives include loan repayment programs and policies that allow nurse practitioners and PAs from other states to provide care in Puerto Rico. This is discussed in more depth in the Health and Social Services COA HSS 11, Add Incentives and Other Supports to Increase and Retain Supply of Health Providers, in the Puerto Rico Recovery Plan.

Conduct Skills and Career Pipeline Analyses

Before beginning any workforce planning and policymaking, it is necessary to conduct analyses on skills demand and labor supply. These types of analyses will support career pipelines by allowing local businesses to better understand the available labor supply and help the government create (and modify through time) its plan to train workers for the needs of local employers. The government of Puerto Rico could use the information to implement new strategies that would better align labor supply with labor demand. While Puerto Rico’s Department of Labor and Human Resources (Departamento del Trabajo y Recursos Humanos) conducts a survey of employers to identify in-demand skills and occupations,\(^{255}\) information on the supply side is missing—information that is crucial for identifying gaps in training pipelines. The *Build Back

\(^{255}\) Departamento del Trabajo y Recursos Humanos, *Destrezas y Ocupaciones en Mayor Demanda* 2017, December 2018.
**Better Puerto Rico** plan and ECN 26, Conduct Studies for Workforce Development and Rapid Response, from the Recovery Plan highlight the importance of these types of analyses.

**Build Data Infrastructure for Integrated Job Opportunities by Municipio, Occupation, and Industry**

To support jobseekers’ awareness of available job openings and training opportunities, we suggest that the government of Puerto Rico build and maintain a person-centered and comprehensive job portal for all businesses and job seekers. Before launching a job portal, the first step would be to build the infrastructure and interface for the portal. This input comports with COA ECN 6, Improve Data Collection, Analysis, and Presentation—a collection of policy levers addressing the use of publicly available data—which was noted in the Puerto Rico Recovery Plan.

**Create Facilities for Educational and Training Institutions**

To ensure that jobseekers from across the island, especially those most in need of employment, have opportunities for training, we suggest that the government of Puerto Rico build or upgrade centers of excellence, career and technical education centers, and other nodes for training and development in centrally located and rural areas across the island. This would improve geographic alignment between jobs available and training centers and provide more training and education opportunities for the underemployed and unemployed. The Puerto Rico Recovery Plan documents this idea in the Telecommunications/IT sector COA CIT 28, Innovation Economy/Human Capital, which creates a public-private initiative to provide digital skills training, entrepreneurship programs, and access to new technologies through a network of innovation hubs and entrepreneur centers, training partnerships with schools, and outreach via mobile labs deployed to rural and underserved areas. This COA promotes a digitally literate employment pool for tech-reliant industries.

**Suggested Key Activities the Government of Puerto Rico Can Undertake**

In this section we elaborate on the four *activities* articulated in Figure 5.2 in Chapter 5. These are key structures to a 21st-century workforce training model that are currently missing or in need of change in Puerto Rico. In order to address this need, Puerto Rico’s Department of Labor and Human Resources, in concert with and with financial support from the U.S. Department of Labor, could (1) develop career pathway models, (2) build a comprehensive job portal, (3) improve Puerto Rico’s career and technical education, and (4) increase on-the-job training opportunities.
Activity 1. Develop Career Pathway Models

The development of career pathways has garnered increased attention, especially at the federal level, as a method to strengthen workforce development systems. In April 2012, the U.S. Departments of Education, Labor, and Health and Human Services jointly issued a letter promoting the adoption of career pathways as a way to ensure that adults and youth have opportunities to gain industry-recognized credentials and skills that allow them to secure employment and advance up a career ladder. The letter defines career pathways as a “series of connected education and training strategies and support services that enable individuals to secure industry relevant certification and obtain employment within an occupational area and to advance to higher levels of future education and employment in that area.”

This perspective represents a shift from conventional thinking. In the 1980s and 1990s, a key goal of a workforce development system was to build a job ladder for the working poor or underemployed that allowed them to move, as needed, from adult “basic” education to a higher education degree and skills training. People would enter this ladder at the appropriate point and then move up. In contrast, a career pathways model is less structured and hierarchical: It is a partnership composed of multiple education, community, and industry partners that provide youth and adults with multiple opportunities to pursue a career ladder in high-demand industries. Career pathways models are designed using real-time labor market information and active employer involvement to ensure that training and education programs meet the skill and competency needs of local employers. Because career pathways systematically link education programs and certifications to the occupational structures in industries, workers can move in and out of education and work to advance their knowledge as well as their careers. The vision for a career pathways model is to have demand-driven education and a workforce development system that aims to be more responsive to the needs of employers and accommodates the wide variation in the ways adults sequence their education and careers.

Industry-based partnerships serve as a platform for the development of career pathways. Within a career pathways model, industry-recognized education and training that incorporates support services (e.g., counseling, transportation, child care, and mentoring) and that has strong linkages to local and regional employers can flourish. It is a “customer-centered approach” in

which talent can better navigate employment opportunities and customize the education and training needed to obtain a job. The resulting credentials can be portable across employers and geographies and stackable with other training certifications.

The portability of credentials within a career pathway model allows the credentials to be taken to any employer or educational institution, as they are externally accredited and thus universally recognized and accepted. Many credentials earned online fall into this category, reaching broader audiences than ever before.\textsuperscript{259} Portable credentials increase geographic and industry mobility for workers, broadening passable career pathways.\textsuperscript{260} Stackable credentials are industry-accepted certificates that, when combined, can become a higher-level credential like a certificate or associate’s degree.\textsuperscript{261} Stackable credentials increase access for income-constrained working adults and thus reduce stop-out and dropout risks\textsuperscript{262} because of their short duration and modular flexibility.\textsuperscript{263} “Lattice” credentialing is a version of stackable credentialing: In this model, students receive foundational certificates that serve as launch pads for multiple pathways in related occupational fields within a specific industry. A student first obtains a basic qualification like a high school diploma and can then qualify for an entry-level position and subsequent specialization within that career field.\textsuperscript{264} Box 6.1 describes an example of lattice credentialing in the health industry.

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\textbf{Box 6.1. Rogue Community College Creates Pathways to Health Careers for All Learners}\\
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The Basic Health Care certificate program created by Rogue Community College in Oregon is an example of lattice credentialing. After taking a skill placement test, students are sorted into introductory courses. After completing these requirements, they can choose among a variety of specialties, such as health care informatics, massage therapy, dental assisting, and nursing. These specialty courses can be leveraged into the foundation for an advanced credential, such as a higher-level certificate or associate’s degree.\\
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Stackable credentialing has been used as a means for individuals to acquire skills in health-related careers to meet the increasing demand for health care professionals\textsuperscript{265} Similarly, in the construction industry, stackable credentials and apprenticeships can be used to certify individuals

\textsuperscript{262} Austin et al., 2012.
\textsuperscript{264} Evelyn Ganzglass, “‘Scaling Stackable Credentials’: Implications for Implementation and Policy,” Center for Postsecondary Economic Success, 2014.
\textsuperscript{265} Lakin and Underwood, 2017.
with little to no accumulation of debt. For example, individuals could stack credentials to obtain 
journeyperson status in one to six years depending on the field.\textsuperscript{266} There are several successful examples of stackable credentials in the CONUS, including an energy sector model, ShaleNET, described in Box 6.2. Figure 6.1 illustrates ShaleNET’s stackable credential model, which includes a range of skills and certifications that build to a bachelor’s degree. We discuss the application of such a model to Puerto Rico’s energy sector later in the chapter.

Box 6.2. ShaleNET Prepares Midwesterners for Energy Careers, Not Just Jobs

ShaleNET is an example of a portable/stackable training institution that serves the energy sector. Started by a $4.94 million grant to a set of technical and community colleges in Pennsylvania and Ohio, ShaleNET initially offered five occupational training programs that the energy industry identified as high need and, with further grants, expanded into a fully stackable model.\textsuperscript{267}

Figure 6.1. An Example of a Stackable Credential Model, ShaleNET

\begin{figure}
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\includegraphics[width=\textwidth]{diagram.png}
\caption{An Example of a Stackable Credential Model, ShaleNET}
\end{figure}

\textsuperscript{266} Utah State Board of Education, “Construction,” undated; Conway and Giloth, 2014.

\textsuperscript{267} ShaleNET, “About,” webpage, undated.
Activity 2. Build a Comprehensive Web-Based Job Portal

To further address labor market issues facing Puerto Rico, ready and available talent needs to be matched to appropriate jobs and careers—a process that can be greatly improved with substantial technological infrastructure. Moreover, as discussed in the previous section, real-time job information is critical to the success of the career pathways model. Although web-based job portals abound, most are not geared toward the local job market. For example, the U.S. Department of Labor’s job and career information portal, “My Next Move” website, has a Spanish-language version, “Mi Próximo Paso,” but both versions of this site lack career outlook information for any of the U.S. territories (including Puerto Rico).

To facilitate matching, we suggest that in cooperation with the U.S. Department of Labor, Puerto Rico’s Department of Labor and Human Resources build a web-based platform that links personal interests and skills to training that is within the context of career outlook and local job openings. Because individuals entering or reentering the labor market generally lack formal career-relevant networks, such a resource is particularly paramount and would help the unemployed or those in overcrowded occupations (such as teaching) retrain in a sustainable—and enjoyable—career.

Diversify and Enhance Training Opportunities Available

Activity 3. Provide On-the-Job Training Opportunities

Apprenticeships. An apprenticeship is a system of training that combines classroom learning with on-the-job training. Apprenticeships generally follow an “earn and learn” model, in which an apprentice works for an employer as part of their training. Historically, apprenticeships have been focused in the building and construction sectors (e.g., for electricians, welders, carpenters, or plumbers), though recently they have expanded to other sectors such as energy, health care, and information technology. In the CONUS, the vast majority of apprenticeships are registered apprenticeships. These apprenticeships meet quality standards set by the U.S. Department of Labor, including direct business involvement, on-the-job training, career-related instruction and quality of instruction, and ratio of apprentices to journey workers, and must allow the apprentice to obtain a nationally recognized occupational credential. In exchange for registering and

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268 The tendency toward multigenerational households in Puerto Rico means that residents are even more geographically constrained than typical job seekers, underscoring the importance of understanding local opportunities (see N. Sarkisian, M. Gerena, and N. Gerstel, “Extended Family Ties Among Mexicans, Puerto Ricans, and Whites: Superintegration or Disintegration?” Family Relations, Vol. 55, No. 3, pp. 331–344).


meeting federal standards, registered apprenticeships entitle the sponsor to funds supporting technical assistance, tax credits, and other federal resources.\textsuperscript{272} There have been recent policy proposals to expand federal funding to nonregistered apprenticeships to increase their growth,\textsuperscript{273} but these policies have not been enacted. In the U.S. context, nonregistered apprenticeships are considered on-the-job training and the nomenclature of “apprenticeship” is not used.\textsuperscript{274} Our description of apprenticeships and their benefits refers to, and relies on data based on, registered apprenticeships.

Apprenticeships are generally one to six years in length and must include a minimum of 2,000 hours of on-the-job training and 144 hours of classroom instruction. According to the BLS, in 2016, the median wages of apprenticeship-trained occupations were well above the median income of $37,400. For example, carpenters earned $43,600; plumbers, pipefitters, and steamfitters earned $51,450; electricians earned $52,720. By 2018, there were approximately 500,000 apprenticeships across 150,000 businesses apprenticeship programs within the federally registered system.

Beyond being an opportunity for workforce and skills development, apprenticeships have also been shown to contribute to youth and social development and to improve mental health outcomes.\textsuperscript{275} Moreover, given that apprenticeships involve on-the-job training in addition to classroom education, they appeal to those with a large variety of learning styles\textsuperscript{276} and thus may appeal to a potential talent pool that does not learn well in a traditional classroom setting.

As discussed briefly in Chapter 2, Puerto Rico does not currently have any registered apprenticeships. However, there have been recent efforts to initiate apprenticeships. In 2016, Puerto Rico’s Department of Labor and Human Resources won $200,000 from the U.S. Department of Labor as part of the ApprenticeshipUSA accelerator grants to “help integrate apprenticeship into their education and workforce systems; engage industry and other partners to expand apprenticeship to new sectors and new populations at scale; conduct outreach and work with employers to start new programs; promote greater inclusion and diversity in apprenticeships, and implement state incentives and system reforms.”\textsuperscript{277} Interviews with officials at the Governor’s Office of Workforce Development in December of 2018 revealed that the government of Puerto Rico was reenergizing its efforts to launch apprenticeship programs among the private-sector


\textsuperscript{275} John Buchanan, et al., \textit{Beyond Mentoring: Social Support Structures for Young Australian Carpentry Apprentices}, Adelaide: NCVER, 2016.

\textsuperscript{276} Conway and Gilo, 2014.

\textsuperscript{277} U.S. Department of Labor, 2016.
community. In support of this effort, below are three tactics we recommend the government of Puerto Rico implement to launch and maintain a successful apprenticeship system.

1. **Provide Technical Support for Employers.** Although government agencies and industry partnerships are vital to building an apprenticeship system, the onus of starting an apprenticeship ultimately lies with employers, who hold the key to opportunities. Hence, a critical aspect of apprenticeship success and utilization is providing technical support and assistance to employers who are starting, or considering starting, apprenticeships to help with the design of apprenticeship program, to connect employers with educational institutions to recruit apprenticeships or house classroom training, and to register the program with the Department of Labor. Box 6.3 describes one such program: Apprenticeship Carolina Initiative.

   **Box 6.3. Example Employer Technical Assistance: Apprenticeship Carolina Initiative (ACI)**

| Affiliated with the South Carolina Technical College System, ACI provides free technical assistance to employers to create registered apprenticeship programs. Employers also receive a $1,000 tax credit per year for each apprentice they hire for up to four years of training per apprentice. The number of programs increased 528 percent and the number of apprentices increased 450 percent because of the initiative. Additionally, the program adds about 120 new apprentices each month. All 16 technical colleges and all 46 counties in South Carolina participate in this program. |

2. **Create Pre-Apprenticeships for Individuals New to an Industry.** Pre-apprenticeships are designed to prepare individuals new to an industry so that they can gain critical academic skills and receive the combination of industry-based training and classroom instruction needed to move along a pathway into an apprenticeship program. Box 6.4 describes one such program called Partners for a Competitive Workforce. In 2012, the U.S. Department of Labor Employment and Training Administration defined a “quality” pre-apprenticeship program as one that includes certain components. These components include:

- a partnership with a registered apprenticeship sponsor
- an approved training curriculum that is based on industry standards and approved by the registered apprentice partner/sponsor
- strategies that aim to increase the opportunities for participants to complete the program and meet the entry requirements of the registered apprenticeship, such as hands-on training
- industry-recognized credentials
- hands-on-training that does not displace paid employees (for example, in a simulated workplace)
- access for participants to appropriate supportive services
- support for the use of registered apprenticeships among employers

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278 Conway and Giloth, 2014.
formalized articulation agreements with registered apprenticeships that allow those who successfully complete the program to enter directly into a registered apprenticeship.

**Box 6.4. Example Pre-Apprenticeship: Partners for a Competitive Workforce (PCW)**

PCW is a Cincinnati partnership of educational institutions, chambers of commerce, private foundations, businesses, service providers, and workforce investment boards. The PCW supports multiple pre-apprenticeship programs. One is a subsidy program that provides support during apprenticeship for individuals who completed the pre-apprenticeship program. Easterseals, a local nonprofit that runs a pre-apprenticeship program, with support from PCW, hired a retention counselor. The effort was intended to replicate the success that PCW had in improving retention in health care apprenticeships. During the two-year pilot program, the retention counselor supported 57 electrician apprentices through mentorship, peer group meetings, and math tutoring. The retention counselor also tried to boost morale and excitement. After 20 months, in June 2013, the retention rate was 80 percent, higher than previous research would suggest (55 percent for men and 74 percent for women).281

3. **Incorporate Inclusionary Policies for Populations Typically Underrepresented in Apprenticeships.** Apprenticeships are associated with jobs that pay higher-than-median wages. Yet apprenticeships do not typically reflect the working-age population who could be most in need of these types of opportunities: unemployed and underemployed low-income workers, women, and opportunity (at-risk) youth. For example, as noted in Table 2.3 in Chapter 2, the most common apprenticeships in the United States are in building and construction. Because these are typically male-dominated fields, women are underrepresented in apprenticeship programs: Only 7 percent of federal registered apprenticeships are held by women.282 Moreover, conditional on having an apprenticeship, women are paid less than their male counterparts.

In addition, apprenticeships are not catch-all opportunities that can incorporate all potential workers. Rather, apprenticeships are typically effective for individuals who possess good foundational skills or who have already been successfully employed previously, but these strategies are not as effective for those workers who lack developmental education, such as reading and math skills, or who have barriers to employment, such as substance abuse or depression.283 This is of concern in Puerto Rico, where there are large pools of workers in the informal market who do not have a track record of employment in the formal labor market and whose working-age population has a high share of high school dropouts and thus might lack the foundational reading and mathematics skills that would make them successful in an apprenticeship.284

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281 Conway and Giloth, 2014.
Because they are paid opportunities, apprenticeships may be more accessible than traditional educational systems. Apprentice opportunities are paid while they work, greatly reducing the need for debt-based financing or a period without income often associated with full-time education. However, schedules can be demanding and can include work during the day, coursework in the evenings, and homework on the weekends. Offering wraparound services for women with children or social services for apprentices coming from lower-income houses can ensure that underrepresented talent can succeed in apprenticeships.

Clearly, merely offering apprenticeships is not sufficient to guarantee that they are inclusive workforce policies. Additional support for apprenticeship trainees (e.g., childcare, books, and supplies) broadens access to apprenticeships for women, parents of young children, and low-income workers.

**Internships, Cooperative Education Models, and Work-Based Learning.** In addition, building integrated programs with institutions of higher learning, creating internships and cooperative education, and where possible, offering online degrees and certificate programs can all support the success of sector-based regional approaches. Indeed, “co-ops”—cooperative educational experiences—are integral in the curriculum of several universities, such as Northeastern University and Rochester Institute of Technology, where students are required to take part in a co-op before graduating. A co-op is a paid, focused internship in the field of the student’s education, allowing the student to test their skills, experience what working in that field is like, and make a good impression on a potential future employer. Furthermore, online education has strengthened internships and co-ops: students are less constrained geographically during their training.

**Activity 4. Build a More Robust K–14 Career and Technical Education System**

CTE provides secondary and postsecondary students with content that is hands-on and applied but still presented in a classroom setting. Unlike previous iterations, such as pure vocational training, CTE encompasses fields that require high school, associate, as well as bachelor’s degrees. CTE programs are most common in high school and are associated with academic success. For high school students in CTE programs, the graduation rate is about 15-percentage-points higher than the national average. Additionally, CTE students are more likely to

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286 Conway and Giloth, 2014.
graduate on time and have higher attendance rates.\textsuperscript{290} However, there are postsecondary CTE classes as well. As part of WIOA, publicly funded CTE programs are managed on the state level. CTE delivery in Puerto Rico occurs in comprehensive high schools, CTE high schools, area CTE centers, specialized career schools, special education schools, and technical institutes. The number of these institutions are as follows:\textsuperscript{291}

- **High schools**: 167 public high schools; 30 primarily CTE high schools
- **High school enrollment**: 77,167 public high school enrollment; 34,277 high school CTE enrollment
- **Postsecondary**: 7 public community colleges; 3,400 community college enrollment, 2,786 postsecondary CTE concentrators

The scope and policy levers of CTE are not limited to or restricted by Perkins funding and WIOA allocation. CTE is a type of workforce training program that is supported through federal grants, but CTE exists outside of what is federally funded. There are numerous ways to incorporate CTE into broader workforce development strategies and career pipelines. We note policy recommendations to strengthen the use and utility of CTE. Some of these policies can or do use existing federal dollars; others can rely on public-private partnerships or private funds.

**CTE and Apprenticeships.** As Puerto Rico works to expand its apprenticeship system, alignment with CTE programs in high schools and community colleges can both help introduce students to career pathways and prepare them for the rigor of apprenticeships. CTE programs that are aligned with registered apprenticeship programs can enhance student work experiences. Increasing cross-agency support for CTE and registered apprenticeships, developing technical assistance at regional and local levels, spreading awareness of program benefits, and tackling barriers to entry (for students and employers) could improve ties between CTE and registered apprenticeships.\textsuperscript{292} Well-aligned CTE and apprenticeships can provide pipelines from education to training and employment or serve directly as pre-apprenticeship programs during high school. Box 6.5 gives an example of a pre-apprenticeship CTE program that is school based.

Although many high school CTE and apprenticeship links are at the local level—a nearby employer partnering with a nearby high school to prepare students for apprenticeships from which they hire—there can be national partnerships as well, in which high schools follow curricula and training requirements for CTE that were designed to fit any high school.

\begin{footnotesize}
\begin{enumerate}
\item Advance CTE, 2019.
\item U.S. Department of Labor, 2016.
\end{enumerate}
\end{footnotesize}
Secondary CTE: Career Magnet High Schools. Secondary CTE education (see Box 6.6 for an example) can be embedded in a traditional high school. CTE classes can be on-site or off-site, depending on the nature of the field and requirements, and a select number of students participate. In some cases, the program is large enough to be a separate track or program within a high school, called the school-within-a-school approach. California uses this model in 340 public high schools as part of the California Partnership Academies to create small, close-knit cohorts of students and faculty. A more intensive version is a complete career magnet high school (see Box 6.7), in which all of the students participate in CTE training in the same field. These high schools are meant to integrate field-specific training and curriculum with internship and shadowing opportunities. One interesting aspect of career magnet high schools is that the career theme is typically a vertically integrated industry theme. Instead of a high school centered around jobs that require the same education level, career magnets are oriented around single industries or areas that have numerous educational requirements. Box 6.8 describes another CTE high school/college-preparatory school.

Box 6.5. Tech-Ready Apprentices for Careers in Kentucky (TRACK)

TRACK is a school-based, pre-apprenticeship CTE program that started as a pilot in a single Kentucky high school. A local employer, a German-based manufacturer, partnered with the local high school and state agencies to start CTE aligned with future hiring needs. The school and employer designed a small initial program of four students. Eventually, the program was expanded to other schools and currently has three tracks: carpentry, electrical, and manufacturing. The CTE occurs in a student’s final two years of high school; students will log 2,000 on-the-job hours, earn wages, and initial training certificates. The program now boasts 200 students across the state. Since TRACK started, 100 percent of students completed their high school degree and half went on to full apprenticeships.

Box 6.6. Multicraft Core Curriculum (MC3) from the North America’s Building Trades Union (NATBU)

The MC3 is a comprehensive pre-apprenticeship curriculum designed by NATBU, one of the largest construction industry unions in the United States. MC3 was not designed solely or specifically for high schools but can be adopted by federally funded CTE secondary programs. Salinas High School, for example, in Salinas, California, had a long-established cabinet-making vocational program. This vocational program expanded to follow MC3 curricula and eventually became its own school-within-a-school at Salinas High, called the Green Academy. MC3 graduates finish their program with nationally recognized and transferrable pre-apprenticeship certificates.

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HSLJ and DeBakey HS are two magnet career high schools in Houston, Texas. HSLJ\textsuperscript{297} was started in 1981 as a way to recruit minority police officers into the Houston Police Department through targeted coursework and shadowing programs. The school has since expanded to encompass three tracks: law enforcement, legal studies, and firefighting and emergency services. The curriculum includes vocational classes, job shadowing, and paid-work assignments; the post–high school track ranges from the police academy to four-year universities. DeBakey is a similarly organized health high school that tailors curriculum for future doctors and nurses. Students at DeBakey go through clinical and laboratory rotations.

The Harbor School was founded in 2003 as a maritime CTE high school on Governors Island in New York City. It is one of several Urban Assembly schools in New York that are college-preparatory schools and was started in partnership with the South Street Seaport Museum and the Waterkeeper Alliance. Starting sophomore year, students may choose one out of seven programs to focus on for the rest of their high school career: vessel operations, ocean engineering, marine systems technology, professional/scientific diving, advanced marine biology research, marine policy and advocacy, and aquaculture. Recently, the Harbor School faculty and students were chosen to implement and oversee the Billion Oyster Project, an ecosystem restoration project to rebuild the oyster population in the New York harbors.\textsuperscript{298}

**Postsecondary CTE: Public Community College and Industry Trade Schools.** We suggest that Puerto Rico develop a robust public community college system. Although there are some private institutions offering associate’s degrees, a robust system would be localized, geographically diverse, and integrated with the existing public secondary school system and postsecondary school system. Community colleges bridge the gap not only between secondary and four-year schools but also secondary schools and private employers, offering classes intended to lead to a transfer to a four-year institution as well as classes intended to result in a job. Degrees are shorter. There is more flexibility with a nontraditional class structure. There is opportunity for direct collaboration in curriculum design with employers. In addition, Puerto Rico needs more credential-oriented institutions and trade schools. We recommend establishing a trade school network that works directly with industries and local employers to create class-credential-job pipelines that can be incorporated into a community college system.

**Suggested Process for the Government of Puerto Rico to Prioritize and Implement Workforce Development System Inputs and Activities**

The policy options and activities outlined in the five strategies of ECN 2, Implement Workforce Development, are wide-ranging and varied. The suggested options offered in this report may seem daunting or difficult to discern among. Large-scale changes in systems typically require strong leadership and technical capability—to steer the effort, navigate challenges, make


decisions, build consensus and negotiate among stakeholders, coordinate among multiple actors, secure outside funding, and communicate results on an ongoing basis.\textsuperscript{299} In the case of Puerto Rico, we expect that leadership will come from several ministries and government offices such as the Governor’s Office and the Department of Labor and Human Resources, with various involved actors and stakeholders groups such as employers, the Department of Education, UPR, or municipality governments. For all of the strategies articulated in Chapter 5 and 6, effective implementation will require careful planning with clearly articulated goals, well-defined tasks, metrics to measure progress, and timelines. Yet changes and decisions need not be executed all at once.

The vision articulated in this report is that the government of Puerto Rico will deliberate on its priorities and put whichever strategies are selected into action. To assist the government in adjudicating among these strategies and activities, we offer two approaches for prioritizing and then implementing whichever strategies and policies the government of Puerto Rico selects to stem acute workforce shortages and to build its 21st-century workforce in the longer-term.

\textit{Discern Priorities by Creating an Implementation “Roadmap”}

When confronted with a wide range of policy options, strategies, or recommendations, governments and organization often use a “roadmap” to support decisionmaking and to aid implementation.\textsuperscript{300} The goal of an implementation roadmap is to itemize and organize recommendations in a way that reflects decisionmakers’ priorities and takes into consideration factors that could facilitate or hinder implementation. It thus could be a useful tool for the government of Puerto Rico. Table 6.1 presents a two-by-two matrix in which recommendations or strategies and policy levers can be organized by priority and ease of implementation. A roadmap organized in such a way could help the government of Puerto Rico in determining its priorities and determining which strategies to implement in the near and longer term.

\begin{center}
\begin{tabular}{|c|c|}
\hline
 & High Priority & Lower Priority \\
\hline
Easier to Implement & & \\
Harder to Implement & & \\
\hline
\end{tabular}
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\textbf{Table 6.1. Example Implementation Roadmap Matrix: Balancing Priority and Ease of Implementation}

\textsuperscript{299} Vernez, Culbertson, and Constant, 2014.

\textsuperscript{300} For an example implementation roadmap used in the development of the Kurdistan region in Iraq, see Sandra H. Berry, et al., \textit{Designing a System for Collecting Policy-Relevant Data for the Kurdistan Region—Iraq}, Santa Monica, Calif.: RAND Corporation, MC-1184-1, 2014.
This ordering can be used to guide strategy selection and decisionmaking if policymakers view certain recommendations as more important than others or see themselves as having different degrees of capabilities to carry out the various activities within each category.

- A “high priority” strategy needs to be determined by decisionmakers as vital or a foundational strategy. Given the limited capacity of the government of Puerto Rico, its education institutions, and the physical infrastructure as the island recovers from the 2017 hurricanes, it is important to identify those recommendations that need to be implemented earlier than others to address crucial bottlenecks and facilitate further development of the workforce.
- An “easier to implement” strategy would be those activities that involve fewer government agencies or partners—that is, tasks are simple, clear, and easy to monitor and processes or institutions to support implementation are already in place. Focusing on an “easier to implement” strategy could provide crucial momentum to the process of building the workforce to mitigate the acute workforce shortages Puerto Rico is experiencing. As detailed in Chapter 5, the Economics Team devised workforce development strategies that could be easier to implement than others or that do not require involvement of multiple agencies or external partners. These could thus be listed in a roadmap as “easier to implement.”

An implementation roadmap should also include a description of the processes that aid implementation. Vital to the success of any of the strategies selected by the government of Puerto Rico to mitigate acute short-term workforce shortages and to build a 21st-century workforce are the strength and viability of processes that will bring together stakeholders in the government, business, education, and economic community who might have conflicting priorities. It is especially important to forge agreement, establish the channels of communications, create recommended oversight boards (to monitor whether goals are being met), and identify the agents responsible for implementing selected recommendations. An implementation roadmap should also articulate how to build capacity within government, municipalities, and education institutions to implement whichever recommended strategies that the government of Puerto Rico determines are actionable.

Implement Strategies in Phases

So as not to overload a government and its education institutions that are already under capacity because of the 2017 hurricanes, and to also manage the scale of the effort involved, a second approach the government of Puerto Rico can undertake is to phase in the implementation of the strategies that had been prioritized and selected (through the use of an implementation roadmap). Studies of change in large organizations have shown that implementation is most

[^301]: Berry et al., 2014.
successful when done in phases. Below we suggest six phases for the government of Puerto Rico.

- **Phase I. Design policies and procedures.** Once strategies have been prioritized and selected, it is incumbent of the government of Puerto Rico to develop and promulgate the policies, program designs, and functions or responsibilities of staff that will be in charge of implementing the selected strategies or activities. At this phase, funding should be secured. The *inputs* described in Figure 5.2 could provide guidance for the government of Puerto Rico in determining which policies could be designed.

- **Phase II. Craft an implementation plan.** To ensure smooth implementation of any selected strategy or activity, the government of Puerto Rico should develop detailed plans that itemize specific tasks, the person(s) responsible for accomplishing each task, and the timelines for completion. Potential challenges, barriers, or risks to implementing the task must be included in the plan so that any unintended or extenuating circumstances that could hinder implementation can be addressed as far in advance as necessary.

- **Phase III. Create a communication plan and announce decisions.** A communication plan that explains the rationale for decisions can help the government of Puerto Rico engender support and buy-in from the broader stakeholder community. This support is important to ensure that strategies that are put in place are met with support and thus effectively implemented.

- **Phase IV. Begin implementation, monitor and evaluate to continuously improve strategies, and adapt.** It is at this point that implementation of specific strategies can begin. Depending on the priorities and ease of implementation determined in the implementation roadmap, strategies could be implemented on a small scale (with a pilot program) where desirable or at full-scale (across the island). Implementation entails collecting data and monitoring progress; creating a culture of learning from experience; evaluating how to improve; and making changes to plans, targets, policies, and procedures based on lessons learned. At the same time, it will be important to balance improvements and innovation with maintaining consistency of policy for a set period of time. Studies have shown that continuity of policy is important for successful long-term implementation of public-sector reforms.

- **Phase V. Sustain strategies that are deemed successful.** In this phase, the government of Puerto Rico could expand implementation of programs and strategies according to the implementation plan devised in phase II. This last phase should also include methods to

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302 Fixsen et al. (2005) conducted a meta-analysis of over 6,000 papers on public-sector implementation of change initiatives. Also see Harman and Harman, 2003; Nadler and Tushman, 1997.

303 These phases, which are based on Vernez, Culbertson, and Constant (2016) and their suggested phases for implementing education policy and program changes in the Kurdistan region in Iraq, are modified to fit the needs of the government of Puerto Rico.

support the sustainability of programs deemed successful according to metrics determined in the implementation plan in phase II, so that they can continue to have an impact over time. Sustainability management will include determining longer-term budgetary needs, ensuring that management and staff are fully trained over time, stabilizing policies, and establishing and maintaining communications with stakeholders.

Conclusion

This chapter provides a set of tactics that the government of Puerto Rico can use to implement a workforce development system in Puerto Rico that is intended to meet the ambitious goal to build a 21st-century workforce as proposed in the government’s Recovery Plan. The tactics presented here align with the priorities and strategic vision already established in the Recovery Plan. We suggest that the government of Puerto Rico develop appropriate policies and infrastructure to build industry-based public-private partnerships that will lead to career pathway models, a web-based job portal, increased on-the-job training opportunities, and an improved career technical education system. Establishing a publicly funded community college system, trade schools, and apprenticeships to fill education and training gaps are other tactics that can support the Recovery Plan and that will allow Puerto Rico to fill jobs that are needed in the middle-skill and lower-skill level, as well as develop a sustainable education and training system to build capacity of its talent pool. Puerto Rico would be well served by establishing a robust system of public two-year institutions to provide technical credentials, as well as a network of trade schools to provide specialized skill training. These two policies should be accompanied by financing mechanisms that both enhance access to education and training and disincentivize migration to the CONUS. Recognizing that there are myriad programs, efforts, and initiatives the government of Puerto Rico could follow with COA ECN 2, Implement Workforce Development Programs, we also suggest a process by which the government can make decisions on priorities and how best to approach implementation.
7. Conclusions

As documented in this report and the broader literature, recovery of the Puerto Rico economy after Irma and Maria will involve rebuilding the public and private infrastructure, strengthening the supply chains, and further developing the island’s human capital and other contributors to economic output in order to reverse prestorm trends and propel the island into the 21st century. Apart from the impact of the hurricanes, Puerto Rico’s economy has a variety of structural problems that have contributed to a lack of growth over the past decade or so. Before the hurricanes, Puerto Rico was already experiencing major challenges to its workforce including (1) low labor force participation in the formal labor market; (2) outmigration of the working-age population and an attractive informal labor market; (3) a fragmented postsecondary education training system; (4) occupations identified as most in-demand that varied in required years of education; (5) a lack of alignment in education and training opportunities available and the occupations most in-demand in Puerto Rico. Each of these challenges has multiple root causes that may be under the control of multiple actors, including the Puerto Rico government, U.S. federal agencies, and Congress.\(^{305}\)

Strategies to Support Workforce Development as Puerto Rico Rebuilds

To address the challenges confronting Puerto Rico as it rebuilds its workforce, this report offers a set of strategies that are described in the Economics COA ECN 2, Implement Workforce Development Programs, which could be used to meet short-term workforce shortages.

- Strategy 1. Use a Market-Based Response for Workforce Development
- Strategy 2. Import a Skilled and Experienced Workforce from the CONUS
- Strategy 3. Train Puerto Rico Workers Remotely in the CONUS
- Strategy 4. Implement Local Project-Based Training in Puerto Rico

These four strategies focus on meeting the acute short-term need to meet workforce shortages in Puerto Rico. Yet Puerto Rico also faces numerous long-term challenges to building the capacity of a 21st-century workforce. We thus recommend that the government of Puerto Rico consider developing an additional longer-term strategy in its recovery efforts.

- Strategy 5. Develop and Implement a Comprehensive Workforce Development System

This strategy recommends that the government of Puerto Rico incorporate policies and activities that will meet both short-term programming and longer-term capacity building for the

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\(^{305}\) See the challenges and opportunities for the Puerto Rico economy at RAND Corporation, undated.
island’s workforce needs. Such a strategy would need to be comprehensive and systemic. The key challenges to implementing a comprehensive workforce development system are coordination among key stakeholders; designing and implementing a workforce and education policy framework to support multiple training programs to meet various sectors’ needs; conducting skills-gap analyses to find instructional staff to fill positions; finding sufficient funds to stand up brick-and-mortar facilities alongside online programming; instituting on-the-job experiences; and encouraging collaborations among education and industry to develop curriculum and find materials. In addition, there is not a robust community college system or public postsecondary education system that is currently positioned to establish the workforce development programs that will be required to fulfill the short-term and longer-term demand. Limited resources, competition for skilled workers, and a lack of alignment across industries pose other challenges.

Process to Prioritize and Implement Workforce Development Policies and Strategies

The government of Puerto Rico could prioritize and then implement whichever strategies and policies it selects to stem acute workforce shortages and to build its 21st-century workforce in the longer term using two approaches.

Discern Priorities by Creating an Implementation “Roadmap”

When confronted with a wide range of policy options, strategies, or recommendations, governments and organizations often use a “roadmap” to support decisionmaking and to aid implementation. The goal of an implementation roadmap is to itemize and organize recommendations in a way that reflects decisionmakers’ priorities and takes into consideration factors that could facilitate or hinder implementation. A “high priority” strategy needs to be determined by decisionmakers as vital or foundational. An “easier to implement” strategy would be one that involves fewer government agencies or partners because tasks are simple, clear, and easy to monitor and processes or institutions to support implementation are already in place. An implementation roadmap should also include a description of the processes that aid implementation that would be needed. An implementation roadmap should also articulate how to build capacity within government, municipalities, and education institutions to implement whichever recommended strategies the government of Puerto Rico determines are actionable.

Implement Strategies in Phases

So as not to overload a government and its education institutions that are already under capacity because of the 2017 hurricanes, and to also manage the scale of the effort involved, a

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306 Sleeper et al., 2016.
The second approach the government of Puerto Rico can undertake is to phase in the implementation of the strategies that were prioritized and selected through the use of an implementation roadmap. Studies of change in large organizations have shown that implementation is most successful when done in phases. We suggest five phases for the government of Puerto Rico.

- Phase I. Design policies and procedures.
- Phase II. Craft an implementation plan.
- Phase III. Create a communication plan and announce decisions.
- Phase IV. Begin implementation, monitor and evaluate to continuously improve strategies, and adapt.
- Phase V. Sustain strategies that are deemed successful.

Overall these recommendations, working in tandem, will help propel Puerto Rico’s workforce into the 21st century and support more strategic alignment between workforce supply and the skills and occupations in most demand by industries on the island.
Appendix A. Full Text of Economic Team’s *Implement Workforce Development Programs* COA

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**ECN 2**  
*Implement Workforce Development Programs*

**Sectors Impacted**

Virtually all sectors are potentially affected, with the Economic sector most relevant.

**Issue/Problem Being Solved**

Low labor force participation rate, lack of economic growth, lack of career and technical education system, inability of workforce to keep pace with the evolving need for skills in the labor market.

**Description**

This COA is a collection of activities and policy levers that support the education and training of the workforce (unemployed, underemployed, and talent in the pipeline toward employment), especially the most vulnerable populations (e.g., youth, women, veterans, and workers who recently lost employment) in high-needs occupations across multiple sectors. These efforts include

- aligning the skills and content knowledge required in the evolving labor market for high-demand occupations with the supply of talent on the island
- establishing workforce training centers (“centers of excellence”) that traverse secondary and postsecondary education levels in strategically selected geographic areas across the island
- instituting policies to encourage industry and education sectors to collaborate in the development of career pathway models, curriculum development for training programs, and supply-demand analyses
- strategically designing a strong K-14 education system to develop a pipeline of talent by supporting vocational education/career and technical education and on-the-job experiences for youth and jobseekers (e.g., through internships or apprenticeships).

**Potential Benefits**

Creating and enhancing a comprehensive workforce development system in Puerto Rico will (1) improve the labor force participation rate (engage heretofore dislocated and disengaged workers who otherwise would not be gainfully employed) and (2) increase individuals’ education levels and skill sets. This will have numerous benefits to individuals and to the island’s economy.
and community well-being. For example, individuals will experience greater earnings potential)\textsuperscript{307} and increased job satisfaction.\textsuperscript{308} They will be able to make more informed decisions about health, marriage, and parenting\textsuperscript{309} and become more goal-oriented and less likely to engage in risky behavior.\textsuperscript{310} In addition, workforce development will have positive effects on education and employment outcomes for children and their health and well-being,\textsuperscript{311} leading to improved trust and social interactions.\textsuperscript{312} These relationships hold even when analyses consider a variety of individual family backgrounds or other characteristics.\textsuperscript{313} For the island’s economic development and community well-being, improvements in the average years of education and increased workforce training have been associated with a community’s higher levels of volunteering and voting,\textsuperscript{314} better birth outcomes and higher levels of school readiness in the next generation,\textsuperscript{315} lower levels of criminal behavior,\textsuperscript{316} and higher levels of economic growth.\textsuperscript{317} Furthermore, increased workforce development should add to the resilience of the economic system in the face of future storm and other stochastic events, as workers are able to use their enhanced skills to engage in pre- and post-storm prevention and recovery activities.

The process by which workforce development can propel the island’s economic development and well-being is presented in Figure A.1. This figure details that ways in which a strong comprehensive workforce development system can have positive outcomes for individuals, institutions, and the community.

**Potential Spillover Impacts to Other Sectors**

Implementing a comprehensive workforce development system will allow industry leaders/businesses across multiple sectors (e.g., energy, education, health and social services, agriculture, tourism) to pull from a strong pool of talent on the island (thereby attracting more businesses to the island without the need for tax breaks or other incentives), support retention of talent, and enhance the education system so that it keeps pace with industry’s evolving needs for skills. This would affect labor availability, and potentially wages, and improve efficiencies in the delivery of education and training.

\textsuperscript{307} For a detailed review of this literature, see Card, 1999.
\textsuperscript{308} Strulik, 2015.
\textsuperscript{309} Chetty, 2006; Cutler and Lleras-Muney, 2010; Lundborg, 2013; Kaushal, 2014.
\textsuperscript{310} Brunello et al., 2016; Strulik, 2015.
\textsuperscript{311} Heckman, Humphries, and Veramendi, 2016.
\textsuperscript{312} Oreopoulos and Salvanes, 2009.
\textsuperscript{314} Dee, 2004.
\textsuperscript{315} Currie and Moretti, 2003.
\textsuperscript{316} Lochner and Moretti, 2004.
\textsuperscript{317} Aghion et al., 2009.
Figure A.1. Expected Process by Which Workforce Development Planning, Policies, and Initiatives Can Propel Economic Development in Puerto Rico

Potential Costs

Potential estimated upfront cost: $68 million
Potential recurring cost: –
Potential estimated total cost: $68 million

Depending on the range of policies and levers employed and the timeline for activities, costs can vary. Policies to enhance workforce development on the island are ostensibly no cost, whereas a large, comprehensive workforce development system that includes various career and technical centers, incorporates the K–12 education and higher education systems on the island, and meets the needs of all sectors could require long-term funding and a high monetary investment.

Potential Funding Mechanisms

Possible funding sources for workforce development programs include (1) Department of Labor Employment and Training Administration grants for apprenticeship programs and other workforce development programs targeted to high-needs occupations; (2) FEMA Dislocated Workers program; (3) HUD Community Development Block Grant–Disaster Recovery (CDBG-DR) assistance; (4) Department of Education career and technical education/postsecondary education grants; (5) the U.S. Economic Development Administration; and (6) consortia of private-industry businesses and philanthropic foundations (e.g., Anne E. Casey Foundation).
**Potential Implementers**

Puerto Rico Department of Labor and Human Resources, Puerto Rico Department of Economic Development and Commerce

**Potential Pitfalls**

Puerto Rico needs to train a workforce to meet short-term acute and longer-term demands for the 21st century. As one example, in the energy sector there is a current shortage of line repairmen to build up the grid. Yet there is a concurrent longer-term need to build capacity in skills in solar and wind energy, microgrid, and smart buildings. How can Puerto Rico adequately address both short- and longer-term demands? Currently, each sector is focused on developing a workforce to stem short-term challenges, but there is not a comprehensive effort to work collectively or to build a sustainable system to meet longer-term needs. A few key issues are challenges to developing a comprehensive, sustainable effort that addresses both short- and long-term demand. Puerto Rico has low labor force participation rates, a strong informal labor market, a migration outflow of people who are of working age, and each municipality has its own unique workforce challenges that need to be considered. Thus, the island needs to build capacity while also incentivizing the newly trained to remain in Puerto Rico and being sensitive to demographic differences and political and legal variation (e.g., codes, regulations) across municipalities.

**Likely Precursors**

Implement a policy framework to support multiple training programs to meet various sectors’ needs; do a skills-gap analysis; find instructional staff; stand up brick-and-mortar facilities alongside online programming; institute on-the-job experiences; establish collaborations among education and industry to develop curriculum and find materials.

**Detailed Policies**

To support the creation and sustainability of a comprehensive workforce development system, Puerto Rico needs a policy framework that supports multiple training programs, collects objective and evolving information and research about skill gaps, identifies and supports instructional staff, and promotes collaboration between educational professionals and the private sector to develop curricula and training materials. The following list includes specific policies and actions that the government of Puerto Rico could take. This list is organized by the investments (inputs) illustrated in Figure A.1—government policies; cross-sector planning (government-industry-education); design of an industry-specific blueprint; skills and career pipeline analyses; data infrastructure for integrated job opportunities by municipio, occupation, and industry; and facilities for educational and training institutions. This list was developed from suggestions in the literature and discussions with the Economics RSF Recovery Plan. Some policies on the list focus on addressing short-term surge needs in construction, health, and
energy; others focus on building a sustainable longer-term system that will support the economic development of the island.

Change government policies.

- Incentivize work in the formal labor market.
  - Altering the structure of social welfare benefits and individual income tax policy can remove the disincentives for work. By reducing the overall level of benefits and/or changing the eligibility structure of certain benefits (e.g., establishing work requirements or using income tax credits to change hard thresholds for benefits eligibility and thus the incentive to work), beneficiaries would be incentivized to enter the formal labor force.

- Update the Workforce Innovation and Opportunity Act.
  - Update the WIOA State Plan to focus its programs and incentives on high-priority sectors and capabilities (e.g., aerospace, software development, and creative services).

- Reduce occupational licensing regulations.
  - Take inventory of all occupational licensing requirements and undertake reforms to reduce unnecessary regulations, creating a more open labor market.

- Invest in the ocean economy (the BLUEtide initiative).
  - The BLUEtide initiative proposes a whole-of-Puerto-Rico approach to mitigation, workforce development, and tourism by developing coastal resources and optimizing ocean assets and the ocean economy.
  - Source: Economics team.

- Retain the educated workforce.
  - Create incentives for UPR graduates to remain in Puerto Rico.
  - Source: Economics team. See ECN 5 (Improve Retention of Educated Workforce Through Policy Change).

- Invest in research and partnerships.
  - Research partnerships leverage the intellectual capital of Puerto Rico, which might increase overall levels of productivity or develop marketable solutions and products to increase economic growth.
  - Source: Economics team. See ECN 7 (Create Research Centers and Partnerships).

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318 Further details on the courses of action referenced here can be found in the Recovery Plan and in the supplemental reports for the sectors, RAND Corporation, undated. The acronyms refer to the following sectors.

- ECN Economic
- EDU Education
- ENR Energy
- HSS Health and Social Services
- CIT Telecommunications/IT
• Incentivize entrepreneurship.
  – Train and support entrepreneurs who can start businesses in Puerto Rico and create new products and services that Puerto Rico can export. They also promote public-private partnerships. Ultimately, if successful, the new businesses will generate local job opportunities.
  – Source: Economics team. See ECN 12 (Provide Innovation and Entrepreneurial Training) and ECN 28 (Implement Initiative to Promote Entrepreneurship).

• Institute job creation efforts.
  – Create jobs within communities, especially jobs targeted at women and young adults. Individuals could work in or near their communities in physical and social reconstruction projects. This COA was presented in the Build Back Better plan. Disaster Dislocated Worker Grants, which were included in the plan, provide funding to create temporary employment opportunities to assist with cleanup and recovery efforts when an area affected by disaster is declared eligible for public assistance by FEMA or other federal agencies.
  – Source: Build Back Better plan, Economics team. See ECN 25 (Assist Dislocated Workers Through the Use of Existing Grants) and ECN 23 (Implement Job Creation Initiative), which has a focus on women and young adults.

Plan cross-sector (government-industry-education) initiatives.
• Engage government, industry, and education institutions.
  – This is a collection of policy levers that can define particular geographic economic zones or districts with varying levels of benefits, including tax advantages and waivers of certain regulations, and state-chartered private-lending institutions offering help to businesses that conventional lenders consider too risky but do not have the high-growth potential required by venture capitalists.
  – Source: Economics team. See ECN 8 (Define and Develop Economic Development Zones) and ECN 33 (Establish Business and Industrial Development Corporations).

Design industry-specific blueprints.
• Agriculture
  – Design and establish a national training center for agriculture that develops secondary school programs, vocational training programs, and national agriculture business training programs for veterans. Such training can address industry problems of outdated farming practices, land and capital-constrained operations, the older workforce, and labor shortages.
  – Source: Economics team. See ECN 35 (Center of Excellence for Agricultural Technologies Training).

• K–12 education
  – Expand and update K–12 vocational programs in Puerto Rico to align with changing workforce needs. Develop and implement new professional development and talent management systems for K–12 teachers and administrators.
  – Source: Education team. See EDU 6 (Expand and Update K–12 Vocational Program), EDU 8 (Strengthen School Leadership Pipeline), and EDU 9 (Develop and Implement Teacher Pipeline Program).
• **Energy**
  - Train a workforce capable of installing, operating, and maintaining Puerto Rico’s future energy system (especially in asset management, system planning, and data management) and quickly responding to and repairing damage to the electric system.
  - Source: Energy team. See ENR 18 (Rightsize and Train the Future Energy Workforce).

• **Health**
  - Expand incentives to retain and train the health care and public health workforce to mitigate shortages in some health specialties and the outmigration of the health care workforce. Initiatives include loan repayment programs and policies that allow nurse practitioners and PAs from other states to provide care in Puerto Rico.
  - Source: Health and Human Services team. See HSS 11 (Add Incentives and Other Supports to Increase and Retain Supply of Health Care Providers and Public Health Practitioners) and HSS 13 (Expand Practice Laws for Health Care Providers).

Conduct skills and career pipeline analyses.

• **Conduct analyses to support career pipelines.**
  - Conduct studies to help local businesses better understand the available labor supply and help the government modify its plan to better train workers for the needs of local employers. The government of Puerto Rico could use the information to implement new strategies that would better align labor supply with labor demand.

Build data infrastructure for integrated job opportunities by municipio, occupation, and industry.

• **Establish blueprints and infrastructure for a web-based job portal.**
  - Develop a person-centered and comprehensive job portal for all businesses and job seekers.
  - Source: Economics team and other sectors. See ECN 6 (Improve Data Collection, Analysis, and Presentation), which is collection of policy levers addressing publicly available data.

Create facilities for educational and training institutions.

• **Build centers of excellence, career and technical education centers, and other nodes for training and development in centrally located and rural areas across the island.**
  - This would improve geographic alignment between jobs available and training centers and provide more training and education opportunities for the underemployed and unemployed.
  - Source: Economics team and CIT 28 (Innovation Economy/Human Capital), which creates a public-private initiative to provide digital skills training, entrepreneurship programs, and access to new technologies through a network of innovation hubs and entrepreneur centers, training partnerships with schools, and outreach via mobile labs deployed to rural and underserved areas. These efforts promote a digitally literate employment pool for tech-reliant industries.
References


RAND Corporation, “Supporting Puerto Rico’s Disaster-Recovery Planning,” webpage, undated. As of June 21, 2019:
http://www.rand.org/hsoac/puerto-rico-recovery

Throughout the report, we note the methodology used in various analyses and enumerate the steps that were taken and the sources of data. In this appendix, we provide more information about the methodological approaches and data sources used in Chapters 2, 3, 4, and 5.

## Data Sources and Methodological Approach for Chapter 2

### Data Sources

- 2012–2016 Puerto Rican Community Survey
- U.S. Census Bureau
- Department of Labor, Employment and Training Administration (ETA)
- Integrated Postsecondary Education Data System (IPEDS)

### Identifying Key Occupations in the Long Term

In Chapter 2, we identify a set of key occupations in Puerto Rico that we use as a framework to assess the secondary and postsecondary training landscape and workforce development system in Puerto Rico. The chapter provides a brief summary of our methods. Our aim was to determine which occupations will be “high priority” in Puerto Rico in the future, either because there are not enough workers (supply) or because we predict there will be more jobs (demand).

The quantitative approach uses two publicly available datasets from the BLS. EP is an annually updated dataset that projects occupational employment and growth over a ten-year period using rigorous quantitative and qualitative analysis. The most recent data available are the 2016–2026 projections, released in 2017. The EP data include, for each occupation, the expected growth in the number of jobs in that occupation, the occupation’s requirements for educational attainment, and the occupation’s requirement for training. We merged the EP data with the OES, also produced annually by the BLS. The OES contains information on current average, median hourly and annual earnings for each occupation, by state.

We applied the SOC code to the data. In about 5 percent of all occupations, there was a level-matching error—that is, the SOC code of the EP and OES occupations were not the same digit.

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320 For more information on the methodology to produce the projections, see Bureau of Labor Statistics, “Employment Projections Methodology,” March 6, 2018.
The SOC enumerates 867 occupations by a six-digit code, in which the first two digits are one of 23 major groups and the last four digits are the occupation. Each nonzero digit of the final four classifies a subgroup (e.g., 4315 is a subgroup of 4300). Merging the EP with the OES, there were instances in which one dataset had information on a five-digit occupation (e.g., 47-4310) but the other on a six-digit occupation (e.g., 47-4315). In those instances, we kept the EP as the anchor and, if the EP was five-digit, took a weighted average of the corresponding six-digit occupations in the OES; if the EP was six-digit, we merged the corresponding five-digit category from the OES with each six-digit in the EP.

Our schema to identify the key occupations was to calculate a score. The score consisted of the occupation’s quantile ranks in a number of categories, summed over each category. The components of the score are explained as follows:

- Percentage change in total projected jobs in the United States from 2016–2026 (EP)
  - Lowest score: 5, included all occupations that will decline in percentage
  - Highest score: 1; included all occupations growing 12.3 percent or more
- Number change in total projected jobs in the United States from 2016–2026 (EP)
  - Lowest score: 5, included all occupations that will decline in number
  - Highest score: 1, included all occupations adding at least 16,000 jobs
- Relative pay gap between Puerto Rico and the six states to which people from Puerto Rico migrate, expressed as the average annual pay for the occupation in Puerto Rico as a share of the average annual pay for the occupation in the Migration States—Florida, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania (OES)
  - Lowest score: 5, included all occupations with a smaller pay gap, Puerto Rico earnings 72 percent or more of Migration States
  - Highest score: 1, included all occupations with larger pay gap, Puerto Rico earnings 41 percent or less of Migration States
- Total employment size in the United States in 2026 (EP)
  - Lowest score: 5, smaller occupations, fewer than 14,000 jobs total
  - Highest score: 1, larger occupations, at least 175,000 jobs total
- Difference in location quotients between Puerto Rico and the Migration States (OES)
  - Lowest score: 5, occupations that have higher location quotient in Puerto Rico than in Migration states (average is 2.67)
  - Highest score: 1, occupations that have lower quotient in Puerto Rico (average is .434).

We then added up the score on each category so that every occupation had a combined score ranging from 5 to 25.

We constructed our score categories to reflect our assessment of what is a key occupation. In terms of growth, the occupation should be growing in both relative and absolute size; we use both number and percentage to not bias our findings toward smaller (percentage) or larger (number) occupations. Particular to Puerto Rico, the occupation should be one that is at risk for
outmigration to the CONUS, which we proxied with a larger-than-average pay gap between earnings in the two locations. In addition, these should be occupations that are not already oversupplied in Puerto Rico relative to the United States, which we proxied with the difference in location quotients. Finally, to be relevant to workforce policy, we ensured that the total size of the occupation was not small.

Our score is calculated over all occupations. Even though we are interested in how occupations vary by education level, we do not score within educational category but across all. Tables B.1 to B.6 provide the component scores for those with the lowest score.

**Table B.1. List of Key Occupations with Score Components, Doctoral Level**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentists, general</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Physical therapists</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Clinical, counseling, and school psychologists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Medical scientists, except epidemiologists</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Family and general practitioners</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Physicians and surgeons, all other</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Surgeons</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Lawyers</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Optometrists</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Health specialties teachers, postsecondary</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Table B.2. List of Key Occupations with Score Components, Master’s Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician assistants</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mental health and substance abuse social workers</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Health care social workers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Occupational therapists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Nurse practitioners</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Educational, guidance, school, and vocational counselors</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Speech-language pathologists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Mental health counselors</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Statisticians</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Urban and regional planners</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Education administrators, elementary and secondary school</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Art, drama, and music teachers, postsecondary</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Instructional coordinators</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Rehabilitation counselors</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table B.3. List of Key Occupations with Score Components, Bachelor's Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal financial advisers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Social and community service managers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Market research analysts and marketing specialists</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Coaches and scouts</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Securities, commodities, and financial services sales agents</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Occupation</td>
<td>Projected Job Growth (Percentage Increase)</td>
<td>Projected Job Growth (Number Increase)</td>
<td>Employment in 2026</td>
<td>Pay Gap with Migration States</td>
<td>Location Quotient</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>--------------------------------------------</td>
<td>----------------------------------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Management analysts</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Medical and health services managers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Computer systems analysts</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Middle school teachers, except special and career/technical education</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Software developers, systems software</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Construction managers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Marketing managers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Information security analysts</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Training and development specialists</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Operations research analysts</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Financial analysts</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Computer and information systems managers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Cost estimators</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Financial managers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Loan officers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Substance abuse and behavioral disorder counselors</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Public relations and fundraising managers</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Network and computer systems administrators</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Public relations specialists</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Computer occupations, all other</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Special education teachers, secondary school</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Occupation</td>
<td>Projected Job Growth (Percentage Increase)</td>
<td>Projected Job Growth (Number Increase)</td>
<td>Employment in 2026</td>
<td>Pay Gap with Migration States</td>
<td>Location Quotient</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------</td>
<td>----------------------------------------</td>
<td>--------------------</td>
<td>------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Kindergarten teachers, except special education</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fundraisers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Clergy</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Civil engineers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Meeting, convention, and event planners</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Surveyors</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Human resources specialists</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Appraisers and assessors of real estate</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical engineers</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table B.4. List of Key Occupations with Score Components, Associate’s Level

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paralegals and legal assistants</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Web developers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Radiologic technologists</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Respiratory therapists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Occupational therapy assistants</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dental hygienists</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Physical therapist assistants</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Diagnostic medical sonographers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Veterinary technologists and technicians</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Preschool teachers, except special education</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
**Table B.5. List of Key Occupations with Score Components, Postsecondary-Certificate Level**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating, air conditioning, and refrigeration mechanics and installers</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Massage therapists</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Medical assistants</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Licensed practical and licensed vocational nurses</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Phlebotomists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Health technologists and technicians, all other</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Dental assistants</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Firefighters</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Hairdressers, hairstylists, and cosmetologists</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Automotive service technicians and mechanics</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Emergency medical technicians and paramedics</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Manicurists and pedicurists</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Medical records and health information technicians</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Computer user support specialists</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table B.6. List of Key Occupations with Score Components, High School Level**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Projected Job Growth (Percentage Increase)</th>
<th>Projected Job Growth (Number Increase)</th>
<th>Employment in 2026</th>
<th>Pay Gap with Migration States</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumbers, pipefitters, and steamfitters</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Operating engineers and other construction equipment operators</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>First-line supervisors of construction trades and extraction workers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Occupation</td>
<td>Projected Job Growth (Percentage Increase)</td>
<td>Projected Job Growth (Number Increase)</td>
<td>Employment in 2026</td>
<td>Pay Gap with Migration States</td>
<td>Location Quotient</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------</td>
<td>-------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Self-enrichment education teachers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Fitness trainers and aerobics instructors</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Insurance claims and policy processing clerks</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Nonfarm animal caretakers</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Bus and truck mechanics and diesel engine</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>specialists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricians</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>First-line supervisors of personal service</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance sales agents</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Brickmasons and blockmasons</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Solar photovoltaic installers</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Automotive body and related repairers</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Loan interviewers and clerks</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sales and related workers, all other</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hazardous materials removal workers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Structural iron and steel workers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>First-line supervisors of housekeeping and</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>janitorial workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation workers</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Sheet metal workers</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>First-line supervisors of landscaping, lawn</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>service, and groundskeeping workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction and building inspectors</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bus drivers, school or special client</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Bus drivers, transit and intercity</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Property, real estate, and community association managers</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Police, fire, and ambulance dispatchers</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Occupation</td>
<td>Projected Job Growth (Percentage Increase)</td>
<td>Projected Job Growth (Number Increase)</td>
<td>Employment in 2026</td>
<td>Pay Gap with Migration States</td>
<td>Location Quotient</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------------------------</td>
<td>---------------------------------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Office and administrative support workers, all other</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Library assistants, clerical</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Security and fire alarm systems installers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Billing and posting clerks</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Paving, surfacing, and tamping equipment operators</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Residential advisers</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Chefs and head cooks</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

**Interviews with Internal Experts**

In order to understand the context for our key occupations identified quantitatively, we drew on sector-based research conducted by HSOAC to support the development of Puerto Rico’s Recovery Plan. A sector may cut across several industries—for example, the health and social services sector includes experts in epidemiology, community medicine, mental health, homelessness, elder care, and social support programs—and thus a broad range of occupations fall under it.

We collected information about current workforce shortages, projected growth occupations based on overall economic changes, and projected growth occupations based on planned recovery spending efforts. We reviewed the quantitative results with sector experts as a check on the translatability of general economic trends to Puerto Rico. In several cases, the sector leads identified occupations omitted by our quantitative analysis and occupations included by our quantitative analysis in which they anticipated no or negative growth.

**Internal Expert Protocol**

1. We’ve identified [list of occupations] as likely in-demand occupations as Puerto Rico goes through reconstruction and economic recovery. Any additions or deletions? Why?
2. Describe the typical training environment for these occupations (institutions, credentials, etc.).
3. What structural changes might improve the pipeline? For example, loan forgiveness, tuition changes, cooperative education, etc.
Data Sources for Chapter 3

Chapter 3 examines the acute workforce needs in Puerto Rico at the time of this study and presents our analysis.

Data Sources

- Reviewed primary data collected during HSOAC’s support for the development of the recovery plan, including scanning documentation created by HSOAC sector teams supporting the Recovery Plan, for workforce-relevant terms (keywords: workforce, worker, training, trained, skill, employ), and elicited information from sector team leads about workforce needs, including which occupations would likely have substantial increases in demand from the recovery effort, which occupations had currently insufficient training pipelines, and what mechanisms or structural changes could address these workforce needs
- Consulted peer-reviewed and media reports of damage estimates for the hurricanes in Puerto Rico, as well as previous hurricanes in other parts of the United States
- Analyzed the Occupational Information Network, O*NET, to identify specific occupations and typical credentials based on key skills and tasks identified by sector leads in interviews and in the review of each sector’s Recovery Plan report
- Bureau of Labor Statistics
- New Zealand Ministry of Business, Innovation, and Employment

Data Sources and Methodological Approach for Chapter 4

Chapter 4 examines the macro estimates of labor supply constraints to Puerto Rico’s recovery and presents our analysis.

Data Sources

- IMPLAN

Modeling Approach

We employ a four-step process in our modeling approach for the analyses in Chapter 4.

Step 1. First, we allocate each COA from the government of Puerto Rico’s Recovery Plan to one of four different two-digit NAICS codes based on keywords with the COA descriptions. The four sectors are (1) Construction; (2) Administrative Services; (3) Management of Companies; and (4) Educational Services. Based on a review of the Recovery Plan, these sectors were the best
sectors to map each of the COAs.\textsuperscript{321} Table B.7 provides the rough mapping from COA to sector. Using these keywords, the breakdown of the Recovery Plan costs is provided in the third column of Table B.7.

### Table B.7. Mapping from COAs to Sectors and Cost Proportions

<table>
<thead>
<tr>
<th>Sector</th>
<th>Keywords</th>
<th>Plan Cost Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Built, build, repair, replace</td>
<td>48</td>
</tr>
<tr>
<td>Administrative</td>
<td>Incentivize, plan, study, task force, steering committee</td>
<td>39</td>
</tr>
<tr>
<td>Management of companies</td>
<td>Business consulting, assist, manage, compensate, improve, implement</td>
<td>12</td>
</tr>
<tr>
<td>Educational services</td>
<td>Training, schooling, education</td>
<td>1</td>
</tr>
</tbody>
</table>

**SOURCE:** Authors’ analysis of government of Puerto Rico Recovery Plan.

**Step 2.** The second step estimates the economic impact of a set of scenarios based on implementation projections for the plan. We use an input-output model of the economy of Puerto Rico calibrated to 2016 data provided by IMPLAN.\textsuperscript{322} Although not ideal, the data in this model represent the best available estimates of the sector-level production functions for Puerto Rico, meaning the way inputs are combined to produce outputs. We aggregate the industries in the input-output model to the two-digit NAICS code sectors to have consistency between our allocation of COAs and the macroeconomic impact estimation. Our scenarios are built around five annual spending levels: $1 billion, $2 billion, $5 billion, $10 billion, and $25 billion. This approach is appropriate because an approximately $100 billion to $140 billion recovery effort is likely to have significant variance in yearly expenditures and we would like to estimate what a nonconstant path of funding would imply for labor demand. Importantly, though, these results can scale to any level because input-output models are linear.

Input-output models are used to estimate a rough order of magnitude of the impacts of spending injections or reductions to an entire economy. The key is that $1 billion of spending does not have a $1 billion effect on the economy. Some of this spending goes to pay workers and some of it is used to buy material inputs both in the local market as well as from nonlocal locations. By tracking the exchanges, we can estimate how much of the spending leaves the market and how much is recycled through to other industries. The increased quantity of inputs demanded is known as the *indirect effect*. Worker wages, proprietor profit, and other payments to

\textsuperscript{321} We have performed sensitivity analysis with respect to this sectoring and other than construction, the economic impact of changing spending across the other three sectors does not significantly change the results. We feel confident that we have identified the construction efforts successfully so that our results should be robust to changes in the sectoring scheme.

\textsuperscript{322} IMPLAN is an input-output modeling platform that downscales Bureau of Economic Analysis national-level data to local-level data. For further information about IMPLAN data and models, see implan.com.
capital increase the demand for all goods through increases in income. This is known as the *induced effect*. Taken together, the direct injection, indirect increases in production, and induced increases in production to meet final demand make up the total economic impact of the initial injection. Especially in the case of an isolated market like Puerto Rico, it is important to consider the local purchasing ability of the economy. Demands not met by local production will “leak” out of the economy, reducing the economic impact to Puerto Rico.

We measure these economic impacts in four different dimensions: *output*, *value added*, *employee compensation*, and *employment*. Output is simply the value of all goods and services that come from the increased spending, including all intermediate inputs. The concept of output double counts the value of an input. For example, if the economy produces $1 million worth of roads and uses $500,000 worth of locally produced concrete, total output for the economy would be $1.5 million, but we have not added $1.5 million worth of value. As such we also report value added, which is the value of the good produced minus the cost of intermediate good and service inputs. It is made up of proprietor income, employee compensation, payments to land, and taxes on production and is akin to measures of GDP for countries or gross regional product for sub-country regions. We separately report employee compensation to gain a better understanding of how workers in Puerto Rico will fare from recovery spending. Finally, we report changes in employment that is available in aggregate as well as by sector. This last measure is important for the next step.

**Step 3.** In this step we translate the increases in employment into increases in occupational demand. Even though Puerto Rico has willing and able workers, it may not have workers in specific occupations that are needed for the recovery. Although not ideal, we use the BLS mapping of occupations by industry. It is not ideal in that this data is based on national-level data that is not specific to Puerto Rico, but it should provide a good proxy for occupations by industry. The data allow us to know how the demand for an additional employee translates into specific occupational demands. We provide these occupational demands at the two-digit and six-digit SOC system codes.

Once we have these occupational demands, we compare the occupational demands induced by the recovery spending to the current distribution of occupations in Puerto Rico. We also calculate the wage disparity by occupation between Puerto Rico and the CONUS as well as the six most common states for outmigrants from Puerto Rico to reside using the BLS wage data by area and occupation dataset.

**Step 4.** Finally, we provide a qualitative discussion for how these occupational demands could be met and what the resulting implications are for the recovery process moving forward. This discussion centers around the role of training and incentive programs in Puerto Rico,

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foreign workers temporarily relocating to Puerto Rico, and U.S. workers living in the CONUS temporarily or permanently relocating to Puerto Rico.

Data Sources and Protocols for Chapter 5

Chapter 5 outlines various strategies the government of Puerto Rico could undertake to accomplish ECN 2, Implement Workforce Development Programs.

Interviews with External Experts

In Chapter 5, we discuss the COAs and their trade-offs in funding, benefits, and drawbacks. This discussion was informed by interviews with subject matter experts in training and construction. We conducted interviews with 13 external experts; an additional 12 did not respond to our requests for interviews. For these interviews, we developed two sets of protocols, one for training and one for construction.

Training Protocol

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<tr>
<td>1. What is your current position?</td>
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<td>2. Which areas of training are within your purview?</td>
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<tr>
<td>a. Building Construction Technology</td>
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<td>c. Construction (Basic)</td>
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<td>f. HVAC</td>
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<td>g. Masonry</td>
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<td>h. Plumbing</td>
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<tr>
<td>i. Metal/Welding</td>
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</table>
j. Other [Specify]
3. Is the focus of the training your organization provides commercial, residential, both, or neither?
4. What is your experience in this field, particularly as a (1) practitioner, (2) instructor, and/or (3) administrator? [Duration in each, years of experience, background credentials]
5. On a range from 0 to 100 (where zero is none and 100 is all of it), what proportion of your organization’s time and resources are spent on training? What about on physical construction and connected logistics?
6. Where is the primary headquarters of your organization, or where is the regional office at which you are located?

TRAINING PROGRAM SPECIFICS
1. Upon completion of your program, what degree, certificate, or other credential do the trainees earn?
2. What method(s) of training do you provide?
   a. Traditional, in-classroom work
   b. Online coursework
   c. Apprenticeship
   d. Nonapprenticeship on-the-job-training
   e. Other [Specify]
3. How dependent on location is your training program—for instance, do there need to be active construction sites for learning, or are there mobile demonstration capabilities that allow the instruction to be semi-independent?
4. What primary population is your training aimed toward in terms of educational attainment, military history, career history, and other demographic factors, such as sex, race, and age?
5. Without changing your current processes, what range of class/cohort sizes can be accommodated?
6. With additional resources and support, could the training be scaled for larger groups without loss of quality? How large could the class/cohort sizes be before quality loss is likely to occur?
7. How long does the training process typically take, on average? If there is a range of times, what is an estimated minimum and maximum time to completion?
8. With additional resources and support, could the training process be shortened? How quickly could training be completed before a loss of quality is likely to occur?
9. Is the training process dependent on structured start times (such as a semester system) or can classes be started ad hoc?
10. How much does it cost your organization to coordinate a class/cohort? Can you break this cost down into personnel, materials, and other relevant subcategories?
11. Are there multilingual staff, specifically Spanish speakers, on your staff?
12. Do you advertise or promote your classes in any way? How?
13. Where do most of your recruited trainees come from?
14. What benefits (if any) do you provide to those in your program? Benefits might include transportation vouchers, meals, a stipend, health insurance, etc.
15. Can you estimate completion rates, and share common reasons for noncompletion?
16. Do you track the placements of your program graduates? How many stay in the field?

CONSTRUCTION PROTOCOL

Before we start, I want to remind you of a few things:
We are audiotaping this interview and we will be preparing notes from the interviews and destroying audio recordings as soon as they are verified, usually within about two weeks after the interview. Is this acceptable to you? [If we are recording]
We will be reporting themes and variation in responses across the interviews. We may include some direct quotes but will not be attributing them to anyone by name or position in a way that would directly identify you. You are free to decline to answer any question and to provide the level of detail you feel is appropriate.
Did you have a chance to read the fact sheet about this project? IF NO ASK: Would you like another copy? It’s short and I can wait while you read it.

PERSONAL HISTORY
1. What is your current position?

CONSTRUCTION OPERATIONS
1. What percent (0–100) of your projects are
   a. Residential new construction
   b. Residential reconstruction
   c. Commercial new construction
   d. Commercial reconstruction
2. I’m going to list several construction tasks. Please tell me whether your firm (a) performs these tasks in-house, (b) subcontracts these tasks to another firm, or (c) is never responsible for these tasks.
   a. Foundation excavation and preparation
   b. Framing/rough carpentry
   c. Roofing
   d. Plumbing
e. Electrical  
f. Drywall/sheetrock installation  
g. Masonry  
h. Floor finishes  
i. Kitchen/bath finishes  
j. Painting

IF IN PUERTO RICO
1. Which of these are substantial hurdles to on-time completion of projects?  
   a. Obtaining permits  
   b. Finding enough workers  
   c. Finding workers with the right specialties  
   d. Sourcing materials (price, quality…?)  
2. How do you recruit workers for your projects?  
3. Has the composition of your projects changed since the hurricanes? For example, are you doing more residential reconstruction than before?
Appendix C. Postsecondary Institutions in Puerto Rico, December 2018

In Chapter 6, we discussed the composition of postsecondary institutions in Puerto Rico: the levels of degrees that they offer; the subject area of their conferrals; and whether they are public, private nonprofit, or private for-profit. We based our analysis on collected information about the postsecondary education system, summarized in this appendix.
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Appendix D. Recommendation to Improve Puerto Rico’s Workforce Development System by Industry

Chapter 6 highlighted overarching policies and activities that the government of Puerto Rico could enact in order to build and maintain a successful workforce development system that would allow it to meet its long-term goal of building a 21st-century workforce. In order for these policies and activities to be successfully implemented, it is important to consider particular industry needs. In this appendix we offer tailored approaches to four industries—construction, health care, energy, and education/social welfare. We discuss each industry in turn, outlining the workforce needs of the industry, the current training landscape, and potential policies going forward. We touch on important issues for each industry, but given the complexities of workforce needs within each industry we do not provide an exhaustive analysis.

Construction

Workforce Needs

Previous chapters outlined a need for (1) a larger construction workforce overall and (2) a particular demand for skilled tradespeople in fields such as carpentry, plumbing, electricity, and masonry, as well as inspectors, planners, and managers. However, operationalizing this targeted workforce growth will be a challenge for a region with continuous decline within the industry. The sections that follow describe the currently available training pipelines in comparison with the likely training need and discuss an array of system and policy changes to help meet this need.

Current Training Landscape

From 2015 to 2017, Puerto Rico averaged 717 sub-baccalaureate conferrals in construction. Using the Department of Labor’s “Career OneStop” website, we conducted an inventory of education and training programs for construction occupations within Puerto Rico. A number of formal training programs exist in Puerto Rico for individuals hoping to become electricians, and these one- to two-year programs often include solar energy technology as well as training sufficient to take the electrician exam. However, while the Department of Labor website details

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325 Omissions from this list—for example, finance—are due in part to a focus on industries that have been targets for reform in the past and will be integral to hurricane reconstruction, and in part to areas in which more comprehensive approaches are appropriate. Finance is not a critical industry for recovery, despite how important it is in the long term, and it was arguably not that greatly affected by the hurricane. In contrast, construction is vital to rebuilding the island, and the number of anticipated school closures will greatly alter the education workforce.

some nine institutions for plumbing training in Puerto Rico, one school shut down completely after the hurricanes, and another six schools do not list plumbing courses or credential programs on their own websites. Career OneStop lists no programs for carpentry. In the CONUS, trade programs are typically run through technical schools, trade schools, or local guilds and unions. Trade specialists typically follow this formal education with an apprenticeship to a master tradesperson. However, the Labor Department’s Employment and Training Administration, which registers apprenticeships, has no knowledge of any apprenticeships in Puerto Rico. Yet the majority of the construction occupations identified as in-need in Chapters 1 and 2 use apprenticeships as a pathway.

Recommendations to Improve Construction Workforce Development in Puerto Rico

**Develop a system of apprenticeships in construction trades.** Trade skill occupations benefit from a robust system of apprenticeships. Apprenticeships provide the employer with the opportunity to tailor an employee’s training to specific needs, and apprenticeships are associated with increased retention. Apprenticeships often end with the apprentice acquiring an industry-accepted credential, providing benefits for the employee as well (see Box D.1). We propose that Puerto Rico’s Departamento del Trabajo y Recursos Humanos—the territory’s equivalent to the U.S. Department of Labor—develop a system of apprenticeships in construction trades (e.g., carpentry, plumbing, electricity) and register the apprenticeships with the U.S. department. Registration of these apprenticeships will ensure the safety and welfare of apprentices as well as a baseline level of training quality, improving portability of credentials.

**Box D.1. Huntington Ingalls Industries Uses School to Attract, Train, and Retain Future Shipbuilders**

| Huntington Ingalls Industries (HII) uses the highly selective, tuition-free Newport News Shipbuilding Apprentice School to recruit and train its next generation of employees, offering four-, five-, and eight-year apprenticeships. HII CEO Mike Petters boasts that his company’s product “is not ships, but the workforce that builds it [sic].” While graduates are guaranteed a job with the company, they are not required to stay with HII. However, the vast majority do, decreasing recruiting and turnover costs. The Apprentice School also collaborates with Old Dominion University to allow students to earn a bachelor’s degree in engineering while training as an apprentice. |

**Standardize curricula.** We suggest that Puerto Rico take advantage of the National Center for Construction Education and Research (NCCER) credential registry. NCCER standardizes curricula to ensure that training programs meet industry standards, and the registry allows contractors to verify the credentials of prospective employees or subcontractors. Such a system may also assist with Puerto Rico’s transition from informal to formal residential construction.

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327 Personal conversation, Maria del Carmen La Santa, Department of Labor, Employment and Training Administration, State Agencies, August 29, 2018.
328 See Table 2.3 for details and a list of top federally registered apprenticeship programs.
Expand public vocational schools in construction trades. While two-year degrees and short credential programs exist for in-demand occupations like HVAC installers and electricians, there is a comparative shortage in formalized programs for other construction occupations such as carpentry, masonry, and plumbing. Anticipated growth in the construction industry in Puerto Rico requires an increase in program offerings to support and train this workforce. Furthermore, the majority of existing programs are provided through private, for-profit institutions, and given the public interest in ensuring a long-term supply of qualified contractors, a diversified (public) community college system could play a key role in increasing access to training. Larger employers of tradespeople could follow the model set by the Apprentice School at Newport News Shipbuilding (described in Box D.1), guaranteeing a steady supply of highly qualified future employees.

Recruit women to work in the construction sector. With the island’s fiscal crisis and recent population loss, school enrollments significantly declined. As a result, Puerto Rico’s Department of Education closed 283 schools. Though some reports indicate that the island’s teachers have already begun leaving the island following Hurricane Maria, these school closings suggest a significant number of teachers (likely women for the most part) are a surplus labor pool. Generally speaking, the island has high unemployment of working-age women. In addition to potential female labor supply, Puerto Rico’s construction sector is experiencing growth with hurricane reconstruction efforts, but this growth comes after years of decline. Using a similar combination of vocational, apprenticeships, and business management training programs described previously, these workers could be (re)trained to assist in reconstruction efforts. Information campaigns to induce women to cross gender divides to work in construction and training to help prevent sexual harassment will be important.331

Female workers often perform the bulk of household tasks in the United States. Mobilizing working-age females who may face competing household expectations will likely require additional work supports. Programs should consider carpools, transportation vouchers, and child care support. Other traditional wraparound services for postsecondary and training programs include learning and professional support services such as tutoring and work coaching. Additionally, workforce training programs must consider concierge wraparound services such as low-cost laundry and meal services. It may be possible to fund at least part of these sorts of wraparound services using complementary workforce and reconstruction development projects organized around smart electric grids and community development (e.g., solar-powered community laundromats located at the training and/or work sites) as well as federal nutrition and welfare programs targeting low-income populations.

Former construction workers likely emigrated or moved to the informal labor market, though there is no data to (dis)confirm this. In any regard, providing incentives for formal wage labor

will likely be important, whether in the form of apprenticeships or an EITC or a similar tax incentive. If gender segregation in the informal labor market is stronger, these female workers may require fewer incentives to enter the formal construction labor market. These tax credits and wraparound services for female construction workers (affecting their dependent children) may also help achieve PROMESA goals of reducing child poverty.

Health Care

Workforce Needs

As described in Chapter 1, Puerto Rico’s health care workforce faces unique challenges. Because of higher salaries in the CONUS, a number of new graduates seek employment outside of Puerto Rico for improvements in standard of living and an increased ability to pay back educational debt. In addition, there is the issue of the migration of already-practicing physicians.\(^{332}\) Puerto Rico relies on physicians more heavily than do the U.S. states, as PAs are not allowed to practice independently\(^ {333}\) and nurse practitioners were only recently allowed to do so. Complicating these supply problems is a likely pent-up demand—Puerto Rico has a much older demographic than most of the United States,\(^ {334}\) necessitating more health care, and the proposed increase in reimbursement rates may further increase that demand.\(^ {335}\)

Current Training Landscape

Puerto Rico has four major medical schools: Ponce Health Sciences University, San Juan Bautista School of Medicine, Universidad Central Del Caribe, and University of Puerto Rico-Medical Sciences. There are also a number of programs in nursing and medical technologies, though several of these occupations require additional exams or licensure for employment in the CONUS. Some of these programs specifically require bilingualism and both Ponce Health Sciences and UPR give preference to Puerto Rico residents or those with ties to Puerto Rico in admissions.\(^ {336}\)

According to the Puerto Rico Health Care Infrastructure Assessment conducted by the Urban Institute, while limited programs for nurse practitioner training do exist in Puerto Rico (following legislation expanding their scope of practice), most graduates have no intention of


\(^{333}\) American Academy of PAs, July 17, 2017.


\(^{335}\) Central Office for Recovery, Reconstruction, and Resiliency, August 8, 2018.

\(^{336}\) Ponce Health Sciences University, “M.D. Program,” webpage, undated.
remaining in Puerto Rico to practice, and many are from outside of Puerto Rico.\textsuperscript{337} Because of
the lack of work authorization for PAs in Puerto Rico, there are no well-publicized training
programs in Puerto Rico.\textsuperscript{338}

\textbf{Recommendations to Improve Health Care Workforce Development in Puerto Rico}

\textbf{Centralize and streamline training for all health careers.} To create a sustainable medical
workforce trained in collaborative care (and the use of advanced clinical practitioners), we
propose a vertically integrated medical campus providing training for a variety of credentials in
the medical field—M.D./D.O. doctors, master’s degree-holding nurses, bachelor’s-level
registered nurses, associate-level medical technologists, and certificate-holding community
health workers and aides. The vertically integrated campus would ideally be affiliated with a
hospital and community health clinic, providing extensive opportunity for experiential learning
and clinical rotations. Vertical integration also generates benefits in scaffolding credentials—
credential-holders at all levels can chart their path to the next credential at a university that
understands the transferability of their previous curriculum. We anticipate that such a campus
would improve health care access not only in the immediate community but also across all of
Puerto Rico as health care providers are given increasing opportunities to upskill and respond to
community needs. Accelerated pathway programs are cropping up in the CONUS and Canada to
allow students with previous clinical experience or relevant coursework to complete medical
degrees in a shorter time frame.\textsuperscript{339} Stackable credential models create similar flexibility for just-
in-time upskilling.

\textbf{Box D.2. Northeast Louisiana Healthcare Partnership Creates Pathways Between Health Credentials}

Hospitals and clinics have joined together to integrate urban and rural resources (both skilled workers and
facilities) to maximize access to care. The partnership also has created pathways between health credentials,
allowing nursing assistants to train to become licensed practical nurses on-site.\textsuperscript{340}

\textbf{Increase affordability of training.} Increasing the on-ramps to training is insufficient if it is
difficult or impossible for students to recoup educational costs. The comparatively low salaries in
Puerto Rico are particularly problematic when graduates are considering opportunities to pay
back their educational loans. We additionally propose that Puerto Rico offer partial or complete
loan forgiveness for health workers accepting employment in underserved communities,
potentially taking advantage of available federal funding from HRSA. While this program could

\textsuperscript{337} Krista Perreira, et al., \textit{Puerto Rico Health Care Infrastructure Assessment}, Washington, D.C.: Urban Institute,

\textsuperscript{338} One exception was a 2010 program for PAs from Chatham University (Pittsburgh, Pennsylvania). PAs were
educated through Chatham’s program but had their clinical rotations in Puerto Rico. The program appears to be
defunct.

\textsuperscript{339} Weiner, 2019.

\textsuperscript{340} Next Generation Sector Partnerships, undated.
primarily target Puerto Rico residents and those who immigrate to the U.S. states for training, students from the CONUS seeking training in Puerto Rico could also be incentivized to work in rural areas. A review of rural health care access initiatives also suggests that the targeted recruitment of rural residents to health care occupations can be effective.\textsuperscript{341} Note that any loan forgiveness programs should be coupled with longevity incentives; access to care is not markedly improved if a community becomes newly dependent on a care provider who then leaves after two years.

**Energy**

*Workforce Needs*

As outlined in Chapters 1 and 2, Puerto Rico’s energy system was in disrepair before the hurricanes, and the energy needs were made both more obvious and more pressing by the hurricanes. Puerto Rico’s electrical system is costly\textsuperscript{342} and dependent on fossil fuels, neglecting the ample potential for using a diversity of power sources (e.g., solar power generation on the sunny set of islands). However, fuel choice and generation are not the only issues: Analysis conducted by the Energy sector team has found that the electrical system and its assets are poorly managed, with centrally produced energy sent over miles of transmission lines precariously perched atop trees and telephone lines, a set of dominos just waiting for a breeze.\textsuperscript{343}

Chapter 2 identifies solar specialists, engineers, asset managers and analysts, and system designers as critical energy-related occupations. The next sections outline the training options currently available in Puerto Rico for these occupations, as well as policy and system recommendations for creating a sustainable pipeline of energy workers.

*Current Training Landscape*

One of the UPR’s main campuses, Mayagüez, has a large and accredited engineering school that produces relevant engineers for the energy sector at the BA level. Like other Puerto Rico–educated college degree holders, engineers are paid much less in Puerto Rico than in the CONUS, though the disparities are on par with average across all occupations, and Puerto Rico educational credentials are accepted in the United States. Presumably, though the authors could not confirm the details, PREPA recruits from the engineering school at UPR-Mayagüez, although PREPA is not a participant in the engineering school’s cooperative education program that places students with employers for experiential learning during their junior year.\textsuperscript{344} For sub-


\textsuperscript{342} Only Hawaii pays more for electricity.

\textsuperscript{343} For the Energy sector team’s report, see RAND Corporation, undated.

\textsuperscript{344} University of Puerto Rico Mayagüez, College of Engineering, “Coop Program,” webpage, undated.
baccalaureate occupations, however, there are far fewer training options, as previously noted in Chapter 1.

**Recommendations to Improve Energy Workforce Development in Puerto Rico**

To revitalize and professionalize the energy workforce in a way that is both integrated with the industry’s needs and nimble to changes in energy sources and technological advancements, we propose a public-private partnership to fund, staff, and maintain a vertically integrated Energy Academy. This academy would offer credentials at every education level and could be attached to the engineering school at UPR-Mayagüez.

Under a public-private partnership model of workforce training, both industry and government maintain ownership of the institution. PREPA, or whatever successor entities spin off from PREPA, would be partial owners and funders of the Energy Academy. The purpose of this joint ownership model, as opposed to a purely public school or independent private school, is to acknowledge the stake that energy providers have in workforce development. More important, this structure allows, to the fullest extent possible, communication between training providers and employers about the skills needed among graduates. In turn, it provides employers frictionless access for retraining or uptraining current employees.

The model for the Energy Academy would be vertical integration of offered credentials, or the portable/stackable model. Portable credentials are independently verified and accredited. Jointly funded by energy companies in Puerto Rico, the Energy Academy would not be an informal training center but an institution that offers credentials. The stackable model allows students to earn shorter-term credentials (shorter than, say, a four-year college degree) so that they gain faster access to the labor market while leaving the opportunity open for future training. With quicker gratification—a credential recognized by employers—the stackable credentials model can also increase student persistence.

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<tr>
<th>Box D.3. Colorado Mandates the Creation of Multiple On-Ramps to Education and Careers</th>
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<td>Colorado’s Manufacturing Career Pathway Act mandates that workforce stakeholders collaborate to develop stackable credentials to supply the state with manufacturing workers. These credentials form a pathway with multiple entry and exit points, allowing students to continue earning an income while earning each credential, taking time to focus on the labor market or schooling as desired.</td>
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The advantage of the stackable credential model is that it lowers the barriers in time, costs, and training for individuals to enter a skilled job while simultaneously building expertise within a workforce—two things that PREPA has struggled to do with the workforce within Puerto Rico. Moreover, a joint public-private model can more easily and efficiently respond to changing energy workforce need as new types of energy production or technology for energy extraction...

345 Austin et al., 2012.
346 Austin et al., 2012.
are adopted (see, for example, the ShaleNET public-private partnership model described in Chapter 6).

**Create a training program specific to energy microgrid development.** Modernizing the island’s electrical grid arguably means micro-izing it with solar and other renewable energy. Increasing weather severity caused by changing weather patterns makes extreme weather events such as Hurricane Maria more likely.\(^{347}\) A centralized electrical grid compounded the hurricane damage. Various experts suggest that Puerto Rico can mitigate future damage to the electrical grid by creating a microgrid similar to the one in Hawaii.\(^{348}\) In this system, a local collection of residential and other solar panels work in tandem with solar batteries to collect and store energy while operating through grids that are both extremely small and extremely local. These localized, or micro, systems can distribute power as needed across the system and can operate even in the event of damage to other micro systems. Recent technological advances allow for “smart” grid systems whereby computers automatically monitor the system and distribute excess stored energy from one part to another.\(^{349}\) In fact, the UPR-Mayagüez has already developed Puerto Rico–specific smart grid technology as part of the OASIS project.\(^{350}\) Given the strong engineering and computer science faculties at Mayagüez and the infusion of federal dollars tied to repairing and modernizing the island’s electrical grid, and based on analysis conducted by the Energy sector team, we recommend a workforce development program targeting (1) the manufacture of solar panels, batteries, and other associated equipment and (2) strategic construction and maintenance of a smart grid system.

### Education and Social Welfare

**Workforce Needs**

Unlike the health, energy, and construction workforces, in which policies are needed to create sufficient labor supply to support recovery and broader economic growth, the education workforce has, to some extent, an opposite problem. Before Hurricane Maria and in the recovery afterward, Puerto Rico had a sufficient supply of teachers. However, two factors have come together to create an oversupply of teachers. First, the outmigration that occurred before and in the wake of the hurricane has been disproportionally composed of families with young children.

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\(^{347}\) Acevedo et al., 2017; Carleton and Hsiang, 2016.


\(^{349}\) Worland, 2017; Akpan, 2018.

Research predicts that the outmigration will continue.\textsuperscript{351} Estimates vary, but the loss of school-age children will continue in the next five years, with anywhere from 22,000 to 42,000 leaving for the CONUS.\textsuperscript{352} At the same time, PROMESA and the federal oversight board has recommended reducing the number of schools in an effort to cut down on public expenditure. The Governor’s office closed 167 schools in the summer of 2017 and announced an additional 265 closures in the summer of 2018.\textsuperscript{353} Although no mass layoffs have been announced yet, it is likely there will soon be a surplus of college-educated teachers.

One option to help the displaced teachers is to pursue policies that allow teachers to follow their students. Some counties within Florida, Massachusetts, and Connecticut, in response to the influx of Puerto Rico migrants, have already adopted credential requirement exceptions for Puerto Rico’s teachers to help fill the teacher shortfall in their state.\textsuperscript{354} However, that is not a solution that directly contributes to the Puerto Rico economy or recovery effects (although it might reduce unemployment); rather, it contributes to continued outmigration.

Therefore, options that help the displaced workforce remain—and be employed—in Puerto Rico would be preferable. As noted in Tables 2.8 and 2.9 in Chapter 2, there are numerous master’s- and doctorate-level professions that will be in shortfall in the coming years that are still in the education or social welfare space: counselors, social workers, psychologists, and postsecondary instructors. The challenge here is how to retrain college-educated workers who are midcareer to reorient into a more stable and in-demand profession.

\textit{Current Training Landscape}

Teachers in Puerto Rico have bachelor’s degrees and professional certificates, meaning they are at once highly educated but have already invested significant time and money in their careers. Further retraining requires additional time and expense, and programs are designed to meet the demand of labor market first-time entrants rather than participants. Many of the post-baccalaureate degrees that could be natural progressions for primary and secondary teachers require significant time commitments. Becoming a counselor or social worker, whether in a school or with a specialty in marriage, trauma, substance abuse, or children, for example, requires an additional full two years of school, in addition to on-the-job training such as internships and further


\textsuperscript{352} Meléndez and Hinojosa, October 2017.


licensure exams and requirements. Beyond the master’s level, an even greater time investment is required. Becoming a full psychologist, regardless of practice environment, requires a doctorate degree, lasting years. The same is true for postsecondary teachers. Although there may be a demand for more training from displaced teachers, and a stock of advanced human capital that should be efficiently used by the economy, this will be difficult to accomplish.

Recommendations to Improve Education and Social Welfare Workforce Development in Puerto Rico

To offer teachers the opportunity to build on their extensive education and experience (as well as other displaced college-educated workers), we propose establishing accelerated master’s and professional training programs at the University of Puerto Rico campuses as well as the proposed community college campuses. These programs can be tailored to students with significant professional experience, if not to teachers specifically.

There are current examples\textsuperscript{355} of similar programs. Rather than adopting a traditional course load of four to five classes that extend over a four-month semester, these programs may offer rolling four- to eight-week classes that are taken one at a time in a nontraditional format.

- Online model—All classes and coursework are completed online in an “asynchronous” model, in which students fully set the pace of readings and assignment completion.
- Hybrid in-person model—Students have in-person classes for a few days at a time once a month, and the remaining coursework and assignments are completed online.
- In-person model—Students meet once a week for lecture.

Nontraditional models have not been as rigorously evaluated for the most effective model for instruction. However, traditional models have proved to be difficult to manage for returning, older students. Small programs, tailored to the needs of the students, can effectively allow displaced professionals to continue high-skilled careers.

Cross-Industry Recommendations to Improve Puerto Rico’s Workforce Development System

Recovery spending will stimulate employment in the sectors outlined above, and our conversations with sector experts did not identify deficiencies in training programs for any other occupations. However, maintaining a skilled workforce rests on access to skills training, and once programs are established, affordability plays a key role in facilitating that access. While tuition rates are generally lower in Puerto Rico than in U.S. states, income is also lower, such that affordability remains a problem, particularly with the proposed increases to UPR tuition. The previous sections outlined key strategies and policies in Puerto Rico, both on the system level and within particular industries, that can build the foundation for a 21st-century workforce.

\textsuperscript{355} Eastern University, “Adult Undergraduate and Graduate Admissions,” webpage, undated.
Now, we present additional policies and considerations for Puerto Rico that are not industry-wide or industry-specific.

**Repurpose Underutilized Buildings at Port of Ponce to Create an International Training Center**

The Port of Ponce is an underutilized port on the southern side of Puerto Rico. Given limitations in shipping into Puerto Rico, it is unlikely that the port, though of high quality and in good physical shape, will become a shipping hub. If the port does recover and is used for shipping, it could serve dual purposes. We recommend repurposing buildings and land at the Port of Ponce into a working school and training center for international shipping. This would require partnering with international unions and shipping companies in a private partnership to commit to training at Ponce, which has the advantage of year-round temperate weather and much less competition than a dock space with commercial interests. We recommend pursuing those partnerships to establish training protocols hosted on-site that meet both U.S. and European labor and safety standards. We further recommend a workforce development program targeting (1) port and shipping occupations, such as stevedores or vessel operators, and (2) instruction in port and shipping certifications, such as occupational certificates or safety licensing.

**Restart YouthBuild**

YouthBuild is a collaborative program from the U.S. Department of Labor and Department of Housing and Urban Development, primarily funded through Labor Department grants as authorized under WIOA. YouthBuild educates young adults who have dropped out of high school or are at risk of dropping out, allowing them to obtain a high school diploma or GED as well as skill development in specific high-paying trades. YouthBuild’s industries of focus are construction, health care, and retail, and young adults may also participate in registered apprenticeships within these fields. We propose that Puerto Rico apply for three YouthBuild sites.

Areas with YouthBuild programs increase the supply of affordable housing. Young adults also gain education to assist in securing gainful employment, and many feel increasingly connected to their communities. If the young adults educated through this program remain in the construction field, they may assist with the reconstruction of Puerto Rico and the mobilization of a construction workforce capable of sustaining future development. Furthermore, the aging of Puerto Rico’s population has created great need for health care workers, which the newly trained workforce could help address.

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356 As noted in Chapter 2, the rate of adults age 25–64 without a high school diploma is 50 percent higher (6 percentage points) in Puerto Rico than in the United States overall.
Depending on the scale and quality of the reconstruction, new housing could improve health and environmental outcomes. Additional access to trained health care professionals, particularly in rural areas, may decrease costs associated with health care and improve health outcomes.

**Engage Low-Income and Out-of-Labor-Force Youth**

Apprenticeships could be especially useful to provide income while youth attend programs. For employers, the youth represent a viable and affordable labor force. In Puerto Rico, newly employed youth ages 25 years and younger can be paid a local federal minimum wage of $4.25 an hour under the PROMESA Act. This aspect of the PROMESA legislation is meant to remove barriers to job creation on the island since the federal minimum wage for other U.S. workers ($7.25/hour) remains high relative to median income on the island (~$19,000/year).

These apprenticeships could be modeled after existing construction certifications, similar to electricians and plumbers. In these occupations, there exist clear career ladders with sizable income growth. This would provide opportunities for upward economic mobility among graduates and potentially help stem population loss through emigration and even fertility on the island.

The government of Puerto Rico could provide grants for especially low-income youth to train in renewable energy manufacturing, installation, and maintenance. Postsecondary education tuition in Puerto Rico is heavily subsidized yet still regressive, since high-income students are more likely to attend postsecondary school and pay the same, relatively low tuition. Grants could be funded via HUD and FEMA funds targeting reconstruction of the island’s electrical grid, National Science Foundation (NSF) funds emphasizing diversity in STEM, and Department of Defense funds targeting advanced manufacturing and other security concerns. Given room, board, and other expenses associated with postsecondary education, these grants should not be limited to tuition. In the Puerto Rico context, access to credit markets is severely limited because of the island’s ongoing financial crisis, and public transportation is limited too. This suggests that at least some youth may require a personal vehicle to attend training programs and work. These grants are in addition to federal Pell Grants and student loans.

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359 University of Puerto Rico, Mayagüez, is the largest producer of Hispanic engineers and is therefore an important engine of STEM—science, technology, engineering, and mathematics—diversity. Furthermore, the quality of the university’s engineering training is noted by employers (Congressional Task Force on Economic Growth in Puerto Rico, December 20, 2016). NSF funds have been separately earmarked for “smart” communities using technology for community improvement and economic develop projects, such as a smart microgrid system.

Many experts previously raised concerns over policy disincentives for individual work on the island.\textsuperscript{361} To avoid similar disincentives in the proposed programs, grants can be tied to grade point average and/or completion requirements as well as perhaps residency requirements for some amount of time after completion of the program.\textsuperscript{362} Such residency requirements are sometimes controversial but arguably important, given the extent of emigration from the island over the last decade and especially following Hurricane Maria. This is in addition to tandem apprenticeship training that increases the likelihood of completion of the program because of the increased likelihood of employment afterward.

We do not recommend loans as the main mechanism for funding workforce training in renewable energy installation and maintenance. Loans are especially onerous for low-income students, and low-income students are less likely to use them anyway.

Research suggests that information campaigns and application support are especially important for reaching low-income youth.\textsuperscript{363} Proposed apprenticeship and vocational programs should be accompanied by informational campaigns based on previous research.

\textit{Provide Business Management and Entrepreneurial Training}

Because of the opportunities afforded by federal disaster relief and investments in modernizing and micro-izing the island’s electrical grid, we recommend including business management and entrepreneurship courses in proposed vocational training. By offering such training, the program could help individuals develop important skills for starting and growing small businesses around the manufacturing, construction, and maintenance of a smart microgrid in Puerto Rico. Doing so helps provide opportunities for upward mobility on the island through self-employment and business ownership. Importantly, given that the Congressional Task Force\textsuperscript{364} notes low take-up rates among people in Puerto Rico for such funding, this sort of training should include information about federal funding from the Small Business Administration, the National Science Foundation, and other federal sources targeting small businesses, as well as how to write grants for such funding.

\textsuperscript{361} Enchautegui and Freeman, 2006; Congressional Task Force on Economic Growth in Puerto Rico, December 20, 2016.
\textsuperscript{363} Hoxby and Turner, 2015.
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One strategic goal in the post-hurricane recovery plan for Puerto Rico is the development of a modern workforce with relevant skills to meet the demands of an evolving labor market. To begin, Puerto Rico must first overcome the acute workforce challenges and structural problems that have impeded economic growth for more than a decade. The authors set out a course of action that strengthens the K–12 and post-secondary education and training system, develops career pathways for individual workers that would improve their employment trajectories, and better aligns workers’ skills with employment opportunities and the needs of local businesses.

More specifically, the authors present four strategies to address short-term workforce shortages and needs. A critical fifth strategy then reimagines Puerto Rico’s entire workforce development system to support Puerto Rico’s economic development and community well-being. This longer-term strategy can be implemented in tandem with any of the short-term strategies, depending on which strategies the government of Puerto Rico decides to implement. Any long-term workforce development policies or strategies must, however, encompass training and education across the spectrum of education levels, from high school diplomas to technical certificates to master’s degree and higher. The report includes recommendations to improve Puerto Rico’s workforce development system cross-industry and specific recommendations for construction, health care, energy, and education industries. With government-industry-education planning, these longer-term policies and initiatives could better link job opportunities by municipality, occupation, and industry and ultimately propel economic development in Puerto Rico.