

WHITE PAPER

Spotlight on Arizona's Optics Industry

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By Michael Coretz and Jan Knight

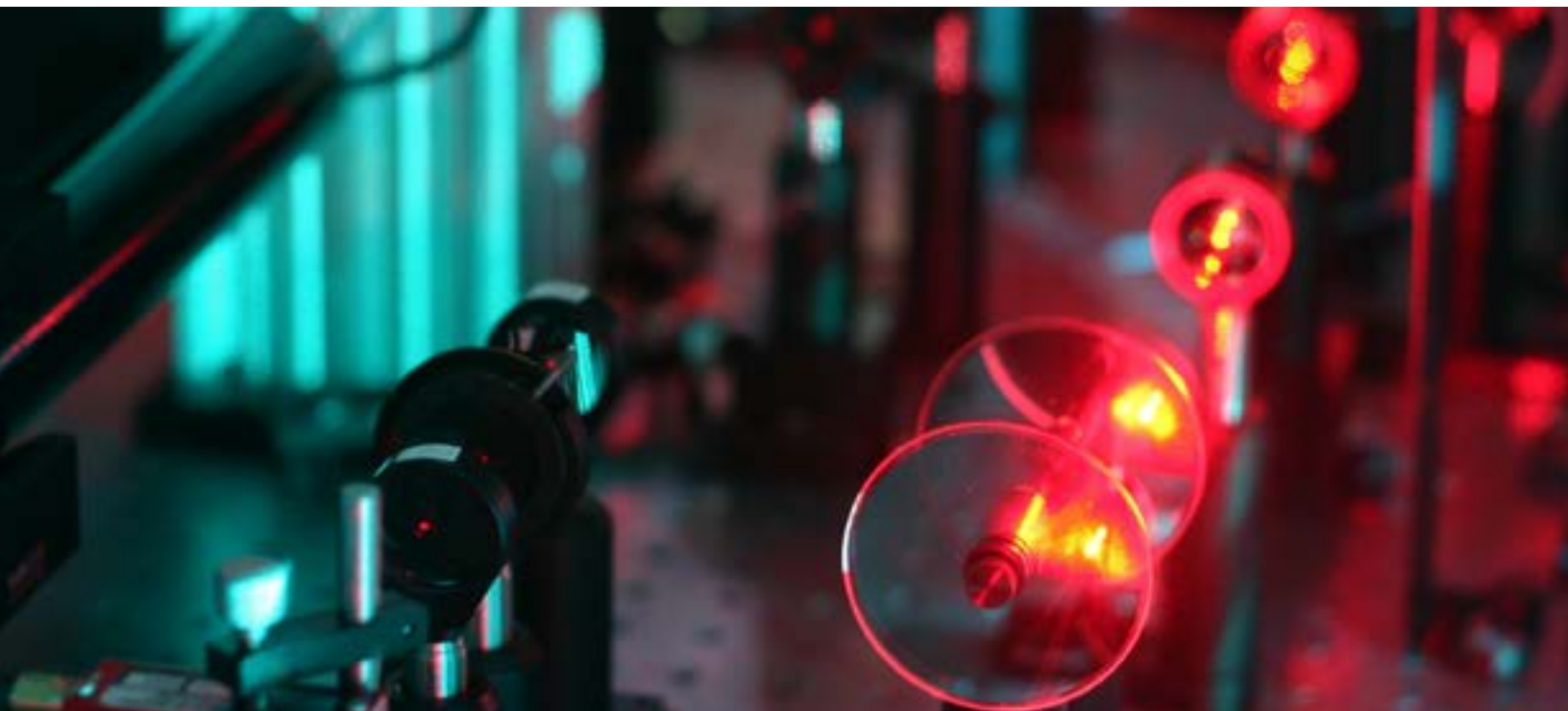


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Arizona can boast of many things. The business benefits are plentiful and one key advantage for those working in Optics and Photonics is that Tucson is home to the **premier educational and research institution in optics, photonics and astronomy**. The University of Arizona in Tucson is known worldwide for its researchers, innovative work and talented student base.

Other great reasons include the dry heat, sunny days and the opportunity to play golf, hike and bike year-round. Yes, those things are attractive to both tourists and residents alike and often initially attract a founder or entrepreneur, as well as employees, to cities like Tucson and Phoenix because of the lifestyle Arizona offers.



This white paper will give anyone considering starting, relocating or expanding their optics business a variety of reasons to put Arizona on the short list of potential states to consider. In fact, you'll be in very good company if you do.

This white paper published by Commercial Real Estate Group of Tucson, LLC. Contact Michael Coretz, your Tucson commercial real estate partner, for more information.



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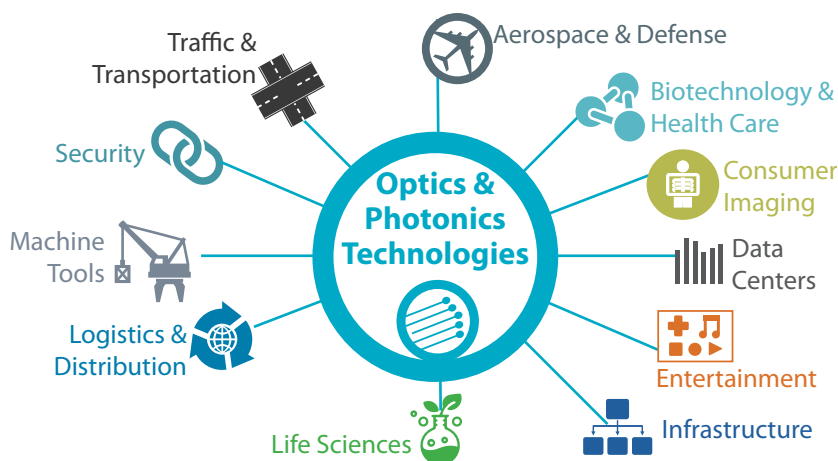
Introduction

So, What Exactly is Optics and Photonics?

▶ If you work in the industry, then you'll have a good answer to that question. If not, you should know that you're likely reading this white paper on an optics-enabled device right now. Think of optics and photonics as the science and application of light. Generally in optics, light is manipulated with lenses, mirrors and prisms. In photonics, photons (light) are generated, manipulated and detected.

Photonics are used in almost every industry you can think of. Obvious ones might apply to science: astronomy, space and planetary sciences, bio and physics. However, in the photonics-enabled markets you'll find consumer electronics, biomed, solar, and sensing as key sectors. Think smart cities to medical imaging and everything in between.

Optics and photonics are used in almost every industry you can think of. Here are some applications, many of which are key industries in Arizona.



"The basic principle is that optics are going to continue to become even more essential as we develop new technologies and as we develop new ways of viewing the world."

...Kate Medicus, CEO, Ruda-Cardinal, Inc.

Optics and Photonics: Facts and Figures

- Global annual revenue from production of optics and photonics core components amounted to \$282 billion in 2018, with nearly 4,300 manufacturing companies producing those core components across more than 50 countries.
- Production of photonics-enabled products generates more than four million jobs worldwide and revenues for those products exceeded \$2 trillion in 2019.
- Experts at Optica forecast venture capital continuing to flow into quantum photonics and computing specifically.

Factors Involved in Promoting a Successful Optics Community

For many technology segments, companies increase their likelihood of success when a strong research presence exists within a community excited about innovation. Arizona checks all the boxes when it comes to opportunities to partner and collaborate and Tucson checks additional boxes with the presence of the premier educational and research institution for optics, photonics and astronomy.





Why Arizona?

There are many reasons why Arizona should be on your short list. Three to start with are location, location, location!

- The world's **premier educational and research institution in optics, photonics and astronomy** is located in Tucson at The University of Arizona.
- Arizona boasts a dedicated industry cluster, Optics Valley, and large tech-driven trade association, the Arizona Technology Council.
- As a significant Southwestern U.S. hub, Tucson is geographically well-positioned for optics companies who require transportation of material and end product. Its proximity to Mexico, just an hour away, is key for collaboration, partnering, importing and exporting.
- Tucson, Arizona is a metro area of about a million people and is thought of as the optics innovation hub of the state, while Phoenix and its surrounding valley cities offer a variety of manufacturers and suppliers.



The Wyant College of Optical Sciences (OSC) at The University of Arizona

Did we mention already that The University of Arizona (UA) Wyant College of Optical Sciences is known worldwide as **the premier educational and research institution in optics and photonics?**

Still fondly referred to as OSC from its origins in 1964 as the Optical Sciences Center, the college is strongly focused on research into both the underlying physics and the novel and ever-expanding applications of optics. OSC educates more students in optics than any institution in the United States, so it's easy to see why a skilled and highly expert workforce is something that attracts new or expanding companies.

Today OSC has approximately 75 tenured, or tenure-track, faculty, and senior researchers, as well as over 40 joint appointments with other departments and colleges such as astronomy, engineering, and medicine. OSC is also investing to address the burgeoning applications and talent needs in optics with tremendous philanthropic and institutional support that will scale the college by an additional 35%

"Our industry partnerships play a critical role in both our educational and research programs here at the College of Optical Sciences. We recognize that—in addition to providing career pathways for our students—our corporate engagements bring outstanding, high-impact, real-world research challenges to our faculty. We welcome anyone with an interest in learning more about how to leverage and grow the Tucson optics ecosystem to visit us here on campus."

... Thomas L. Koch, Ph.D., Dean of the College of Optical Sciences



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in the coming several years. This includes 14 new Endowed Chairs in Optical Sciences and ample new laboratory space in the seven-story, \$100 million Grand Challenges Research Building that is under construction and connected to the college's existing Meinel complex.

OSC supports industry needs in many ways – whether you're a one-person startup company, a successful revenue-generating company with hundreds of employees, or one of the nation's largest high-tech corporations, the OSC offers a rich history of formal and informal research and academic engagements with private, commercial enterprises.

Its thriving Industrial Affiliates program has nearly 60 member companies, including both local and large national partners, and provides a compelling venue to develop and enrich a mutually beneficial ecosystem. By providing highly interactive meetings where business owners and inventors can engage students as well as college faculty and staff, this successful and growing ecosystem includes access to research, lab facilities, workshops, networking opportunities and, especially, the critical future talent pipeline to grow member businesses.

"Space telescopes, the metaverse, quantum processors, iPhones – optics is central to the most exciting advances. The Tucson ecosystem of optics companies, experts, UA faculty and students is globally unique and powerful in the development of products that see, show, compute and communicate."

...David Brady, J. W. and H. M. Goodman Endowed Chair in Optical Sciences.

Another great benefit of being in Tucson and having a world-renowned Optics program in your town is the weekly OSC Colloquium series held at the College of Optical Sciences. Entrepreneurs, owners and innovators in startups and established businesses participate in ongoing exchanges of ideas, techniques and research.

Educational, Research and Workforce Support

Having a globally recognized optics program in Tucson is just the start of collaborative research and business opportunities in the state.

- Tucson's University of Arizona also houses the Steward Observatory, the research arm of the department of astronomy, and its researchers and facilities are heavily involved in the operation of several telescopes in Arizona as well as other high-profile facilities around the world. In fact, the University features as an integral contributor to the December 2021 launch of the James Webb Space Telescope, an international collaboration among NASA and the European and Canadian Space agencies.
- The University of Arizona's BIO5 Institute is a renowned affiliated unit and helps to "harness the collaborative power" of its five core disciplines – agriculture, engineering, medicine, pharmacy and science.
- Arizona State University in Tempe, in the Phoenix Valley, gathers together a large group of faculty from various disciplines to foster new ideas and perform collaborative research in its Center for Photonics Innovation (CPhI).
- The optics industry also finds future workforce support from a variety of community colleges as well as middle and high schools around the state. Many are moving toward education and training for optical technicians. Tucson's Pima Community College, for example, offers Optical Manufacturing Technician training and an Optics Technician Apprenticeship program.





Advances in optics have revolutionized the basic sciences, drug discovery and medical diagnostics fields. Southern Arizona is home to a diverse group of companies—from multi-nationals to small startups—who leverage optical technology and the expertise of the University of Arizona to cure disease and improve health. The BIO5 Institute catalyzes breakthroughs in optics into better understanding of the world as we work with Southern Arizona companies to meet their needs for optics and biosciences expertise, as well as a highly-trained workforce.

... Jennifer Kehlet Barton, Ph.D., Director, BIO5 Institute



Industry Growth and Business Opportunity Led by Optics Valley

Optics Valley is recognized worldwide as a leading cluster for optics, photonics and astronomy. The group builds domestic and international collaborations and partnerships through its mission to “catalyze, convene and connect” the optics, photonics, astronomy and supporting business interests throughout Arizona. Today, it has 90 members and growing.

Optics Valley helps its members thrive through business acceleration, workforce development, startup support, and connections to local and worldwide opportunities. Its activities include:

- Business-building through regular meetings and events including its flagship Arizona Photonics Days conference, and the Optics Valley Pavilion at SPIE’s Photonics West.
- Monthly communication with the FOCUS Newsletter and Technical Series webinars.
- Growing the skilled workforce needed by industry by working closely with educational institutions for technician training and degree programs as well as 9-12 grade STEM (science, technology, engineering, math) and CTE (career technical education) programs.
- Connecting member companies and prime contractors to resources to accelerate business relationships, including supplier contacts and customer prospects.

Arizona’s Robust Entrepreneurial Ecosystem

The state has a multitude of government and private entities who support entrepreneurial and general startup activity overall through grants, private equity, angel funding and venture capital. The Arizona Commerce Authority (ACA), the state’s leading economic development organization offers connections, resources and tools for any newcomer to the state.





Specialized Commercial Real Estate Needs

Many industry segments have special requirements for the properties they lease or build. Companies in the optics industry are no different. Depending on the specific needs of the company, there might be requirements for any or all the following:

- clean rooms
- laboratories
- coating facilities
- high bays
- electronics manufacturing rooms
- isolated slabs engineering
- collaborative work spaces
- complex plumbing and ventilation systems
- sophisticated, dedicated data centers.

Michael Coretz of Commercial Real Estate Group of Tucson was great to work with in assisting me with leasing a commercial space. He was always available to answer questions, and I greatly appreciated the introductions he made for me in the local business community. Highly recommend.

...Craig Ament, Founder, Arizona Thin Films

Additionally, companies in this segment often need to adapt to changing needs related to energy and water efficiency to ensure lower operating costs. Appropriate locations for optics and photonics companies often put them in close proximity to other intellectual resources and facilities.

Spaces, particularly work spaces, need to address health concerns regarding distancing and ventilation.

Often a group of professionals from different disciplines act as the development team. Ranging from scientists, architects, engineers and financiers to building contractors and commercial real estate brokers, the team must understand the special needs of the optics industry and help anticipate each tenant's future space needs.

CREG Tucson offers many commercial real estate sources that directly address these needs including a Relocation Guide and Infographics on Buying vs Leasing. They are listed in the Resources section of this white paper.

CREG Tucson also is an active participant in Optics Valley and with optics companies. It maintains an extensive list of local optics companies that provide a network for all industry businesses and startups.





Let's Not Forget Lifestyle

▶ We know that employers have an easier time recruiting people to work in places that offer not just a great business working environment, but a lifestyle that they and their families can enjoy.

For those who haven't heard, Arizona boasts 350-plus days of sun a year. For most of the year, humidity is low, although the brief summer monsoons bring a welcome break with heavy rainfall and strikingly beautiful storms that amateur and professional photographers love.

Tucson Emerges as Global Leader in Bicycling? Yes, Really!



One of Tucson's major benefits for those who like the outdoors is The Loop. Consisting of 137 car-free miles, the paved trails provide an urban system that connects bus and bike routes, hotels, restaurants, parks and trailheads. Most areas are flat and family-friendly. Much of The Loop runs adjacent to Tucson's river beds and almost all of it provides views of the mountains. In addition to cyclists and pedestrians, The Loop is open to horseback riders, who also use adjacent dry river beds. In addition, the city boasts 1,098 miles of bike facilities overall.

Hiking & Golfing

Tucson and Phoenix offer an abundance of hiking trails ranging from flat desert landscapes to mountain forests with beautiful vistas, not to mention many opportunities in and around the Grand Canyon in Northern Arizona. There's just no excuse not to walk outdoors when you live in Arizona.

If you prefer to trade in those walking poles for golf clubs and spend time in more manicured environs the state has an abundance of municipal courses, PGA pro-designed resort courses and golf communities. Many pro golfers make their home in the Phoenix/Scottsdale area and both Tucson and Phoenix continue to host professional golf tournaments annually.

Arizona's world-famous resorts and spas also often offer hiking opportunities along with golf in close proximity and attract visitors and business conferences from all over the world.





Arts, Culture, Sports and Food

There is no shortage of all of the above in Arizona. You can experience symphonies, operas, museums, ballet and pro sports as easily as you can experience intimate music and arts venues. The Southwest in general also offers its own unique flavor of local art and culture.

In 2017, Tucson became the first American city to become part of UNESCO Creative Cities Network for Gastronomy, an award that hones and recognizes the “region’s rich agricultural heritage and thriving food traditions.” While the Mexican and Southwest cuisines are especially prominent, the variety of restaurants, bars and eateries is mind-boggling to even long-time residents.

As Arizona is also a magnet for tourism, the state has more than its fair share of high-end resorts, spas and health-oriented destinations. Historic and elegant hotels that have always attracted celebrities, like the Arizona Biltmore in Phoenix to the Arizona Inn in Tucson, are just a few miles often from world famous health spas such as Miraval (one of Oprah’s favorites) or Canyon Ranch, both in Tucson.



Housing

Now that we’ve explored the many ways to spend your leisure time, think how adding affordable housing to the mix can really cement the work-life balance for the whole family. Arizona has long been appearing on lists for “best places to retire” but it also ranks high in affordable homes while offering a large variety of unique neighborhoods. Whether your preference is urban chic, historic Barrio, or suburban Southwest (likely complete with a swimming pool), the options are plentiful. In November 2021, Tucson’s median home price was \$330,000 while the Phoenix/Scottsdale metro was \$450,000. Arizona also boasts many multi-million dollar mansions too, if you’re into those!

All this says, Arizona makes an ideal base for remote work given the lifestyle and affordability. So, come and check us out.





Arizona's Optics Companies

The presence of dozens of optics and photonics companies in Tucson, and hundreds across the state, supports the idea that Arizona does indeed offer just what companies need to be successful. This is just a sampling of a few Arizona-based companies but it shows the diversity of the strong optics and photonics supply chain in Tucson, and the state in general. Some are smaller private companies while others are global, publicly-traded firms who have chosen Arizona for their headquarters or expansion.

A listing of optics and photonics companies in Arizona who are members of Optics Valley is available at the Arizona Technology Council's Optics Valley membership page. <https://bit.ly/3yLN4nn>

4D Technology is the leader in high-resolution surface and wavefront measurements used in a variety of challenging environments, locations, and applications. <https://4dtechnology.com/>

AdValue Technology supplies high quality materials for advanced material research and production and is a leading supplier of high temperature ceramic products. <https://www.advaluetech.com/>

Applied Energetics is a leader in advanced optical and directed energy technologies serving the defense and industrial segments. <https://aergs.com/>

Arizona Thin Films is a manufacturer of custom optical coatings utilizing state of the art automated vacuum coating equipment. <https://arizonathinfilms.com/>

Benchmark provides innovative technology and engineering design services and manufacturing to multiple global market segments including aerospace and defense,, medical, industrial, telecommunications. <https://www.bench.com/tempe-az-headquarters>

Distant Focus Corporation is an R&D engineering firm specializing in optical and sensing technologies and routinely partners with academic researchers, national laboratories, and military contractors to develop cutting edge solutions. The company moved to Tucson from Illinois in 2019. <https://www.distantfocus.com/>

Edmund Optics (EO) is a leading global manufacturer and supplier of optics, imaging and photonics technology serving a variety of markets including life sciences, biomedical, industrial inspection, semiconductor, R&D, and defense. EO added a second facility in Tucson in 2021. <https://www.edmundoptics.com/>

"We have found that the building of membership in Optics Valley has been of great advantage to our Arizona optics companies. Through our activities and events, companies are now able to collaborate and partner both locally and globally, to the benefit of all parties."

...John Dennis, Chair, Optics Valley

"Tucson is ground zero for emerging optical talent and technologies. Having an office in Tucson allows us to keep the pulse of the optics industry. Our Tucson office had tripled in size over the last decade. This wouldn't have been possible without the local talent pipeline and thriving optics ecosystem."

..Marie Edmund, Chief Marketing Office, Edmund Optics.





Global Superabrasives (GSA) provides manufacturing, sales, distribution and service of superabrasive products and accessories. GSA's markets include high-tech ceramics, medical, aerospace, precision optics and electronics industries. <https://www.globalsuperabrasives.com/>

Leonardo Electronics US, Inc., provides product development, program support and vertically integrated production of laser and electronic components and systems to the defense, security, medical and industrial segments. Leonardo expanded in Oro Valley in 2021. <https://www.leonardo.us/laser-solutions>

PADT is a globally recognized engineering product and services company that focuses on helping customers who develop physical products by providing Numerical Simulation, Product Development, and 3D Printing solutions. www.padtinc.com/

Photonics Automation Specialists designs and manufactures custom instruments, test stations and burn-in racks. <https://www.photonicsautomation.com/>

Vaisala is a global technology leader and expert in weather, environmental and industrial measurements whose product supports the needs of governments and private sector companies. <https://www.vaisala.com/en>

Viavi Solutions is a global leader in network test, monitoring and assurance solutions for communications service providers, enterprises, network equipment manufacturers, government, and avionics. Viavi relocated its headquarters to Chandler, Arizona in 2021. <https://www.viavisolutions.com>

"In February 2022 we moved our headquarters from California to Arizona and announced plans to build a new state-of-the-art manufacturing facility in the state. Arizona's strong optics ecosystem, business-friendly climate, and deep pool of talent made the decision easy for our team."

...Oleg Khaykin, president and CEO of VIAVI Solutions.





Conclusion

- ▶ This white paper has identified many factors that must be present in a city or region for optics companies to thrive.

Arizona really does check all the boxes. There are many community leaders, stakeholders and local professionals who are eager to help new or established companies make Arizona their new home. Tucson, being home to the premier academic institution for optical sciences, also adds to the attraction.

As this paper details, many companies have chosen Arizona and we hope you'll join them and us.

"Michael helped our company relocate to Tucson. He has helped a lot to establish contacts with organizations and businesses here. He continues to be very responsive and helpful with any questions we have."

....Leanne, Distant Focus

TuSimple chose to locate and scale in Tucson for many reasons and high on the list is the world-class talent in optics due to the foundation laid by the University of Arizona, and other local industries that recruit top talent. Tucson is a warm and welcoming city with business friendly environment.

...TuSimple

"Michael helped us get the ball rolling on our recent relocation. He understood our unique needs as an optics company and showed us variety of properties. ... (H)e helped us through the initial contract negotiations and got us started on the tenant improvements with an architect and contractor."

...Brent Bergner, Chief Engineer, Mahr

Contact Michael Coretz, your Tucson commercial real estate partner, or Optics Valley, for more information.





Resources, Associations & Publications

Arizona Technology Council www.aztechcouncil.org

BIOSA (Bio Association of Southern Arizona) www.biosaz.org

BizTucson The Region's Business Magazine www.biztucson.com

Center for Photonics Innovation (CPhI), Arizona State University <https://photonics.asu.edu>

Optics Valley www.opticsvalleyaz.org

Optics Valley Member List <https://bit.ly/3yLN4nn>

Pima Community College Apprenticeship Training Program
www.pima.edu/business-industry/apprentice-training.html

Sun Corridor Inc. www.suncorridorinc.com

SPIE www.spie.org

Startup Tucson <https://www.startuptucson.com/>

The University of Arizona

Arizona Center for Innovation (AzCI) techparks.arizona.edu/azci

BIO5 Institute www.bio5.org/

Department of Astronomy & Steward Observatory www.as.arizona.edu/

Tech Launch Arizona techlaunch.arizona.edu

The College of Optical Sciences www.optics.arizona.edu

The University of Arizona www.arizona.edu

Tech Parks Arizona techparks.arizona.edu

Lifestyle

45 Reasons to Move to Tucson www.tucsonopia.com/45-reasons-to-move-to-tucson

Visit Tucson www.visittucson.org

Tucson 101 from Sun Corridor <https://suncorridorinc.com/living-and-working/tucson-101/>

Commercial Real Estate

Relocation Guide

www.commercial-real-estate-tucson.com/resources/2018-relocation-guide

Infographic on Buying vs. Leasing

www.commercial-real-estate-tucson.com/market-resources/infographics

Business Facilities magazine's ranking of states:

www.commercial-real-estate-tucson.com/market-advice/infographics/?doing_wp_cron=1637601192.95175504684444824218750





Tucson's response to site selectors' COVID-19 concerns www.commercial-real-estate-tucson.com/resources/site-selectors-guild/?doing_wp_cron=1637601298.1456990242004394531250

Arizona's Affordability vs. California www.commercial-real-estate-tucson.com/resources/arizona-business-costs-win-over-california/?doing_wp_cron=1637601392.7235810756683349609375

Arizona's business incentives: www.commercial-real-estate-tucson.com/resources/2019-arizona-business-incentives/?doing_wp_cron=1637601436.6600980758666992187500

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