

Working Paper

Arizona State Freight Plan

(ADOT MPD 085-14)

Trends, Needs and Issues

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Working Paper on Trends, Needs and Issues

This working paper describes the macro social, technological, economic, environmental and political trends that are expected to influence freight flows in Arizona. It also summarized related Arizona freight transportation system needs and issues and potential policy responses.

Acknowledgements

The CPCS team would like to thank the Arizona Department of Transportation (ADOT) for its guidance and input in developing this working paper, as well as the input and comments of those consulted in its development. Further input from the Technical Advisory Committee (TAC) and Freight Advisory Committee (FAC) is anticipated.

Opinions

Unless otherwise indicated, the opinions herein are those of the author and do not necessarily reflect the views of ADOT, the TAC, FAC, or the State of Arizona.

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Executive Summary

This working paper identifies several trends which will have important implications for Arizona's freight transportation system. Most significantly:

- **Population growth, concentrated in the Phoenix and to a lesser extent Tucson metro areas** will have the dual impact of generating more truck trips to serve local demand while also increasing pressure from passenger vehicles on area roads. Road capacity needs and issues will be most acute in and around Phoenix and this is likely to get worse as Arizona's population increases.
- The **gradual and continuing economic recovery in Arizona** will also lead to more truck trips on roads in major urban centers. A rebound in trade will also add pressure on some of Arizona's Key Commerce Corridors. This may be offset-somewhat if regional water scarcity and regional manufacturing challenges erode some of Arizona's growth prospects.
- Though more difficult to predict, **climate change has been associated with a greater number of extreme weather events**. An increase in the frequency of extreme weather events negatively impacts the stock of transportation infrastructure in Arizona, and cause disruptions for the freight supply chains that rely on Arizona's freight transportation system. Preparedness and resilience to disruptions will need to be a key consideration in Arizona freight planning.
- **Funding freight projects in Arizona will continue to be a challenge** given scarce resource and competing funding priorities. This challenge is particularly acute given that there are no dedicated freight funding programs in Arizona, though the FAST Act creates one means of helping pay for critical freight projects.

Beyond these most significant trends, needs and issues, previous analysis has identified several highway-specific needs and issues, which, unless addressed, are likely to become more pronounced with increased passenger and freight related traffic, economic growth and increased trade with Mexico, as well as increased frequency of weather events such as dust storms.

- **Congestion in and around urban centers**, for example along the I-10 in Greater Phoenix and Tucson and at key junctions (US 60, SR 95, SR 85, on urban portions of the I-17).
- **Border-related delays**: For example all traffic is stopped at milepost 25 of the I-19 due to border inspection activity contributing to delay and reduced corridor reliability.
- Winter **weather-related disruptions** in the northern part of the state (e.g. snow related closures along the I-40) and **dust storms** along the I-10 between Tucson and Phoenix.
- **Lack of passing and climbing lanes** on Key Commerce Corridors (e.g. along I-17, I-10, I-40, I-11 U.S. 93).

Other highway/road sector needs and issues, include:

- **Lack of safe truck parking** across Arizona, especially on the I-17 corridor between Phoenix and Flagstaff and on I-10 between Tucson and Blythe, California.
- **Low axle-load restrictions** are often cited as a top issue, particularly for natural resources sector stakeholders.
- The **shortage of truck drivers** is a national phenomenon, and is pronounced in Arizona.
- **City ordinances related to noise** have been cited by retail sector companies as issues in certain areas of Tucson and Phoenix, which limits the ability of certain stores to be replenished outside of congested hours.
- Some companies – largely serving the retail sector - noted **challenges in maneuvering large trucks to and from delivery docks** at shopping centers.
- Agricultural sector stakeholders note that **transportation equipment (trucks and trailers) can be in high demand during harvest seasons** and cause difficulty in scheduling.

Non-highway/road needs and issues include:

- **Rail:** Additional road/rail grade separation, where traffic justifies. Some have called for greater north-south rail infrastructure and access to industrial sites, though these are purely commercial consideration of freight railroads.
- **Air:** Inadequate international air connections at Sky Harbor, limited weekend and off-hour customs services, localized truck issues around Sky-Harbor (“first and last” mile).
- **Pipeline:** A lack of fuel storage capacity in Arizona provides little inventory and/or options (e.g. redundancy) to redistribute product in the event of system disruptions. As with new rail infrastructure, these are strictly commercial considerations.
- **Borders and international trade gateways:** Limited land port of entry highway and rail capacity and limited roadway connections, poor reliability at the Mexican border (unpredictability of crossing times).

The prioritization of ADOT actions and identification of specific projects and improvement options is to come. Nevertheless, key considerations that should inform policy responses in light of the trends, needs and issues identified in this working paper include:

- **Looking beyond freight.** The evaluation of project priorities and improvement options should recognize both freight and passenger benefits. The development of the Arizona State Freight Plan should be closely coordinated with the update of Arizona’s LRTP.
- **Focusing on needs and issues in urban centers.** Related policy responses and investments should be closely coordinated with the Metropolitan Planning Organizations in each Phoenix and Tucson metro areas.
- Maintaining a focus on **improving the performance of Arizona’s Key Commerce Corridors**, including some of the specific needs identified herein, and enabling improved performance of road connectivity to Mexico land ports of entry.
- **Aligning with FAST Act requirements** for freight investments.

Acronyms and Abbreviations

3D	THREE DIMENSIONAL
AADTT	ANNUALIZED AVERAGE DAILY TRUCK TRAFFIC
ACA	ARIZONA COMMERCE AUTHORITY
ADOT	ARIZONA DEPARTMENT OF TRANSPORTATION
BNSF	BNSF RAILWAY
BTU	BRITISH THERMAL UNIT
CAD	CANADIAN DOLLAR
CMAQ	CONGESTION MITIGATION AND AIR QUALITY
CNG	COMPRESSED NATURAL GAS
COG	COUNCIL OF GOVERNMENTS
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY
EUR	EURO
FABS	FABRICATION PLANTS
FAC	FREGHT ADVISORY COMMITTEE
FAST ACT	FIXING AMERICA'S SURFACE TRANSPORTION ACT
FHWA	FEDERAL HIGHWAY ADMINISTRATION
GDP	GROSS DOMESTIC PRODUCT
KCC	KEY COMMERCE CORRIDORS
LOS	LEVEL OF SERVICE
LNG	LIQUID NATURAL GAS
LPOEs	LAND PORTS OF ENTRY
LRTP	LONG RANGE TRANSPORTATION PLAN
MAG	MARICOPA ASSOCIATION OF GOVERNMENTS
MAP-21	MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY ACT
MPD	MULTIMODAL PLANNING DIVISION
MPH	MILES PER HOUR
MPO	METROPOLITAN PLANNING ORGANIZATION
MXN	MEXICAN PESO
PAG	PIMA ASSOCIATION OF GOVERNMENTS
PHX	PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
POE	PORT OF ENTRY
SIP	STATE IMPLEMENTATION PLAN
SO2	SULFUR DIOXIDE
SSDS	SOLID-STATE DRIVES
STEEP	SOCIAL, TECHNICAL, ENVIRONMENTAL, ECONOMIC AND POLITICAL
TAC	TECHNICAL ADVISORY COMMITTEE
TIFIA	TRANSPORTATION INFRASTRUCTURE FINANCE AND INNOVATION ACT
TIGER	TRANSPORTATION INVESTMENT GENERATING ECONOMIC RECOVERY
TPP	TRANS-PACIFIC PARTNERSHIP
TPTI	TRUCK PLANNING TIME INDEX
TTTI	TRUCK TRAVEL TIME INDEX
TUS	TUCSON INTERNATIONAL AIRPORT

UPRR	UNION PACIFIC RAILROAD
USD	U.S. DOLLAR

1

Introduction

Key Messages

The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy.

The purpose of this working paper is to:

1. Highlight macro trends and describe how these will influence freight industry operations in Arizona
2. Synthesize related Arizona freight transportation system needs and issues.

1.1 Introduction: Context

Arizona's economic potential is supported by the state's transportation infrastructure, which connects sources of production to markets.

When transportation infrastructure and related services are efficiently designed and competitively positioned, businesses benefit from lower transport costs, faster and better transportation services, and increased reliability; which in turn contribute to their own competitiveness and growth, and that of the broader region.

Effective freight planning and programming can help achieve these ends. Yet, fiscal realities are such that Arizona's Department of Transportation (ADOT) cannot address all transportation system needs and constraints. Rather, it must be strategic in defining and prioritizing its investments and system improvements.

To this end, ADOT's Multimodal Planning Division (MPD), is developing Arizona's State Freight Plan (Freight Plan, or Plan) which will provide strategic guidance to achieve its vision, goals and objectives.

Vision: Arizona's freight transportation system enhances economic competitiveness and quality growth through effective system performance and management.

Figure 1-1: Arizona State Freight Plan Goals and Objectives



Source: CPCS

1.2 Project Objectives

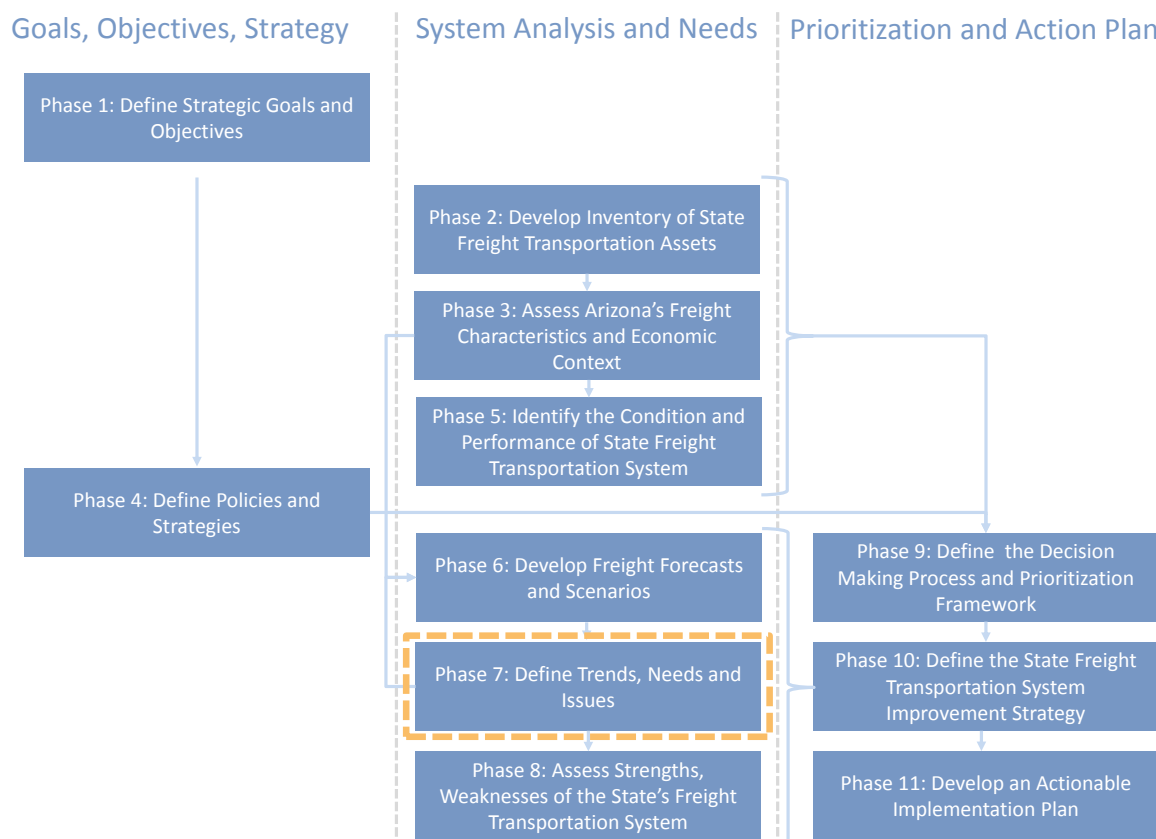
The State Freight Plan will define immediate and long-range investment priorities and policies that will generate the greatest return for Arizona's economy, while also advancing other key transportation system goals, including national goals outlined in MAP-21. It will identify freight transportation facilities in Arizona that are critical to the State's economic growth and give appropriate priority to investments in such facilities.

The State Freight Plan will ultimately provide Arizona with a guide for assessing and making sound investment and policy decisions that will yield outcomes consistent with the State's visions, goals, and objectives, and notably, promote regional competitiveness and economic growth.

1.3 Freight Plan Development Phases

The State Freight Plan is being developed in 11 phases, organized under three overarching headings, as summarized in the Figure 1-2. The present working paper is an output of Phase 7.

Figure 1-2: Phased Approach to the Development of Arizona's State Freight Plan



1.4 Purpose of this Working Paper

The aim of this working paper is to define the trends, needs and issues that will influence freight flows in Arizona and related transportation system performance requirements in the future. Specifically, this working paper addresses the following questions:

Which trends, needs and issues are likely to affect Arizona's freight transportation system?

- How will macro trends affect future freight flows and related system performance?
- How will these and other sector-specific trends influence freight flows, and what are the implications for the State's multimodal freight transportation system?
- In light of these trends, how can Arizona most meaningfully enable the goals and objectives of the Arizona State Freight Plan?

This working paper is submitted for review and comment by the Technical Advisory Committee (TAC) and Freight Advisory Committee (FAC). It will subsequently be revised or updated based on TAC and FAC comments, as appropriate.

1.5 Methodology

This working paper is organized to answer each of the key questions listed above. The findings were informed by a combination of literature reviews, data collection and analysis, and consultation with the operators and asset owners of Arizona's statewide multimodal freight system. The Arizona State Freight Plan Scenario Planning workshop held in Phoenix on November 5th, 2015 also informs this working paper. Of note, this working paper is a complement to earlier and ongoing work relating to the Arizona State Freight Plan. Earlier findings are synthesized, as relevant to this working paper, though sought to minimize redundancy.

1.6 Limitations

This report is in many cases informed by data and input provided by third parties. CPCS has verified this information to the extent possible through analysis and cross-checking with other sources but cannot guarantee the accuracy of data received from third parties.

2 Trends Influencing Freight Flows in Arizona

Key Messages

The trends that are likely to influence freight flows in Arizona include the following:

- **Social:** Population growth, concentrated in the Phoenix and to a lesser extent Tucson metro areas. This will drive consumer goods and associated transportation and logistics flows in these centers. It will also result in increasing pressure from passenger vehicles on metro area roads.
- **Technological:** The technology-enabled sharing economy, potential shifts in Arizona's energy mix, automation in transportation are among the key technological trends which will likely influence freight activity and flows in Arizona, although the magnitude remains unclear.
- **Economic:** Arizona's economy has begun to recover to pre-recession levels based on trade with Mexico and employment. The high tech sector is expected to continue to do well, while general manufacturing is likely to continue to decline. Natural resources will continue to be highly subject to commodities prices.
- **Environmental:** The possibility of increased extreme weather events is likely the most significant environmental trend in Arizona and will likely result in supply chain disruptions across most sectors. The potential for future water scarcity would also negatively impact the natural resources and water-intensive manufacturing sectors.
- **Political:** Constrained funding for transportation projects will limit ADOT's capacity to address the needs and issues facing the freight sector in Arizona.

Many factors influence the competitiveness and growth of Arizona's freight sectors and associated freight flows. The trends that are likely to influence freight flows in Arizona are discussed below, organized using the "STEEP" (Social, Technical, Economic, Environmental and Political) framework.

2.1 Social Trends

Population growth, the geographic concentration of Arizonans and their age distribution are key social trends which will influence freight activity and flows in Arizona, as summarized below.

2.1.1 Population Growth

Arizona is today home to some 6.7 million people. Population growth in Arizona, particularly in its major urban areas, has been highly cyclical in line with economic cycles. Population gains were highest from the early 1990s through the mid-2000s, but the gains in recent years, impacted by the deep 2008-2009 recession, have been the lowest since the 1960s.¹

Between 2010 and 2014, Arizona was the eighth fastest growing state, its population having increased by a total of 5.0 percent in the four year period, or 1.2 percent per year. By comparison, the overall population growth in the United States for this period was a total of 3.1 percent.² Growth in population is also expected to continue. Between 2012 and 2050, an additional 5.1 million people can be expected to be living in the state, meaning the population will increase by almost 80 percent, or 1.5 percent annually, from 6.5 million people in 2012 to 11.6 million in 2050.³

Unlike most geographic areas, where the primary source of population gains is the natural increase resulting from births and deaths, the majority of Arizona's population gains have for decades come from migration. The migration has come both from domestic sources, particularly Midwestern and western U.S. states, and from international sources, particularly Mexico.⁴ Consistent with this, migration is forecast to contribute more than two thirds of the growth in Arizona's population going forward. Between 2012 and 2050, domestic and foreign migration are forecast to account for, respectively, 46 percent and 22 percent of the overall population growth, while the natural increase should contribute 32 percent.⁵

Arizona's population growth will continue to spur demand for consumer goods and agricultural products and related transportation and logistics activity and freight flows.

¹ Arizona Indicators, *Indicator Insight, Demographics, An Expert's Insight on the Issue in Arizona*, Volume 4, Issue 1 (March 2013).

² United States Census Bureau. *Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2014* (December 2014).

³ Arizona Department of Administration, Office of Employment and Population Statistics, *Arizona State and County Population Projections; 2012 to 2050, Medium Series*. [Link Here](#).

⁴ Arizona Indicators, op. cit.

⁵ Arizona Department of Administration, Office of Employment and Population Statistics, op. cit.

2.1.2 Geographic Distribution of Population

Growth in population has not been uniformly distributed. The majority of population growth experienced by Arizona has been in urban areas. Between the 2000 and 2013, the size of urban areas in the state has increased by 514 square miles, from 1,686 to 2,200 square miles. The figure below maps out this increase, with red areas representing the increase in urban land use between 2000 and 2013.

Figure 2-1: Growth in Size of Urban Areas in Arizona

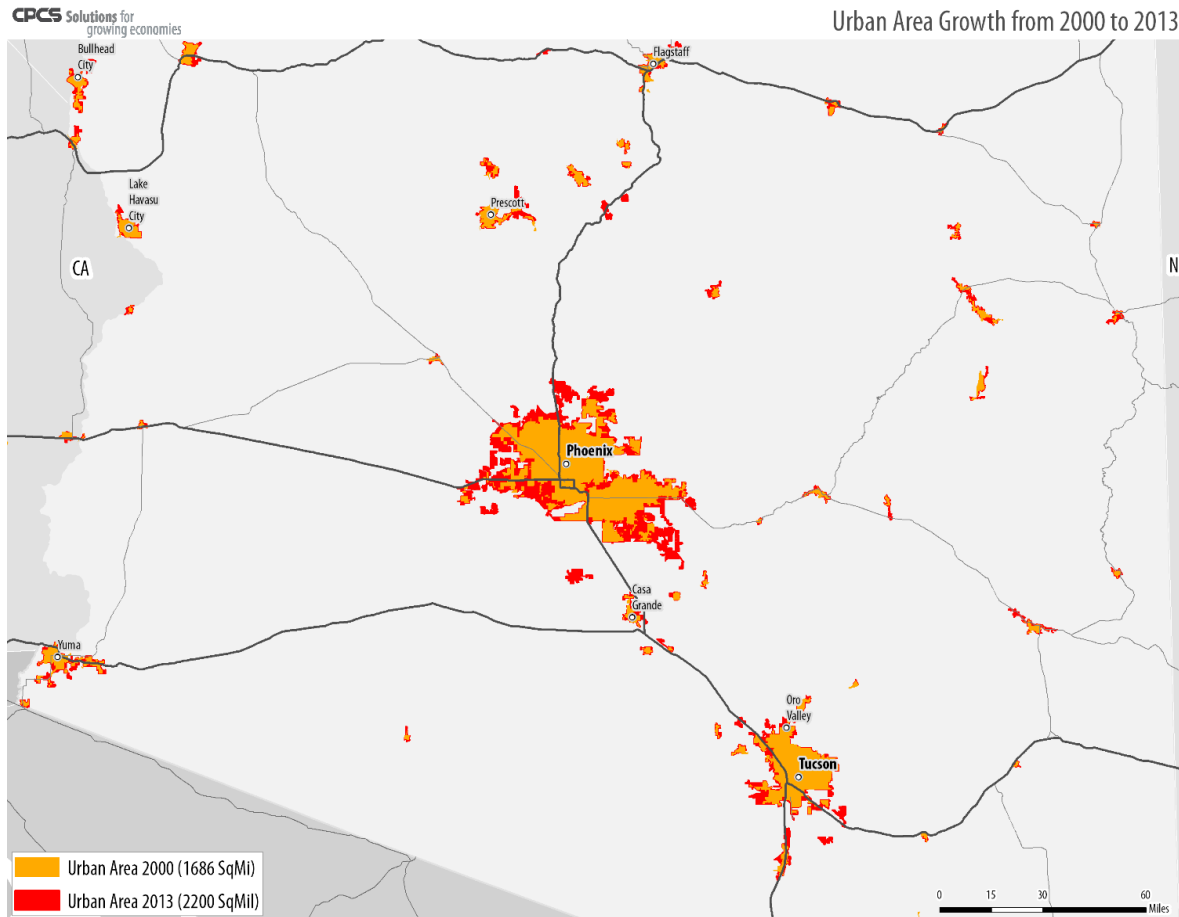
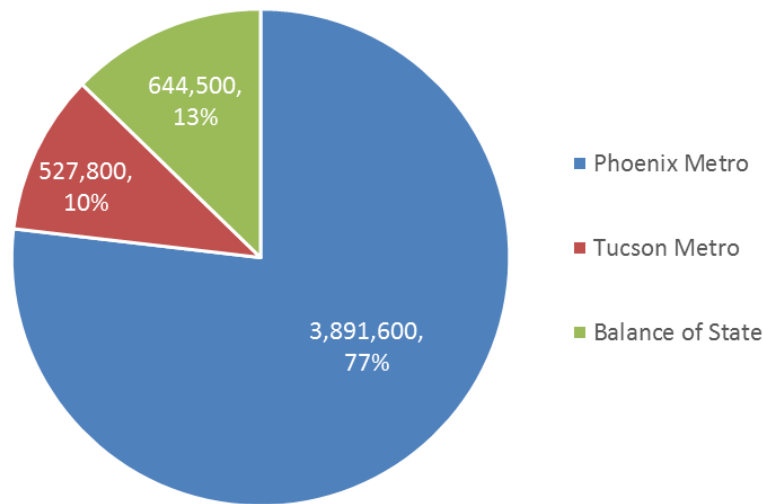


Figure 2-2 breaks down the projected increase in population by location within the state. The Phoenix Metro Area can be expected to lead this growth. Of the 5.1 million additional inhabitants expected to be living in Arizona between 2012 and 2050 (according to the “medium forecast”), it is forecast that 77 percent of those will be located in the Phoenix Metro Area, 10 percent will be located in the Tucson Metro area, and the remaining 13 percent will be located in other areas of the state. In relative terms, Metro Phoenix in 2050 will be 1.9 times its population in 2012, with Tucson Metro and the balance of the state both expected in 2050 to have 1.5 times their respective 2012 populations.⁶

⁶Ibid.

Figure 2-2: Growth in Arizonan Population by Urban Area (number of additional inhabitants expected 2012-2050)
(Medium Forecast)



Source: Arizona Department of Administration, Office of Employment and Population Statistics

The increasing concentration of Arizona's population in the Phoenix and to a lesser extent Tucson Metro areas will lead an increasing concentration of freight flows in and around these centers. It will also result in increasing competing pressure for Metro-area road capacity from commuters and other passenger trips.

2.1.3 Age Distribution of Population

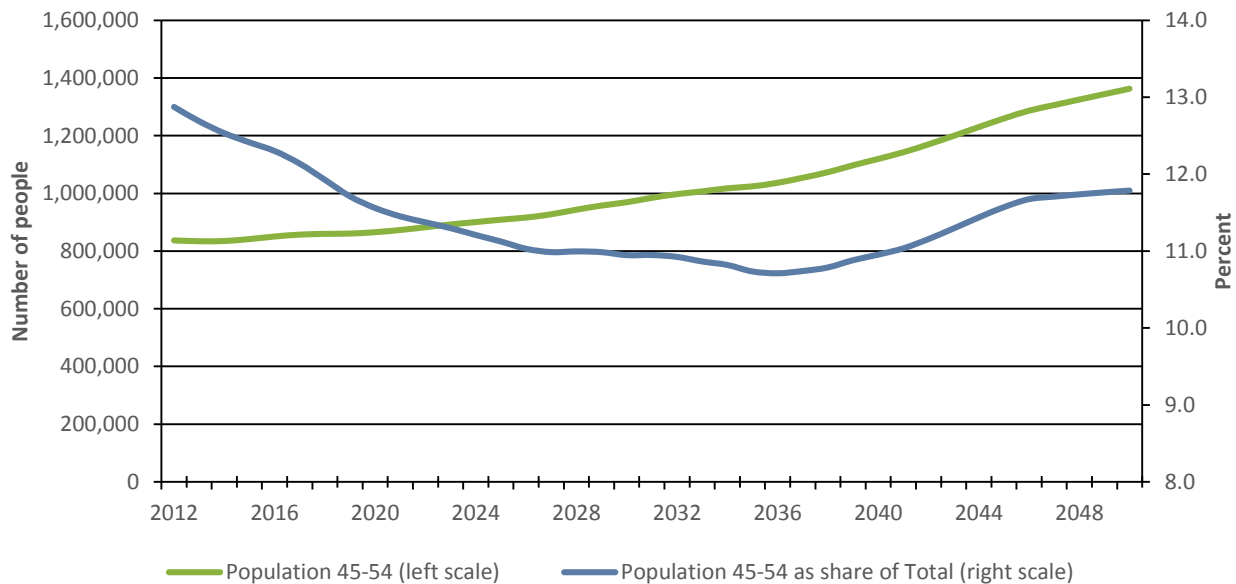
The U.S. has just passed through the period where one of the largest generations in U.S. history, the "Baby Boomers," reached its spending peak. The generation following ("Generation X") is estimated to be significantly smaller. Importantly, the younger generation, the "Millennials" born during the last two decades of the 20th century and now between 15-35 years of age, is estimated to be an even larger group than the baby boomers. And while the baby boomers are moving into retirement ages, the Millennials are now approaching their peak earning and spending years.

Peak spending years are considered to be when the primary income earner is between ages 45-54. At this age, households typically consume the greatest amount of transportation and freight intensive goods and services such as housing (utilities, household furnishing and equipment, etc.), transportation (autos, gasoline etc.), food and other items.

Of the 6.7 million people in Arizona, about 12.5 percent are within the ages of 45-54. This share is about 0.6 percent below its peak in 2009-2010. As shown in Figure 2-3, the share of this age group should continue to decline until 2035. It should then reverse, reaching 11.8 percent in 2050, and stimulating demand as the Millennial generation ages. In numbers, the Arizona

population ages 45-54 is forecast to increase by 63 percent, or 1.3 percent annually, from some 837,000 in 2012 to 1.3 million in 2050.

Figure 2-3: Arizona Population Ages 45-54



Source: Arizona Department of Administration, Office of Employment and Population Statistics, *Arizona State and County Population Projections; 2012 to 2050, Medium Series*

Beyond population growth, the demand for consumer goods and related transportation and logistics activity will be influenced by the absolute growth of the population in their “peak spending years”.

2.1.4 Implications for Freight Sectors

Consumer Goods Sectors

Population growth, in particular in the Phoenix and Tucson Metros, and related demographic trends are expected to increase the demand for consumer goods, and associated freight flows. The concentration of population in and around the Phoenix and Tucson Metro areas will also likely also create a greater concentration of flows to these centers.

Manufacturing Sectors

A growing and more concentrated population base will increase Arizona’s labor pool in and around the Phoenix and Tucson Metro areas. This could have positive implications for manufacturing sectors, though does not on its own assure the growth or success of Arizona’s manufacturing base.

Natural Resources Sectors

For the agricultural sector, an increase in population is expected to lead to increasing demand for food products. However, an increase in urban population may mean ongoing loss of productive lands around the Phoenix Metro area, requiring production to either shift elsewhere in the state or move out of state. For industries related to construction, such as the forestry and mining sectors, growth in new housing developments and supporting infrastructure will generate demand for lumber and wood products as well as inputs from sectors such as aggregates from the mining sector.

Transportation and Logistics Sector

Transportation and logistics activity is expected to follow demand generated by other sectors, including in particular, the consumer goods sectors. This is expected to create new demands for additional capacity to warehouse and distribute goods to retail and other locations. At the same time, increases in congestion as a result of the larger populations in metro areas may make the cost of transporting goods more expensive.

2.2 Technological Trends

The technology-enabled sharing economy, Arizona's changing energy mix, automation in transportation and manufacturing are among the key technological trends which will likely influence freight activity and flows in Arizona, as summarized below.

2.2.1 Technology-Enabled "Sharing Economy"

In 2013, Forbes estimated the revenue flowing through the shared economy directly into people's wallets would surpass \$3.5 billion, with growth exceeding 25%.⁷ PwC estimates that the global sharing economy will generate \$335B in revenue by 2025.⁸

For example, in 2015, the number of people driving for Uber in the U.S. grew from 160,000 to more than 400,000. Airbnb signed up new hosts. Grocery-platform Instacart enlisted thousands of more shoppers.⁹ Perhaps the more significant impact for the freight sector will be in leveraging and extending the technologies that enable the sharing economy for freight.

The range and extent of impacts of the sharing economy on Arizona's freight transportation system continue to evolve, but could include a reduction in personal vehicle use and better utilization of assets used in transportation and logistics.

⁷ Forbes, *Airbnb and the Unstoppable Rise of the Share Economy*. January 23, 2013. [Link Here](#).

⁸ PwC, *The Sharing Economy – Sizing the Revenue Opportunity*. [Link Here](#).

⁹ Quartz, *The Verdict on the "Sharing" Economy, from the 20% of Americans who've Worked in it*. January 7, 2016. [Link Here](#).

2.2.2 Changing Energy Mix

While Arizona is highly dependent on the import of fuels, new technologies among other factors are influencing a shift to lower emitting fuels sources, with resulting implications for freight flows (such as reduced flows of coal, for example). Arizona has in particular been one of the leading developers of a solar industry in the U.S.¹⁰

With respect to transportation fuels, both compressed (CNG) and liquefied (LNG) are viable fuel sources for heavy duty vehicles. While national trends such as an increasing supply of natural gas, environmental regulations, and growing natural gas fueling infrastructure may push the conversion of truck fleets to natural gas in the long-term, short-term conversions will likely remain limited. Nationally, the U.S. Energy Information Administration predicts that natural gas will fuel 14 percent of heavy-duty vehicles by 2040, though this information is not disaggregated to the state level.

In the west and southwest, natural gas trucks could emerge sooner than in other parts of the U.S., due to more stringent environmental regulations (in California) and the development of supporting infrastructure.

Currently Arizona has three LNG stations and 15 CNG stations.¹¹ Most of the CNG stations are in the Phoenix metropolitan area, and are publically accessible but may not be truck accessible.

2.2.3 Automation in Transportation

One of the largest technological advances that may impact the future of transportation is research in autonomous and connected vehicle technologies. Vehicles such as Freightliner's partially autonomous "Inspiration Truck" may point to changing dynamics in freight transportation. Several automotive companies are researching and working on the future development of fully autonomous passenger and freight transportation vehicles, and the vehicle-to-vehicle technology installed on these units may also enable the vehicles to be "connected." In the case of trucks, this would allow multiple trucks to operate as convoys on road in the future, requiring only a lead driver guiding the other tractors.

The implications of autonomous and connected trucks will extend to supply chain management, business decisions, labor markets, as well as transportation infrastructure planning.

¹⁰ Solar Energy Industries Association, *2014 Top 10 Solar States*.

¹¹ U.S. Department of Energy, *Natural Gas Fueling Station Locations*. [Link Here](#).

Associated industries, such as truck stops and truck repair services, would also be secondarily impacted.

2.2.4 Automation in Manufacturing

Advances in production technology are occurring all over the U.S. and are changing the way companies conduct their business as well as lowering their costs. The biggest advancement in this arena is 3D printing, also known as Additive Manufacturing, which has emerged as a viable option to distribute manufacturing widely as well as allow for new designs for engineered materials. Large-scale 3D printing has enabled entire houses to be printed in less than 24 hours. Bridges can be “printed” in place and assembled with minimal disruption to the traveling public. In Arizona, one local manufacturer plans to debut the LM3D in 2016, which would be the first 3D printed car to hit roadways and be available for purchase.

The proliferation of manufacturing sites, with on-site 3D printing production capability, will change the dynamics of supply chains considerably and likely lead to a reduction in the flow of finished products.

Component part movement may be replaced by that of raw materials to feed 3D printers, requiring a transportation system that deftly handles bulk commodities.

2.2.5 Implications for Freight Sectors

Many of the technological trends noted are evolving quickly and their impact on the freight transportation system in Arizona are not yet fully known. Nevertheless, potential impacts on Arizona’s four economic sector groups are noted below.

Consumer Goods Sectors

The continued growth of the shared economy and gradual proliferation of 3D printing will likely lead to a decentralization of production and distribution activities. The extent to which this would result in fewer truck flows or changed truck transportation patterns is not yet known, although as fast as these things are evolving, their impact will likely take many years.¹²

Manufacturing Sectors

The manufacturing sectors may be impacted in a similar way as the consumer goods sector, though the extent of these impacts on freight flows in Arizona are not yet evident.

¹² The timeline for implementation of the Arizona State Freight Plan is five years, which potentially limits the extent to which the state will be impacted by these trends. That said, there is still value in ADOT identifying and tracking these trends as they emerge and impact the transportation system, so that the DOT may engage in effective long-range transportation planning.

Natural Resources Sectors

Certain natural resources freight flows are expected to decrease over time. A decreasing dependence on coal will result in lower volumes of coal using Arizona's transportation system. Alternatively, wider adoption of technologies could supplement a decrease in coal. For example, as the adoption of electric cars and other battery powered technologies increases, Arizona would expect an increase in commodities such as lithium from northern Sonora using Arizona's transportation and border infrastructure.¹³

Transportation and Logistics Sector

Alternative fuels for transportation could also reduce transportation costs for carriers and reduce or otherwise change the product and modal mix of fuels destined for consumption in Arizona. Automation in transportation, such as increasing automation in vehicles and the potential for future autonomous vehicles, could lead to productivity increases in transportation. Automation may allow for fewer drivers to be needed in the transportation and logistics sectors. In the long run, these productivity increases may translate into lower transport costs for shippers and more efficient uses of transport infrastructure (increase in vehicle throughput due to automation).

The speed at which Arizona is able to adopt automated technologies may impact the competitiveness for all freight modes and their related sectors in the future.

¹³ Jamasmie, C. *Bacanora's Lithium Project in Mexico Three Times Richer than Thought*, November 23, 2015 Mining.com. [Link Here](#)

2.3 Economic Trends

2.3.1 Synthesis of Economic Trends Identified in the Economic Context Report (Phase 3)

The separate Economic Context Report, developed as part of Phase 3 in the development of the Arizona State Freight Plan, presents a number of economic trends that will likely influence Arizona freight flows:

- **GDP Growth:** Although the Arizona economy outperformed the U.S. economy by over 2 percent (nominal GDP growth) per year between the 1990s and the Great Recession, Arizona has since underperformed relative to the overall U.S. economy.¹⁴
- **Employment:** Evidence of an improving economy, Arizona regained the jobs lost during the Great Recession in February of 2016.
- **Retail Trends:** Between 2009 and 2014, retail activity growth in Arizona averaged 3.5 percent per year in nominal terms, which remains less than that of pre-recession levels (4.8 percent per year between 1997 and 2007, on average).
- **Residential Construction:** The Arizona house construction sector was one of the worst hit in the U.S. during the Great Recession.¹⁵ The level of new residential construction activity is only now recovering but it remains far below the level in between the mid-1990s and the mid-2000s.¹⁶
- **Trade with Mexico:** Arizona's share of the imports from Mexico is small but Arizona has seen its share grow, both in absolute and relative terms. These imports - which are dominated by agricultural products - are highly seasonal. Imports into the United States entering through Arizona totalled 4.1 million tons (3.7 million tonnes) in 2014, up from 2.2 million tonnes (2.4 million tons) in 2004.

In the interest of minimizing redundancy, these economic trends are not discussed further here. Related details are included in the Phase 3 Economic Context Report.

The following sub-sections highlight other economic trends which could influence Arizona freight flows.

¹⁴ CPCS Analysis of Bureau of Economic Analysis Regional Accounts

¹⁵ Bureau of Economic Analysis, *Gross Domestic Product by State, Advance Statistics for 2008 and Revised Statistics for 2005–2007*. Survey of Current Business Vol. 89, No. 6 (June 2009). [Link Here](#).

¹⁶ U.S. Census Bureau, Building Permits Survey

2.3.2 Export Trade Patterns

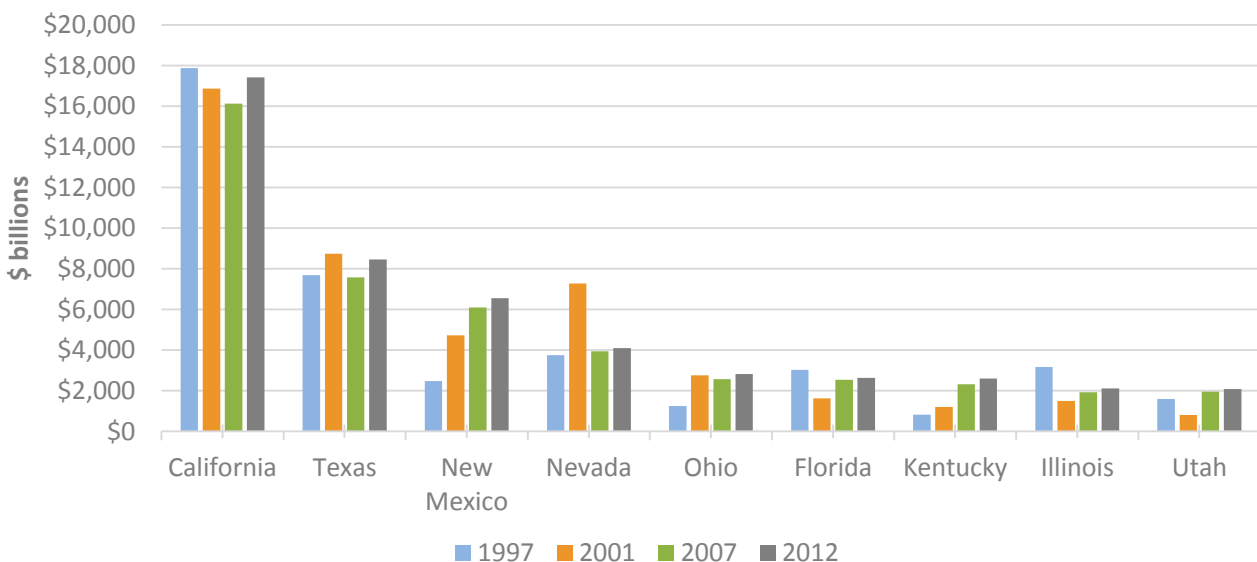
Domestic

Based on the latest Commodity Flow Survey, Arizona's exports to other U.S. states totals approximately \$76 billion (2012). Figure 2-4 shows the states that comprise the most important destinations for these domestic exports (some of which are ultimately destined for abroad).

California and Texas have consistently been the leading destination states, with these states together accounting for more than one third of Arizona's domestic exports. This is expected to continue.

In terms of the growth in domestic exports, the top destinations are New Mexico, Kentucky and Ohio, with these states together accounting for 60 percent of the growth in Arizona's domestic exports over the period 1997-2012.

Figure 2-4: Arizona Domestic Exports, Top Destinations



Source: FHWA Office of Freight Management, Freight Analysis Framework

International

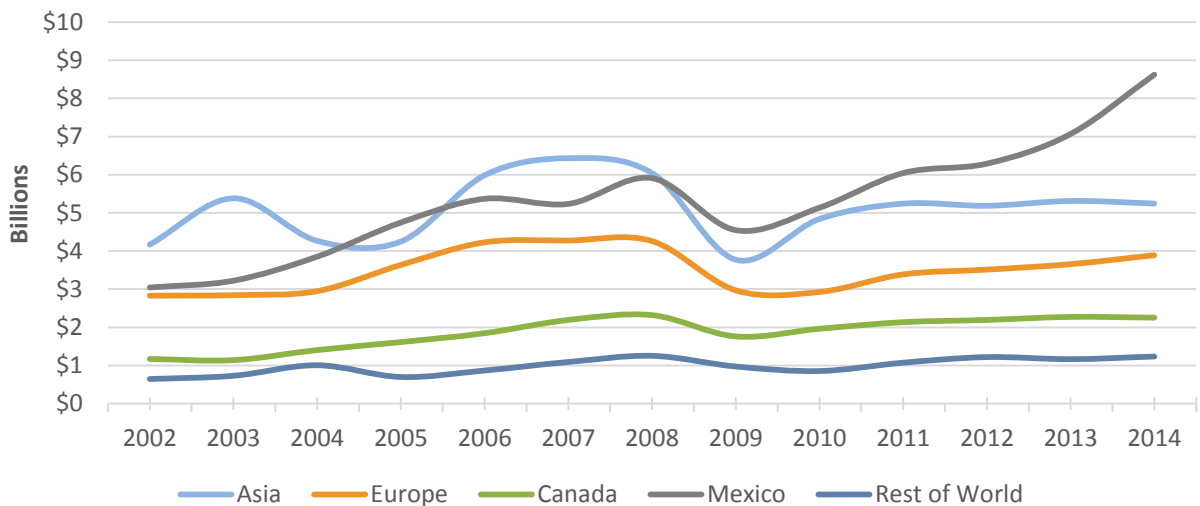
Arizona's total exports to international destinations have grown strongly, from \$11.9 billion in 2002 to \$21.2 billion in 2014, an increase of nearly 80 percent over this period, or 5 percent per year.

Figure 2-5 shows the pattern of international exports by destination region. The cyclical ups and downs are evident, particularly in the exports to Asia, Europe and Canada. It is also evident that, after recovering from the recession in 2009, exports to Asia and Canada have been flat.

Most striking, however, is the strong growth in exports to Mexico (some of which is ultimately destined to other regions), including the steady growth in the years following the 2009 recession. Exports to Mexico are now the largest component.

Overall, Arizona's exports to Mexico have increased by almost three times, from about \$3 billion in 2002 to \$8.6 billion in 2014, or at an annual rate of 9 percent.

Figure 2-5: Arizona International Exports by Destination



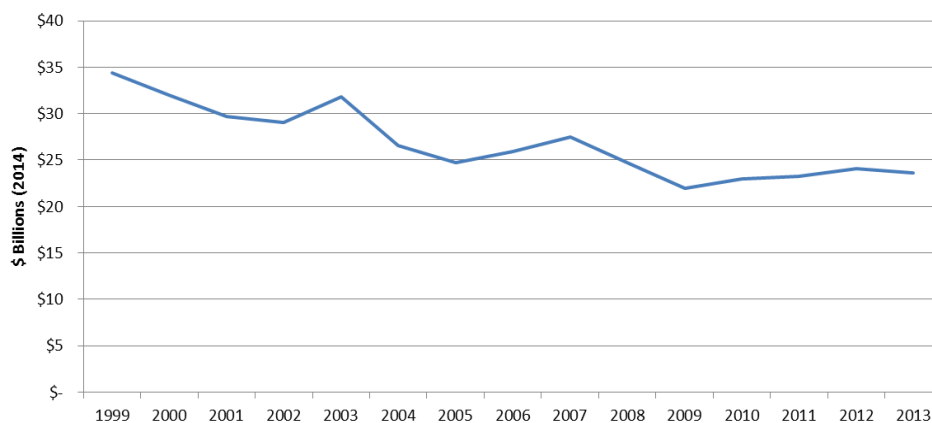
Source: U.S. Census Bureau, Trade Data Online

2.3.3 Trends in Key Arizona Economic Sectors

High Tech: Arizona has developed a reputation as being competitive for high-tech sectors such as optics/photonics and aerospace and defence, which have a strong presence in Arizona. Arizona's strength in these sectors is expected to continue.

Manufacturing: Arizona manufacturing has been dominated for the last ten years by computer and electronic products, followed by the production of transportation equipment. However, manufacturing GDP in the state has shown a declining trend during the last 15 years.

Figure 2-6: Total Arizona Manufacturing GDP

Sources: Bureau of Economic Analysis¹⁷

An analysis of historical data on the top five manufacturing industries in Arizona (ranked by GDP) shows the following trends (see Figure A-2):

- The computer and electronic industry's production seems to have fallen notably at the same time as the 2008 recession; however by 2013 it returned close to the 2007 level of production.
- The production of Other Transportation equipment fell from a height of almost \$6 billion (2007) to \$4.6 billion (2014) in 2013.
- The production of food, beverage and tobacco products has steadily risen.
- The rise of miscellaneous durable goods manufacturing shows a trend to diversification within the industry.
- The fabricated metal industry has not recovered from the recession.

Commodities: Several of the top ten freight sectors, namely mining, agriculture and forestry, produce outputs that consist of, or include among the products, basic commodities. Production level and related sector development projects are closely tied to commodities prices, which can be highly volatile (copper prices, for example) and are largely out of the control of producers (beyond keeping costs low).

Appendix A provides a more detailed discussion of sector specific trends.

2.3.4 Other Economic Trends

A number of other economic trends were presented and discussed at the Scenario Planning workshop held in Phoenix in 2015. These include global economic trends, electricity and energy prices (a key input for Arizona industry and transportation), currency exchange rate trends,

¹⁷ Bureau of Economic Analysis, *Regional Data, Current GDP by state for Arizona inflated with the Bureau of Labor Statistics West Urban Consumer Price Index*.

among others. Some of this analysis is presented in Appendix B, for reference. The long range outlook for these economic factors, and how these will influence the freight transportation system in Arizona, remains unclear.

2.3.5 Implications for Freight Sectors

Arizona's economy has begun to recover to pre-recession levels based on trade with Mexico and employment.

Consumer Goods Sectors

Demand for consumer goods, although likely most closely tied to population growth, should nevertheless continue to improve along with broader economic activity in Arizona, as jobs and incomes continue to rebound from the recession.

Manufacturing Sectors

The high-technology freight sectors will likely continue to be key drivers of high value employment and exports for the state of Arizona. Given the high-value and low weight/volume and export-dependent nature of the high-tech manufacturing sector, Arizona's competitiveness compared to that of other states is highly impacted by transportation competitiveness.

Natural Resources Sectors

For mining, agriculture and forestry, commodity prices are a key factor. Producers of basic commodities such as copper and cattle have, at best, limited pricing power and must instead live with whatever price is dictated by the market. Under such circumstances, being a low cost producer is essential. Also, for commodities, transport costs are a significant portion of the delivered price of the product. Commodity producers are therefore highly sensitive to the costs of transport, as well as dependent on access to an efficient transportation system in order to get products to market competitively.

Transportation and Logistics Sector

As is well recognized, transportation and logistics is not something desired for its own sake but is a "derived demand" emanating from the production of other goods and services and the need for their distribution. In general, the demand for freight transportation with respect to GDP is usually considered to have an elasticity of 1.0, meaning that it increases in proportion to GDP growth.

Also, trade patterns have important implications for investments in Arizona's Key Commerce Corridors. It is important that current freight routes like I-10 be properly maintained due to the current and future trade volumes expected. Investments should also support growing trade routes, such as the I-19 and MX-15 corridor into Mexico.

2.4 Environmental Trends

Climate change and associated extreme weather events is likely the most significant environmental trend in Arizona, as summarized below.

2.4.1 Climate Change

According to the U.S. Environmental Protection Agency, the average annual temperature in the southwest U.S. (including Arizona) has increased by 1.5 degrees Fahrenheit over the last century, and is projected to rise an additional 2.5 to 8 degrees Fahrenheit by the end of the century.

Increases in average annual temperatures are projected to produce more severe droughts and further reductions in water supplies.

Concerns over the potential for future water scarcity increase with the frequency and severity of droughts. Additionally, future water scarcity due to droughts would be further exacerbated by Arizona's population growth.¹⁸

The agriculture sector in Arizona is expected to be particularly impacted by climate change. More than 36 percent¹⁹ of Arizona's land is used for farming and ranching. Changes in availability of water, carbon dioxide levels, vegetation cover, and frequency of extreme events like flood, drought, or frost will impact crop and forage production, increasing costs for both producers and consumers. For example, farmers using irrigation systems that rely on rivers and underground aquifers could face higher costs as water prices rise in reaction to scarcity.

The forestry sector will also be impacted, as higher temperatures increased the likelihood and incidence of wildfires – 2015 provided to be one of the most challenging years this decade in terms of the incidence of wildfires in the western U.S.

2.4.2 Air Quality

Like all vehicles, trucks contribute emissions. The U.S. Environmental Protection Agency is mainly concerned with emissions which are (or could be) harmful to people. Monitoring and reducing these "criteria" pollutants is required by the Clean Air Act Amendments of 1990. Transportation-related criteria pollutants include carbon monoxide, nitrogen dioxide, ozone and particulate matter. The U.S. EPA designates areas with these pollutants as attainment (meeting), maintenance or nonattainment (not meeting) of the air quality standards. As shown in Figure 2-7, there are over 20 nonattainment or maintenance areas throughout the state of Arizona. While transportation conformity is not required in sulfur dioxide (SO₂) nonattainment areas, Arizona DOT has indicated these locations for illustrative purposes.

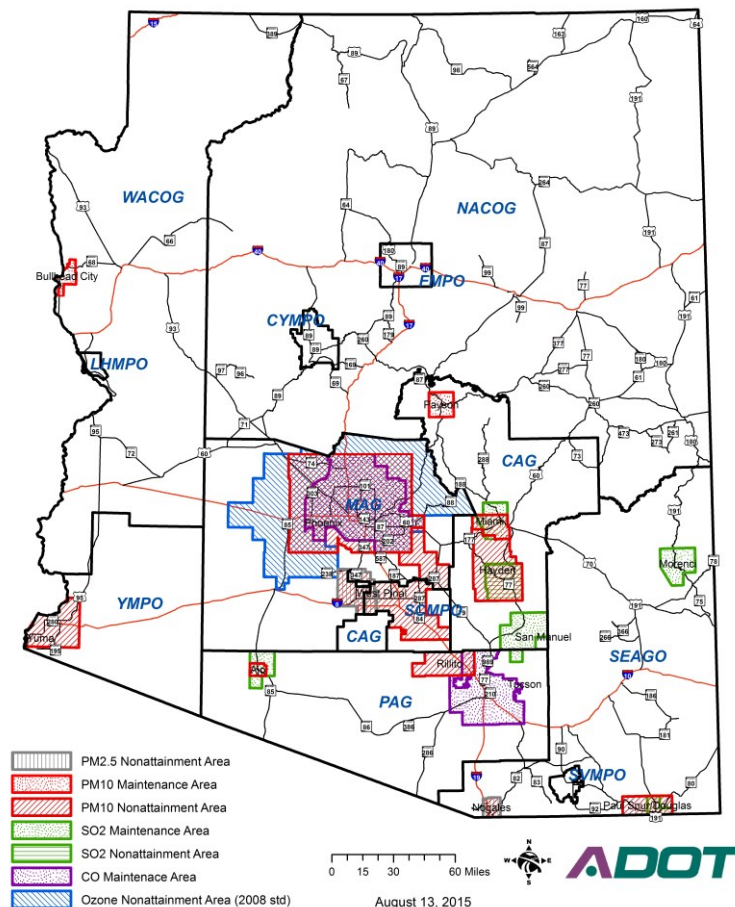
¹⁸ U.S. EPA, *Climate Change Southwest Impacts*. [Link Here](#).

¹⁹ United States Department of Agriculture Economic Research Service, *State Fact Sheets*. (Data Updated May 8, 2015).

Once an area has been designated as a nonattainment area for a given pollutant, the state must create a State Implementation Plan (SIP) to bring the region back into attainment status. Included in the SIP are emission budgets for various pollutant sectors, including on-road mobile source transportation, that outline the maximum emissions allowed as well as any transportation control measures used to reduce transportation emissions. There are numerous measures identified in Arizona's SIP to reduce trucks emissions – some which impose costs on carriers (e.g., engine retrofits), and some that the public sector may be able to assist with (e.g., operational improvements to reduce truck idling at borders and while parking). Most will alter how companies operate/invest in their fleets.

One challenge for Arizona is that chief sources of ozone and other pollutants are vehicles and transport from out of state. Vehicle emissions can only be regulated by the U.S. EPA and California already has stringent pollution controls in place. Therefore, international transport from Canada and Mexico plays a large role in contributing to pollutants in the West.²⁰

Figure 2-7: Arizona MPOs/COGs and Nonattainment/Maintenance Areas



Source: Arizona DOT, [Linked Here](#)

²⁰Arizona Department of Environmental Quality, *Briefing Paper – EPA's New, Lower Ozone Standard*. October 2, 2015. [Link Here](#).

2.4.3 Implications for Freight Sectors

Consumer Goods Sectors

The impact of climate change is not clear, though it could include weather-related disruptions to consumer goods flows and supply chains in the state.

Manufacturing Sectors

As with the consumer goods sector, impacts to the manufacturing sector could include weather-event-related disruptions to consumer goods flows and supply chains in the state. Water dependant manufacturing operations could also face increasing challenges and costs associated with water use.

Natural Resources Sectors

In the event that the frequency and severity of drought increases, water dependant agricultural and forestry sectors, among others, are likely to be significantly impacted by decreasing water availability, with expected material consequences on the movement of related outputs.

Transportation and Logistics Sector

Extreme weather events are likely to increase the number of disruptions to freight flows and Arizona supply chains.

Air quality regulations and other measures could include vehicle emissions control measures such as retrofits, the introduction of clean diesel and alternative fuel vehicles, and truck stop electrification. Traffic flow enhancement have been suggested to improve operations at border crossings. And, additional significant control measures such as regional diesel anti-idling regulations have also been identified.²¹ While all industries in the State would feel some impact of these changes, they likely will be most strongly felt by the carriers that operate the vehicles in regions where emissions are aimed to be reduced.

²¹ Arizona DOT, *Air Quality Guidebook for Transportation Conformity*. December 2013.

2.5 Political Trends

Government funding for transportation and related infrastructure is the most significant political consideration for freight.

2.5.1 Funding for Transportation

When Arizona DOT developed its most recent long-range transportation plan it highlighted a daunting challenge: prioritizing nearly \$89 billion of transportation needs over the next 25 years with only \$26 billion of expected revenue.

ADOT's planning efforts include developing a Five-Year Transportation Facilities Construction Program, which is revised annually. This Program covers capital costs for highways, transit, airports and highway-support facilities.²² The program focuses on multimodal forms of transportation, though there are no dedicated funds for freight projects. ADOT is also prohibited from making contributions to freight railroad projects.

A key finding from Phase 4 Working Paper on Policies and Strategies was that there is no specific funding dedicated to freight transport improvements in Arizona.

Freight projects in Arizona are currently examined under the same envelope as all other transport priorities.

In December 2015, President Obama signed the first law enacted in over ten years that will provide long-term funding certainty for surface transportation - the Fixing America's Surface Transportation Act (FAST Act).

The FAST Act provides freight specific programs that provide both formula and discretionary grant dollars that can be used to fund freight projects. The formula program will provide \$6.3 billion to states over five years, and the discretionary grant program will invest \$4.5 billion over 5 years.

Under the terms of the FAST Act, state freight plans must identify specific freight projects to be eligible for federal freight project funding.

2.5.2 Business Climate

The Tax Foundation's 2016 State Business Tax Climate Index ranks Arizona overall as 24th for the state business tax climate ranking. Of the five indicators measured to develop the business climate ranking, three have in particular impacted on competitiveness with other states: corporate tax rank (22nd), unemployment insurance tax rank (9th), and property tax rank (6th).

²² Arizona Department of Transportation, *Transportation Programming Summary*. [Link Here](#).

Arizona is in the process of further phasing down its corporate tax rank from 6.5% to 4.9% by 2018. This reduction is expected to improve Arizona's corporate tax rank and competitiveness.

Arizona's neighboring, competitor states, were also ranked in the index. Nevada (5th), Utah (9th) and Texas (10th) each scored in the top 10 best states to do business, and California (48th) scored near the bottom.

2.5.3 Trade Promotion (with Mexico)

Recent efforts have been made by various levels of government to support the continued growth in trade with Arizona and Mexico. After shutting its Mexican trade office in 2011, Arizona re-opened a trade office in 2014 in Mexico City. Delegations, including a visit from the Governor in June 2015, show support at a political level for Arizona-Mexico trade.

The Mariposa Port of Entry (POE) in Nogales is one of the busiest land ports in the U.S., in particular for produce imports into the U.S. The Mariposa Land POE Expansion project is one of the largest projects funded under the American Recovery and Reinvestment Act. Investments at the Mariposa POE will increase commercial lanes and booths from 4 to 8, secondary inspection stations from 33 to 56, and commercial exit booths from 2 to 5. The expansion project is expected to facilitate increased commercial goods traffic across the border and make Mariposa the land port of entry with the shortest wait times on the border with Mexico.²³

2.5.4 Implications for Freight Sectors

These trends are likely to impact directly or indirectly, each of the four economic sector groups.

The FAST Act has ushered in a new era for freight project implementation through formula and grant programs. However the level of funding provided in the Act overall is only an 11 percent increase in the next five years over past levels. This means that while additional transportation system funding will be provided, and some of those funds will have the flexibility to be used on multimodal freight projects, the overall assessment is that states will continue to feel the pinch of not enough transportation funding to meet system needs. In some states exploration of additional sources of funding will be continued, such as revenue based on vehicle miles traveled instead of fuel taxes, or other user fees. While a proposal is not on the table for either of these options in Arizona, as these new sources of revenue are implemented across the U.S., industry sectors will be impacted by additional costs and will pass these on to consumers.

There are both opportunities and obstacles for Arizona given the current political climate. Neighboring states continue to rank above Arizona as the best places to do business, but even California that doesn't rank well, continues to grow and attract residents and business. Arizona business leaders are taking a proactive approach to attracting and retaining industry, and recognizes partnership with Mexico as a key vehicle to accomplishing this. Arizona's trade office in Mexico is a valuable platform for binational freight infrastructure coordination to ensure efficient cross border movements, benefitting Arizona's key industry sectors.

²³ Maricopa Association of Governments, *Building an International Economic Network*. September 2015

3

Arizona Freight Transportation System Needs and Issues

Key Messages

The needs and issues resulting from the identified trends include:

Road capacity needs and issues. These will be most acute in and around Phoenix and Tucson and are likely to get worse with the continued growth of Arizona's population and increasing economic activity and trade.

Funding freight projects in Arizona will continue to be a challenge given scarce resources and competing funding priorities. The FAST Act presents an opportunity to identify and help fund freight projects in Arizona.

Though more difficult to predict, a greater number of extreme weather events have the potential to negatively impact the reliability of operations on the state's freight transportation system.

Beyond these most significant trends, needs and issues, previous analysis has identified several highway-specific needs and issues, which, unless addressed, are likely to become more pronounced with increased passenger and freight related traffic, economic growth and increased trade with Mexico, as well as increased weather events. These are discussed herein, along with other road needs and issues and non-highway/road needs and issues.

3.1 From Trends to Big Picture Transportation System Needs and Issues

The preceding chapter identified several trends which will have important implications for Arizona's freight transportation system. Most significantly:

- Population growth, concentrated in the Phoenix and to a lesser extent Tucson metro areas will have the dual impact of generating more truck trips to serve local demand while also increasing pressure from passenger vehicles on area roads.

Consultations with freight transportation system stakeholders in Arizona identified recurring congestion and bottlenecks in and around urban centers, particularly Phoenix, as the most significant barrier to transportation system performance and sector competitiveness in the state.

Road capacity needs and issues will be most acute in and around Phoenix and Tucson and are likely to get worse as Arizona's population increases.

- The gradual and continuing economic recovery in Arizona will also lead to more truck trips on roads in major urban centers. A rebound in trade will also add pressure on some of Arizona's Key Commerce Corridors. This may be offset-somewhat if regional water scarcity and regional manufacturing challenges erode some of Arizona's growth prospects.

The performance of Arizona's Key Commerce Corridors is also a priority to support the recovery and growth of Arizona's economy.

- Funding freight projects in Arizona will continue to be a challenge given scarce resource and competing funding priorities. This challenge is particularly acute given that there are no dedicated freight funding programs in Arizona, though the FAST Act creates one means of helping pay for critical freight projects.

Many freight stakeholders, notably those in the transportation and logistics sector, highlighted concerns about the limited funding available to maintain and expand the state's highway network.

Freight projects should recognize their benefits for passenger transportation in Arizona vice versa. But it should also be recognized that freight projects merit funding in their own right and these projects should be identified and evaluated accordingly.

- Though more difficult to predict, a greater number of extreme weather events have the potential to negatively impact the reliability of operations on the state's freight transportation system.

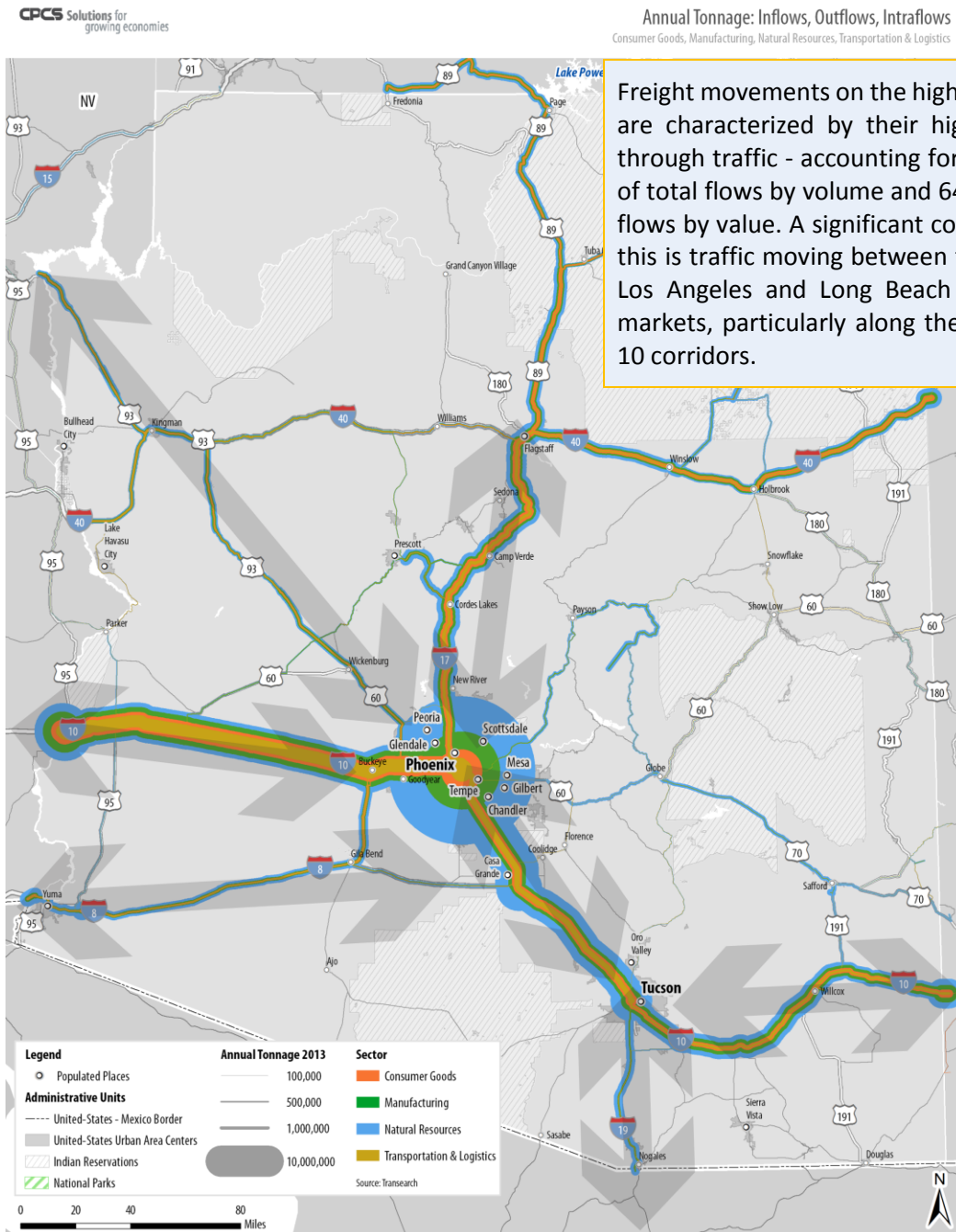
Preparedness and resilience to disruptions will need to be a key consideration in Arizona freight planning.

Beyond the noted big picture needs and issues, previous analysis has identified several highway-specific needs and issues. These are synthesized in the following section, by Key Commerce Corridor. This is then followed by a synthesis of non-highway needs and issues, and other needs as identified by Arizona's key freights sectors.

3.2 Highway Needs and Issues Specific to Arizona's Key Commerce Corridors

For reference, the following provides an overview of freight flows over Arizona's Key Commerce Corridors (KCCs). Specific road needs and issues on each corridor follow. Greater detail is provided in the separate Phase 5 Conditions and Performance Report.

Figure 3-1: Freight Flows over Arizona's Key Commerce Corridors, by Economic Sector



3.2.1 I-8 – Casa Grande to California Border

This east-to-west corridor connects Casa Grande to San Diego, California. I-8 provides a direct connection to Yuma and southern California.

Truck Freight Activity: Near the California border, trucks account for approximately 18 percent of vehicles. Natural resources (agricultural) flows comprise an important share of this traffic. Although growth in this traffic is expected, to support growing demand for food products in Phoenix and elsewhere in the U.S., these flows may be negatively impacted in the long run by decreasing water availability in the region and other climate change impacts.

Infrastructure Condition: Conditions on I-8 are generally good. The carrying capacity of this road has remained virtually unchanged over the last 30 years. There are 4 “non-rampable” bridges in the Casa Grande region that prohibit trucks from exiting I-8.

Mobility and Reliability: Mobility and reliability on I-8 is generally good, aside for AM, Midday and PM truck bottlenecks in the Yuma vicinity. Seventy-seven percent of urban miles have good truck mobility, and only a small portion of the miles have fair mobility.

Figure 3-2: I-8 Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-8 Casa Grande to California Border	180	Rural	165	99%	1%	0%
		Urban	15	77%	23%	0%
Overall segment ratings:		Good <1.35	Fair 1.35 to 1.60	Poor >1.60		

3.2.2 I-10 – California to New Mexico Corridor

This east-to-west corridor connects California to Florida through Arizona’s largest metropolitan areas, Phoenix and Tucson. I-10 is the southernmost transcontinental highway in the Interstate Highway System.

Truck Freight Activity: I-10 is the single most important freight transportation facility serving Arizona measured by value of trade, providing a conduit to Arizona’s two largest domestic trading partners of California and Texas. The greatest concentration of freight activity is located along the I-10 corridor in Phoenix and Tucson.²⁴ Trucks as a percent of total vehicles on this route range from close to 10 percent in the urban areas of Phoenix and Tucson, to a high of 45 percent near the New Mexico border. This corridor handles significant consumer goods, manufacturing and other transportation and logistics activity, among other things.

²⁴ This includes clusters located at Tolleson, Sky Harbor Airport, Chandler, and the Port of Tucson. Outside the two metropolitan areas, clusters are notably located in Casa Grande, Yuma City, Prescott Valley, Flagstaff, Lake Havasu City, Bullhead City, Sierra Vista, and the border city of Nogales.

Infrastructure Condition: The basic carrying capacity of I-10 has remained virtually unchanged during the last 30 years. Generally bridge and pavement conditions are good along I-10, but also similar to I-8 there are numerous “non-rampable” exits, in particular between Casa Grande and the New Mexico border, that limit truck maneuverability. ADOT’s Climbing and Passing Lane Prioritization Study recommended six high-priority climbing lanes on multilane highways, primarily along I-17, I-10, and I-40.

Mobility and Reliability: Congestion is noticeable on I-10 within the urban areas including the Greater Phoenix and Tucson and at key junctions (US 60, SR 95, SR 85). However the level of service (LOS) for most segments of the corridor is LOS C, meaning there is low congestion on the corridor and travel is generally stable with periodic delays.

Overall truck transportation reliability issues along I-10 are minimal, considering the significant volume of overall and truck traffic the corridor serves. There are a few locations where operations could be improved, including major junctions with U.S. 60, SR 95, SR 85, the Phoenix and Tucson metro areas, and location that have two-lane limited directional capacity through mountainous regions (i.e., Dripping Springs).

The growing population base in Phoenix and to a lesser extent Tucson will create added pressure on the I-10, both from increased truck activity and passenger flows. Further pressures will also result as economic activity and trade continues to grow.

Figure 3-3: I-10 Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-10 and SR 85 California Border to Gila Bend via I-10 and SR 85	150	Rural	145	95%	4%	1%
		Urban	5	94%	6%	0%
I-10 I-10 at SR 202L to New Mexico Border	235	Rural	190	91%	8%	1%
		Urban	45	92%	8%	0%

Overall segment ratings: **Good <1.35** **Fair 1.35 to 1.60** **Poor >1.60**

Other Issues: While dust storms can occur throughout the state, the stretch of I-10 between Tucson and Phoenix has the highest incidence of closures, with the area of Picacho Peak (milepost 213-214) reporting the highest incidence along I-10. It is not clear if dust storms would increase with climate change.

3.2.3 I-11 (US 93) – Phoenix to Nevada Border

This corridor connects Phoenix and Las Vegas via Wickenburg and Kingman.

Truck Freight Activity: Truck volumes on this corridor range from approximately 12 to 19 percent of total traffic. This route has relatively low volumes of freight traffic, largely relating to natural resources traffic, and to a lesser extent, consumer goods sector traffic.

Infrastructure Condition: Conditions on U.S. 93 are lower than other comparable KCCs, due in part to the fact that the route is not an interstate, is not constructed to interstate standards and has a lower speed limit (55-60 mph). Pavement conditions are generally fair.

Mobility and Reliability: Mobility on both the urban and rural segments of U.S. 93 are generally good, aside for one-lane directional travel within Wikieup area; steep grade and inadequate passing/climbing lanes.

Mobility notwithstanding, the U.S. 93 corridor is one of the lower performing KCCs, with urban and rural delay indices above 10. Truck reliability is noted as fair due to limited directional capacity and inadequate passing/climbing lane in the Wikieup area. Urban activity within Wickenburg, Kingman, and Wikieup also reduce truck reliability.

Figure 3-4: I-11 (US93) Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-11 (US 93) Phoenix to Nevada Border	225	Rural	210	80%	13%	7%
		Urban	15	95%	5%	0%

Overall segment ratings: **Good <1.35** **Fair 1.35 to 1.60** **Poor >1.60**

3.2.4 I-17 – Phoenix to Flagstaff Corridor

This north-to-south corridor located entirely within the state of Arizona, connects Phoenix, at I-10, with its northern terminus in Flagstaff, at I-40.

Truck Freight Activity: Truck volumes on this corridor range from approximately 9 percent of total traffic in Greater Phoenix, and increase to 25 percent south of I-40 outside of Flagstaff. I-17 freight flows between Phoenix and Flagstaff are dominated by manufacturing sector flows, though consumer goods and transportation and logistics sector flows are also important.

Infrastructure Condition: I-17 gains more than a mile in altitude between Phoenix (at 1,117 feet) and Flagstaff (at 7,000 feet). Not surprisingly, ADOT's Climbing and Passing Lane Prioritization Study recommended six high-priority climbing lanes on multilane highways, primarily along I-17, I-10, and I-40.

I-17 has segments within the Flagstaff area where poor pavement conditions were reported. Pavement condition along the northbound direction is worse than the southbound direction as a result of loaded truck activity; trucks typically drive loaded in a northbound direction through Flagstaff to the Midwest and are unloaded in the southbound direction returning to Phoenix.

Mobility and Reliability: Mobility on the urban portions of I-17 is poor due to heavy truck volumes in an urban environment. Rural mobility scores "good" but also has some challenges, driven by grade (northbound - mileposts 245 to 263 and 299 to 320; southbound 278 to 288).

Mountainous terrain at Black Canyon City, Camp Verde, and south of Flagstaff affect travel. Winter weather also affects travel time. Similar to mobility, truck reliability is poor in the Phoenix and Flagstaff urban portions of this corridor.

As along the I-10, the growing population base in Phoenix will create added pressure on the I-17, in and around Phoenix. Further pressures will also result as economic activity and trade continues to grow.

Figure 3-5: I-17 Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-17 Phoenix to Flagstaff	145	Rural	110	68%	23%	9%
		Urban	35	50%	18%	32%

Overall segment ratings: Good <1.35 Fair 1.35 to 1.60 Poor >1.60

3.2.5 I-19 – Nogales to Tucson Corridor

This North-to-south corridor connects the U.S.-Mexico port of entry at Nogales with Tucson. Like I-17, I-19 is an interstate highway located entirely within Arizona.

Truck Freight Activity: Natural resources sector flows dominate freight traffic along the I-19 between Tucson and Nogales, likely representing a combination of agricultural products and mining products. Manufacturing also uses this corridor and is particularly important in terms of the value of flows. Within Nogales trucks represent 9 percent of total traffic and south of I-10 that share increases to 13 percent.

Infrastructure Condition: I-19 has some areas within the Tucson area as well as near the U.S.-Mexico border near Nogales where poor pavement conditions were reported. Bridge conditions are also an issue in the corridor.

Mobility and Reliability: Mobility on I-19 is fair. On the rural portion of the corridor, a border inspection station in the northbound direction at milepost 25, and heavy truck traffic contributes to congestion and delay. In the urban area, heavy truck traffic due to U.S.-Mexico border activity at Nogales, and congestion at the interchange with I-10 limits mobility.

Delays near the U.S.-Mexico border crossing in Nogales have been identified. Again, all traffic is stopped at milepost 25 due to border inspection activity contributing to delay and reduced corridor reliability.

The growing population base in Tucson may create added pressure on the I-19, both from increased truck activity and passenger flows. Further pressures will also result as economic activity and trade with Mexico continues to grow.

Figure 3-6: I-19 Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-19 Nogales to Tucson	65	Rural	42	83%	11%	6%
		Urban	23	72%	7%	21%

Overall segment ratings: **Good <1.35** **Fair 1.35 to 1.60** **Poor >1.60**

3.2.6 I-40 – New Mexico to California Border

This major east-to-west freight corridor connects California to North Carolina through north-central Arizona, passing through Kingman and Flagstaff. I-40 is the third-longest interstate highway in the U.S., after Interstates 90 and 80.

Truck Freight Activity: I-40 is a major truck through route and has some of the highest truck percentages in the state, ranging from 32 percent near the California border to 40 percent near the New Mexico border.

Infrastructure Condition: I-40 has good pavement conditions with the exception of the Kingman area west to U.S. Route 93 and the Bellmont area (west of Flagstaff). The poor pavement condition along these sections of I-40 are partially attributable to freeze-thaw cycles and de-icing treatments applied in winter months. Bridge conditions are also an issue in the corridor.

ADOT's Climbing and Passing Lane Prioritization Study recommended six high-priority climbing lanes on multilane highways, primarily along I-17, I-10, and I-40 (ADOT 2015b).

Mobility and Reliability: In spite of the high truck percentages, mobility on I-40 is generally good. Some issues that hinder mobility include changing weather conditions along the corridor, congestion at key junctions (SR 89, U.S. 93), and lack of passing/climbing lane at key points.

The extent of delays on the I-40 are relatively low, however reliability is reduced for the corridor due to unpredictable weather conditions, limited roadway capacity and lack of passing/climbing lanes where heavy truck activity exists. The Flagstaff urban area is noted as a location where truck reliability could be hindered.

Figure 3-7: I-40 Corridor Truck Mobility

Corridor	Length (miles)	Rural / Urban and Performance	Miles by Area Type	Good Rating (% miles)	Fair Rating (% miles)	Poor Rating (% miles)
I-40 Flagstaff to California Border	210	Rural	200	82%	16%	2%
		Urban	10	99%	1%	0%
I-40 Flagstaff to New Mexico Border	165	Rural	150	97%	2%	1%
		Urban	15	99%	1%	0%

Overall segment ratings: Good <1.35 Fair 1.35 to 1.60 Poor >1.60

Other Issues: Snow-related closures and activity is limited to higher elevation highways in the northern part of the state. Extreme weather events associated with climate change may aggravate this. The major freight routes routinely affected by snow-related closures are largely limited to the Colorado Plateau (primarily areas of I-40 and U.S. 60) and in the eastern part of the state, on and above the Mogollon Rim (SR 260). During these incidents, weather-related crashes may occur, and delays and closures can last hours for any single event. Working Paper 2 provides detail on the

3.3 Other Road Sector Needs and Issues

Beyond the conditions and performance of Arizona's KCCs, consultations with Arizona freight transportation system stakeholders revealed several other road sector needs and issues. These are synthesized below.²⁵ Many of these issues related to regulatory, policy and planning issues.

Inadequate truck parking facilities: Truck drivers are concerned about the lack of safe truck parking across Arizona, especially on the I-17 corridor between Phoenix and Flagstaff and on I-10 between Tucson and Blythe, California. Carriers expect the truck parking situation to deteriorate further once electronic logs go into full effect. Drivers in Arizona are reportedly already spending up to a half-hour to find parking each day.

Non-recurring congestion and bottlenecks: Although less frequently cited than recurring urban congestion, several stakeholders – across most sector groups – noted non-recurring congestion and road closures as hindering the reliability of their transportation operations. Cited causes are many and include road construction-related lane closures, crashes, and weather events.

Axle-load restrictions: Several shippers noted that axle load restrictions in Arizona are low relative to other states that allow gross vehicles weights in excess of 80,000 lbs. This was most often cited as a top issue for natural resources sector stakeholders - particularly for mining and forestry sectors. Higher axle-loads would allow from greater economies of scale in moving product, which would drive down per ton cost, thereby increasing shipper competitiveness.

Truck driver shortage: The shortage of truck drivers is a national phenomenon. In Arizona, the driver shortage is aggravated by the improving economy and the tightening labor pool. It is unclear if the increase in Arizona's population could help address this challenge. The trend towards automated truck transportation could also help alleviate the driver shortage, though this is unlikely in the short term.

Municipal noise ordinances as barrier to off-peak deliveries: City ordinances related to noise were cited by retail sector companies as issues in certain areas of Tucson and Phoenix, which limits the ability of certain stores to be replenished outside of congested hours. The growing urban population base could lead to further resistance to off-peak deliveries due to related noise issues.

Location specific truck maneuverability issues: Some companies – largely serving the retail sector - noted challenges in maneuvering large trucks to and from delivery docks at shopping centers, leading to increased transit time and lower equipment/labor utilization.

Truck reliability and availability during peak periods: Agricultural sector stakeholders note that transportation equipment (trucks and trailers) can be in high demand during harvest seasons and cause difficulty in scheduling. During these times unexpected delays throughout the supply chain can be particularly costly given the time-sensitivity of bringing perishable products to market.

²⁵ A more expansive discussion of these needs and issues are included in the Phase 3 Economic Context Report and associated Economic Sector Working Papers

3.4 Arizona's Non-Highway/Road Freight System Needs and Issues

Previous analysis has also identified non-highway freight needs and issues. These are synthesized below, along with the implication of identified trends, as relevant.

3.4.1 Freight Rail System Needs and Issues

Three-quarters of Arizona rail tonnage is moving through the state – mostly between the Ports of Los Angeles and Long Beach and major rail hubs in Chicago and Dallas over BNSF Railway's (BNSF) Transcon and Union Pacific Railroad's (UPRR) Sunset Route. Since the freight-rail network lacks infrastructure to move goods in the north-south direction, the majority of these movements are east-west.

Continental intermodal traffic to and from the Ports of Los Angeles and Long Beach passing through Arizona will largely follow the pace of U.S. economic growth. The drop flows to, from and through Arizona of coal and other commodities hit hard by the drop in world commodity prices will likely depress rail volumes moving in Arizona. In any case, the trends identified in this working paper do not suggest an imminent rail capacity problem in Arizona. Other considerations, including the extent to which rail service may be considered as an alternate to truck transportation for through traffic, or as part of shipper supply chain resiliency planning, remains unclear. Nevertheless, previous analysis did identify perceived freight rail needs and issues:

Additional rail infrastructure and service to support Arizona freight. Branch services of both the BNSF Railway and Union Pacific currently serve as the primary freight rail routes into and out of Phoenix from I-40 (BNSF) to the north and I-10/I-8 to the south (UPRR). Currently most rail traffic in Arizona is through traffic (over 75+ percent), neither originated nor destined within the state. Some have noted that Arizona is lacking north-south rail infrastructure (notably along the CANMEX Corridor), intermodal facilities and connections to Arizona industrial sites. This need is often advanced on economic development grounds. However, since freight rail investments and operations are led by private railroads, any investments and operations would need to realistically provide a return on investments to be justified. This reality is particularly true in Arizona given that the government is precluded from supporting rail investments by the State Constitution.

Additional road/rail grade separation, where traffic so justifies. Some have identified a need to separate at-grade road/rail crossings, where existing at grade crossings negatively impact the performance of both road and rail networks. This need is likely to become more acute in and around major centers, notably Phoenix, as population growth and economic activity leads to increased road traffic.

3.4.2 Air Cargo System Needs and Issues

The majority of air cargo in Arizona is handled by two airports. Phoenix Sky Harbor International Airport (PHX) moves approximately 90 percent or 510 million pounds (2013) of all air cargo originating or terminating in Arizona. Tucson International Airport (TUS) handles approximately ten percent or 62 million pounds of the state's cargo.

Beyond the gradual growth of the high tech sector, which is highly reliant on the air cargo system, and the additional volume of passenger traffic associated with Arizona's increasing population base, most of the other trends identified in this working paper are unlikely to result in significant new pressures on Arizona's air cargo system. Several needs and issues with respect to Arizona's air cargo system are synthesized below.

Dissatisfaction with air connections and service: Improving international air connections at Phoenix Sky Harbor International Airport (PHX), particularly to Asia and Europe, was the most frequently mentioned improvement need by manufacturing sectors (notably, the high tech sector). California airports such as LAX are within a day's drive by truck, which limits the scheduled service at PHX, but are not necessarily a deal-breaker for Arizona manufacturers. Nonetheless, the minimal service to Europe and Asia results in heightened complexity, risk, and cost for manufacturers.

Limited customs airport services was also mentioned as a challenge: Several manufacturers noted that customs operations are lacking on the weekends and during off-hours and is otherwise oriented overwhelmingly to passenger operations.

Localized truck issues around Sky-Harbor ("first and last mile"). Approximately 90 percent of statewide air freight is shipped through Phoenix Sky Harbor International Airport, located in the center of the Phoenix metropolitan area. This level of air cargo activity and resulting truck movements have significantly increased roadway congestion and delay in the surrounding area. This is exacerbated by air cargo arriving in Phoenix limited to truck movements/activity on one route, 24th Street. This will likely become more acute with population growth in and around Phoenix and increasing trade and economic activity.

3.4.3 Pipeline System Needs and Issues

There are two major pipelines – both operated by Kinder Morgan – that supply Arizona with petroleum products. The "West Line" supplies products from the Los Angeles basin to Phoenix while the "East Line" originates in El Paso, Texas and connects to both Tucson and Phoenix. Given the limited oil and gas production in the state, there are effectively no gathering pipelines in Arizona.

The continued shift in Arizona's energy mix, including the gradual adoption of CNG and LNG as transportation fuels could influence changes to Arizona's existing pipeline and associated fuel storage network. These investments would however be made by private actors based on commercial considerations. Arizona DOT's role with respect to related investments and changes is largely limited to following these developments, as they may impact other parts of Arizona's multimodal freight transportation system (rail and truck transportation of fuel, for example). Current needs and issues are synthesized below:

Lack of storage capacity. A lack of fuel storage capacity in Arizona provides little inventory and/or options (e.g. redundancy) to redistribute product in the event of system disruptions. In addition, capacity constraints with petroleum pipelines may result in additional shipments by rail and/or truck, which burdens the highway and rail systems and introduces safety concerns, especially with the potential shift of the movement of highly flammable materials to either truck

or freight rail. As with rail investments, however, any investment in pipeline or associated storage capacity will be made by private pipeline interests on a return on investment basis. There are nevertheless opportunities to improve and increase the regulatory approvals process for pipeline projects.

3.4.4 Borders and International Trade Gateways Primary Needs and Issues

Land-based cross-border flows are heavily concentrated in two border crossings: Nogales-Nogales and Douglas-Agua Prieta.²⁶ The San Luis border crossing (Yuma) has the third highest trade flows of Arizona border crossings (roughly 2.3 percent). The CANAMEX corridor is a main route that links Nogales to several cities along Interstates I-10 and I-15.

Increasing trade with Mexico is the most significant trend influencing the performance of the U.S./Mexican borders and trade crossings in Arizona. Specific related issues include:

Poor reliability of the crossing times at the U.S.-Mexico Land Ports of Entry: The unpredictability of crossing times at the Mexican/U.S. border, notably at Nogales (the busiest Port of Entry for the manufacturing sector) was identified by several manufacturers as problematic.

Limited LPOE capacity and poor roadway connections. Like most Ports of Entry on the U.S.-Mexico border, most Arizona Land Ports of Entry (LPOEs) are capacity constrained. In many cases, as with Arizona LPOEs, this is a result of inefficient operations in facility design, security concepts and institutional issues, long-standing international agreements and laws, and intermodal conflicts (e.g., parking areas, waiting areas, security between trucks, personal autos, and pedestrians). In addition, these operational flaws are exacerbated by the general poor condition and limited capacity of road network leading to and from the LPOEs. This situation also includes limited design issues with the LPOEs with increased intermodal conflicts with parking/waiting area constraints.

These issues are likely to become more pronounced with growth in trade with Mexico.

²⁶ Over 85 percent of exports and 88 percent of imports from or to Arizona use the Nogales-Nogales border crossing; and over ten percent of exports and imports from or to Arizona use the Douglas-Agua Prieta border crossing.

4

Policy Responses to Trends, Needs and Issues

Key Messages

The prioritization of ADOT actions and identification of specific projects and improvement options is to come. Nevertheless, key considerations that should inform policy responses in light of the trends, needs and issues identified in this working paper include:

- Looking beyond freight. The evaluation of project priorities and improvement options should recognize both freight and passenger benefits. The development of the Arizona State Freight Plan should be closely coordinated with the update of Arizona's LRTP.
- Focusing on needs and issues in urban centers. Related policy responses and investments should be closely coordinated with the Metropolitan Planning Organizations in each Phoenix and Tucson metro areas.
- Maintaining a focus on improving the performance of Arizona's Key Commerce Corridors, including some of the specific needs identified herein, and enabling improved performance of road connectivity to Mexico LPOEs.
- Aligning with FAST Act requirements for freight investments.

4.1 Key Considerations to Inform Policy Responses

The [vision, goals and objectives](#) of the Arizona State Freight Plan should direct policy responses to address the needs and issues outlined in this working paper and complementary components of work. Likewise, the [policy and strategies](#) of the Arizona State Freight Plan should guide ADOT's policy responses and associated actions with respect to these needs and issues. The prioritization of ADOT actions and identification of specific projects and improvement options is to come (Phase 9²⁷ and Phase 10²⁸). Nevertheless, key considerations that should inform policy responses include:

- **Maintaining a focus on improving the performance of Arizona's Key Commerce Corridors.** Related policy responses could include addressing truck parking needs on the I-17 corridor between Phoenix and Flagstaff and on I-10 between Tucson and Blythe, California, making exit ramps more truck friendly, where appropriate, and adding passing lanes, where the benefits so justify.
- **Looking beyond freight.** Many of the most significant freight transportation system performance issues are largely the result of increasing passenger traffic. This said, projects that can improve the performance of the freight transportation system can also benefit passenger vehicles, and vice versa. The evaluation of project priorities and improvement options should recognize both freight and passenger benefits. For the same reasons, the development of the Arizona State Freight Plan should be closely coordinated with the update of Arizona's Long Range Transportation Plan (LRTP).
- **Coordinate with MPO partners to improve freight movement in urban centers.** The majority of the needs and issues identified relate to congestion – from both freight and passenger traffic - in the Phoenix and to a lesser extent Tucson metro areas. These urban pressures are expected to become more pronounced with the growing population base in these metro areas. Other urban-centric issues include municipal noise ordinances inhibiting off-peak delivery, and location-specific maneuverability issues. Given the urban nature of many of the freight transportation issues and needs identified, policies and investments should be closely coordinated with the respective Metropolitan Planning Organizations in each metro area, the Maricopa Association of Governments, and the Pima Association of Governments. This is consistent with the Arizona State Freight Plan strategy to coordinate and plan improvements in partnership with other transportation system stakeholders.
- **Enabling improved performance of road connectivity to Mexico LPOEs.** In anticipation of growing trade with Mexico, ADOT should assess and evaluate all options – including hard infrastructure, operating and regulatory options, to improve LPOE accessibility.
- **Focusing on what ADOT can directly influence and seeking complementary partnerships.** ADOT has limited ability to influence non-highway infrastructure needs such as freight rail investments, new international air services, or additional pipeline sector fuel storage. Similarly, it also has limited capacity to directly address workforce issues such as the truck driver shortage.

²⁷ Phase 9: Define the Decision Making Process and Prioritization Framework

²⁸ Phase 10: Define the State Freight Transportation System Improvement Strategy

ADOT should focus on areas where it can directly influence and improve the highway freight system, while engaging with those stakeholders that do make complementary investment and operating decisions to promote a common understanding of needs and issues and to coordinate any responses, to the extent feasible.

- **Aligning with FAST Act requirements for freight investments.** The FAST Act provides an opportunity to attract federal funding for freight projects. The Arizona State Freight Plan and associated policy responses should seek full compliance with FAST Act requirements.
- **Investments in network expansion and additional system capacity should be a plan of last resort.** Consistent with the strategy of the Arizona State Freight Plan and that of the LRTP, policy responses to the needs and issues identified in this working paper should prioritize the maintenance and modernization of the existing Arizona transportation system before expanding the system.

These policy response considerations will be further developed in the context of the development of the prioritization of ADOT actions and identification of specific projects and improvement options in forthcoming phases of work.

Appendix A: Sector Specific Trends

High Tech Sector Growth

The high-technology freight sectors are key drivers of high value employment and exports for the state of Arizona. Given the high-value and low weight/volume of many high-tech goods, the sector can be particularly sensitive to transportation challenges. For example, the costs of a delay of a truck containing high-tech goods may be considerable higher than the costs of delay of a truck of very low, value, bulky goods given the large discrepancies in the values of these shipments. High-tech sectors may more frequently make transportation decisions that ensure speedy and reliable transport of goods. Given the export-dependent nature of the high-tech manufacturing sector, Arizona's competitiveness compared to that of other states is also highly impacted by transportation competitiveness.

Arizona has developed a reputation as being competitive for high-tech sectors such as optics/photonics and aerospace and defence, which have a strong presence in Arizona. The high-tech sector produces high value goods and generates high-paying job opportunities for Arizonans. Compensation per employee in the high-tech (computer and electronic) and transportation equipment manufacturing sectors in Arizona is more than double the average compensation for the state.²⁹ The Arizona Commerce Authority (ACA) has identified several key sector opportunities for the state, almost all which relate to high-tech industries. The full list of industries identified by the ACA is:

- Aerospace & Defense
- Technology & Innovation
- Optics/Photonics
- Bioscience
- Renewable Energy
- Advanced Manufacturing
- Advanced Business Services

²⁹ CPCS analysis of Bureau of Economic Analysis Regional Accounts employment and compensation (wages plus benefits) data for the state of Arizona.

Aerospace and Defense

Arizona has developed itself as a national leader in the aerospace and defense industry, employing 52,592 people, with exports of \$3.5 billion in 2014.³⁰ Arizona hosts many of the largest aerospace and defense companies in the world, including Raytheon, Honeywell, BAE Systems, Orbital ATK, and Boeing, as well as many smaller and medium-sized companies supplying parts and repairs to the sector.

Arizona's existing strength in the aerospace and defense industry is driven in part by the strong presence of military facilities in the state, a pro-business regulatory climate, as well as by the state's warm and dry climate, which allows for ideal testing of equipment under extreme desert conditions. Arizona is a top 10 state for aerospace and defense contracts with the U.S. Department of Defense, which executed over 20,000 transactions in the state, worth \$8.7 billion in 2014. Arizona is the second largest employer in the U.S. for both space and defense systems manufacturing, and guided missiles and space vehicles manufacturing.³¹

Educational institutions in Arizona offer 78 college programs related to aerospace and defense – notably Embry-Riddle Aeronautical University, the world's largest, fully accredited university specializing in aviation and aerospace. These programs provide a strong base for building technical know-how and expertise to support the regional industry.³²

The vast majority of manufacturing in the transportation equipment manufacturing sector takes place in the Phoenix and Tucson areas, where the industry's most important manufacturers are located. The state has also developed a strong supply chain with Mexican maquiladoras that are playing an increasingly large role in manufacturing components of aerospace and defense company outputs.

Electronics and Advanced Manufacturing

The semiconductor industry has long been a backbone of Arizonan manufacturing. Intel, Microchip Technology and Freescale Semiconductor, which rank among the top 100 employers in the state (with Intel in the top 10),³³ operate wafer fabrication plants (fabs) in the state. Fabs are large, complex, and very expensive facilities where integrated circuits (chips) are manufactured. Arizona is noteworthy, along with Texas and Oregon, in being home to several companies' fabs. Internationally, Asia and Europe are also very competitive locations for these plants.

Growth for semiconductors and electronics is expected to remain strong, driven by smartphones, solid-state drives (SSDs) and ultramobiles.³⁴ Over the last decade, semiconductor exports and employment have both declined considerably in Arizona,³⁵ but the existing large

³⁰ Arizona Commerce Authority, *Arizona's Aerospace and Defense Industry*. 2015.

³¹ Ibid.

³² Ibid.

³³ AZCentral, *Arizona Republic 100: State's Largest Employers*. 2015

³⁴ Gartner, *Gartner Says Worldwide Semiconductor Sales Expected to Reach \$354 Billion in 2015, a 4 Percent Increase from 2014*. Press release, April 22, 2015.

³⁵ Employment data from Arizona Department of Administration, Export data from U.S. Commercial Service. Cited in Sunnucks, Mike, *Arizona's shrinking semiconductor sector forcing real estate fallout*. Bizjournals.com. April, 2015.

capital investments are an incentive for manufacturers to retain a strong presence in the state. Given the dominance of a few big actors, the state of the industry in Arizona is tied broadly to the ongoing performance of its top companies.

Arizona is also home to many other advanced technology manufacturers, including in the fields of bioscience and optics (the latter are clustered in the Tucson area in what is termed “Optics Valley”). These advanced manufacturers tend to be smaller and benefit from linkages to the University of Arizona and proximity to the aerospace industry. Also, two electronics distributors with significant operations in the state, Avnet and Arrow, rank first and second globally in sales.³⁶ Avnet is based in the state, with its global distribution center in Chandler.

The advanced manufacturing sector is very much nationally and globally oriented, particularly the semiconductor industry. Competition is also global. America’s major advantages lie in its strong intellectual property laws, high quality higher education system, and advanced capital markets. Domestically, Arizona has relatively strong universities, and a mix of warm climate and inexpensive housing attracts trained labor. Arizona also has competitive tax rates and concessions. On a relative basis, it is somewhat close to West Coast transportation gateways and tech hotbeds. However, Arizona’s venture capital funding is underdeveloped and the state must continually actively attract business and engineering talent from out of state.³⁷

Tech Companies

Many tech companies are increasingly looking to Arizona as a competitive location with a pool of skilled labor and a competitive environment to participate. In February 2015, Apple announced a \$2 billion investment in a command center in Mesa in a site designated as a foreign trade zone that benefits from lower taxes. GM also located a major IT innovation centre in Chandler, where it has indicated it expects to hire over 4,000 over several years, many of which have already been hired. Many innovators and start-ups are also located in the area. Both an approach of tax incentives for high-tech businesses as well as programs to support the development of youth in the sector has helped Arizona be seen as competitive and a desirable region to locate for many of these companies.

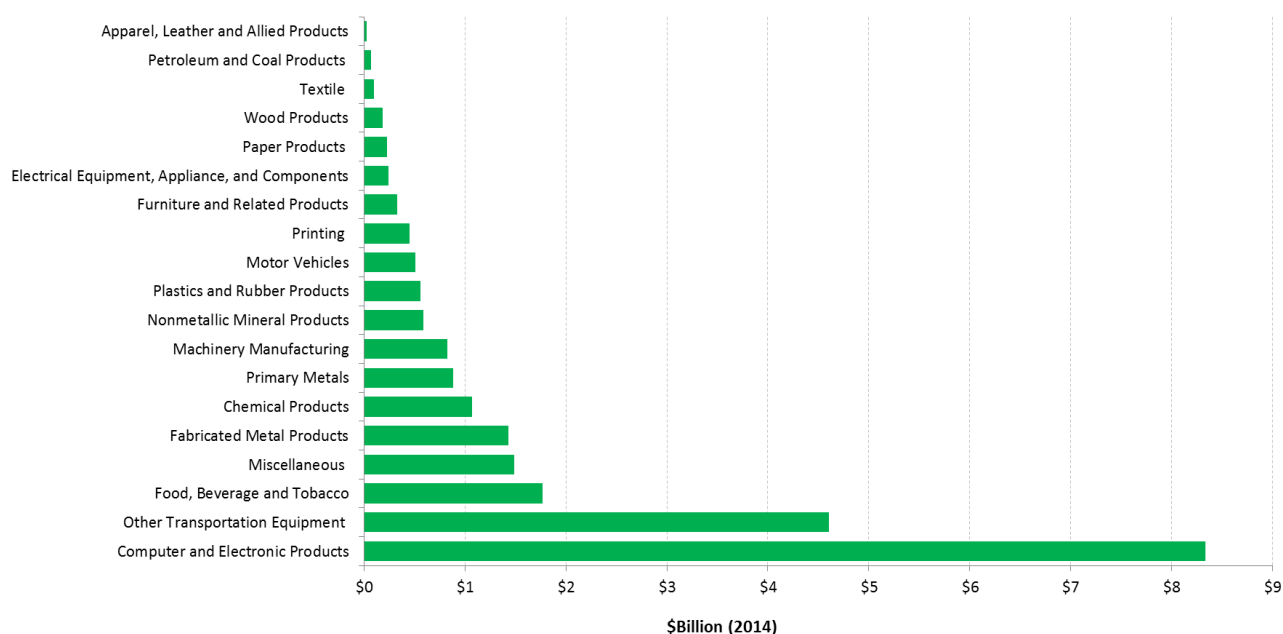
³⁶ Global Purchasing, *Top 50 Distributors 2014*.

³⁷ Marsh, RaeAnne, *Tech Sectors: The Technology Advantage, Sustaining Arizona’s Economy*. InBusiness June, 2015.

Arizona Manufacturing

Arizona manufacturing has been dominated for the last ten years by computer and electronic products, followed by the production of transportation equipment. However, manufacturing GDP in the state has shown a declining trend during the last 15 years. Moreover, with defense contracts being a significant stimulant for the aerospace industry, recent austerity measures on Federal expenditures could further reduce growth in specific manufacturing sectors such as transportation equipment.

Figure A-1: GDP of Manufacturing Industries in Arizona



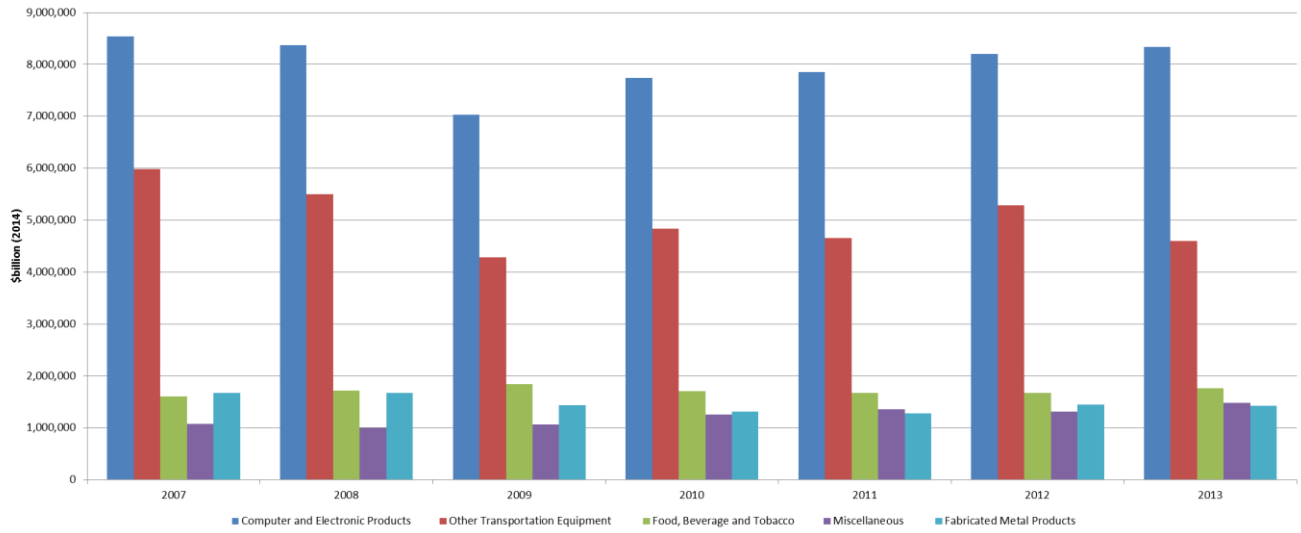
Sources: Bureau of Economic Analysis, *GDP by industry*³⁸

An important amount of manufactured goods in Arizona are geared towards the export market. Figure A-3 shows the value of manufactured goods exported from Arizona to the world.³⁹ A drop in manufacturing exports occurred in 2008, however by 2011 Arizona's exports were above 2008 levels. With many of Arizona's main export markets now experiencing economic growth and expected to carry on growing in the next few years, Arizona manufacturing should likewise grow, however it is unknown if this will offset the long term decline.

³⁸ Bureau of Economic Analysis, *Regional Data, Current GDP by state for Arizona inflated with the Bureau of Labor Statistics West Urban Consumer Price Index*.

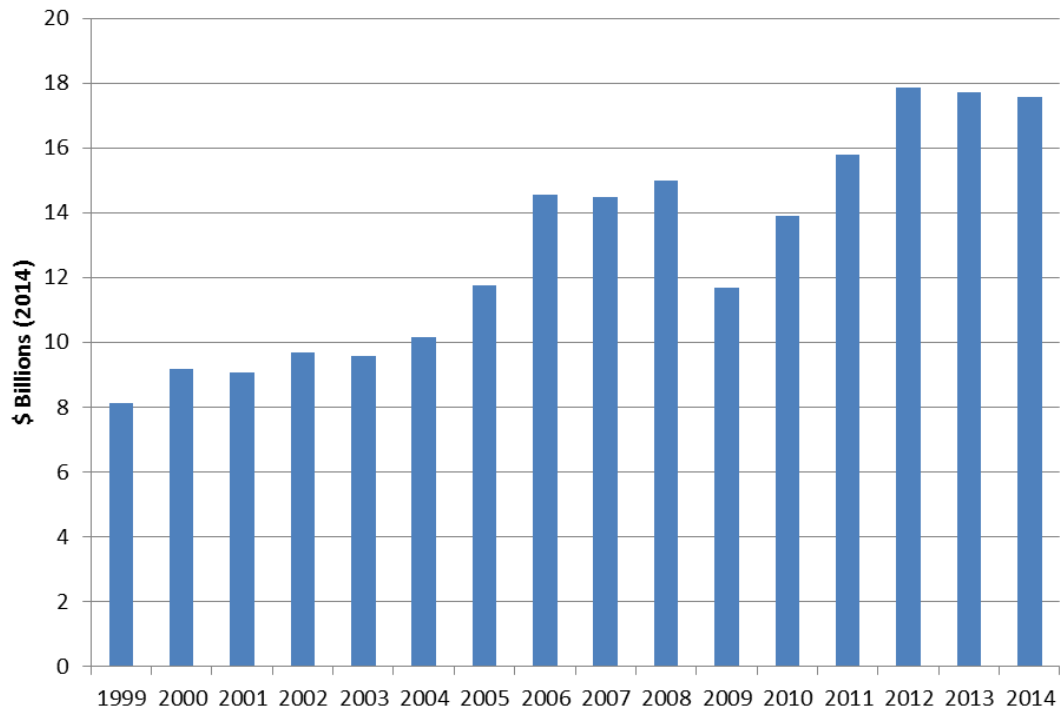
³⁹ This is not necessarily the same as goods manufactured and exported from Arizona, rather it is those manufactured goods, which started their recorded journey from Arizona.

Figure A-2: Top 5 Manufacturing Industries



Sources: Bureau of Economic Analysis, *GDP by industry*

Figure A-3: Manufactured Goods Exported From Arizona



Sources: Foreign Trade Division, U.S. Census Bureau⁴⁰

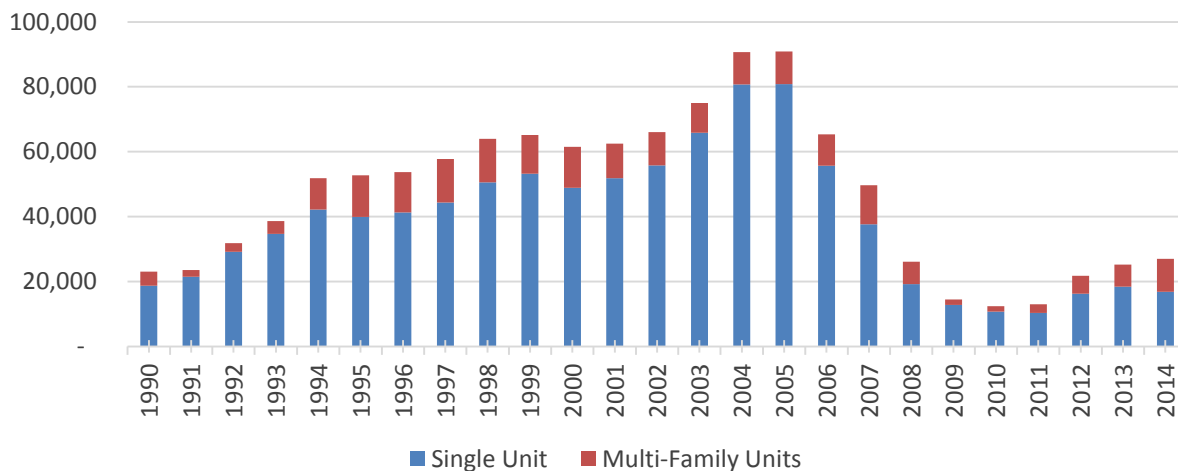
⁴⁰ U.S. Department of Commerce, International Trade Organization, TradeStats, Arizona,

Housing Market

Arizona Housing Market: Boom, Bust and Slow Recovery

Following a major housing boom throughout much of the 1990s and early 2000s, new housing starts fell dramatically in 2006, and are only just recovering to the levels of the early 1990s. Not only have U.S. housing starts been down (relative to ten years ago), but the typical footprint of new homes in the U.S. has also been decreasing. The average 2,500 square foot home of earlier housing booms is being replaced increasingly by smaller homes.

Figure A-4: New Privately Owned Housing Units Authorized by Building Permits, Arizona, 1990 - 2014



Source: CPCS Analysis. U.S. Census Bureau, *Building Permits Survey*. [Link Here](#).

The single family housing market is expected to recover slowly as fewer people are moving. In the U.S. between 2005 and 2010, fewer people moved than in any other five year period since 1965 to 1970 when the U.S. Census Bureau started keeping data. Initially during the latest recession, fewer people moved because jobs were scarce. Later in the cycle, it became clear there were other issues at play, including the following:

- **Homeowners who are under-equited.** About one-third of homeowners (nationally) have negative equity in their homes, when taking into account the percent of borrowers that have less than 20 percent equity ownership. This means that they are unable to sell their home and have enough money left to cover moving costs and for a down payment on another home.
- **Limited access to financing.** A large number of homeowners went through foreclosures and short sales in the recent economic downturn and are still in the period where they cannot get new financing from banks and lending institutions. Factors such as higher down payment requirements, higher credit score requirements (e.g. FICO), and lower debt to income ratios have made financing more difficult to obtain.
- **Younger people living with their parents.** The percentage of 18 to 34 year olds living with their parents went from 27 percent in 2004 to 31 percent in 2013. This represents over 3.3 million people who were out of the housing market in 2013 that were in it in 2004.

Millennials are also postponing marriage, which typically results in a delay in having children and associated demand for housing.

- **Student loan impacts on home buying.** The purchasing power for a home is reduced by \$54,000 for every \$250 monthly student loan payment. Approximately 35% of the households with student debt pay more than \$250 per month in student loans. This is up from 22 percent in 2005. Most households paying \$750 or more per month in student loans are priced out of the market (approximately two million people, nationally).

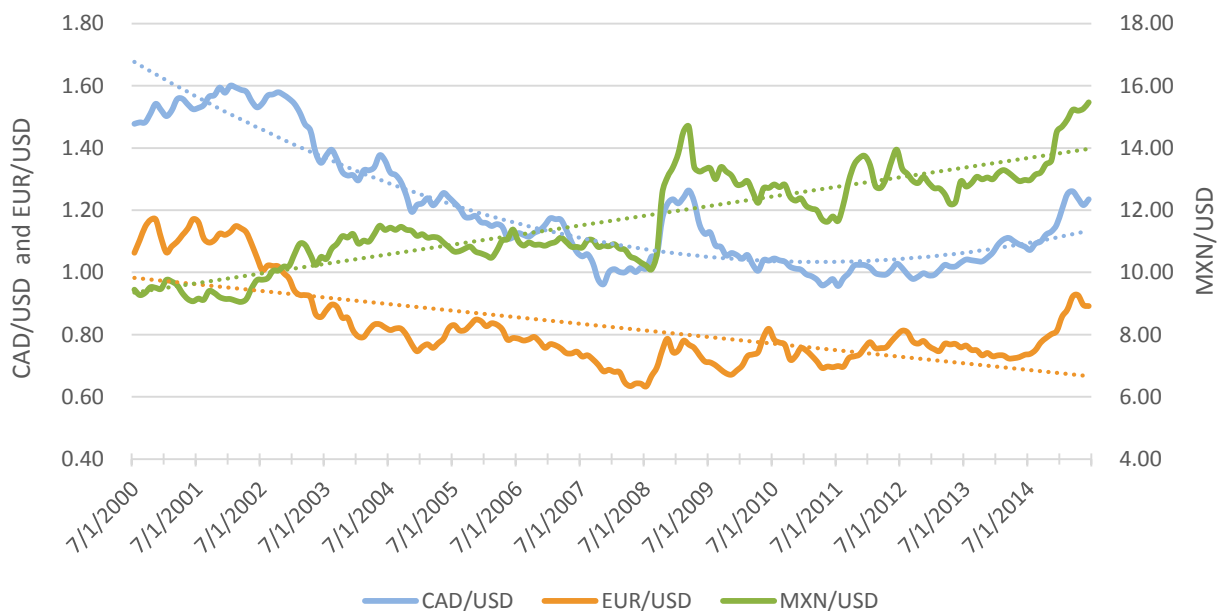
The housing market is expected to improve slowly over time. More people will be in a position to move. And as they see jobs being created in Arizona, more people will move to the area. Millennials will eventually get married, have children and buy homes. Finally, access to finance should gradually improve and reach a balance between the challenges now and the over-easy access to financing of the early 2000s.

Appendix B: Other Trends

U.S. Dollar Exchange Rate

The figure below shows historical exchange rates with three of Arizona's most important trading partners – Mexico, Canada and Europe – over the past 15 years. Over this period, the U.S. dollar has weakened relative to the Canadian dollar and Euro, and strengthened relative to the Mexican Peso. However, there have been major fluctuations throughout the period; over the past few years, the U.S. dollar has generally strengthened against all of these key trading currencies.

Figure B-1: Historical Exchange Rates, Canadian\$/US\$, Euro/US\$ and Mexican Peso/US\$, 2000-2015



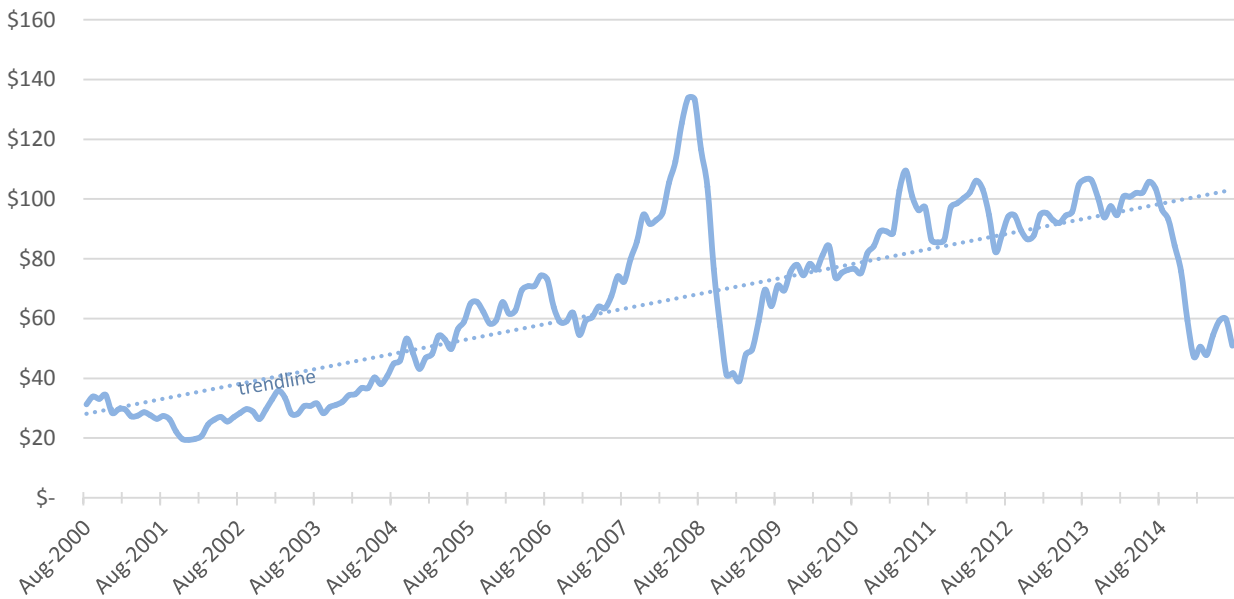
Source: CPCS analysis from [Oanda](#) Data (average monthly bid rates, July 1, 2000 – June 30, 2015)

Energy Prices

Crude Oil

The price of crude oil has generally increased over the past fifteen years but significant variations - from a low of \$20/barrel in 2001 to a high of over \$ 130/barrel in 2008. Crude oil is currently trading at about \$31/barrel (January 2016).⁴¹

Figure B-2: Crude Oil Prices, U.S.\$ / barrel, 2000 – 2015

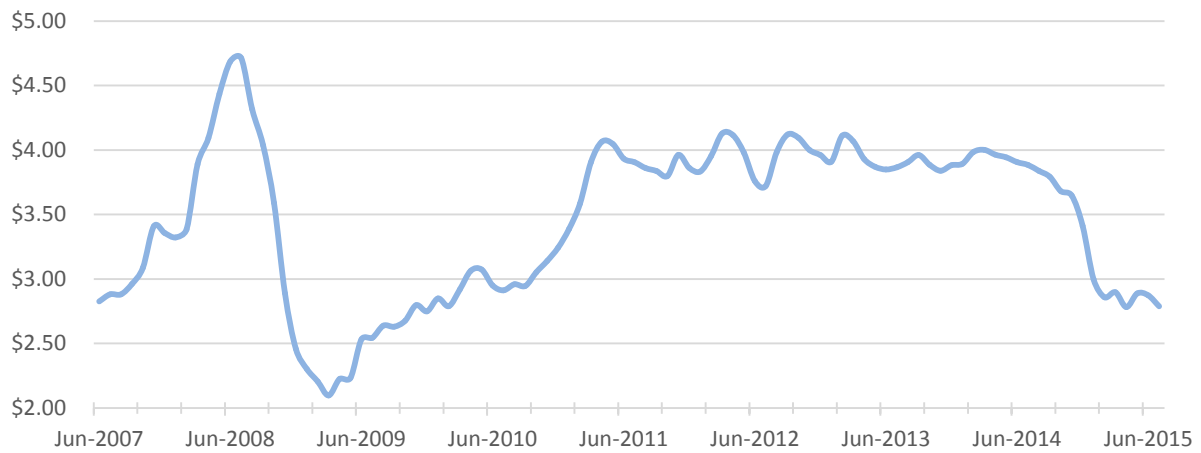


Source: CPCS analysis of U.S. Energy Information Administration, *Crude Oil, Cushing Oklahoma WTI Spot Price FOB*.

The price of diesel fuel and gasoline are important derivative products of crude oil. Figure B-3 shows the price of diesel for the period from mid-2007 through mid-2015. As shown, this has fluctuated in-line with changes in the price of crude oil, including the decline in the past year or so, to July 2015.

⁴¹ U.S. Energy Information Administration, *Crude Oil, Cushing Oklahoma WTI Spot Price FOB*.

Figure B-3: U.S. No 2 Diesel Ultra Low Sulfur Diesel Prices, U.S.\$/gallon, 2007 – 2015

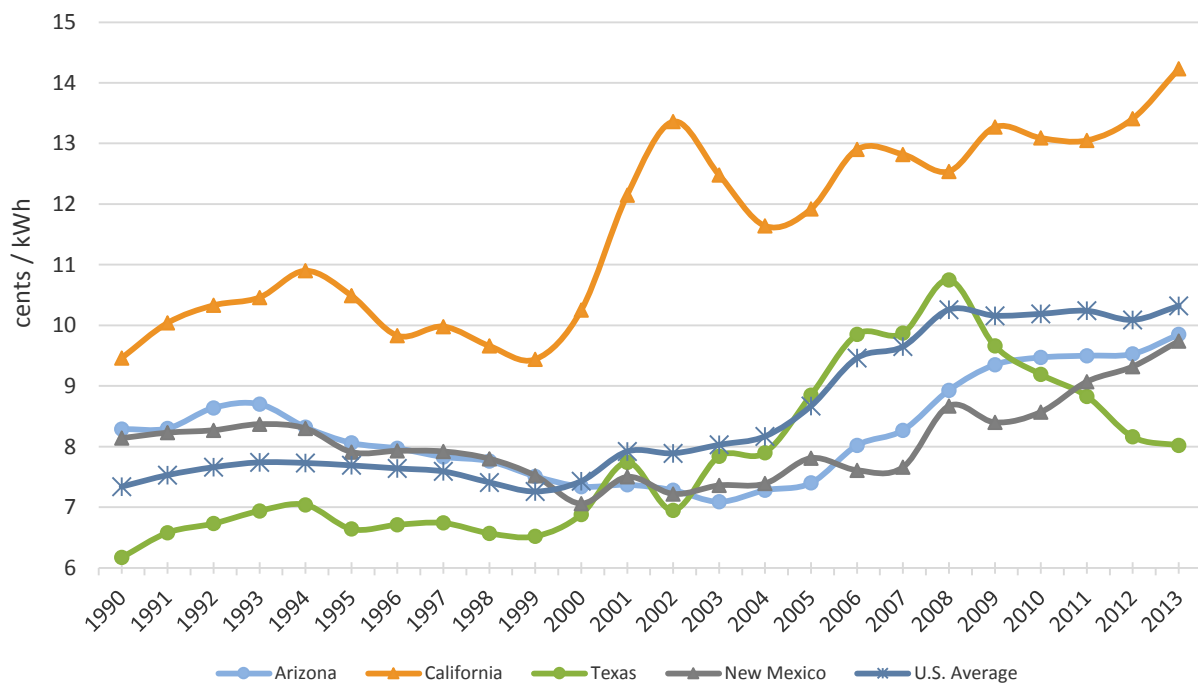


Source: CPCS Analysis of U.S. Energy Information Administration Data

Electricity Prices

As shown in the figure below, electricity prices in Arizona paid by commercial establishments trended down over much of the 1990s, but have risen more or less steadily over the past decade (2003 to 2013). When comparing Arizona with neighboring states, electricity prices for commercial establishments have been similar to those in New Mexico, but much lower than in California. The Arizona prices are currently lower than the U.S. national average but substantially higher than those in Texas.

Figure B-4: Average Retail Price Electricity (Commercial), Arizona and Other Areas, cents/kWh, 1990 - 2013



Source: CPCS Analysis of U.S. Energy Information Administration, *Arizona State Electricity Profile* and *United States Electricity Profiles*.