Leveraging LBNL's Second Campus for Regional Economic Development

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EXECUTIVE SUMMARY

In early 2011, Lawrence Berkeley National Lab ("LBNL" or "the Lab") announced its intention to build a second campus, setting off a wave of excitement in the San Francisco Bay Area. The Lab, home to prominent scientists and researchers including 13 Nobel Prize Laureates in its 75 year history, had outgrown its facilities in the hills above the University of California, Berkeley campus. After public meetings and careful evaluation, the Lab has chosen six site finalists. Each of the sites are located within the East Bay, within 25 minutes of the Lab. The public anxiously awaits the final selection, scheduled for 2012. The Second Campus – as it has become known – is expected to open in 2016.

The development of the Second Campus comes at a pivotal moment in the world of science, especially in the areas of energy and natural resources. Concerns about the eventual depletion of the planet's fossil fuels and the environmental impact of their consumption have heightened the search for alternative energy sources. As the oldest of the U.S. Department of Energy's National Labs, LBNL is at the forefront of energy innovation. Efforts to commercialize scientific discoveries from LBNL produced spinoff companies that have emerged as industry leaders. These firms, in turn, give rise to a network of supporting industries.

Our report offers an analysis of the economic impacts of this innovation ecosystem. Our study was conducted as part of a sustainable economic development studio course by Masters candidates from the Department of City & Regional Planning at UC Berkeley, led by Professors Karen Chapple and Cecilia Estolano. The material synthesized in this report is the culmination of an investigative process that included review of existing literature and reports, site visits, cluster case studies, economic and workforce models, and interviews with key stakeholders and experts from LBNL, city government, the bioscience industry, real estate, and trade and advocacy groups.

Key Elements

This report is organized according to major areas of analysis and recommendation. We begin by analyzing the biosciences industry, which provides a framework for understanding the industry's development needs and economic impacts. We then offer a review of LBNL's effects on the East Bay regional economy to date, which lays the foundation for projecting the likely impact of the Second Campus. On the basis of these findings, we recommend strategies for cities and the region, with the aim of maximizing the economic development potential of the Second Campus by actively fostering a regional bioscience cluster.

Bioscience: A New Field, an Emerging Economy

The Second Campus offers an enormous opportunity to drive regional economic expansion and job creation in the East Bay. The LBNL institutes that will be housed on the Second Campus—the Joint BioEnergy Institute, the Joint Genome Institutes and the Life Sciences Division—produce cutting-edge research and development (R&D) focused on biofuels and industrial biotechnology. This sub-sector of bioscience is therefore the focus of our investigation. Biofuels production involves the use of microbes to deconstruct organic material to produce a given substance, which then is synthesized into usable fuels. While much of the R&D is conducted in pursuit of new fuel sources, advances in the industry have demonstrated that this process can also be used to produce plant-based chemicals, fuels and plastics.

The path to commercialization involves distinct phases, with differing functions, spatial and locational characteristics and employment needs. The Department of Energy provides funding for scientific research and breakthrough discoveries are taken up by startups, backed with considerable risk by venture capital. We found that the East Bay is home to many firms at this stage, with the potential for further growth. Taking these firms to scale involves the refinement of biomatter in large quantities. At this stage, the East Bay shows less promise for pilot refineries that prioritize proximity to cheap agricultural land and specific transport infrastructure, which are in scarce supply in the region.

There is wide variation in the numbers of employees per firm, largely dictated by the stage of commercialization. Pilot plants are typically small with low staffing needs. The next phase involves scaled production, which our research indicates is capital intensive and light on labor. Feedstock is usually produced by partner companies with an existing labor supply, which generate industrial feedstock as a byproduct of their own processes. We found that most biofuel companies do not produce the end product but instead work with larger fuel companies to create blends that meet national standards. Biofuels thus share the existing distribution and employment networks as result of the fuel industry. For this reason, indirect employment effects in the end markets are likely, but expectations for additional jobs should be limited. Our analysis concludes that there is a significant opportunity for industrial biotech development in the East Bay, but the region will face challenges in keeping firms local as they scale up.

Impact of LBNL's Second Campus: Institutional and Economic Analysis

To understand the potential of the Lab to catalyze the development of a regional bioscience cluster, we investigated the Lab's funding, employment practices, purchasing patterns, community programs and technology transfer activities. Our findings lead us to make a measured assessment of LBNL's capacity to play an active role in regional economic development. While the development of the Second Campus will undoubtedly produce economic benefits for the region, historically the Lab's impacts have been largely incidental rather than intentional. The Lab is a major employer that recruits locally for support staff positions; however, scientists are recruited internationally. The proposed Second Campus divisions spend approximately $80 million on procurement annually, but only 10% of this spending went to East Bay firms in 2010. In terms of community programs, the Lab has placed an emphasis on science education, but no tracking exists to measure the long-term benefits to the East Bay workforce. Finally, although the Lab does license technology to spin-off companies, the rate of spin-off generation from the Lab alone is not high enough to support a cluster, nor does the Lab seem to be a factor in the locational decisions of spin-offs. The Lab currently lacks the capacity to nurture spin-offs through close working relationships and access to resources. In general, we found the Lab's ability to promote regional economic development to be limited by two factors: as a federally-funded entity, the Lab is restricted in how it may use its funds, and as a world-class research institution with a national mission, the Lab is less inclined to consider its influence in a regional context.

To quantify the economic impacts of the Second Campus and potential cluster development, we used the IMPLAN regional input/output model to run an analysis for the East Bay, which we define as Alameda and Contra Costa Counties.

In the short term, the Second Campus will generate a significant number of full-time and part-time jobs in the construction of facilities. In the longer term, the wages paid to employees will make their way into the economy through consumption of everyday items and services, producing induced employment and spending impacts. The Lab will also act as a consumer through its procurement of goods and services, producing indirect impacts through the Lab's supply chain. We considered both the Second Campus itself and scenarios of how technology transfer from the lab could help form an innovation cluster in the region. Our analysis projected the following economic impacts:

Second Campus

- Phase I construction of 450,000 sq. ft. will result in 2,719 direct, indirect and induced jobs.
- Each job will result in 0.4 indirect or induced jobs.
- By 2015, Phase I purchasing and payroll will result in approximately 1,000 direct jobs, 428 indirect and induced jobs and $105 million in direct and indirect purchasing per year.
- By 2030, purchasing and payroll will result in approximately 1,500 direct jobs, 576 indirect and induced jobs and $188 million in direct and indirect purchasing per year.

Cluster Development (co-location of related and complementary businesses)

- Construction of 800,000 sq. ft. for new lab and office space would result in 3,540 direct, indirect and induced jobs.
- Each job will result in one indrect or induced job.
- A "modest cluster" scenario with 20 firms and 1,900 employees would result in 1,850 indirect and induced jobs and a total output of $879 million.
- Complementary businesses produce a much higher multiplier effect in the economy than direct jobs at LBNL alone.

The Lab's activities alone will not necessarily stimulate significant inter-industry regional economic activity; we project the greatest impacts among household-serving businesses.

City Strategies: Building a Cluster

Based on our research, we identified key strategies for cities to consider as a means to encourage biotech cluster development in the region. First, cities can adjust zoning policies that accommodate the needs of biotechnology firms. Developers and firms value certainty and clarity when considering space and building needs. However, they can be deterred if existing zoning might not allow for the necessary uses, or do not clearly state where bioscience activity is permitted. Furthermore, the nature of the industry requires that supporting uses be in close proximity to research labs, since the industry relies on collaboration across administration, lab research, and production. It is therefore crucial that these various uses be allowed within one area or in close proximity. We also found that the industry workforce values proximity to amenities. Typically, employees don't want to feel sequestered in a purely industrial area; a mix of uses including retail, restaurants and recreation, in proximity to bioscience areas will help to foster an attractive environment for industry firms. Other recommendations address the following issues:

The role of developers Interviews with firms and developers revealed that developers play a highly active role in the bioscience industry, acting as primary investors in space that is often very expensive to build. It is rare that start-ups have sufficient capital to build their own space. Bioscience facility developers have become extremely knowledgeable about the industry and function as key partners in attracting and maintaining bioscience firms.

Infrastructure demand The bioscience industry also has intensive infrastructure needs that include transportation networks for obtaining inputs and a high demand for water and power to operate labs. Cities that hope to attract bioscience development should therefore commit to maintaining and improving existing infrastructure.

Community involvement Bioscience is an emerging and dynamic industry, and communities might have concerns based on serious issues or common misconceptions. In order to facilitate development, cities can help educate their communities on the nature of bioscience work and the goals of the industry. This can help develop community support and reduce obstacles to development. Cities can also help developers understand community concerns and plan accordingly.

Assessing city strengths Each city can play a role in the East Bay's "cradle-to-scale" cluster by conducting realistic assessments of its strengths to strategically attract firms and bioscience activities that align with existing assets.

Additionally, we evaluated zoning and fiscal impacts for two areas that have Second Campus site proposals - the Southern Gateway of Richmond and West Berkeley. For the zoning analysis, we assessed the potential for two particular bioscience building types - "a science hotel" and an "R&D lab" - to be constructed in Berkeley and Richmond. In Berkeley, the zoning code imposes maximums on building height and floor area ratio that make it difficult to develop bioscience lab space. The Master Use Permit would offer a way to get around these restrictions. We found that Richmond's planned update to their General Plan accommodates an R&D lab that presents only a slight concern about parking requirements.

In the fiscal analysis, we examined the tax revenue that Berkeley and Richmond currently receive from key opportunity sites in the area around the proposed Second Campus. We then evaluated tax impacts of a future scenario in which opportunity sites had been built out with the ideal bioscience buildings from our zoning analysis.

Regional Workforce: Understanding East Bay Assets and Needs

As a new industry, jobs are expected to increase over the long term in the biotechnology sector, requiring highly skilled and highly educated individuals with Science, Technology, Engineering, and Math (STEM) skills. Additionally, technically proficient individuals will be needed to fill research assistant-type roles but minimal administrative capacity will be required. There is a broad array of types of so-called Professional, Scientific, and Technical Service (PSTS) jobs, which includes anything from lawyers and accountants to designers and printers. For the cluster to continue to mature and develop effectively, an educated workforce is critical. As it stands, the baby boomers are in the process of retiring, taking their lifetime of accumulated skills with them. The key concern will be to see if those roles can be backfilled by the upcoming generations, with STEM and PSTS jobs the major areas for growth.

In this light, we found that workforce development systems will be crucial to the East Bay and the nascent biotechnology cluster. Some are already in place throughout Alameda and Contra Costa Counties, but impediments and gaps need to be addressed, especially as they relate to high drop out rates, and a lack of STEM and PSTS skills. Fortunately, the East Bay has several pipeline initiatives that target high school and community college students. Many of these are created in partnership with industry leaders that help shape curricula and the learning process. Courses and biotech certificates are often coupled with mentoring and other hands-on opportunities to develop the highly valued work experience required by employers. Key partnerships exist between industry and schools, forming an active bridge from the classroom to the workplace, with some emphasis on biotechnology and advanced manufacturing.

While these programs are beneficial, their effectiveness would be increased through better coordination and planning. Furthermore, the mechanisms for tracking the relationship between educational programs and actual workforce outcomes are missing. As a result, there is a dearth of data on the workforce pipeline, possibly causing duplicative efforts, the promotion of silos, and the inefficient use of increasingly limited resources.

Regional Leadership: A Crucial Element

Proactive, consistent, and dynamic regional leadership is likely to be the most important component in fostering a vibrant biotechnology cluster and business ecosystem. As a result, we identified five leadership needs or responsibilities that must be fulfilled by one of the various entities in the field, such as LBNL, the East Bay Green Corridor, or potentially new organizations. These recommendations are based on research into other bioscience clusters, successful research parks, and current East Bay biotech dynamics.

First, the region needs a leader who can rally stakeholders and orchestrate a broad-based inclusive strategy. The way forward must involve teamwork, but someone must also be the conductor. Second, the region needs a robust and organized local supply chain, including workforce, goods, and services, that can support bioscience companies. Third, the region needs denser networks across the broad array of stakeholders working in and benefiting from the R&D and business ecosystem: scientists, VCs, developers, industry experts, students, and local officials. There is an abundance of expertise related to the complicated path that takes science from breakthrough to commercialization. Efforts should focus on extracting and propagating that knowledge to the cluster. Fourth, the region needs to bridge the knowledge gap around local and state regulations. Conducting this research and building these kinds of companies is extraordinarily complicated, and involves various levels of regulation. Making these regulations transparent is the first step to helping companies navigate them and finding areas of potential reform. Finally, promoting and marketing the region will be crucial toward the development of an East Bay brand that will be widely known as a business ecosystem for biofuels and industrial biotech.

Already, the East Bay has an advantage in its world-class institutions, industry leaders, a prepared workforce, and contributing factors such as culture, amenities, and relative affordability. All the pieces for this cluster are already in place, and the region doesn't need to wait for the Second Campus. However, the region does need a vision that can capture the imagination and interests of all stakeholders; this will be the cornerstone of a stable and thriving bioscience innovation cluster.

Conclusion

Development of the Second Campus is a once-in-a-lifetime event for the East Bay. It has great potential to act as a catalyst for the region, driving the growth of a bioscience cluster. The Second Campus alone, however, will not lead to sustained economic development. The East Bay needs strong leadership and a unifying vision around the bioscience industry in order to capture its full economic potential regionally. The strategies identified in this report provide a starting point for cities, institutions, private industry and additional stakeholders to build momentum around the siting of the Second Campus.

Introduction and Methodology

The Lawrence Berkeley National Lab ("LBNL," "the Lab," "Berkeley Lab") is one the nation's preeminent scientific research institutions. Based in Berkeley, LBNL is planning to locate a new campus in the East Bay (defined as Alameda County and Contra Costa County) at one of six proposed sites. The development of the Second Campus, regardless of the site selected, has the potential to strengthen the regional bioscience cluster and act as a catalyst for regional economic development. This report investigates how East Bay cities can maximize the economic development potential of the Second Campus by strengthening connections between LBNL and the existing innovation ecosystem and localizing the benefits of LBNL's innovative research.

While we initially set out to examine the Lab's economic impact based on a specific site, our research revealed that the full economic development potential would occur at the regional scale and require collaboration among the cities of the East Bay. The final siting of the Second Campus will certainly be significant for the selected city, but we believe that the Lab's location will not be the most important factor in determining how the cities and the region realize economic benefits. This report will demonstrate that steps taken at the city and regional level will be necessary for the formation of a regional cluster. Each city can take advantage of purchasing patterns from LBNL and cultivate a balanced cluster of co-locating and complementary businesses to amplify economic value. Most importantly, regional collaboration will be necessary for the East Bay to foster a thriving innovation cluster.

The clients for this report are the City of Berkeley, the City of Richmond, and the East Bay Green Corridor Partnership, a collaboration between UC Berkeley, California State University East Bay, Peralta Community College District, LBNL, and the cities of Berkeley, Oakland, Richmond, Emeryville, Alameda, Albany, El Cerrito and San Leandro. Our assignment was to assess the regional economic impacts of LBNL's Second Campus.

This assessment involved a number of core research questions:

• What regional economic impacts will the Second Campus research centers generate?

• Does the Second Campus have the potential to serve as an anchor for an innovation cluster in the East Bay?

• What can be done at both the city and the regional level to facilitate technology transfer and spin-offs from LBNL's research?

The research process was orchestrated in the spirit of a student studio course: highly collaborative, driven by students with guidance from instructors, and pursued through multiple, simultaneous research projects. We were responsible for refining the research questions and coordinating the research process, based on our sense of the clients' interests.

We used a variety of tools and methods to explore our research questions. Interviews helped us understand the technology applications of Second Campus bioscience research, the workforce need of the bioscience sector and the existing regional workforce development ecosystem. Case studies of existing research parks gave us insights into how innovation clusters form. Quantitative analysis of LBNL purchasing data illustrated direct, indirect, and induced spending generated by the lab. IMPLAN – an economic modeling software – allowed us to project county-level economic impacts of the existing Lab and the proposed Second Campus development. Finally, GIS provided spatial insights into zoning, land values, local supply chain for the lab, and development impacts.

This array of qualitative and quantitative methods allowed us to consider these complex issues from a variety of perspectives. The results of our analysis are summarized in this report.

CHAPTER ONE

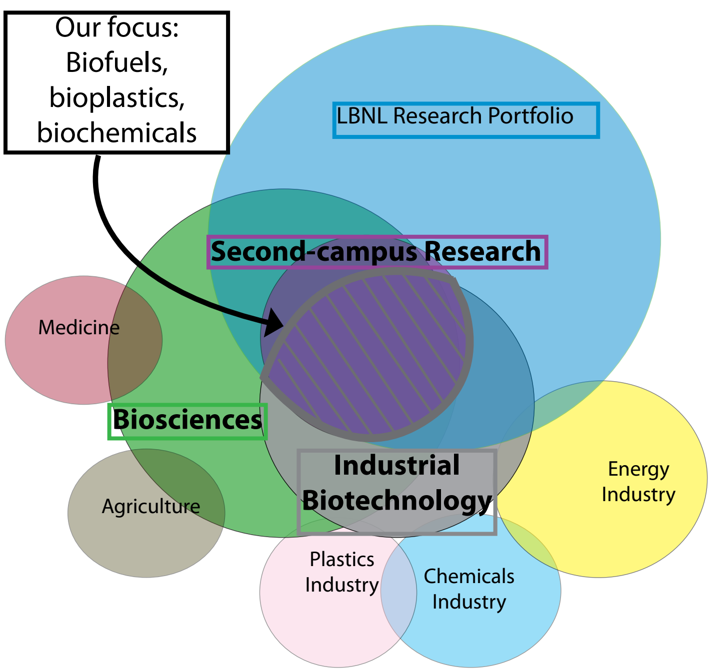
The Science of the Second Campus

Introduction

The Second Campus – and the cutting-edge bioscience R&D it will produce – offers new opportunities for economic development in the East Bay. For this reason, we sought to understand the actual science and research that will take place in the Second Campus to better understand the commercialization potential. Our analysis and subsequent research suggested that spin-offs and clustering effects must be considered at the regional scale, and that the actual location of the second campus within the East Bay is not the most important factor in cluster development. Moreover, cluster development will also depend on technologies from other major research institutions in the East Bay, including the Energy Biosciences Institute, Lawrence Livermore National Lab, and various departments at UC Berkeley. A comprehensive analysis of the East Bay's R&D and innovation portfolio was beyond the scope of this class. The East Bay Economic Development Alliance conducted a regional analysis of the East Bay's innovation economy, which provides a useful overview of the region's strengths in biotech, medicine, information, and design, among others. Our research should help situate the Second Campus within this broader landscape.

The three institutions that will be consolidated in the second campus focus on biofuel research, specifically biofuels derived from plant material. We sought to understand how this biofuel technology could make its way to market - which markets, through what vehicles, and with what impact. To understand these sectors, we interviewed scientific experts, VCs, industry analysts, student researchers, and leaders in different companies.

FIGURE 1. **Shape and Relationship of Sectors and Research**



This section is not an analysis of the entire bioscience sector, nor does it cover all the research conducted at either LBNL broadly or the Second Campus specifically. LBNL itself has research divisions across the scientific spectrum, which includes other forms of clean energy technology such as solar. It also conducts life sciences research beyond biofuels. However, we focused on biofuels because the three institutes of the Second Campus predominantly focus on biofuel research and because it is the least understood in terms of cluster development. The predominant conception is that life science spin-offs are medical or pharmaceutical, but the research underpinning biofuels is of a different nature. While there are major overlaps, the fields do differ on important points, and identifying these differences is key to understanding commercialization and tech transfer from the second campus. Figure 1 illustrates "bioscience" and the various subsectors that fall within and relate closely to it, and situates the biofuels-oriented research of the Second Campus within this landscape.

First, we will elaborate on the relationship between the science of the labs, the sector in which it is commercialized,

LBNL's Second Campus

The Second Campus will consolidate three research institutions. To understand the relationship between science, tech transfer, and cluster development, we investigated the scientific research happening at these three institutions.

The **Joint BioEnergy Institute (JBEI)** has a Department of Energy (DOE) mandate to focus on second-generation cellulosic biofuels. The lab itself is organized around the process of developing these fuels, with a Feedstock division, a Deconstruction Division, and a Fuel Synthesis Division. JBEI is one of three DOE Bioenergy Research Centers (BRC) in the nation; the other two BRCs are located in Tennessee and Wisconsin.

The **Joint Genome Institute (JGI)** is a facility for DNA sequencing, and most projects map microbes and plants that are part of the bioenergy process. JGI typically receives DNA in a test tube, and then researchers will reassemble that sequence, annotate it and ultimately make the information available on the web. We learned that JGI's largest "customers" are JBEI and the two other BRCs.

Life Sciences has a Bioenergy division that develops very specialized imaging technologies for studying gene form and function. These tools support the genetic work done at both JGI and JBEI. This division is involved in a wide range of research, however, with many other projects oriented to medical applications.

and briefly, how that relates to the larger umbrella of "bioscience." Second, we will look at the path to commercialization for a technological breakthrough in this type of research, examining the employment and spatial needs at each stage of the path. Finally, we will assess the implications for the East Bay as a region. The majority of the research for this section was conducted in a series of interviews of scientists and leaders at existing companies, as well as industry experts.

The Science and Industry

Biofuels lie in the category of "industrial biotechnology," also known as "white biotechnology," which is defined by the European Association for Bioindustries as:

"[T]he modern use and application of biotechnology for the sustainable processing and production of chemicals, materials and fuels. Biotechnological processing uses enzymes and micro-organisms to make products in a wide range of industrial sectors including chemicals, pharmaceuticals, food and feed, detergents, paper and pulp, textiles, energy, materials and polymers."

Historically, biotechnology has developed in three general "waves" of research. The first commercial application of biotech was primarily agricultural, producing modified seeds and fertilizers to enhance productivity. The second wave was medical biotechnology, in which bioscience was used to produce pharmaceuticals and conduct stem cell research. While these areas continue to advance, industrial products such as chemicals, fuels, and plastics are emerging as the "third wave" of biotech. Biofuels are a part of the third wave of biotechnology research.

The biofuel industry is somewhat difficult to classify, using common industry classification systems. This is particularly true for the second-generation biofuels. First-generation biofuels – including ethanol plants – are more easily and clearly classified. Their NAICS codes are generally either Ethyl Alcohol Manufacturing (325193) or Industrial Gas Manufacturing (325120). Table 1 illustrates the wide range of NAICS codes that represent biofuel and industrial biotech companies. All of these companies have a focus on biofuels, and a large portion fall into the categories of basic chemical manufacturing (3251), other chemical product and preparation manufacturing (325998), and scientific research and development services (5417). Yet some companies self-report NAICS codes that are seemingly

TABLE 1. **Biofuels Related NAICS codes**

NAICS Code	Industry Description	Companies
324199	All Other Petroleum and Coal Products Manufacturing	KiOR
325110	Petrochemical Manufacturing	Sapphire Energy
325120	Industrial Gas Manufacturing	Amyris, BlueFire Energy, Range Fuels, Pacific Ethanol
325193	Ethyl Alcohol Manufacturing	KL Energy, POET Energy, BlueFire Energy, Enerkem
325199	All Other Basic Organic Chemical Manufacturing	Albengoa, PetroAlgae, KiOR, Dupont Danisco, Verenium
325311	Nitrogenous Fertilizer Manufacturing	Rentech
325414	Other Biological Prod Manufacturing	Novozyme, Coskata, Fulcrum BioEnergy
325998	Other Misc Chemical Prod Manufacturing	Gevo, Solazyme, Codexis, Amyris
424720	Petroleum and Petroleum Products Merchant Wholesalers	Aurora Algae
425720	Other Petroleum Merchant Wholesalers	LS9
541330	Engineering Services	Ineos Bio, ZeaChem
541690	Other Scientific and Technical Consulting Tools	Terrabon
541711	Research and Development in Biotechnology	OriginOil, Cobalt Technologies, Amyris, Codexis, Synthetic Genomics
541712	Research and development in the physical, engineering, and life sciences (except biotechnology)	Qteros, Joule Unlimited

Biofuels 101

Biofuels are solid, liquid and gas fuels produced from organic materials. At its simplest, the production of biofuels is a process wherein an organic material is eaten, digested, or broken down by a microbe in a controlled environment to produce a certain substance, which is then synthesized into usable fuels.

First-generation biofuels rely on starchy plant materials as inputs. Corn ethanol production, which constitutes the vast majority of first generation biofuels produced in the US, totaled 13 billion gallons in 2010, with total industry spending at $23.9 billion. In a report prepared for the Renewable Fuels Association in 2010, the total impact (direct, indirect, and induced) of the ethanol industry was calculated at more than 400,000 jobs, $36 billion in income, and a contribution of $53.6 billion to the GDP.[1]

The widespread production of first generation biofuels came in response to renewable fuel volume mandates established by the Energy Policy Act (EPAct) of 2005. EPAct created standards for blending biofuels into gasoline, requiring by 2012 that 7.5 billion gallons be integrated into gasoline sold in the US. This mandate guaranteed a market for biofuels, and the industry subsequently drew significant federal, state, and private funding.

In 2007, federal mandates for renewable fuels were expanded by the Energy Independence and Security Act (EISA) with the goal of driving the expansion of the US biofuels industry, decreasing greenhouse gas emissions, and reducing the country's reliance on imported petroleum. The present target is 36 billion gallons by 2022, and of this 21 billion gallons must come from second generation, or cellulosic, biofuels.

JBEI, JGI and the Life Sciences Division are involved in different aspects of second generation biofuels research, which derives fuels from fibrous, non-food plant materials (see Figure 2). Cellulosic biofuels is a nascent industry compared to first generation. Best practices are still being defined, and production is generally in pilot testing stages.

Second generation biofuels research tends to focus on one of three interrelated elements of the process: feedstock, deconstruction, or synthesis (see Figure 3). Feedstock development is concerned with engineering plant cell wall structures that are more easily broken down into component sugars. Deconstruction research focuses on the pretreatment processing of plant materials, as well as the microbes and enzymes used to break down feedstocks. Synthesis refers to the process by which the plant sugars are fermented or otherwise converted into different biofuels. At each stage of this process, significant advances are made that have impacts beyond biofuel development.

1 Urbanchuk 2010.

FIGURE 2. **First, Second and Third Generation Biofuels Pathways**

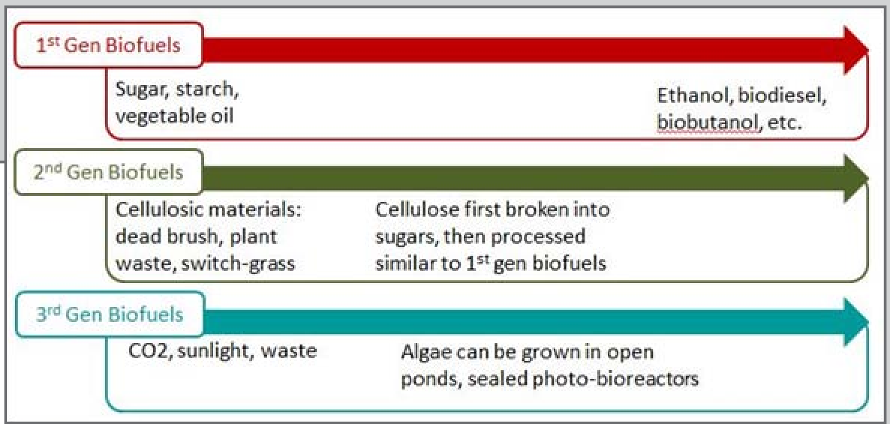
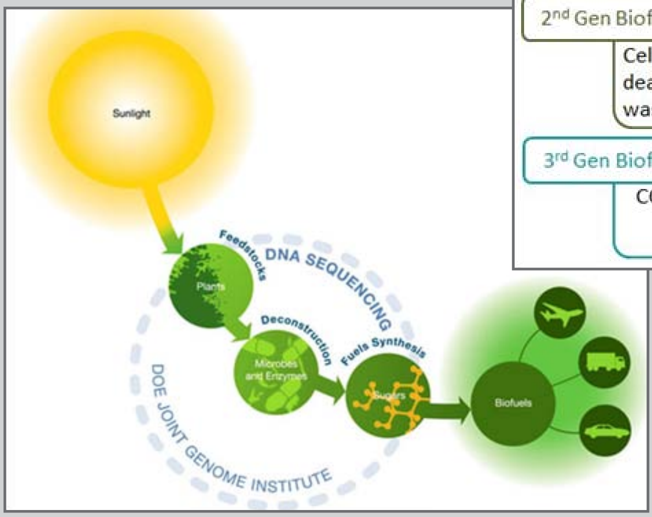


FIGURE 3. **Second Generation Biofuel Production**



Source: Joint Genome Institute

far removed from biofuels, such as petroleum products merchant wholesalers (424720) and nitrogenous fertilizer manufacturing (325311).

The majority of funding in industrial biotech is going to biofuels, but there is significant potential for growth among other industry subcategories. Venture capital is readily available, although most goes to early R&D rather than to the later stages of commercialization and production. Our interviews suggest that there are approximately 400 to 500 firms currently working in industrial biotech. While production has slowed in light of the recession, recent reports suggest that industrial biotech is faring better than other industries, due in part to the growing demand for "green" products . Many US companies that currently work on biofuels are also producing other bioproducts, or are planning to do so in the future. In contrast to biofuels, which offer low profit margins, these other non-fuel bioproducts are attractive investments because they can be sold in smaller quantities at more competitive prices. This lets biofuel companies travel down the cost curve to mass produce biofuels.

Commercialization Path: Conceptual and Geographical

Given that we would like to examine spin-offs and tech transfer as key pieces to the economic development strategy related to the Second Campus, we wanted to understand the path to commercialization for biotech. Figure 4 illustrates a pathway to growing a vertically integrated company from a particular turnkey technology or set of technologies, and also shows ways that companies can diverge from this path. This section will examine each piece of the path in turn, focusing on function, employment, and spatial and locational characteristics.

Start-Up Phase: R&D and Headquarters

The first phase of the commercialization of technology, of course, is in the research and development. Given that most research occurs in large research institutes (see R&D box), the first step towards commercialization is drawing that technology out into a start-up company. A science-savvy

Government Role in R&D

The primary financial drivers of biofuels R&D are the DOE and US Department of Agriculture (USDA), though the DOE provides the lion's share. They funnel money to research institutions and to small outfits; the former primarily focus on foundational science while the latter focus on process innovation and demonstration projects. The DOE has a fairly comprehensive strategy of developing this industry, from basic scientific breakthroughs to cost-effective demonstration biorefineries. Their funding focus has currently been on second-generation biofuels. First-generation biofuel is a more mature science and industry, and most experts agree that ethanol can now survive without subsidies.

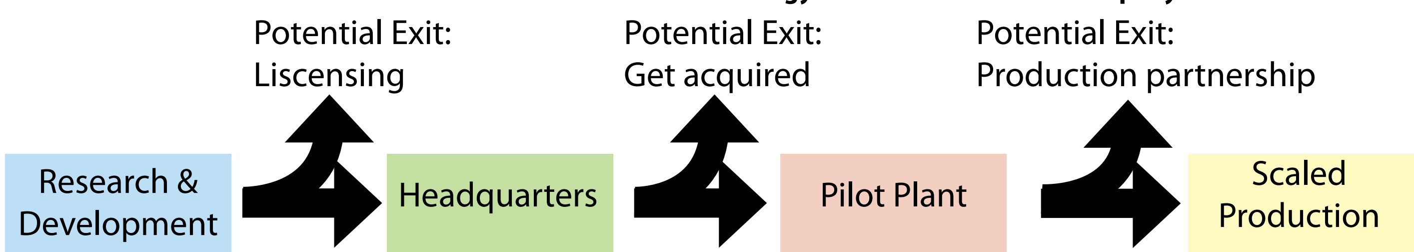
R&D numbers are difficult to define given that so many funded initiatives might be scientific, but a report estimated that in 2009, $1.5 billion was spent on R&D.[1] At least $600 million of that came from American Recovery and Reinvestment Act (ARRA) funding.

JBEI is one of three flagship research institutes funded by DOE; in 2007, they were guaranteed $135 million over 5 years. The other two Bioenergy Research Centers are located in Oakridge, Tennessee and Madison, Wisconsin. Breakthrough research will likely remain in these institutes, because it requires world-class expertise in biology, chemistry, engineering, botany, and other disciplines that are difficult to gather under one roof.

Interviews suggested that the basic science is not the primary barrier right now, but that there's a need to integrate scientific discovery with engineering components of production, distribution, and consumption – in other words, the barrier is further down the market process. Additionally, more funding needs to come from the private sector, especially if budget cuts at the federal and state levels hit this basic research. It is likely that energy companies will start to invest more in biofuels, likely taking the form of public-private partnerships such as the BP Institute. The Energy Biosciences Institute (EBI) at UC Berkeley was established by BP in partnership with LBNL in 2007. EBI was guaranteed $500 million over 10 years, giving it a larger research budget than JBEI. This will likely have implications for commercialization of science.

1 Urbanchuk 2010.

FIGURE 4. **Commercialization Path for a Technology or Industrial Biotech Company**



venture capital (VC) community, led by companies such as Khosla Ventures and Vantage Point, has been very strategic in getting inventions out of the labs and into spinoff companies. Some companies, like Amyris, have grown organically from laboratory to company, guided by entrepreneurial scientists. Thus far, most technologies seem to be pushed by small companies, and the large dominant players in energy, agriculture, and chemicals are waiting for entrepreneurs to prove the concept before they begin aggressive licensing.

A couple of years ago, this process was the bottleneck for cellulosic biofuels, and the risk was seen as too high and too uncertain to attract enough private capital. US government funding, including American Recovery and Reinvestment Act (ARRA) funding, has helped push the sector through this process. Now the spin-off and start-up process is highly dynamic, with specialized VCs, developers, scientists, and entrepreneurs engaged. The recent bankruptcy of Solyndra has thrown the sector into uncertainty, and the future of this research is unclear, but interviews suggested that this sector was just beginning to outgrow dependence on federal funding. Nonetheless, the major research institutions have backlogs of scientific research that is currently being spun onto the market.

The more established companies have grown to the stage of having headquarters, which help with business development, partnership formation, and strategy. In general, company headquarters seem to be fairly closely tied to the R&D piece of the company, and most often these are geographically co-located. These are generally not located near the refineries or the feedstocks – in fact, one interviewee said that locating in the middle of nowhere to be next to feedstocks was "the biggest mistake" a company could make.

Instead, we found that companies tend to locate their R&D labs and headquarters based on other factors, and that the East Bay could indeed be a good place for these companies to locate:

Where original technology was developed. Technology is often developed at University research centers, which is why many clusters have formed around universities.

The right talent pool. For industrial biotechnology and biofuels, this includes expertise in biology, botany, chemistry, engineering, and energy. In addition, spinoffs require management, marketing, and venture capital familiar with the sector.

Cooperative local government and community. One interviewee noted that when a start-up company is running on venture capital, they don't want to waste their funding trying to navigate bureaucratic mazes.

Available flex lab-office space. Start-ups will locate where the appropriate physical building space already exists. They need particular lab space, and often they need a small space initially with the potential to expand.

Livability. Interviewees noted that they like to be in a livable area that has restaurants nearby, is transit accessible, safe, and close to the home residences of senior staff. This kind of biotechnological research does not need industrial warehousing.

Proximity to other biotech firms. Interviews revealed that venture capitalists may have some influence on company location, given that they often sit on the boards of companies and nudge them in the direction of a cluster or to where there are already other companies that the VC has funded.

Pilot Stage

On the path towards actual commercialization, the next phase is to pilot the production process. With a pilot plant, companies can prove that they have developed or licensed technology that works through all parts of the process from plant matter to end product. A successful pilot is crucial in order to demonstrate that technology can be scaled, in order to provide confidence to be able to secure funding for construction of a refinery. Generally, these pilot plants are not large, and are an extension of R&D.

Amyris Pilot Plant in Emeryville. Source: Wired.com

They are not a production facility for marketable products. Because of this small scale, companies often prefer to locate them near their R&D/headquarters if possible. Amyris has done this in Emeryville. Cities that enable the co-location of these somewhat atypical facilities with lab and office space through flexible zoning are likely to be able to attract biofuels companies.

Scaled Production

Scaled production is the stage at which companies refine biomass (their feedstocks) in large quantities to produce their preferred end-product. This is considered the current "Valley of Death" for second-generation biofuels. The US is vastly under its mandated targets for 2011 for cellulosic biofuels, due in part to the extremely high cost of building a refinery, which can range from $500 million to $1 billion. Given the variety in technologies being developed for second-generation fuels, each plant needs to be custom-designed and built.

It is unlikely that the East Bay will be able to capture these refineries, primarily because refineries generally need to be adjacent to their feedstocks. Given that California's agricultural land is used for high value food crops, it's unlikely that these would be replaced with bioenergy crops. Baybio, a Bay Area biotechology industry association, conducted a survey of California industrial biotech companies, which showed that many companies intended to build production facilities outside the state. California thus far has momentum in biogas and energy produced from used vegetable and cooking oils, but the connections between this technology and research at the Second Campus is not as direct as with cellulosic biofuels. Currently, nearly all biofuel in the U.S. is coming from cornfields, but second generation biofuel feedstocks have the potential to be more diverse. Amyris currently uses sugarcane as their primary feedstock and thus have their refining facilities located in Brazil, adjacent to the sugarcane fields. Other companies have plans to locate refineries near paper-yards or lumber mills, so they can use the waste products from those mills as feedstocks.

A second important consideration in refinery location is the distribution infrastructure, whether rail, barge, train, or major pipelines. The output from the refinery would rarely go directly to market; rather it gets sold to major chemical, energy, and product companies to be incorporated into their production processes. One second generation biofuel company located in Texas that we interviewed noted that they have an advantage because of the wealth of infrastructure that currently exists in Texas for liquid fuels due to the oil industry.

Finally, companies locate their refineries in states or regions that can provide incentives – either in the form of tax breaks or fast-tracked permitting processes.

Given the difficulty with scaling production facilities for second generation fuels, one emerging strategy is to first enter the chemicals market, which is a higher-value, lower-quantity product that requires a much cheaper biorefinery. This can attract more capital earlier and lets a company travel down the cost curve of their technology in preparation for biofuel production.

Locational Dispersion of the Industry

The biofuels industry in the US is widely distributed across the county, with many firms located in the Midwest and on both coasts. Distinct spatial patterns emerged when we examined different fuel types and stages of production, such as biorefineries.

The figures below illustrate the distribution of biorefineries across the United States. Figure 5 shows first- and second-generation biorefineries with existing facilities in green and planned facilities in yellow. There is an unsurprising concentration of biorefineries in the "Corn Belt" of the Midwest, underlining the country's focus on production of first generation corn ethanol. Taking advantage of tax breaks and other incentives, many corn producers jumped on the ethanol bandwagon after federal renewable fuel standards were set in 2005. There are exceptions to the rule, however: Pacific Ethanol, for example, operates four first generation biorefineries on the west coast, relying on corn shipments from the Midwest.

Figure 6 shows the locations of existing and planned second-generation, or cellulosic, pilot plants and biorefineries as of 2008. Red indicates existing facilities, blue and teal

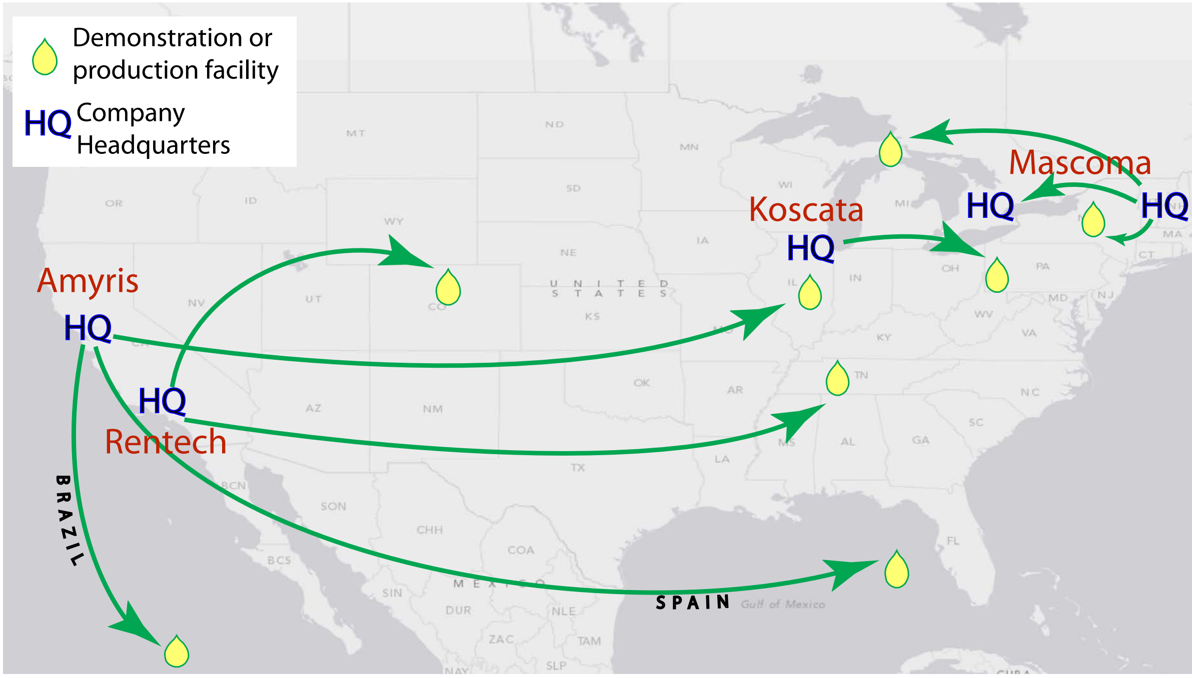
FIGURE 5. **Existing First and Second Generation Refineries**

Source: Renewable Fuels Association, 2011

FIGURE 6. **Existing and Planned Second Generation Refineries**

Source: Biotechnology Industry Association, 2008

FIGURE 7. **Existing Second-Generation Cellulosic Biofuels Company Example Locations**



indicate planned facilities. There are few second-generation biorefineries in existence, and those are pilot or demonstration-scale plants. The majority located in California are pilot plants, such as Amyris. No commercial-scale cellulosic biorefineries currently exist in the United States, but a few are in the works. In September 2011, the DOE awarded POET, one of the largest corn ethanol producers in the country, $105 million to develop the first commercial-scale cellulosic biorefinery. Project LIBERTY, as POET has dubbed this biorefinery, will rely on cellulosic corn waste products like corncobs, husks and leaves. In general, however, second-generation pilot plants are more dispersed than first-generation due to the variety of feedstock inputs. For example, Fulcrum Bioenergy uses municipal solid waste in its Sierra Biofuels plant outside Reno, Nevada. Citrus Energy converts citrus waste to ethanol in its refinery outside Boca Raton, Florida.

We also examined how different facilities and establishments within a single bioenergy firm are related spatially, with examples of four bioenergy companies shown in Figure 7. As mentioned above, metropolitan areas are attractive to startups on account of proximity to research universities and a highly-skilled labor pool. As firms grow, these areas continue to be fertile ground for headquarters and research operations.

Other Strategies

As shown in Figure 4 this particular pathway is not the only way for a particular technology to come to market. Some scientific breakthroughs, while important, may not be enough to build a company on their own. Also, it can be difficult to move the discoveries from large academically-oriented institutes into commercialization. JBEI has modeled a unique form of institutional research with entrepreneurial leadership, a culture of goal-driven innovation, and a focus on technology transfer, which has resulted in higher rates of commercialization. JBEI has staff members devoted to pushing technological developments out into the market, and they use several methods to facilitate this process. One way they do this is through licensing technology to companies that will commercialize it. Another way is through their "start-up track," where JBEI helps to collect a portfolio of Intellectual Property (IP), connects with entrepreneurs, and then brings them together with venture capital. Finally, JBEI works with various existing private companies through Cooperative Research and Development Agreements (CRADAs). CRADAs enable government-funded research institutes to work with private companies in the development of technology and allow them to share patents and licenses.

In addition to various licensing arrangements, there are other ways that technologies and companies can veer from this path. One possibility is that companies are acquired before they reach scaled production. Dupont, BP, and other energy and chemical companies already have shown interest and have sought to acquire promising technologies. It is likely that this trend will increase as the demand for bio-products increases and as the technologies become more developed and cost effective. Other partnerships are likely to occur increasingly in production and distribution, given that most fuels are blends of biofuel and fossil fuels. Amyris and Total, a global energy and chemicals company primarily focused on fossil fuels, recently announced a partnership in which they would jointly work to develop Amyris' bio-based fuels and incorporate them into Total's distribution infrastructure and the global market.

Employment Patterns of the Industry

Just as different stages of production have different space requirements, they also have different employment patterns. This section will review the staffing needs as the sciences makes its way to market.

Since R&D and headquarters tend to co-locate, we will evaluate these two pieces together. There is currently a wide range in terms of number of employees per company in second-generation biofuels, given the different stages of companies in terms of development, and the fact that none are yet at scale with second- or third--generation biofuels in the U.S. Amyris is one example of a well-established company that currently employs over 300 people in their facilities in Emeryville. However, Amyris is one of the most established and successful companies in this industry, and this size is much larger than the average company currently.

Many more of the companies that are innovating in this space have only a handful of staff, the scientists, working in R&D. As the company headquarters develops, they may begin to hire business development and support staff, but these levels of employment tend to remain fairly small, at least so far. One example company, established in 1995, which is innovating at the forefront of second generation fuels from municipal solid waste, currently employs about 20-25 people between their research lab and company headquarters. A report written for the Renewable Fuels Association estimates the total direct employment in R&D in the "ethanol" industry at this stage at 9,517 jobs nationwide. However, this number is likely inflated due to ARRA funds that went into the market in the year of this analysis.[1]

While pilot plants are an important part of the process, they are generally small, and typically do not have significant staffing needs. It is important to understand, that these pilot plants are intended to further refine, test, and prove technology, not produce marketable quantities of end products.

In the next phase—scaled production—companies employ people to staff the actual refineries. They require skilled labor, generally people with two-year associates degrees, and these jobs tend to pay living wages. Currently, however, most companies in second-generation biofuels do not yet have refineries. Though many are planned, as mentioned earlier, it is very difficult to secure the funding to build a refinery. Thus, in order to assess the number of jobs that a refinery would create, we again looked to first-generation ethanol production. There are hundreds of ethanol refineries in the US, producing 13-14 billion gallons of corn ethanol per year. Even so, ethanol production is capital intensive and light on labor. The Renewable Fuels Association report estimates the average number of workers per plant at 43, with the total direct employment in ethanol currently at 8,320 jobs. As one interviewee said, "It hasn't been the job-creator everyone hoped it would be."

We found that the majority of employment impacts from biofuels production occur in the cultivation of the feedstocks. In first-generation ethanol, refineries will purchase corn directly from farmers, or farmers will form cooperatives or entities that own the refineries. The economic impacts on the agricultural sector are very high, especially with first-generation biofuels, given that approximately 40 percent of the US corn production goes to ethanol. The Renewable Fuels Association report estimates the employment impact in agriculture at over 43,400 direct jobs with another 230,000 indirect and induced. For second-generation biofuels, we surmise that these impacts may be similar, or may actually go down, since second generation companies are pursuing feedstocks that are more efficient or are potentially current waste streams, such as woodchips or municipal solid waste.

As a caveat, the economic impact numbers from the RFA report are for ethanol, which is too narrow for an analysis

TABLE 2. **Economic Impact of the Ethanol Industry: 2010**

	GDP (Mil 2010 $)	Employment (Jobs)	Income (Mil 2010 $)
Production			
Direct		8,320	$494
Indirect		30,577	$2,116
Induced		28,602	$1,341
Subtotal	$6,839	67,499	$3,951
Construction			
Direct		7,131	$299
Indirect		9,161	$603
Induced		9,926	$466
Subtotal	$2,022	26,218	$1,367
Agriculture			
Direct		45,433	$448
Indirect		23,614	$18,480
Induced		207,710	$9,757
Subtotal	$42,124	276,757	$28,685
R&D			
Direct		9,517	$970
Indirect		6,212	$351
Induced		14,473	$678
Subtotal	$2,622	30,202	$1,999
Total Impact			
Direct		70,402	$2,212
Indirect		69,564	$21,550
Induced		260,711	$12,242
Total	$53,606	400,677	$36,004

Source: John Urbanchuck "Contribution of the Ethanol Industry to the Economy of the United States." 2010. Renewable Fuels Association.

1 Urbanchuk 2010.

of second-generation biofuels, especially for industrial biotech. However, the employment numbers do give an idea of where the impacts occur, and those are likely to hold true in research and refineries. Another impact that isn't noted here is in the construction sector as the refineries are built. These are temporary jobs, but were significant in 2010 at just over 7,000. This is likely to grow as more second-generation refineries are constructed and/or first-generation plants are modified to be able to process second generation feedstocks.

Implications for the East Bay

Our analysis of the biofuels and industrial biotech industry suggests that there is significant opportunity for continued R&D activities and the development of a knowledge cluster in the East Bay. Proximity to world-class institutions, a strong labor pool, and the presence of VCs and developers make the Bay Area an attractive location for new firms. Table 3 shows the location quotients of various sectors in the East Bay. The higher the location quotient number, the more concentrated that industry is in the area. The high concentration of biological product manufacturing and chemical manufacturing suggests an existing specialized labor force and industry networks. Industrial biotechnology companies can benefit from this existing expertise. According to the data, the region has less of a concentration in R&D in biotechnology than California as a whole, suggesting more effort could be placed in promoting this sort of activity in the East Bay.

There seems to be limited potential, however, for significant economic development associated with industrial biotech based on cellulosic pathways, the focus on the Second Campus. Bear in mind that manufacturing these products is a fundamentally different process from the kinds of manufacturing currently seen in medical biotech and chemicals. This process focuses on plants and vegetation, large-scale agricultural inputs, and enzymes and bacteria. Scale-up in cellulosic second-generation biofuels is still facing challenges, but even as scale-up takes place, the Bay Area faces disadvantages: production will be located near feedstocks, which are not generally grown in California, and biorefineries might also be deterred by California's air quality and development regulations.

However, the East Bay can still stand to benefit from the development of technology at LBNL's second campus. The following chapters of this report will offer more of a focus on the East Bay specifically - its strengths and opportunities, detailed potential economic impacts of the second campus and this sector, and recommendations. Some specific points merit mention here, however.

The East Bay has a robust advanced manufacturing sector, and it currently has ties to the existing biotechnology sector, focused on medicine. While actual cellulosic biorefineries seem unlikely, the core technology is a platform for biological production, and the industry is still taking shape. Smaller, leaner, more versatile forms of industrial biotech manufacturing may emerge, and if they do, the East Bay's history in manufacturing, chemicals, and biotechnology could make it a good location for this type of firm.

Biofuels is only a small piece of the research being done at the several prominent research institutions in the East Bay, and in thinking about regional economic development, it's

TABLE 3. **East Bay's Strengths & Growth in Bioscience-Related Industries**

NAICS Code	Industry	East Bay Employment (2009)	% Change Local Employment (2004-2009)	Location Quotient compared to CA (2009)
325120	Industrial Gas Manufacturing	377	75.3%	2.40
325199	All Other Basic Organic Chemical Manufacturing	375	-8.5%	2.76
325414	Other Biological Prod Manufacturing	2,443	122.9%	3.45
325998	Other Misc Chemical Prod Manufacturing	575	63.4%	2.02
541690	Other Scientific and Technical Consulting Tools	2,183	100.5%	0.69
541711	Research and Development in Biotechnology	2,350	66.8%	0.65
541712	Research and Development in the physical, engineering, and life sciences (except biotech)	12,900		1.18

Source: US Census County Business Patterns important to also consider additional research and innovation that these institutions are driving. For example, the Lab's research could also be used to support the biomedical and biopharmaceutical sectors. These sectors tend to place more of a premium on proximity to the source of primary research, access to an education labor force, and quality of lide amentities. Also, high value added production and advanced manufacturing is less likely to relocate to low cost and low skill areas outside of the region. Thus, the East Bay may be better positioned to attract these types of firms. With this more holistic view, we can see that biofuels-related companies spinning off of LBNL's Second Campus can be drivers in fostering and creating a larger and diverse innovation cluster in the East Bay that includes an array of innovation-oriented industries, some of which are closely tied to manufacturing.

This innovation cluster, and industrial biotechnology as part of that cluster, can attract other kinds of companies as well. First, major existing biotechnology or energy companies may locate branches here to be part of the growing concentration of knowledge and qualified talent in this field. Additionally, complementary businesses may support a bioscience cluster, such as lab and technical equipment suppliers, legal services, and business services. Interestingly, Table 3 shows that the East Bay is rapidly growing in scientific and technical consulting - which is an industry that is likely to have high levels of synergy with a growing cluster of innovation-based companies. Finally, a cluster that has great companies, working space, and is well designed, reputable, and well-located, will attract other co-locating companies that aren't necessarily related to bioscience. This occurred in Mission Bay—San Francisco's medical biotech cluster—when Salesforce chose this area as a great place to locate their headquarters with 3,000 employees. See the text box on pg. 43 for more information.

The bottom line for the East Bay is that a cluster exclusively focused on biofuel innovation driven by LBNL may not itself be a major job creator, aside from adding high-level jobs for science PhDs which are drawn from a global pool. A more diverse cluster of complementary and co-locating businesses, including a variety of innovation companies, along with parts of their supply chain and other supporting businesses will provide broader and deeper economic benefits to the East Bay, including a larger variety of jobs and a larger economic multiplier. This conclusion is supported by our work with IMPLAN—input-output economic modeling software. The next chapter details the results of this work.

CHAPTER TWO

Lawrence Berkeley National Lab's Impact in the East Bay

Part 1: The Lab's Programs and Policies

LBNL's Hill Campus in Berkeley
Source: Roy Kaltschmidt, Lawrence Berkeley National Lab

Ever since Lawrence Berkeley National Lab announced its intention to build a Second Campus, there has been considerable excitement over the notion of the Lab as the anchor institution for an East Bay bioscience cluster. The Lab's role as an economic engine for the region has been promoted by the Lab itself, which touts on its website that its activities generate 5,600 jobs and $700 million in economic activity in the nine-county Bay Area.

To investigate the Lab's impact on employment and economic activity in the East Bay, we interviewed Lab staff in a variety of departments and conducted a regional economic impact analysis for Alameda and Contra Costa Counties. In this chapter, we describe the Lab's employment, purchasing, community outreach and technology transfer activities, focusing on how these policies and programs shape economic benefits to East Bay cities and counties.

Generally, we found that while LBNL has had a demonstrable positive impact on the East Bay economy, this has been largely incidental rather than intentional. As a prestigious science research institution, the Lab's focus is often national or even international in scope; local economic development has not been a primary goal of the lab. The Lab has made efforts to foster relationships with the local community; however, its position as a federally-funded lab is often at odds with regional economic development goals. For example, there is a lack of flexibility in how the Lab can use research funding or even lease its space. There are federal mandates against favoring local companies in procurement decisions or local investors in licensing decisions. In terms of spin-off effects, we have found that LBNL's relationship with spin-offs has historically not been active enough to make the Lab itself a significant draw for start-ups to the region.

Funding

Lawrence Berkeley National Lab is a member of the US Department of Energy (DOE) National Laboratory system. The Lab is operated by the University of California for the DOE Office of Science. As a national research center, the Lab has historically been dependent on federal funding which tends to fluctuate based on political conditions. The Senate recently approved $4.8 billion for DOE Office of Science in FY2012, which is comparable to funding for FY2011 but significantly less than the $5.4 billion requested by President Obama earlier this year. Federal funding also imposes certain restrictions; for example, DOE prohibits its preference to local vendors in purchasing decisions.

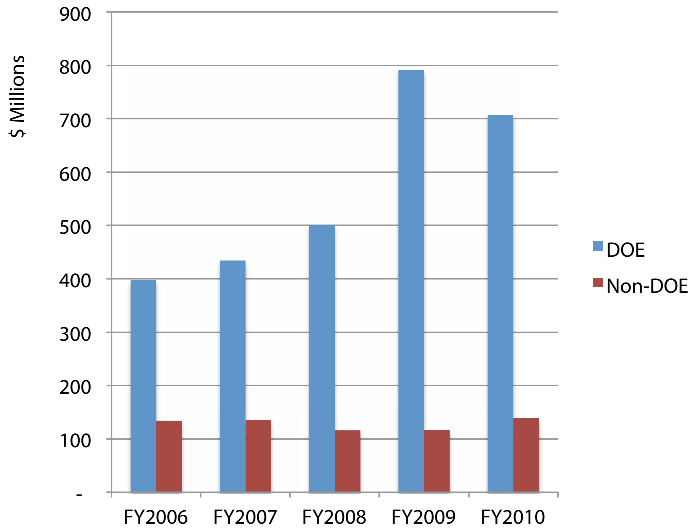
Total DOE funding for FY2010 at LBNL was $847 million (Figure 8). This amount is 7 percent less than FY2009 funding, which reflects a ramp down of American Recovery and Reinvestment Act (ARRA) funding.

The Lab's funding from DOE comes primarily out of the Office of Science and the Energy Efficiency and Renewable Energy (EERE) program. In FY2010, 64 percent of the Lab's total funding came from the Office of Science and 14 percent came from the Energy Efficiency and Renewable Energy program.[1] Office of Science funding decreased from FY2009 to FY2010, reflecting the aforementioned ramp down of ARRA funding. EERE program funding increased by $63.3 million, with a sizable portion going to the Joint Center for Artificial Photosynthesis (JCAP) and the Advanced Biofuels Process Development Unit (ABPDU). ABPDU works closely with the Joint Bioenergy Institute (JBEI) and other national Bioenergy Research Centers to scale up biofuels production.

After factoring inflation, LBNL's annual operating costs have increased an average of 2.3 percent each year for the past 30 years. Additionally, the LBNL workforce grew just shy of 1 percent each year, and the amount of facility space grew an average of about 1.2 percent.[2] As LBNL's growth has outstripped the capacity of its hillside campus in Berkeley, the Lab has resorted to leasing space elsewhere in the East Bay to house several divisions. As scarcity

1 Office of the Chief Financial Officer 2011.
2 Robinson, personal interview. 2011.

FIGURE 8. **LBNL funding from DOE and non-DOE funding sources for FY2006 through FY2010.**



Source: Office of the CFO, LBNL Annual Report 2010

of working space becomes a more prevalent issue on the original LBNL campus, the Operations division has stressed a need for greater communication from all department heads, particularly if a department is seeking additional grant funding. That way, the Operations division can plan ahead, and not have to resort to openly discouraging grant application submissions made by LBNL science divisions. The fact that the Lab leases spaces in places like Emeryville and West Berkeley is a commitment toward accommodating expanding scientific research. However, the cumulative leasing costs are consuming an increasing portion of the Lab's operating costs and there lies the inherent need for a Second Campus.

The uncertainty of DOE funding forces LBNL to be cautious in its growth projections and expansion plans. LBNL has also relied on grants for performing work for other agencies such as the National Institute of Health (NIH), Environmental Protection Agency (EPA) and Department of Homeland Security (DHS). Additional funding has been available via Cooperative Research and Development Agreements (CRADAs) with non-federal institutions such as Stanford University and the California Energy Commission. Non-DOE funding totaled 16 percent of LBNL's funding in FY2010. To counter the uncertainty regarding DOE funding, the Second Campus facility will be owned by the UC Office of the President, not DOE. According to our conversations with Second Campus Project Director Kem Robinson, this will minimize the financial risk to the UC system by maintaining the ability to lease out space if DOE funding decreases in the future.

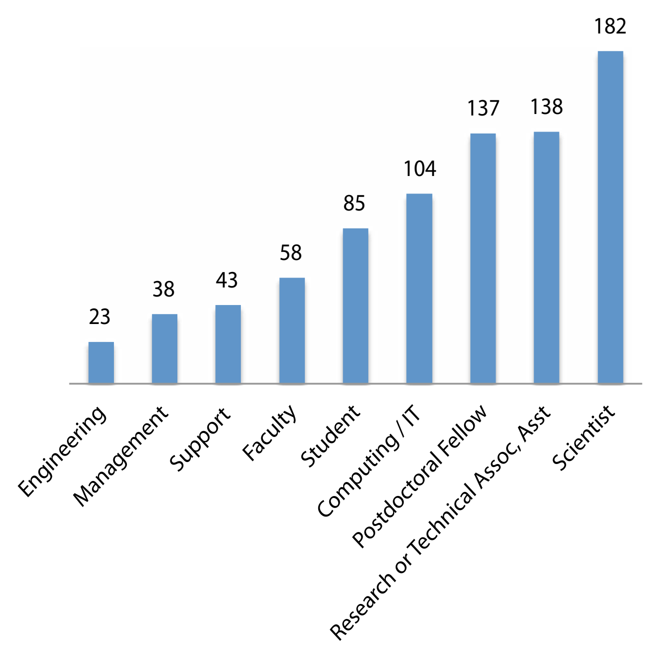
Jobs and Hiring

Employment is one of the major direct economic impacts of the Lab. On its web site, the Lab reports that it has 4,200 employees. According to information we received from the Lab, approximately 800 of these employees work for the three divisions slated to move to the Second Campus during Phase I. These employees represent a range of positions, including faculty, scientists, research associates, engineers, technicians, program managers, procurement, administrators, postdoctoral fellows and students. Figure 9 shows the distribution of employees among different career paths.

To account for the presence of part-time employees, the Lab's Annual Report provides data on employment in Full-Time Equivalent (FTE) units. A post-doc student who works 10 hours per week and is paid by the Lab would be counted as 0.25 FTE. Figure 10 shows the FTE employment at the Lab as a whole and at the three Second Campus Phase I divisions for financial years 2005 through 2010. According to this data, the Second Campus divisions currently account for 22 percent of total employment at the Lab.

These FTE numbers do not include a large number of "guests" who are at the Lab on a daily basis but are not on the Lab's payroll. This includes on-site contractors and visiting scientists who come from around the world to use the Lab's facilities such as the Molecular Foundry, Advanced Light Source and the Joint Genome Institute. These guests in the latter category are known as "users" and are supported by their home institution. The Lab hosts

FIGURE 9. **Breakdown of employees by different career tracks at Second Campus divisions.**



Source: Lawrence Berkeley National Lab, 2011

Purdue Research Park Case Study: Institutional Leadership

Purdue Research Park
Source: Purdue Research Foundation

Located in a metropolitan area of roughly 180,000 people, the Purdue Research Park may not immediately come to mind as a case study suitable for the East Bay. The rural location, 120 miles southeast of Chicago, has created a new hometown for private enterprises in an uncertain economy. However, this 725 acre park, managed by the non-profit development entity known as the Purdue Research Foundation (PRF), offers a uniquely comprehensive approach to business incubation in all of its stages.[1] This approach, used in conjunction with government incentives, spatial proximity, and regular communication, bridges the gap between the two worlds of academic research and private industry. Boasting over 3,200 employees working in life sciences, information technology, and defense research, Purdue Research Park should be taken very seriously as an example what an institution can accomplish for a region.

The Purdue Research Park, located one and a half miles north of the main Purdue University (PU) campus, was opened by PRF in 1961. PRF originally utilized the park as a mechanism to raise University revenue through real estate, which modestly grew in size over time. It would take three decades before the PRF began aggressively prioritizing the commercialization of research, but in 1993, the first companies moved into a business incubation space on the Park campus. The City of West Lafayette set up a tax increment finance district for the Purdue Research Park; revenues went straight toward expanding roads, sewers, lighting, and trails. The State of Indiana and Tippecanoe County, on the other hand, actively recruited companies to the region, even offering to cover their relocation costs.

The strong government assistance and pro-incubation philosophy certainly got Purdue Research Park off the ground, but the success of the Park may actually be in the attention and accommodation given to the full process of a company's genesis, growth, and relationship with PU. The first meeting between a company and the PRF development team will usually be up to two years before the company actually moves into the Purdue Research Park. The PRF development staff is crucial in facilitating the company's access to Purdue's eclectic research faculty. Every company entering the Park must have a relationship with PU, whether it is contracted research or a commitment to hire graduates. Milestones for growth and employment have to be set. Working with the PU Office of Technology and Commercialization (OTC has its main office on the campus of the Purdue Research Park), the PRF development team and legal team will

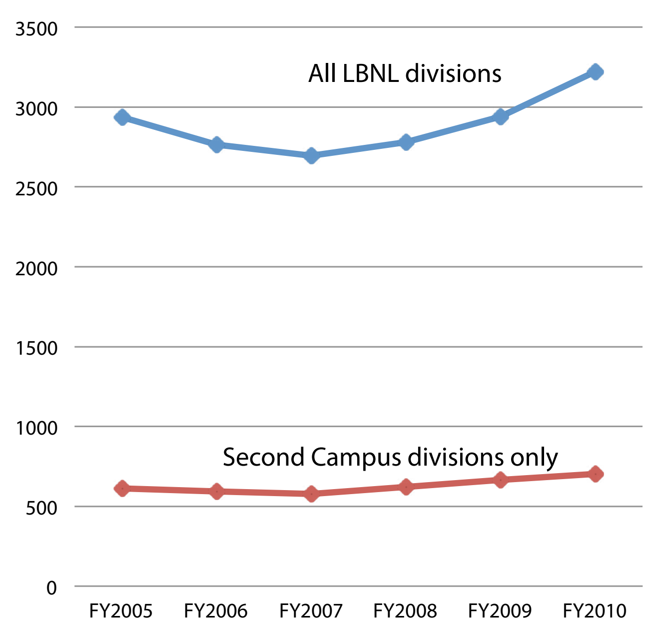
1 Thomas P. Miller & Associates 2011.

up to 4,000 guests per year total, including users, contractors, and research faculty exclusively paid by UC Berkeley.

As Figure 10 illustrates, there was a decrease in FTE numbers from FY2005 to FY2007, and since then the number of FTE employees has been increasing. The decrease in FTE numbers from FY2005 to FY2007 can be attributed to a few divisional changes. First, the Computational Research divisions and the NERSC Center were consolidated under the umbrella of the Computing Sciences division in FY2006. Additionally, there were substantial reductions in the Lab's administrative divisions, namely the Lab Directorate and Operations divisions in FY2006, as well as the Facilities division in FY2007. The rise in jobs since FY2008 is partially attributable to funding through ARRA. The federal stimulus dollars primarily funded post-doctorates on a term-limited basis.

The hiring practices of LBNL are aligned with the institution's objective of utilizing government funding towards

FIGURE 10. **Comparison of Full-Time Equivalent Employees at LBNL as a whole and at Second Campus divisions.**



Source: Author's calculations based on raw LBNL procurement data arrange the specific terms of intellectual property discovered in conjunction with Purdue researchers.

In the meantime, companies gain support for seed funding, through connections leveraged by PRF. One prominent investor has been Biocrossroads, an organization of business leaders and researchers, that manage a private fund, which in turn, provides the critical capital for life-science startups in Indiana.[2]

Since 1999, 56 companies have graduated from business incubation (7). Many of them have gone on to lease space on the Purdue Research Park campus, some of which eventually expanded or got bought out by the company, thus increasing revenue for PRF. According to the PRF, roughly half of the 50 buildings on the Park's campus are owned by the private business operating there. Even upon achieving success, however defined, the PRF team will advocate for their tenants. When SSCI, a local molecular research firm, was acquired by Aptuit, the PRF successfully lobbied for SSCI to remain on the campus and not move to Connecticut. When the Indianapolis-based subsidiary Dow Agrosciences wanted to expand their operation, the PRF worked with the State Economic Development Fund to construct a 11,300 square foot greenhouse exclusively for Dow and PU researchers.[3]

2 Ibid.

The value of a company keeping roots in a place like West Lafayette goes hand in hand with the importance of keeping business relationships close. The director of economic development for the PRF values her time spent in meetings on the PU campus and City Hall, as she makes sure that all parties are in the loop about the PRF's plans. On any university campus, it is hard for research faculty to necessarily know about business opportunities in the context of their own seemingly narrow focus. Thus, the PRF Office of Economic Development, the PU Vice President for Research, and OTC must not only be in communication, but they must also frequent these laboratories and pockets of research activity.

3 Purdue Research Foundation 2010.

The extent to which the East Bay can learn from Purdue's example is in the centralized institutional leadership provided by the PRF. Although PU controls more land, employs more people, and commands more national attention, PRF is more versatile and responsive to the needs of the public and private sectors. They are the intermediaries between government, business, and research. In doing so, the PRF has their finger on the pulse of the region's economy. Another important takeaway for the East Bay is the strategic location of a tech transfer and commercialization apparatus. Both administrators from PRF and PU stressed how important it was that OTC was located on the Research Park Campus. For Purdue, proactive networking, physical proximity, and hometown roots still have currency in this modern global age.

conducting the most elite scientific research in the world, while maintaining an efficient operation.

Roughly 2,000, or two-thirds of the FTE employees at LBNL are career staff. This category includes scientists, support staff, maintenance workers, analysts, assistants, and technicians. Non-scientist positions are recruited primarily from the East Bay, and generally experience less turnover because they are permanent positions, as opposed to a term-limited positions contingent on a grant. Over 800 of these employees are represented by a union, primarily in the maintenance trades. The Lab attends about two dozen annual job fairs in the Bay Area to recruit for the positions that are planned to be locally hired.

Meanwhile, LBNL will usually conduct a worldwide search for scientists. When a grant comes in for a new project, the Human Resources division will collaborate with the grantee (usually a manager or a science division head) to search for employees. The grantee will usually have a worldwide network of scientists and experts to recruit from; in some cases, the job position may not even be publicly posted.

Essentially, the amount of time it takes to hire an individual at LBNL is a function of the geographic scope for that position's recruitment. From the time that a job opening for a support staffer is posted, it will take approximately 60 to 90 days until the hire is completed. For a position akin to a technical supervisor, it will take up to 120 days. For the senior scientists, it will usually take about 200 days to complete a hire. These varying timespans for hiring indicate the range of the Lab's workforce, from local hires to internationally-recruited scientists.

Purchasing

As a grantee of the United States Department of Energy, the Lab is prohibited from giving preference to local vendors under the US Constitution's commerce clause. In spite of this, LBNL strives to purchase goods and services locally to the extent possible. It is important to note, however, that the Lab's definition of "local" is the entire nine-county Bay Area, which means that East Bay suppliers are not treated differently than other Bay Area suppliers.

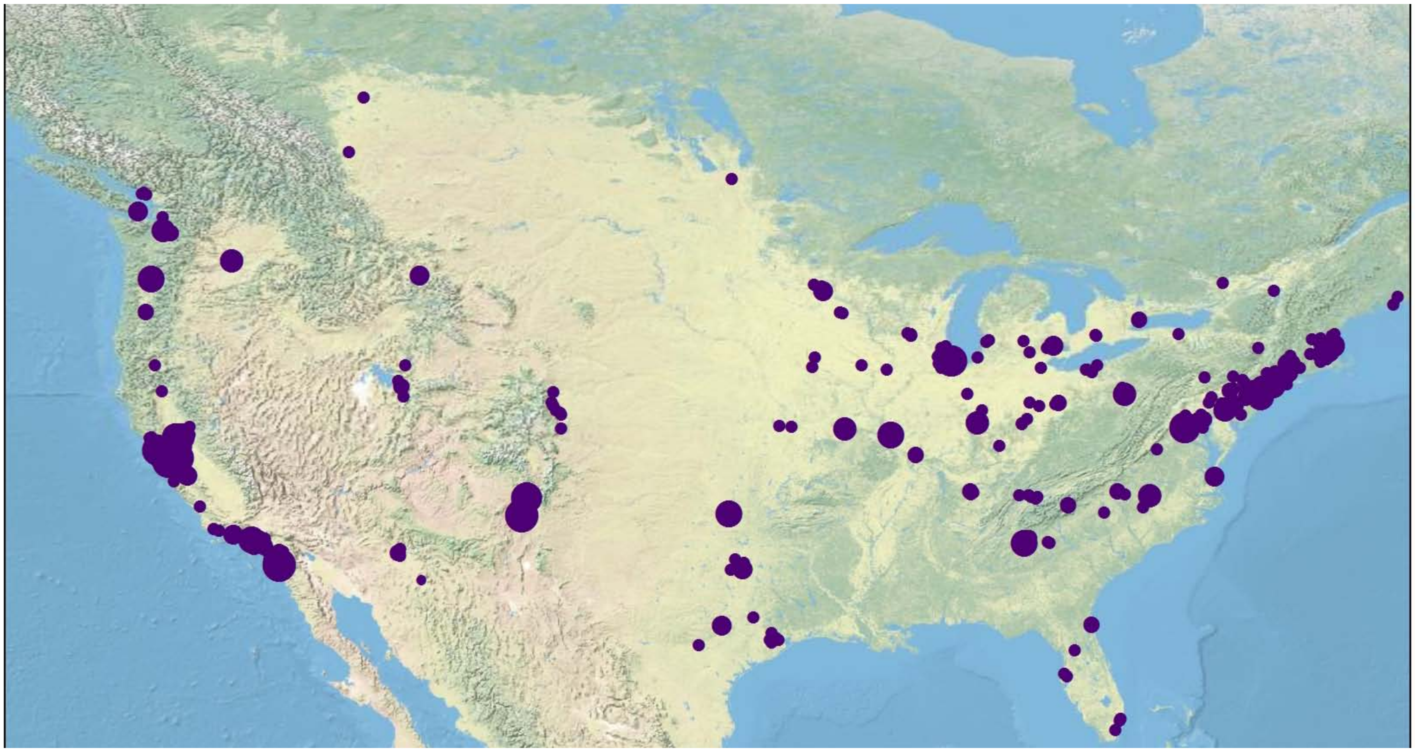
Findings

Construction costs, property leases and fabrication contracts make up the bulk of the Lab's purchasing expenditures. While construction labor is inherently local and Alameda County construction trade unions have benefitted from the Lab's considerable spending, goods and services can easily be purchased outside of the region. Using raw data on the LBNL as a whole, as well as the specific divisions on the Second Campus, we were able to comprehensively analyze the Lab's relative influences on the supply chains at multiple geographic scales. Our analysis for fiscal years 2007 to 2010 reveals considerable leakage of goods and services procurement from the East Bay region. At the same time, the Second Campus divisions' overall aggregate spending appears to be on the decline from a high of 15 percent in 2008 to just 9 percent in 2010. While were unable to determine the reason for the decline in Second Campus divisions' spending (a figure disproportionately lower than the Second Campus divisions' percentage of total employees), these data suggest that local economic benefits due to household consumption may be greater than economic benefits due to Second Campus supply chain purchasing.

Figure 11 maps the location of suppliers to the three Second Campus divisions in 2008 and 2009. The size of dots reflect the amount of spending in each city. As the map illustrates, LBNL's supply chain is spread throughout the United states and Canada.

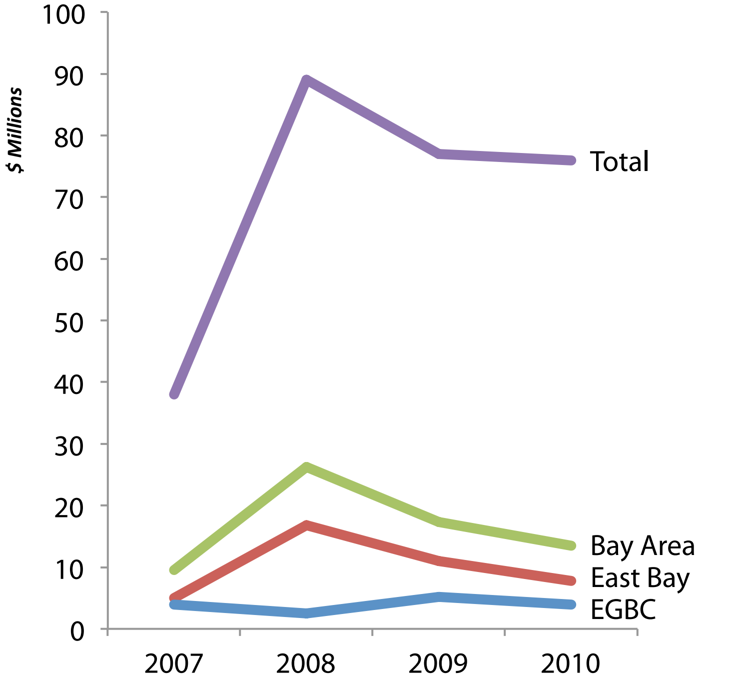
The Lab reports purchasing 46 percent of all goods and services within the nine-county Bay Area. Looking at spending for the Second Campus divisions specifically, we found that the percentage of Bay Area purchasing is significantly lower than 46 percent. Figure 12 and Table 4 compare purchasing amounts in East Bay Green Corridor cities (San Leandro, Alameda, Oakland, Emeryville, Berkeley, Albany, El Cerrito, and Richmond), the East Bay as a whole (Alameda and Contra Costa Counties), and the nine-county Bay Area from 2007 to 2010. The percentage of local purchasing in the East Bay and the Bay Area as a whole appears to have had a recent peak in 2008, at 19 percent and 29 percent respectively. In 2010, the East Bay captured only 10 percent of these divisions' total purchasing.

FIGURE 11. **Location of LBNL suppliers in the United States and Canada. Dot size represents amount spent in each location.**



Source: Author's calculations based on raw LBNL procurement data

FIGURE 12. Trends in Second Campus divisions' purchasing for various regions compared to total



Source: Author's calculations based on raw LBNL procurement data

FIGURE 13. Second Campus divisions' average purchasing totals by county, 2006-2010

Source: Author's calculations based on raw LBNL procurement data

TABLE 4. **Second Campus divisions' purchasing totals and percentages for various regions**

	2007		2008		2009		2010	
	$M	%	$M	%	$M	%	$M	%
EBGC	3.9	10	2.5	3	5.2	7	3.9	4
East Bay	5.0	13	16.8	19	11	14	7.8	10
Bay Area	9.5	25	26.2	29	17.3	22	13.5	18
Total	38	100	89	100	77	100	75.9	100

Source: Author's calculations based on raw LBNL procurement data

Figure 13 shows the average purchasing totals for 2007 to 2010 for Bay Area counties. San Mateo and Alameda captured the highest proportion of spending in the Bay Area, followed by Contra Costa and Santa Clara.

Interviews with the Deputy Director of the Lab's Procurement and Property Management Division and the Office of Small Business and Supplier Management revealed that they believe a significant number of firms with local addresses are sales outposts of firms headquartered beyond the Bay Area. This is particularly relevant for East Bay cities vying to secure LBNL's proposed Second Campus and benefit from its spending behaviors.

Internal and external promotion

The Lab actively pursues local firms through several formal systems and programs. All Lab divisions have their own buyers familiar with the unique needs of their scientists. Division buyers are required to inform the Office of Small Business and Supplier Management of upcoming contract opportunities so that they can match buyers' needs with local firms. Each division also has procurement liaisons who, like division buyers, understand the needs of their scientists but who are more involved in managing relationships with small and local vendors ensuring that transactions are smooth and customer satisfaction is high. When contractors provide unsatisfactory service, liaisons work with them to improve in the trouble areas. The Office of Small Business and Supplier Management also presents at internal division meetings to educate division buyers, purchasing liaisons and users on their services and solicit ways to assist them in their scientific pursuits.

The Procurement Division also conducts regular outreach. On a monthly basis, they hold events to inform potential local vendors of opportunities and educate them on the process of becoming lab contractors. Also on a monthly basis, the lab meets with local trade organizations to try and match lab needs with potential suppliers. Lab representatives also attend the DOE national small business conference to build relationships with vendors. A key component of this outreach includes firm prequalification to expedite the bidding process when the time comes, and as a means to increase a firm's competitiveness. Firms can self-certify to become federal contractors, but the lab helps facilitate the process for those that have not.

The Office of Small Business and Supplier Management maintains "vendor tables" where they track all small and local firms they have done business with in the past. The current table contains 1,600 firms. An estimated 50 percent are local. They also maintain a website where they post upcoming contract opportunities and announce events tailored for local and small firms.

Challenges

Small firms often charge more because they are less able to leverage economies of scale, thus reducing their competitiveness. This in turn creates a more volatile small business climate as firms go out of business and new firms emerge. This flux impacts the Lab's capacity to develop long-term relationships with small local contractors and maximize local purchasing.

As previously mentioned, the nature of federal contracting encourages savvy firms to establish what appear as small and/or local firms near the Lab which are, in fact, sales offices of larger, non-local firms. Anecdotally, the number of these firms and contract dollars they capture is significant.

Recommendations

In spite of legal prohibitions against local purchasing, LBNL strives to support local, small businesses and their programs and staffing attest to this. Competitive and quality assurance parameters play into their procurement decisions and yet there is an emerging field that focuses on supply chain analysis for the purpose of identifying opportunities to maximize various characteristics from sustainability to local purchasing.

Given the Lab's demonstrated commitment, cities in the East Bay would be wise to develop closer relationships with the Lab's purchasing department. Models exist of communities partnering with anchor institutions to shift supply chain procurement more locally.[3] For the Lab and local cities, there may be opportunities to source goods locally that are currently coming from outside the region, while assuring quality and price competitiveness.

3 See Alperovitz et. al. 2010.

Community Impacts

LBNL's education programs were designed to increase local support for and awareness of the sciences. The Lab has also made efforts to be a good neighbor in the community by establishing a Community Advisory Group. In addition, the Lab participates in local and statewide groups and committees.

Educational Programs. LBNL operates 17 different educational programs, reaching students from kindergarten through high school, as well as community college students, undergraduates, and teachers. In the last five years, 4,500 high school students and 4,000 grade school students have participated in at least one of these programs. Nearly 80 high school students, community college students, and science teachers have participated in the internships that the Lab hosts every summer. These programs provide important educational opportunities for Bay Area youth. Without extensive participant tracking, however, it is unclear how effective these programs are in encouraging participants to pursue a career in the sciences.

Community Advisory Group (CAG). Established in 2010, the CAG consists of 18 community residents and leaders. They meet bi-monthly with LBNL staff in meetings open to the public to discuss issues of common concern to the community, from environmental concerns over capital projects to the Second Campus. So far, the CAG has led to improved communications between LBNL and the community, but has had limited direct impact, according to interviews.

Local partnerships. LBNL is a member of the Berkeley Chamber of Commerce, the East Bay Green Corridor, the

Oakland Tech high school students visiting LBNL facilities.
Source: Roy Kaltschmidt, Lawrence Berkeley National Lab

Silicon Valley Leadership Group, and the Bay Area Council's Bay Area Science and Innovation Consortium.

State partnerships. LBNL also participates in several statewide commissions, particularly around renewable energy and energy efficiency initiatives in a technical advisory capacity.

Technology Transfer

Overview

In 1989, the Lab created a Technology Transfer Department to encourage commercialization of Lab technologies. Technology transfer activities include: encouraging scientists to report their inventions, assessing reported inventions, obtaining patents, licensing patented technology to start-ups or established companies, and establishing research partnerships with industry. Prior to the passage of the Bayh-Dole Act in 1980, institutions such as LBNL were not able to grant exclusive licenses of government-funded inventions to other parties for the purpose of further development and commercialization. Although the Lab's primary mission is academic scientific research, recently, there has been a greater emphasis at the Lab on commercialization as an alternate means of getting discoveries into society for the public benefit.

In the past 20 years since the establishment of the Technology Transfer program, Lab technology has led to the formation of 30 start-up companies, in a variety of fields including renewable energy, health, information technology and advanced materials. The number of spin-offs has ranged from one to four per year. Due to the variety of factors that influence the formation of start-ups, the Technology Transfer Department at LBNL does not set a target for a number of spin-offs per year, but they do track the number of Records of Invention per year, which they interpret as a sign of scientists' engagement with the process of technology transfer. In FY2010, the Lab had 127 inventions disclosed and 27 US patents issued.[4] The Lab also licenses technologies to more established companies. In FY2010, the Lab issued 6 new license agreements and had a total of 60 active licenses.

4 University of California 2010.

Challenges in commercialization

There are high expectations for LBNL to serve as an anchor for an East Bay biotech cluster. Yet, if the Lab continues producing spin-offs at a similar rate as it has historically, it is not realistic to expect that the cluster will be populated entirely by LBNL-related firms. As a point of reference, Mission Bay is currently home to 37 biotech firms.[5] We interviewed LBNL Tech Transfer staff to understand some of the challenges on the path from science to commercialization. We found that there is a tension between the core mission of the Lab—to perform academic research—and the goal of getting discoveries into the marketplace. We also learned that DOE funding hinders the ability of researchers to pursue ideas to the point of commercial viability.

Cultural gap

At a research institution like LBNL, scientists are primarily focused on getting their discoveries recognized through academic publication. The effort required to record and patent their inventions involves additional tasks that fall lower on researchers' priorities, and may also seem counter to the academic paradigm of sharing knowledge freely with peers. The Tech Transfer staff are in the position of promoting the idea that commercialization is also an important means by which inventions can benefit society. Additionally they believe that patenting an invention, rather than sharing it freely, may be the only way to harness the financial resources to take the idea to reality. The Technology Transfer Department asks researchers to submit Records of Invention for review and action prior to publication. They ask researchers not to make written or oral public disclosures of inventions before a patent application is filed.

The Lab does provide practical incentives for scientists to encourage commercialization. When intellectual property is licensed, the inventor receives 35 percent of the royalty fees. Employees are also encouraged to list inventions on their annual self-assessments so that their work on technology transfer can be recognized alongside their papers during their performance appraisal.

Scientists' motivation to help society address important issues such as climate change may be a key factor in increasing the market-orientation of LBNL technology. The science emerging from LBNL is very relevant to the challenge of climate change, and scientists are recognizing that their findings need to be made available.

5 Reilly, personal interview. 2011.

Spin-off Interview: Polyplus Battery Company

Lithium seawater batteries
Source: Martin LaMonica, CNET News

Year founded: 1990
Location: Berkeley
Employees: 27

PolyPlus was one of the first real spin-offs from LBNL. The company recently made a breakthrough in battery technology by using ordinary seawater or air to interact with lithium, resulting in a high energy, non-toxic and environmentally friendly battery. Their battery could provide electric vehicles with up to 500 miles of range, and made Time Magazine's list of "50 Best Inventions of 2011." We spoke to PolyPlus CEO, CTO and Founder Dr. Steven Visco.

Their space: PolyPlus has been located in Berkeley since its founding. Its current space is 10,000 sq.ft, two-thirds of which is lab space, one-third of which is office.

On staying in Berkeley: A major reason the company has stayed in the City of Berkeley is that key staff are still associated with LBNL (Dr. Visco held a 50/50 appointment at PolyPlus and LBNL until five years ago). Additionally, the company recognizes plenty of other advantages including the availability of intellectual capital, Berkeley's instant name recognition, and the supply of high quality machine shops and electronic device consultants to meet the company's R&D needs. Although housing and office space is cheaper elsewhere in the East Bay, PolyPlus is commited to keeping its intellectual center in Berkeley. They even plan to start pilot manufacturing in Berkeley. When they scale-up manufacturing, they may have to find space elsewhere. The company reports that all their interactions with the City for obtaining permits have gone very smoothly.

On its relationship with LBNL: Initially, LBNL helped connect PolyPlus with resources such as corporate attorneys and other services. Now, there is not a lot of interaction other than an annual progress report on how PolyPlus is developing the licensed technology. PolyPlus is interested in taking advantage of LBNL's user facilities, such as the Molecular Foundry, but would need to follow the same process as other prospective users. Because IP is so important to PolyPlus, the company would have to have a proprietary agreement, which would mean paying for use.

On hiring: About 50% of the company's employees are educated at the high school level and received on-the-job training in material handling and SEM (scanning electron microscope) operation. The other half of the employees have college degrees, master's degrees or PhD's. The company has had to recruit staff from Asia, because American graduate schools tend to not focus on industries which are not particularly strong domestically—including battery technology.

Funding Gap

As mentioned earlier, research at LBNL is funded by federal grants. The scope of these grants is specified such that, even if a researcher encounters a promising idea in the course of her research, she may be unable to pursue the idea because it is outside the scope of her grant.

In September 2011, the Lab invited scientists to submit applications for the first-ever round of "Innovation Grants," a program which acknowledges and aims to rectify this funding gap. As the Call for Proposals states: "Lab research produces promising inventions, however, many are too nascent to attract the investment of companies and investors…These inventions have arrived at the first 'valley of death' where they may languish, as there is no funding available to advance them." The Innovation Grants are intended to support further development of inventions with strong commercial promise.

LBNL's Relationship with Spin-Offs

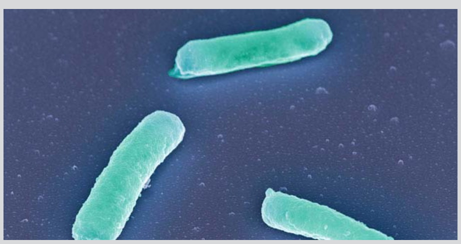
In case studies of other R&D clusters, we found that a strong relationship between the anchor institution and co-locating companies was often an important factor in success. For example, in Indiana, the Purdue Research Foundation goes out of its way to find companies that want to co-locate, like HP and Dow AgroScience, by offering them incentives, space at a competitive price, and an exclusive arrangement with the University's research and commercialization apparatus. Our findings about LBNL's relationships with spin-off companies do not indicate that LBNL currently has the resources to actively support cluster collaboration in the way that other anchor institutions have. Nevertheless, LBNL Technology Transfer staff expressed an interest in greater collaboration through the development of a cluster in close proximity to the campus.

The Technology Transfer Department at LBNL does not have the staff or the funding to maintain an active, formal relationship with spin-off companies. As companies are getting off the ground, the Tech Transfer Department helps to connect them with resources such as investors, attorneys and cities that may have suitable lab space. Once the spin-off has left the Lab and the licensing agreements are taken care of, the relationship between the Lab and spin-offs is ad hoc and informal. Interactions are more likely to be based on personal relationships between individuals than on structured programs.

One issue of particular concern to East Bay cities is the "brain drain" of start-up companies to San Francisco or the Silicon Valley. According to an assessment of Lab spin-offs by CBRE, 5 of the 25 identified companies that have spun-out of the Lab are currently located in the East Bay. 11 of these firms are based in San Francisco or the Silicon Valley, and an additional 4 firms are elsewhere in the State of California.[6] Because LBNL considers the entire San Francisco Bay Area to be "local," the decision of spin-offs to locate outside the East Bay is not perceived to be a negative.

6 CB Richard Ellis 2010.

Spin-off Interview: Second Genome



Highly magnifed bacteria
Source: Second Genome

Year founded: 2010
Location: San Bruno
Employees: 7

Microbiomes are the trillions of bacteria in our bodies that contribute to both disease and wellness. Second Genome identifies microbiome-based signatures to provide personalized diagnosis and treatment for patients with gut health disorders. We spoke to Second Genome CEO Peter DiLaura.

Their space: Second Genome occupies a small office space of only 1800 sq. ft. The company has no lab space; instead, it uses contract labs in Massachusetts and North Carolina and visits these spaces twice a year. This allows them to have low leasing costs.

On locating in San Bruno: When the company was initially founded, the core employees were working virtually and meeting one to two times a week. The company's seven employees commute from locations as distant and disparate as Santa Cruz, Livermore, Los Altos and San Francisco. With decent highway service, San Bruno is reasonably accessible from all these locations. The cost per square foot in San Bruno was lower than in locations farther down on the Peninsula, south of Highway 92. The location also provides proximity to the life sciences industry, including investors, board members, vendors, other CEOs, and consultants. In the life sciences sector, there are a lot of consulting resources to help with HR and finance functions, making small firms more capital efficient.

On their relationship with LBNL: Second Genome does not have an active, working relationship with the Lab. They do interact with the Technology Transfer Department simply to maintain technology license, and there is some ongoing dialogue. One of the founders used to be on a partial appointment with Second Genome, but is now a full-time employee.

On hiring: People with the right skillset for Second Genome come from the human health field. This means finding "alumni" from Genentech or other firms in the South San Francisco biotech cluster.

Part 2: Second Campus Economic Impact Analysis

The Second Campus has the potential to benefit the East Bay region in five major ways:

- **Construction**. Building the Second Campus will be a major project in itself, resulting in jobs and regional spending.
- **Employment**. The Lab hires full-time and part-time employees in a range of occupations, ranging from technicians to faculty.
- **Wages**. The Lab pays its employees, who then spend a portion of their income within the East Bay.
- **Purchasing**. The Lab buys a wide variety of goods and services including lab equipment, office supplies, computing infrastructure and contract labor.
- **Catalyzing cluster formation**. Spin-offs and co-locating start-up companies will generate additional economic activity through their own construction, employment, wages and purchasing.

As workers spend wages within the region, and as suppliers make purchases and hire more workers within the region, the dollars spent by the Lab cycle through the regional economy. Household consumption results in what are termed "induced impacts," while spending by lab suppliers are termed "indirect impacts." A "multiplier" is a measure of the number of times that a dollar spent by the Lab cycles through the region. When dollars are spent outside the region, they cease to benefit the regional economy and constitute leakage. Thus, the degree to which Lab activities benefit the region depends on the local spending on the part of the Lab and its workers.

In March 2010, the Lab published a CBRE study of the economic benefits provided by the Lab. The report, while serving as an important baseline for our study, is limited in its applicability to our project in two major ways. First, the CBRE report focuses on the Lab as a whole, whereas the Second Campus will be comprised of a subset of divisions within the Lab. Secondly, the CBRE report calculates the economic impact for the following geographic regions only: the Cities of Berkeley, Emeryville and Walnut Creek; the Bay Area; the state of California and the United States. In this report, we are interested specifically in the impact with respect to the East Bay, which we have defined to include all of Alameda and Contra Costa Counties.

To develop our own understanding of the Second Campus impacts within the East Bay we used IMPLAN, the same economic impact analysis tool used by CBRE in their study.

IMPLAN Tool and Methodology

IMPLAN is an input-output model that measures economic impact within a given study area using purchasing patterns between industries and information on the distribution of jobs and wages by industry. IMPLAN defines 440 different sectors which correspond to North American Industry Classification System (NAICS) sectors in most cases.

The impact of a given stimulus to the economy can be modeled in terms of added jobs or spending within a given industry. Leakage is modeled through the use of local purchasing percentages which determine how much of the spending will occur within the study area.

For our analysis, we defined our study area as Alameda and Contra Costa Counties and defined multiple scenarios for LBNL Second Campus development and a more general bioscience cluster development. For each scenario, we modeled construction, payroll and purchasing impacts.

Construction impacts were modeled as a given amount of spending in the non-residential construction industry (IMPLAN sector 36, NAICS 2362).

Payroll impacts of the Lab were modeled as additional labor income in the *Scientific Research and Development Services* sector (IMPLAN sector 376, NAICS 5417). Labor income translates into household spending, resulting in induced impacts.

Purchasing impacts were modeled as a given amount of spending in the *Scientific Research and Development Services* sector. Industry spending results in both indirect and induced impacts.

Industry purchasing patterns

Rather than using default IMPLAN assumptions about purchasing patterns for the Scientific Research and Development Services sector, we used actual purchasing records from FY2008 to FY2009 to indicate how lab spending would be distributed across various industries.

We first converted LBNL's internal purchasing categories to IMPLAN sectors. We then calculated the distribution of LBNL's purchases across IMPLAN sectors, and replaced the default purchasing coefficients with LBNL purchasing coefficients. Next, we adjusted local purchasing percentages (LPP) to reflect the lab's actual purchasing patterns. In

TABLE 5. **Comparison of IMPLAN assumptions and LBNL actual local purchasing percentages (LPP)**

IMPLAN Sector	IMPLAN Default LPP	LBNL Actual LPP	LBNL Actual Spending	LBNL Percent of Total Spending
Wholesale Trade	88%	28%	$15,636,100	11%
Software	12%	1%	$44,900	0.03%
Scientific Research	88%	10%	$2,002,200	1.4%
Other Support Services	22%	6%	$129,300	0.09%

Source: Author's own calculations based on 2008-2009 purchasing data from LBNL

adjusting the IMPLAN's default LPP values we found several notable discrepancies, shown in Table 5. The unique character of the Lab may explain why spending patterns diverge from typical behaviors in the sector.

While we felt it was important to change the sector's purchasing pattern to reflect LBNL's actual spending activity, this had the side effect of imposing LBNL's spending patterns on other firms in the same sector. In reality, we might expect a local supplier to have a different purchasing pattern and a greater percentage of local purchases than a national research lab such as LBNL.

Second Campus Scenarios

This section describes the scenarios we created to model Phases I and II of the Second Campus and three different spin-off scenarios. Table 6 summarizes the Phase I and II scenarios we constructed for the model.

Year

We assumed that Phase I construction would begin in 2013 and take two years to complete, with occupancy starting in 2015.

In our communications with the Second Campus Project Director Kem Robinson, we learned that the Second Campus will likely reach full build-out approximately 50 years from now, in 2060. Although we originally intended to evaluate the impact of the Second Campus at full build-out in 2060, the IMPLAN tool only performs analysis up to 2030. Thus, our Phase II impacts are based on an intermediate stage of build-out in 2030.

Square footage

Phase I We assumed Phase I would be roughly 450,000 sq. ft. based on LBNL's RFQ as well as conversations with LBNL staff.

Phase II The campus is expected to be 2 million sq. ft. at full build-out 50 years from now. Given the steady, slow nature of the Lab's growth, we estimated that in 20 years, the Second Campus will be 40 percent of the way to full build-out, which translates to 800,000 gross square feet. This amount would require 350,000 sq. ft. to be added between 2015 and 2030.

Number of employees

Phase I. Currently, there are approximately 800 employees within the three Second Campus divisions. The employee growth rate of these divisions averaged 43 employees per year from FY2007 to FY2010; however, this growth can be partly attributed to ARRA funds and to the early growth of JBEI. We assumed that growth would continue at this rate over the next four years, such that the total number of Second Campus employees by 2015 will be approximately 1,000. This number is compatible with our estimated gross area of 450,000 sq. ft., resulting in an employee density of 450 sq. ft. per employee.

Phase II. We determined the number of employees for Phase II based on our assumption of the gross square footage of 800,000 by 2030. Subtracting 125,000 sq ft for a large computing facility that is slated to be built on the Second Campus, we calculated that there would be 675,000 sq. ft. of lab and office space. Assuming 450 sq. ft. per employee, this works out to 1,500 employees in 2030, an increase of 500 from Phase I in 2015.

TABLE 6. **Summary of Second Campus scenarios**

	Year	Employees	Gross sq. ft.	Sq. ft. / employee
Phase I Operations	2015	1000 total 810 residing in the East Bay	450,000	450
Phase II Operations	2030	1500 1215 residing in the East Bay	800,000	533

We did not include Lab guests in our analysis because these individuals are not on the Lab's payroll.

Household spending within the region

Currently, 19 percent of LBNL employees in the three proposed Second Campus divisions live outside of Alameda and Contra Costa Counties. We assumed that this rate of in-commuting would remain in both the Phase I and Phase II scenarios. To simplify our analysis, we assumed that employees who lived outside the Study Area would not spend any money within the Study Area. This is a conservative estimate becuase we would expect these employees to purchase lunch and make other trips for goods and services while in the East Bay. This would slightly increase the induced impacts estimated in our model.

Annual purchasing

Phase I We assumed $76 million in annual purchasing, equal to the FY2010 purchasing total for the three Second Campus divisions.

Phase II We assumed that spending would increase roughly proportionally with the number of employees, so we multiplied the Phase I spending amount by 1.5, resulting in $114 million in annual purchasing for 2030.

Second Campus Impacts

Construction

Because construction activity is likely to span several years, it is important to realize that not all jobs will be created simultaneously.

According to our analysis, construction of Phase I of the Second Campus will generate 1,560 jobs. In this case, we estimate that construction will take approximately two years, so there will be roughly 780 construction jobs created per year. According to the Bureau of Labor Statistics, nearly 20 percent of construction jobs are part-time (between 1 and 34 hours per week), so roughly 310 jobs over the two years of construction will be part-time.

Another 512 jobs will be created by construction contractors purchasing materials and services from other companies; these are "indirect impacts" of the construction. 650 jobs will be created by the personal spending of construction workers on items such as food, beverages, health services, entertainment, housing and the like. The impact of all this activity will lead to a total of 2,719 jobs created over a two year period.

Table 7 lists the top ten sectors where jobs will be created by construction activity. In addition to the expected job creation in the fields of construction, architecture and engineering, other prominent sectors on this list are related to household needs such healthcare, food and general merchandise.

TABLE 7. **Top 10 sectors for employment, Second Campus Phase 1 Construction**

Sector	Jobs
Construction of nonresidential structures	1,558
Architectural, engineering, and related services	154
Food services and drinking places	76
Real estate establishments	58
Wholesale trade businesses	54
Employment services	41
Offices of physicians, dentists, other health practitioners	33
Private hospitals	30
Retail Stores - Food and beverage	27
Retail Stores - General merchandise	25

TABLE 8. **Top 10 sectors for employment, Second Campus Phase I operations**

Sector	Phase I jobs
Food services and drinking places	32
Wholesale trade businesses	22
Employment services	22
Real estate establishments	21
Offices of physicians, dentists, and other health practitioners	16
Private hospitals	14
Architectural, engineering, related services	11
Scientific research and development services	11
Private household operations	10
Retail Stores - Food and beverage	10

TABLE 9. **Employment impacts from Second Campus payroll and purchasing**

	Direct jobs	Purchasing ($M)	Induced jobs	Indirect jobs	Total jobs	Job multiplier
Phase I	1000	76	308	120	1428	1.43
Phase II	1500	114	462	181	2143	1.43

TABLE 10. **Spending impacts from Second Campus purchasing**

	Purchasing ($M)	Indirect & induced spending ($M)	Total spending ($M)	Multiplier
Phase I	76	29	105	1.38
Phase II	114	74	188	1.65

Operations: payroll and purchasing impacts

Table 9 summarizes employment impacts of LBNL's payroll and purchasing activities in Phase I and Phase II. The job multiplier is quite similar for both phases, with each job at LBNL resulting in roughly 0.4 additional jobs through induced or indirect impacts. Interestingly, the number of induced jobs is more than 2.5 times greater than the number of indirect jobs. This suggests that the Lab's activities will not necessarily result in a lot of inter-industry regional economic activity; instead, the greatest impacts are in the businesses that serve households.

These results are likely due to the low local purchasing percentages specified in our model. The number of indirect jobs would increase if LBNL were to increase its purchasing within the region.

Table 8 shows the top 10 sectors for induced and indirect jobs due to Phase I operations. The top sectors for Phase II would be the same. As expected from the number of induced jobs relative to indirect jobs, many of these sectors are those which benefit from the spending of households, such as food and beverage, real estate establishments and healthcare. There are also firms which benefit from indirect impacts of the Lab's spending, such as employment services and scientific research and development services.

Table 10 summarizes the impacts of Phase I and Phase II purchasing in total dollars of spending in the East Bay. The multiplier increases significantly from 1.38 for Phase I to 1.65 for Phase II. We speculate that this reflects increasing synergies in the regional economy as regional purchasing amounts reach a certain threshold.

Cluster Scenarios

Regardless of where the Second Campus is eventually located, the fact that the Lab is exanding in the East Bay will develop the East Bay's reputation as the center of bioscience innovation, which will attract both top researchers and new firms. Below, we look at what some of the economic impacts from this cluster might be.

To analyze the potential economic impacts of tech transfer from the Lab, we created three clusters scenarios assuming different levels of cluster development by the year 2020. We imagined that a cluster would consist of not only spin-offs from the Lab, but other bioscience start-up companies, complementary sectors and co-locating firms. There is already a substantial bioscience cluster in the East Bay—notably in Berkeley and Emeryville—which we believe puts the area at an advantage in attracting new emerging businesses as the industry continues to grow. In this sense, the impacts of the Second Campus will be additative to the existing regional strengths in bioscience.

We assumed that these firms would primarily come from four sectors: Scientific Research and Development Services, Management of Enterprises, Wholesale Trades and Biological Product Manufacturing. We reasoned that,

TABLE 11. **Cluster scenarios**

	Year	Firms	Employees in Scientific R&D	Employees in Management of Enterprises	Employees in Wholesale Trade	Employees in Biological Product Manufacturing
Scattered Spinoffs	2020	5	70	70	0	0
Modest Cluster	2020	20	700	700	500	0
Major Regional Cluster	2020	50	1750	3000	1000	1750

given the research-based nature of biofuels and biological firms, most headquarters of firms in the biofuels space are focused on R&D rather than manufacturing. Significant portions of these firms will also be occupied with corporate functions such as marketing, human resources, and executive management. We also assumed that cluster development would include co-locating firms in the LOHAS (Lifestyles of Health and Sustainability) sector. A number of such firms, such as Clif Bar and Mountain Hardware, already have headquarters in the East Bay. In IMPLAN, we modeled these firms as belonging to the Wholesale Trade sector. Table 11 summarizes the parameters of each scenario.

Scenario 1: Scattered Spin-offs Five spinoffs, with a small research outfit, a couple small labs, and a couple medium-sized firms.

Scenario 2: Modest Cluster 20 firms, including a couple boutique firms, some medium-sized firms, one Amyris-level bioscience success, and two co-locating offices.

Scenario 3: Major Regional Cluster Mix of research centers, start-ups, successful companies, major player relocations, co-locating firms, and retail and entertainment.

Cluster Impacts

Construction

Based on typical industry values, we assumed construction costs to be $230/sq. ft. for office buildings, $800/sq. ft. for lab buildings, and $1,100/sq.ft. for pilot plant space.

Table 12 presents the economic impacts of construction activity for the three scenarios.

For the scattered spin-offs in Scenario 1, we reasoned that existing lab and office space would be able to accommodate the small number of bioscience firms expected to locate in the East Bay between now and 2020. Thus, no new construction will need to occur under this scenario.

For more robust cluster development in Scenario 2, there would be over half a billion dollars in construction activity to build 630,000 sq. ft. of lab space and 165,000 sq.ft. of office space. This activity would create a total of 3,540 jobs.

In Scenario 3, 3 million sq. ft. of lab, office and pilot plant space would be built, costing a total of $1.8 billion and creating 14,300 jobs.

TABLE 12. **Employment impacts from cluster construction**

	New lab space (sf)	New office space (sf)	New pilot plant space (sf)	Construction cost ($M)	Direct jobs	Indirect & inducedjobs	Total jobs
Scattered Spin-offs	0	0	0	0	0	0	0
Modest Cluster	630,000	165,000	0	542	2,000	1,540	3,540
Major Regional Cluster	1,500,000	1,300,000	200,000	1,800	8,200	6,100	14,300

TABLE 13. **Employment impacts from cluster activity**

	Direct jobs	Indirect & induced jobs	Total jobs	Job multiplier
Scattered Spin-offs	140	144	284	2.03
Modest Cluster	1,900	1,850	3,750	1.97
Major Regional Cluster	7,500	7,997	15,497	2.07

TABLE 14. **Economic output from cluster activity**

	Direct output ($M)	Indirect & induced output ($M)	Total output ($M)	Output multiplier
Scattered Spin-offs	41	28	69	1.68
Modest Cluster	525	354	879	1.67
Major Regional Cluster	2,429	1,544	3,973	1.64

TABLE 15. **Top 10 sectors for employment, modest cluster scenario**

Sector	Jobs
Management of companies and enterprises	720
Scientific research and development services	713
Wholesale trade businesses	565
Food services and drinking places	140
Real estate establishments	136
Employment services	80
Services to buildings and dwellings	62
Offices of physicians, dentists, and other health practitioners	55
Private hospitals	49
Management, scientific, and technical consulting services	45

Cluster employment and spending

All cluster scenarios result in a job multiplier of approximately 2.0. That is, for every job in the cluster, another job is created through spending by cluster suppliers or cluster employees. Table 13 summarizes the direct, indirect and induced jobs created in each scenario. Each dollar of output by a firm in the cluster results in approximately $0.65 of output by other firms in the region due to indirect and induced impacts, as shown in Table 14.

Table 15 shows the top ten industries for employment in our medium spinoffs scenario, based on a total of direct, indirect and induced jobs in each sector. (These top ten sectors are the same for both the high and low scenarios, though the order is slightly changed, and of course the employment numbers are different.) As expected, the top three sectors are the same sectors which we specified for direct employment. Food services and drinking places, as well as real estate establishments have the next highest employment, with a total of 140 and 136 jobs respectively. These are sectors that likely receive business from both firms and households.

Comparison of Impacts

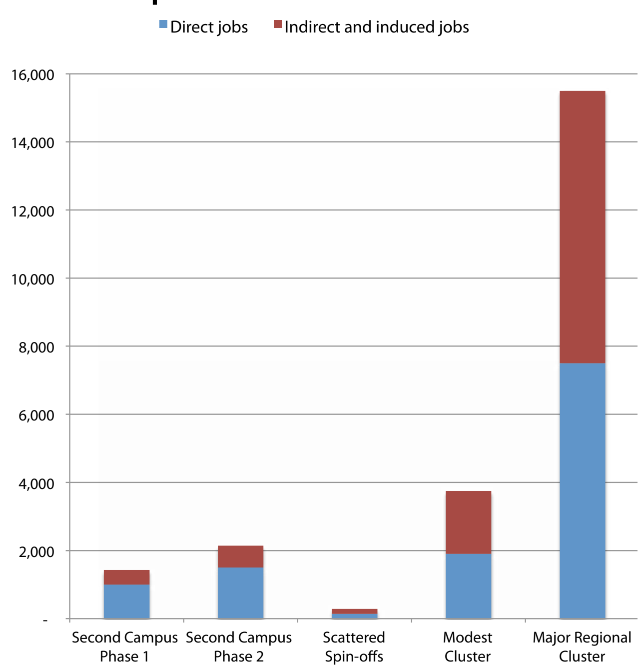
These scenarios reflect the assumption that any significant amount of cluster development will provide more employment than possible from the Lab alone. A recent report on the Lab also notes that the economic impacts of the Lab's spin-off companies "exceed the impacts of the Lab itself" due to the greater number of aggregate jobs.[1] The IMPLAN results provide us with a new insight about the importance of balanced cluster development.

Figure 14 compares the job impacts of the two Second Campus scenarios with that of various scales of cluster development. By comparing the impacts for the LBNL Second Campus to the Modest Cluster (Scenario 2), it is clear that the induced and indirect employment impacts are proportionally greater for the Modest Cluster than for the Second Campus scenarios. In other words, the job multiplier is higher for the cluster scenarios—with 1 induced or indirect job created for each direct job—than for the Lab, which results in only 0.4 induced or indirect jobs created for each direct job. Thus, the IMPLAN results suggest that a cluster with a mix of sectors provide more economic benefits for a given amount of spending than the Lab alone. This underscores the importance of fostering a cluster ecosystem.

In terms of the bioscience firms that will populate the cluster, our analysis of LBNL's history of technology transfer suggests that the cluster will need to attract a significant number of companies in addition to LBNL spin-offs.

1 CB richard Ellis 2010.

FIGURE 14. **Comparison of employment impacts for Second Campus and cluster scenarios.**



CHAPTER THREE

The City Perspective: General Strategies & Zoning and Fiscal Analysis

Part 1: Strategies for Cities

A regional strategy for cluster development will be crucial for the East Bay to realize the economic development potential of the LBNL Second Campus. Within the regional collaboration, there are a number of strategies that cities can use to maximize their potential as part of the East Bay's "cradle-to-scale" cluster.

This set of strategies was formulated on the basis of an analysis of the regulatory framework and opportunity areas for the cities of Alameda, Albany, Berkeley, Emeryville, Oakland and Richmond. These analyses are presented in Appendix A. While we selected these cities based on the final six sites under consideration for the Second Campus, our research suggests that all cities have the opportunity to be a part of an East Bay bioscience cluster regardless of the Lab's location.

Strategy 1: Zone for an Ecosystem

The bioscience industry encompasses a range of activities from lab research to production and warehousing. In order to attract bioscience firms, cities should consider three imperatives that arise from the industry's unique characteristics.

Zoning for the Core

Bioscience is a new industry and some industrial activities don't conform to definitions offered in the existing zoning code. In some cases, existing uses might not allow for bioscience activities, while in others, the zoning code lacks clear indication of where bioscience activity is permitted. Developers and firms value certainty and clarity, in some cases more than the low cost of land. Cities can indicate that they understand the requirements of the industry and welcome bioscience firms by clearly indicating where bioscience uses are permitted in the zoning code, and under which conditions. Bioscience uses do not necessarily need to be singled out within the code itself; another option is to provide an industry-specific "guide to local zoning designations" that explains to developers and firms which zones permit bioscience uses.

Zoning for Support

The bioscience industry relies on collaboration across administration, lab research and production. Whether these activities are housed within a single firm or distributed over many, these uses must be in close proximity to one another. Cities can create an attractive environment for the bioscience industry by creating zoning that allows for a variety of uses in close proximity, under a single zoning category or adjacent classifications.

Example: Mission Bay

Mission Bay is an excellent example of zoning for bioscience uses, support activities and amenities. The Commercial Industrial and Commercial Industrial/Retail zoning designations explicitly allow chemical and medical research, biotech research facilities and experimental laboratories. Supporting uses such as light manufacturing, office space and wholesaling are permitted in the same zone. The Mission Bay South Redevelopment Plan also allows for urban amenities. To facilitate an attractive environment for bioscience firms, Land Use Objective 1 in the Mission Bay South Redevelopment Plan is to create an urban neighborhood that "incorporates a variety of uses" including retail, entertainment, hotel, education, housing, recreation and open space.

FIGURE 15. **Land use map for Mission Bay**

Source: SF Redevelopment Agency

Zoning for Amenities

The industry workforce values proximity to amenities. While many bioscience activities fall under "industrial" use codes, employees don't want to be sequestered in a purely industrial area. Mixed uses, including retail, restaurants and recreation, should be encouraged in proximity to bioscience areas to make development attractive to firms and their employees.

Strategy 2: Developers are Investors

The kind of space required by bioscience firms is highly specialized and technologically complex, resulting in construction costs that are typically two to three times that of regular office space. As a result, small firms and start-ups generally can't afford to build their own space. Developers play a highly active role in forming bioscience cluster, investing in both cities and firms. Developers are thus key partners in supporting industry growth.

By nurturing their bioscience clients, developers can better secure their investments. Their relationship toward tenants often seems more like that of an investor rather than of a landlord. Firms we interviewed reported hiring scientific experts to help determine the likely success of potential tenants, asking for equity share in high risk tenants and even introducing tenants to venture capitalists.

Strategy 3: Leverage Existing Infrastructure

The bioscience industry has intensive infrastructure needs. Firms depend on well-maintained and abundant transportation for the procurement of inputs and the distribution of final products. Lab operations require large quantities of water and power. The cost of building new infrastructure is high, so cities should be strategic about where to focus cluster development. Cities that hope to attract bioscience development should commit to maintaining and improving existing infrastructure.

Oakland is well-positioned with regards to transportation infrastructure. This advantage was a factor in the decision to site a biodiesel facility in West Oakland, adjacent to EBMUD's water treatment plant, in close proximity to the rail line and to end customers such as the Port of Oakland. The plant will be developed by Oakland-based Viridis Fuels and is expected to produce 20 million gallons of biodiesel per year.

Example: West Berkeley / Emeryville Bioscience Cluster

In the West Berkeley/Emeryville Bioscience Cluster, developer involvement in the planning process has been particularly important. Representatives of Wareham Development have worked closely with both Berkeley and Emeryville to create an ideal environment for bioscience. Between the two cities, Wareham has developed 2.5 million sq. ft. of flex-lab space, some focused specifically on bioscience, that has attracted both startups and large firms.

The QB3 East Bay Innovation Center demonstrates the power of public-private-partnerships. QB3, also known as the California Institute for Quantitative Biosciences, is a multi-campus institute associated with UC Berkeley, UC Santa Cruz and UCSF. With the help of private partners, QB3 has created two incubators to provide small, low cost, spaces for UC spin-offs looking for a place to progress their research and test their concepts. Wareham Development operates the QB3 East Bay Innovation Center, which offers 9,300 sq. ft. of wet labs, private offices and conference rooms.

QB3 East Bay Innovation Center
Source: QB3

Strategy 4: Bring the Community Along

Bioscience is an emerging and dynamic industry. Communities often have concerns based on serious issues or common misconceptions regarding bioscience work. Communities might have valid questions about the local environmental impact of bioscience development. There may also be concerns over broader questions including the production of genetically modified organisms, the sustainability of biofuels, and the implications of corporate partnerships. In order to facilitate development, cities can help educate their communities on the nature of bioscience work and the goals of the industry. This can help develop community support and reduce obstacles to development.

Cities can also help developers understand these community concerns. With clear communication about community priorities, developers and firms can improve their proposals to better accommodate community needs. One tool available in negotiating community concerns is the community benefits agreement (CBA), a project-specific, negotiated agreement between a developer and a community coalition. CBAs ensure that development remains an inclusive process and enforces accountability for its partners. Cities can also play a role in addressing community concerns by soliciting input and representing community needs and concerns in a development agreement with the project developer. By improving communication between communities and developers, cities can help ensure that development reflects the community's priorities and enforces accountability, while facilitating quick approval of developers' proposals.

Strategy 5: Play to Your Strengths

Each city can play a role in the East Bay's "cradle-to-scale" cluster. While cities have the potential to accommodate a wide range of bioscience activities and cluster development, no individual city is best suited for the entire range of uses associated with the bioscience industry. Realistic assessment of assets can help cities plan strategically to attract firms and bioscience activities that play on their strengths, while also supporting bioscience development in other cities within the East Bay.

Example: Voices2Vision in Albany

Since Albany voters passed Measure C in 1990, all changes to the city's waterfront require voter approval. As a result, developers face uncertainty about proposed projects and risk of defeat is high. In order to foster a more supportive and collaborative process, in 2008, the City of Albany initiated "Voices2Vision," a two-year visioning process for community members to put forth recommendations for an ideal waterfront development. Clearly articulated community input helps developers plan in ways that are likely to have community approval.

Albany residents engaged in a community visioning process
Source: City of Albany

Example: Richmond looks to the future

Richmond's advantages include land at low rents, workforce training programs and an available workforce. The city would be attractive to large firms looking for affordable land, lots of space and a local workforce. Richmond has also been proactive in defining itself as a player in the green economy. The City's updated General Plan, anticipated to be adopted in early 2012, includes policies and programs that reflect the City's commitment to economic development based on bioscience and green tech research and development. Their voluntary Energy and Climate Change Element includes strategies to transition city vehicles and public transportation to climate-friendly fuels and to develop regional partnerships to retrofit and replace polluting cars, trucks, rails, ships and equipment. The General Plan also includes a green business strategic plan and a business incentives program linked to their model workforce development system.

Mission Bay Case Study: The Role of the Public Sector

The creation of Mission Bay as the biotech hub of San Francisco was no accident. Catellus originally owned the land, got entitlements from the Redevelopment Agency, and then spun-off Mission Bay Development Group (MBDG) with some of its key staff to manage it. Because of his connections with the company, Mayor Willie Brown was able to push Catellus to give UC San Francisco 40 acres for free, laying the groundwork for the future biotech cluster and preventing the major San Francisco-based institution from building a new campus across the bay in Alameda. Infrastructure upgrades and affordable housing were financed with both Redevelopment and a bonded Mello Roos district that was created for the area.

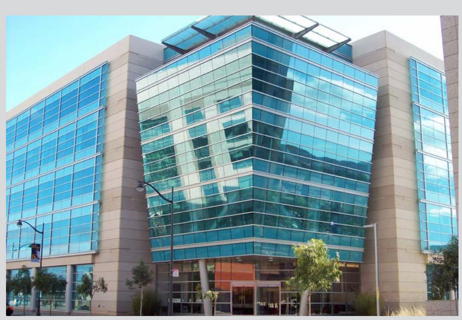
Developers want certainty, and no doubt that was the mission of Catellus in this project. Catellus did a long and intensive amount of community outreach prior to starting the development, which provided the community with amenities like children's parks and dog parks. After all contentious issues were discussed, Catellus entered a Disposition and Development Agreement with the Redevelopment Agency, which set into place the conditions which would allow them to proceed with the project.

A strong vision from UCSF's real estate arm also pushed the second campus to an undeveloped site and encouraged future development. MBDG sold parcels to other developers like Alexandria who were knowledgeable about the industry and experienced at developing lab space, including the "science hotel" for startups. Other developers built housing, retail, and office space. ARE has created the "science hotel" model where small companies can rent lab space but not have to buy their own equipment, such as glass wash, sterilizer, and vivarium, which can be prohibitively expensive for start-ups. Through ARE's model, it is possible to have a more complete ecosystem of biotech companies in Mission Bay because it is affordable. An aggressive and successful role by QB3, a collaboration between UCSF, UC Berkeley, and UC Santa Cruz, helped to shape the integration of the university and hospital with surrounding private businesses. These uses helped to create a functioning biotech ecosystem to support a range of startups and established firms.

What followed was continued success. Catellus' use of Design for Development brought about a very generous public benefits package that included parks, infrastructure, shuttle services, and police. The inclusion of affordable and market-rate housing allowed for residents not affiliated with UCSF or the biomedical institutions to move in and create an interesting mix of people and an exciting place to live. The purposeful flexibility of land uses accommodated a variety of users, allowing Mission Bay to adjust to current market conditions and for the available parcels to continue to sell. Not only has Mission Bay become a vibrant place to live and work, but the continued success of the biotech industry has hinged on a healthy community of researchers, venture capitalists (VCs), and private companies.

Lab tenants have an incentive to locate near UCSF because of the opportunity to build relationships with scientists from similar and larger companies, as well as the University. VCs coming from the peninsula eventually started leasing offices in the ARE buildings out of an interest to be closer to the labs. VCs also keep a close relationship with the landlord (ARE), which is in some instances playing a similar role in nurturing smaller companies. The CEO of ARE has relationships with VCs that span 10 years, no doubt a key role to their success in the industry.

Mixed use development
Source: Author



Lab space at 1700 Owens St.
Source: Alexandria Real Estate Equities

Street furniture and bike racks
Source: Author

Part 2: Zoning and Fiscal Analysis

Regardless of where the Second Campus is ultimately located, the creation of a biotech cluster could have sizeable impacts on all East Bay cities. In this section, we look at two different building types that might be built in a biotech cluster. The first type of building is a "science hotel" incubator; the second is a research and development lab. We then attempt to locate these building types in Berkeley and Richmond, respectively, and measure how well local zoning allows for them. Finally, we calculate an approximation of the potential city general fund revenue that could be generated from the build-out of opportunity sites in both West Berkeley and Richmond's Southern Gateway area.

Bioscience Buildings

The Science Hotel

Incubator space is an important component of the cluster ecosystem, particularly in the bioscience industry where even small start-ups have a need for specialized lab space, but do not have the means to build such facilities themselves. The "science hotel" is a model in which developers build, own and operate laboratory buildings with rentable suites of a large range of sizes, along with shared amenities such as lab space, equipment and conference rooms. The concept enables smaller companies to save costs by sharing resources, while offering a collaboration-friendly environment, access to VCs, and the flexibility to expand into more space as needed.

Laboratory buildings are typically over 100,000 square feet due to the high capital costs of various components, including the seismic system, oversized utility supplies and drainage systems, internal mechanical, electrical, and plumbing systems, and lab interiors. Floor-to-floor heights are tall, ranging from 15 to 18 feet to accommodate HVAC systems, exhaust ducting for chemical fume hoods, gas piping and electrical conduits. Combining the minimum floor area with typical floor heights and a minimum floor plate of 25,000 square feet leads to a four-story science hotel building of 72 feet in height.

The science hotel fits well in the fabric of a walkable, semi-urban environment, and may even integrate retail uses on the ground floor. To promote a dense and walkable environment, parking should be below-grade, and parking ratios should be no more than 1.5 spaces per 1,000 square feet. Table 15 summarizes the specifications for a prototypical science hotel that might be appropriate for West Berkeley.

Large-scale Research and Development Lab

A large-scale research and development lab will have some features similar to the science hotel, but is often a lower density development with larger suite spaces to

TABLE 16. **Specifications for a science hotel**

Number of stories	4
Floor-to-floor height	18 ft
Total height	72+ ft
Flex lab/office space	120,000 sq. ft.
Rentable suite size	Divisible from 500 to 30,000 sq. ft.
Parking	1 per 1000 sq.ft., underground
Amenities	Shared lab facilities, proximity to VCs
Mixed use	Ground floor restaurants and services

1500 Owens St., Mission Bay is six stories and 160,000 sq. ft.
Source: Alexandria Real Estate Equities

Alexandria Center for Life Science is 15 stories and 310,000 sq. ft.
Source: Alexandria Real Estate Equities

accommodate larger tenants. This type of lab is often located in light industrial areas, away from residential and commercial spaces, in order to accommodate potentially noxious activity in the labs. Table 16 summarizes the specifications for a large R&D lab.

TABLE 17. **Specifications for a large R&D lab**

Number of stories	3
Floor-to-floor height	18 ft
Total height	54 ft
Flex lab/office space	280,000 sq. ft.
Possible suite size	5,000 to 70,000 sq. ft.
Open space	40,000 sq. ft.
Parking	2-3 spaces/1,000 sq. ft.
Amenities	Trails, park space
Mixed use	No
Adjacent uses	Restaurants and services

The Science Center in South SF is 3 stories, and 200,000 sq.ft.
Source: BioMed Realty

1681 Gateway Blvd, South SF is 4 stories and 130,000 sq. ft.
Source: Alexandria Real Estate Equities

Zoning for Bioscience

After we identified the parameters of these two building types, we next assessed two East Bay neighborhoods—West Berkeley and Richmond's Southern Gateway—to determine if the cities' zoning regulations would allow these types of buildings. In particular, we assess the potential for a science hotel to locate in Berkeley and a research lab in Richmond.

Locating a Science Hotel in West Berkeley

The first development scenario we analyzed was locating a science hotel in West Berkeley. West Berkeley is already rich with amenities, including restaurants and shops along Fourth Street and good access to many transportation options such as the 80/580 freeway, Amtrak, BART, several bus lines, and the Bay Trail. West Berkeley has two zoning designations that a science hotel would potentially fit within: Mixed Manufacturing and Mixed Use Light Industrial. However, as Table 17 illustrates, a science hotel would have to overcome several hurdles in the zoning regulations before actual development could occur. Regulations presenting major barriers are colored red; regulations presenting some hurdles are colored orange, and regulations presenting no issues are colored green. The largest barriers are the height and floor area ratio maximums.

The City of Berkeley could allow developments of the height and FAR of the proposed science hotel through the use of a Master Use Permit (MUP). The MUP would create a special approval process for sites that are over five acres and would allow for heights up to 75 feet. However, only six MUPs are allowed in West Berkeley over a 10-year period, and the large site requirements limits its applicability to only a handful of locations. Meeting the development needs of a medium-scenario bioscience cluster would restrict the City's ability to allow for other uses in the area.

Locating a Research and Development Lab in Richmond's Southern Gateway

Next, we analyzed the potential to locate a new research and development lab in Richmond's Southern Gateway, using the land use designations outlined in the draft General Plan, expected to be adopted in 2012. The light industrial area of the Southern Gateway is bound by the waterfront to the south and the 580 freeway to the north and east, which provide useful buffers separating the light industrial uses from the residential areas to the north. Table 18 illustrates that overall, a research and development lab would fit well in a light industrial land use district.

TABLE 18. **West Berkeley Zoning Regulations as applied to a Science Hotel Development.**

	Mixed Manufacturing	**Mixed Use Light Industrial**
Permits lab space?	Use Permit after Public Hearing	Use Permit after Public Hearing
Permits office space?	Above 1st floor, with Zoning Certificate if less than 20,000 SF or Admin Use Permit* if between 20,000 - 40,000 SF	Use Permit after Public Hearing
Permits storage?	Admin Use Permit if 20,000-40,000 SF	Admin Use Permit if 20,000-40,000 SF
Maximum height	45 feet	45 feet
Maximum FAR	2.0	2.0
Permits retail?	No	No
Parking	0.67 / 1,000 SF	1.5 spaces / 1000 sq. ft. sp
Restrictions	Special provisions protecting existing uses such as manufacturing, wholesale trade and warehouses.	

Source: Berkeley Zoning Code

TABLE 19. **Richmond General Plan land use designations as applied to a large-scale R&D Lab development**

	"Light industrial" land use designation
Permits office space?	Yes
Permits lab space?	Yes
Permits storage?	Yes
Permits manufacturing?	Yes
Maximum height	55 feet
Max FAR	3.0
Parking	1.5 to 3 spaces/1000 SF

Source: Richmond Draft General Plan

Regulations presenting major barriers are colored red; regulations presenting some hurdles are colored orange; and regulations presenting no issues are colored green.

Fiscal Impact of a Bioscience Cluster: Potential General Revenues from New Development

We assessed the amount of general revenues for each city that might be generated from this new development. There are two steps to this process. First, we reviewed property tax bills of comparable properties in the area and determined the amount that went to the city's general fund. Next, we calculated the approximate value of new development on currently underutilized or vacant parcels. We used these findings to then determine an approximate value for new general revenues for the city.

West Berkeley Assessment

In the West Berkeley area, approximately 53 percent of a property's tax bill is the Prop 13 one percent ad valorem property tax, of which the City of Berkeley receives 33 percent. Another 33 percent of the property's tax bill goes towards special assessments and fixed charges. Finally, 14 percent is for other ad valorem taxes, including three percent for a city ad valorem tax.

In order to calculate how much the city receives for its general revenues, we added the amount of the city ad valorem tax together with the amount of the Prop 13 one percent ad valorem property tax that the city receives. These two amounts are illustrated in red in the pie charts in Figure 175.

For our assessment of West Berkeley, we limited the scope of potential development sites to those that are already under consideration for the proposed Aquatic Park Second Campus, which includes a group of parcels right next to Aquatic Park on Bancroft for the Lab buildlings, and a set of parcels four blocks to the north for support facilities at Third and Cedar. The current tax revenues from these parcels are shown in Table 1920. If the Aquatic Park site is chosen for the LBNL second campus, the city could lose roughly $80,000 a year in general revenues because the Second Campus would not pay property taxes.

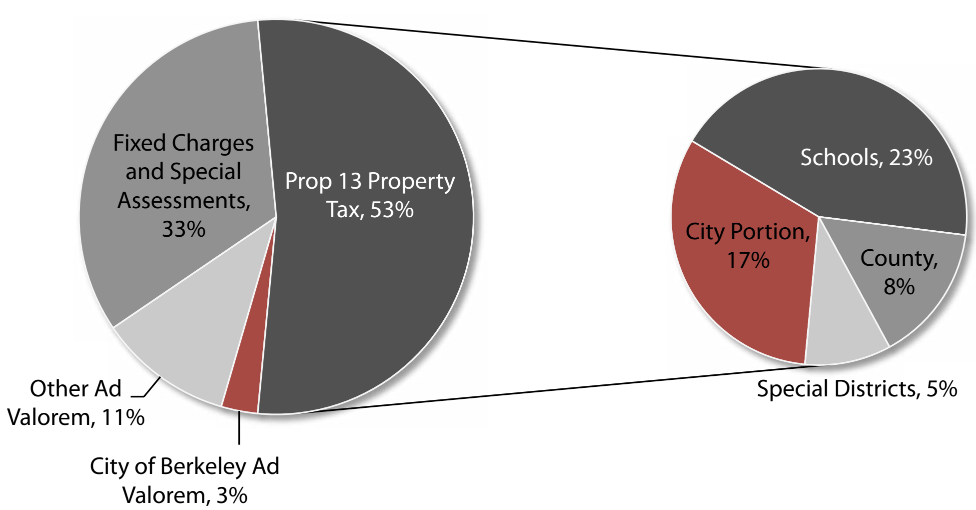
However, if LBNL does not choose the Aquatic Park site for their second campus, there is the possibility that other biotech firms could locate on those parcels. To illustrate the potential impact of this kind of development on the city's general revenues, we calculated the potential value of these improvements, illustrated in Table 201.

In this scenario, we assume the new improvements would cost $140 per square foot and have an average FAR of 1.5. These are based on comparable developments in the area, as well as the development assumptions for a science hotel previously outlined in this report. Because the Bancroft lots adjacent to Aquatic Park already had improvements that exceeded the land value, we only calculated the potential value of developing the Third and Cedar lots that are allocated to support facilities in the proposal. According to the above scenario, the four parcels in the Third and Cedar area, if developed, could generate an additional roughly $125,000 a year in general revenues, as shown in Table 21.

Richmond Southern Gateway Assessment

In the Southern Gateway area, approximately 59 percent of a property's tax bill is the Prop 13 one percent ad valorem

FIGURE 16. **Berkeley Property Tax Structure**



Source: Author calculations from county assessor data

TABLE 20. **Current General Revenues from Various West Berkeley Parcels**

	Acres	Land Value	Improvements Value	Total Value	Total Tax Assessed	Approximate City Revenue
Aquatic Park Lab Sites						
620 Bancroft Way	8.18	$1,644,672	$1,838,009	$3,482,681	$70,216	$12,956
600 Bancroft Way	1.5	$1,729,274	$1,581,476	$3,310,750	$68,106	$12,316
91 Bolivar Dr	1.36	$939,161	$4,248,161	$5,187,322	$110,697	$19,297
747 Bancroft Way	0.99	$127,918	$481,348	$609,266	$52,189	$2,266
701 Bancroft Way	0.85	$863,568	$497,913	$1,361,481	$43,521	$5,064
2220 4th St	0.35	$88,296	$1,029,619	$1,117,915	$29,820	$4,159
2200 4th St	0.6	$676,580	$676,580	$1,353,160	$53,232	$5,034
Aquatic Park Total	13.83	$6,069,469	$10,353,106	$16,422,575	$427,781	$61,092
Aquatic Park Support Facilities Site						
Folsom St Lot	0.97	$1,370,000	-	$1,370,000	$18,046	$5,096
Third St Lot	1.22	$2,060,000	-	$2,060,000	$30,920	$7,663
Cedar St Lot	0.59	$910,000	-	$910,000	$11,624	$3,385
Cedar St Lot	0.52	$690,000	-	$690,000	$8,832	$2,567
Support Facilities Total	3.3	$5,030,000	$0	$5,030,000	$69,422	$18,711
					Total current general revenue:	$79,803

Source: Alameda County Assessor's Office

TABLE 21. **Potential revenues from a science hotel development in Berkeley**

	Acres	Description	Land Value	Improvements Value	Total Value	Approximate City Revenue
Support Facilities Parcels	3.7	Science Hotel	$5,030,000	$33,810,000	$38,840,000	$144,484
Aquatic Park Parcels	13.83	No Change	$6,069,469	$10,353,106	$16,422,575	$61,091
					Potential tax revenue:	$205,575
					NET DIFFERENCE:	**$125,772**

property tax, of which the City of Richmond receives approximately 21 percent. Another 21 percent of the property's tax bill goes towards special assessments and fixed charges. Finally, 28 percent is for other ad valorem taxes, including 10 percent for a city ad valorem tax.

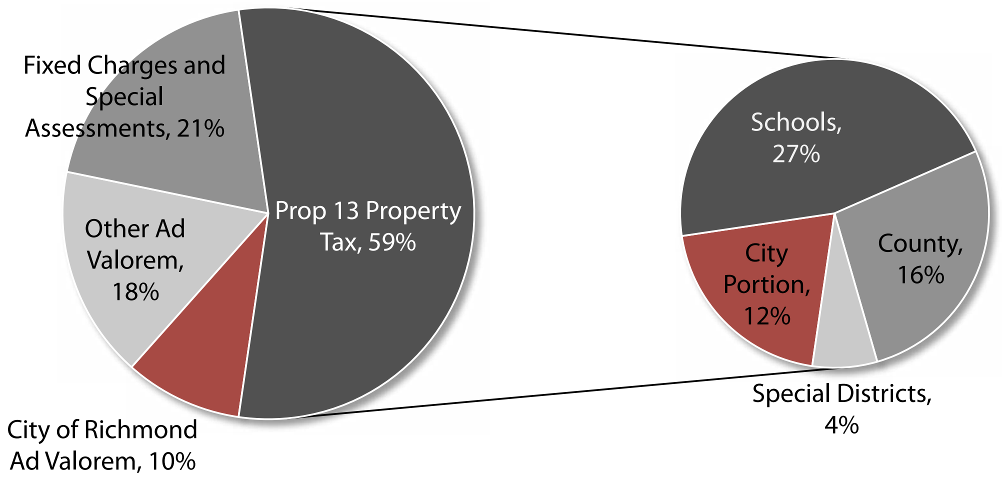
In order to calculate how much the city receives for its general revenues, we added the amount of the city ad valorem tax together with the amount of the Prop 13 one percent ad valorem property tax that the city receives. These two amounts are illustrated in red in Figure 186.

For our assessment of Richmond, we looked at the Richmond Field Station, currently owned by the UC Regents and one of the proposed sites for the second campus, as well as four other nearby potential sites for development. The current tax revenues from these parcels are shown in Table 212.

The city does not receive any general revenues from the Richmond Field Station, and so would not lose any revenues if the second campus locates there. However, there is the potential for the city to see an increase in general revenues if new development occurs on the other currently underutilized sites, as illustrated in Table 223.

In this scenario, we assumed the new improvements would cost $60 per square foot and have an average FAR of 1.5. These assumptions are based on comparable developments in the area, as well as the development assumptions for a research and development lab outlined previously in this report. According to the above scenario, these four parcels, if developed, could generate an additional $1,178,000 a year in general revenues for the City of Richmond.

FIGURE 17. **Richmond Property Tax Structure**



Source: Author calculations from county assessor data

TABLE 22. **Current General Revenues from Various Richmond Parcels**

	Acres	Land Value	Improvements Value	Total Value	Total Tax Assessed	Approximate City Revenue
Del Monte/Safeway	38.2	$13,396,802	$31,832,486	$46,524,930	$865,449	$162,837
Zeneca	49.5	$28,639,690	$531,319	$29,171,009	$411,137	$102,099
49th St Lot	0.7	$318,653	$0	$318,653	$6,185	$1,115
51 St Lot	0.1	$36,272	$0	$36,272	$1,084	$127
Richmond Field Station	371.5	$19,039,482	$30,342,611	$49,382,093	$133,682	$0
				Total current general revenue:		$266,178

Source: Contra Costa County Assessor's Office

TABLE 23. **Potential revenues from R&D lab development in Richmond**

	Acres	Description	Land Value	Improvements Value	Total Value	Approximate City Revenue
Del Monte/ Safeway	38.2	R&D Lab	$13,396,802	$159,948,192	$173,344,994	$606,707
Zeneca	49.5	R&D Lab	$28,639,690	$206,800,608	$235,440,298	$824,041
49th St Lot	0.7	R&D Lab	$318,653	$3,120,000	$3,438,653	$12,035
51 St Lot	0.1	R&D Lab	$36,272	$480,000	$516,272	$1,807
LBNL Site	371.5	R&D Lab	$19,039,482	$1,553,620,128	$1,572,659,610	$0
					Potential Tax Revenue:	$1,444,590
					NET DIFFERENCE:	**$1,178,412**

CHAPTER FOUR

Regional Workforce Development

Opportunities and Challenges

Advanced biofuels is a nascent industry and specific growth subsectors remain unclear, but in the East Bay jobs are expected to increase along the innovation and production chain, which will likely intersect with biofuel and industrial biotech activity (Table 234). Research and development facilities will require highly educated scientists and technically skilled research assistants with limited administrative staffing. Production facilities, including advanced manufacturers, will employ skilled production technicians, engineers, machinists, and some management and administrative staffing. The professional, scientific, and technical service (PSTS) spectrum is broad, inclusive of designers and printers, lawyers and accountants and specialized scientific services such as DNA processing and specialty refrigeration. Jobs across these fields require post-secondary education and in many cases advanced degrees. Current job outlooks highlight researchers, research assistants, and laboratory, production, quality assurance and manufacturing technicians.

An educated local workforce is critical in ensuring a competitive local labor pool. The East Bay boasts among its primary assets a highly educated, highly skilled workforce. But as the baby boom generation phases into retirement, opening up job opportunities for incoming workers, there are concerns that they will not be qualified to fill them.[1]

1 California Council on Science and Technology 2009.

See Appendix C for a full detail of biotech occupations by educational requirements and growth trends

Over the next 10 years, seven out of every ten projected jobs will be replacement jobs, yet employers are already reporting difficulty finding qualified workers for higher skill-level technical positions, and projecting shortages to fill middle-skilled positions.[2] These are positions that require some post-graduate education but not a four-year degree. For the East Bay's advanced biofuels sector this is particularly relevant because STEM (science, technology, engineering and math) and PSTS jobs are slotted to propel the region's future economic growth. Jobs at all skill levels require specialized technical education—75 percent of STEM job openings through 2016 will require some post-secondary education, with 50 percent requiring bachelor's degrees.[3] A recent assessment of the East Bay economy found STEM job growth outpacing other job-types, PSTS jobs projected to grow 3 percent annually, and advanced manufacturing expanding relative to the sector as a whole.[4]

Effective, well-coordinated regional workforce development systems are instrumental in providing pathways to good paying jobs in the growing advanced biofuels sector, but there are impediments compromising the region's

2 East Bay Economic Development Alliance 2011.

3 Ibid.

4 Ibid.

TABLE 24. **East Bay Annual Projected Job Openings though 2018**

Occupational Category	Job Growth	Replacement	% Growth from Replacement
Service Occupations	3,512	6,199	63.8%
Professional and Related	2,073	4,520	68.6%
Management, Business and Financial	932	2,984	76.2%
Office and Administrative Support Occupations	728	3,640	83.3%
Sales and Related Occupations	515	3,320	86.6%
Construction and Extraction Occupations	354	1,112	75.9%
Installation, Maintenance, and Repair Occupations	131	755	85.2%
Transportation and Material Moving Occupations	95	1,692	94.7%
Farming, Fishing, and Forestry Occupations	15	45	75.0%
Production Occupations	-646	1,251	100.0%
Total Jobs	**7,709**	**25,518**	**76.8%**

Source: California Employment Development Department competitiveness that require more attention. In both Alameda and Contra Costa Counties, high school graduation rates are declining and over half of graduates do not qualify for UC or CSU admissions, considerably higher than the state average.[5] California is also not producing enough STEM college graduates. Over the past six years, the state has gone from 14th in science and engineering bachelors degrees awarded to 45th, nationally.[6] Decreased state funding for education at all levels threatens the state's capacity to educate the future workforce. Increased costs and reduced post-secondary offerings also raise barriers for lower-income students, who in the East Bay, tend to come from communities disproportionately burdened with unemployment, poorer quality schools and troubling educational outcomes. In particular, African-American and Latino students, the fastest growing demographic in the region and the state have particularly low educational outcomes in high school graduation, college admissions, and post-secondary matriculation at all levels.[7] Limited access to higher skilled, higher wage jobs in the biotech sector because of low academic achievement will deepen existing economic disparities in the region. Emerging scholarship acknowledges that regional economic disparities ultimately hamper regional economic competitiveness.[8]

5 Ibid.
6 Ibid.
7 Ibid.
8 Pastor 2006.

Existing Workforce Development Ecology

STEM skills gaps and projected worker shortages have garnered federal and state attention and funding will support a variety of career pipeline initiatives targeting high school and community college students. The recently released "Federal Science, Technology, Engineering, and Mathematics (STEM) Portfolio" found that federal investments in STEM education totaled $3.4 billion for 2010.[9] For this report, we focus on these programs because they are tailored in partnership with industry to meet employers' needs and address the particular barriers to education and employment facing the East Bay's emerging workforce. Shared components of these programs include "linked learning" career pipelines that bridge high school and community college career training programs with key involvement from education and industry leaders to shape the curriculum and create workplace linkages. Linked learning is an educational model that provides academic and career-themed technical training with work-based learning and support services for student, designed to facilitate successful attainment of post-secondary education and entry into the workforce. Instrumental to these educational models is hands-on, experiential learning both in the classroom and through industry internships. Employers value potential employees who have experience with industry specific processes and equipment, and

9 National Science and Technology Council 2011.

Construction and Local Workforce

This report focuses on the biotech sector and related workforce ecology. It does not cover expected construction industry impacts, strengths or opportunities. The scope of the proposed campus facilities and potential complementary development in the host city and across the region will undoubtedly generate significant construction jobs. As discussed in Chapter 2 of this report, the Second Campus is expected to generate 1,550 construction jobs for Phase 1 development. However, the long term impacts of this campus and ensuing bioscience cluster development on the construction industry are less clear. Projects like the "science hotel" will require specialized training tailored to the industry's specific space needs.


RichmondBUILD students constructing a new home. Source: RichmondBUILD

The Cities of Richmond and Berkeley both have local hire ordinances that will likely cover some aspect of these projects. Negotiating opportunities early in the development process with the developers, cities and LBNL will ensure that local job benefits are maximized and administrative burdens over the course of the project are minimized. Additionally, Richmond's nationally recognized construction trade training program, RichmondBUILD, would be well-suited to support the project's workforce needs while creating access to well-paying construction careers for local residents.

workers benefit from industry exposure enabling them to make informed choices about career pathways. In the past, several of the region's community college-based career technical training programs focused on retraining displaced and incumbent workers. More recently, these programs have shifted focus to the emerging workforce at the high school level. See Appendix B for a list of Bioscience Workforce Development Programs.

In California, Contra Costa County ranks first and Alameda County fourth in the number of linked learning programs offered to high school and community college students.[10] The California Department of Education supports these programs through the California Partnership Academies initiative, which has been shown to increase high school graduation rates. In the East Bay, STEM related programs exist at Berkeley High School, several Oakland high schools, and El Cerrito, Kennedy, Richmond and Pinole high schools.

Each program is developed with industry and maintains connections to nearby community college programs. The Contra Costa Economic Partnership has been very active in supporting Contra Costa County programs, serving as a bridge between industry partners, the high schools and Contra Costa College. They sponsor industry dialogue events and biotech career fairs and they run summer biotech science camps for high school students and teachers hosted on the Contra Costa College campus.

The California Community Colleges Chancellor's Office Economic and Workforce Development Program operates multiple sectoral initiatives, including programs in biotechnology and advanced manufacturing. At the state level, programs are strategically located according to existing industry concentration. Each program has an advisory board comprised of educators, industry leaders and technicians who assist in curriculum development, direct instruction and linkages to internship opportunities. The aim of these programs is to open up multiple career pathways for students who can opt to complete two-year Associates of Science (AS) degrees and transfer to four-year institutions, or acquire technical certificates and secure entry-level positions with the option of returning to complete their AS degree and transferring to a four-year university at a later date.

The Northern California Biotechnology Center is one of four centers in the state supported by this initiative. Housed at Ohlone College in the City of Fremont, it coordinates programs at 26 community colleges in the Greater Bay Area. For the purposes of this study, we highlight those offering specialized biotech training programs in Alameda and Contra Costa Counties. Programs offer 2-year AS degrees and specialized biotechnology certificates for a variety of job tracks.

Ohlone College is home to the largest and most comprehensive program in this system serving the cities of Fremont, Newark, Union City, and Hayward. They offer 5 technical certificates all focused on industrial biotechnology and biofuel production—biotechnology, bio-manufacturing, bio-statistics, cell production/fermentation, quality control/research assistant and computer applications in biotechnology.

The program works with feeder high schools to develop and articulate courses for their biotechnology career pathway programs. The program targets students from groups underrepresented in the sciences and many graduates continue their studies in the college's biotech learning community after high school graduation. Ohlone College offers over 25 biotechnology and related courses on the most current industry techniques and processes, using cutting-edge equipment. Nearly 350 students have enrolled in these courses, including many industry employees taking courses to hone skills.

10 California Department of Education 2010.

Engineering Program Lab at Richmond High. Source: Chevron

Biotechnology Lab at Ohlone College. Source: Ohlone College

An informal network of advisory board firms, local scientific staffing agencies, area start-ups and an on-campus Workforce Investment Board One Stop Center internship keeps program leadership and participants aware of internship and job opportunities. The program places graduates in a variety of positions that fall generally under the "research assistant" classification at local firms including: Bayer, Novartis, Genentech, Amgen and a number of start-ups. Start-ups come to the college looking for interns and employees, much more so than the larger companies who work through staffing agencies, like Kelly Scientific. The emerging trend, not unlike other parts of the workforce, is for businesses to contract new employees through staffing agencies for six-month probationary periods. Successful candidates are often hired full-time. The Director of the Ohlone program said that prior work experience is one of the most important qualifications employers are looking for and that her students, because of their internship experiences, often secure positions over university graduates with less experience.

Biotech Partners is a linked learning program that supports high school and community college students from Berkeley and Oakland. The program targets youth from populations that are traditionally under-represented in the sciences. The program partners with Berkeley and Oakland Technical high schools, as well as the Peralta Community Colleges. The high school Biotech Academies provide bioscience-based education and training, and give students the opportunity to earn college credits while in high school. These Academies are directly linked to the Bioscience Career Institute at Berkeley City College, where students can earn a Certificate of Achievement in Biotechnology or a 2-year Associates of Science degree in Biotechnology.

The other Peralta Community Colleges offer additional bioscience-related programs. Laney College in the City of Oakland partners with the Regional Technical Training Center (RTTC), the Rubicon Programs, and the Oakland Metropolitan Chamber of Commerce to offer a Biomanufacturing program. Students in this program can earn a Certificate of Proficiency in Biomanufacturing from a fast-tracked, one-semester course of study, or a Certificate of Achievement in Biomanufacturing over the course of two semesters. The program has no pre-requisites—students may come from any educational background. Merritt College, also in Oakland, has a specialized Microscopy Program in which students can earn a Certificate in Bioscience Microscopy or a two-year

Biotechnology Department at Ohlone College

Ohlone College in Fremont offers the largest and most comprehensive biotechnology program in the East Bay. They offer a two-year Associates of Science degree in biotechnology and five different technical certificates focused on industrial biotechnology and biofuel production:

- Bio-manufacturing Certificate of Achievement
- Bio-statistics Certificate of Achievement
- Cell Production / Fermentation Certificate of Achievement
- Quality Control / Research Assistant Certificate of Achievement
- Computer Applications in Biotechnology Certificate of Accomplishment

Students in Biotechnology Lab in Ohlone.
Source: Ohlone College

Ohlone College serves the Cities of Fremont, Newark, Union City, and Hayward. The program works with area high schools to develop and articulate courses. Unique among regional programs, the Ohlone program also hosts a Workforce Investment Board One Stop Center offering internship and job placement support services. Ohlone also hosts the Learning Alliance for Bioscience (LAB) Program, a career pathway program for high school students, and the Biotechnology Summer Institute, an intensive summer course that prepares students for an internship in the biosciences.

Industry Partners
Abgenix, Allergan, Amgen, Applied Biosciences, Bayer, BioImagene, Boston Scientific, Cell Genesys, Corium Novartis, Diagnostic Biosystems, DiscoveRx, Genencor, Genentech, Impax, Lab Vision, Inamed, Lynx Therapeutics, Kelly Scientific, Mendel Biotechnology, Metabolex, Spring Bioscience, Tethys, ViOptix, and Xoma.

Institutional Partners
Ohlone College is home to the Northern California Bay Area Biotechnology Center (NCBC) for the California Community Colleges Biological Technologies Initiative. The NCBC promotes collaboration across all sectors of the bioscience industry, and works with Economic Development Agencies in Fremont, Newark, and Hayward, the East Bay Economic Development Alliance, and the Alameda County Workforce Investment Board.

Biotech Partners Program

The non-profit organization Biotech Partners provides linked learning biotechnology training programs that support high school and community college students from populations that are traditionally underrepresented in the sciences. The high school Biotech Academy program offers students the opportunity to earn college credits while in high school, and students can continue their studies at the Bioscience Career Institute at Berkeley City College. Here, they can earn a:

• Certificate of Proficiency in Biotechnology after a fast-tracked one-semester course of study
• Certificate of Achievement in Biotechnology after a two-semester intensive course of study
• Associate of Science degree after a two-year course of study

The education and training provided through the Bioscience Career Institute prepares students for different entry-level positions as bioscience technicians. The program supports 120-150 students annually, and graduates of the program have gone on to work at Bayer, Novartis, LBNL, and the California Department of Health and Human Services among others.

Industry partners:
Established in 1993 as part of a development agreement between Bayer HealthCare and the City of Berkeley, the program now has over 35 other corporate and industry partners including Novartis, Amgen Inc, Genentech, Xoma, Kaiser Permanente, and Tethys Bioscience.

Institutional partners:
Primary educational partners include Berkeley High School, Oakland Technical High School, and Peralta Community College District, which includes Berkeley City College, College of Alameda, Laney College, and Merritt College. The US Department of Agriculture, the Department of Energy's Joint Genome Institute (JGI), LBNL, the Joint Bioenergy Institute (JBEI), East Bay Municipal Utility District (EBMUD), and others have provided internships to students and jobs to graduates of the Biotech Partners program.


Intern explaining research at Bayer Healthcare. Source: Biotech Partners

Associate of Science degree. The Microscopy Program provides students with extensive hands-on training with cutting-edge microscopes, preparing them for internships and jobs in a wide range of life sciences firms. The fourth Peralta college, College of Alameda, offers all biology and mathematics courses required for an AS degree, but does not offer any specialized bioscience or biotechnology courses at this time.

Contra Costa College, in the City of San Pablo, offers technical certificates in biotechnology, bio-manufacturing and applied biotechnology. Their advisory board includes scientists and managers from Bio-Rad, Genentech, Novartis, UCSF and the CA Department of Health.

The program serves 10–15 students per cohort drawn from partner California Partnership Health and Engineering Academies at Richmond, Kennedy and Hercules High Schools. Hercules has a special partnership with Bio-Rad as well. Partner high school students are able to dual enroll, accelerating their movement through the pipeline and enabling them to gain access to internships with industry partners. Due to budget cuts, their job center staff was recently cut. The program maintains relationships with regional staffing agencies, like Kelly Scientific, who fill this gap.

Contra Costa College also hosts Middle College, a small charter high school for students who demonstrate strong academic potential. Their curriculum is not focused on technology careers, but students can dual enroll in biotech courses at the college, pursue internships and participate in college life activities, providing exposure and support for continued education.

The Center for Science Excellence (CSE), also at Contra Costa College, is not a part of the CA Biotech initiative and they do not partner with high schools. Funded by the National Science Foundation, the Department of Energy and the University of California- Math, Engineering Science Achievement Program (UCOP-MESA), their objective is to provide financial and academic support to disadvantaged STEM majors for non-remediated transfer to four-year universities. They provide academic support and summer internship opportunities at UC facilities, national labs across the country, private sector firms and the US Department

2010 Graduates of the Biotech Academies Program.
Source: Biotech Partners

of Agriculture. They routinely place students in nationally competitive internships.

Since Fall 2010, over 800 students have participated in CSE with over 90 percent transferring to four-year universities.[11] Since they are so focused on continued educational attainment, they do not track job-related outcomes.

There are also some notable initiatives that fall outside of the systems already mentioned. The Introduction to College Level Experimental Microbiology (iCLEM) is an intensive biotech-centered program targeting disadvantaged high school juniors and seniors, as well as teachers from Oakland, Berkeley and El Cerrito. The program is operated by SynBERC (Synthetic Biology Engineering Research Center) and is a partnership between UC Berkeley, QB3 and the National Science Foundation. Their goals are to increase college attendance and the pursuit of science and engineering careers.

The program hosts eight-week summer biotech internships at the JBEI facility in Emeryville, focused on biofuels. They have served 26 students over the past four years, nearly all of whom graduated in four years and gone on to attend UC institutions or community colleges. They have also served 8 teachers who have gone on to teach 180 students per academic year. The program pays student stipends, funds their transportation, feeds them and provides health insurance. Because it is so resource intensive, the program serves only a handful of students each year, but the Joint Genomic Institute (JGI) is interested in expanding the program.

California State University East Bay (CSUEB) has recently unveiled an ambitious cradle to career education and workforce partnership modeled off of the Strive program in Cincinnati, Ohio and Northern Kentucky. Strive has been successful at increasing kindergarten readiness, 4th grade reading and 8th grade reading outcomes through linking targeted academic and social services and the use of an extensive data collection.[12] The CSUEB program is one of four national demonstration sites now in their second year of development. The program identifies key literacy and numeracy benchmarks along the educational roadmap and builds on existing networks and programs across K-12 and community college school districts, corporate partners, community based organizations and four-year universities to support student success from early childhood education through completion of post-secondary education.

As outlined above, the state, local school districts, community college districts and universities are striving to meet the workforce needs of the emerging biotech and advanced biofuels sector. It is important to note the increasing importance of industry-based funding to leverage increasingly limited public sector dollars. Many of the programs listed above work closely with industry to provide the resources necessary to run these programs.

Analysis and Recommendations

There are strong bioscience training programs in Alameda and Contra Costa counties, but regionally there is a need to address gaps across programs and gaps between programs and the workplace. There is a general need for coordination and leadership. What role can cities play in supporting programs that serve their residents and local institutions? What roles can they have with local firms?

Particularly troubling gaps lie in tracking educational outcomes, internships and job placements. These are challenging requirements, but they are the ultimate measures of effectiveness. Educational leaders interviewed for this report relayed anecdotal success stories, but an effort of this scale and regional importance should be documented more comprehensively and if required, it could be accomplished. For example, after September 11, 2001, massive layoffs in the airline industry prompted a massive Workforce Investment Board funded program to retrain workers for the emerging biosciences. Ohlone College operated a very successful program with high job placement rates. Unfortunately, funding ran out and the program ended.

Recommendation: Fund a regional initiative to track educational and workforce outcomes across programs in the region. Include regional stakeholders such as the East Bay Green Corridor, the East Bay Economic Development Alliance, the Bay Area Workforce Funding Collaborative, Workforce Investment Boards and representatives from the private sector.

Bridging classrooms to careers is at the heart of these initiatives. Aside from gaps in tracking, there are gaps in information that weaken these career pipelines. Funding

11 Contra Costa College 2011.

12 STRIVE Partnership 2011.

Introduction to College Level Experimental Microbiology (iCLEM) Program

iCLEM is a biofuels-focused program targeting disadvantaged high school juniors, seniors and teachers from Oakland, Berkeley, and El Cerrito. The highly selective summer program hosts six students and two teachers for eight weeks of bioenergy research in a microbiology laboratory. The program pays students stipends, provides food and subsidizes transit, health insurance and intensive training.

To be eligible for the program, students must attend a high school in Alameda, Contra Costa or San Francisco Counties. In addition, their family's household income must be no more than $60,000. Over the four year history of the program, 85% of students are underrepresented minorities, 77% are the first generation in their family to go to college, and for 65% of students, English is not spoken at home or is not their primary home language.

The program is a multi-institutional partnership between UC Berkeley, QB3 and the National Science Foundation, and is operated by the Synthetic Biology Engineering Research Center (SynBERC) at the Joint Bioenergy Institute (JBEI) in Emeryville. The Joint Genomic Institute (JGI) is interested in replicating the model and when the LBNL Second Campus is operational, they will look into scaling up the program.

iCLEM interns work with Post-docs at JBEI. Source: Roy Kaltschmidt, Berkeley Lab Public Affairs

Institutional partners:
UC Berkeley, QB3, the National Science Foundation, SynBERC (Synthetic Biology Engineering Research Center), the Joint Bioenergy Institute (JBEI)

for employment services has been cut and remains under threat. Workforce Investment Boards and One Stop centers target a different demographic, for the most part. Many programs have relationships with the private sector through advisory boards and information flows on an ad-hoc basis. There are few formal resources that link workers and employers; rather it tends to fall on already burdened administrative and teaching staff. Private staffing agencies are filling this gap in some cases, but without data it is impossible to understand how effective they are in this role and which populations they serve. There is room here for public sector actors to play a more significant role in filling this gap. In North Carolina, a public-private partnership between local firms and the community colleges implemented a program in which industry partners who hire graduates agree to pay 8 cents per $100 of property value to a training fund.[13] A model like this could be modified to fund job placement services, programs and staffing.

Recommendation: Fund employment support services including staffing, a managed online internship and job clearinghouse and other online social media based services, coordination of job fairs, and provision of basic employment support services.

There is also a lack of overarching coordination among programs and between programs and employers. Since each program has its own mandate, they tend to operate in silos. As the biotech industry matures, it will be important to understand how and if these programs are meeting industry needs from a more comprehensive level to maximize efficiency of resources and effectiveness of programming. For example, the East Bay is in the national spotlight on account of LBNL's contribution to the advancement of biofuels research. This report focuses on LBNL's place in this effort but it is not alone. In Southern Alameda, the planned Livermore Valley Open Campus (LVOC) proposes a new 110-acre research park adjacent to the Sandia and Livermore Laboratory facilities to increase public-private partnerships in the fields related to energy security. This facility adds an additional anchor institution to the East Bay. It is unclear how the two national labs' work will overlap or complement each other. Alone and in tandem they will increase demand for technically skilled workers, making clear coordination and tracking along regional workforce development pipelines all the more essential.

Recommendation: Continue to support and encourage school to career training partnerships with strong industry involvement in order to keep pace with rapidly changing industry needs. Continue to engage local firms – both new and more well-established firms - in advanced biosciences curriculum development and provision of internship opportunities.

Finally, leadership is a key missing ingredient. With so many institutions in the region working towards similar goals without strong cohesion or coordination, inefficiencies thrive. With limited, even diminishing resources, there is an incentive to rationalize efforts and maximize the efficiency of this rich network of programs. This will require a strong vision, strategic planning and coordination that do not exist within any existing programs or within

13 Lowe 2007.

the private sector. Regional bodies already exist to support this work, such as the East Bay Green Corridor, the East Bay Economic Development Alliance, the Bay Area Workforce Funding Collaborative, etc. The bioscience sector is thriving throughout the Bay Area, in the South Bay, San Francisco and in multiple sites across the East Bay, and in these areas stronger leadership and coordination played a role in local success. Mission Bay in San Francisco, Emeryville and Stanford are prime examples. For the East Bay to capitalize on its competitive advantages and maximize the benefits of this growing sector, stronger leadership will be essential.

Recommendation: Regional coordination and leadership from workforce development agencies is needed to connect cities, firms, and bioscience training programs; these agencies need to take a proactive role as "regional labor market developers" by directly supporting new or growing bioscience firms seeking to hire locally.[14]

14 Ibid.

CHAPTER FIVE

Regional Leadership and Strategies

Introduction

The competition among cities for the LBNL Second Campus is well documented, and much attention and resources have been devoted to creating a localized campus of bioscience research, adjacent spinoffs and supplemental retail. However, when a site is finally selected by LBNL, the remaining five municipalities should not feel like they somehow lost their only chance to reap the benefits of a once-in-a-lifetime expansion. If the desired outcome is to leverage the expansion and consolidation of bioscience research into tangible regional economic development, the real winner is the entire East Bay sub-region.

A new bioscience cluster will not be realized in the same form of a typically centralized 20th century industrial park. Particular to the East Bay, such a bioscience research cluster has the potential to be dynamic, local, and integrated within the established urban fabric of the region. After all, frameworks and components of a bioscience ecosystem in the East Bay already exist. This is a great opportunity for the region, and best of all, every stakeholder throughout the region stands to benefit even before LBNL makes their decision. The Second Campus may be a sign of continuing growth in the general bioscience sector, but in order to capture this growth in the East Bay, there must be strong regional leadership exhibited along specific points of intervention.

We identified five major needs in the region – five responsibilities a regional entity could assume to encourage cluster development. These were informed by our case study research into existing research parks, analysis of the industry, and conversations with existing entities in the East Bay. These responsibilities at the regional level are:

1. Leading the way: the region needs a leader to help build a vision and orchestrate others to help realize it.

2. Building the supply chain: a robust supply of regional workers, goods, and services can support new businesses and benefit from their growth.

3. Cultivating networks: helping convene different actors in the region can facilitate commercialization.

4. Making the rules clear: bioscience R&D and business is extraordinarily complicated, and help navigating the many local, regional, and state regulations can help businesses decide where to locate.

5. Branding and advertising: the world should know that the East Bay is growing an innovation cluster.

Regional Leadership Entities

Several entities and organizations are already playing key leadership roles in the region, some by virtue of their position, others as a result of purposeful collaboration. LBNL is a world-renowned institution whose prodigious amount of scientific breakthroughs make it a natural and formidable anchor for a bioscience cluster. Its expansion to a Second Campus has spurred discussions about enhancing its regional role and formalizing its business development program. LBNL, together with various East Bay cities, anticipated the need for a collaborative vehicle and formed the East Bay Green Corridor (EBGC). As a non-government entity, the EBGC's leadership role has been to foster collaborative relationships with regional institutions and coordinate efforts across the disparate legislative contexts of the various cities.

Other regional clusters are also working to develop their brand and coordinate business development to maximize potential. These models offer instructive techniques and leadership templates for the East Bay. In Massachusetts, for example, the biosciences and biomedicine industry has formed the oldest biotechnology trade association in the form of the Massachusetts Biotechnology Council, dubbed MassBio. As a nonprofit, it boasts high revenues ($4.4M in 2009) and has a staff of over 25 individuals that includes fundraisers, communications staff, and in-house counsel, all working toward the objective of advocating on behalf of and providing services to its 600 member groups. Additionally, MassBio has an educational foundation that works with colleges and high schools throughout the state to support science and biotechnology education through school programs and workforce development training.

MassBio performs all the functions identified, and it is an extreme example of a specialized, highly focused, and well-resourced regional entity. Nonetheless, it should show that regional leadership is not a trivial matter. Regardless of how leadership roles develop and which structures evolve, there are multiple strategies where a regional-level intervention would be most productive for the East Bay's growth into a hotbed of bioscience research and business.

Strategy 1: Leading the Way

The region needs a leader who can push a multi-stakeholder vision.

The East Bay actors can rally behind a strong vision—and a strong leader who helps create and push it. Paradoxically, this leader must be able to make decisions independently but also have the full input, participation, and confidence of regional stakeholders.

First, this requires a vision for the region that includes the interests and perspectives of all stakeholders. A regional entity is needed to initiate this process, bring everyone to the table, and facilitate a conversation in which all stakeholders at the table voice their perspective and hear that of others. This process culminates in a vision that captures both the imagination and interests of the region and the individual goals of the stakeholders, and lays out a roadmap for realizing that vision.

Second, a leader must ensure this vision lives on and that regional actors follow the roadmap. Cluster development is a mixture of many dynamic processes—scientific research, market development, policy incentives, etc.—and the key to success is having the widest range of tools possible: access to capital, real-estate and land use controls, lobbying power, local policies, public outreach, and more. Using these tools effectively requires coordination which will not happen spontaneously, and especially during uncertain economic times, a leadership entity that can cut across disciplines and interests while advocating a centralized and consistent vision for the region's growth will keep the cluster stable and strong.

For example, BioCrossroads helps guide the Purdue Research Park by listening to all stakeholders, identifying development needs, filling gaps where necessary, and constantly revisiting progress. As indicated, their board includes VCs, academic researchers, and foundations and business leaders who collectively know the science, the market, the spinoff process, and the effects of policy. This helped them identify crucial gaps for the research park: state regulations and incentives, lack of seed funding, and educational programs. They lobbied at the state level, formed several seed funds, and helped start some local educational and training programs. They periodically organize industry conferences that help them identify emerging needs. This also helps build confidence: even though there are many venture capitalists who aren't affiliated with BioCrossroads, they can trust the expertise of BioCrossroads.

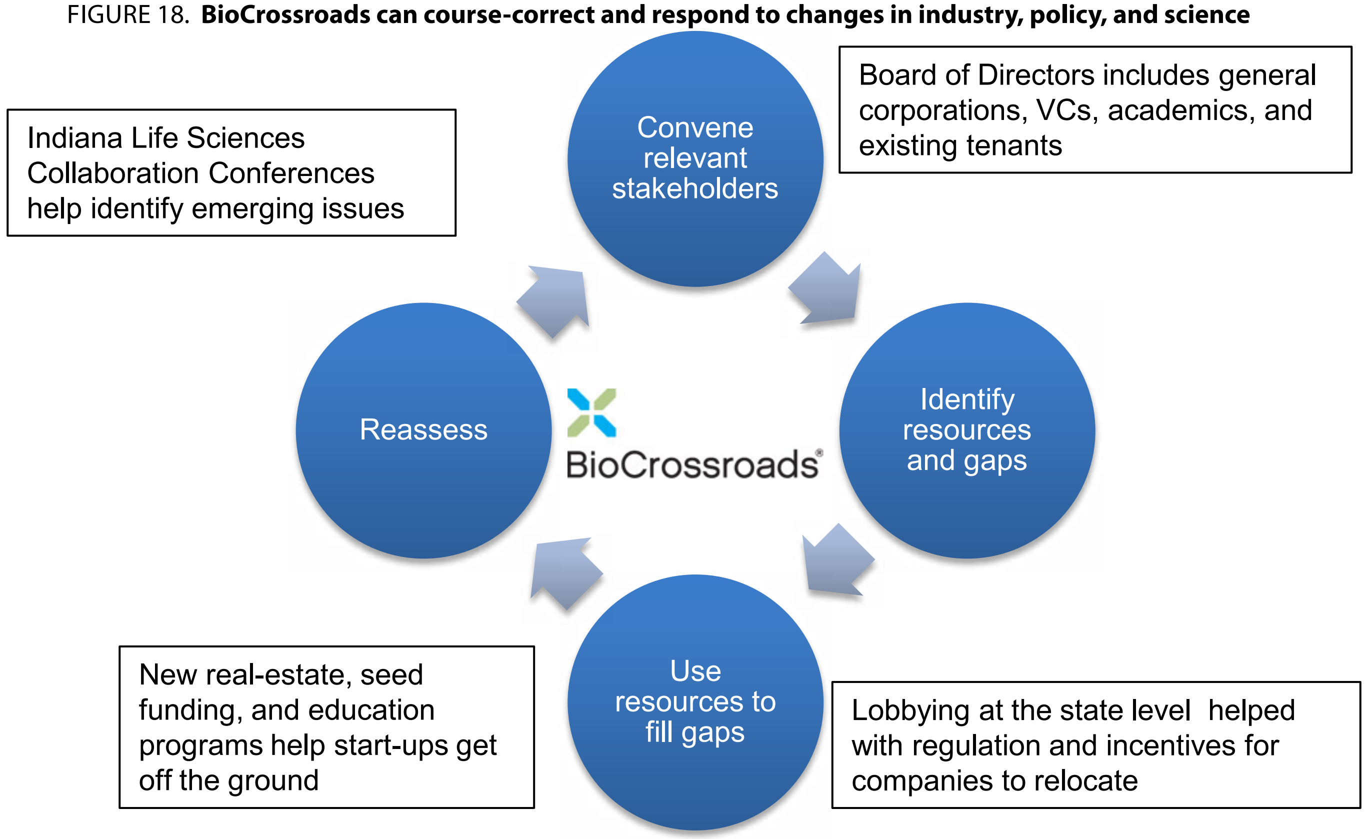
This role involves long-term commitment, political tact, and resources. A regional entity that assumes this leadership role can do the following:

• Facilitate a visioning process that helps clarify the regions priorities and available resources, and puts forward a strategy for developing the cluster.

• Form a multi-stakeholder body that represents the varied interests within the region, the research process, and industry.

• Ensure the following perspectives are sought out: venture capital, scientific research, industry, local policy, real estate development, and the community.

FIGURE 18. **BioCrossroads can course-correct and respond to changes in industry, policy, and science**



Strategy 2: Building the Regional Supply Chain

The region needs to be mindful of the range of local people, goods, and services that bioscience firms can work with, and develop a system for certifying and sharing that information.

Regional leaders should not overlook the importance of the supply chain. Chapter 4 explored the region's workforce, and a regional entity should support these crucial pipelines that can support local residents and biotech businesses. Many businesses will follow talent, and having a quality workforce available and accessible will help growth.

In addition, local suppliers can support new businesses in biofuels and biotech. The purchasing data from LBNL, outlined in Chapter 2, is an invaluable resource in understanding the supply chain needs of R&D related to different sectors of bioscience. Although LBNL is not mandated to procure locally, it has expressed interest in building local relationships and it can help build a directory of trusted local suppliers. As the bioscience cluster emerges in the East Bay, there will be a growing need and opportunity to support both new and exisitng local suppliers.

First, local suppliers need to be identified and contacted. These suppliers would obviously include laboratory equipment distributors (such as pipette specialist Rainin Industries in Oakland) and waste disposal specialists. However, any growing firm will have a need for basic services. Firms that specialize in accounting, telecommunications, information technology, law, and human resources could all benefit from a growing bioscience company's business.

Additionally, these suppliers and firms need to be communicated to the market. A regional institution may want to objectively certify a firm for a specific purpose and communicate their selection to the region's bioscience firms. The free publicity that comes from a regional brand affiliation will induce more business and jobs to stay within the region. Local discounts or deals between suppliers could also incentivize local procurement.

For example, MassBio has established a "Purchasing Consortium" to handle diverse bioscience needs including office supplies, packaged cylinder gases, lab recycling, chemical waste removal, and biomedical waste removal. In selecting "primary suppliers," MassBio employs a "competitive process to select the company that will offer our members the best combination of price and service in each category."[1] These suppliers are then contracted by MassBio to be prominently featured on the MassBio web site, complete with direct account manager contacts and discounts exclusively for MassBio members.

FIGURE 19. **MassBio arranges deals with suppliers to serve various types and sizes of member companies**

Purchasing Consortium Case Study
(small organization)

Employees: 14 employees
Company Type: Drug Development
Items Purchased:
**Lab Supplies*
**Biomedical Waste Management*
**Travel*

Est. List Price:	*$ 573,275*
Consortium Spend:	*$ 416,087*
Est. Savings:	*$ 157,188*
+Year-End Rebate:	*$ 3,074*
- MassBio Annual Dues:	*$ 1,500*
Bottom Line Savings:	***$158,762***

Source: MassBio

The East Bay has a diverse range of complementary businesses that could replace business going elsewhere in Bay Area or out of the region. It will be particularly helpful to startup firms to know about these firms and know that they are trustworthy partners. Specifically, a regional entity will need to:

• Identify and contact local suppliers that can conduct bioscience work in all stages of research or business.

• Publicize and certify these local suppliers and services.

• Arrange incentives for local procurement in the form of discounted purchasing from certified suppliers.

Strategy 3: Cultivating Networks

Regional leaders need to proactively arrange networking opportunities that cut across disciplines.

The necessary expertise for a successful bioscience businesses is abundant in the East Bay. Developers like Wareham have proven their development expertise in a struggling economy. UC Berkeley has some of the most elite scholars of business, law, policy, and planning in the world. JBEI employs some of the nation's most brilliant pioneers in cutting-edge bioenergy research. Nevertheless, the path from a scientific breakthrough to commercialization is complicated by the different motivations behind markets and research. For a company to successfully commercialize a scientific discovery there must be communication and partnership among the essential, yet distinct, bodies of knowledge.

1 http://www.massbio.org

Stanford Research Park: Case Study

The research park at Stanford University is the oldest university-affiliated research park in the world and remains one of the most successful. It had a crucial role in supporting the emergence of Silicon Valley as the world's leading region for technological innovation. By facilitating collaboration with students and faculty and offering access to the University's resources, Stanford remains very attractive to growing and established research, science, and technology firms.

Origins

In 1951, Stanford was struggling with a limited budget and a powerful innovation drain. As students left the University for other areas, the West lost the benefit of new businesses and remained dependent on East Coast businesses for equipment and technologies. Inspired by the need for income, the vision of a dynamic innovation economy, and a certain amount of regional boosterism, Dean of Engineering Frederick Terman proposed that the University establish an industrial park on some of its land. The University established the Stanford Research Park (SRP) in 1951 with the goals of encouraging University-industry collaboration, raising funds for the University in rent, and increasing faculty pay through consulting opportunities.

The Research Park Today

Today the park is operated by the Stanford Management Company. SRP has been influenced by three developments that have affected research parks across the country: an increasing focus on research and development and decreased manufacturing; the arrival of intermediate services such as law, financial service, accounting; and a shift towards mixed-use development.

Tenants are primarily science, technology, and research firms. There are limited manufacturing facilities, abundant intermediate services, and amenities. Stanford's research park is much larger than typical American parks in acreage, square footage, and total employment.

University-Industry Collaboration

Many research parks offer technical assistance including linking to or providing capital, business planning, marketing and sales strategizing, and providing technological or market analysis. Stanford takes a different approach, providing services that focus on fostering collaboration and knowledge-sharing. These services fall into three categories:

1. University-industry relationships: Stanford supports a variety of initiatives to foster relationships and knowledge sharing among the University community and tenants. These include allowing tenants to sponsor research projects and conduct seminars and workshops, connecting students with internship opportunities at tenant firms, and facilitating faculty participation on corporate boards and as consultants.

2. Shared resources: Stanford provides tenants with access to their Office of Technical Licensing and the University's library system.

3. Programs: Stanford offers programs for tenant employee professional development through the Stanford Center for Professional Development and facilitates faculty consultation for tenant firms through its Affiliates Program.

Technology Transfer

Stanford takes a proactive approach to technology transfer through its Office of Technical Licensing (OTL). OTL operates by soliciting invention disclosures from faculty, hundred of which are submitted each year. The Bayh-Dole Act entitles researchers and institutions to profit from inventions based on federally funded research, which has created an incentive for faculty disclosures and allowed Stanford to substantially increase its research budget. The Office's large staff of licensing associates evaluates the licensing potential of each disclosed invention, speaking with inventors and industry experts. Associates then work with inventors to develop and pursue an appropriate licensing strategy. OTL files patents for approximately half of all submissions and works with researchers and licensees to support commercialization.

OTL has found more success with life science licensing because of a longer lifecycle, and less with physical sciences such as electronics and communication because of the rapid pace of developments and fierce competition, although some physical science licenses, such as technologies licensed to Google, have been extremely successful. The Office has also found that they do more licensing with small companies, as large companies often conduct in-house R&D.

Through OTL, Stanford has licensed 3,000 technologies, 850 of which are active, for a cumulative $1.33 billion in revenue, with a record annual earning of $65.5 million in FY09-10. The University has held an equity stake in 190 companies, about half of which has been sold for a total of $365.5 million.

Easy ways to cultivate networks could be regularly scheduling mixers, conferences, and forums among local stakeholders. Many such efforts already exist, even among entities like JBEI, Wareham, and EBGC, but these networks themselves can be further integrated and fine-tuned. Regional leaders must also ensure all stakeholders are aware of the networks for them to join. To ensure that collaborations become more embedded in the culture, a regional leader with involvement and credence in these various industries can emerge as the trusted organizer and sponsor of such networks.

BayBio, a life science association serving Northern California, is primarily committed to generating networking activities that pertain to entrepreneurship, science education, or careers. In identifying networking needs in these areas, BayBio will either coordinate events, or sponsor relevant events coordinated by other entities (and offer members discounts for registration). Entrepreneurship events focus on essential investor connections and tips for start-ups. Science education focuses on developing relations between the industry, K-12 schools, and community colleges to expand awareness of STEM education and opportunities, and events related to careers deal with continuing education for professional development. However, BayBio's membership is not all-inclusive of all potential stakeholders in the Bay Area, let alone the East Bay. JBEI and Amyris have held their own mixers related to similar needs.

To that end, a regional leader should:

• Arrange and sponsor relevant networking opportunities for all bioscience stakeholders, including governments, non-profits, developers, entrepreneurs, venture capitalists, and researchers.

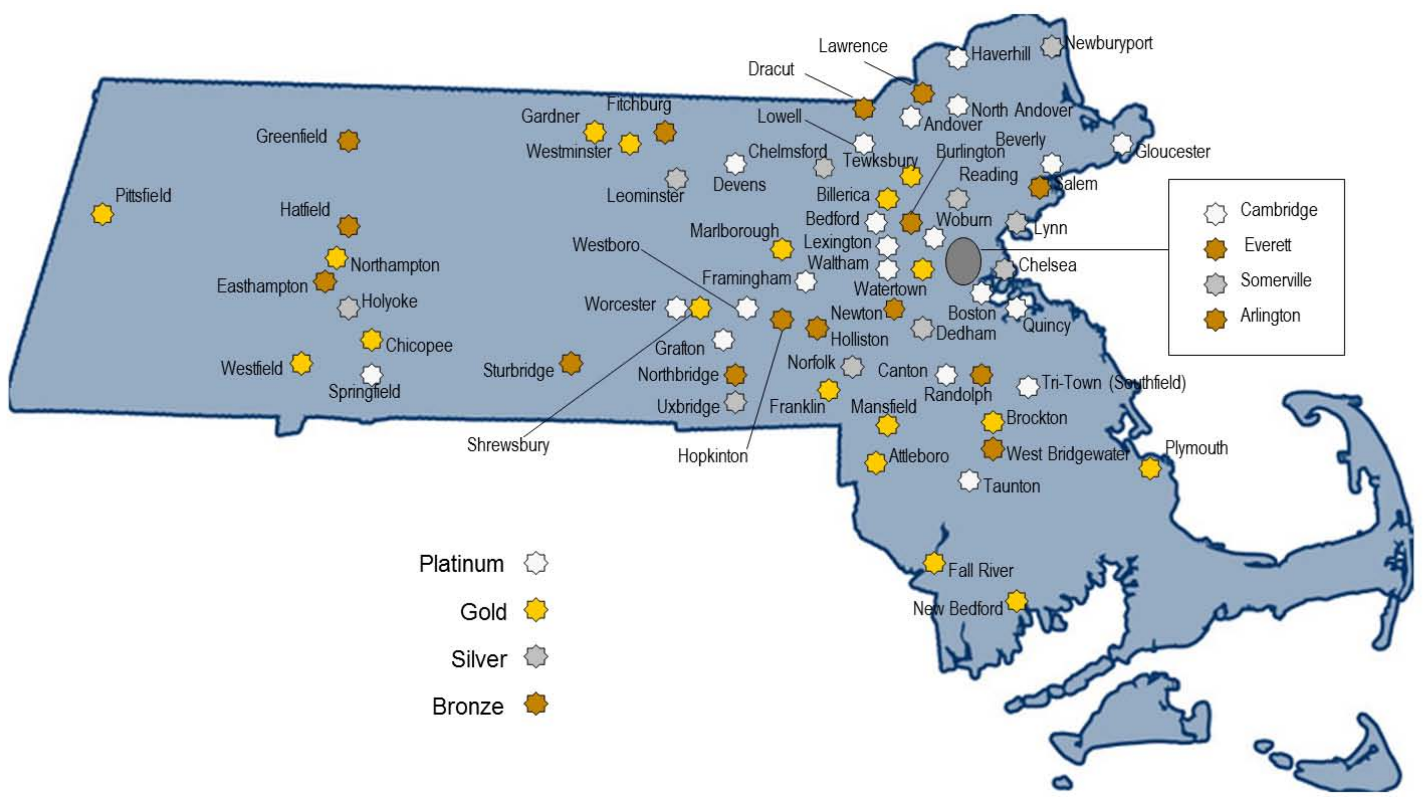
• Partner with existing entities and ensure all stakeholders are aware of such networks.

Strategy 4: Making the Rules Clear

The region should establish a platform in which all necessary regulations, permitting processes, and incentives are made clear.

A major gap in knowledge for a bioscience start-up is the multitude of government regulations on laboratory spaces, the nature of research, and the ends of production, among other aspects. A bioscience firm may not be particularly knowledgeable about where regulations change from one municipality to another, and they may simply prefer to do business where it is easiest to do so. The same gap may also exist for certain business incentives, which would obviously affect a company's decision-making process for locating. Therefore, a need exists for a regional leader to make such rules clear to new and incoming firms.

FIGURE 20. **Massachusetts municipalities ready for bioscience development**



Source: MassBio

Cities and developers also need to learn about what it takes to attract bioscience firms. A regional leader could be instrumental in identifying the facility requirements for lab space, the range of chemicals that are actually being used, and the extent to which small scale production may occur. If a certain zoning code has not been changed to reflect the specificities of bioscience work, misunderstandings could aire. This transparency can have transformative power—in seeing what neighboring municipalities are doing in this space, cities can learn from each other.

Additionally, a regional entity can establish a standard of a city's current conduciveness to bioscience. In addition to all the regulations a new business must navigate, they will also consider the availability of existing laboratory space, experienced developers, and wastewater treatment, for example. To simplify all these needs, a standardized rating system can clarify how relatively easy it will be for a bioscience firm to work in a certain city.

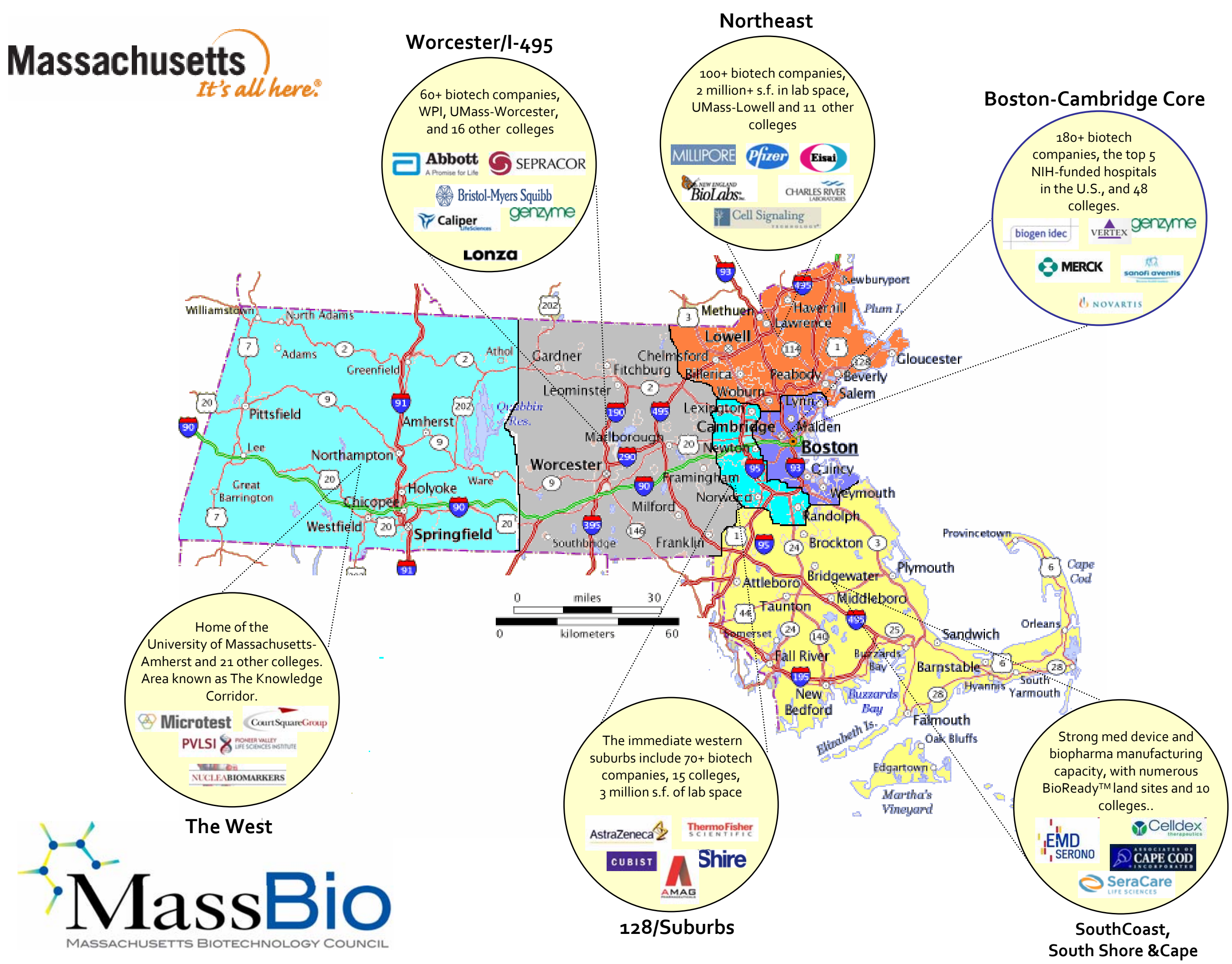
With this purpose in mind, MassBio created a publicly accessible forum that not only profiles the numerous benefits and incentives in each region, but also rates each town's "readiness" for biotechnology on a scale ranging from Bronze to Platinum (Figure 20). This scale encourages simplification of the various regulations, incentives, and conditions for biotech companies to set up shop.

To help make the rules clear to all stakeholders, an East Bay regional entity can:

• Publish information about what it takes to build bioscience space and do biotech R&D and business throughout the East Bay.

• Assess communities and identify areas of opportunity and areas of potential reform.

FIGURE 21. **MassBio's biotech brand has a compelling history, evidence of success, and a regional guide.**



Source: MassBio

Strategy 5: Branding and Advertising

The region needs a brand and advertising vehicle to communicate the strengths of the East Bay as a bioscience innovation region.

Prominent branding of the East Bay as the home of tomorrow's bioscience discoveries and business is crucial. Collaborative marketing and promotion efforts would bring all leadership interventions and concepts full circle. Well coordinated, timely, and relevant campaigns would serve to elevate the East Bay as robust business ecosystem, one that is available and welcoming to businesses seeking to expand, relocate or co-locate within or to the region. After all, the East Bay has a decided advantage as a region with many viable selling points.

Already, the East Bay is a vibrant biotechnology hub. It is anchored by world-class research institutions and entities like LBNL and other several leading universities. Savvy businesses and industry leaders across sectors have chosen to make the East Bay region their headquarters. Additionally, the East Bay sub-region lies in close proximity and has strong ties to other nearby technology and science clusters, including Silicon Valley and San Francisco, elevating the entire San Francisco Bay Area to the status of a bona fide super-cluster.

The East Bay has a high quality of life and an intellectual culture. Several universities and colleges produce leading professionals that strengthen the workforce for innovation clusters. This intellectual character and urbane quality is also embodied in the many dynamic offerings of the various cities that include diverse retail, a premier dining scene, and celebrated built and natural attractions. All this, and yet the East Bay is more affordable than other clusters including San Francisco, Los Angeles, New York City, or Boston. These businesses, the cities that host them, and the individuals and residents of the East Bay are ready for the economic activity generated by an increased presence of bioscience firms.

This is another role MassBio has performed well. Though focused on Boston and its leading academic institutions, MassBio markets the entire state of Massachusetts as a "supercluster" including over 600 firms and services as members. In addition to certifying and ranking how "bioready" the various cities might be, MassBio tracks the history of successful incubation and discoveries within the state, provides valuable data on the industry's growth, and offers guides and resources regarding local regulations on the organization's web site. Like Massachusetts, the East Bay is the sum of many municipalities, each with different strengths for different stages of a company's life cycle.

The role of marketing and branding requires expert communications capacity, an in-depth understanding of the institutional and scientific landscape, and the ability to marshal resources dedicated for this purpose. Specifically, the entity that assumes this role will need to:

• Develop and manage a multi-faceted, far-reaching, and effective marketing and branding campaign that utilizes a variety of forums and technological vehicles and that disseminates the idea of a vibrant East Bay biotechnology cluster.

• Facilitate relationships and networks within and outside the cluster to foster opportunities for growth.

• Gather key facts, statistics, and other pertinent business data to assist in the attraction and retention of biotechnology businesses and complimentary ventures.

The five regional needs listed above are most potent altogether, but each one is powerful on its own. Different regional entities can play different roles, depending on resources and particular literacies. Each is a commitment. Above all, a regional actor should keep in mind three things.

First, the East Bay can start today. The ingredients are already here. Wareham has built biotech and wet lab space for years. Amyris is growing up and has built a pilot plant. JBEI and LBNL are already churning out scientific breakthroughs. Many cities in the East Bay would already be certified Gold or Platinum in MassBio's "bioreadiness" ranking system. The Second Campus will help consolidate research, but cluster development doesn't need to wait.

Second, the East Bay is on the frontier of biotech economic development. The playbook for an innovation cluster anchored around biofuels and industrial biotechnology hasn't been written in the way it has for medical and pharmaceutical biotech. These two worlds require different things, have different perceptions, and are subject to different regulations. The East Bay has an opportunity to figure out how they differ, conflict, and integrate, and this knowledge will be very valuable in the coming 10-20 years as industrial biotech further matures around the world.

Finally, above all, a bold vision and clear leadership are needed for maximum impact. Sustainable economic development does not happen overnight. It requires the involvement of many stakeholders and great minds to build, catalyze, and support the new bioscience economy. Such a vision will be the crucial piece of the puzzle that can successfully coordinate this wealth of expertise and experience into something truly beneficial for the regional economy. The above strategies will add speed and momentum, but a unifying vision will be the wings that lift the East Bay off the runway.

Conclusion

Throughout our research into LBNL, the bioscience industry and the economic impacts of clustering, it became increasingly apparent to our team that the Second Campus will be one component of an ecosystem that will drive economic development . Complementary and co-locating firms will play an equal and possibly greater role than the Lab in creating jobs and revenue for the East Bay.

Without a doubt, the opportunity presented by the expansion of a world-renowned research laboratory by as much as two million sq. ft. is a once-in-a-lifetime event for any of these six cities. However, our analysis suggests that LBNL's current economic impacts on the East Bay are more incidental than intentional. Although LBNL has delayed its decision regarding the Second Campus location November 2011 to early 2012, the East Bay should not wait to prepare for economic growth. All stakeholders in the area, including city officials, institutional leaders, developers, researchers, and venture capitalists will have to take an active and intentional role in making the East Bay the next great bioscience cluster.

The challenges are noteworthy. Although the region prides itself on being a hotbed of advanced research, there are still deficiencies in the educational pipelines that are training the next generation of the East Bay workforce. While institutional efforts have been made to increase science education outreach in the community, there is a lack of shared information about their outcomes and best practices. Additionally, while institutions and businesses have voiced an interest in utilizing more regional suppliers and services for their operations, these efforts are hampered by a lack of information. Finally, many cities and developers are still working to fully understand the building uses and laboratory spaces required by bioscience firms for R&D, headquarters and scaled up production. While these challenges are significant, they can be overcome with strategic planning and regional collaboration.

In addition to sharing knowledge about the bioscience sector from an economic standpoint, we have identified strategies specifically tailored to East Bay cities and regional leaders that can begin to address these obstacles and capture economic development potential. It is our sincere hope that these strategies are acted upon and tracked throughout their implementation while the East Bay bioscience cluster grows. If all stakeholders can work together to form a strong regional vision and build momentum, the East Bay can race to the top.

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