“States across the nation are increasingly seeking to leverage the science and technology assets found at their research universities as a source of competitive advantage.”

–Battelle Memorial Institute

The global economic crisis that began in 2008 had a particularly harsh impact on cities of the southwestern United States. Over the previous few decades Phoenix had experienced the fastest growth of any major American city. This demographic dynamic was linked to an unprecedented housing and construction boom that made many individuals and companies wealthy. Like the gold rushes of the 19th Century, this get-rich-quick success dampened potential interest in alternative models that would require longer-term investment, like the creation of strong public institutions and more knowledge-based jobs.

At the same time that Sunbelt cities like Phoenix were embracing automobile-based hyper-growth, cities in other parts of the U.S., especially the Northwest, were acknowledging and adapting to a world of more limited resources. In the process, they were finding new economic opportunities and improving their residents’ quality of life. In the minds of environmental activists and urban planners, a dichotomy was drawn between the slower-growth, denser, less car-centric urban forms typified by Portland and Vancouver, B.C. and the no-holds-barred growth and sprawl of Phoenix and Las Vegas. By the mid-2000s, Phoenix became a poster child for how not to achieve the increasingly popular civic goals of “urban sustainability” and “livability.”

And yet, as is often the case, the reality of a place is more complex than its stereotypes. The metro Phoenix region took several steps as early as the 1980s that facilitated the launching of an ambitious yet pragmatic green agenda nearly 20 years later. The governance aspects of this unusual economic development story have been described by others. This chapter focuses on a series of knowledge-based initiatives, several of which were led by universities, which brought together academic, business, and government interests in innovative ways tried by few other parts of the country. While the ongoing economic crisis and political changes have slowed some
of those programs, new ones continue to emerge. Indeed the region’s little-heralded and still incipient sustainable technologies emphasis is one of the few factors contributing to its resilience, somewhat blunting the impact of the current downturn².

It is too early to know how the “Green Phoenix” story will play out. Phoenix faces a number of sustainability issues including water scarcity, air pollution, the urban heat island effect and influxes of immigrants fleeing economic, political and environmental distress. In this, as well as its libertarian politics, Phoenix may be more representative of conditions faced by most of the world’s cities as they deal with the challenges of a changing climate, resource depletion, and population growth, than those of wetter, cooler, wealthier, more homogeneous and more progressive cities of the Northwest U.S. and southwest Canada. However, in order for society to successfully address these growing global threats, all major cities will need to determine how to balance their environmental, economic and social priorities.

A recent history of Phoenix

The growth of metro Phoenix took off in the 1950s, as World War II veterans that had been trained in the area returned, and as air conditioning made summers more tolerable. Industrialization of production home-building expanded in the 1950s and 60s, making home-ownership more affordable, especially in and around Phoenix, which had an abundance of relatively cheap, undeveloped land. That, coupled with the mild winter climate laid the groundwork for future rapid population growth. The economy transitioned from agricultural to service oriented during this period, with suburbs spreading into previous farmland to the south, east and west and into pristine desert to the north. Indian reservations partly blocked the sprawl
to the east and south, and large municipal parks enclosed most of the mountain ranges that
punctuated the urban landscape

The post-war economy of Phoenix featured many electronics firms. Motorola had started
a research laboratory in the city in the 1940s and opened electronic manufacturing facilities in
the 1950s. By the 1980s, Motorola, Intel, and some of their suppliers formed the core of a
semiconductor manufacturing cluster. Allied Signal, Raytheon, and Goodyear were among the
many early defense contractors in central Arizona. Later these firms were joined by others
including, Boeing, which made Apache helicopters in Mesa; General Dynamics, which
purchased some of Motorola’s defense-oriented divisions in Scottsdale; and Gilbert-based
Spectrum Astro, which built and launched satellites. Most of the major automobile makers had
hot-weather test tracks in and around metro Phoenix, although they maintained little other
presence. Several healthcare providers including Banner Health and Catholic Healthcare West
became major employers in the region. A few other corporations and banks were based in
Phoenix, including Dial, Greyhound, UHaul, Pinnacle West, and Arizona Bank. However by the
end of the 20th Century, only a few large companies and no large banks were still headquartered
in Phoenix. These were replaced by local entrants Avnet, America West Airlines, PetSmart and
Insight Enterprises, but none of these were directly involved in technological innovation. The
most dramatic and disconcerting loss was that of Motorola, long the region’s dominant high-tech
company, due in large part to the off-shoring of manufacturing jobs to Asia, and because of
increased product design competition from Asia and Scandinavia.

One explanation for the corporate flight from Arizona is that the lack of critical mass of
locally-based companies made other sites appear more attractive from a synergistic standpoint.
Another is that the low level of government investment in social services, especially schools,
made it difficult to recruit mid-level executives with young families. Whatever the cause, the result was that the corporate philanthropy and civic leadership that had previously existed and that was common in older, comparably-sized cities was mostly absent by the end of the 1990s.

The growth of the metro area was originally polycentric, with Phoenix, Mesa, Scottsdale, Tempe, Glendale, Chandler and others merging geographically but remaining independent in their pursuit of resources, jobs and prestige. Because the state legislature had essentially forced the cities to rely on local sales tax for their public revenue, competition for shopping malls, big-box stores, automobile dealerships, and supermarkets became intense. This led to economic inefficiencies and a monotonous aspect to the built environment. It also overshadowed the pursuit of high tech companies that offered higher-paying jobs with benefits.

The politics of Arizona, and Phoenix in particular, followed national trends, becoming increasingly polarized during the two Bush and Clinton presidencies. Most significantly from an economic development perspective, a cooperative culture of pragmatic leaders of both parties that had prioritized the metro Phoenix region’s well-being in the 1970s gave way to a more rigid politics. Anti-government ideologues came to dominate the Arizona Legislature, blocking measures and investments intended to promote the growth of newer high-tech industries. A series of scandals in the 1980s and 90s brought down many members of the Legislature and two Republican governors, and served to further lower the public’s opinion of its political leaders and tarnish Arizona’s national reputation.

An exception to this trend was Arizona’s intentional and successful establishment of economic clusters, beginning in the 1980s with the creation of the Arizona Strategic Partnership for Economic Development (ASPED), later reconstituted as the Governor’s Strategic Partnership for Economic Development (GSPED). These non-partisan advisory committees, consisting of
industry, government and academic representatives, worked to facilitate economic development around specific industrial groupings as well as strengthen the state’s fundamentals for economic growth such as public education, capital formation and transportation infrastructure. Two governors in particular actively promoted this approach, Jane Hull (1997-2003) and Janet Napolitano (2003-2009). Hull, formerly a long-time Republican legislator, created the Arizona Partnership for the New Economy (APNE) in 1999. APNE went beyond ASPED and GSPED to consider not only the emergence of new high-tech industries, but also how those technologies could infiltrate and transform the ways society works. Napolitano, a Democrat and former Arizona Attorney General created the Governor’s Council on Innovation and Technology (GCIT), in which she played a very active leadership role. Hull and Napolitano both supported legislation that would help enact the recommendations of these task forces, the goals of which included a better-educated workforce, the ready availability of venture capital, better coordination of state-based research and development, the strengthening of industry alliances, adoption of technological advances by government, and a greater emphasis on an improved quality of life⁵.

One of the outgrowths of the APNE process was the commissioning of Battelle Memorial Institute to prepare a series of three technology-oriented, long-range economic development roadmaps for Arizona⁶. The plans were funded by the Arizona Department of Commerce, the Arizona Board of Regents, and the private biomedically-focused Flinn Foundation. All of these plans⁷ analyzed the competitive strengths of the three state universities and identified priority areas for cultivation and investment. In the non-biotechnology arenas, the top areas with the greatest potential, based on numbers of faculty, grants, and publications, were (1) advanced communications and information technology, and (2) the broad domain of “sustainable
technologies.” Battelle laid out a detailed timeline for forming a “new economy” in Arizona. In broad terms, they proposed that with sufficient public and private sector investment, three synergistic technology platforms could come online sequentially over the following 15 years: advanced communications and I.T. within 5 years, biomedicine and biotechnology in 5-10 years, and sustainable technologies in 10-15 years.

A common theme of Battelle’s recommendations, both in their Arizona analysis and in studies they did in other parts of the country, was that the expertise distributed across the state or region should be pooled for competitive advantage. Thus, for instance, they identified nearly 500 faculty members at University of Arizona (UA), Arizona State University (ASU) and Northern Arizona University (NAU) working in the broad area of sustainability and proposed a series of strategies and administrative structures that would take advantage of those collective intellectual assets. As will be described below, this idealized approach was commonly thwarted by inter-institutional and intrastate rivalries.

The role of universities in Arizona’s clean tech development

Historically, the identification of a city or region with new technology platforms is commonly led by universities. Silicon Valley and Route 128 in Boston are two of the best known examples. In those cases, much of the inspiration came from private universities (Stanford; MIT and Harvard; respectively). Administrators and faculty at public universities have added motivation to try to impact their economies because of the possibility of better justifying their research functions and budgets to legislators and business leaders.

Although today’s focus on green technology in Arizona is centered in Phoenix, much of the state’s knowledge-based industrial experience began 100 miles to the south in Tucson, home
of the University of Arizona. UA is the state’s land-grant university, with the only public medical and agricultural schools. For more than half a century, as the state’s two other public universities—ASU in metro Phoenix and NAU in Flagstaff—focused largely on teaching, UA was where companies and government looked for technologically-relevant ideas and talent. In the 1960s, UA became recognized as an international research leader in two key sectors that would eventually relate to sustainability: optics and hydrology.

Now the College of Optical Sciences, UA’s optics program emerged from the presence of world-class telescopes taking advantage of the clear skies on the mountains surrounding Tucson. It gave rise to many start-up companies and the growth of a southern Arizona-based cluster, under the moniker of “Optics Valley.” These skills contributed significantly to the development of telecommunications, computing, and aerospace expertise in the state. They also helped UA space scientists win large grants and contracts from NASA for planetary exploration and astronomical research. Today, UA’s lens-making talents are also being applied to concentrating solar energy cells.

UA’s hydrologic sciences proficiency is another outgrowth of place-based priorities. With a school of agriculture in a desert environment, there was strong pressure to find ways to locate and conserve water resources. Expertise in hydrology combined with climate science to create the ability to forecast future water availability based on tree-ring data, remote sensing of snowpack, and computer models. UA’s hydrologists partnered with colleagues in other arid parts of the world, including the Middle East and Australia. UA also collaborated with the U.S. Geological Survey, which co-located an office on the UA campus, and the Arizona Department of Water Resources. A few of the water-related topics that received less attention at UA,
including urban hydrology, water quality and clean-up technologies, eventually became central to Arizona State University’s urban-oriented sustainability portfolio.

ASU and NAU had different areas of expertise related to sustainable technologies. As far back as the 1960s, ASU had engineers and architects working on solar energy technology from both theoretical and applied standpoints. In the early 1990s, ASU opened the first photovoltaic testing laboratory (PTL) in North America. One of only three in the world at the time of its opening, the PTL was a place where companies could send their solar panels and cells to certify that they met performance standards. By running this facility, ASU built relationships with many of the world’s top photovoltaic (PV) companies. ASU architects became leaders in the design of energy-efficient buildings with innovations such as the incorporation of PV into their structure, appliances running on direct current, and high-performance insulation. As discussed below, these twin legacies of engineering and architectural expertise would, years later, form the basis for the growth of a solar cluster in partnership with local companies, utilities and government leaders.

In the 1970s, an Australian expert in micro-characterization moved to ASU’s Chemistry Department, where he helped create the leading center for electron microscopy in the U.S. Funded by the National Science Foundation, the Center for High Resolution Electron Microscopy, was made available to local industry, which used it to help improve various manufacturing processes. Combining characterization with complementary expertise in electrical engineering and supply chain management, ASU became known as a place where companies could turn to learn how to improve their high-technology manufacturing.

A third area of expertise, remote sensing of urban environments, grew out of strong connections to NASA’s planetary exploration program. This linkage began with the purchase by ASU’s Chemistry Department of a large collection of meteorites in 1960. Subsequent
recruitment of faculty for the resulting Center for Meteorite Studies brought in planetary
geologists that also had interest in examining earth from space. The ability to use remote sensing
to look at cities helped ASU win, in 1997, the National Science Foundation’s competition for an
urban Long Term Ecological Research (LTER) program. ASU’s urban LTER (one of only two in
the country) focused on the impact that the city of Phoenix had on its underlying desert
ecosystem and vice versa, and formed the foundation for what eventually became, seven years
later, the Global Institute of Sustainability (GIOS). ASU’s sustainability programs established
close partnerships with state agencies for monitoring and modeling urban air quality, water
availability, and public health.

Meanwhile, Northern Arizona University was cultivating an environmentally-oriented
curriculum and research portfolio. In particular, it emphasized forestry, restoration ecology,
climate studies and renewable energy. Although limited by size, small state budget allocation,
and a mission that was primarily oriented toward teaching, NAU harnessed the enthusiasm of its
faculty members and created a robust, regionally-oriented sustainability initiative that supported
local industry in forest services, tourism, biotechnology, and distance education.

From an economic development perspective, it made great sense for Arizona’s three state
universities to collaborate in order to better compete with other states and regions in the United
States. In practice, this was frequently complicated by inherent rivalries and real or perceived
competition to get resources from the Arizona Board of Regents (ABOR) and Legislature.
ABOR consisted of a Governor-appointed group of lawyers, ex-politicians and business leaders,
each of whom tended to have allegiance to one or another of the three state universities. The lack
of cooperation was also a function of history. UA had long been the state’s flagship university. In
the 1990s, as ASU and NAU began to establish themselves as leaders in particular niche areas of
research, some members of the UA faculty and administration, and their supporters in ABOR and the Legislature, tried to protect their longstanding advantages by slowing this emergence. The failure of the universities to work together frustrated politicians and ABOR members alike as they tried to create statewide strategies. However, during the first decade of the 21st century, economic development initiatives emerged on which all three schools agreed to cooperate. In particular, they collaborated effectively through the APNE and GCIT processes and in administering the Technology and Research Initiative Fund, described in greater detail in the next section.

Proposition 301 and the Technology and Research Initiative Fund (TRIF)

Following the lead of their neighbors in California and other western states, Arizona voters in the late 1990s became enamored of the initiative process, partly because it allowed them to enact laws and regulations that could not be easily modified by the Legislature or Governor. In 2000, Arizonans passed Proposition 301, which enacted a 20-year, 6/10 of a cent sales tax increase dedicated to the improvement of schools and K-12 teachers’ pay, especially in rural parts of the state. Lobbyists for economic development interests and for the state universities arranged for the bill to also allocate up to 12% of the generated revenue to the creation of the Technology and Research Initiative Fund (TRIF), which could be used for research at the three state universities in support of economic development goals identified by APNE. Administration and allocation of TRIF, estimated to potentially total up to $1.5 billion over 20 years, fell to ABOR, which required that UA, ASU and NAU derive detailed plans for how these resources would be used to achieve the goal of technology-oriented economic development.
The Regents decided that each of the universities could have up to three specific and complementary research focus areas. These would be selected on the basis of existing strengths and their potential for innovation, the goal being to diversify the State’s economy and improve its competitiveness. The chosen topics included optics, water, and biotechnology for UA; manufacturing, materials, and biotechnology for ASU; and environmental research, distance education and biotechnology for NAU. Each school was also expected to use some of the funding to enhance workforce development and technology transfer. The universities were to put together coordinated planning documents showing how their funds would provide citizens of the state with a return on their investment. This represented an unprecedented degree of cooperation across the state university system, and was also the first official acknowledgement that university-based research was a potential instrument for statewide economic development.

Over the next eight years, TRIF was used to support the launch of major initiatives based at all three state universities and their host cities. In particular, the Biodesign Institute at ASU, the BIO5 Institute at UA, and The Center for Microbial Genetics and Genomics at NAU leveraged Proposition 301 funds and brought in large amounts of federal and private sector revenue. The scale of interdisciplinary and inter-institutional planning that Proposition 301 engendered carried over to other major science-based programs including the Translational Genomics Research Institute in Phoenix and Flagstaff, and Science Foundation Arizona, launched in 2006.

The arrival of Michael Crow as President of Arizona State University

The flight of corporate headquarters from Phoenix in the 1990s coupled with the growing unpopularity of elected officials resulted in something of a leadership vacuum in the region. In
2002, Michael Crow became the 16th President of ASU, coming from Columbia University where he had been executive vice provost, a position similar to but more powerful than the vice president for research at most other universities. Crow had had great success in promoting entrepreneurial activities at Columbia and was nationally recognized for his studies of technology transfer, university-based innovation, and public-private research and development partnerships. He made it clear that the primary attraction of the ASU presidency was the unique combination of a young, large, and fast-growing university within a young, large, and fast-growing city. Also significant was the fact that ASU was the only major university in what was soon to become the 5th largest city and 14th largest Metropolitan Statistical Area in the country. Perhaps more than had been done in any other urbanized area Crow quickly set about to intimately link the future of the university with that of the region.

Eschewing the traditional antipathy between Arizona’s Legislature and higher education, President Crow began to cultivate conservative members of the state’s House and Senate, presenting them with a series of investment propositions. Crow’s basic case statement was that if government would commit the upfront resources to provide additional infrastructure, the resulting research and associated economic development activity by and around the universities would generate sufficient revenue to more than re-fill the public coffers. Variations of this argument were made repeatedly over the next eight years to different audiences of potential “investors”: state legislators, cities, corporations, foundations and individual donors. The only standard academic revenue source he did not pursue was direct appropriations, or earmarks, from Congress. By all measures, his was a remarkably successful strategy.

Another of Crow’s distinctive positions was that a public university had obligations to society that extended beyond the core missions of providing students with a first-class education
and conducting research. For instance, Arizona’s public universities had freshman-to-sophomore year retention rates that were considerably lower than many of their peers from other states. Rather than simply blaming these statistics on inadequate teaching and oversized classes in Arizona’s high schools, Crow admonished ASU’s College of Education to produce many more high-quality secondary school teachers. He also endorsed a proposal to have ASU establish K-12 charter schools on each of its four campuses, where teaching innovations could be tested and perfected before being transferred to the public school system as a whole. A separate university-based program, funded by private philanthropy, addressed the connections between homelessness and family harmony. This commitment of the university community to broader societal goals, described under the heading of “social embeddedness,” gained Crow and ASU regional as well as national attention. It also suggested that any sustainable technology focus in Phoenix that involved ASU would place value on social as well as environmental and economic outcomes.

Research infrastructure legislation

The passage of Proposition 301 in 2000 provided operating funds for new research projects and programs at the three state universities related to economic development. But it soon became clear that the success of that initiative was jeopardized by a lack of laboratory facilities in which the research could be conducted. At the same time, an economic downturn in 2002 seriously impacted the state’s dominant construction and real estate industries. In response, ASU President Crow and UA President Peter Likins worked with the Arizona business community, pro-education legislators, and newly-elected Governor Janet Napolitano to create legislation that would authorize bonding for $440M of new construction at UA, ASU, and NAU. Following a
lobbying campaign led by the construction industry, which emphasized the potential for associated job creation, the bill passed, leading to the building of major new facilities at all three universities. This significant expansion of the state’s research capacity was especially important because Arizona is one of the few states that do not include capital funds in their funding formulae for public universities.

ASU’s Downtown Phoenix Campus

Another example of Crow’s ability to leverage ASU’s value to obtain outside investment was the public financing of the university’s Downtown Phoenix Campus (DPC). The first of the eight tenets of Crow’s “New American University” agenda9 is “leveraging place.” Probably no other collaboration between the university and its surrounding region better exemplifies this aspiration than the DPC.

At the time of his arrival at ASU in 2002, the City of Phoenix was seeing an accelerating exodus of residents from its downtown area, which had been losing population to the suburbs over the previous few decades. At the time, ASU had a small presence in a partially abandoned shopping center in the downtown area. In a series of discussions with Mayor Phil Gordon and members of the City Council, Crow proposed that a significant portion of a citywide ballot initiative be dedicated to the creation of a new ASU campus in downtown Phoenix capable of serving over 15,000 students. ASU was interested in expanding the overall enrollment on its various campuses (DPC would be its fourth), while also attempting to generate a critical mass of faculty researchers and teachers involved in urban issues and public outreach that could benefit from the downtown setting. For its part, Phoenix wanted to establish a core of 24-hour residents that could spur the establishment of a more vibrant downtown culture and economy.
In March 2006, the initiative passed with a 66% plurality, authorizing the sale of bonds that provided ASU with $223 million\(^{10}\). This was in addition to $100 million of buildings that the city had already purchased and donated to the university. According to city and university officials, this was the first time in U.S. history that a municipal government funded the expansion of a state university campus. ASU moved several programs to the DPC that could take advantage of being located in the business and government hub of the state, which also offered proximity to several major hospitals. Within two years, the DPC housed the Schools of Nursing, Journalism and Public Programs. The latter offers degrees in social work, public affairs, and community resources and development.

Another key economic development and transportation consideration was the design of the new campus around a stop for the planned light rail system, which opened two years after the launch of the DPC. The planners for the project surveyed a variety of options for the location of the campus but quickly converged on the idea of making sure that all new facilities would be within a five-minute walk of the central intermodal transportation hub. There was considerable doubt about the viability of public transportation in an auto-centric region. However, thanks to the strategic location in the downtown area and incentives to encourage them to leave their cars behind, the students helped to model new behaviors for the general public. Valley Metro, the Phoenix light rail system, now takes 22 minutes to link the DPC with ASU’s primary campus in Tempe (45,000 students), and ASU affiliated passengers are one of the largest components of its ridership. This is another case where the university has helped catalyze the “greening” of the region.

President Crow’s involvement with green tech in Arizona
The emergence of green tech as a state economic development priority was also consistent with Crow’s agenda and philosophical leanings. At Columbia, one of his proudest accomplishments was merging the university’s many environmental programs under a single umbrella called the Earth Institute. This large group of experts became best recognized for their research and teaching about the evidence for and impacts of global climate change.

Crow had also arranged for Columbia to take over the Biosphere 2 facility in Oracle, Arizona, just north of Tucson. Biosphere 2 had been created by oil tycoon Ed Bass to see whether a group of individuals could live together in a totally-enclosed environment for a period of months to years, as preparation for a possible future escape from an environmentally-compromised Earth. Columbia wanted to transform this counter-culture icon into a giant laboratory facility and spent tens of millions of dollars of Ed Bass’s money upgrading the infrastructure while also building an on-site campus for research and teaching about environmental sciences and policy. Crow’s vision for Biosphere 2 was that it would eventually become a national laboratory for climate research and related technology, modeled after the Department of Energy’s research laboratories in California, New Mexico and Tennessee.

Upon arriving at ASU, Crow proposed that the university redefine itself by embracing the emerging concepts of sustainability in its research, teaching and business operations. He brought in international sustainability leaders as advisors and authorized the recruitment of senior faculty members to strengthen these capabilities. A long term goal of this strategy was to create “green” economic development opportunities for the metro Phoenix region, consistent with the earlier Battelle recommendations. In 2004, Crow enticed a wealthy donor to pledge $25M to create the “Global Institute of Sustainability” (GIOS), and encouraged the faculty to establish the world’s first degree-granting “School of Sustainability” (SOS). In 2007, he gave the GIOS Director a
second title of “University Sustainability Officer,” with authority to oversee and influence all of ASU’s business operations to make sure that they conformed to the environmental and social principles espoused in the Institute’s research and teaching. This centralization of functions related to sustainability was unprecedented in any academic institution. Among the initiatives that it engendered were the installation of over 10 megawatts of PV on the roofs of ASU’s buildings and parking structures, a comprehensive recycling program, and the launching by Aramark, the country’s largest academic food service provider, of its first on-campus organic restaurant. Crow also arranged for GIOS to have an influential Board of Trustees, which included some of the country’s leading faculty members and industrialists interested in sustainability and economic development.

Flexible Display Center

Just as UA research had spawned a burgeoning and unique optics industrial cluster in Tucson, ASU sought to bring novel high tech economic development to metro Phoenix. An important opportunity arrived in 2002 when the Army announced a competition for a $44 million, university-based Flexible Display Center (FDC). The ultimate goal was to develop wearable, low-cost and low-power wireless communication devices that soldiers in the field could use to receive information about battlefield situations. Combining a number of different emergent technologies, the proposed FDC would need to bring its new innovations to pre-manufacturing stage, and would require the involvement of many different companies, both established and start-up. One of the most challenging aspects would be setting up licensing arrangements that would allow the companies to retain some of their proprietary intellectual property while sharing other components. The intention was for the consortium to
simultaneously develop primary military applications while coincidentally spurring the growth of a variety of low-power, wireless, flexible electronic consumer products, so that commercial competition would accelerate evolution of the technology.

Leveraging TRIF resources and its new Biodesign Institute, ASU mounted its most comprehensive proposal preparation effort ever, bringing together an interdisciplinary team of its most experienced scientists and engineers as well as outside consultants including Washington-based “rent-a-generals” to provide advice about Army-based site visits. Technology transfer experts from President Crow’s former office at Columbia University were also involved. Despite spending over $700K in proposal preparation, ASU was considered a long shot, as it lacked specific display expertise, did not have much prior experience in working with the Army and had not competed for this magnitude of funding before.

The team found a unique competitive edge in a recently-abandoned, flat-panel display research and manufacturing facility that Motorola had built a few years earlier in ASU’s Research Park. After a series of complex negotiations, Motorola gave the university an option to purchase the building for less than a third of its original $100 million cost, contingent upon the Army awarding ASU the grant. This option, and a creative approach to technology transfer, became the decisive factors, as ASU beat Cornell, Princeton and University of Texas at Dallas (which had close connections to Texas Instruments) to win the award. The university then purchased the 275,000 square foot facility, which contained over 50,000 square feet of clean room space. Over the first five years of the program, ASU and its partners in the Army, other universities, and over two dozen companies produced prototypes that represented the United States’ primary entry into the embryonic yet highly competitive global flexible electronics industry. In 2008, the Army agreed to provide ASU with $50M of Phase 2 funding.\(^\text{16}\)
While flexible displays can form the basis for lighter-weight, lower-power consumer electronic devices, the other “green” spinoff application of the FDC is in solar technology. Displays use electricity to generate and emit light, while photovoltaic systems do the opposite: absorb light energy and convert it into electricity. With its capacity to handle not only the development of new devices, but also the early stages of their manufacture, the FDC offers solar technology companies unique partnering opportunities. ASU is currently taking advantage of these through the co-location of their new Solar Power Laboratory\(^{17}\). Several of the different strategies for designing flexible displays, including organic LEDs, amorphous silicon, and electrophoretic systems, are being explored for their potential solar applications.

The creation of Science Foundation Arizona

In 1996, Columbia University appointed William Harris as the first President of Biosphere 2, reporting to Michael Crow. Harris had previously served as Assistant Director for Mathematical and Physical Sciences at the National Science Foundation. In 2001 he became the founding Director General of Science Foundation Ireland (SFI), a non-profit organization that allocates substantial levels of Irish research funding to universities and industry in order to boost science- and technology-based economic development. SFI’s three priority technological investment areas paralleled those identified by Battelle for Arizona: information/communications, biotechnology, and sustainability.

In 2005, ASU’s President Crow began making the case that Arizona should view its economic development as being like that of a small country, citing Ireland as an appropriate analog in terms of population and other metrics. He proposed to Governor Napolitano and industry leaders that a “Science Foundation Arizona” (SFAz), modeled after SFI, could catalyze
critical R&D, through matching grants and other targeted outlays, positioning Arizona to compete more effectively against better established states like California, New York and Massachusetts. The idea appealed to Napolitano, who made it one of her signature initiatives. Crow worked with elected officials and business leaders to keep the proposal non-partisan, repeating the political strategy and return-on-investment logic that had helped persuade the Arizona Legislature to pass the research infrastructure bill in 2003.

In June 2006, the Legislature and Governor appropriated $35 million for SFAz with the goal of “developing the necessary resources for Arizona to become globally competitive in science and engineering.” A year later the Legislature approved an additional $100 million, spread over four years, which required matching funds from the private sector. Harris was recruited to be the first President of SFAz. Upon his return to Arizona in 2006, he met with industry and academic leaders to formulate an investment strategy that emphasized topics that would be complementary to existing local R&D funding sources, such as the Flinn Foundation’s support of the state’s biomedical research agenda.

Over the next several years, SFAz became an invaluable source of matching funds for grants, fellowships for students and post-docs, and a strong driver of large-scale partnerships across the state university system. However, despite its early success, SFAz became a target for politically-motivated budget cuts when the economy soured and Napolitano stepped down as Governor to become President Obama’s Secretary of Homeland Security. As will be discussed in the final section of this chapter, the future prospects for SFAz are cloudy.
Recruiting solar manufacturers to Phoenix

Arizona is an obvious place to develop and deploy solar technologies. Even before it became a university in 1958, ASU had one of the nation’s first solar research programs, based in its engineering and architecture departments. This expertise persisted and grew through the interests of ASU faculty over the ensuing decades. By 2005, ASU had assembled a diverse set of solar-related programs and skills spread across more than a dozen departments, including architecture, construction, physics, electrical engineering, mechanical engineering, chemistry, biology, business and materials science. Yet despite this home-grown knowledge base, when it came to installation of photovoltaic systems for generating electricity, Arizona persistently lagged behind other states and countries. Solar was seen as one of the most prominent missing components of any green economic development strategy for Phoenix.

As cited earlier, ASU possessed one solar-related asset that no other academic institution in the world had: the Photovoltaic Testing Lab (PTL). Besides helping to provide access to the companies whose solar panels they tested, the PTL also trained influential technicians that were distributed throughout the industry. The rest of ASU’s interdisciplinary solar expertise also made it an attractive partner for companies competing for federal renewable energy research grants. Yet strangely, the economic development leadership in Phoenix as late as early 2007 had still not capitalized on the local solar potential, despite Governor Napolitano’s commissioning of an “Arizona Solar Electric Roadmap Study” by a task force overseen by the Arizona Department of Commerce.

Here again, ASU asserted itself on behalf of the community. Two senior research administrators from the university and the director of the PTL traveled to Germany and China in 2007 to meet with representatives of eight leading solar companies, including SolarWorld,
Solon, Schott, Q Cells, and Suntech, as well as with the member of the German Bundestag (Parliament) responsible for Germany’s groundbreaking feed-in tariff\(^2^2\). Their message was that Arizona represented an ideal site in which to set up a U.S. manufacturing presence, because of the proximity to the California market, affordability of housing and labor, availability of academic research partners and the PTL, and favorable energy policies. Their visits contributed to an enhanced awareness of Arizona among the global solar industry, later capitalized on by the Greater Phoenix Economic Council (GPEC), the region’s principal economic development organization.

Based on the Germany and China visits, the ASU administrators identified Suntech as the most promising target, both because of its size (it is now the world’s largest manufacturer of solar panels) and its potential interest in research collaboration. They visited Suntech’s CEO and senior leadership several times in China and California and, along with senior administrators of Arizona Public Service and SFAz, co-hosted a visit they made to Phoenix in July 2008, including arranging meetings with Governor Napolitano, leaders of the Department of Commerce and several local companies. Recognizing that Suntech had strong research ties with University of New South Wales in Sydney, Australia, where their CEO, Zhengrong Shi, had received his PhD, ASU lured two faculty members from University of Delaware that had been fellow graduate students with Shi. After subsequent negotiations led by GPEC, Suntech in 2009 agreed to open a manufacturing site in metro Phoenix, its first in the U.S. Discussions are currently underway between GPEC and other Chinese manufacturers to expand metro Phoenix’s growing solar cluster. The entrance of Suntech onto the local scene illustrated the influence that a prominent green tech corporation can have on regional economic development policies and politics. In late 2009, Arizona legislators opposed to what they perceived to be overly-generous government
subsidies of the solar, biofuels and wind power industries proposed that nuclear power be counted toward the percentage of the state’s energy mix that was mandated to come from renewable sources. This radical reinterpretation would have eliminated subsidies for the solar industry and essentially driven all of Arizona’s renewable energy projects to other states. Suntech publicly announced that if the legislation passed, they would not come to Arizona. That threat motivated Governor Jan Brewer to convince her fellow Republicans in the legislature to withdraw their bill, preserving one of the strongest incentives for development of a green tech economy in the state. Keeping the PTL as a unique asset with which ASU could help the region create a robust solar power industry was another strategic economic development goal of the university. By 2007, as global solar manufacturing expanded, especially in Asia, PTL could no longer keep up with demand. Turnaround time on panel evaluations dropped dramatically, causing client companies to complain. In response, Underwriters Laboratories (UL) announced plans to open a competing facility to PTL in San Jose, supported by the emerging renewable energy interests in Silicon Valley, and taking advantage of California’s aggressive state incentive programs for using solar power. ASU countered this threat by opening negotiations with PTL’s largest international rival, TUV-Rheinland. These discussions, led by ASU’s Office of the Vice President for Research and Economic Affairs, resulted in the creation of a commercial joint venture, TUV-PTL, in renovated and greatly expanded facilities near ASU’s Tempe campus. Not only did this move retain PTL’s important ties with the solar industry, it expanded its customer base, created new jobs and did so in what became the world’s premier commercial solar testing lab. Furthermore, it gave Arizona access to one of the world’s largest technology testing companies, with associated long-term benefits.
The “Energize Phoenix” project

President Crow’s expansive mandate for the university, combined with his personal interest in environmental issues and his relentless pursuit of institutional resources and recognition all came together in one of ASU’s most lucrative sustainability initiatives. Prepared collaboratively by ASU faculty members and administrators, leaders of the state’s largest utility (Arizona Public Service), and the City of Phoenix, the “Energize Phoenix” proposal sought federal stimulus (ARRA) funds to create jobs, reduce environmental impacts and strengthen neighborhoods. The project obtained $25M from the U.S. Department of Energy in May 2010 to install various technologies that reduce energy use and improve the overall energy efficiency of buildings along a 10-mile stretch of the new light rail line in downtown Phoenix, while concurrently working to change the behavior of the residents in the surrounding communities so they would also use less energy.

ASU’s ongoing role in the project is to monitor and analyze the impact and financial savings associated with the new infrastructure and to try to learn about the personal investment decisions and behaviors that lead to energy efficiency. The project is intended to be scalable through creative financing mechanisms so that the lessons learned can be directly applied across the entire city of Phoenix and into the surrounding metro region by reinvesting the savings that come from energy conservation. The infusion of new federal dollars came at a particularly opportune time because city budgets were painfully stressed by a reduction of state funds. This is an example of a sustainability opportunity that ASU identified and led in order to benefit the broader community, but from which faculty members and students will also gain valuable research experience and support.
Lessons learned and relevance to other cities

This chapter highlights some of the unique events and characters responsible for helping to bring metro Phoenix, and Arizona more broadly, into the “green economy.” Critical factors included early success in coordinating high tech development across the state through the establishment of economic clusters; an emphasis on leveraging Arizona-specific assets, like semi-conductor expertise and the potential for academic partnerships to promote solar manufacturing; and the ability of academic leadership to persuade a spectrum of legislators to view public research universities as entrepreneurial enterprises worthy of temporary but large investments rather than as government agencies entitled to steadily-increasing, recurrent budgets.

Yet, the most recent episode of the metro Phoenix story reveals that green economic development gains remain vulnerable. The same fiscally conservative Republican leaders that were receptive to non-partisan “return-on-investment” pitches for research infrastructure made an about-face and eliminated public funds for Science Foundation Arizona when the state budget came under pressure and the Democratic Governor stepped down to join the Obama Administration. Legislative enthusiasm for using Arizona-based renewable energy to help the U.S. gain independence from unstable foreign governments has recently been offset by the suspicion that all sustainability initiatives are somehow connected to “socialistic” climate change conspiracies. Support for locally-based solar thermal projects that were among the most ambitious in the world have run up against the recognition that such systems require large amounts of water, which in Arizona is already over-allocated. Inter-university cooperation on green technology development, encouraged by the business community and the promise of joint funding from Science Foundation Arizona, has waned as faculty members retreat to their historical interests in parochial intrastate competition. Incipient collaboration on advanced
technology development across Tucson and Phoenix is being shelved as the two metro areas resume jockeying for statewide technological dominance, which ironically is becoming irrelevant as they merge demographically into one “Sun Corridor Megapolitan” region\textsuperscript{25}. Even Proposition 301, the flagship initiative that started Arizona on its recent path to a more diversified technological future is under threat as desperate legislators look for any resources they might re-appropriate to fill yawning budgetary holes, and as cutbacks in consumer spending reduce the sales tax revenues on which TRIF depends.

The fragility of Phoenix’s recent progress toward a green future may reflect a lack of depth to the support for those more progressive outcomes. Seattle, Portland, San Francisco, Chicago, New York and Austin have all put in place policies and initiatives that parallel those seen in Phoenix over the past decade. What’s different is the political context in which those other cities have made their moves toward sustainability. While in each such setting, a mayor, CEO, or other civic leader may have put forward one or more specific ideas, they have taken root, become nourished, and thrived in a diverse culture of popular interest. The cities were already poised to accept these new concepts as logical extensions of widely-held values and historical assets.

In metro Phoenix, many of the green advances ultimately arose from the influence of a single charismatic leader, Arizona State University’s president, Michael Crow. But other than the brief period when Governor Napolitano used her position to push for similar goals, Crow’s technocratic view of a future shaped in sizable measure by a university’s actions was not reciprocated or complemented by any other players or constituencies that shared his vision, energy, and institutional clout. Even within ASU, there is a sense that Crow’s long-term impact
may be fleeting, because his well-formulated ideas were grafted onto an academic setting that had not yet matured sufficiently to fully appreciate and incorporate them.

The underlying question for Phoenix, as for any city that is plotting its way to a greener future, is how quickly and long-lastingly can transformation occur through technological and political means, if the culture is not yet sufficiently receptive?
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2 The author was engaged in several of the activities described in this chapter, through his administrative service to Arizona State University (ASU) as Vice Provost for Research (1997-2002), Vice President for Research and Economic Affairs (2002-2007), Director of the Global Institute of Sustainability (2007-2009), and University Sustainability Officer (2007-2008). As a consequence, this account may emphasize the importance of ASU disproportionately relative to other institutions.


New American University: [http://newamericanuniversity.asu.edu/](http://newamericanuniversity.asu.edu/)


When then Executive Vice-Provost Michael Crow and the President and Provost of Columbia University all left their positions in 2002, the incoming administration severed ties with Biosphere 2, which now is run by the University of Arizona.


Vice President for Research and Economic Affairs Jonathan Fink; Associate Vice President for Economic Affairs, Rob Melnick; and PTL Director Govindaasamy Tamizhmani.


24 TUV Rheinland PTL: http://www.tuvptl.com/