



# TUCSON Resilient Together

Climate Action and Adaptation Plan



Acción  
Climática  
¡Ya!  
✓LCV



# Letter from the Mayor

Dear Tucsonans,

When we declared a Climate Emergency in 2020, we did so in recognition of several, harsh realities. Climate change is an existential threat, and our public health, economy, and way of life are on the line. Tucson is one of the fastest-warming cities in the country and we can already see dangerous implications. Extreme heat endangers the lives of people in our community. Wildfires destroy our natural environment and pollute the air we breathe. Drought compromises our water supply. We also know, as overwhelming evidence continues to show, that these impacts are felt first and worst by Black, Indigenous, and Brown communities, as well as seniors and low-income families who are now, and will continue to be, at the frontlines of climate change.

These realities demand urgent action. In the 2020 Climate Emergency Declaration, we committed to achieving carbon neutrality for City operations by 2030 and to creating a climate action and adaptation plan that is actionable, comprehensive, and equity-centered. The plan would need to not only lay down the path for reducing greenhouse gas emissions, but also put in place the community resource and physical infrastructure to help us adapt and develop resilience to the changing climate. It would not be our first step as a City to address the climate crisis, but it would be our most significant effort to tackle the issue head-on.

*Tucson Resilient Together* is the result of this years-long effort, combining rigorous data analysis, a climate vulnerability and risk assessment, and a holistic community engagement process. It is the distillation of your hopes, expectations, knowledges, and truths as Tucsonans. And it will be the strategic framework by which we as a community will work together to tackle climate change.

Now comes the real challenge: to implement Tucson Resilient Together and fulfill our commitment to take meaningful, prudent, and impactful actions to fight climate change and build our community. We are further committing ourselves to an additional challenge: achieving community-wide carbon neutrality by 2045. We will meet both targets while also creating a more climate-resilient and prosperous Tucson.

We know there is so much work to be done, but it can be done if we rise to the challenge as one. We will achieve our carbon neutrality goals, and we will be – as we have always been – resilient together.

We are one. Somos uno.

In community,



A handwritten signature in black ink, which appears to read 'Regina Romero'. The signature is fluid and cursive.

Regina Romero  
City of Tucson Mayor

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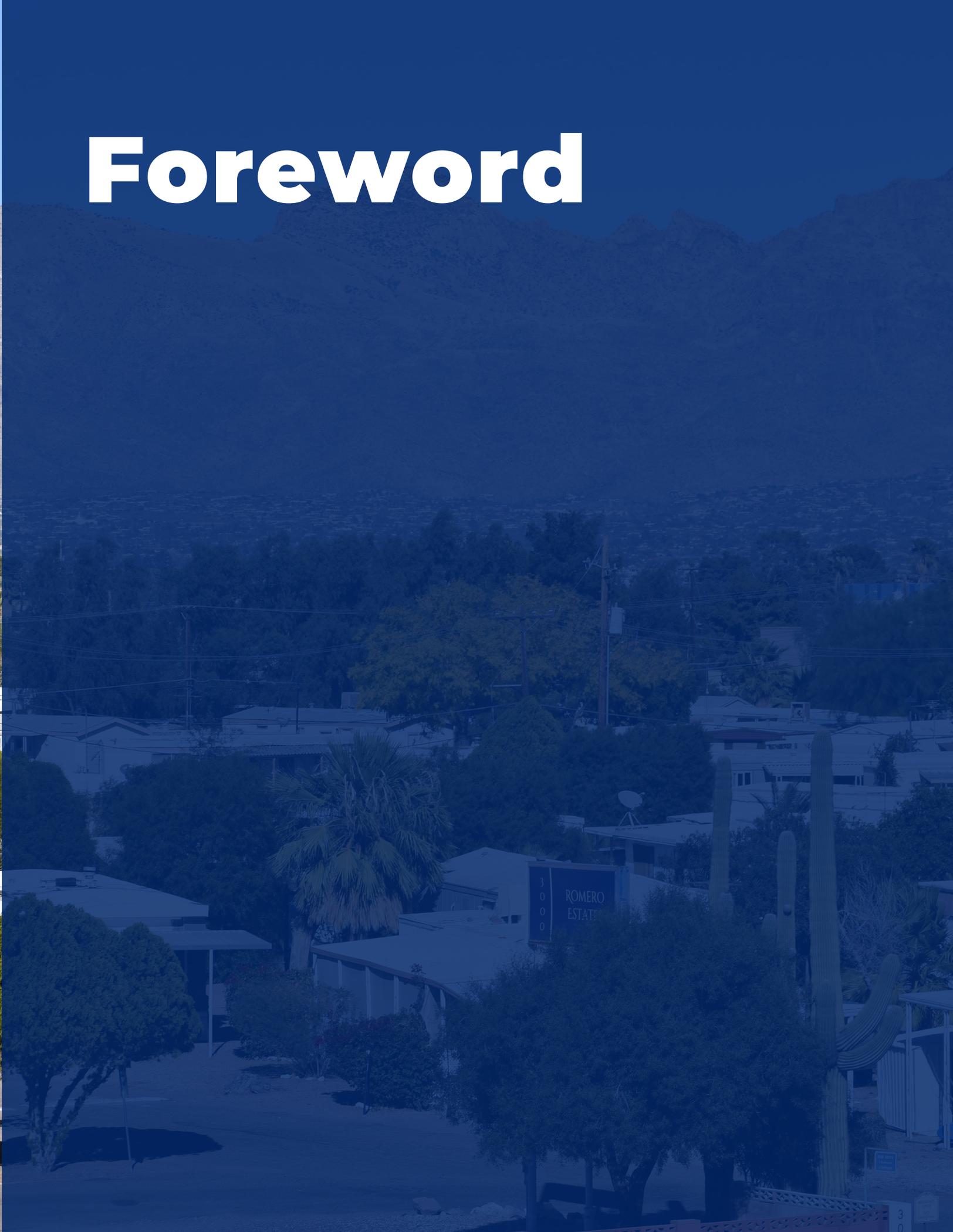
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# Foreword



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# 1 Foreword

## Land and People Acknowledgment

The City of Tucson acknowledges the tribal nations in the S-cuk-Son land. Tucson was founded on the unceded territory of the Tohono O'odham peoples – caretakers of this land from time immemorial. The City further acknowledges the Pascua Yaqui tribe and their multi-millennial presence and stewardship in the region.

By appreciating Indigenous knowledge, as well as the wealth of Tucson's diverse cultures and experiences, the City seeks to implement an intersectional approach to achieving climate equity for present and future residents of Tucson, all while honoring the history of this land and its original stewards.

The City of Tucson seeks to build reciprocity with sovereign tribal nations and Indigenous communities to address local climate change impacts, build frontline community resilience, and inspire Tucsonans today and tomorrow to love and care for the land we share and call home.



## Community Partner Acknowledgments

In creating Tucson Resilient Together, the City strove to develop meaningful partnerships with community partners and organizations to ensure that the voices of our frontline communities – those most vulnerable to the impacts of climate change and who have often been left at the margins of planning and policymaking – shaped this plan.

The City acknowledges that these partnerships are imperfect. This planning effort, however unifying, cannot mend relationships, restore trust and make up for generations of harm. Tucson Resilient Together is only one of the earnest steps that we are taking to restore these connections and earn the trust of the communities of Tucson. Furthermore, the City will continue to learn from these efforts and from true and transparent partnership with community groups and leaders.

We are grateful to the groups who dedicated their time to bringing communities together, hosting workshops, sharing concerns and ideas to ensure that their community priorities are guiding this plan. First, we extend our gratitude to the community partners who offered their time and insights in the development of this report and the strategies therein:

- AZ Youth Climate Coalition
- International Indian Treaty Council (IITC)
- Local First Arizona
- NAACP Tucson Branch
- Paisanos Unidos
- San Xavier Co-Op Farm
- Southside Worker Center

For the Climate Listening Sessions that laid critical foundations for Tucson Resilient Together, we give our thanks to the many hosts, groups, and individuals who made them possible, and to all participants, including:

- 4Tucson-Biblical Solutions for City Problems
- Arizona Faith Network
- Arizona Interfaith Power and Light
- AZ Youth Climate Coalition
- Calpolli Teoxicalli
- Community Food Bank of Southern Arizona
- Community Home Repair Projects Arizona
- Culture of Peace Alliance
- Desert Dove Christian Church
- Direct Advocacy and Resource Center
- Episcopal Diocese Creation Care Committee
- Extinction Rebellion Tucson
- Familias Unidas Ganando Accesibilidad (FUGA)
- Goodwill Metro Center
- Grace St. Paul's Episcopal Church
- Hope of Glory Ministries
- Interfaith Community Services
- Jewish Community Center

- Jewish Family and Children's Services of Southern Arizona
- Las Milpitas Community Farm
- Local First Arizona
- Lutheran Social Services of the Southwest
- Mentoring Tucson's Kids
- Mormon Women for Ethical Government
- No More Deaths
- Paisanos Unidos
- Pascua Yaqui Tribe
- Pima County Board of Supervisors
- Pima County Smartscape Training Program
- Planned Parenthood Arizona
- Sema Foundation
- Southside Worker Center
- St. Andrew's Presbyterian Church
- Sunrise Tucson
- Sustainable Tucson
- Tohono O'odham Tribe
- Tu con Climate
- Tucson Borderlands Young Adult Volunteers
- University of Arizona
- Youth Justice Collective

We also would like to thank the Tucson Convention Center and the venue hosts that donated their spaces to the City as we gathered community members for developing *Tucson Resilient Together*:

- Donna R. Liggins Center
- Goodwill Metro Youth Center
- Las Milpitas Community Farm
- Literacy Connects
- Pueblo High School
- San Xavier Co-op Farm
- Southside Presbyterian Church
- Woods Memorial Library
- University of Arizona Main Campus Library

Above all, we thank the constituents and communities of Tucson who participated in our public workshops and offered their time, thoughts, and experiences throughout the development of *Tucson Resilient Together*.

## City and Advisory Acknowledgments

We give our sincerest thanks to Tucson's elected officials and their offices, City staff, and trusted advisors who offered their advice, feedback, and perspective throughout the creation of *Tucson Resilient Together*.

### Mayor & Council and City Manager

- Regina Romero  
*Mayor*
- Lane Santa Cruz  
*Vice Mayor, Ward 1*
- Paul Cunningham  
*Ward 2*
- Kevin Dahl  
*Ward 3*
- Nikki Lee  
*Ward 4*
- Richard Fimbres  
*Ward 5*
- Steve Kozachik  
*Ward 6*
- Michael Ortega  
*City Manager*

### Commission on Climate, Energy, and Sustainability (CCES)

- Vanessa Gallego  
*Chairperson*
- Robert Bulechek  
*Vice Chairperson*
- Tiffany Cleveland  
*Member*
- John Andrew Eisele  
*Member*
- Camila Martins-Bekat  
*Member*
- Alma Anides Morales  
*Member*
- James Sell  
*Member*

## Mayoral Climate Action Advisory Council

- Vanessa Gallego
- Carolyn Campbell
- Laura Dent
- Ian McDowell
- Sandy Bahr
- Mackenzie Moore
- Amy R. Juan
- Katie Gannon
- Neha Gupta
- Diana Liverman
- Shirley-Ann Behravesh
- Trevor Ledbetter



## Project Team Acknowledgments

Finally, we give our thanks to the City staff and consulting team who oversaw the development of *Tucson Resilient Together*.

### City Project Team

- Timothy Thomure  
*Assistant City Manager*
- Fátima Luna  
*Climate and Sustainability Advisor*
- Jeremiah Dean  
*Project Manager*

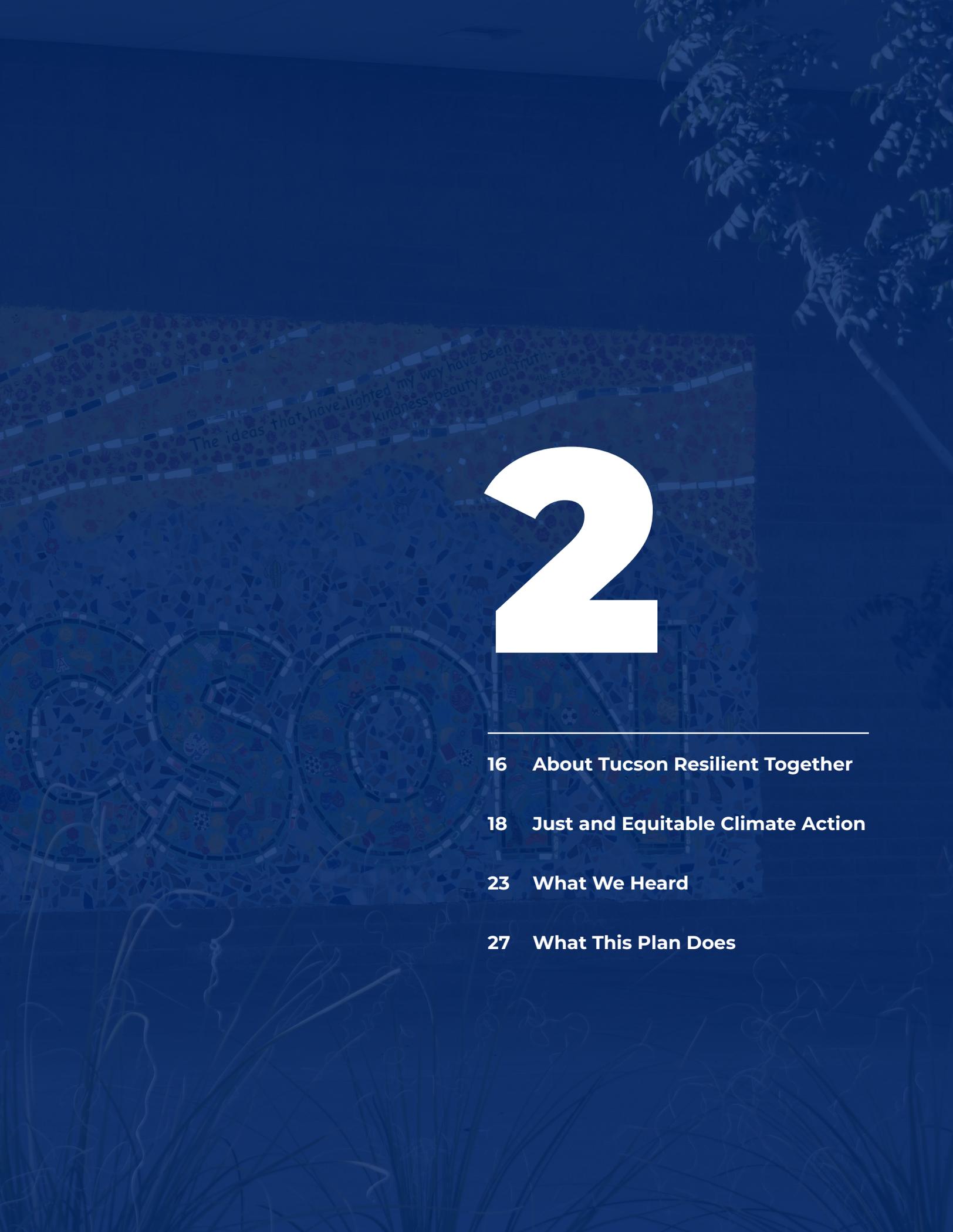
### Consultant Team

- Buro Happold
- Living Streets Alliance
- Autocase Economic Advisory
- Drachman Institute at University of Arizona College of Architecture, Planning and Landscape Architecture

# Executive Summary

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The ideas that have lighted my way have been kindness, beauty, and truth.

# 2

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# 2 Executive Summary

## About Tucson Resilient Together

*Tucson Resilient Together* is the climate action and adaptation plan for the City of Tucson. This plan outlines the City's roadmap to reduce greenhouse gas (GHG) emissions, as well as to adapt and build community-wide resilience to the current and future impacts of climate change. Resilience refers to the ability to cope with adverse shocks and stresses. Tucson Resilient Together centers equity and environmental justice in these efforts because the impacts of climate change are unfairly distributed toward the frontline communities of Tucson, which historically have been marginalized by government-led planning efforts. This plan, from its conception to its implementation, demonstrates our commitment to not only address climate change, but also to do so in way that reflects the experiences, hopes, and expectations of those whom climate change most affects.

Through this plan, the City of Tucson is taking steps to following through on the goals laid out in our 2020 Climate Emergency Declaration: to neutralize our carbon emissions from City operations by 2030. In addition to this local government effort, we are also striving to reach carbon neutrality, or a state of net zero carbon dioxide emissions, community-wide by 2045. But as Section 4 below makes clear, this is an ambitious and transformative undertaking that and it will require concerted actions by City government, residents, and businesses, and partners across the region and the State of Arizona, that go beyond the scope of this Plan. All of us together must take swift and decisive action to avoid suffering for Tucson's families and future generations.

To achieve these goals, *Tucson Resilient Together* lays out strategies that both reduce emissions and strengthen community resilience to climate change. These measures were developed through a deep engagement process in collaboration with seven community partners: the Arizona Youth Climate Coalition, the International Indian Treaty Council (IITC), Local First Arizona, the NAACP Tucson Branch, Paisanos Unidos, the San Xavier Co-Op Farm, and Southside Worker Center.

### **Tucson Resilient Together Goals**

**Carbon neutrality across  
City operations by 2030**

**Carbon neutrality  
community-wide by 2045**

The final strategies reflect input and guidance from these community partners, members of the Tucson community, the Mayor’s Climate Action and Advisory Council, subject matter experts from the University of Arizona, City departments, the City’s Commission on Climate, Energy, and Sustainability, and the Mayor and Council. Our engagements with the Tucson community included a community survey, 14 Climate Listening Sessions, two public workshops, 13 community dialogues led by community ambassadors (Promotores), and 9 pop-up events across Tucson. This engagement resulted in the 24 strategies and 123 actions that make up *Tucson Resilient Together* and will take us toward our carbon neutrality targets.

The strategies and actions laid out in this plan were also informed by an evaluation of existing conditions, GHG emissions analyses, and a climate vulnerability and risk assessment. They are organized into five areas of focus:



## Governance and Leadership

Actions to embed climate action across City operations and coordinate the implementation of Tucson Resilient Together with community organizations, businesses, and regional partners



## Energy

Actions to reduce emissions from energy used by City operations and the community at large, inclusive of actions to decarbonize the grid and integrate renewable energy



## Transportation and Land Use

Actions to shift transportation to low- or zero-emission modes, including land use changes to promote density and transit-oriented development as well as fleet electrification



## Community Resilience

Actions to adapt and build resilience to the impacts of climate change, including the proliferation of resilience hubs and strategies to protect communities from extreme heat and other climate hazards



## Resource Recovery and Management

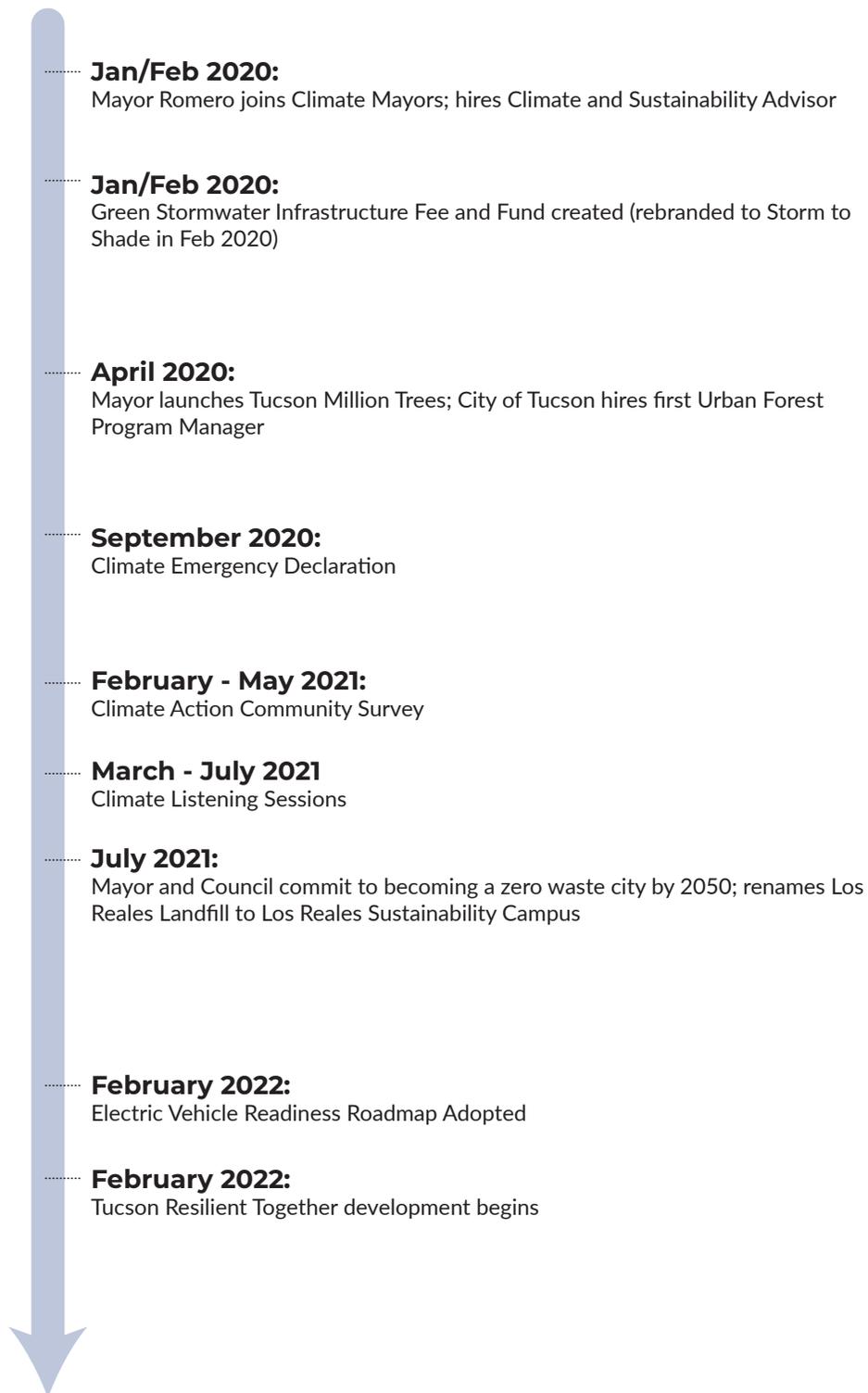
Actions to reduce emissions from resource use and disposal, including shifts to zero waste, piloting technologies and actions that support a circular economy, and expanding green infrastructure

The actions in Tucson Resilient Together are not the only initiatives that can be developed to accomplish our climate goals, but they are rooted in evidence, supported by stakeholders, and representative of the City's jurisdiction and sphere of influence in addressing global climate change. A few examples of actions within this plan include:

- **G-1.1:** Establish and staff a permanent Climate Action Team (CAT) tasked with implementing the Tucson Resilient Together plan.
- **E-3.1:** Engage with Tucson Electric Power and Trico to expedite the shift to renewable electricity supplied to the City and community.
- **T-3.1:** Orient community planning efforts toward a '15-minute' city, enabling community access to basic amenities within a 15-minute walk or bike ride from home.
- **T-4.1:** Launch a subsidized all-electric bike share and car share program that prioritizes neighborhoods with lower rates of household access to vehicles, and support an electric bike rebate program and e-bike lending library which lower barriers to active modes of transportation.
- **CR-1.1:** Establish one or more resilience hubs – in partnership with schools, community-based organizations, neighborhood associations, and faith-based institutions – to ensure that surrounding and vulnerable communities are better prepared for climate-related emergencies.
- **RR-2.2:** Coordinate with haulers to establish an organic waste curbside collection program across the City and provide residents with organic waste bins and education.

Finally, Tucson Resilient Together builds upon a history of climate action across the City of Tucson and folds into our existing network of planning and implementation efforts to reduce our environmental impacts and adapt to the impacts of climate change.

Figure 1. Climate Action Planning and Implementation Efforts



## Just and Equitable Climate Action

We cannot talk about climate change without talking about equity and environmental justice. Climate change is a social justice issue. Like many cities across the United States, we cannot ignore that our own history as a city is rooted in discrimination, segregation, and oppression. By law and by practice, Black, Indigenous, and people of color (BIPOC), as well as Latinx and/or Spanish-speaking communities, have suffered undeserved harm from government decisions, and the residual structures and practices from this history have continued to marginalize these communities.

These histories and harms matter when we discuss climate change. The people most responsible for climate change also tend to be the ones who are most protected from it; climate impacts are felt first and worst by communities of color and low-income communities who do not have the same access to the institutions and services that can protect them or help them be resilient.

Climate change is here, and while we understand its potential, future impacts, we are not condemned to a predetermined and dangerous future. We have an opportunity to avoid the worst impacts and create a safe and dignified future for Tucson residents. We believe that everyone should have a say in what that future looks like. To do that, we must center and uplift the voices that have historically been excluded, including the communities that are most vulnerable and at risk.

### Targeted Universalism and Reciprocity

As we developed Tucson Resilient Together, we embraced and centered our efforts around targeted universalism: the idea of setting universal goals for Tucson that can be achieved through targeted short- and long-term solutions.<sup>1</sup> To meet the needs of different groups and identify culturally appropriate climate solutions, we considered the social structures, cultural dynamics, geographies, and barriers that exist within and amongst communities in Tucson, making sure that we reached and amplified the voices of the communities historically excluded from traditional forms of engagement.

In addition, our efforts were centered on the principle of reciprocity. As we engaged with community members and organizations, we sought to avoid an 'extractive' relationship by sharing City of Tucson resources, such as information about service providers. Community ambassadors, or Promotores, as well as community partner organizations and dialogue participants, were compensated for their time, effort, and participation.

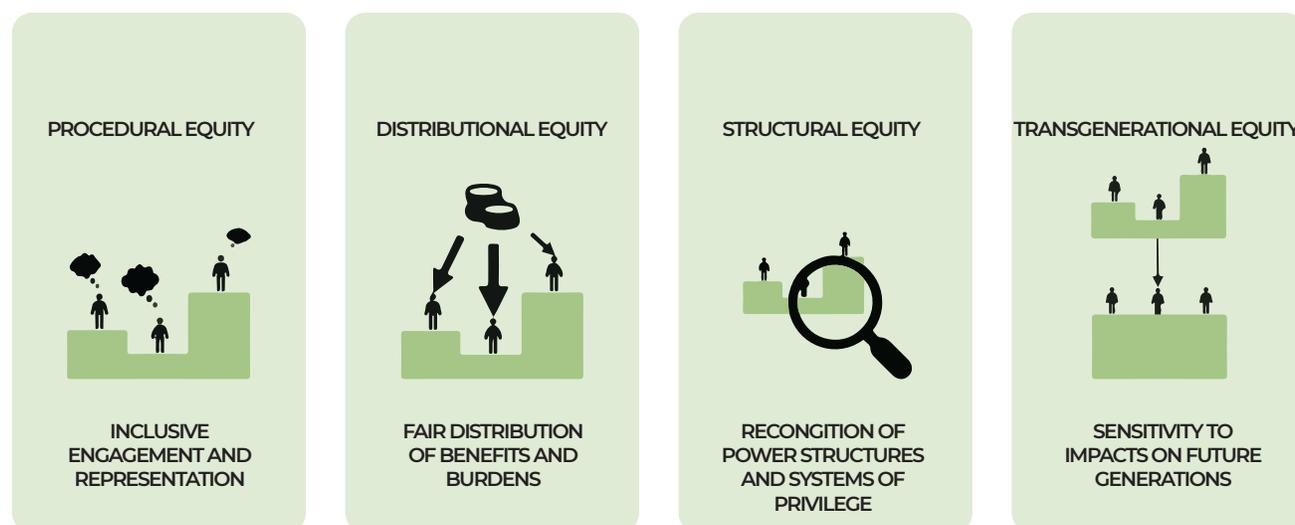
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<sup>1</sup> The concept of targeted universalism was initially introduced by the Othering & Belonging Institute at the University of California, Berkeley.

We developed the solutions presented in this report with equity at front of mind, considering the unique characteristics of Tucson's communities and acknowledging the barriers that have affected their health and well-being. We strove to advance four dimensions of equity: procedural, distributional, structural, and transgenerational.<sup>2</sup>

- **Procedural equity** requires that authentic, inclusive, and accessible community engagement be embedded in the development of policies and programs.
- **Distributional equity** requires that policies and programs equitably distribute the benefits and burdens across all communities.
- **Structural equity** requires a recognition of the historic, cultural, and institutional dynamics that lead to inequalities in climate action and impacts.
- **Transgenerational equity** refers to the contemplation of the impacts of policies and programs on future generations.

Figure 2. The Four Dimensions of Equity



2 Angela Park. (2014). Sustainability and Equity Scan. Urban Sustainability Directors Network. <[https://www.usdn.org/uploads/cms/documents/usdn\\_equity\\_scan\\_sept\\_2014\\_final.pdf](https://www.usdn.org/uploads/cms/documents/usdn_equity_scan_sept_2014_final.pdf)>.

## Community Partners



### Arizona Youth Climate Coalition

The Arizona Youth Climate Coalition is a group of youth who are fighting for climate justice by working to build community power across the state.

### International Indian Treaty Council

The International Indian Treaty Council (IITC) is an organization of Indigenous Peoples from North, Central, South America, the Caribbean and the Pacific working for the Sovereignty and Self Determination of Indigenous Peoples and the recognition and protection of Indigenous Rights, Treaties, Traditional Cultures and Sacred Lands.



### Local First Arizona

Local First Arizona is a nonprofit organization committed to community and economic development throughout Arizona. Their work connects people, locally-owned businesses, and communities for meaningful actions that build a diverse, inclusive and prosperous Arizona economy.



### NAACP Tucson Branch

The mission of the National Association for the Advancement of Colored People (NAACP) is to ensure the political, educational, social, and economic equality of rights of all people; and to eliminate race-based discrimination.



### Paisanos Unidos

Paisanos Unidos is a community group made up of Latino and Hispanic families who provide mutual support to one another under distinct circumstances



### San Xavier Co-Op Farm

The San Xavier Cooperative Association, run by members of the Tohono O’odham Nation, is committed to healthy farming practices and growing traditional crops to support cultural and environmental values, as well as supporting economic development within the community.



### Southside Worker Center

The Southside Worker Center supports a community of worker-leaders building collective power and raising the standards of worker conditions so that members can take part in dignified work and earn just wages.



## What We Heard

Throughout our engagements with community members and organizations, what we heard were the stories, experiences, beliefs, and truths of the people of Tucson. In the “Listening” phase of our engagement process (described in detail in the Introduction chapter), we asked community members to share the issues of greatest concern or highest priority to them. And through the subsequent “Visioning” and “Strategizing” phases, we not only refined those issues into specific, community-sourced recommendations for mitigation and adaptation measures, but we also more deliberately centered the voices of frontline communities. While the strategies and actions in this plan are informed by best practice, they are more importantly sourced and inspired directly by the residents of Tucson.

Throughout Tucson Resilient Together, we strive to highlight where and how the voices of Tucsonans directly fold into all aspects of the plan. However, five themes emerged as persistent threads through the entire planning process:

### Extreme Heat and Heat-Related Illness

Extreme heat is among the most prominent concerns of Tucsonans as it pertains to the impacts of climate change. In our community survey results and throughout our climate listening sessions, Tucson residents expressed concerns of heat “lasting longer” throughout the day, and that Tucson has felt “a lot hotter than it has ever been.” Conversations with community members at community dialogues and workshops, as well as with City Councilmembers, highlighted serious concerns. For instance, dealing with extreme heat is tougher for those who are not as financially secure because they either lack the insulation or air conditioning to keep cool, or that it becomes prohibitively expensive to use air conditioning. In addition, extreme heat is particularly dangerous to individuals with chronic health issues and to those who primarily work outdoors.

Tucsonans expressed that climate adaptation solutions around extreme heat were of highest priority, and they came prepared with solutions. Community dialogue and CLS participants highlighted the need for increased shade through tree cover or shade canopy (especially at transit stops and community centers), as well as the need for better-maintained and increased green space. Some suggested shifts in work schedules,

both daily and seasonally, to reduce heat exposure for outdoor workers. And others suggested accessible, community spaces where Tucsonans could stay and cool down during high heat days.

Example actions which address this theme include:

- **CR-2.1:** Develop a comprehensive urban heat mitigation strategy and implementation plan that addresses shade equity, pavement prevention and reduction, cool roofs and surfaces, and urban greening
- **CR-2.2:** Install and maintain additional shade canopies, playground shade structures, shade trees, splash pads, drinking water fountains and/or water bottle filling stations in areas of greatest need.
- **CR-2.8:** Provide resources, training, and discussion spaces for employers and workers that encourage and support protection from extreme heat.



## Clean Energy and Building Decarbonization

Tucsonans highlighted the need for community-wide action on decarbonization, starting with the grid and buildings. Some suggested community choice energy or aggregation as an impactful way to eliminate greenhouse gas emissions from the grid, as well as the municipalization of Tucson’s electric utilities. Solar energy, in particular, was identified as the top mitigation solution by listening session participants, ranging from increased solar on buildings across Tucson to decentralized, community solar – “like a co-op solar energy farm.” Tucsonans also expressed that solar energy needed to become more accessible, and that the City should “decrease barriers for low-income families to install solar.” Community dialogue participants shared ideas for the City to not only create support programs for community members to

procure and install solar, but also to raise awareness and educate community members to encourage installation.

Example actions which address this theme include:

- **E-3.2:** Work with community advocates and other jurisdictions to co-form a community choice energy program or joint powers authority to procure 100% renewable power for Tucson.
- **E-4.4:** Explore community solar co-op models to democratize access to solar energy.
- **E-4.7:** Develop additional incentives and reduce permitting fees for residents and businesses to install solar PV and/or energy storage systems.

## Sustainable and Equitable Transportation

Decarbonization was also important to Tucsonans in the context of how they move around the city. Electrified transportation, including electric vehicles, electrified buses, and an increased number of public charging stations, was a commonly raised mitigation solution by engagement participants. Even more participants emphasized the need for a community-wide transportation system that encourages people to rely less on their vehicles and use more sustainable and equitable modes of transportation, with many emphasizing the need for “bikeability,” “walkability,” “proximity,” and “connectedness” in Tucson.

Specific solutions to encourage mode shift, or switching to more sustainable forms of transportation, ranged from shaded pedestrian areas and routes (to protect individuals from extreme heat), to protected bike paths and transit stops, to reduced or eliminated parking requirements. Some solutions were more focused on alleviating poverty and promoting equity, including increased affordable housing along transit corridors, subsidized or free public transit for frontline communities and financially challenged individuals, and increased routes for public transit that go further beyond the reaches of the University of Arizona and downtown to become more accessible for the majority of Tucsonans.

Example actions which address this theme include:

- **T-1.2:** Promote walking, biking, and rolling by creating attractive and universally accessible street environments through ADA ramps, traffic safety enhancements, accessible seating, shaded sidewalks, protected bike paths and lanes, bike- and scooter-share programs, and other improvements.
- **T-2.2:** In partnership with Sun Link and Sun Tran, identify options for expanding streetcar, bus rapid transit (BRT) and/or local bus access to underserved communities.

- **T-4.3:** Pursue public-private partnerships to install EV charging stations on City-owned land.

## Water Resources and Drought

Water continues to be a top concern for the communities of Tucson. Shifts in precipitation patterns and prolonged drought have strained water resources across the region, and while many Tucsonans have commented on the Tucson’s leadership as a steward of water resources, they still remain very concerned given present climate trends and the variability of recent rains in Tucson. Community members shared concerns that water is being pumped too aggressively in favor of water-intensive developments such as golf courses. Indigenous groups shared that in some homes on reservation land there is no running water, and they also expressed uncertainty around how the City would partner with tribal nations to address water issues and shortages.

Tucsonans have largely expressed the need for continued incentives and programs to promote water conservation and recycling, as well as a desire for Tucson to prioritize climate-appropriate or native plant species around the city. Recommended solutions also included resources to help residents establish gardens and collect rainwater in both homes and rented spaces.

While water demand and supply solutions are not explicitly addressed in *Tucson Resilient Together*, they will be addressed in the *One Water 2100* master plan.

Example actions which address this theme include:

- **RR-5.1:** Address barriers to implementing small-scale infrastructure projects on individual properties.
- **RR-5.2:** Build upon existing efforts and partnerships through Storm to Shade partnerships to promote green infrastructure practices at the neighborhood and lot scale.

- **RR-5.3:** Work with homeowners associations to update their landscaping requirements to include interconnected green infrastructure practices and climate adaptive planting palettes.

## Partnership and Community Development

Finally, given the community- and equity-centered approach of *Tucson Resilient Together*, many of our community partners and engagement participants shared their visions for both partnerships between the City, community-based organizations, and community groups across Tucson, as well as tools and resources to empower the greater Tucson community. Some community members emphasized the need for the City and tribal nations to come together, and for the City to involve tribal nations in decision-making and other processes. Members of the Indigenous community at large shared that it would be a priority for the City to work on finding common ground between itself, tribal nations, and other non-tribal entities based on shared priorities. In addition, community members emphasized the importance of inclusion, equity, transparency, and corporate responsibility in decision-making and governance. Local business sector was also a highly raised area of partnership for the City to focus on across all areas of climate action.

“Education” and “awareness” were prominent in the vocabulary of Tucsonans, who shared a wide range of recommendations in those areas. Many community members focused on education at early ages, inclusive of experiential learning around tree planting, community gardens, and agriculture. Others expressed the need for the City to expand upon and improve its existing resources to be more accessible and “culturally competent,” especially with respect to those that encourage sustainable behavior or direct Tucsonans to important services.

Example actions which address this theme include:

- **G-2.4:** Partner with local organizations, community, and local businesses groups to invest in and create youth employment training and professional development in the environmental and climate sectors.
- **G-2.5:** Collaborate with neighboring tribes and local jurisdictions to share information and resources, coordinate implementation of climate mitigation and adaptation strategies, and build resilience across Greater Tucson.
- **G-3.1:** Develop multilingual, culturally competent climate action toolkits that include information about (a) how to prepare for and respond to climate-related emergencies and stressors and (b) the benefits of building electrification and electric vehicles, and (c) how to procure affordable materials and labor for building retrofits, green infrastructure projects, and more.
- **CR-3.5:** Coordinate with community-based organizations such as co-operative farms to incorporate urban agriculture and community farming across Tucson.

## What This Plan Does

*Tucson Resilient Together* is a strategic framework for adapting to the current and future impacts of climate change across Tucson. It is also a strategic framework to achieve significant and lasting carbon emissions reductions. The measures and emissions targets included in this plan have been informed by and developed in partnership with community members and organizations across Tucson, as well as by elected officials and City staff.

However, *Tucson Resilient Together* will only be successful if the strategies and actions are implemented with a level of urgency that matches that of the climate crisis. As such, this plan serves as a call to action for elected officials, City staff, and community members alike to come together and make it happen.

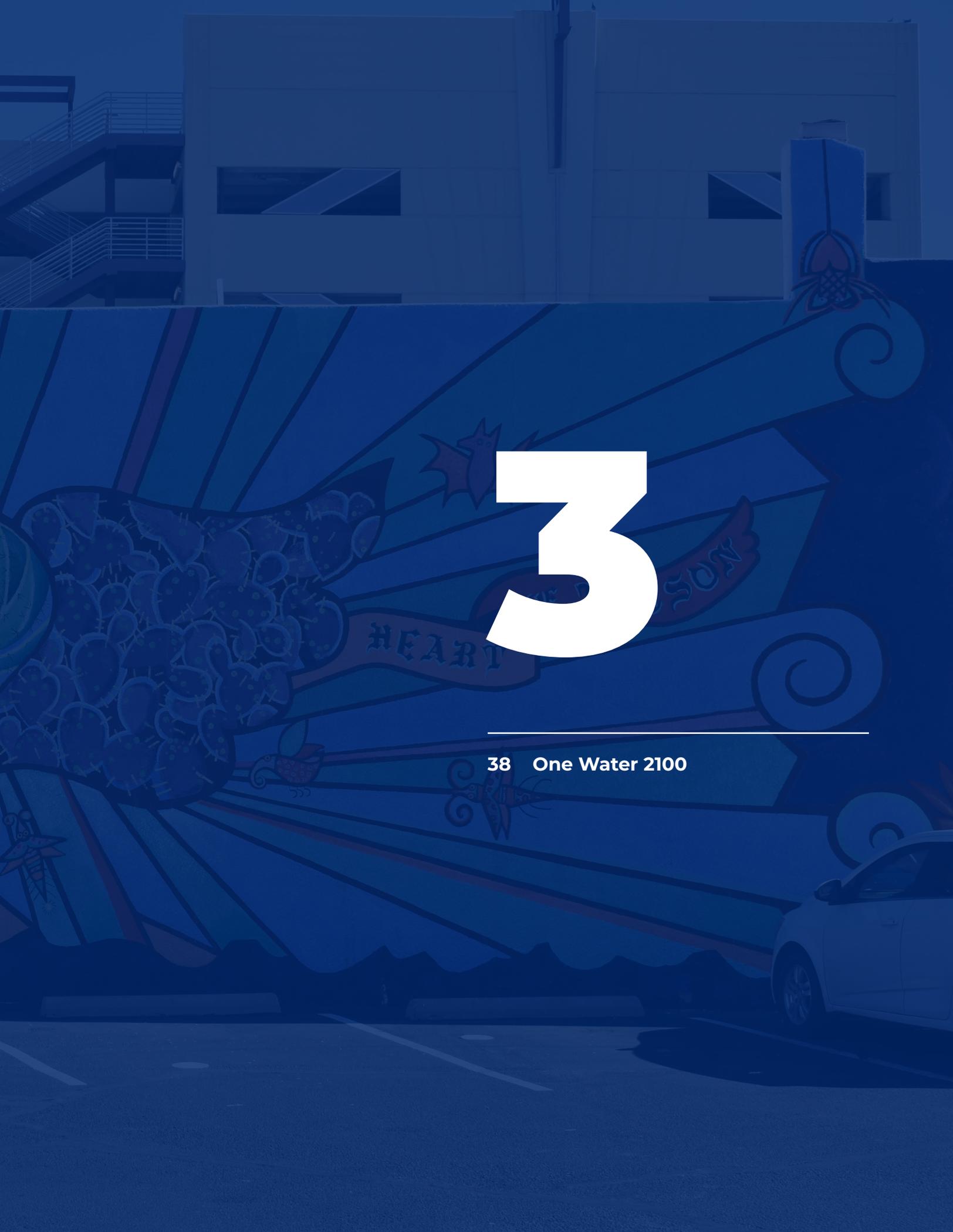
*Tucson Resilient Together* was developed during a specific moment in time, based on the best available information. We anticipate and accept that new information, potential opportunities, and possible disruptions may advance or interrupt the implementation of this plan. This plan is not a static report, but it is instead a living document that must be reviewed and updated regularly. In the sections that follow, we lay out a roadmap for implementation, as well as for monitoring and evaluation, so that we not only measure our progress but also account for the opportunities where we can redouble our efforts and/or recalibrate our timelines as needed.

Structurally, this plan provides a summary of existing conditions in Tucson, as well as a contemporary evaluation of greenhouse gas emissions and climate vulnerability and risk across the city, before proceeding into the roadmap for implementing climate action and adaptation strategies. This plan is more than a checklist of the things we need to do. More importantly, it reflects the hopes, dreams, fears, expectations, and aspirations of Tucsonans. It is our latest and greatest opportunity to take meaningful, equitable, and appropriate action on climate change.



# Introduction





# 3

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38 One Water 2100

# 3 Introduction

Tucson is a site of natural and social confluence. It is here where Santa Cruz and Rillito rivers meet, where mountain ranges converge and form a valley, and where a diverse population of flora and fauna live and thrive in the expansive Sonoran Desert. It is one of the oldest inhabited areas in all of North America, and it has seen its share of communities, social upheaval, and cultures, from the Hohokam Civilization to the Tohono O’odham and Pascua Yaqui tribes who have presided and stewarded the land for thousands of years, to the Spanish Empire, to the governments of Mexico and the United States. The consequence of this challenging history, spanning nearly 12,000 years of human settlement, is a complicated and intricate fabric of individuals and communities that call Tucson home.

Our city has long been one of Arizona’s largest economies, with steady population and job growth spanning decades. It is second only to Phoenix in population amongst Arizonan cities. It is home to the University of Arizona, one of the country’s top public universities and a national leader in climate change research and action. Our green businesses have championed sustainable values from local food to renewable energy, and Tucson is renowned for the solar energy sector.

Our city is diverse in landscape, from the neighborhoods rich with Mexican architecture to the south and west, over to the desert parks and Davis-Monthan Air Force Base to the east, up to the Santa Catalina Mountains to the north and northeast, and back to the barrios and historic neighborhoods that make up Tucson’s downtown area.

Our community is not immune to the global and existential threat of climate change. Tucson is one of the fastest warming cities in the United States, and as both our city and the globe heat up, we are at increasing risk of serious harm from increasingly dry summers, intense and historic wildfires, and prolonged drought that threatens every Tucsonan - especially the most vulnerable among us.



## Climate Emergency Declaration

In September 2020, Tucson declared a climate emergency. With a unanimous vote from our Mayor & Council, the City passed Resolution No. 23222, endorsing the declaration, requesting regional collaboration for an equitable and just transition, and kickstarting an urgent mobilization effort to restore a safe climate. Through the declaration, Tucson committed to achieving carbon neutrality across City operations by 2030, and specifically called for the development and implementation of this climate action and adaptation plan.

Through this declaration, Tucson officially recognized the realities of climate change, affirmed global and local efforts in progress, and directed our elected officials, City staff, advisors, and community to act. The declaration also signified a commitment to align our efforts with the Paris Agreement, through which 175 countries agreed to limit global warming to no more than 2°C above pre-industrial levels and to attempt to keep it below 1.5°C. The declaration referred to the science emergent from the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC), as well as the United States National Climate Assessment, which detail the current and projected impacts of climate change. And finally, the declaration was a commitment to advance and coordinate the existing efforts across Tucson and Pima County to reduce our carbon footprint and build resilience to climate change.

## Climate Action to Date

*Tucson Resilient Together* is not the only action this City has taken on climate change. It is the latest of a series of efforts on our behalf, dating back nearly 20 years, to advance climate action. In 2008, Tucson adopted its Framework for Advancing Sustainability, which provided the City with the original roadmap for sustainability initiatives and established a direction for acting on climate change and integrating GHG emissions mitigation into planning and activities. The Framework was developed after then-Mayor Bob Walkup and the City Council signed onto the Mayors' Climate Protection Agreement, under which cities would commit to reducing City and community-wide GHG emissions to 7% below 1990 levels. Shortly thereafter, in 2011, Tucson prepared the Community Economic Security and Climate Action Analysis, which was the first in-depth assessment of our contributions to climate change citywide and included specific strategies for action with supporting cost-benefit analyses.

*Plan Tucson*, our most recent General and Sustainability Plan, was adopted in 2013. In this

plan, Tucson established a few overarching climate action goals: to reduce the community's carbon footprint, to create greater energy independence, to achieve growth based on transit-oriented and infill development, and to create a community that is resilient and adaptive to climate change. It was around this time as well that the City passed or advanced several energy initiatives, including sustainable energy efficiency standards and the installation of solar photovoltaics (PV) and solar water heating at City and community facilities. The Sun Link Streetcar also opened in 2014, signaling a significant move toward transit-oriented development in Tucson.

Climate action efforts have quickened in recent years, and during this time we have folded adaptation and resilience into our plans and projects. In 2019, the Mayor & Council adopted the *Complete Streets Design Policy*, with the goal of shifting the City's approach to transportation planning and design toward safe, connected, and equitable transportation, including safer corridors for zero-emission modes of travel such as walking, biking and rolling, as well as creating more inviting and safe public spaces and transit stops. Two years later, we adopted *Move Tucson*,

our transportation master plan, which is geared toward increasing travel options, increasing safety for pedestrians and cyclists, providing multimodality, and increasing equity in transportation investments across neighborhoods. In the same year (2021), Tucson adopted its People, Communities, and Homes Investment Plan (P-CHIP), which set goals to mitigate neighborhood vulnerabilities, advance social equity and inclusion, and support inclusive economic development. Through this plan, we identified transportation-disadvantaged areas, areas with insufficient shade and resilience to climate change, and areas with limited access to parks and open space.

Most recently, the Mayor and Council adopted the Electric Vehicle Readiness Roadmap, recognizing electric vehicles (EVs) as a key climate strategy to reduce GHG emissions and setting a course of action to support EV adoption across Tucson. The Roadmap lays out goals and strategies to remove barriers to EV adoption, and to turn over the City's fleet of light duty vehicles to electric over the next decade.

Additional ongoing initiatives include, but are not limited to:

- **Storm to Shade:** our green infrastructure program which installs infrastructure that uses or mimics natural systems to capture, clean, and infiltrate stormwater, shade and cool buildings, support tree canopy, reduce flooding, and create wildlife habitat on public property throughout Tucson;
- **Tucson Million Trees:** an initiative led and driven by Mayor Regina Romero to plant one million trees by 2030 to increase the city's tree canopy and help mitigate the impacts of climate change in heat-vulnerable neighborhoods; and
- **Solar Tucson:** an initiative to promote and install solar in the community through highly visible installations on city-owned buildings, including community centers, the Tucson Convention Center, police substations, water facilities, park shade structures, and parking lots.

## Advisory Bodies on Climate Action

We know that real climate action is not possible without the guidance of subject matter experts and implementers. Tucson leans upon the work of two advisory bodies, one internal and one external, that directly advise the Mayor and Council on issues of climate change and sustainability:

### Commission on Climate Change, Energy, and Sustainability (CCES)

Established in 2017, the Commission meets monthly and advises M&C on meeting the climate, energy, and sustainability goals laid out in Tucson's General Plan.

### Climate Action Advisory Council (CAAC)

The CAAC was formed following the Climate Emergency Declaration. The Council is composed of various stakeholders across Tucson and the State of Arizona, including representatives from the CCES, the Coalition for Sonoran Desert Protection, the Sierra Club, the University of Arizona, the IITC, Tucson Clean & Beautiful, Arizona State University, local businesses, and more. The CAAC is tasked with advising the M&C on the development and implementation of *Tucson Resilient Together*.

## Climate Action Process

*Tucson Resilient Together* is intended to coalesce, coordinate, and expand our existing efforts on climate action. It is a continuation of the vision laid out in the Framework for Advancing Sustainability, but it is an important affirmation and demonstration of our commitment to centering equity and justice in climate action as resolved in our Climate Emergency Declaration. And it is a critical step toward coordinating City and community action to address the climate crisis and build a more resilient Tucson for an uncertain climate future.

To develop the plan, Tucson contracted with consultant partner **Buro Happold** in January 2022, alongside a consultant team including **Living Streets Alliance**, a local advocacy organization committed to advancing complete and safe streets across Tucson, **Autocase Economic Advisory**, an economics firm tasked with performing cost-benefit and multi-criteria decision analyses for this plan, and faculty from the **Drachman Institute at the University of Arizona College of Architecture, Planning & Landscape Architecture** with expertise in planning, green infrastructure, and climate resilience. In partnership with this consultant team, the City of Tucson formally kicked off the planning process in February 2022.

The consultant team first reviewed Tucson's existing policies, programs, and climate conditions as part of a broader existing conditions assessment and performed a gap analysis that compared the City's existing efforts to current best practices and other contemporary climate leaders. Informed by recommendations from the CAAC and previous community engagement, a vulnerability and risk assessment identified climate hazards and delivered projections and analyses with respect to their future impacts, the sensitivity and exposure of Tucson communities, geographic areas, and physical assets, and Tucson's adaptive capacity. To identify the significant emissions reduction opportunities for Tucson to meet its carbon neutrality goals, Buro Happold conducted an analysis of Tucson's

existing GHG emissions inventory and reviewed emissions across sectors. The analysis includes an emissions forecast, including business-as-usual and business-as-planned scenarios, to identify the impacts of strategies over time towards carbon neutrality.

Concurrently, a comprehensive internal engagement and community engagement effort was in process. This started with a community survey and climate listening sessions that were conducted in 2021, as well as meetings with the CAAC to develop recommendations for the emissions and climate vulnerability analyses. Upon onboarding the Tucson Resilient Together consultant team in February 2022, the City developed a community engagement strategy that was built around partnerships with seven community organizations representing population groups and communities that have been historically excluded from or marginalized by the City's planning and engagement efforts. The strategy included multiple public workshops, the onboarding and training of community ambassadors (or Promotores) to facilitate engagement within their communities, community dialogues led by the Promotores, and pop-up events around the City of Tucson.

These engagements, alongside ongoing touchpoints with City staff and the CAAC, Ward offices informed the strategies and actions presented in this plan. These strategies and actions, as well as the analyses supporting them, were presented to community members and City stakeholders at multiple stages throughout the plan. The consultant team consolidated and integrated this feedback into Tucson Resilient Together, marrying it with expert analysis, resulting in an implementable plan that is as much driven and guided by science and best practice as it is by community aspirations, knowledge, expertise, and truths.

## Community Engagement Approach

Through this process, we sought to prioritize the communities and neighborhoods that have historically been excluded from decision-making. This includes youth, older adults, women and girls, gender non-conforming individuals, veterans, individuals affected by the criminal justice system, low-income individuals, renters, individuals experiencing homelessness, people of color, Indigenous peoples, people with disabilities, immigrants, and LGBTQ+ individuals. Throughout the engagement process, we considered climate impacts and decision-making in the context of the experiences within each of these groups, as well as across their various intersections.

Conventional approaches to community engagement can exclude people by design, largely because organizers are asking participants to come to them without recognizing practical and emotional barriers to participation. These approaches are insufficient to engage individuals or groups without the time, means, or comfort to participate in conventional meetings. Our equity-centered approach supplemented conventional gatherings with strategies to meet people where they are.

Our community engagement approach has used various tools and strategies, including but not limited to the following:

- community survey, an online tool to solicit general feedback on themes of interest and priorities;
- listening sessions, or small-group workshops focused on direct interface with and listening to targeted groups;
- public meetings, or larger workshops that bring together various stakeholders;

- promotores, or trusted community leaders and ambassadors with specialized training for outreach and facilitation;
- community dialogues, or small-group workshops with targeted communities for information sharing and gathering, led by promotores; and
- pop-up events, or targeted small-scale events located at strategic locations frequented day-to-day.

Together, these strategies provided flexibility for a range of community members to participate. Furthermore, they collectively demonstrated the approach of **appreciative inquiry**, whereby conversations were focused on inspiring collective action and creating a common vision by highlighting strengths and successes, as well as fostering and reinforcing relationships. These strategies also created decision-making spaces that ensured equal footing and valued lived experience just as much as technical expertise. Finally, they supported and mobilized networks of trusted community partners, enabling historically excluded communities to feel safe, comfortable, and supported throughout the process.

The strategies and actions laid out in this plan were developed through a multi-phase process inclusive of community and internal stakeholder engagement, as described on the following pages.

## LISTENING

The “**Listening**” phase included various efforts to engage the community in anticipation of *Tucson Resilient Together*, with the intent to understand the issues of highest concern.

- **Climate action community survey:** We partnered with the University Climate Change Coalition (UC3) at the University of Arizona to issue a survey on climate action. The survey garnered nearly 4,000 responses and equated to nearly 200 hours of public comment.
- **Climate listening sessions:** In partnership with UC3, Tucson Climate Coalition, and Southwest Decision Resources, we implemented 14 distinct community listening sessions that brought together over 150 Tucsonans. The listening sessions elicited over 1,300 unique comments, concerns, and recommendations. For these sessions, 29 community members and eight student interns were trained as facilitators, who also helped to enter and code responses into a database.
- **Community partner connection and preparation:** We engaged with community partners identified early in the planning stages and worked with them to set goals and visions for climate action and adaptation in Tucson. The goal was to understand the specific needs and priorities of the groups presented, as well as the appropriate locations and times for touchpoints.

## VISIONING

The second phase, “**Visioning**,” was intended to raise public awareness about Tucson Resilient Together and to provide additional opportunities for engagement.

- **Promotores selection and training:** Building upon our initial connections with our community partners, we invited promotores, or community ambassadors, to lead forthcoming dialogues with their organizations and community members. Each promotor(a) participated in a training on facilitation and on climate change discussion topics.
- **Public workshop:** We held the first public workshop for Tucson Resilient Together in May 2022, welcoming nearly 120 community members from across Tucson and the region. Attendees participated in a 3-hour long workshop, sharing and recording their visions for a climate-resilient Tucson.
- **Community dialogues:** During the summer, our community partners and promotores facilitated several community dialogues to build upon the visioning discussions started in Phase 1 and during the public workshop.

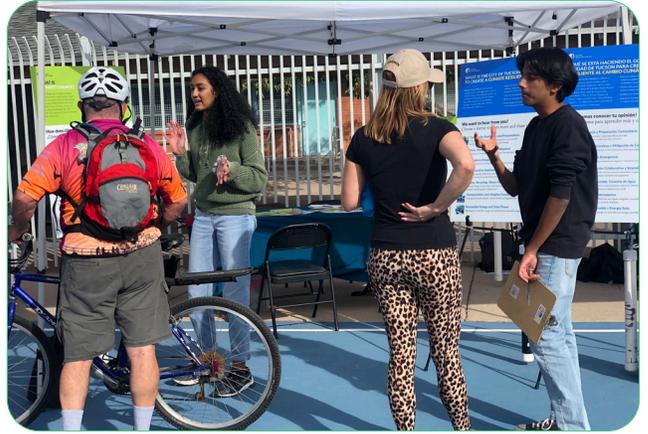


## STRATEGIZING

The final phase, “**Strategizing**,” was characterized by a focus on best practices and strategies. Community members and past participants from climate listening sessions were invited to pre-vet selected climate action and adaptation strategies and prepare specific recommendations for *Tucson Resilient Together*.

- **Community dialogues:** We continued with six additional, facilitated community dialogues, centered on reviewing strategies and actions for the plan.
- **Pop-up events:** To meet people where they are, we identified locations and events across Tucson for pop-up stands to communicate the priorities of Tucson Resilient Together and solicit feedback on a curated list of strategies and actions. During this phase, we held nine pop-up events.
- **Public workshop:** We held the second and final public workshop for Tucson Resilient Together in November 2022, with over 120 community members from across Tucson and the region. As with the first workshop, attendees participated in a 3-hour long workshop, through which they were able to provide input on strategies and actions on the issues that were of greatest importance or impact to them.





# One Water 2100

Water in the desert is precious, so the impacts of climate change on water are the leading concern in our community. Tucson Water, a department of the City of Tucson and the largest water provider in the region, has a 390-square-mile service area and serves nearly 30 billion gallons of water to customers each year. Tucson's water resources include groundwater, surface water (Colorado River water delivered via the Central Arizona Project), recycled water, and storm water. All of these water resources are equally valuable.

Tucson Water updates its master plan and long-range water use projections every decade, which includes its current master plan update: *One Water 2100*. The planning process for *One Water 2100* has coincided with the planning process for *Tucson Resilient Together*. City staff working on these plans have been coordinating to ensure that public feedback is reflected in the recommended strategies and actions within each plan. To avoid duplicative efforts, water supply and demand management strategies are not included *Tucson Resilient Together* and will be addressed in *One Water 2100*, though the two plans and their implementation will work in tandem after they are adopted.



## One Water Approach

Tucson Water's master plan takes a "One Water" approach to integrated resource management, focusing on water supply and demand management strategies while centering sustainability and equity. One Water 2100 is Tucson's commitment to resilience, equity, stewardship and quality of life. The guiding principles of Tucson Water's master plan are as follows:

- to deliver water reliability through water supply diversification, conservation, and innovative improvements to infrastructure;
- to reinforce resiliency by planning for climate change, leading mitigation efforts, and implementing collaborative and adaptive strategies;
- to enhance the community's quality of life by preserving and restoring riparian areas, increasing urban tree canopies and supporting economic growth;
- to achieve affordability, accessibility, and social justice by committing to fiscal responsibility and prioritizing equitable projects and programs; and
- to ensure public confidence with safe, high-quality water supplies and exceptional customer service that includes transparency and responsiveness.

Due to the severity of the drought on the Colorado River, our primary source of drinking water, the Tucson Mayor and Council have been considering a number of water related policies as the One Water 2100 master plan is being developed. In October 2022, Mayor and Council asked staff to develop an ordinance requiring new commercial and multifamily properties to install irrigation meters and new residential developments to use low-impact or green infrastructure to keep stormwater onsite. The building code will also be updated to require EPA WaterSense fixtures. Staff was also asked to research a Net Zero Water conservation measure and non-functional turf restrictions for new development. The results of these efforts will be documented and reported on by the city.

The One Water 2100 master plan is expected to be completed in 2023. Check out [tucsononewater.com](https://tucsononewater.com) to shape our water future and stay updated on the plan's progress.

# Climate Change in Tucson



# 4

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# 4 Climate Change in Tucson

## Global Climate Trends

Human activity is directly affecting the climate. Due to the burning of fossil fuels such as coal, oil, and gas, large volumes of carbon dioxide and other greenhouse gases are being put into the atmosphere. Other contributors to global greenhouse gas emissions include but are not limited to agriculture, deforestation and other land use changes, methane from landfills, industrial processes, and chemical products. As a result, the Earth has experienced unprecedented warming since 1850 (see Figure 3). Global surface temperature and oceanic temperatures rose over the last four decades, global precipitation patterns are shifting, and extreme weather events are increasing in frequency and severity.

The impacts of climate change are far-reaching. Warming oceans are expediting melting at our poles and in glaciers, and experiencing an expansion of seawater as it warms to contribute to sea level rise. Shifts in surface and oceanic temperatures are causing extreme weather events to increase in frequency and severity. The combination of high temperatures and prolonged drought are increasing risk and occurrence of wildfire. These disruptions are contributing to significant damage to ecosystems, some of which the IPCC considers to be irreversible.

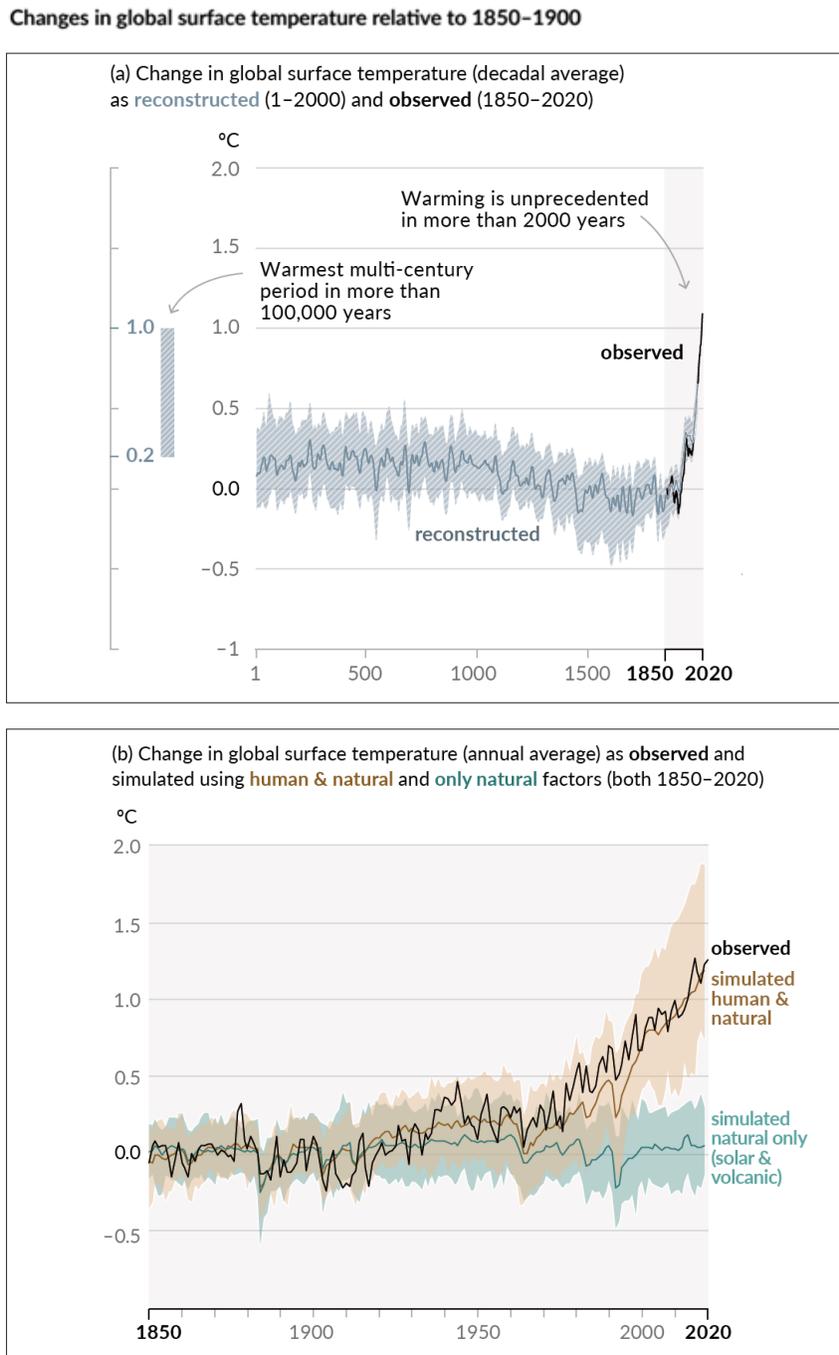
In AR6, the IPCC models a range of possible climate futures. These scenarios are based on climate models

and projections with differing emissions outputs through mid- and end-of-century. The IPCC concludes that global surface temperature will continue rising through 2050 under all emissions scenarios, and the warming thresholds of 1.5°C and 2°C will be exceeded this century without substantive emissions reductions.

It is important to understand that while climate change is a global issue, it is having significant impacts at the local and community level. As we assembled this plan, we repeatedly heard concern from our communities about the impacts of climate change here in Tucson: extreme heat and drought threaten our resources, our livelihoods, and our health; Tucson's water sources are being depleted and are not being sufficiently replenished; and the ecosystems and natural environments characteristic of Tucson are at risk.

While it requires concerted global action to address, it is critical that we as a city do our part. We must not only reduce our own greenhouse gas emissions, but we must also deploy the tools and infrastructure to adapt to ongoing and future change. In this chapter, we explain the unique climate and environmental context of our city, speak to our current and projected greenhouse gas emissions, and elaborate on community vulnerability to the impacts of climate change. This context has been and will continue to be critical as we implement strategies to act on climate change.

Figure 3. History of global temperature change and causes of recent warming (IPCC AR6)<sup>1</sup>



1 IPCC 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp.3-32, doi: 10.1017/9781009157896.001.

## Climate and Environment in Tucson

Climate change is happening in Tucson, but how it affects our city and region depends greatly on our local climate and natural environment. Tucson's site and situation in the Sonoran Desert, as a city subject to the Southwest U.S. Monsoon and in close proximity to the Gulf of California and Gulf of Mexico, have significant bearing on how climate change manifests and will continue to unfold across our city. As we describe in this chapter, the extremes that Tucson will face are likely to be exacerbated, and conventional climate and weather patterns will shift and become less predictable.

Later in this chapter, we will talk about the impacts of climate change on communities and infrastructure across Tucson, but it is also important to remember that the fauna and flora that make up Tucson's unique landscape and rich biodiversity also stand to be affected by a changing climate. We cannot talk about climate change, and how to address it as a community and as a city, without the context of Tucson's natural environment.

### Environment and Ecosystem

As one of the largest cities in the Sonoran Desert, Tucson is located in the eastern portion of Pima County and is bordered by multiple protected natural areas. These include Catalina State Park, Saguaro National Parks East and West, Ironwood Forest National Monument, and Coronado National Forest.

Despite its semi-arid conditions, the Sonoran Desert is considered the most biologically diverse desert on the continent, including more plant species than any other desert on the planet. Over 60 mammal, 350 bird, 100 reptile, and 2,000 native plant species thrive in this desert.<sup>1</sup> It is the only place in the world where our renowned saguaro cactus (*Carnegiea gigantea*) grows in the wild, and yet it is only one of the many types of cacti found in the Sonoran Desert. The area southeast

of Tucson near the Mexican border is also home to the sole jaguar population within the United States.

However, climate change and other human-caused stresses are threatening the health and sustainability of these habitats and the species they house. The sprawl of large metropolitan areas across the Sonoran Desert, including Tucson, has encroached into the desert and taken ground at alarming rates. Furthermore, shifts in local precipitation and temperature due to climate change threaten even the most resilient flora and fauna. Climate change has the potential to change climate and weather patterns in such a way that, as has been observed in ecosystems around the world, may reduce or bring extinction to our native plant and animal species.

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1 Center for Biological Diversity. (n.d.). "Sonoran Desert." <[https://www.biologicaldiversity.org/programs/public\\_lands/deserts/sonoran\\_desert/index.html](https://www.biologicaldiversity.org/programs/public_lands/deserts/sonoran_desert/index.html)>.



## Climate and Weather

Tucson is considered a warm arid or semi-arid climate, with an annual average temperature high of 84.0°F and average maximum temperatures near or above 100.0°F during the summer months.<sup>2,3</sup> The city's annual average temperature low is 57.3°F, with average minimum temperatures dropping to the low 40s during winter months. Spring and fall days tend to be mild with clear skies, although trends show higher temperatures that are beginning earlier in the year and ending later.<sup>4</sup>

Notably, temperatures across Pima County are rising. The long-term average, between 1895 and 2018, for Pima County was 66.8°F.<sup>5</sup> However, in almost every year since 1985, the county's average annual temperatures have exceeded that figure. Projections show that average temperatures are likely to increase into mid and late-century, which will be discussed further in the *Climate Vulnerability* chapter.<sup>6</sup>

2 Peel, M.C., Finlayson, B.L., and McMahon, T.A. (2007). "Updated world map of the Köppen-Geiger climate classification." <<https://hess.copernicus.org/articles/11/1633/2007/hess-11-1633-2007.pdf>>.

3 National Weather Service. (2022). "Tucson Monthly and Daily Normals (1991-2020)." <<https://www.wrh.noaa.gov/twc/climate/tus.php>>.

4 Arizona State University and Arizona Department of Health Services. (2015). "Arizona Extreme Weather, Climate, and Health Profile Report."

5 Meadow, A., LeRoy, S., Weiss, J., and Keith, L. (2019). "Climate Profile for The Highlands at Dove Mountain." <<https://climas.arizona.edu/sites/climas.arizona.edu/files/CLIMAS%20Highlands-Dove-Mountain-FINAL.pdf>>

6 Ibid.

## PRECIPITATION, MONSOONS, AND DROUGHT

Tucson has a dry spring and autumn, and a wet winter and summer. Regional precipitation varies year-to-year, with an average annual precipitation of 10.61 inches.<sup>7</sup> During the summer monsoon, Tucson receives southerly and south-easterly airflow from the gulfs of California and Mexico, bringing warm, moist air that can trigger heavy, localized thunderstorms.<sup>8</sup> Over the last 30 years, the southwestern U.S. has experienced less frequent extreme storms and reduced average annual precipitation. However, annual precipitation in Tucson has slightly increased over time, and monsoons have become more intense as the average amount of precipitation during monsoon storms has increased.<sup>9</sup>

Tucson has relatively light winds, but during monsoon season, localized strong winds called microbursts can occur due to outflows from thunderstorms and straight-line winds. These winds can pick up and generate dust storms.<sup>10</sup> It is expected that maximum wind gusts during extreme storms will increase across the region, which is important as dust storms have multiple, negative impacts.<sup>11</sup> They negatively impact air quality, creating public health concerns for vulnerable populations, and in more extreme

situations can trigger disruptions across transportation and electric infrastructure, causing vehicular accidents and triggering power outages.<sup>12</sup>

In 2008, the National Weather Service decided to consider June 15th through September 30th the official U.S. Southwest monsoon.<sup>13</sup> But, prior to that time, the specific monsoon onset date was defined by seasonal atmospheric patterns, specifically the average daily dewpoint temperature, which vary from year to year. Historically, the most common summer monsoon start date in Tucson was July 3rd, but it is documented to have started as early as June 17th (2000) and as late as July 25th (1987).<sup>14</sup>

Pima County and the Colorado River Basin at large (within which much of Arizona lies) have been in a heat drought for over 20 years, with almost every year since experiencing precipitation levels below the long-term average since 1999.<sup>15</sup> The drought has reduced winter precipitation and increased average winter temperatures.<sup>16</sup> However, this trend has varied significantly: while 2020 had the second-driest monsoon season on record, 2021 recorded the second-wettest.

7 National Weather Service. (2022). "Tucson Monthly and Daily Normals (1991-2020)." <<https://www.wrh.noaa.gov/twc/climate/tus.php>>.

8 Meadow, A., LeRoy, S., Weiss, J., and Keith, L. (2019). "Climate Profile for The Highlands at Dove Mountain." <<https://climas.arizona.edu/sites/climas.arizona.edu/files/CLIMAS%20Highlands-Dove-Mountain-FINAL.pdf>>

9 Luong, T., Castro, C., Chang, H., Lahmers, T., Adams, D., Ochoa-Moya, C. (2017). "The More Extreme Nature of North American Monsoon Precipitation in the Southwestern United States as Revealed by a Historical Climatology of Simulated Severe Weather Events." <<https://journals.ametsoc.org/view/journals/apme/56/9/jamc-d-16-0358.1.xml>>.

10 Meadow, A., LeRoy, S., Weiss, J., and Keith, L. (2019). "Climate Profile for The Highlands at Dove Mountain." <<https://climas.arizona.edu/sites/climas.arizona.edu/files/CLIMAS%20Highlands-Dove-Mountain-FINAL.pdf>>

11 Luong, T., Castro, C., Chang, H., Lahmers, T., Adams, D., Ochoa-Moya, C. (2017) The More Extreme Nature of North American Monsoon Precipitation in the Southwestern United States as Revealed by a Historical Climatology of Simulated Severe Weather Events. *Journal of Applied Meteorology and Climatology* 56, 2509 - 2529.

12 Pima County. (2017). "Pima County Multi-Jurisdictional Hazard Mitigation Plan."

13 Climate Assessment for the Southwest (CLIMAS). (n.d.). "Southwestern Monsoon." <<https://climas.arizona.edu/sw-climate/monsoon>>.

14 National Weather Service. (2022). "Tucson Monsoon start date, occurrences by date (1946-2021)." <<https://www.weather.gov/twc/monsoon>>.

15 Meadow, A., LeRoy, S., Weiss, J., and Keith, L. (2019). "Climate Profile for The Highlands at Dove Mountain." <<https://climas.arizona.edu/sites/climas.arizona.edu/files/CLIMAS%20Highlands-Dove-Mountain-FINAL.pdf>>

16 Ibid.

## Greenhouse Gas Emissions

To reach our goals of carbon neutrality for City operations by 2030 and community-wide carbon neutrality by 2045, we must significantly reduce our greenhouse gas emissions. Substantive and lasting emissions mitigation requires a comprehensive understanding of what greenhouse gases are, how exactly the carbon cycle works, how much greenhouse gases we are emitting, and from which activities those gases are being emitted. It also requires a shared understanding of what carbon neutrality means as a concept and a goal. Only then can we begin to identify the necessary steps to reduce greenhouse gas emissions, quantify their impact, and take appropriate action.

### What is the carbon cycle?

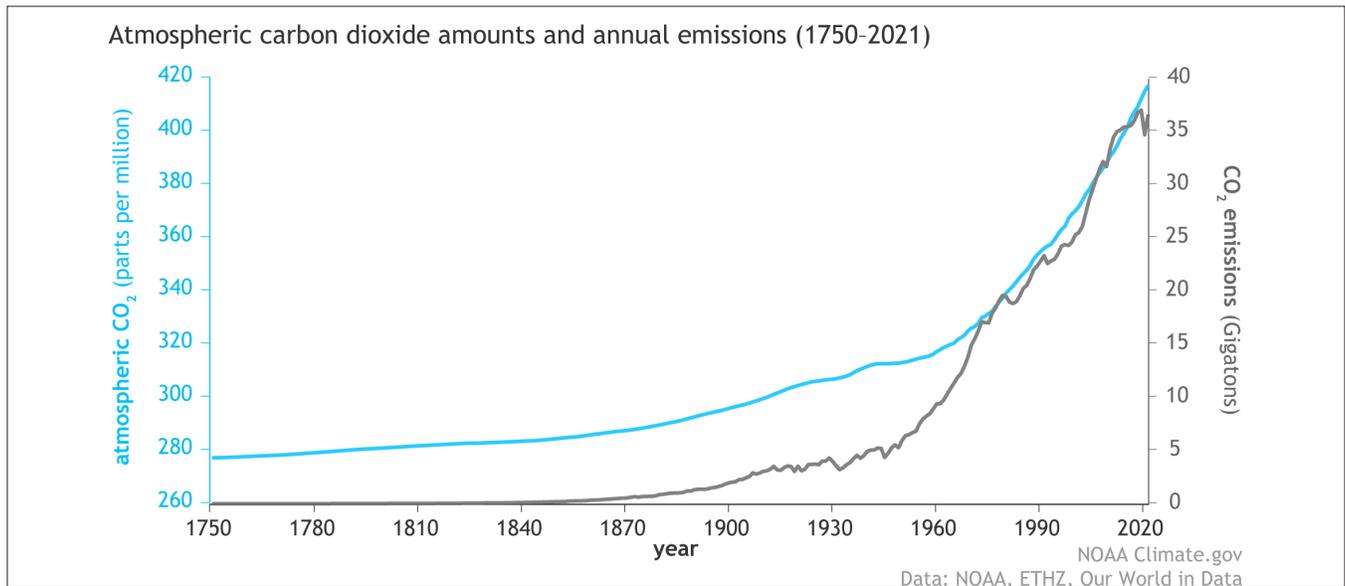
Carbon is essential to life on Earth as a natural element which can be found in all living organisms. It also can be found in the atmosphere in the form of carbon dioxide (CO<sub>2</sub>). The carbon cycle is the set of ongoing natural processes that shift carbon between living organisms, the atmosphere, oceans, rocks, and sediments.

Human activity is disrupting the balance in the biological carbon cycle. For example, fossil fuels contain carbon from living organisms that died millions of years ago. As we burn those fuels for energy, carbon dioxide and other greenhouse gases are released into the atmosphere at a much quicker rate. Similarly, when people significantly alter land cover, such as through deforestation, this changes the size of natural carbon sinks which can absorb (or "sequester") atmospheric carbon. Methane generated from agricultural livestock and decomposing landfill waste, as well as industrial processes and products, are among the many activities that also contribute to human-caused (or "anthropogenic") greenhouse gas emissions. The cumulative effect is measurable as a rapid, net increase in atmospheric carbon, as shown in Figure 4.

### What are greenhouse gases?

Greenhouse gases, or GHGs, are gases that trap heat in the atmosphere and they include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases. GHGs come with molecular properties that enable them to absorb and attach to heat in the form of infrared photons. These gases capture heat radiating from the sun and reflecting off the Earth's surface, thus preventing it from escaping the Earth's atmosphere. This process is commonly referred to as the 'greenhouse effect.' The greenhouse effect is critical to our survival on Earth: without it, human life would not be possible. Some presence of GHGs in the atmosphere is natural and essential to life on Earth. However, the increasing concentration of GHGs is "thickening the Earth's blanket" and making the planet warmer, which in turn causes long-term shifts in temperature and weather patterns across the globe.

Figure 4. Atmospheric carbon dioxide amounts and annual emissions (1750-2021)



Because the Earth cannot absorb these increased carbon emissions quickly enough, we have significantly increased the concentration of GHGs in the atmosphere, typically measured in parts per million (ppm). Consequently, global air and oceanic temperatures have increased significantly around the globe since the industrial revolution. Since 1750, the amount of atmospheric CO<sub>2</sub> has risen from just under 280 ppm in 1750 to nearly 420 ppm as of 2021.<sup>1</sup>

## How do we measure greenhouse gas emissions?

To understand how we measure GHG emissions, it is important to know how they are categorized. First, there is **biogenic** carbon, which is naturally emitted, absorbed, and stored by organic matter (e.g., trees, soil), and there is non-biogenic or **anthropogenic** carbon from human activity sources such as the combustion of fossil fuels (e.g., coal, oil, gas). When accounting for our GHG emissions, we are most concerned with quantifying and reducing anthropogenic GHG emissions, because they are the emissions for which we are most directly responsible, thus the ones which we can most effectively reduce or eliminate.

Typically, GHG emissions can be quantified by source, sector, or scope. In the case of source, emissions are quantified based on whether or not they come from stationary energy sources (e.g., homes, buildings, infrastructure), transportation (e.g., vehicles, airplanes), or waste (e.g., landfill). If measuring by sector, emissions are generally sorted into residential, commercial, industrial, or municipal emissions with some sub-categories. Finally, emissions can be measured by scope, which has to do with the direct or indirect control of activities contributing to emissions.

17 The amount of carbon dioxide in the atmosphere (blue line) has increased along with human emissions (gray line) since the start of the Industrial Revolution in 1750. Emissions rose slowly to about 5 billion tons per year in the mid-20th century before skyrocketing to more than 35 billion tons per year by the end of the century. NOAA Climate.gov graph, adapted from original by Dr. Howard Diamond (NOAA ARL). Atmospheric CO<sub>2</sub> data from NOAA and ETHZ. CO<sub>2</sub> emissions data from Our World in Data and the Global Carbon Project.

There are three scopes of emissions that are internationally recognized and standardized:

- **Scope 1:** Direct emissions from owned or controlled sources. These can include on-site fuel combustion, emissions from owned vehicles, and fugitive (unintentionally leaked or discharged) emissions from refrigerants, fire suppression systems, and more.
- **Scope 2:** Indirect emissions from purchased electricity, steam, heating, and cooling.
- **Scope 3:** Indirect emissions from all other activities, which can include purchased goods/services, business travel, commuting, waste disposal, investments, leased assets, and more.

## What is carbon neutrality?

Carbon neutrality is measured as a net zero balance of anthropogenic GHGs that are emitted versus absorbed (or "sequestered") from the atmosphere by plants, soil, or water bodies. These "carbon sinks" may be natural or artificial, and include but are not limited to land management of forests, grasslands, and croplands. In other words, if an entity theoretically emitted 100,000 MTCO<sub>2</sub>e in a year, it would be considered carbon neutral if it either completely eliminated those emissions, or if it countered those emissions using carbon insets (investing in an entity-owned project

## Tucson's greenhouse gas emissions

Tucson's greenhouse gas emissions, both from City operations and community-wide activities, are measured on an annual basis and reported on a biennial basis through the Pima Association of Government's (PAG) Regional Greenhouse Gas Inventory Report. Tucson Water also conducts and maintains a distinct GHG emissions inventory for its activities. In PAG's report, emissions are reported in a mixed fashion accounting for source, sector, and scope, whereas Tucson Water quantifies by scope.

Sorting emissions into scopes is most commonly recognized and accepted because it provides direction to emitting entities with respect to where they can have the greatest impact or ownership of emissions and their mitigation. Nearly all climate mitigation efforts focus on Scope 1 and 2 emissions, and there are increasing efforts to address Scope 3 emissions.

Finally, emissions are most typically measured in metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>e). This unit allows for comparisons of the global warming impact of different GHGs. One unit of methane, for example, has approximately 30 times the global warming potential (GWP) of carbon dioxide, meaning that one ton of methane will absorb 30 times as much energy as one ton of carbon dioxide and thus contribute more to global warming.

that sequesters emissions, like an urban forest) or carbon offsets (investing in a non-related project that reduces or sequesters emissions, like a U.S. forestry project or livestock methane capture project).

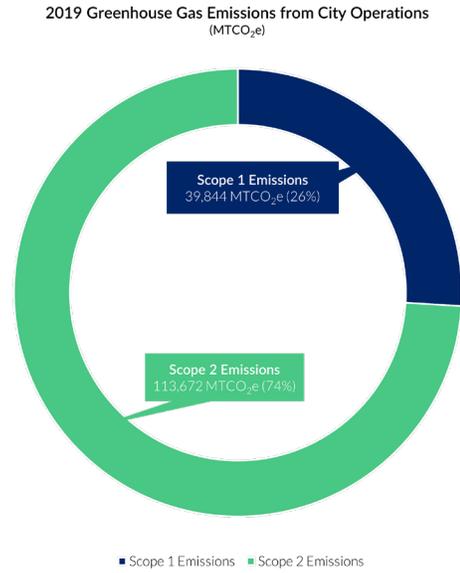
For the purposes of Tucson's municipal and community-wide inventories, carbon neutrality accounts for Scope 1 and 2 emissions alone and excludes Scope 3 emissions. As a note, these inventories do not include any insets or offsets, and only include actual emissions.

To identify strategies toward the achievement of our carbon neutrality goals, we established the City's most recent inventory from 2019 as a baseline for projections and mitigation impact measurements. Consequently, the inventory summaries and analyses included herein are based on our 2019 inventories as published in the most recent PAG report.

## EMISSIONS FROM CITY OPERATIONS

### 2019 Baseline Emissions

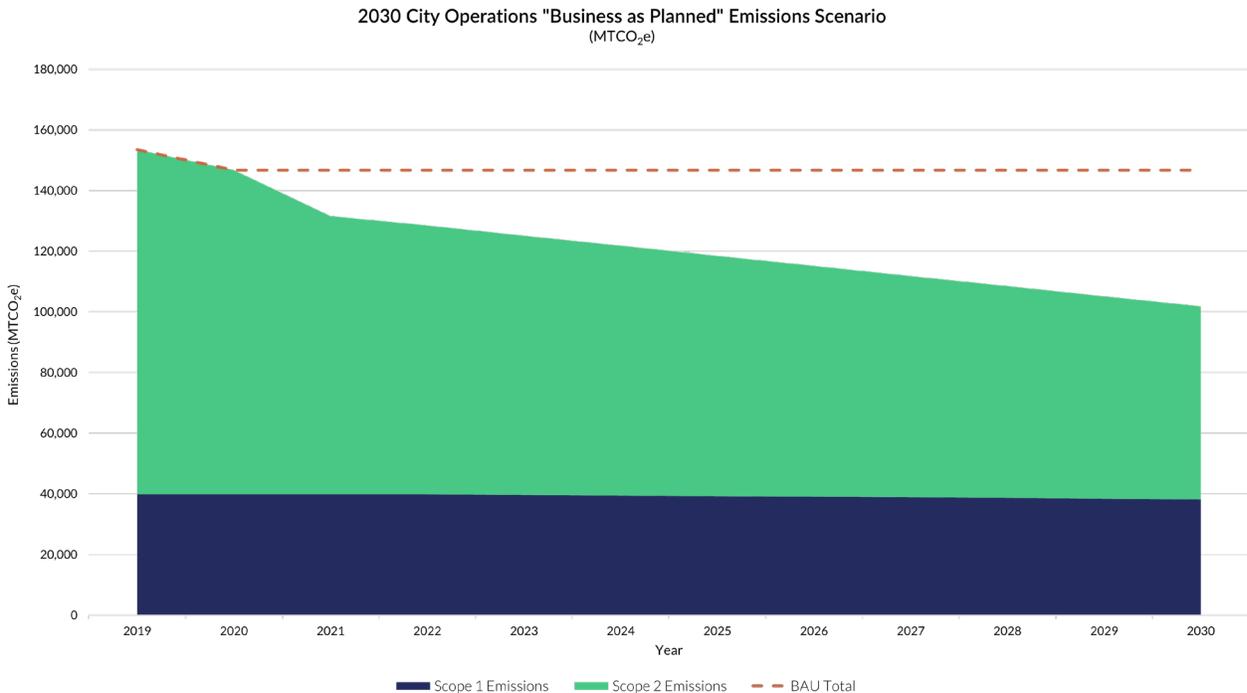
It is estimated that, in 2019, the City of Tucson emitted approximately 153,517 MTCO<sub>2</sub>e across its assets and activities under Scopes 1 and 2. Approximately 26% of municipal emissions were Scope 1 emissions, or from assets directly owned by the City, and the remaining 74% were Scope 2 emissions, or procured electricity. The overarching breakdown of emissions by source is shown below in Figure 5.



### Projected GHG Emissions through 2030

Projected emissions through 2030 are shown in figures below that show business-as-usual (BAU) and business-as-planned scenarios (BAP). BAU assumes that no additional actions are taken to reduce GHG emissions apart from existing or ongoing initiatives. Plans, proposed initiatives, and policies not yet implemented are assumed to not occur during this timeframe. BAP assumes that such actions are being implemented as planned. The BAP scenario is represented by the stacked area, whereas the BAU is overlaid as a dotted line in Figure 06.

Figure 6. Projected BAP GHG emissions scenario from City Operations through 2030



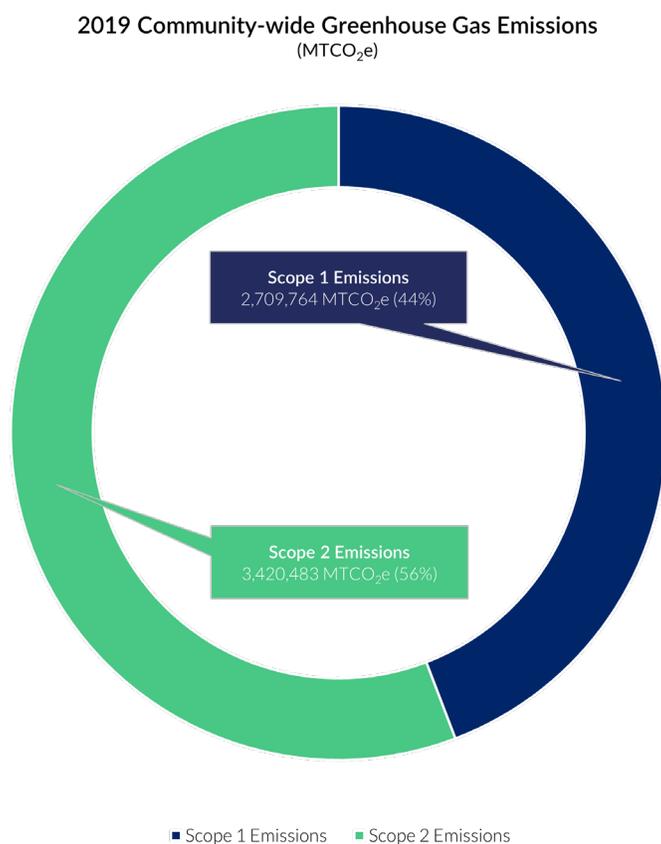
In the BAP scenario, emissions decline by 34% by 2030 from 2019 levels, based on assumptions that Tucson Electric Power (TEP) will achieve its preferred portfolio of 70% renewable energy by 2035, that the City successfully transitions its light-duty vehicle fleet to electric by 2030 (per commitments in the *2022 EV Readiness Roadmap*), and that the City is on track to achieve zero waste by 2050. The BAP scenario at 2030 is 31% lower than the BAU scenario during the same year.

## COMMUNITY-WIDE EMISSIONS

### 2019 Baseline Emissions

It is estimated that, in 2019, the Tucson community emitted over 6.1 million MTCO<sub>2</sub>e across Scope 1 and 2 emissions. 44% of community-wide emissions are classified as Scope 1, including fossil fuel use across residential, commercial, and industrial sectors, as well as emissions from transportation. The remaining 56% come from Scope 2 emissions (procured electricity). The overarching breakdown of community-wide emissions by source is shown in Figure 7.

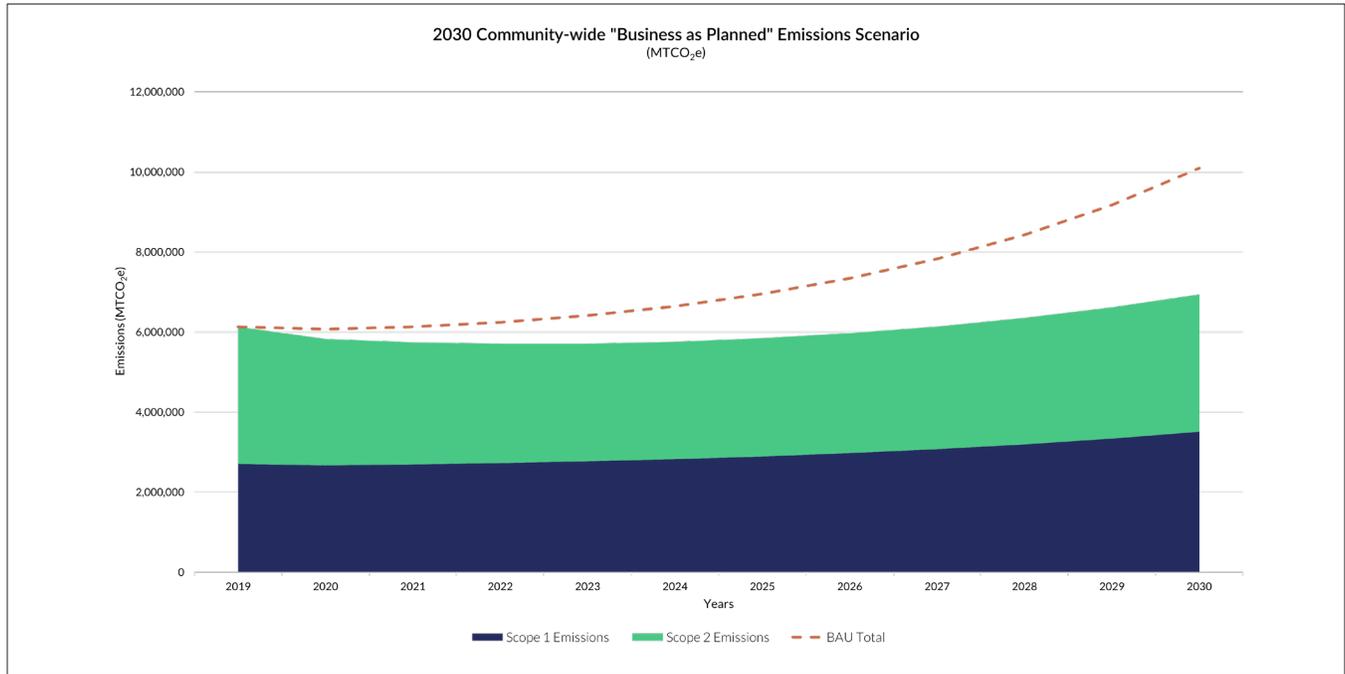
Figure 7. 2019 Community-wide GHG emissions by sector



## Projected GHG Emissions through 2030<sup>1</sup>

As with City Operations, projected community-wide emissions through 2030 are shown in figures below that show business-as-usual and business-as-planned scenarios.<sup>2</sup>

Figure 8. Projected BAP community-wide GHG Emissions through 2030 by source



Under the BAU scenario, community-wide emissions rise 65% by 2030 from 2019 levels, with emissions increasing across all sectors. However, in a BAP scenario, this diminishes to a 13% increase. The BAP scenario assumes once again that Tucson Electric Power achieves its preferred portfolio of 70% renewable energy, and that the City implements the full-build scenario from Move Tucson through 2045 (meaning that all planned transit and transportation projects are completed) with an accompanying increase in vehicle miles traveled (VMT). Both of these scenarios account for expected population growth across Tucson through 2030, as well as improving vehicle fuel economy standards. The largest emissions reductions in the BAP scenario occur in stationary energy due to the declining carbon intensity of the grid.

<sup>1</sup> The same comments with respect to limitations in data and granularity apply for the community-wide emissions analysis.

<sup>2</sup> Projections are only shown through 2030, as these analyses pre-dated the establishment of a 2045 community-wide carbon neutrality goal.

## Emissions takeaways and look-ahead

All across Tucson, our stationary energy – inclusive of building energy – makes up the largest share of our GHG emissions. This presents a great, targeted opportunity for emissions mitigation. The strategies laid out later in this report will focus on building electrification and grid decarbonization, with actions ranging from incentives and reach codes to community choice energy and/or utility municipalization. Having the right policies in place can ensure that all Tucsonans have access to reliable, affordable, and clean energy.

Transportation is also a significant contributor, especially on a community scale. Strategies focused on complete streets and transit-oriented development, and the advancement of *Move Tucson* and the *EV Readiness Roadmap*, will promote the mode shift needed to decarbonize the transportation sector and reduce VMT across Tucson. In addition to directly addressing our transportation infrastructure, our decisions about housing and other land uses will shape how we move about Tucson, and whether we can make those trips by walking, biking, rolling, and taking public transit.

While other sectors such as solid waste and wastewater processing represent a small proportion of communitywide emissions, our carbon neutrality goals require us to pursue every emissions mitigation opportunity. This extends to sectors that aren't accounted for within the inventory due to data limitations – such as the consumer goods that we import from outside city limits. Climate change is a global problem, and we will do our part to address as much as we can.

### EMISSIONS REPORTING AND MANAGEMENT

Analyses from Tucson Resilient Together have shown that comprehensive, verified, and routine GHG emissions inventories will be critical to the achievement of our carbon neutrality goals and

tracking our progress. We recognize that, as these inventories and analyses stand, there are substantive limitations, exclusions, and misalignments in our data and inventory scoping that compromise the accuracy and reliability of these inventories and their accompanying analysis.

One of the strategies put forth in this plan is to take ownership of and solidify our City operations inventory, as well as to work more closely with the Pima Association of Governments to co-report and co-monitor community-wide GHG emissions on a routine basis in alignment with internationally recognized reporting standards. We also have dedicated a segment of this plan to detail how we will monitor, evaluate, and report out on our progress as we move forward with implementing Tucson Resilient Together. And so, we are committed to improving the integrity and comprehensiveness of these measurements going forward.

## Climate Vulnerability

Understanding climate vulnerability is an integral part of adaptation planning. It allows communities to grasp the climate hazards relevant to their local context, identify the people and places most at-risk to current and future impacts, and inform and prioritize adaptation strategies. To successfully address Tucson's climate vulnerability, this section explores the city's exposure, sensitivity, and adaptive capacity.

This vulnerability assessment leverages current climate science to understand how hazards and their impacts in Tucson may change over time. While not an exhaustive list, the four hazards shown in the table below were selected for analysis based on their probability of occurrence and expected magnitude of consequences in Tucson. In general, these climate hazards will continue to increase in frequency and intensity. It is important to note that these hazards do not occur in isolation, nor are they limited to Tucson city limits. Global climate change will have cascading social, political, and economic consequences that will affect our city in myriad ways.

Figure 9. Tucson Resilient Together CVRA Climate Hazards

Climate Hazard	Climate Variables	Projected Change
Extreme Heat	Temperature	Warming
Wildfire	Temperature, Precipitation, Wind	Increasing
Drought	Temperature, Precipitation	Increasing
Extreme Precipitation and Flooding	Precipitation	Increased Variability

### Key Terms

The Intergovernmental Panel on Climate Change (IPCC) provides useful definitions that are critical to understanding this section of the Tucson Climate Action Plan. Definitions of the following terms as defined by the IPCC in AR6 have been adopted in this section.

- Adaptation:** the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities
- Resilience:** the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or [reorganizing] in ways that maintain their essential function, identity, and structure as well as biodiversity in case of ecosystems while also maintaining the capacity for adaptation, learning and transformation. Resilience is a positive attribute when it maintains such a capacity for adaptation, learning, and/or transformation.
- Vulnerability:** the propensity or predisposition to be adversely affected and encompasses a variety

of concepts and elements, including sensitivity to susceptibility to harm and lack of capacity to cope and adapt.

- **Risk:** the potential for adverse consequences for human or ecological systems, [recognizing] the diversity of values and objectives associated with such systems
- **Hazard:** the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.
- **Sensitivity:** the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of flooding due to increased storm intensity).
- **Exposure:** the presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

## Exposure

The climate hazards assessment for the city of Tucson uses downscaled climate modeling datasets<sup>1</sup> for temperature and precipitation alongside federal hazard monitoring data for flooding and drought. Future projections for temperature and precipitation are based on two GHG emissions scenarios, commonly referred to as Representative Concentration Pathways (RCPs), with RCP 4.5 representing the lower emissions scenario and RCP 8.5 representing the higher. These emission scenarios illustrate varying severities of future impacts and are then forecasted for the mid-century (2040-2069) and late-century (2070-2099) time periods to understand how Tucson's exposure to climate hazards may change over time.

### EXTREME HEAT

Tucson, like many other southwestern cities, saw rapid growth and development in the post-World War II era. Land cover change and waste heat emissions associated with this growth contribute to the urban heat island effect and exacerbate extreme heat, particularly in low vegetated areas of the city.<sup>2</sup> Climate models indicate that the frequency, severity, and duration of Tucson's high heat days are projected to increase through mid- and late-century. The annual average maximum temperature (AAMT) in Tucson

between 1971 and 2000 was 85.6°F.<sup>3</sup> Under the RCP 4.5 scenario, the AAMT is projected to rise to 88.9°F by mid-century, and 90.7°F by late century. Under RCP 8.5, the AAMT is projected to rise to 90.8°F by mid-century, and 94.8°F by late century.

Recent record-breaking heat waves show that Tucson has begun experiencing these increasing extremes. In September 2020, Tucson broke its record for the most days reaching or exceeding 100°F in a single year (108), breaking the previous record (99) set in 1994.

1 Downscaled data sets are versions of large-scale Global Climate Models data that have been translated into smaller spatial scales, such as by census tract or zip code, or down to a certain square mile radius

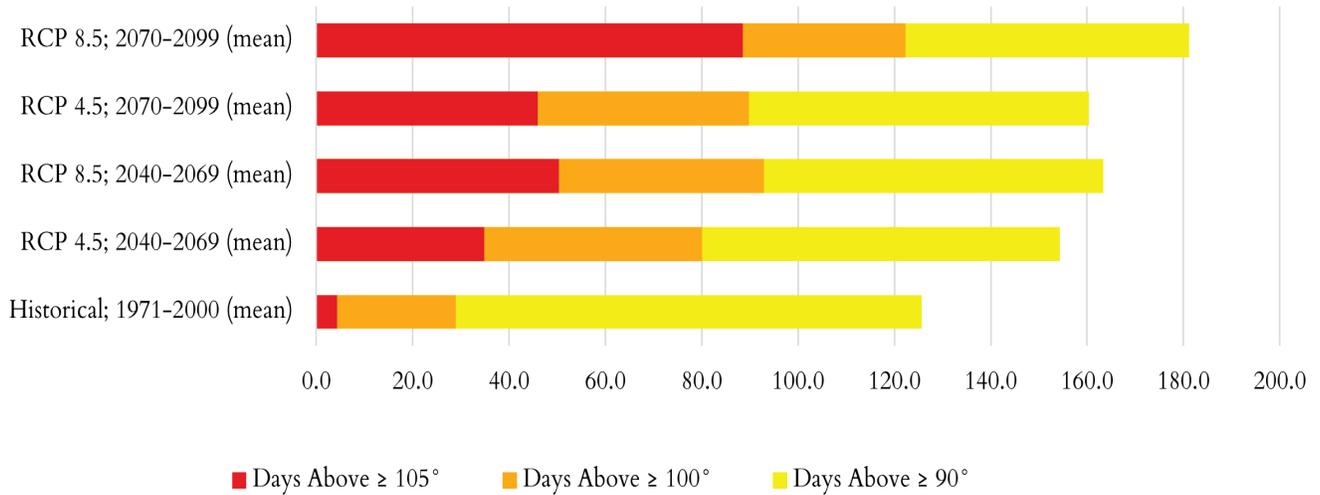
2 Comrie, A.C. (2000). "Mapping a Wind-Modified Urban Heat Island in Tucson, Arizona." *Bulletin of the American Meteorological Society*, 81(10), 2417-2432. <[https://doi.org/10.1175/1520-0477\(2000\)081<2417:MAWMUH>2.3.CO;2](https://doi.org/10.1175/1520-0477(2000)081<2417:MAWMUH>2.3.CO;2)>.

3 Abatzoglou, J.T. and Brown, T.J. (2012). "A comparison of statistical downscaling methods suited for wildfire applications." *International Journal of Climatology*, 32, 772-780.

The National Weather Service defines an Excessive Heat Warning as when the maximum heat index temperature is expected to be 105°F or higher for at least two days, while night-time air temperatures do not drop below 75°F.<sup>4</sup> Figure 9 displays the historical and projected heat index in Tucson. The mean number

of days over 105°F between 1971 and 2000 was 4.3 days.<sup>5</sup> Under an RCP 4.5 scenario, this figure rises to 34.8 days by mid-century and 45.9 days by late century.<sup>6</sup> Under RCP 8.5, the mean number of days rises to 50.3 by mid-century, and 88.5 days by late century.<sup>7</sup>

Figure 9. Historical and projected heat index in Tucson.



4 National Weather Service. (n.d.). "Heat Watch vs. Heat Warning." <<https://www.weather.gov/safety/heat-ww>>.

5 Hegewisch, K.C., Abatzoglou, J.T., Chegwidan, O., and Nijssen, B. (2022). "Climate Mapper web tool." Climate Toolbox. <<https://climatetoolbox.org>>.

6 Ibid.

7 Ibid.

## EXTREME PRECIPITATION AND FLOODING

Even though Arizona’s climate is classified as arid or semi-arid, the region’s exposure to moisture surges from the Gulf of California and Gulf of Mexico, as well as to Eastern Pacific tropical systems, results in precipitation events during the summer monsoon from July through September. This contradictory climate pattern within the region has led to significant seasonal variability in extreme storm events, with up to 30% of annual precipitation being recorded in the months of July and August alone, while barely any rain falls between April and late June.<sup>1</sup>

As climate change progresses, the seasonal variability in rainfall will likely increase in severity at both extremes. Although there is still some uncertainty in climate modeling, we generally expect that Tucson will experience both wetter storm events and more severe drought periods. In Tucson, the maximum annual precipitation depth (MAPD) between 1971 and 2000 was 14.88 inches with a median of 12.15.<sup>2</sup> Under RCP 4.5, the lower-emission scenario, the MAPD increases to 15.10 inches by mid-century and 15.24 inches by late-century. Under the high-emission scenario, RCP 8.5, the projected MAPD slightly increases to 14.90 inches by mid-century but decreases to 14.50 inches by the end of the century. This late-century decrease in maximum annual precipitation depth corresponds to the expected increase in temperature and drought conditions in Tucson and the larger southwestern region as a whole.

As a result of heavy rainfall in the summer months, steady expansion of impervious land cover through development, changing ground conditions due to increased wildfire occurrence, and the city’s surrounding mountain ranges, Tucson faces multiple flooding hazards including flooding within city streets, riverine flooding, and flash flooding. Between 1983 and 2012, the city experienced 16 flood events with significant economic and environmental impacts, including severe damage to bridges spanning the Santa Cruz River.<sup>3</sup> In 2019, winter storms throughout the larger Pima County and surrounding areas cost the state about \$2.2 million in recovery.<sup>4</sup>

With the potential increase in the magnitude and intensity of extreme storm events due to climate change, more frequent flash flooding and stream overflows can be expected. Also, as temperatures increase and soils become drier, the capacity for infiltration reduces as drier soils generally store more water. Thus, runoff may be expected to increase, worsening the outlook on flash flooding and the negative impacts of stormwater runoff.<sup>5</sup>

1 Arizona Department of Water Resources (2013). “Probable Maximum Precipitation Study for Arizona.” <<https://new.azwater.gov/sites/default/files/ArizonaPMPStudyFinalReport.pdf>>.

2 Climatology Lab (n.d.). “Multivariate Adaptive Constructed Analog (MACA) Dataset.” <<https://www.climatologylab.org/mac.html>>.

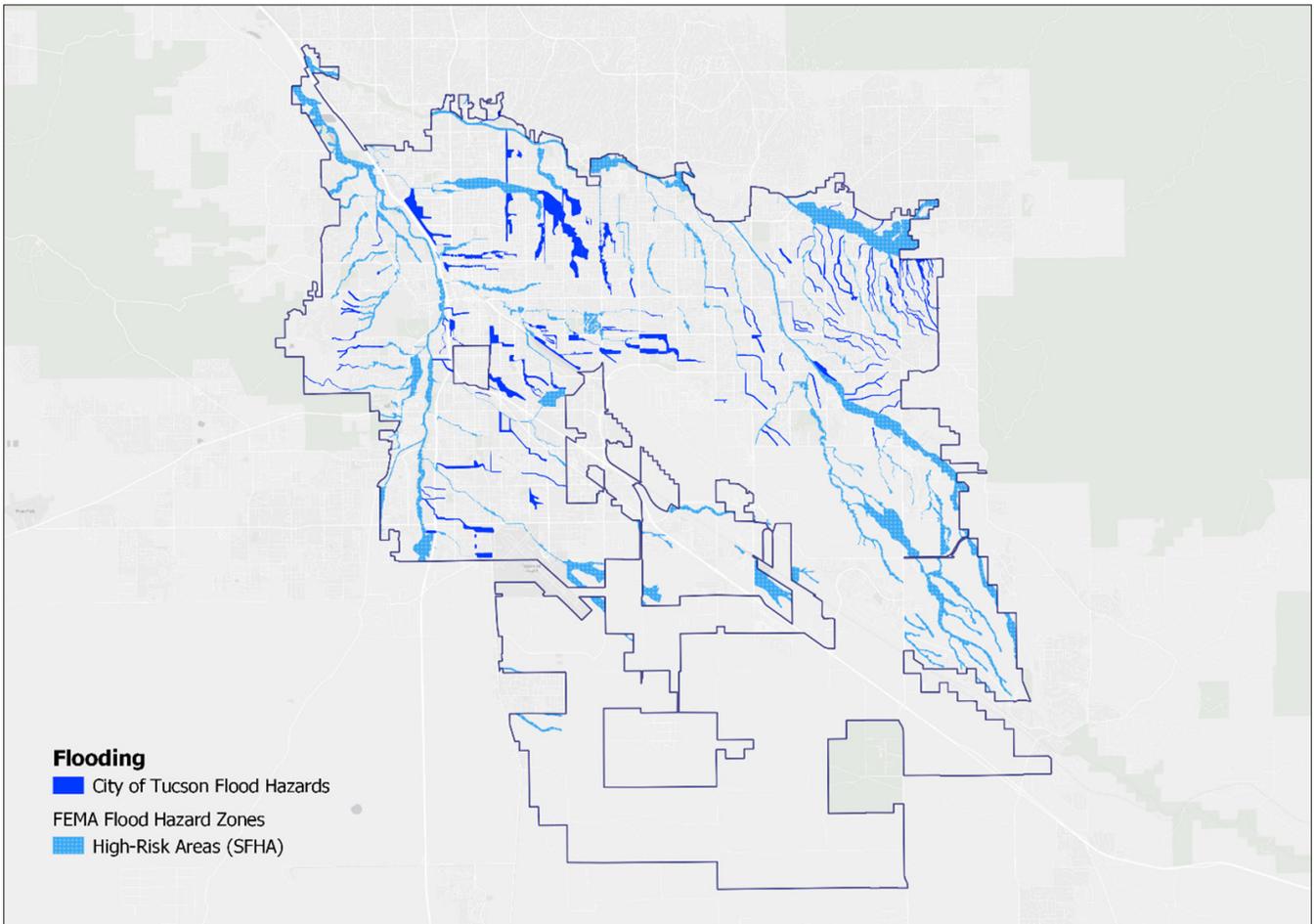
3 City of Tucson. (2016). “Resolution No. 22619: Relating to Floodplain Management: Updating the 1990 Version of the Tucson Stormwater Management Study (Phase 5) by Adopting the New 2016 Tucson Floodplain Management Plan; and Setting an Effective Date.” <[https://www.tucsonaz.gov/files/pdsd/Resolution-22619\\_TucsonFMP.pdf](https://www.tucsonaz.gov/files/pdsd/Resolution-22619_TucsonFMP.pdf)>.

4 Pima County Multi-Jurisdictional Hazard Mitigation Plan (2022). <[https://webcms.pima.gov/UserFiles/Servers/Server\\_6/File/Government/OEMHS/2022%20Pima%20Co%20Plan%20Update%20FINAL%20-%20For%20Public%20Review.pdf](https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/OEMHS/2022%20Pima%20Co%20Plan%20Update%20FINAL%20-%20For%20Public%20Review.pdf)>

5 Powell, B. F. (2010). “Climate Change and Natural Resources in Pima County: Anticipated Effects and Management Challenges.

Figure 10 features the Federal Emergency Management Agency (FEMA) Special Flood Hazard High-Risk Areas, showing which parts of the city are in the floodplain and are expected to experience flooding in the event of a 100-year storm. The map also outlines flood hazard areas that have historically experienced flash flooding as reported by Tucson residents. It should be noted that the FEMA Flood Hazard analysis does not consider climate projections and, as a result, does not capture the full extent of flooding potential in the region.

Figure 10. FEMA Special Flood Hazard High-Risk Areas and Flood Hazard Areas in Tucson



## DROUGHT

Drought is a regional hazard characterized by prolonged dry periods, resulting from abnormally low rainfall and abnormal temperature patterns. Drought conditions have been prevalent across Arizona since the mid-1990s.<sup>1</sup> Projected rise in temperature due to climate change and related decreases in snowpack increase likelihood of more frequent and more severe droughts in the Southwest in the future.<sup>2</sup>

Additionally, the City of Tucson experienced population growth and urban sprawl which both increase strain on water reserves.<sup>3</sup> Since the Central Arizona Project's (CAP) official opening in 1993, Colorado River water has largely replaced groundwater as the City's primary water source.<sup>4</sup> For decades, Tucson Water utilized a well system to supply groundwater to the city's municipal and industrial users. However, over-pumping decreased the Tucson's groundwater table. Currently, about two-thirds of Tucson's annual CAP allotment goes to users through aquifer recharge and recovery, with the other third diverted to recharge aquifers for future use.<sup>5</sup> Continued drought may compromise, or fail to adequately replenish, Tucson's water reserves going forward.

The Colorado River is experiencing reduced water inflow, causing the federal government to declare a water shortage and implement water supply cuts in 2022.<sup>6</sup> The Tier 1 shortage equates to 30% reduction of the CAP's supply and results in less Colorado River water available for agricultural uses (due to the Project's prioritization system).<sup>7</sup> In August 2022, the federal government declared a Tier 2 shortage for 2023, which will reduce supply for municipal/ industrial and tribal water users.<sup>8</sup> A Tier 3 drought response, triggered if Lake Mead falls below 1025', would include a response by the Mayor and Council to consider water use restrictions and/or policy adjustments regarding new requests for water service outside of the City limits.<sup>9</sup>

1 Arizona Department of Natural Resources (2021). "Arizona Drought Preparedness." <[https://new.azwater.gov/sites/default/files/media/ADPAR\\_2021.pdf](https://new.azwater.gov/sites/default/files/media/ADPAR_2021.pdf)>.

2 USGCRP. (2018). "Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II." <<https://nca2018.globalchange.gov>>.

3 Pima County. (2022). "Pima County Multi-Jurisdictional Hazard Mitigation Plan."

4 Tucson Water. (2020). "Drought Preparedness and Response Plan."

5 See footnote #14

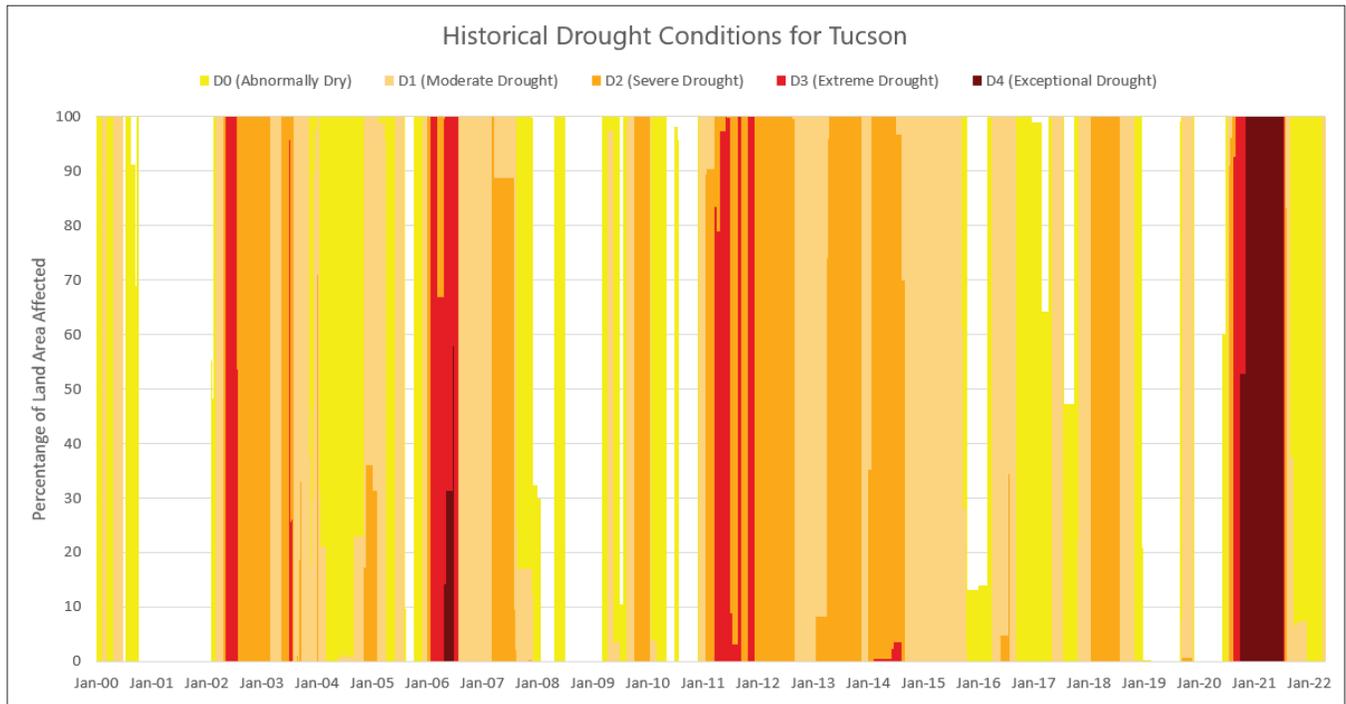
6 Fountain, H. (2021). "In a First, U.S. Declares Shortage on Colorado River, Forcing Water Cuts." The New York Times. <<https://www.nytimes.com/2021/08/16/climate/colorado-river-water-cuts.html>>.

7 Arizona Department of Water Resources. (2021). "Colorado River Shortage Factsheet." <<https://knowyourwaternews.com/wp-content/uploads/2021/09/CAP-Colorado-River-Shortage-Factsheet.pdf>>.

8 Central Arizona Project. (2021). "Adapting to Shortage: Colorado River Shortage." <<https://www.cap-az.com/water/water-supply/adapting-to-shortage/colorado-river-shortage/>>.

9 City of Tucson. (2023). <<https://www.tucsonaz.gov/water/drought-preparedness>>.

Figure 11. Historical drought conditions in Tucson<sup>1</sup>



1 United States Drought Monitor (USDM). "Tucson, AZ in US Drought Monitor Categories." <<https://droughtmonitor.unl.edu/Data.aspx>>.

## WILDFIRE

Tucson and its neighboring communities are grappling with significant wildfire risks. Fire is a natural and integral ecological process in southeast Arizona's sky islands. However, climate change and human-induced fire suppression created larger and more intense wildfires that pose risks to local biodiversity, wildlife habitats, and human communities. Most recently, the 2022 Contreras Fire in the Baboquivari mountains spread over 29,482 acres and took 13 days to fully contain.<sup>2</sup> Wildfire smoke contains harmful air pollutants and can reach communities located miles away from the initial fire. Co-exposure to both wildfire smoke and extreme heat can significantly amplify the health consequences.<sup>3</sup> In August 2020, Tucson saw its worst air pollution in nine years, connected to wildfires as close as the Rincon Mountains and as far as California.<sup>4</sup>

Wildfire risk is impacted by a variety of indicators, including precipitation, drought, wind, heat, topography, and vegetation. Wildfire risk is increasing due to heat and drought conditions driven by climate change.<sup>5</sup> Pima County's existing plans identify the higher elevations of the Baboquivari, Rincon, and Santa Catalina mountains as the focus areas for wildfire intervention.<sup>6</sup> Wildfire risk in the region includes forests, shrublands, and grasslands.

Historically, the City of Tucson was viewed as less susceptible to damage or loss from wildfire. However, increasing vegetation, including non-native species like

buffelgrass, and continued infrastructure expansion in the wildland-urban interface (WUI) increases the risk profile for the city.<sup>7</sup> The wildland-urban interface refers to the zone of transition between unoccupied wildland and urban or suburban development. While the major landcover within the city itself is designated as "impervious," the open lands near the Tucson International Airport, I-10 by Houghton Road, and the Pima County fairgrounds are at moderate to high wildfire risk. Homes that are located within the wildland-urban interface are also at elevated risk.

2 Arizona Emergency Information Network. (2022). "Final update for Contreras fire as containment reaches 100%." <<https://ein.az.gov/emergency-information/emergency-bulletin/final-update-contreras-fire-containment-reaches-100>>.

3 Rahman, M.M., McConnell, R., Schlaerth, H., Ko, J., Silva, S., Lurmann, F.W., Palinkas, L., Johnston, J., Hurlburt, M., Yin, H., and Ban-Weiss, G. (2022). "The Effects of Co-Exposure to Extremes of Heat and Particulate Air Pollution on Mortality in California: Implications for Climate Change." *American Journal of Respiratory and Critical Care Medicine*, (ja). <<https://doi.org/10.1164/rccm.202204-0657OC>>.

4 Davis, T. (2020). "Wildfire smoke brings Tucson's worst air pollution in nine years." *Arizona Daily Star*. <[https://tucson.com/news/local/wildfire-smoke-brings-tucson-worst-air-pollution-in-nine-years/article\\_38c99629-a36d-50c9-a1ef-4c2368cc0a22.html](https://tucson.com/news/local/wildfire-smoke-brings-tucson-worst-air-pollution-in-nine-years/article_38c99629-a36d-50c9-a1ef-4c2368cc0a22.html)>.

5 Mueller, S. E., Thode, A.E., Margolis, E.Q., Yocom, L. L., Young, J.D., and Iniguez, J. M. (2020). "Climate relationships with increasing wildfire in the southwestern US from 1984 to 2015." *Forest Ecology and Management*, 460(15). <<https://doi.org/10.1016/j.foreco.2019.117861>>.

6 Pima County. (2013). "Pima County Community Wildfire Protection Plan.

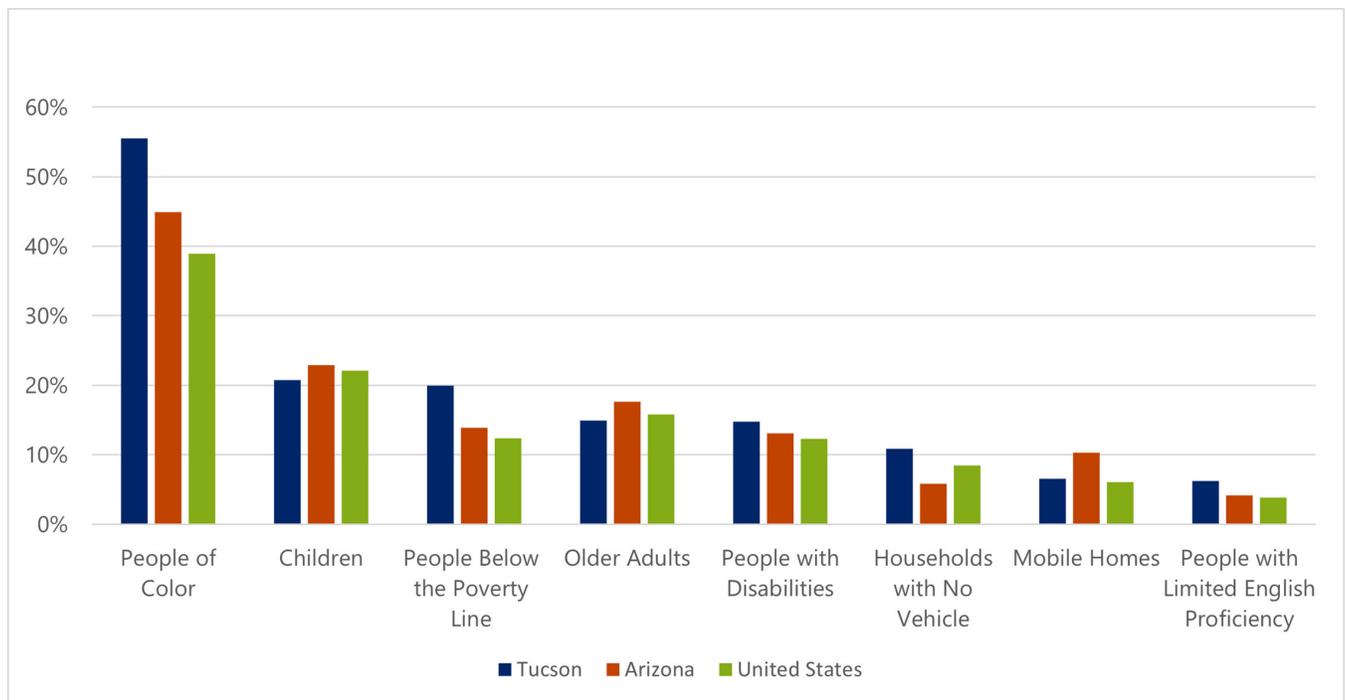
7 Pima County. (2022). "Pima County Multi-Jurisdictional Hazard Mitigation Plan (DRAFT)."

## Social Vulnerability in Tucson

While climate hazards pose a risk to all Tucson residents, certain populations are and will be more susceptible than others. Some of the most vulnerable populations in Tucson include those living below the poverty line, older adults, children, people with disabilities, and people of color as shown in the chart below.

The City of Tucson generally has a proportion of vulnerable communities larger than or comparable to the State of Arizona and the United States. Tucson has a higher prevalence across five indicators: people of color, people with disabilities, people below the poverty line, people with limited English proficiency, and households with no vehicle.

Figure 12. Percentage of key social vulnerability indicators across Tucson, Arizona, and the United States (Source: US Census Bureau, ACS 2020 5-year Estimates)



## Climate Impacts

### HOW EXTREME HEAT IMPACTS TUCSON

#### Infrastructure

- While electrical system failure is the primary threat to infrastructure from extreme heat in Tucson, the city's vulnerability is significantly minimized due to system reliability and resilience efforts by Tucson Electric Power. Higher temperatures can cause transmission lines to sag and lose carrying capacity and can also reduce the efficiency of natural gas power plants and solar photovoltaic arrays. Furthermore, increased demand for energy from air conditioning during extreme heat periods places added stress on substations and power plants.<sup>1</sup>
- Extreme heat can also impact the lifespan of roadways by causing them to soften and expand, potentially creating potholes in high-traffic areas and by placing stress on bridge joints.<sup>2</sup>

#### Populations

- Extreme heat is the top climate change impact of concern for many Tucsonans.<sup>3</sup> It is the leading cause of weather-related mortality in the United States, even though most heat-related deaths are preventable through outreach and adaptation

interventions.<sup>4</sup> Older adults, children, people with disabilities, and those with preexisting cardiovascular conditions are most vulnerable.

- Tucson's outdoor workers are at an increased risk of heat stress, and the mix of heat and air impurities can further exacerbate breathing issues.<sup>5</sup>
- Prolonged air conditioning use during a heat wave increases energy costs, forcing Tucson households to make tough compromises between cooling their homes and paying for basic needs.<sup>6</sup>
- Accessing cooling centers becomes difficult for households without a vehicle or proper access to transit, increasing risk of heat-related illness.
- Mobile and manufactured homes can lack proper insulation from extreme heat. In Tucson, mobile home communities are often located outside of urbanized areas, isolating residents from cooling resources.<sup>7</sup>
- Hot pavement can make sidewalks inaccessible during high heat days for those who rely on service animals.<sup>8</sup>

1 Pima County Multi-jurisdictional Hazard Mitigation Plan < [https://webcms.pima.gov/UserFiles/Servers/Server\\_6/File/Government/OEMHS/2022%20MJHMP%20Final%20Submittal%2009232022%20to%20FEMA.pdf](https://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/OEMHS/2022%20MJHMP%20Final%20Submittal%2009232022%20to%20FEMA.pdf)>

2 U.S. Environmental Protection Agency, 2017. "Climate Impacts on Transportation." <[https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-transportation\\_.html](https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-transportation_.html)>

3 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."

4 U.S. Environmental Protection Agency. (2021). "Climate Change Indicators: Heat-Related Deaths." <<https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths>>.

5 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."

6 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."

7 McCann, L., Hibberd, R., and Kear, M., 2021. "A Profile-Based Approach to Indexing Housing Vulnerability in Tucson: A Case Study of Manufactured Housing." Making Action Possible in Southern Arizona. <[https://mapzdashboard.arizona.edu/sites/default/files/2021-10/MAP\\_MH\\_Final\\_Oct5\\_2021%20V2.pdf](https://mapzdashboard.arizona.edu/sites/default/files/2021-10/MAP_MH_Final_Oct5_2021%20V2.pdf)>.

8 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."



- Frontline communities often experience higher temperatures than affluent, white neighborhoods.<sup>9</sup> In these neighborhoods, a lack of vegetation and impermeable surfaces amplify urban heat island effect.
- Extreme heat impacts learning and cognitive function in school-aged children, especially if their schools do not have adequate air conditioning or thermal insulation.<sup>10</sup>

### Natural Environment

- Extreme heat can diminish vegetative cover and dry out soil, erasing the necessary ecosystem services they provide like temperature regulation and infiltration.
- Rising temperatures amplify threats to air quality, including ozone (smog) formation and particulate matter (PM) emissions from wildfire.<sup>11</sup>

### Adaptive Capacity

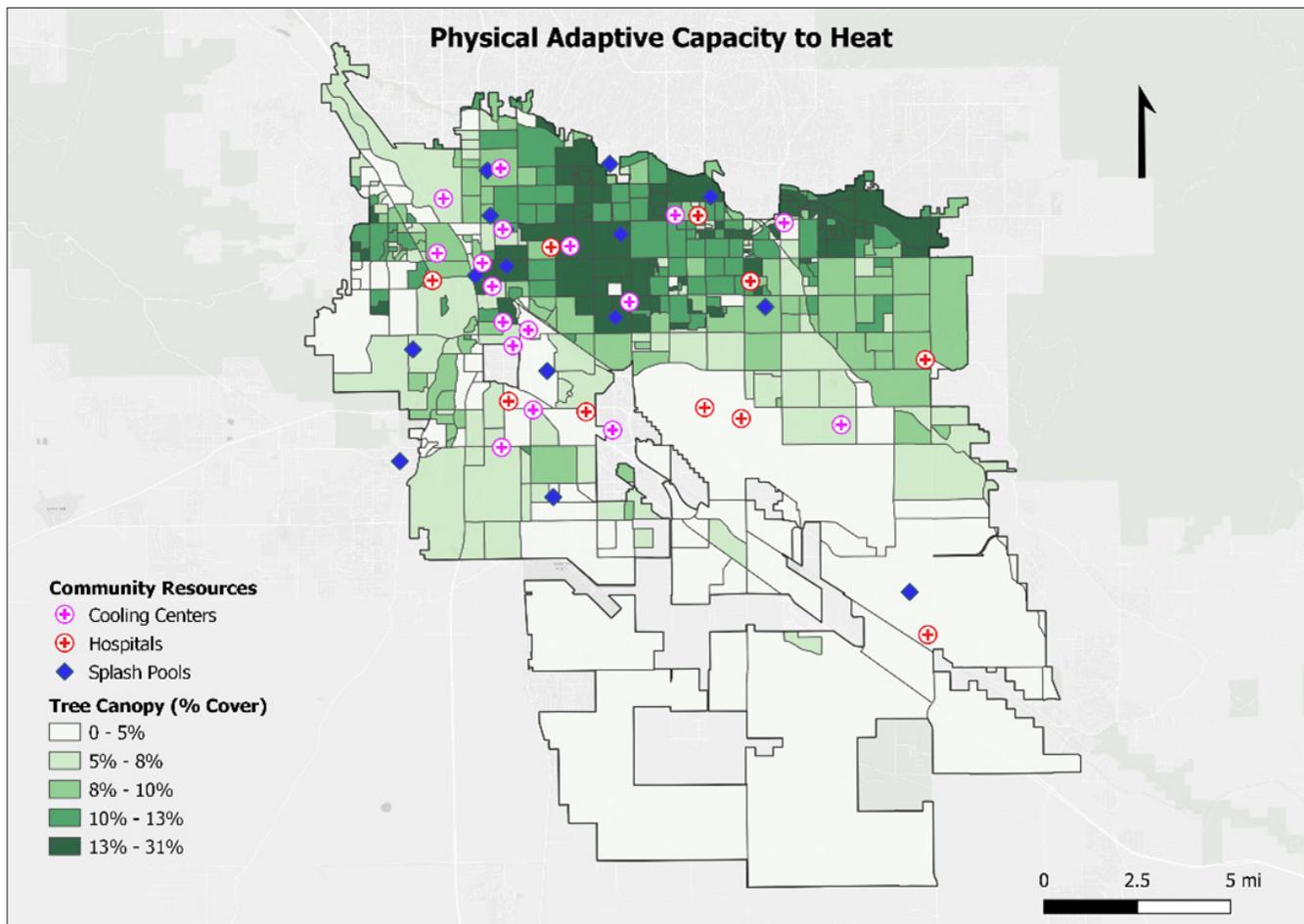
- Mayor Regina Romero initiated the Million Trees Initiative, pledging to plant 1 million trees by 2030. The commitment is both science-based and people focused, meaning the project will utilize native and drought resilient trees and will focus on frontline communities most impacted by environmental degradation.
- The Tucson Pima Collaboration to End Homelessness (TPCEH), a coalition of faith-based organizations, businesses, government entities, and advocates, operates a network of heat refuges specifically for people experiencing homelessness. In addition to water and shaded areas, TPCEH's heat refuges often include case management services, showers, food, and housing referrals.
- Tucson Electric Power maintains a diversified energy portfolio and continually invests in upgrades to its distribution and transmissions systems to ensure grid resiliency during extreme heat.

9 Dialesandro, J., Brazil, N., Wheeler, S., and Abunnasr, Y. (2021). Dimensions of Thermal Inequity: Neighborhood Social Demographics and Urban Heat in the Southwestern U.S. *Int J Environ Res Public Health*. 18(3). <<https://doi.org/https://doi.org/10.3390/ijerph18030941>>.

10 Park, R. Jisung, J. Goodman, M. Hurwitz, and J. Smith. (2020). "Heat and Learning." *American Economic Journal: Economic Policy*, 12(2): 306-39, <<https://www.aeaweb.org/articles?id=10.1257%2Fpol.20180612>>.

11 Diviant, J. (2021). "Health Impacts of Wildfire Smoke as a Consequence of Climate Change and Recommendations for Public Health Officials and the General Public in the Albuquerque Metropolitan Area."

Figure 13. Physical Adaptive Capacity to Extreme Heat



### HOW EXTREME PRECIPITATION AND FLOODING IMPACTS TUCSON

#### Infrastructure

- Flooding from heavy rainfall makes roads impassable and disrupts transportation across the city of Tucson. This creates limitations in emergency and hazard response as people are unable to evacuate or get to hospitals as needed. Past monsoons and thunderstorms have resulted in road closures with Tucson residents trapped in their vehicles while awaiting water rescue.
- Bridges and roadways around the city are also vulnerable to substantial damage during large-scale floods.
- Energy infrastructure such as overhead utility (transmission) lines are also at risk of destruction from extreme precipitation events, potentially leading to localized loss of power.
- As we transition to electrified transit services and electric vehicles, interruptions to the electricity grid can significantly impact community mobility.

## Populations

- Serious floods can damage homes and leave households at risk of displacement or houselessness, particularly low-income households and people living in mobile and manufactured homes.
- Buildings impacted by flood damage can accumulate mold, which can irritate the eyes, throat, and skin and aggravate preexisting respiratory conditions.
- People experiencing houselessness are often exposed to the elements, placing them at an elevated risk of damage, loss, and health consequences during monsoon season.
- Transit shutdowns due to flooding can limit transit access, impacting transit riders' ability to get to work or other necessary services.
- Flooded sidewalks can limit mobility for those with physical and visual impairments.

## Natural Environment

- High-velocity water flows can uproot trees and other plants.
- Floodwater can carry pollutants and contaminate delicate wildlife habitats.

## Adaptive Capacity

- Tucson Department of Transportation and Mobility's (DTM) annual Operation Splash campaign sends crews around the city to prepare washes ahead of heavy storms and deliver barricades to mark unsafe roads for Tucson motorists.

- Tucson's Green Streets Policy requires new and reconstructed roadway projects to integrate green infrastructure to capture the first 1/2 inch of rain. Additionally, projects must meet a 25% tree canopy cover and a 25% shrub and grass cover benchmark.
- Move Tucson, the citywide transportation plan, takes stock of existing services and infrastructure and identifies the necessary investments to build a resilient transportation system.
- In 2016, the city of Tucson developed its first Floodplain Management Plan to address community-wide flooding hazards and define mitigation measures.
- Tucson Electric Power invests heavily in the reinforcement of transmission and distribution infrastructure and replacement of aging infrastructure such as power lines and poles.<sup>1</sup>



1 Tucson Electric Power. <<https://www.tep.com/reliable/>>

## HOW DROUGHT IMPACTS TUCSON

### Infrastructure

- Low river flows and reduced reservoir volumes places increased stress on water utilities to provide water for domestic and commercial use. In 2021, the US Bureau of Reclamation declared a shortage on the Colorado River due to prolonged drought conditions. Continued drought and deeper cuts for shortages could impact Tucson's access to the Central Arizona Project.

### Populations

- Developing a resilient water system is a top priority for Tucsonans; residents are concerned with the equitable distribution of water resources across the growing city.<sup>1</sup>
- Drought-related water supply reductions can hit the agricultural industry hard, leading to fallow land, reduced income, and job losses. These consequences can result in higher food prices for Tucson families. Some tribal communities are unable to access their water allocation due to insufficient infrastructure and funding.<sup>2</sup> Drought-related supply constraints further exacerbate these challenges for tribal water users.
- Water shortages over time can lead to higher utility costs, increasing risk of housing insecurity for low-income households.

### Natural Environment

- Stresses on water resources can negatively impact vegetation and result in vegetation loss.
- Reductions in water flows can increase the concentration of pollutants and cause stagnation. These environmental conditions may increase the risk of contracting West Nile virus and Valley Fever, as they favor mosquito populations.

### Adaptive Capacity

- Tucson Water has made strides to address water stress and drought conditions through water efficiency rebate programs with an annual budget of \$3.5 million going towards conservation rebates and incentives, community education, and neighborhood-scale stormwater harvesting systems.<sup>3</sup>
- Tucson Water's Drought Preparedness Plan details the utility's strategy for managing drought, including exploring alternative water sources like reclaimed water and rain and stormwater harvesting.
- Tucson Water has also developed a comprehensive master plan for managing water resources and addressing climate impacts on the city's water services. The governing plan is the Water Plan 2000-2050 with the upcoming One Water 2100 currently in development.<sup>4</sup>

1 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."

2 Colorado River Research Group. (2021). "The Status of Tribal Water Rights in the Colorado River Basin." <<https://www.getches-wilkinsoncenter.cu.law/wp-content/uploads/2021/04/Policy-Brief-1-The-Status-of-Tribal-Water-Rights.pdf>>.

3 Tucson Water (n.d.). "Case Study, Tap into Resilience." <<https://tapin.waternow.org/resources/tucson-water/>>

4 Tucson Water <<https://www.tucsonaz.gov/water/waterplan>>

## HOW WILDFIRE IMPACTS TUCSON

### Infrastructure

- Overhead transmission lines may be at risk in the event of wildfires, leading to blackouts.

### Populations

- Fires can destroy entire communities, leaving households without permanent shelter. People living in mobile homes are of particular concern, as there are limited options for residents to recoup their investments.
- People with limited English proficiency are at risk of missing important messaging from the City or service providers, especially if they rely on word-of-mouth communication. Working with emergency responders can prove difficult when cultural norms or practices are difficult to translate.
- Evacuation during a wildfire can prove difficult for people without access to a car and people with disabilities.
- Tucson residents with asthma and other lung conditions experience aggravated symptoms from wildfire smoke, especially those living in homes with poor air ventilation.<sup>1</sup>

### Natural Environment

- Soil exposed to the extreme heat of wildfires can dry up and erode, artificially increasing the amount of sediment in the water and degrading water quality.<sup>2</sup>

- The combustion of organic matter and the resulting particulate matter (PM) emissions into the atmosphere can significantly impact air quality in airsheds that span miles.<sup>3</sup>
- Wildfire fighting requires water sources for aerial application and often requires the application of fire retardants, with uncertain risks to future water quality.

### Adaptive Capacity

- In response to increased wildfire risk, Tucson Fire invested in a wildland fire program through acquiring specialized equipment and personnel with specialized wildland firefighting training.<sup>4</sup>
- The Arizona-Sonora Desert Museum's Save Our Saguaros program received \$50,000 in federal funding for buffelgrass removal and habitat restoration in the Tucson Mountains, helping reduce fuel load in high wildfire risk areas.
- The Pima County Community Wildfire Protection Plan coordinates action across the region's fire districts, natural areas, and other stakeholders to outline a collaborative mitigation strategy that includes community education, fuel load reduction, and investments in wildfire suppression equipment.

1 Tucson Mayor's Office. (2022). "Climate Listening Sessions Report."

2 Pima County. (2017). "Pima County Multi-Jurisdictional Hazard Mitigation Plan."

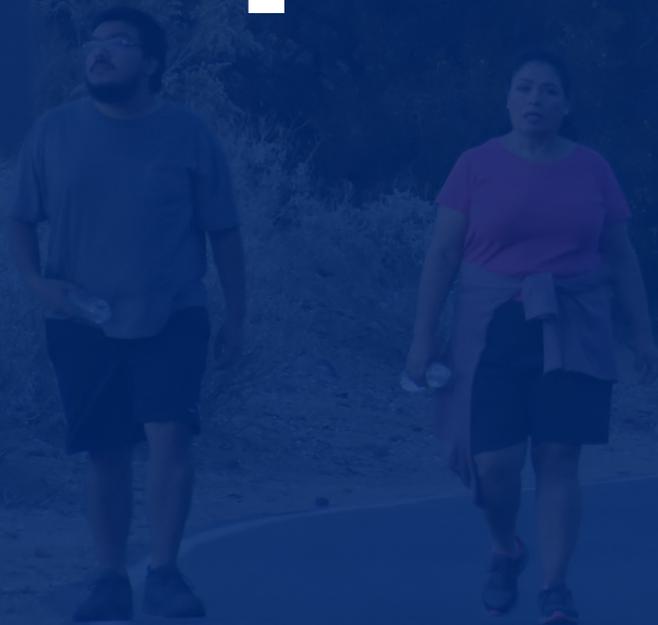
3 Neary, D.G. and Leonard, J.M. (2021). "Physical Vulnerabilities from Wildfires: Flames, Floods, and Debris Flows."

4 Pima County. (2022). "Pima County Multi-Jurisdictional Hazard Mitigation Plan."

## Key Findings

- The City of Tucson has already begun experiencing extreme heat, flooding, and drought hazards over the past several years and climate projections suggest that the city's exposure to these hazards is set to increase with compounding impacts over the next 100 years. As temperatures rise further and extreme heat persists, drought conditions will worsen, impacting water availability for municipal and ecological uses. By the end of the century, climate modelling predicts that droughts will be so bad as to cause a decrease in mean annual precipitation. While Tucson's physical vulnerability to wildfire remains limited, its risk profile has increased in recent years due to infrastructure expansion into surrounding wildlands. As wildfire risk and extreme heat increases, poor air quality from wildfire smoke compounded by higher temperatures can be expected.
- Tucson is home to several vulnerable sub-populations including people of color, people living below the poverty line, those with disabilities, households without vehicles, and those living in mobile homes, as well as older adults and children. The groups are especially susceptible to climate impacts as they are likely to experience severe energy, water and transportation stress, leading to adverse health effects such as heat exhaustion, heatstroke, and delayed access to life-saving services.
- The City of Tucson has begun taking steps to address these climate hazards. Flood risk, while significant, is no longer a top priority for the community as measures such as the Tucson Floodplain Management Plan have been implemented to address it. As the volume of water in Lake Mead continues to decrease, Tucson Water continues to develop and implement water conservation and management strategies to address the increasing water stress on Tucson's growing population. Cooling centers and greening programs such as the Million Trees Initiative and Storm to Shade have also been established to mitigate the impacts of extreme heat on the community. The City has also invested in buffelgrass removal projects to eliminate the risk of wildfire spread from surrounding areas in the region.
- While Tucson has already built some capacity to withstand and respond to climate hazards, the ability to cope with certain hazards varies by neighborhood and subpopulation. Looking at extreme heat, neighborhoods in the northward part of Tucson have significantly higher tree cover and are home to over 90% of cooling centers, community pools, and hospitals. Additionally, almost 50% of Sun Tran bus stops do not have shelter, making those who use public transportation more susceptible to adverse health effects from heat exposure. As such, there is an opportunity to improve the adaptive capacity of communities in the south - which exhibit higher social vulnerability and have less existing cooling infrastructure - and that of commuters by increasing tree cover, establishing housing quality and weatherization programs, and providing shelter at all bus stops.

# Climate Action and Adaptation Roadmap





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# 5 Climate Action and Adaptation Roadmap

## Overview

To mitigate GHG emissions, adapt to climate change, and build community-wide climate resilience, we have identified 24 strategies and 123 actions, organized into five categories. Together, these actions will move us toward carbon neutrality across City operations by 2030 and contribute towards community-wide carbon neutrality by 2045. Throughout this roadmap, the strategies and actions presented here are accompanied by anticipated costs, anticipated timeframe for completion, potential funding sources, and lead and supporting City departments. Across the vast majority of strategies and actions presented here, our partnerships with neighboring cities, Pima County, community-based organizations, local businesses, and the community at large will be critical toward achieving our carbon neutrality goals and creating a more climate-resilient Tucson.



## How to Read This Plan

The diagram below displays and defines the key elements of this Climate Action and Adaptation Roadmap.

This is a **climate strategy**. Strategies are overarching approaches to reducing greenhouse gas emissions and building climate resilience. Below the listed action are multiple cells indicating the responsible implementer(s) as well as the anticipated timeframe, cost, and funding sources.

This is a **climate action**. Actions are the specific policies, programs, projects, or tools that the City of Tucson will implement.

G-1

### Formalize climate action and resilience priorities in City operations, budgeting, processes, performance monitoring, and investments

The City will take meaningful action to embed climate action and resilience into our governance. This includes establishing a climate emergency mobilization office, issuing public-facing reports and communications on climate action process, developing administrative directives and resources for climate action, and integrating these principles into our decision-making and procedures.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office	All departments	Mayoral Climate Action Advisory Council	Ongoing	🍃	\$

Action #	Action
G-1.1	Establish and staff a permanent Climate Emergency Mobilization function tasked with implementing the <i>Tucson Resilient Together</i> plan.
G-1.2	Incorporate climate action, climate resilience, and equity-centered performance objectives into annual reviews of City department heads and into departmental budget processes.
G-1.3	Issue biennial progress reports on the implementation of <i>Tucson Resilient Together</i> , and update the plan at least every four years.
G-1.4	Issue monthly communications to Tucson residents on climate action progress and develop a public-facing dashboard to show progress on specific climate metrics.

### Key

Cost	Cost Range
Very Low (\$)	\$0 - \$100,000
Low (\$\$)	\$100,001 - \$500,000
Medium (\$\$\$)	\$500,001 - \$1,000,000
High (\$\$\$\$)	Over \$1,000,000

Emissions Reduction Potential
Municipal GHG emissions reduction potential represented on a scale from low (🍃) to high (🍃🍃🍃🍃🍃).

This Roadmap organizes these strategies and actions into five categories: Climate Leadership and Governance, Energy, Transportation and Land Use, Resource Recovery and Management, and Community Resilience.

# Climate Leadership and Governance



# Climate Leadership and Governance

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Carbon neutrality cannot happen without coordinated leadership and government action. While *Tucson Resilient Together* is a strategic framework for the City to act on climate change, we must go beyond isolated actions. A holistic approach, whereby the principles of climate change mitigation, adaptation, resilience, equity, and justice are embedded into our institutions, processes, and policy, is the only way forward. It is Tucson's aspiration to be a climate leader, and every step we take must reflect that aspiration.

However, holistic climate action cannot be achieved by government alone, and no strategy here should be executed without the perspective, partnership, and input from the communities who stand to be most affected by climate change. We must elevate all Tucsonans – they must be our partners and co-implementers in this effort.

Going forward, the City of Tucson will strive to integrate climate action within and across all its functions. And we will build upon the partnerships we have developed through this process and fold in community groups and the people they represent into this process. After all, if we are to lead, we must lead together.

## Current Status

In the last fifteen years, Tucson has moved steadily toward integrating climate action into its decision-making. *The Framework for Advancing Sustainability* in 2011, followed by the *Community Economic Security and Climate Action Analysis* in 2013, constituted the first target-setting efforts and accompanying analyses pertaining to climate change mitigation in Tucson. These principles were reinforced by *Plan Tucson* in 2013, but up until 2020, no additional targets or functions had been assembled on climate change.

With respect to advisory bodies, the City had an established Environmental Accords/Green Cities Declaration and Sustainability Committee up until 2008. The 2011 Framework dissolved that committee and established a Climate Change Advisory Council in its place to develop a climate change mitigation and adaptation plan. This never materialized, and in 2017, this committee was dissolved and replaced by the current Commission on Climate, Energy, and Sustainability (CCES). The CCES meets monthly and



advises the Mayor and Council on meeting the climate, energy, and sustainability goals laid out in Plan Tucson.

Mayor Regina Romero ran for office on the platform of climate action, and since then, Tucson has moved to position itself as a statewide and nationwide leader. In 2020, the Mayor and City Council declared a Climate Emergency, issuing Tucson's first climate target in nearly a decade: to achieve carbon neutrality across City operations by 2030. Since that declaration, the Mayor has hired a Sustainability and Climate Advisor and has assembled a Climate Action Advisory Committee to advise on the development of Tucson Resilient Together. The Mayor's Office has also set up an online Climate Action Hub, which communicates information and data with respect to the City's efforts.

While multiple departments are acting on climate change, the City does not currently have a dedicated office or officer(s). Prior to 2021, the City has acted fairly independently of community organizations, but Tucson Resilient Together diverges from this approach, instead using the planning process to build community partnerships around climate action across Tucson.



## Focus Areas and Priorities

To position Tucson as a climate leader and govern holistically on the issue of climate change and resilience, we intend to prioritize the following approaches which are further detailed in the strategies and actions:

**Climate emergency mobilization:** set up appropriate structures, processes, and personnel to implement Tucson Resilient Together and advance climate mitigation, adaptation, and resilience measures across Tucson.

**Community partnership and equity:** welcome community members and organizations into the governance process, positioning them as decision-makers to ensure the equitable distribution of benefits and burdens from climate action.

# What We've Heard

Tucsonans have stated firmly that action on climate change is critical, and that they are looking to their leaders in the City and across Tucson for **accountability**. The buck stops with the City to lead this work, and to embed it into every aspect of our operations and interfaces with the community. Strategy G-1, under which the City will “formalize climate action and resilience priorities in City operations, budgeting, processes, performance monitoring, and investments,” directly addresses these points. Under this strategy, we commit to specific actions, such as establishing a climate emergency mobilization function and embedding climate and equity considerations into performance objectives. In addition, Strategy G-4, in which we “monitor and report emissions performance to adapt decarbonization strategies,” commits to more consistent and complete reporting of municipal and community-wide GHG emissions. These strategies are our response to Tucsonan’s clear requests for accountability.

Residents of Tucson have also expressed a desire for the City to not only be a leader, but to be a collaborator and to uplift the groups and individuals that have been doing this work for so long. They are not looking to the City to do the work or to speak for them, but to center and support their efforts as much as possible. You have asked us to commit to collaboration and communication, and to create a sustainable, collaborative infrastructure that enables ongoing partnership between the City, tribal nations, community groups and organizations, academic institutions, local businesses, residents, and other jurisdictions and regional entities. Strategy G-2 states that the City will “accelerate climate action, adaptation, and resilience strategies through community and regional partnerships.” Under this strategy, we commit to continuing our work with the community partners and ambassadors who have been critical to developing Tucson Resilient Together and to create the opportunities and places for collaboration between the City and all of these groups to ensure that this plan is implemented expediently, responsibly,

and equitably.

Finally, throughout the entirety of this process, Tucsonans have tirelessly expressed the importance of education. Parents and community leaders want to educate their children about the environment and climate change. And more importantly, Tucsonans want to participate in the process of actualizing a climate-resilient future for their city and community. Through Strategy G-3, we intend to develop communications, outreach, and fiscal resources to carry out a community-wide educational initiative, and to do so in partnership with organizations and schools who are already doing this important work.

- + **accountability**
- + **sustainable, collaborative infrastructure**
- + **communication**
- + **climate education**
- + **public participation**

# Climate Leadership and Governance

G-1

## Formalize climate action and resilience priorities in City operations, budgeting, processes, performance monitoring, and investments

The City will embed climate action and resilience into our governance. This includes establishing a Climate Action Team (CAT), issuing public-facing reports and communications on climate action process, developing administrative directives and resources for climate action, and integrating these principles into our decision-making and procedures.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office	All departments	Mayoral Climate Action Advisory Council	Ongoing		\$

Action #	Action
G-1.1	Establish and staff a permanent Climate Action Team (CAT) tasked with implementing the <i>Tucson Resilient Together</i> plan.
G-1.2	Incorporate climate action, climate resilience, and equity-centered performance objectives into annual reviews of City department heads and into departmental budget processes.
G-1.3	Issue biennial progress reports on the implementation of <i>Tucson Resilient Together</i> , and update the plan at least every four years.
G-1.4	Issue monthly communications to Tucson residents on climate action progress and develop a public-facing dashboard to show progress on specific climate metrics.

Action #	Action
G-1.5	Use climate projections instead of historic data for weather and precipitation modeling to inform planning, landscape, infrastructure, and community development processes and policy.
G-1.6	Develop guidelines for inclusive and equitable outreach and engagement, to guide program implementation and consultant procurement processes.
G-1.7	Evaluate existing investment portfolios for City pensions and supplemental retirement benefits and identify opportunities to divest from fossil fuel companies and environmentally harmful organizations.
G-1.8	Explore federal, state, and local funding opportunities to help create an equitable climate action fund or a revolving Community Green Revolving Fund and empower community members to determine how it is applied.



G-2

## Accelerate climate action, adaptation, and resilience strategies through community and regional partnerships

Tucson will build on the community relationships it has fostered through the *Tucson Resilient Together* and other planning processes, bringing partners into the decision-making process. We will also work alongside our partners, including local organizations, businesses, jurisdictions, and regional entities, to advance this work.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office	All departments Ward Offices	Mayoral Climate Action Advisory Council AZ Youth Climate Coalition International Indian Treaty Council Local First AZ NAACP Tucson Branch Paisanos Unidos San Xavier Co-op Farm Southside Worker Center	Ongoing		\$

Action #	Action
G-2.1	Continue working with promotores (community ambassadors) to maintain ongoing collaboration with community-based organizations as Tucson Resilient Together is implemented.
G-2.2	Partner with the Arizona Green Business Program to promote energy and water efficiency, waste reduction, green building materials, and local sustainable purchasing amongst the City's business community.
G-2.3	Convene workforce development stakeholders, including the Tucson 2030 District, Pima JTED, PCC Workforce Development, and other educational institutions to coordinate city-wide programming and training related to building decarbonization, or the practice of making existing buildings (including residential housing stock) more efficient and resilient.
G-2.4	Partner with local organizations, community, and local businesses groups to invest in and create youth employment training and professional development in the environmental and climate sectors.
G-2.5	Collaborate with neighboring tribes and local jurisdictions to share information and resources, coordinate implementation of climate mitigation and adaptation strategies, and build resilience across Greater Tucson.

G-3

## Develop educational, communications, and outreach resources and assets promoting climate action and adaptation

We will provide equitable, accessible, and up-to-date resources for Tucsonans to act on and adapt to climate change. We will also recognize and showcase climate leadership across Tucson.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office	Communications Division Economic Initiatives Housing and Community Development Department Ward Offices	Mayoral Climate Action Advisory Council AZ Youth Climate Coalition International Indian Treaty Council Local First AZ NAACP Tucson Branch Paisanos Unidos San Xavier Co-op Farm Southside Worker Center	Ongoing		\$

Action #	Action
G-3.1	Develop multilingual, culturally competent climate action toolkits that include information about (a) how to prepare for and respond to climate-related emergencies and stressors and (b) the benefits of building electrification and electric vehicles, and (c) how to procure affordable materials and labor for building retrofits, green infrastructure projects, and more.
G-3.2	Develop an annual Resilient Tucson Awards program to recognize achievements by community organizations, businesses, City departments and divisions, students, and/or outstanding community members.
G-3.3	Develop accessible educational resources that provide guidance on behavior change that promotes climate change mitigation and adaptation (e.g., adopting plant-based diets, converting from natural gas to electric appliances, planting climate-adapted vegetation, and reducing food loss and waste).
G-3.4	Partner with community organizations to run tours of sustainable infrastructure / design projects, and provide related public education.
G-3.5	Continue existing efforts through school partnerships and the Environmental Education Exchange to develop Tucson-specific climate, sustainability, and conservation curricula for students across all grades.

## G-4

## Monitor and report emissions performance to adapt decarbonization strategies

We will improve our monitoring efforts to date and establish a comprehensive GHG emissions inventory aligned with internationally recognized standards. We will also evaluate our emissions impacts from indirect activities and from the consumption of goods and services in Tucson.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office Environmental and General Services Department	All departments	N/A	0-1 years; annual		\$

Action #	Action
G-4.1	Develop and maintain a municipal GHG emissions inventory that is updated on a minimum two-year basis and aligns with ISO 14064 reporting standards.
G-4.2	Initiate City-wide quantification of fugitive emissions to include in municipal GHG inventory, including refrigerants, fire suppression systems, methane leakage, and other sources, and identify low global warming potential (GWP) substitutes where available.
G-4.3	Determine which Scope 3 emissions to include and monitor in municipal GHG inventories and integrate strategies to reduce Scope 3 emissions into future plan updates (e.g., Central Arizona Project, employee commuting, waste, and business air travel for City employees, etc.)
G-4.4	Coordinate with the Pima Association of Governments to accurately calculate and co-monitor community-wide emissions.
G-4.5	Develop a consumption-based inventory that estimates GHG emissions from the local consumption of goods and services.

# From Ideas to Actions



The process for developing *Tucson Resilient Together* involved an extensive community engagement process in collaboration with seven community partners. See how ideas from a workshop with NAACP Tucson Branch translate into the final plan.

**G-3** Develop educational, communications, and outreach resources and assets promoting climate action and adaptation.

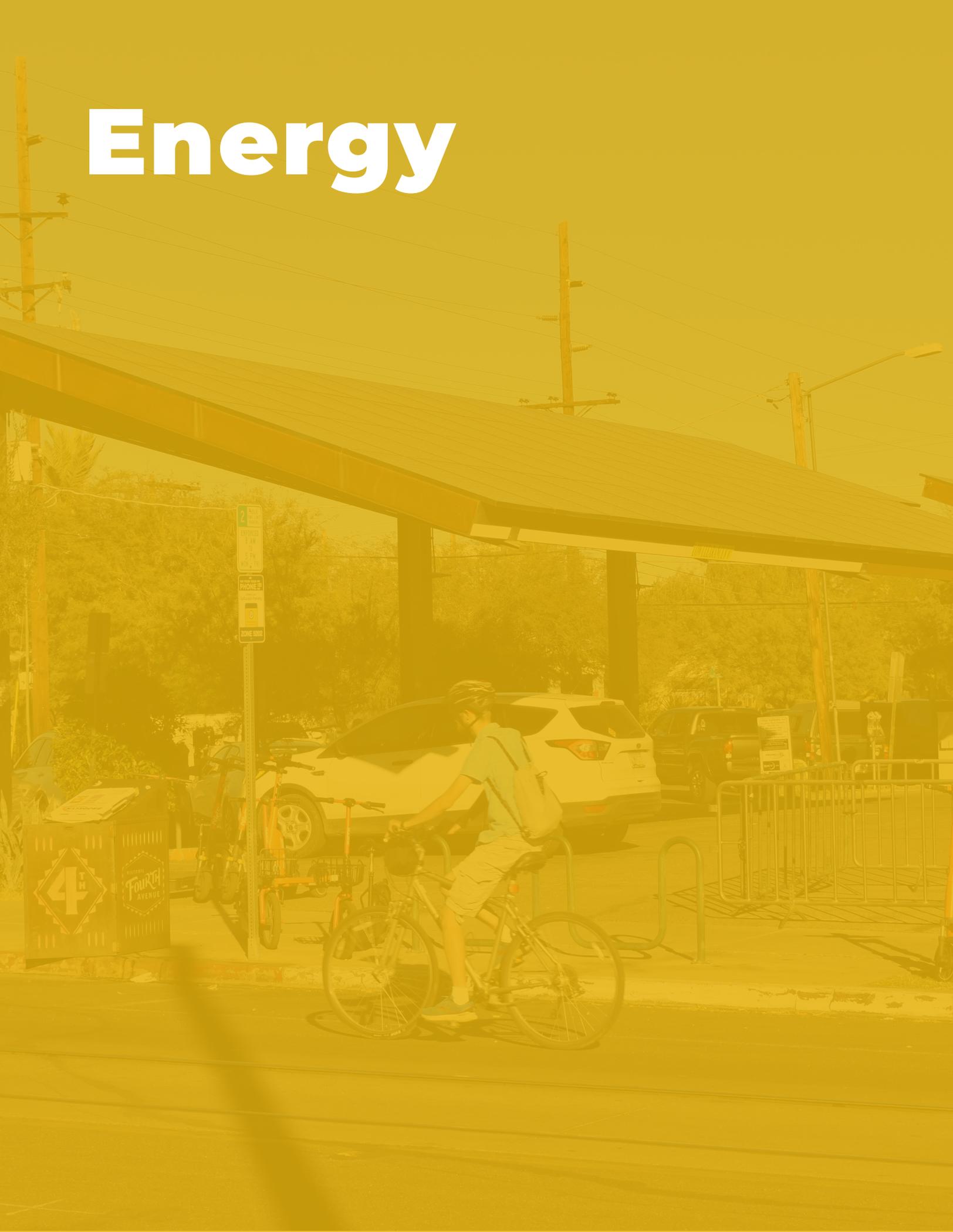
**E-4.4** Explore community solar co-op models to democratize access to solar energy.



**RR-5** Build on the existing work of the Storm to Shade program to encourage green infrastructure.

**G-3.5** Continue existing efforts through school partnerships and the Environmental Education Exchange to develop Tucson-specific climate, sustainability, and conservation curricular for students across all grades.

# Energy



# Energy

Energy is essential for the economic and environmental vitality of Tucson and the world at large. The United Nations has affirmed this with a Sustainable Development Goal to “ensure access to affordable, reliable, sustainable, and modern energy for all.” We use various forms of energy to heat and cool our homes and businesses, power lights, cook food, move vehicles, and even pump water from the Colorado River – life as we know it wouldn’t be possible without energy.

However, our current energy supply is unsustainable and harmful to people and the planet. That is because we are highly reliant upon fossil fuels such as oil, natural gas, gasoline, and diesel. When these fuels are burned in power plants, furnaces, and engines, they produce harmful air pollutants and GHG emissions (also known as carbon pollution). As we look to the future, we must embrace renewable forms of energy such as solar and wind, and ensure that the future energy system is resilient, affordable, and accessible.



## Current Status

To understand where and how we can make progress with respect to energy, we must start by examining where and how we procure it. Electricity is provided to Greater Tucson by Tucson Electric Power (TEP), an investor-owned utility and subsidiary of Fortis. About 30 percent of TEP’s energy comes from renewable sources, with most of the remainder coming from fossil fuel power plants.<sup>1</sup> TEP has plans to fully transition away from coal

1 Tucson Electric Power. (2022). “TEP to Issue All-Source Request for Proposals for Additional Energy Resources.” <[Tucson Resilient Together | 85](https://www.tep.com/news/tep-to-issue-all-source-request-for-proposals-for-additional-energy-resources/#:-:text=Tucson%2C%20Ariz.,to%20be%20July%201%2C%202022.></a></p>
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power by 2032 and increase its renewable energy share to 70% by 2035. It has also committed to reduce its carbon emissions by 80% from 2005 levels by 2035.

Tucson Water's drinking water distribution system includes properties served by Trico Electric Cooperative instead of TEP. About one-quarter of Trico's energy comes from renewables, one-twelfth from hydropower, and the rest from fossil fuels.<sup>2</sup> Natural gas is provided to Greater Tucson by Southwest Gas, an investor-owned utility that provides service to customers in Arizona, Nevada, and California.

The City of Tucson, like other local governments, does not have direct control over the broader energy supply system. Utility companies are regulated by the Arizona Corporation Commission (AZCC), and the State has created other barriers to local control. In February 2020, Governor Doug Ducey signed into law House Bill (HB) 2686, prohibiting municipalities from creating any code, ordinance, regulation, or fine/penalty imposition on utilities for providing natural gas for new construction projects. This legislation was supported by both Fortis and Southwest Gas.

Despite these barriers, Tucson has stated its position, and we are still making progress on our own. In 2020, we passed a resolution requesting the AZCC to adopt a clean energy standard of 100% by 2050. In 2007, Tucson was designated a Solar America City by the U.S. Department of Energy. Now, nearly 13% of the energy for City facilities comes from 14 MW of solar power generated at those locations. More city solar projects are in the pipeline for installation through the end of the decade. In 2021, we launched SolarApp in partnership with Pima County to offer same-day permitting for rooftop solar, which has paved the way for thousands of installations across Tucson.

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Tucson Electric Power plans to:

- **fully transition away from coal power by 2032**
  - **increase its renewable energy share to 70% by 2035**
  - **reduce its carbon emissions by 80% from 2005 levels by 2035**
- 

2 Trico Electric Cooperative. "Trico's Energy Mix." <<https://www.trico.coop/sustainable-energy/energy-programs/#:~:text=Retail%20renewables%20represent%20over%2084%2C000%2C000,of%20Trico's%20total%20renewable%20portfolio>>.

## Focus Areas and Priorities

Moving towards clean energy requires several different approaches which are described below; the energy used in the transportation system is addressed in the Transportation and Land Use section.

**Measure:** An initial step towards reducing GHG emissions from energy is to track energy use to better understand usage patterns and identify opportunities for energy conservation. This includes energy “benchmarking,” or comparing the energy performance of individual buildings against other comparable buildings.

**Reduce:** Energy conservation is essential in moving towards a zero-carbon energy future. Buildings are a major consumer of energy in Tucson and account for two-thirds of community-wide emissions. “Passive” design approaches can reduce energy consumption and make buildings resilient to power outages by making use of daylight, shading, insulation, and reflective materials to create comfortable and low-energy indoor environments.

**Electrify:** In order to become carbon neutral, we must stop using fossil fuels. This will require that we eventually replace all the equipment used for heating, hot water, cooking, and clothes drying. While new construction offers the opportunity to select electric technologies, most of the buildings that we will have in 2030 and 2045 already exist today – and are based on fossil fuel equipment. Thus, we must provide existing renters, building owners and managers with the financial and technical tools they need to electrify their buildings.

**Decarbonize:** Finally, we must also “decarbonize” the electric grid, moving from fossil fuel power plants that produce large amounts of carbon dioxide and other pollutants, to clean and renewable energy sources such as solar and wind. Utility-scale efforts can be completed in partnership with TEP, or the City of Tucson can explore other options. Advocacy groups such as Arizonans for Community Choice have initiated efforts to establish Community Choice Energy in Arizona, which could give Tucsonans the choice of receiving 100% renewable energy from the grid. An alternative option would be to create a public power utility fully owned by the City of Tucson.

Each of these approaches requires careful consideration of affordability and housing tenure; providing equitable access for renters, low-income households, multifamily and manufactured homes is essential for the transition to a clean, affordable, and reliable energy system that serves all Tucsonans.

Shifting from fossil fuel combustion to renewable power will change our relationship with energy. We expect this “energy transition” to require an increase in transmission and distribution capacity, as well as various forms of energy storage to address intermittency (i.e. cloudy days that reduce solar output) and ensure reliability. Some of the ways that we can manage this transition efficiently include investing in renewable power generation close to Tucson, thus reducing transmission losses, and taking actions to better align renewable energy production and consumption. For example, “smart grid” technologies can help to balance in energy demand by scheduling appliances to run or batteries to charge when solar photovoltaic panels are generating the most electricity.

City residents can also support the transition to a renewables-based grid by installing rooftop solar, participating in community solar, and/or adopting energy storage, including dedicated battery energy storage and/or EVs paired with bidirectional charging equipment when it becomes more widely available. These are examples of "distributed energy resources (DERs)" which generate and store clean power near the intended source. They can help to balance the grid and ensure reliability.



# What We've Heard

Dating back to our community survey and listening sessions in 2021, renewable energy – especially solar – has been a high priority for Tucsonans. Listening sessions participants identified solar as one of the top climate mitigation strategies for Tucson, and that has not changed through each of the community dialogues and pop-up events held for *Tucson Resilient Together*. Residents are looking to Tucson to improve solar affordability and accessibility, and to do so in a way that is equitable. Furthermore, Tucsonans want more than solar installations that feed clean energy into the grid: they are looking for community-based solar that can directly support and decarbonize their homes and neighborhoods. Through this plan, we are building on recent efforts to improve access to solar, including SolarApp and our recently adopted Solar Empowerment Program, which provides loans and grants to low-income households for rooftop solar systems. Strategy E-4 includes specific actions to explore community solar co-op models as a way to increase access to solar and to continue exploring ways to streamline permitting for solar PV installations on buildings and properties. Under this strategy, we also intend to build out 30 MW of solar and battery storage projects over the next several years.

However, Tucsonans are well aware of the urgency of the climate crisis and recognize that one of our most significant levers to pull is the electricity grid. Advocacy in favor of community choice energy, through which jurisdictions can partner to procure clean, renewable energy and deliver it through existing utility transmission lines to customers, has consistently shown itself at public workshops and community dialogues. Strategy E-3 speaks to this solution and others: we intend to work with community advocates and other jurisdictions across Arizona to co-form a community choice energy program to procure 100% renewably-sourced electricity for Tucson, while simultaneously continuing to engage with Tucson Electric Power and Trico Electric Cooperative to expedite their portfolio transitions to renewable electricity. Some have suggested municipalization or forming a public power utility as an option for the City to decarbonize its grid electricity. Through this strategy, we intend to commission a study assessing the feasibility of that approach.

Finally, many residents have spoken to the importance of programs and resources to enable them to decarbonize their homes through energy efficiency, weatherization, and other retrofits. Strategy E-2 features multiple, collaborative actions to help set up home energy audit and retrofit programs for Tucson residents (with a priority for low-income families and homeowners), as well as to establish a revolving loan fund to help finance solar and energy efficiency projects for small businesses, among other actions.

**+ retrofit funding**

**+ community-owned solutions**

**+ solar affordability**

**+ community choice energy**

# E Energy

E-1

## Decarbonize City-owned and operated buildings and facilities

The City of Tucson will lead by example and act to both reduce the carbon emissions from City buildings and facilities, as well as bolster the resiliency of City operations. The following actions will reduce energy consumption, eliminate fossil fuels where possible, and improve the health and wellbeing for City workers and Tucsonans at large.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services Facilities, Architecture and Engineering	City Manager's Office Procurement	Energy performance contractors	5-10 years	🌿🌿🌿🌿	\$\$\$\$

Action #	Action
E-1.1	Benchmark energy use of City buildings and facilities using EnergyStar Portfolio Manager.
E-1.2	Create an internal carbon tax for City departments that is informed by the City's emissions portfolio.
E-1.3	Implement ongoing weatherization and commissioning (building tune-ups).
E-1.4	Develop a net zero building framework for City-owned buildings and facilities, including but not limited to energy efficiency, electrification, and renewables.
E-1.5	Utilize an energy services company (ESCO) to rapidly but strategically implement energy efficiency measures and equipment in City-owned buildings, and ongoing energy management.
E-1.6	Pilot new and emerging clean energy technologies, including solar streetlights.
E-1.7	Transition municipal landscaping equipment to cordless battery equipment and/or manual tools, and pursue AGZA Green Zone Certification.

E-2

## Support the electrification and decarbonization of existing and new residential and commercial buildings

Installing all-electric systems in new buildings reduces construction costs while benefiting people and the environment by eliminating the air pollution associated with burning fossil fuels indoors. The lower cost of development also supports housing affordability. Converting existing buildings is also necessary, and the City will provide new resources to assist building tenants, owners, and managers to undertake retrofit projects. The City will take an equitable approach to ensure that frontline communities benefit from the utility cost savings and are not unfairly burdened by the costs of retrofit projects.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services Planning and Development Services	Economic Initiatives Facilities Facilities, Architecture and Engineering	Local First AZ Pima County SAHBA MPA Architects and builders Tucson Electric Power Trico Electric Cooperative University of Arizona	Ongoing		\$\$ - \$\$\$\$

Action #	Action
E-2.1	Partner with the private sector to implement a home energy audit and retrofit program for Tucson residents, with a priority for low-income families and homeowners.
E-2.2	Collaborate with other Arizona cities to pursue funding to develop regional energy code standards (including mandatory and voluntary energy reach codes) that promote highly energy efficient and/or zero-emission buildings in new construction.
E-2.3	Establish a Revolving Loan Fund (RLF) to support small businesses with financing decarbonization projects, including solar and energy efficiency projects.
E-2.4	Identify and utilize partnerships, funding, and incentives for new and existing buildings to replace gas-powered systems and appliances with electric-powered alternatives.
E-2.5	Develop a net zero accelerator program that is designed to provide building and property owners with direct training, guidance, and resources to improve energy efficiency and reduce carbon emissions from buildings.

E-3

## Procure zero-emission electricity and decarbonize City and community power supply

Moving to a renewables-based electricity supply is absolutely necessary to achieve carbon neutrality, and the City will investigate various options to get there – and implement the action that best supports the goals of a just transition that benefits historically impacted communities.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services	City Manager's Office Procurement Attorney's Office	Tucson Electric Power Trico Electric Cooperative Kinect Community choice energy advocates	Ongoing		\$\$\$

Action #	Action
E-3.1	Engage with Tucson Electric Power and Trico to expedite the shift to renewable electricity supplied to the City and community.
E-3.2	Work with community advocates and other jurisdictions to co-form a community choice energy program or joint powers authority to procure 100% renewable power for Tucson.
E-3.3	Commission a feasibility study on the formation of a public power utility, ahead of Tucson Electric Power's franchise agreement expiration (2025).
E-3.4	Pursue solar service agreements (SSAs) or virtual power purchase agreements (PPAs) to meet the City's power needs for municipal operations.

E-4

## Install and promote distributed energy resources (DERs) such as rooftop solar to provide local renewable energy and enhance energy resilience

Shifting to electric building systems is going to change Tucson’s relationship with the electric grid, and we must also expand our “distributed energy resources” such as local solar power and battery energy storage, which can help meet varying energy demands throughout the course of a day, and also operate independently from the grid during outage events. This strategy also includes ways for residents and businesses to access the benefits of local renewable energy, even if they occupy buildings that are not physically suitable for solar panels.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services Planning and Development Services Real Estate	Procurement Emergency Management Parks and Recreation Sun Tran	Solon Pima County Tucson Electric Power Trico Electric Cooperative External vendors	Ongoing		\$\$\$ - \$\$\$\$

Action #	Action
E-4.1	Install at least 30 MW of solar photovoltaics (PVs) on City-owned buildings and carports.
E-4.2	Coordinate with electric utilities to install battery energy storage systems in City-owned buildings and carports, with an emphasis on combined solar + storage for community-serving critical facilities.
E-4.3	Utilize City properties as off-taker and/or host sites for community solar and utility-scale renewable energy projects.
E-4.4	Explore community solar co-op models to democratize access to solar energy.
E-4.5	Explore opportunities to further streamline permitting for solar photovoltaic (PV) installations on residential, commercial, and industrial buildings and properties, as well as utility-scale installations.
E-4.6	Identify opportunities to use electric vehicles (including buses and utility vehicles) to provide backup power through vehicle-to-load (V2L) capabilities, as well as vehicle-to-grid (V2G) and/or vehicle-to-building (V2B) capabilities available in the future.
E-4.7	Develop additional incentives and reduce permitting fees for residents and businesses to install solar PV and/or energy storage systems.

E-5

## Pursue additional local sources of renewable energy, including resource recovery and heat exchange

Tucson has multiple sources of untapped renewable energy beyond solar power. For example, the ground has a near constant temperature under the surface – we can use geothermal heating and cooling technology to move heat from inside buildings to the ground or vice versa. Another form of local renewable energy is the methane generated from decomposing waste, which can be captured and converted into useful fuel. The City is already leveraging this source of energy through the Los Reales Sustainability Campus but will continue to explore other opportunities now and into the future

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services Facilities, Architecture and Engineering	Sun Tran		Ongoing		\$\$\$\$

Action #	Action
E-5.1	Implement a methane capture project at the Los Reales Sustainability Campus that redirects the biogas as a source of renewable energy.
E-5.2	Investigate opportunities to incorporate renewable thermal (heating and cooling) energy, including geothermal heat pumps.
E-5.3	Monitor academic research on the potential for safely blending hydrogen into the natural gas distribution system.

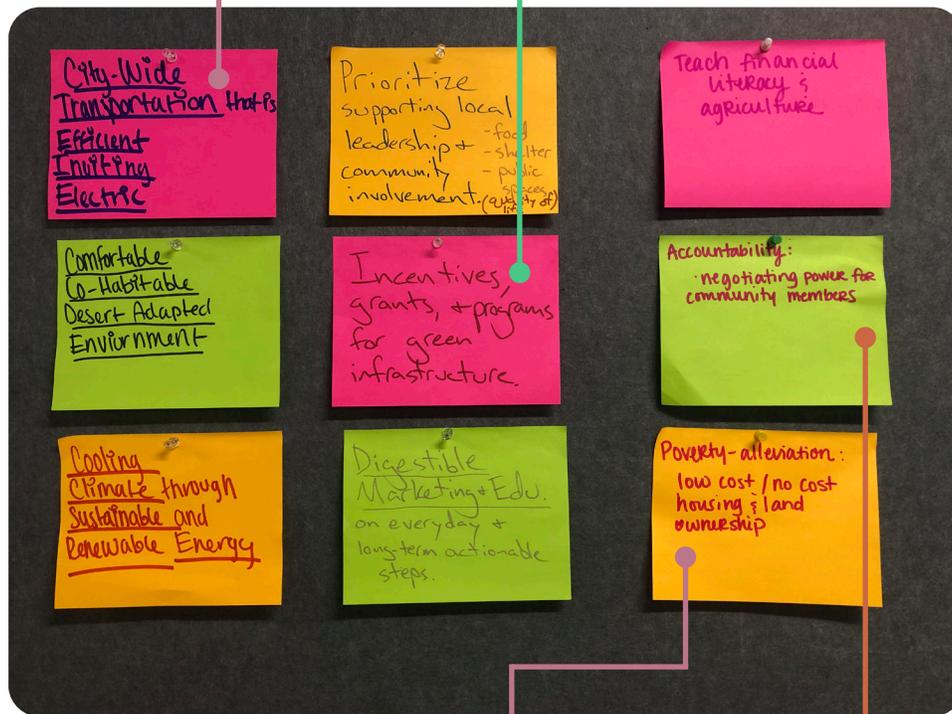
# From Ideas to Actions



The process for developing *Tucson Resilient Together* involved an extensive community engagement process in collaboration with seven community partners. See how ideas from a workshop with **Local First Arizona** translate into the final plan.

**T-2** Invest in safe, comfortable, and convenient public transit as the backbone of a sustainable and resilient transportation system.

**RR-5** Build on the existing work of the Storm to Shade program to encourage green infrastructure.



**T-3.2** Utilize urban overlays and anti-displacement measures to incentivize higher density mixed-use, mixed-income, and affordable housing developments in areas with high-frequency transit.

**G-2** Accelerate climate action, adaptation, and resilience strategies through community and regional partnerships.

# Transportation and Land Use



# Transportation and Land Use

A climate-resilient transportation system provides residents of all ages, abilities, and income levels with access to safe, reliable, and affordable options that reduce air, water, and climate pollution. A high-quality system enables residents and goods to reach their destinations and is essential for a well-functioning local economy that provides access to jobs, education, services, and recreation. It also prioritizes equity, providing services and access to resources that help protect the most vulnerable from the impacts of climate change.

For decades, government and business interests have prioritized private vehicle travel over all other modes; the majority of trips in Tucson today occur in private vehicles which discharge harmful pollutants into the air and water. Looking towards our resilient future, we will reprioritize sustainable movement – starting with walking, biking, rolling, and public transit. This will be supported by land use regulations that support our vision for a “15-minute city,” where every resident can access daily necessities within 15 minutes of walking, biking, and rolling. This means considering clusters of affordable and market-rate housing as well as neighborhood amenities, schools, and employment centers located near transit corridors. It also means using tools such as Planned Area Developments and Flexible Lot Developments, as well as incentive-based programs, that support high-quality attractive design for new housing and promote a diverse mix of uses, densities, and housing types. With respect to housing, we must not only work toward making housing more affordable for low-income residents and families, but we must explore housing types that are more attainable at market rates for middle-income households. We will update our standards and zoning regulations to enable these types of housing.

Finally, we will take action to accelerate the transition to electric vehicles, starting with public fleets and the City workforce, in addition to reducing barriers and providing incentives for private vehicle owners to go electric or to use alternative, electric mobility and micro-mobility options.



## Current Status

Cars are currently the dominant form of transportation in Tucson, which can be seen in our commute travel patterns. Prior to the pandemic, 74% of workers drove alone to work, with smaller proportions of workers who carpooled (11%), took public transportation (3%), walked (3%) or bicycled (3%). While these patterns have likely shifted somewhat during the pandemic due to increased telecommuting options, these figures still reflect the quality of Tucson's transportation infrastructure which, as a result of decades of vehicle-oriented decision making, caters more towards cars and trucks than it does for people walking, biking, and rolling.

Recognizing this imbalance, the Tucson Department of Transportation and Mobility (DTM) released a new transportation plan in fall 2021 called Move Tucson. The plan lays out a vision to create a transportation system that prioritizes safety and increases equity, with investments that improve the City's economic and environmental resilience. The master plan identifies over 200 programs and projects over the next 20 years with an estimated cost of \$5.7 billion, including roadway modernization, bus rapid transit integration, new greenways, bus service improvement, road repair, and programs and policies such as Vision Zero and Safe Routes to School. Move Tucson also seeks to address heat resilience by increasing shade and vegetation to improve comfort and safety along roads and paths.

DTM provides oversight and coordination for multiple forms of public transportation, including the Sun Link streetcar system, the Sun Tran bus system, and Sun Van paratransit system. Transit fares were waived during the COVID-19 pandemic and safety measures were implemented to help protect the community from the virus. The City owns the vehicles and operating equipment, which are operated by private sector companies.

In April 2021, the City Council adopted its Electric Vehicle Readiness Roadmap, which provides a roadmap for the future of EVs in Tucson. This was followed by a series of code changes approved in August 2022 that will require varying levels of EV readiness for new retail, office, and multifamily developments.<sup>1</sup>

With respect to land use, development patterns have been shifting to focus on transit-oriented and infill development, density, and affordable housing:

- The launch of the Sun Link Streetcar in 2014, alongside various zoning changes, has transformed the downtown area and has facilitated the development of thousands of new housing units (including hundreds of affordable housing units, and it has helped create an environment for new retail establishments and job creation.
- Tucson has also deployed various zoning tools in recent years to promote infill development, including an Accessory Dwelling Units (ADU) ordinance in 2021. The Mayor and Council also recently adopted the first affordable housing density bonus in Tucson as part of the Sunshine Mile Overlay District. Housing and Community Development (HCD) is evaluating the terms of the density bonus and is exploring additional incentives that can be incorporated into this and future transit overlays to encourage affordable and mixed-income housing on key transit corridors.

<sup>1</sup> Residential code changes for EV readiness were approved in June 2021.

## Focus Areas and Priorities

Moving towards climate-resilient transportation systems and land use patterns requires a holistic approach that ultimately makes it easier for people to make sustainable choices. That approach comprises three areas of action:

**Avoid:** Many vehicular trips can be avoided by having better integrated transportation and land use decisions. For instance, promoting affordable housing to be constructed within walking distance of job centers, schools, and neighborhood amenities can avoid the need for longer trips, and virtual meetings can enable more people to work and/or learn from home.

**Shift:** Other trips can be shifted from private vehicles to more sustainable choices. For example, workplaces can nudge employees to walk, bike, or take public transit by providing financial incentives (such as discounted transit passes) or conveniences (such as lockers and showers). Comfort and convenience are huge motivating factors; more Tucsonans will be motivated to walk or bike if we can provide sidewalks, bike lanes, and bike paths that are attractive and shade protected. Similarly, prioritizing the movement of buses on our roadways can greatly improve service for transit riders.

**Electrify:** Finally, transportation is about to see an electric revolution, particularly for cars and light trucks. We can accelerate this transition through incentives and regulation, such as the requirement for charging options in new construction. For heavy duty vehicles that do not have market-ready electric alternatives, we can seek out other low-carbon technologies.



# What We've Heard

An improved transportation system has been chief among the recommendations and desires shared by Tucsonans for *Tucson Resilient Together*. Several groups and individuals commented on the needs for Tucson to be less car-centric, and to provide for more accessible and equitable public transit, walkability and bikeability, and increased proximity to amenities and resources. Specific recommendations included shaded pedestrian areas and routes, protected transit stops and bike lanes, increased route frequency for public transit, and additional transit stops and mobility solutions for low-income families and communities far from downtown. Strategies T-1 and T-2 focus on making it easier to shift to zero-emission modes of transportation and improving public transit respectively, including actions to deploy ADA ramps, shaded sidewalks, and protected bike paths and lanes, create space for walkways, expand the Frequent Transit Network, and commission a first-mile/last-mile study to identify solutions for communities with low proximity or access to public transit.

Some of these actions go hand-in-hand with changes or continued efforts on shifting land use patterns to transit-oriented development, for which Tucsonans also voiced support. Some of our engagement participants called for eliminating zoning requirements that have provided barriers to walkable, bikeable neighborhoods such as parking minimums. Affordable housing was also a chief concern for many Tucsonans who participated in the community engagement process, emphasizing the need for density and housing that was affordable for both low- and middle-income earners. Strategy T-3 emphasizes a “smart growth” approach that concentrates public services and infrastructure investments in existing neighborhoods, and includes actions that incentivize higher density mixed-use, mixed-income, and affordable housing developments along transit corridors, as well as expand housing options for middle-income earners.

Finally, throughout all of our engagements, Tucsonans have consistently expressed a desire for electric vehicle readiness and access to electric forms of transportation, both through independent electric vehicles as well as electrified public transit (i.e., buses, micro-mobility services, etc.). Specific suggestions included incentives for both individuals and businesses to encourage and enable EV ownership and use. In Strategies T-4 and T-5, we draw from the measures laid out in the *2022 EV Readiness Roadmap* to promote electric transportation for the public, as well as to transition the City’s vehicle fleet to electric vehicles in a timely fashion.

+ **protected bike lanes**

+ **accessible and equitable public transit**

+ **affordable transit-oriented development**

+ **electric vehicle incentives**



105

357



# Transportation and Land Use

T-1

## Champion walking, biking, and rolling as sustainable and climate resilient mobility options

Walking, biking, and rolling are the most energy-efficient and lowest-carbon forms of transportation in the world. Investing in sidewalks, bike lanes and paths, seating and shading infrastructure will attract and enable more Tucsonans to move about their neighborhoods safely and sustainably. Protecting against heat impacts will be especially important to guard against rising temperatures and more frequent and intense heat waves.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Planning and Development Services  Department of Transportation and Mobility	Housing and Community Development	Living Streets Alliance  Metropolitan Pima Alliance	Ongoing		\$\$\$\$

Action #	Action
T-1.1	Use various funding sources, including Prop 411, to implement bicycle, pedestrian, and other zero-emission mobility projects identified in <i>Move Tucson</i> to create a transportation network aligned with the <i>Complete Streets</i> approach.
T-1.2	Promote walking, biking, and rolling by creating attractive and universally accessible street environments through ADA ramps, traffic signal safety enhancements, accessible seating, shaded sidewalks, protected bike paths and lanes, bike- and scooter-share programs, and other improvements.
T-1.3	Create additional financial and zoning incentives to add more convenient locations for bike parking at commercial and multi-family developments and encourage these developments to locate near existing transit and bike share stations where viable. Explore staffing opportunities to track compliance of bike parking development codes city-wide.
T-1.4	Develop or support K-12 walk- and bike-to-school programming.
T-1.5	Increase safety for all road users, including pedestrians and bicyclists, by eliminating lanes on wide roads and creating public space, walkways, enhanced crossings and signals, and protected bike lanes.

T-2

## Invest in safe, comfortable, and convenient public transit as the backbone of a sustainable and resilient transportation system

Buses and streetcars are the most efficient ways to move large numbers of people across longer distances. They take up less road space than the equivalent number of private vehicles, produce fewer pollutants, and provide the greatest societal benefit. We must invest in making them safest, most comfortable and convenient transportation choice for longer trips as well.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Department of Transportation and Mobility Sun Tran	Planning and Development Services Housing and Community Development	University of Arizona Local businesses School districts	1-5 years		\$\$\$\$

Action #	Action
T-2.1	Maintain and expand the Frequent Transit Network to increase Sun Tran service frequency and improve Sun Tran bus service.
T-2.2	In partnership with Sun Link and Sun Tran, identify options for expanding streetcar, bus rapid transit (BRT) and/or local bus access to underserved communities.
T-2.3	Establish partnerships with local institutions (e.g., school districts, the University of Arizona, and other major employers) to provide free transit or reduced fares for students, youth, seniors, low-income riders, and riders with disabilities.
T-2.4	Pilot a transit ambassadors program to support a safe and comfortable experience for Sun Link and Sun Tran riders, and additionally provide information on climate preparedness.
T-2.5	Improve bus transit customer protection, access, and comfort by installing ADA accessible features, shelter, trees, boulders, noise mitigation, and other enhancements at bus stops.
T-2.6	Compile data on bus shelters and accessibility, resilience, and protection features and upload onto a public database or map.
T-2.7	Commission a First-Mile/Last-Mile study to identify supplemental solutions for communities with low proximity or access to public transportation, including microtransit and micromobility options.

**T-3**

## Adopt a “smart growth” approach that supports car-free and car-lite living throughout the City of Tucson and concentrates public services and infrastructure investments in existing neighborhoods

Tucson continues to experience population and economic growth, and additional residents and workers bring with them increased demand for homes, workplaces, and the infrastructure to support them. The way we choose to direct that growth has climate impacts. For example, encouraging new affordable housing along transit corridors can enable Tucsonans to reduce their dependency on cars – and the associated costs of ownership. This form of “infill” development can promote walkability by enabling more daily destinations to be located in the same area, but it must be accompanied by anti-displacement measures in order to protect and uplift existing residents and small businesses.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Planning and Development Services	Department of Transportation and Mobility Sun Tran Economic Initiatives Housing and Community Development	University of Arizona Local businesses School districts Neighborhood associations	Ongoing		\$\$\$

Action #	Action
T-3.1	Orient community planning efforts toward a '15-minute' city, enabling community access to basic amenities within a 15-minute walk or bike ride from home.
T-3.2	Utilize urban overlays and anti-displacement measures to incentivize higher density mixed-use, mixed-income, and affordable housing developments in areas with high-frequency transit.
T-3.3	Update development standards and create tools to incentivize higher density affordable housing development, particularly along transit corridors to increase mobility options for lower income households, in line with the Housing Affordability Strategy for Tucson (HAST).
T-3.4	Expand contextually-appropriate 'missing middle' housing (i.e., duplexes, triplexes, and fourplexes) through the General Plan update, initiatives, and code changes to encourage walkability and increase housing option diversity.

Action #	Action
T-3.5	Revise traffic engineering standards for new development and roadway design, to prioritize multimodal trips rather than designing to the 'worst case' of vehicular traffic impacts.
T-3.6	Assess parking needs within key areas with quality options for walking, biking, rolling, and public transportation, and explore solutions to reduce excessive parking, including but not limited to reducing parking minimums, establishing parking maximums, conducting a parking inventory, increasing efficiency in residential parking permit districts, and implementing dynamic pricing.
T-3.7	Join the C40 Green and Healthy Streets declaration to ensure a major area of Tucson is zero-emission by 2030.



**T-4**

## For unavoidable vehicular trips, promote electric vehicles via charging infrastructure expansion, building codes, partnerships, and advocacy

In order to meet our climate goals, cars and trucks powered by fossil fuels must be replaced with electric vehicles over time. The City doesn't have direct control over consumer choices, but we can make it easier to own an electric vehicle through a variety of methods including the expansion of charging infrastructure.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Department of Transportation and Mobility Planning and Development Services	Economic Initiatives Housing and Community Development	University of Arizona Local businesses School districts Neighborhood associations Rideshare companies	Ongoing		\$\$\$\$

Action #	Action
T-4.1	Launch a subsidized all-electric bike share and car share program that prioritizes neighborhoods with lower rates of household access to vehicles and support an electric bike rebate program and e-bike lending library which lower barriers to active modes of transportation.
T-4.2	Adopt a voluntary zero emissions delivery zone, spaces designated to prioritize deliveries from zero-emission modes of transportation.
T-4.3	Pursue public-private partnerships to install EV charging stations on City-owned land.
T-4.4	Build on recently passed EV code amendments and create specific EV charging station provisions for affordable housing developments.
T-4.5	Explore opportunities community-wide for the installation of grid-independent EV charging stations.
T-4.6	Offer subsidized electric vehicle charging for City employees, made publicly accessible during off-hours.
T-4.7	Partner with major employers to install charging stations.
T-4.8	Encourage rideshare services and delivery companies to incorporate EVs into their fleets.

**T-5**

## Transition public agency fleets to zero-emission and near-zero-emission vehicles

The City will lead the electric vehicle revolution by replacing its fossil fuel vehicles. Battery electric options are more limited for medium- and heavy-duty vehicles, and in these cases the City will seek out vehicles that utilize zero and near-zero-emission fuels.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Department of Transportation and Mobility Environmental and General Services	Facilities, Architecture and Engineering	School districts	Ongoing		\$\$\$\$

Action #	Action
T-5.1	Implement a fleet management plan that mandates all newly purchased City vehicles (including replacements) are zero-emission vehicles and implements fleet efficiency evaluations to ensure that the City does not own or use more vehicles than it needs at any time. Implement the introduction of bicycles and e-bikes as fleet vehicles to replace the use of small passenger vehicles and cargo bikes to replace the use of utility vans, where applicable.
T-5.2	Develop capital project plans to install charging stations to meet the projected demand of fleet vehicles.
T-5.3	Develop implementation plan for replacement of City-owned medium-to-heavy duty vehicles with zero and near zero emission vehicles.
T-5.4	Partner with school districts to electrify school bus fleets.
T-5.5	Create a funding and purchase plan for battery electric buses, paratransit vehicles, and other zero emission vehicles across all public transportation services.

**T-6**

## Encourage City employees to reduce the carbon footprint of their commutes and work-related travel

With more than 4,500 employees, the City will lead by example as a major employer in encouraging its workforce to choose sustainable forms of transportation for daily commutes as well as work-related trips.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office	Human Resources Department of Transportation and Mobility		Ongoing		\$

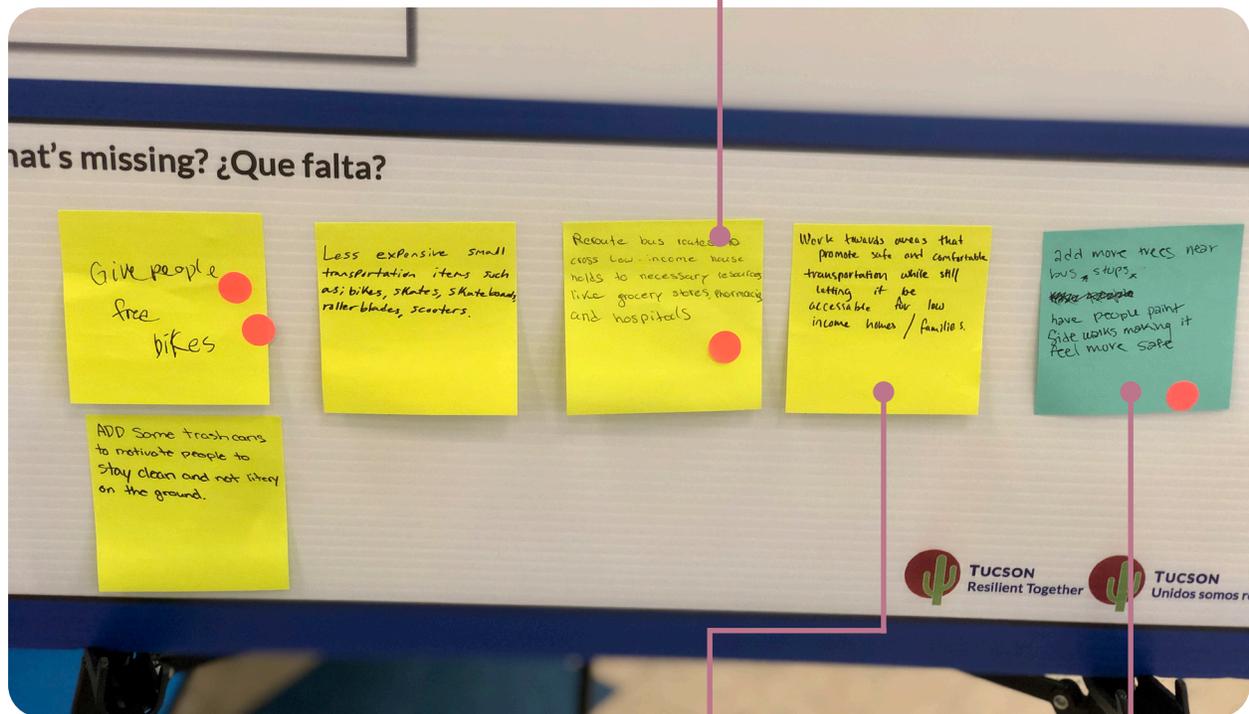
Action #	Action
T-6.1	Provide financial incentives to encourage sustainable transportation choices for commuting, and create a permanent remote or hybrid work option for applicable City employees (dependent on role and need) with applicable guidelines to ensure effectiveness, efficiency, and accountability.
T-6.2	Provide secure short-term and long-term bicycle parking options at City-owned buildings and shower facilities, lockers and bike repair stations made accessible at no-cost for City employees, and revise existing Administrative Directives (AD 6.03-1).
T-6.3	Institute a no-idling policy for city vehicles, prioritizing areas with high pedestrian traffic, school zones, and other pollution-sensitive areas.

# From Ideas to Actions



The process for developing *Tucson Resilient Together* involved an extensive community engagement process in collaboration with seven community partners. See how ideas from a workshop with AZ Youth Climate Coalition translate into the final plan.

**T-2.2** In partnership with Sun Link and Sun Tran, identify options for expanding streetcar, bus rapid transit (BRT), and/or local bus access to underserved communities.



**T-2.4** Pilot a transit ambassadors program to support a safe and comfortable experience for Sun Link and Sun Tran riders, and additionally provide information on climate preparedness.

**T-2.5** Improve bus transit customer protection, access, and comfort by installing ADA accessible features, shelter, trees, boulders, noise mitigation, and other enhancements at bus stops.

# Resource Recovery and Management



# Resource Recovery and Management

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Our use of materials affects climate change. Energy is required to bring material into a system or an economy, and after that resource is used, its disposal typically requires additional energy and may result in additional emissions. For example, a natural resource like water requires energy to draw from aquifers and reservoirs, as well as to pipe across great distances and into our buildings. The same goes for anything we buy, from the furniture in our offices to the food on our plates. When those materials reach their end of life, how they are handled matters. Food waste that is left to decompose in a landfill will emit methane – a highly potent greenhouse gas – into the atmosphere. In contrast, composting that food into mulch keeps it from going to landfill, allows it to be used to grow more fruits and vegetables, retains important nutrients in our ecosystem, and reduce carbon emissions.



In our Climate Emergency Declaration, we committed to becoming a zero-waste city. “Zero waste” is conventionally understood as diverting at least 90% of waste from landfill, whether that be by reuse, recycling, or composting. By transitioning to zero waste, we also move closer to having a circular economy: keeping material in use and in circulation and reducing our waste output as much as possible. This also benefits our ecosystem health, as landfills have the potential for soil and water contamination that can harm animals, plants, and humans alike. It also reduces GHG emissions in the long term.

Water is an even more significant part of this conversation – especially in Tucson. Water management that keeps water in the system allows us to reduce the amount of water we draw from reservoirs. Given the nationwide

drought that is significantly impacting Lake Mead and water supply from the Colorado River, a “closed loop” approach to water use is more important than ever.

Collectively, committing to strategies that advance zero waste and encourage water recycling will go a long way toward not only reducing our contributions to climate change, but also toward supporting Tucsonans by preserving material and water resources.

As a note, readers will observe that this plan does not feature a water section. While this chapter includes actions on green infrastructure, water supply and demand strategies will be addressed in One Water 2100. As noted earlier in this plan, Tucson Resilient Together and One Water 2100 were being developed concurrently, and the latter will be released in 2023. These two plans will complement each other in the broader efforts to secure water resources for Tucsonans and to act on climate change. The strategies in both plans will also inform the City’s General Plan update.

Refrigerants are fluids that are needed to operate refrigerators, freezers, air conditioners, heat pumps, and other appliances and equipment. They may be released during production, from leaks, and during end-of-life disposal, the latter of which is responsible for 90 percent of global refrigerant emissions. The most common refrigerants are called hydrofluorocarbons (HFCs), which are not ozone depleting substances but are far more potent than CO<sub>2</sub> when measured by their global warming potential.

### Current Status

At the time of drafting, the City of Tucson is finalizing a *Zero Waste Roadmap* that will meet the goals set in the Mayor and Council’s Climate Emergency Declaration: to attain 50% waste diversion by 2030,

and to achieve Zero Waste by 2050. Under this *Roadmap*, we are defining Zero Waste as 100% waste diversion. The *Roadmap* will be released by November 2022.

Up to this point, Tucson has taken proactive steps to move towards zero waste across all areas of activity, including construction. For example, the Los Reales landfill was renamed the Los Reales Sustainability Campus, recommitted in purpose to advance zero waste by reusing waste that would otherwise sit in landfill as production material. In addition, the Campus will serve as a space for food waste composting, and filtering recyclables out of landfill waste to increase waste diversion.

In addition, the City has worked with ByFusion, which makes machines that produce blocks made entirely out of recycled plastic instead of concrete or mortar. The intent is to divert plastic that would otherwise go to the conventional recycling stream – which itself has impacts on the emissions and the environment – and use it instead to build sustainably in Tucson. The City has used ByFusion blocks in Prop 407 projects, such as public parks facilities (e.g., ramadas, public restrooms, etc.). This is one example of a pilot project with potential for ramping up waste diversion in Tucson.

With respect to water resources, the City has a long history of working toward water and drought resilience, including the Water Plan 2000-2050, followed by the 2007 Drought Preparedness and Response Plan (which was updated in 2021). Since then, the City has put into place several water conservation and green infrastructure programs by ordinance, including but not limited to a Gray Water Harvesting Ordinance, a Commercial Rainwater Harvesting Ordinance, a Low-Income Rainwater Harvesting Program, and a Green Stormwater Infrastructure Fund (now referred to as Storm to Shade).

1 Project Drawdown. “Refrigerant Management.” <<https://drawdown.org/solutions/refrigerant-management>>.

## Focus Areas and Priorities

To take significant strides toward zero waste and water resource recovery goals, we intend to prioritize the following:

**Waste prevention and reuse:** Move away from leaning on conventional recycling and working towards using less material and producing less waste.

**Circular economy:** Disrupt the conventional, linear process of procuring material, using it, and disposing it by implementing policy, procedures, and projects that keep resources and materials in circulation for as long as possible.

**Sustainable procurement:** Consider the upstream impacts of the materials we procure in addition to their end-of-life impacts. This includes considering where and how materials are produced, from where and how they are sourced and transported, and the energy and material required to produce the products we procure.

**Green infrastructure:** Continue our leadership on green infrastructure systems by expanding opportunities for residents and businesses alike to install green infrastructure and better recover and manage water as a precious commodity in the short and long term.

**Refrigerant Management:** Minimize impacts by maintaining equipment to prevent leaks, ensuring proper disposal practices, and monitoring the market availability of alternatives to hydrofluorocarbon refrigerants.



# What We've Heard

Resource recovery and management brings together material and water resources and focuses on reducing our disposal of those resources and keeping them in circulation. The principles of reducing, reusing, and recycling have been prominent in the input we've received from Tucsonans throughout the development of *Tucson Resilient Together*. Many community members called for increased access to and information regarding recycling, as well as improved recycling services and sorting, but even more have called for an organics composting program to help reduce the amount of food and greenwaste going to landfill. Strategies RR-1 and RR-2 are focused on moving the entirety of Tucson toward zero waste by 2050 (diverting all waste from landfill), with a focus in the latter strategy on establishing an organics recycling program community-wide. Strategy RR-4 focuses on exploring pilot technologies to find more innovative ways to keep waste out of landfill.

The principle of a circular economy has also reverberated throughout the conversations Tucsonans have had on resource recovery and management, who have also challenged us to consider what we procure as a City and throughout the community. Strategy RR-3 is centered on developing a consumption-based inventory for the City of Tucson and creating a Sustainable Procurement Policy (already in progress) that sets standards on the sustainability of products purchased and used by the City across operations.

While water is not being specifically addressed in this plan, green infrastructure is addressed here in large part because of Tucsonan's demand for it, as well as increased access to incentives to install projects in their own residences and neighborhoods. Community members offered a number of specific recommendations to promote green infrastructure, including requirements to build homes that are gutter-friendly and enable stormwater retention, as well as expansions to existing green infrastructure incentive programs to better reach low-income households. Strategy RR-5 will build on the existing achievements of Tucson's Storm to Shade program and expand the deployment of green infrastructure and nature-based solutions to preserve water resources.

+ organics  
composting

+ green  
infrastructure

+ sustainable  
procurement

+ recycling  
education and  
outreach



# RRR Resource Recovery and Management

**RR-1** **Implement a Community-wide Zero Waste Plan and accompanying initiatives to achieve zero waste for City operations by 2030, and community-wide zero waste by 2050**

The City will adopt and implement its Zero Waste Roadmap and take significant steps to diverting as much waste from landfill as possible, both from City operations and across the community.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services	Procurement		1-3 years		\$\$\$

Action #	Action
RR-1.1	Complete a solid waste characterization study to understand how much metal, glass, plastics, food waste, and other materials are in Tucson's waste stream, in order to devise tactics to reduce waste and disposal costs.
RR-1.2	Implement Zero Waste Plan for community-wide solid waste diversion.
RR-1.3	Incorporate Zero Waste goals and objectives into the City's waste contracts and franchise agreements.

## RR-2 Create a community-wide organics collection and treatment program

The City will supplement its existing recycling systems with organics collection and treatment, which will go further toward preserving food nutrients and reducing potential methane emissions from organic waste such as food and green landscape waste.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services	Procurement	Waste haulers Local businesses Food donation organizations Restaurants	1-5 years	🌿🌿	\$\$\$

Action #	Action
RR-2.1	Prioritize food waste reduction via food loss prevention, food rescue/donation, and organics composting.
RR-2.2	Coordinate with haulers to establish an organic waste curbside collection program across the City and provide residents with organic waste bins and education.
RR-2.3	Develop a comprehensive strategy to divert organic waste from Los Reales Landfill.



RR-3

## Develop a Sustainable Procurement Policy for City operations

Tucson has committed to developing a policy that sets standards and ethics around the materials we procure, where they are purchased from, and the processes and raw resources from which they are made to move toward sustainably and ethically sourced products and services.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Procurement	City Manager's Office		1-2 years		\$

Action #	Action
RR-3.1	Complete a comprehensive inventory of City-procured goods and their associated emissions.
RR-3.2	Adopt a Sustainable Procurement Policy or Plan that designates third-party sustainability certification, sourcing, management and disposal requirements for City purchases (including both materials and food), with goals and targets to support local businesses, lower upstream emissions, support downstream diversion, and minimize refrigerant leakages.



## Use new technologies and partnerships to divert waste from landfill

We will pilot technologies and innovative approaches to reducing waste across operations and construction.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services	City Manager's Office Economic Initiatives Procurement	ByFusion Local businesses	Ongoing		\$\$

Action #	Action
RR-4.1	Continue piloting new zero waste technologies (e.g., ByFusion blocks) and establish metrics to evaluate their performance.
RR-4.2	Partner with businesses to identify opportunities for waste reduction and diversion and to facilitate information-sharing on new technologies.

RR-5

## Build on the existing work of the Storm to Shade program to encourage green infrastructure

We will expand our existing green infrastructure programs, regulations, and requirements to improve access to incentives and resources, as well as explore opportunities to restore existing riparian areas and make new, climate-resilient riparian zones.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Environmental and General Services Tucson Water	City Manager's Office Facilities, Architecture and Engineering	Tucson Clean and Beautiful	Ongoing		\$

Action #	Action
RR-5.1	Address barriers to implementing small-scale green infrastructure projects on individual properties, including code amendments where needed.
RR-5.2	Build upon existing efforts and partnerships through Storm to Shade partnerships to promote green infrastructure practices at the neighborhood and lot scale.
RR-5.3	Work with homeowners associations to update their landscaping requirements to include interconnected green infrastructure practices and climate adaptive planting palettes.
RR-5.4	Restore existing riparian areas and create new, context-appropriate and climate-resilient riparian areas.

# From Ideas to Actions



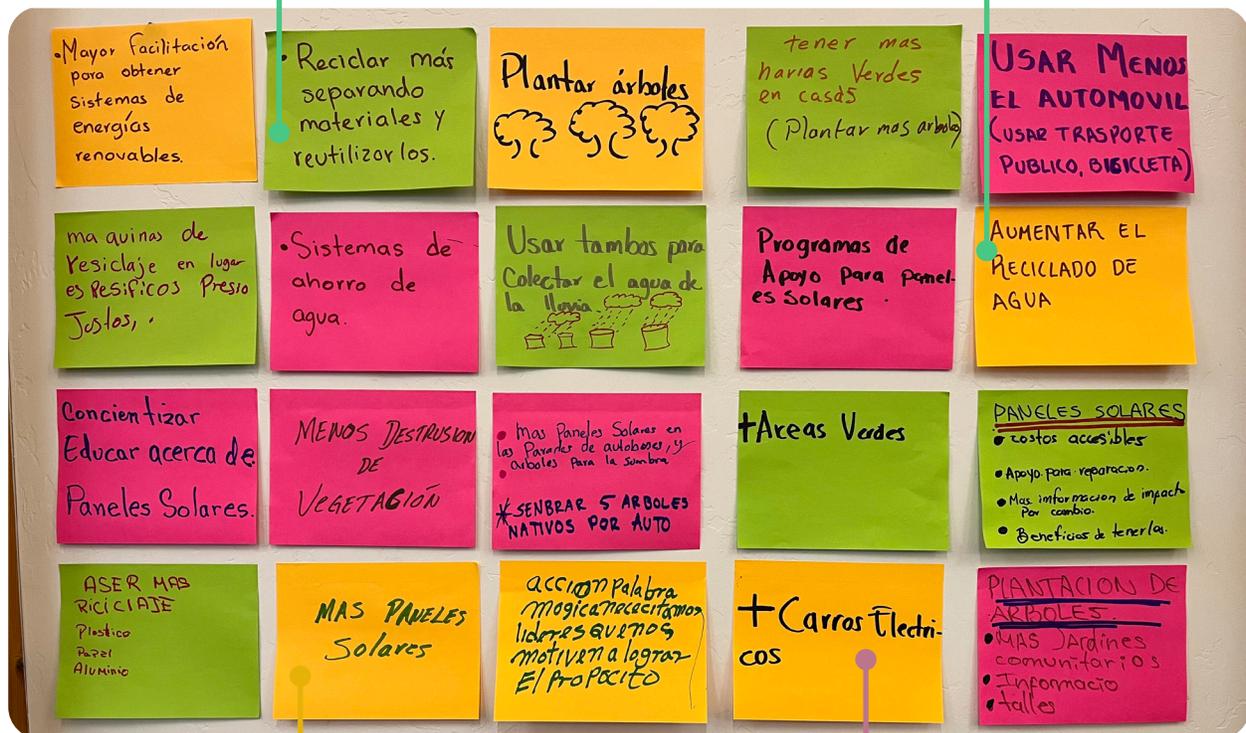
The process for developing Tucson Resilient Together involved an extensive community engagement process in collaboration with seven community partners. See how ideas from a workshop with Paisanos Unidos translate into the final plan.

**RR-1.2**

Implement Zero Waste Plan for community-wide solid waste diversion.

**RR-5**

Build on the existing work of the Storm to Shade program to encourage green infrastructure.



**E-4.7**

Develop additional incentives and reduce permitting fees for residents and businesses to install solar PV and/or energy storage systems.

**T-4**

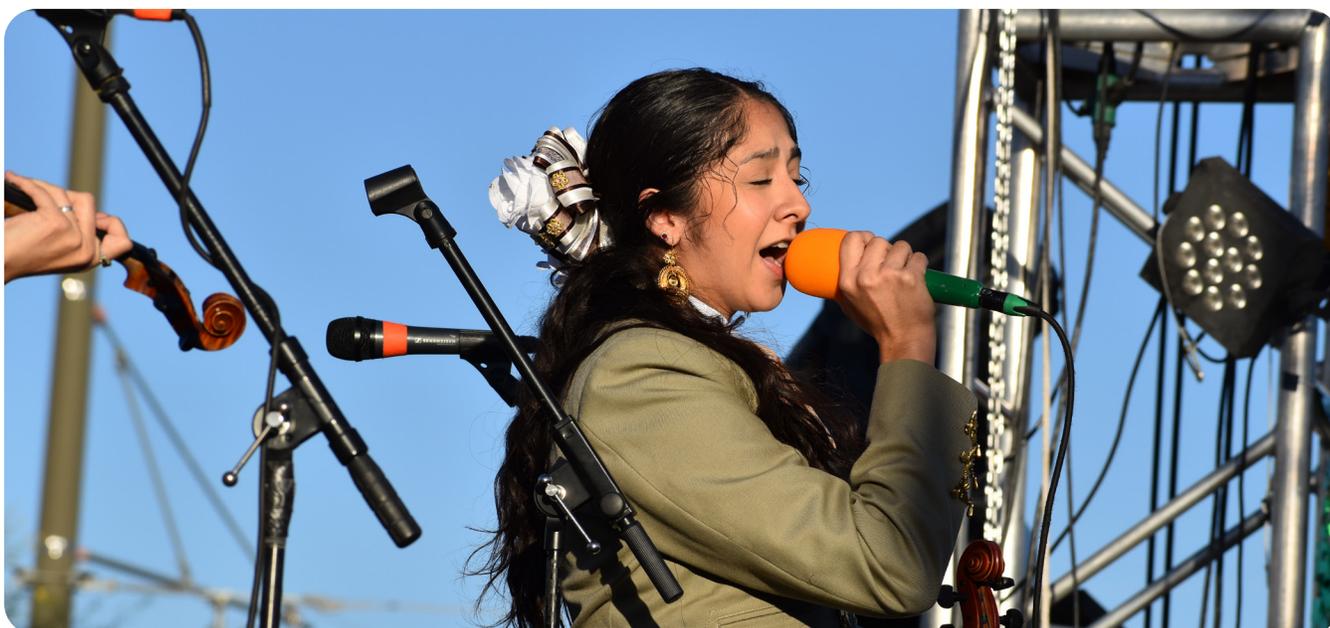
For unavoidable vehicular trips, promote electric vehicles via charging infrastructure expansion, building codes, partnerships, and advocacy.

# Community Resilience



# Community Resilience

Community resilience is the ability of a community to withstand, adapt, and recover from adversity. Building community resilience extends beyond investment in physical infrastructure: a robust network of social services and a strong sense of solidarity and belonging amongst community members are just as important. A community is only as strong as its most vulnerable. An individual's capacity to adapt to climate shocks and stresses varies greatly depending on a range of factors, including access to economic resources, race and ethnicity, health status, gender, living conditions, and surrounding environment. Centering the needs of those impacted first and worst by climate change in our adaptation strategy will ensure fewer lives are radically disrupted by climate hazards. Through developing stronger social and physical systems, we can collectively build a more resilient Tucson for all.



## Current Status

The City is proactively addressing its flooding and extreme heat concerns through expanding green infrastructure citywide. Tucson Water has partnered with Tucson Clean & Beautiful, a community non-profit organization, to create the Green Stormwater Infrastructure Mini-Grant (GSI Mini-Grant) program, which gives neighborhood groups the resources they need to lead green infrastructure projects in their own communities. Mayor Regina Romero launched the Million Trees Initiative, pledging to plant one million trees by 2030 in frontline communities. The Green Streets Policy sets stormwater harvesting, tree cover, and shrub and grass cover standards for all publicly-funded new and redeveloped roadway projects.

The city's water utility, Tucson Water, incorporates resilient principles into its decision-making and planning. Tucson Water is preparing the One Water 2100 Master Plan which will provide guidance on how the utility can adapt and manage water resources over the next century. This includes reducing dependence on Colorado River water, increasing use of recycled water, and prioritizing the equitable distribution of resources. Tucson Electric and Power

ranks in the top quartile of electric utilities across the nation for service reliability. Just from 2019 to 2022, TEP invested \$432 million in upgrades to the energy grid and \$148 million in improvements to the transmission system to ensure resiliency during extreme temperatures and extreme storms.

Public communications and community engagement around extreme heat, flooding, and wildfire risk are all critical for maintaining public safety during a crisis. During monsoon season, Tucson Department of Transportation and Mobility distributes barricades and signage for flooded roadways and offers self-serve sandbags to residents.

## Focus Areas and Priorities

The City will focus its resilience efforts on the following themes:

**Mitigate:** Introducing resilient infrastructure into our environment minimizes the impact of climate hazards. Tree coverage, green roofs, and bioswales offer nature-based solutions that mitigate the urban heat island effect.

**Prepare:** Climate-informed planning is essential for maintaining future public safety. Establishing a network of resilience hubs with inclusive resources ensures Tucson communities are prepared to navigate a climate emergency.

**Respond:** Community outreach and robust social services build necessary social cohesion. Mutual aid networks and mobile cooling resources address the needs of vulnerable populations during a climate event.

Figure 14. Tree Coverage Comparison in Tucson



*South Liberty Avenue in Southside*



*East 3rd Street in Sam Hughes*

# What We've Heard

The primary driver of Tucson Resilient Together is community-wide concern about climate change, and at the heart of all of the experiences, perspectives, and recommendations that have been shared by Tucsonans has been a desire to actualize a more climate-resilient Tucson. While other segments of this roadmap include a mix of municipal and community-based initiatives, this particular segment is different in that it is entirely community-focused, and thus most of the strategies and actions here are sourced from or have been affirmed by Tucsonans.

Community members have spoken to resilience hubs and cooling centers persistently, specifically speaking to the lack of these resources in some of the neighborhoods that lie furthest from the downtown area (which was affirmed by our climate vulnerability and risk assessment). They've also expressed a real need and desire for resources that not only direct residents to places and support whether there is an ongoing extreme event or not, but also are both culturally competent and accessible. Strategy CR-1 addresses this feedback, focusing on building out resilience hubs and resources to support climate preparedness and response across Tucson.

While residents shared their concerns with each other regarding various climate hazards, extreme heat has been the most tangible and pervasive in our conversations with Tucsonans. For many Tucsonans, this is one of their greatest, shared experiences, but it is also one of their most significant fears. Community members expressed particular concerns for outdoor workers and for individuals with health conditions who are particularly vulnerable to the heat and are at greatest risk of heat-induced illness. The most commonly suggested solution was increased shade, whether it be through tree canopy or constructed shade canopy, in as many areas around Tucson as possible with a focus on the areas that are most lacking. They also shared that protection from extreme heat is especially important for many of them who depend on public transit or walk or bike to work, and thus shade protection at transit stops, along pedestrian walkways, and bike paths was common amongst suggestions. Strategy CR-2 addresses many of these concerns, focusing on heat mitigation through increased shade, climate-resilient design,

resource-sharing, and partnership with public transit services.

"Tree" may have been the most frequently said and written word across all of our conversations with community members. Many Tucsonans commended the Million Trees Initiative but shared there was still a need for tree cover, vegetation, and other nature-based solutions across the city to protect them from heat and other hazards such as flooding. Strategy CR-3 builds upon the City's existing efforts and is intended to expand and drive them forward.

Finally, another consistent thread across all areas of action in this plan has been about communication and resources, in the context of both access to education, incentives, and programs, as well as access to information and protocols during extreme climate events. In relation to conversations about heat and other climate hazards, many Tucsonans voiced concerns about limited communications and limited reach to particularly vulnerable populations, such as unhoused individuals, the elderly, and those with disabilities. Some of the suggestions we received focused around partnering with neighborhood associations, businesses, and community-based organizations to build community-wide infrastructure and networks that specifically support those populations during emergencies. Strategy CR-4 encompasses many of these suggestions, focusing on bolstering networks to aid in community-wide emergency response as well as broader resource sharing.

**+ cooling centers**

**+ resilience hubs**

**+ shade canopy**

**+ targeted outreach**

# CR Community Resilience

**CR-1 Establish accessible resilience hubs across all Wards to provide information and resources related to climate preparedness and response**

The City will work to identify areas for and establish resilience hubs across Tucson, with support and guidance from the Pima County Health Department, community members, and City staff. These resilience hubs will come equipped with resources that are culturally competent and accessible in multiple languages and formats for Tucson residents.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Planning and Development Services	Communications Division Housing and Community Development Real Estate	Pima County Health Department School districts Community-based organizations Neighborhood and homeowners associations Faith-based institutions	1-5 years		\$ - \$\$\$\$

Action #	Action
CR-1.1	Establish one or more resilience hubs - in partnership with schools, community-based organizations, neighborhood and homeowners associations, and faith-based institutions - to ensure that surrounding and vulnerable communities are better prepared for climate-related emergencies.

Action #	Action
CR-1.2	Work with Pima County Health Department to develop guidance, specifications, and best practice recommendations for accessibility, amenities, and programming of resilience hubs.
CR-1.3	Develop guidelines and/or procedures for emergency response protocols, resource mobilization and availability, and transportation for residents to and from the future resilience hubs.
CR-1.4	Create multi-lingual, multi-format resources to distribute and share with Tucson residents regarding resilience hubs and associated programs.



CR-2

## Bolster City-owned and community-wide heat mitigation resources to reduce the urban heat island effect and protect vulnerable individuals and communities

The City will move forward with a comprehensive urban heat mitigation strategy, looking to supplement its existing efforts by expanding and installing shade, cool pavements and roofs, and other technologies to mitigate urban heat. The City will also look to provide additional cooling resources – both stationary and mobile – to make sure that everyone has access, especially on high-heat days. We will also coordinate with Sun Tran and other public transit services to help Tucsonans connect with and navigate to these resources.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Planning and Development Services	Community Safety, Health & Wellness team Environmental and General Services Procurement Sun Tran	Neighborhood and homeowners associations Developers Employers	1-5 years		\$\$\$\$

Action #	Action
CR-2.1	Develop a comprehensive urban heat mitigation strategy and implementation plan that addresses shade equity, pavement prevention and reduction, cool roofs and surfaces, and urban greening.
CR-2.2	Install and maintain additional shade canopies, playground shade structures, shade trees, splash pads, drinking water fountains and/or water bottle filling stations in areas of greatest need.
CR-2.2	Work with the City's Community Safety, Health & Wellness team and social service providers to increase access to stationary and mobile resources such as bathrooms, showers, kitchens, and laundry facilities in parks and public spaces that can be activated to support community resilience during emergencies.
CR-2.4	Pilot high-albedo (or light-color and heat-reflective) surfaces on buildings, roadways, sidewalks and paths, and parking lots at City-owned properties.
CR-2.5	Create climate-resilient design codes and standards for residential, commercial and institutional, and industrial buildings, including standards for landscaping (e.g., tree canopy, green infrastructure) and architecture (e.g., passive design to support thermal comfort and air quality).
CR-2.6	Create climate-resilient design codes for buildings with a focus on energy efficiency, including but not limited to specifications for low-income weatherization, air conditioning, and enhanced filtration for wildfire smoke.

Action #	Action
CR-2.7	Expand current standards for shade trees in parking lots to include higher level requirements or additional options for solar or shade canopies.
CR-2.8	Provide resources, training, and discussion spaces for employers and workers that encourage and support protection from extreme heat.
CR-2.9	Work with Sun Tran and other public transit services to create a cool corridor network that connects people to cooling resources during high-heat days and extreme heat events.



**CR-3**

## Deploy and maintain equitable nature-based solutions that reduce or sequester emissions, improve ecosystem health, and bolster climate resilience

Building upon its existing green infrastructure and urban forestry initiatives, the City will utilize nature-based solutions to support emissions sequestration and bolster climate resilience community-wide. Actions include completing an urban tree inventory and mobilizing public, central spaces such as our Ward offices to deploy these solutions.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
City Manager's Office Mayor's Office	Environmental and General Services Tucson Water	Community-based organizations	Ongoing		\$\$ - \$\$\$

Action #	Action
CR-3.1	Advance the Tucson Million Trees initiative with a continued focus on native and contextually appropriate tree species, tree equity, and water conservation around Tucson.
CR-3.2	Complete an urban tree inventory and implement an urban forest master plan that builds upon Tucson Million Trees.
CR-3.3	Identify opportunities at City-owned facilities for nature-based solutions such as green roofs, pollinator gardens, and rain gardens with a focus on Ward offices, parks, and greenways as examples of these solutions in practice.
CR-3.4	Identify community-wide opportunities for nature-based solutions to mitigate flooding, such as land or watershed restoration projects.
CR-3.5	Coordinate with community-based organizations such as co-operative farms to incorporate urban agriculture and community farming across Tucson.

## CR-4 Bolster community and regional networks to improve community-wide emergency response and resource-sharing

Tucson will turn to its community partners and stakeholders to enhance and expand existing networks around emergency response and resource-sharing. Approaches include trainings for community emergency response teams, coordinating with local businesses for emergency response, and developing mutual aid networks and preparedness plans to support residents in need during extreme events, particularly older adults, people without access to air conditioning, and people living in mobile/ manufactured homes.

Lead Implementer(s)	Supporting Implementer(s)	Partners	Timeframe	Emissions Reduction Potential	Cost
Housing and Community Development	All departments	Neighborhood and homeowners associations Resident and tenant associations Local businesses	Ongoing		\$

Action #	Action
CR-4.1	Conduct trainings with neighborhood and homeowners associations, resident and tenant associations, and other local groups to share information about the City's climate resiliency programs and form community emergency response teams (CERTs).
CR-4.2	Work with business organizations, retailers, and small stores to build capacity to sustain neighborhoods and ensure continued operations during and after an extreme climate event or natural disaster.
CR-4.3	Collaborate with community partners to develop mutual aid networks or "buddy" programs to identify vulnerable individuals, check on them during extreme climate or weather events, and connect them to food, water, and other necessities.
CR-4.4	In coordination with existing Community, Safety, Health & Wellness programmatic efforts, develop and provide training for City staff and emergency responders to support residents and connect them to resources during extreme events.
CR-4.5	Work with Tucson's business community to proactively establish Heat Illness Preparedness Plans and create an advisory group with particular attention to people who work outdoors and within warehouses and other unconditioned buildings.
CR-4.6	Pursue additional projects to improve interconnectivity and community-wide resilience, such as expanding broadband access.

# From *Ideas* to *Actions*



The process for developing *Tucson Resilient Together* involved an extensive community engagement process in collaboration with seven community partners. See how ideas from a workshop with **Southside Workers Center** translate into the final plan.

**G-3.1** Develop multilingual, culturally competent climate action toolkits that include information about (a) how to prepare for and respond to climate-related emergencies and stressors and (b) the benefits of building electrification and electric vehicles, and (c) how to procure affordable materials and labor for building retrofits, green infrastructure projects, and more.

## What's missing? ¿Que falta?

UN-TV. en la Area principal para informarnos de lo que ocurre en el mundo

que abran mas Centros comunitarios para que las personas cuiden cuando esta asiend mucho calor

Que ha mas informacion de Emergencia

Buscar llegar desde las fuentes informetruas (gobierno) a las comunidades mas vulnerables por medio de los canales mas rapidos que son redes sociales, paginas web y mensajes sms

Actualizar la forma en la que se propaga la informacion.

**CR-2** Bolster City-owned and community-wide heat mitigation resources to reduce the urban heat island effect and protect vulnerable individuals and communities.

**CR-4** Bolster community and regional networks to improve community-wide emergency response and resource-sharing.

# BLACK LIVES MATTER

END RACISM

BLM

By: Nolan Peterson  
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A group of people are seated around a table in what appears to be a meeting or workshop. The scene is overlaid with a semi-transparent blue filter. In the foreground, a blue water bottle with a white logo is on the table. A man with glasses and a name tag is visible on the right side of the frame, looking towards the left. Other participants are partially visible in the background, some looking at documents or talking.

# Implementing Tucson Resilient Together



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# 6 Implementing Tucson Resilient Together

*Tucson Resilient Together* is an ambitious, climate- and equity-centered plan, but without a concerted and intentional implementation process, it will remain unfulfilled. To achieve our carbon neutrality goals and to realize a climate-resilient Tucson, we must treat Tucson Resilient Together as not just a guide, but as a call to action and as a measure of accountability to Tucsonans and the greater global community. As with our approach to the planning process itself, our implementation approach must also be equity-forward. We commit to enacting the measures in Tucson Resilient Together in ongoing partnership with the community organizations and individuals who molded and shaped this plan. This plan and the strategies therein will also be incorporated into the City's forthcoming General Plan update.

## Implementation Plan

All actions listed cannot begin immediately or be implemented concurrently. The City's existing staff and budgetary resources require us to be strategic with how we proceed with and prioritize these actions. As a part of the Tucson Resilient Together planning process, we ran these strategies through cost-benefit and multi-criteria decision analyses, accounting for climate mitigation and adaptation potential, equity and environmental justice, financial resources, and implementation feasibility, to determine which broader strategic areas are expected to have the greatest impact in the shortest amount of time.



## Multi-criteria decision and cost-benefit analyses and findings

To inform the implementation of Tucson Resilient Together, the strategies and actions presented in this plan were selected and filtered through multiple analyses. First, they were filtered through a multi-criteria decision analysis, which is designed to first select which actions or projects the City of Tucson should pursue based on the priorities of its stakeholders and how much weight or importance is assigned to those priorities by stakeholders. The results of this analysis are evident, in part, in the Climate Action and Adaptation Roadmap chapter, which lists the strategies and actions that the City intends to pursue. In addition, the strategies identified to be of highest priority are outlined in this chapter.

After strategies and actions were identified, the highest-priority actions underwent a cost-benefit analysis, which not only considers the financial ramifications of pursuing certain strategies, but also folds in co-benefits from those strategies. This more holistic approach to cost-benefit analysis allows it to consider actions in their true context. For example, while building and transportation electrification may be more expensive relative to other strategies, they also yield significant GHG and air pollutant emissions reductions, improving health outcomes for communities across Tucson and reducing corrective or remedial costs in the long-term. The findings of this analysis are also in part evidenced in the Roadmap chapter, where each strategy is assigned an expected cost and emissions reduction potential. More detailed findings are available in Technical Memos on Tucson's Climate Action Hub and included in the appendices to this plan.

Listed below are the strategic elements that we will prioritize to significantly reduce GHG emissions and support climate adaptation and resilience, considering the benefits and burdens experienced by frontline communities and our responsibility as stewards of taxpayer dollars:

### GRID DECARBONIZATION AND ELECTRIFICATION

Our emissions inventory analyses revealed the substantial contribution of stationary energy from procured electricity and gas, making up a significant majority of emissions from City operations and community-wide. Decarbonizing our grid electricity through community choice energy, power purchase agreements, and/or municipalization is the most substantive and swiftest action we can take to achieve carbon neutrality. Renewable energy is becoming increasingly cost-competitive against fossil energy, and there is plenty of precedent across the U.S. supporting the move towards purchasing 100% renewable power. We must also electrify our buildings and transportation vehicles to maximize the benefits of that renewable power. Decarbonization and

electrification must come hand-in-hand with actions that reduce demand and increase the resilience of the grid to assure that Tucsonans have sustainable and reliable energy – when they need it.

### TRANSIT-ORIENTED DEVELOPMENT, DENSITY, AND AFFORDABLE HOUSING

Conversations with community members and urban planners alike have indicated the need for transit-oriented development, density, and affordable housing. Vehicle-centric urban sprawl has led to a transportation system that is responsible for approximately a third of our community-wide emissions. Electric vehicles and public transit are useful and important tools to reduce emissions from transportation, but the greatest progress will come from shifting our land use and development practices around the principle of a '15-minute city.' This entails



creating residential developments in proximity to transit, neighborhood amenities, and protected walkways and bike paths; moving toward dense and multi-use developments, and; prioritizing affordable and mixed-income housing developments that will give low-income households proximity and access to community resources and mobility services. These actions will reduce GHG emissions and further climate and environmental justice, by significantly reducing harmful pollution from vehicles and improving access to essential services.

### **EXTREME HEAT PROTECTION AND RESILIENCE HUBS**

Through our community survey, Climate Listening Sessions, community dialogues, pop-up events, and workshops, community members strongly and consistently emphasized the need for Tucson to address extreme heat and build community-wide climate resilience. These are the issues that not only exist across the entirety of Tucson, but extreme heat is one of the most threatening climate hazards for frontline communities. The City will prioritize the development and proliferation of extreme heat protection and resources, including continued efforts

to increase tree equity and canopy cover through Tucson Million Trees and installing cooling resources such as splash pads and shade canopies in public spaces where they are lacking. In addition, it is critical that we swiftly build out a network of resilience hubs that not only serve to protect communities from climate hazards but also provide accessible resources in the case of other significant disruptions such as wildfires, floods, grid outages, and extreme weather.

## Monitoring and Evaluation

To achieve the aforementioned implementation priorities, we must create and mobilize assets that will ensure the implementation of Tucson Resilient Together and track its progress. To do this, and as one of our primary strategies, we will establish a climate emergency mobilization office or working group that will be devoted to this plan's implementation. This office or group will be responsible for coordinating amongst departments and community partners toward the implementation of strategies, inclusive of routine meetings or check-ins to monitor intra- and inter-departmental progress on assigned actions.

Furthermore, we will commit to establishing a City-managed GHG emissions inventory process by which City staff is responsible for developing annual inventories for both City operations and community-wide. This action is essential, as an internally managed inventory can better enable staff to track progress and ensure that the City is making strides toward its carbon neutrality goals. It will also help the City prioritize actions over the next several years, balancing other factors with emissions reduction potential. Staff will be responsible for collecting and managing data routinely to ensure that accurate and verifiable inventories are available for evaluation and reporting.

The climate emergency mobilization function, supported by department resources, data, and GHG emissions inventories, will be responsible for evaluating progress on Tucson Resilient Together. This includes working with department heads to integrate implementation progress into performance evaluations as well as to sharing out progress to all City staff. This function or working group shall also periodically determine if any milestone or long-term targets should be modified in Tucson Resilient Together to reflect progress, and consequently shall update the plan at least every four years to incorporate new measures as appropriate.

## Reporting

Recognizing that Tucson Resilient Together is an act of accountability, we will report out on our progress using several approaches. First, we will create a public dashboard on the Climate Action Hub that will feature our emissions inventories, as well as other important progress updates on climate action and adaptation projects, programs, policies, and initiatives. The Climate Action Hub will be updated regularly, and the inventory data will be updated every year as new inventories are prepared.

Second, we will utilize existing mailing lists from our Tucson Resilient Together engagement process and other public list-servs to communicate our progress on a monthly basis (at minimum) to community members and stakeholders. These updates will emphasize progress on the plan, as well as alert residents to resources, upcoming events, and opportunities for engagement with City staff around the implementation of the plan.

Third, we will produce a brief report every two years with a summary of progress on Tucson Resilient Together that will be shared with the public.

Finally, we will identify and participate in third-party reporting platforms to communicate and benchmark our progress to other cities and neighboring jurisdictions. These may include LEED for Cities and Communities, ICLEI ClearPath, C40 Cities, Global Covenant of Mayors for Climate and Energy, and other platforms or networks.

# Conclusion



7

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# 7 Conclusion

In this plan, we described Tucson as a place of confluence, defined as the act or process of merging. We think that is an appropriate word to describe this plan, too. Tucson Resilient Together, first and foremost, is about coming together to meet the challenge of climate change. It is the reason we have brought together Tucsonans from all walks of life, from our youth to our elected officials, from members of the Tohono O'odham nation and the Pascua Yaqui tribe who have called Tucson home for hundreds of generations to our newest arrivals. Tucson is our beautiful home, and we not only share it together, but we share it with plants and wildlife who also face the impacts of a changing climate. We will continue acting together to care for our home.

Tucson Resilient Together also represents the confluence of knowledges and experiences. Here, the perspectives of our community members come together with the responsibilities of our elected officials. Indigenous truths and knowledges come together with those of climate scientists and environmental activists. This confluence is the foundation for this plan and its roadmap to carbon neutrality.

This plan represents a confluence of approaches, methods, and tools to reduce GHG emissions, adapt to climate change, and build community resilience. What we have learned through this process is that there is no one way to address these issues; there is only the urgent need to address them. And in this plan, our collective mind opens not only to new ways of doing things, but to new ways of designing, building, and navigating a city as historic and diverse as Tucson.

And finally, Tucson Resilient Together demonstrates the confluence of climate change, equity, and justice. History has shown that these concepts have not always aligned. Our civic memory includes well-documented histories of privilege, discrimination, prejudice, and oppression. This plan is our earnest attempt to rectify those histories. Through our process, and through our strategies and actions to mitigate and adapt to climate change, we are hopeful that we will be successful in doing just that. And while we know this plan alone will not undo generations of damage, it is the right step forward.

We emerge from this planning process optimistic that our carbon neutrality goals will be achieved. And more importantly, we emerge with a sincere and fervent belief that achieving this plan to the fullest extent possible will prepare us for climate change, create a better world for those who come after us, and instill in all of us the sense that we are - and will always be - resilient, together.

**WHAT HAVE I  
DONE TODAY  
TO END  
CLIMATE CHANGE  
?**

BE THE

# Glossary

8

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# 8 Glossary

## A

<b>Abatement potential</b>	A measurement of the potential to decrease greenhouse gas (GHG) emissions from a particular sector or through an action. The abatement potential is measured in GHG emissions (e.g., tonnes of carbon dioxide equivalent). Also referred to as <i>Emission Reduction Potential</i> .
<b>Active Transportation</b>	A mode of transportation that includes walking, running, cycling, scootering, skateboarding and other human-powered forms of transportation. It can also include low-speed electrical devices such as motorised wheelchairs, e-scooters and electric-assist bicycles. Also referred to as <i>Active Mobility</i> or <i>Non-Motorised Transport</i> .
<b>Activity data</b>	A quantitative measure of a level of activity that results in GHG emissions. Activity data is multiplied by an emission factor to derive the GHG emissions associated with a process or an operation. Examples of activity data include kilowatt-hours of electricity used, the quantity of fuel used, the output of a process, hours equipment is operated, and distance travelled.
<b>Adaptation</b>	The potential or ability of a system, region, or community to adapt to the effects or impacts of climate change.
<b>Adaptive Capacity</b>	The potential or ability of a system, region, or community to adapt to the effects or impacts of climate change.
<b>Albedo</b>	The reflectivity of solar radiation of a surface or object. High albedo surfaces can reflect sunlight and absorb less heat.

## B

<b>Baseline year</b>	A historical datum (e.g., year) against which a city's emissions are tracked over time.
<b>Baseline year emissions goal</b>	A mitigation goal that aims to reduce or control the increase of emissions relative to an emissions level in a baseline year.
<b>Baseline forecast</b>	A GHG emissions scenario based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in progress and/or those that are planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Also referred to as <i>Business-as-Usual Scenario</i> .
<b>Benchmarking</b>	The process of measuring performance of a certain metric and comparing to similar cases in order to identify areas for improvement.

<b>B</b>	
<b>Biodiversity</b>	The variety and variability of flora, fauna and ecosystems. Biodiversity can be observed on macro levels, micro levels, and in-between. Biodiversity is complex, fragile, and increasingly threatened by urbanization and climate change. Rich biodiversity supports many aspects of human life from food and medicine to environmental quality.
<b>Biogas</b>	A by-product of the breakdown of organic matter in an oxygen-free environment like a sanitary landfill, an anaerobic biological reactor, or fermentation tank. Biogas is a combustible compound composed primarily by methane and carbon dioxide and can be processed to be used as fuel for turbines to generate electricity.
<b>Bus rapid transit (BRT)</b>	Similar to a train or underground system, a bus rapid transit system is a service where buses run on a separate, dedicated right-of-way from other road traffic flows. The systems often include enhanced stations, off-board fare payment, signal prioritisation and other measures intended to improve efficiency, reliability and customer experience.
<b>Business-as-Usual (BAU) Scenario</b>	See <i>baseline forecast</i> .
<b>C</b>	
<b>Carbon neutral</b>	<p>Global carbon neutrality is achieved when anthropogenic CO<sub>2</sub> emissions are balanced by anthropogenic carbon dioxide removals over a specified period.</p> <p>A city has achieved carbon neutrality when it has demonstrated net-zero GHG emissions in a given year from:</p> <ul style="list-style-type: none"> <li>• Fuel use in buildings, transport, and industry (scope 1)</li> <li>• The use of grid-supplied energy (scope 2)</li> <li>• The treatment of waste generated within the city boundary (scope 1 and 3)</li> </ul> <p>And, where a city accounts for additional sectoral emissions in their GHG accounting boundary, net-zero GHG emissions from all additional sectors in the GHG accounting boundary. Also referred to as Emissions Neutral, Net-Zero Emissions, or Net-Zero Carbon.</p>
<b>Carbon offsets</b>	<p>A carbon offset is a reduction in emissions of carbon dioxide or other greenhouse gases made in order to compensate for ("offset") an emission made elsewhere.</p> <p>For cities, carbon offsets are a mechanism for cancelling out -- in accounting terms -- residual GHG emissions by developing, funding, or financing carbon credit projects (and retiring associated credits) that avoid or sequester GHG emissions outside of the city GHG accounting boundary and exhibit environmental integrity principles. Cities must retain the beneficial ownership rights to the GHG emission reductions claimed from the project, and those reductions must be retired or otherwise cancelled, such that they may not be used again.</p>
<b>Climate action</b>	Any policy, program, project or activity initiated with the intention to provide some contribution to climate mitigation or adaptation.
<b>Climate action plan</b>	A strategic document (or series of plans and documents) that demonstrates how a city will deliver on its commitment to address climate change.
<b>Climate change</b>	A long-term shift in global climate patterns predominantly caused by human activities. Often, climate change refers specifically to the rise in global temperatures from the mid-20th century to present that is attributed to anthropogenic, or human-induced, greenhouse gas emissions.
<b>Climate hazard</b>	A short or long-term climate event that have the potential to cause damage or harm to humans and natural systems. These include meteorological, climatological, hydrological, geophysical, and biological events. Examples include wildfires, flooding, and extreme temperatures.

## C

**Climate vulnerability assessment**

An analysis of the extent to which a species, habitat, ecosystem or civilization is susceptible to harm from climate hazards. Vulnerability assessments are essential for informing the prioritization of actions and investment into climate adaptation and resilience.

**Co-benefit**

A non-greenhouse gas reduction benefits of a climate action. Measuring co-benefits examines how climate action is interrelated with and delivers outcomes for provision of basic services, health, prosperity, equity, and other sustainable development agendas.

**Carbon dioxide equivalent (CO<sub>2</sub>e)**

The universal unit of measurement to indicate the global warming potential (GWP) of each GHG, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate the climate impact of releasing (or avoiding releasing) different greenhouse gases on a common basis.

**Composting**

A controlled process to break down organic matter sourced from separated waste or agricultural residues in aerobic conditions to stabilize the biological activity or organic matter to reduce its environmental impact and produce usable by-products like soil amendments, filling material and biofertilizers.

**Community-based organization (CBO)**

A public or private not-for-profit resource hubs that provide specific services to the community or targeted population within the community.

**Consumption-based emissions**

A greenhouse gas accounting approach that captures direct and lifecycle GHG emissions of goods and services (including those from raw materials, manufacture, distribution, retail, and disposal) and allocates GHG emissions to the final consumers of those goods and services, rather than to the original producers of those GHG emissions.

**Cool surface**

High albedo, or reflective surface, that reflects more light and traps less heat than a conventional surface and helps to mitigate the heat island effect. Examples include cool roofs, green roofs, and light-colored pavement and roads.

**Cooling center**

A community facility that offers relief from extreme heat and keeps people safe from severe temperatures. These spaces also provide other important resources such as potable water, toilets, medical attention, or social services.

## D

**Decarbonization**

Process of reducing embodied or operational GHG emissions. Typically refers to a reduction of the carbon emissions associated with energy consumption, industry, and transportation.

## E

**Electrification**

The process of transitioning away from technologies that use fossil fuels to technologies that use electricity. Electrification of systems paired with a power grid with 100% renewable energy sources can significantly reduce GHG emissions.

**Embodied carbon**

In the built environment, embodied carbon refers to the GHG emissions related to the extraction of raw materials, their manufacturing, assembly during construction, any maintenance or replacements, the disassembly and demolition and any associated transport, waste and end of life impacts. Also referred to as Embodied Emissions.

**Emissions factor (EF)**

A multiplier that converts activity data into GHG emissions data (e.g., kg CO<sub>2</sub> emitted per liter of fuel consumed, kg CO<sub>2</sub>e emitted per kilometer travelled) or other outcomes (beyond GHGs) such as PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>, etc.

## E

<b>Emissions scenario</b>	Greenhouse gas emissions projected based on a set of economic, technological, and behavioral changes over time. Also referred to as Emissions Forecast, Emissions Trajectory, or Emissions Reduction Scenario.
<b>Emission reduction potential</b>	A measurement of the potential to decrease GHG emissions from a particular sector or through an action. The abatement potential is measured in GHG emissions (e.g., tons of carbon dioxide equivalent).
<b>Energy efficiency</b>	The use of less energy to provide the same function or service. A process, building, machine, or other energy-consuming object is more energy efficient if it delivers more functions or services for the same energy input or the same function or service for less energy input, compared to a conventional process.
<b>Energy efficiency retrofits</b>	The process of upgrading inefficient equipment or appliances by replacing them with more efficient systems or appliances. These retrofits can also involve building upgrades such as insulation changes and envelope improvements to reduce heating and cooling demand.
<b>Energy storage system</b>	Technologies that collect generated energy so it may be used at another time. Energy storage includes electric systems such as batteries as well as thermal systems such as hot or cold water storage tanks. Energy storage can enhance the technical and economic viability of a distributed generation system, balance fluctuations in renewable generation, and operate critical systems during grid outages and emergency events.
<b>Energy use intensity (EUI)</b>	The amount of energy consumed by a building over a period of time and normalized by another factor, such as per square foot or per person. These factors allow for the comparison of building performance across buildings of different types and sizes. Also sometimes referred to as <i>Building Energy Intensity</i> .
<b>Envelope efficiency</b>	Designing the thermal envelope of a building to minimize energy use by reducing the heating and cooling demands. A passive design strategy will typically reduce air leakage, install thermal insulation, and will optimize glazing design to manage solar heat gains. Good envelope efficiency can extend the life of mechanical equipment and is cost-effective at the time of construction, but it can be difficult and/or costly to retrofit into existing buildings.
<b>Equity</b>	The absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically or geographically. As opposed to the concept of equality where everyone is given equal access, equity provides proportional access to redress historical and current disparities and ensure the same level of opportunity for all.
<b>Exposure</b>	The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas or areas with high levels of pollution or toxic substances.

## F

**Fossil fuels**

Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil and natural gas, that emit greenhouse gases and other pollutants when combusted and/or leaked into the ocean, groundwater or atmosphere.

**F**

**Frontline communities**

Communities that experience the “first and worst” impacts of climate change. These include, but are not limited to, youth, older adults, women, LGBTQIA+ individuals, BIPOC individuals, documented and undocumented immigrants, people with disabilities and chronic illnesses, people experiencing homelessness, victims of domestic violence and human trafficking, people experiencing linguistic isolation, outdoor workers, and those with limited access to transportation, critical infrastructure, and/or municipal services.

**G**

**Global Protocol for Community-Scale GHG Emissions Inventories (GPC)**

The GPC is a protocol developed by C40, World Resources Institute and ICLEI-Local Governments for Sustainability. The GPC outlines standards for developing a GHG emission inventory, establishing a base year, ensuring consistent methods for reporting, enabling aggregation at the national level and facilitating benchmarking.

**Global warming potential (GWP)**

A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO2.

**Green economy**

An economy powered by renewable energy sources, where economic production minimizes waste and hazardous by-products, improves social equity, and prioritizes ecological restoration.

**Green infrastructure**

The use of natural capital and ecosystem services to help people manage urbanization and adapt to the adverse effects of climate change. Often associated with water management practices which protect, enhance, or mimic the natural water cycle, green infrastructure can include green roofs, rain gardens, and other measures that capture, filter, and make beneficial use of stormwater. Green infrastructure is also inclusive of other natural and semi-natural features such as trees, low-water use plants, parks, and forests.

**Green jobs**

Employment opportunities that support a green economy, the transition to renewable energy sources, and ecological restoration. See also *Green Economy*.

**Greenhouse gas (GHG) emissions**

Gases that trap heat in the atmosphere by absorbing and emitting solar radiation within the atmosphere, causing a greenhouse effect that warms the atmosphere and leads to global climate change. GHGs include seven gases: carbon dioxide (CO2); methane (CH4); nitrous oxide (N2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF6); and nitrogen trifluoride (NF3). Also sometimes simply referred to as *Carbon Emissions*.

**Greenhouse gas inventory**

A quantified list of a city’s GHG emissions and sources.

**H**

**Hard-to-reach**

Those groups or individuals within a society that typically underrepresented in the engagement process or have limited capacity to be involved.

**Houseless or homeless**

Lacking or in need of a house or home; sometimes referred to as unsheltered or transient. People experiencing homelessness are also described as individuals or families who lack a fixed, regular, and adequate nighttime residence.

**I**

**Impacts**

The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social, and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes and can be adverse or beneficial.

**I**

**Impervious surfaces** Solid surfaces, such as paved roads and car parks, which do not allow water to penetrate the ground below.

**Inclusive climate action** Action ensuring that efforts to address climate change help create sustainable cities for all. Climate change is not solely an environmental issue but is inextricably linked to challenges of eradicating poverty and increasing inclusiveness.

**Indicator** A means of measuring the state or level of an impacted phenomenon. Indicators are expressed using metrics which define their units of measurement. For example, air quality is measured by the concentration of certain particles or molecules in the air, such as milligrams of particulate matters per cubic meter of air or parts-per-million (ppm). Also sometimes referred to as *Key Performance Indicators (KPI)*.

**Interdependencies** Linkages within and across different infrastructure sectors (e.g., energy, transportation, telecommunications, water/wastewater, solid waste and food), and the implications for the provided services caused by the adverse ripple effects from climate change. These ripple effects include an increase in the magnitude and frequency of extreme weather events such as coastal and inland flooding, heatwaves, droughts, and wildfires. Identifying infrastructure interdependencies and climate impacts can serve as a first step in reducing risks to systems. Infrastructure interdependencies can be categorised into four main types: physical, cyber, geographic, and logical.

**J**

**Just transition** Established by labor unions and environmental justice groups, Just Transition is a vision and framework for social change that builds economic and political power to shift from an extractive economy to a regenerative economy while providing just pathways for workers to transition to quality jobs. Its principles, processes, and practices may apply to a sector, city, region, or economy.

**L**

**Low carbon materials** Types of materials with low embodied emissions which include:

- Materials from renewable bio-based sources, such as timber, bamboo, cork, straw, hemp, earth and natural fiber;
- Innovative materials manufactured with low process and energy emissions;
- Reused materials;
- Materials with high recycled content

**M**

**Microgrid** A decentralized electrical distribution network that is connected to distributed energy sources and loads and can enter into “island mode” (i.e., operating independently from the centralised electric grid) in the case of emergency or other need.

**Mitigation** The process of limiting greenhouse gas emissions for the purposes of lessening the impacts of climate change.

**Mode share** A number or percentage of users or trips, using a particular type of transportation such as driving a single-occupancy vehicle, carpooling, riding public transit, walking or cycling.

## M

**Mode shift**

The transition from using one habitual form of travel, or mode, to another. Transportation modes include mass transit, non-motorized transit and automobiles.

**Monitoring, evaluation, and reporting (MER)**

The long-term process for delivering a climate action plan demonstrated through a process of setting key performance indicators, ongoing monitoring, impact evaluation and progress reporting.

**Monitoring** is the continuous, systematic collection of data on specified indicators to provide management of an ongoing intervention.

**Evaluation** is the process by which a city assesses and understands changes over time, measured by indicators and against the baseline. Contrary to monitoring, which is ongoing, evaluation is conducted periodically.

**Reporting** is the process of presenting monitoring data and analysis to stakeholders for information and/or knowledge-sharing. Reporting may be used to inform program management, demonstrate accountability, raise funds or promote wider learning.

## N

**Nature-based solutions (NBS)**

Actions designed to utilize natural systems to address challenges. These solutions often aim to restore ecosystems, address climate change, and provide human health and biodiversity benefits simultaneously. For example, one solution could be to restore wetlands in catchment areas to minimise the impact of flooding

**Net-zero carbon**

A building where the annual carbon dioxide emissions associated with operations are zero or negative. Net zero carbon buildings are highly energy-efficient and are often fully powered by on-site or off-site renewable energy sources. See also **Carbon Neutral** and **Decarbonization**.

## O

**Organic waste**

Biodegradable waste containing materials from living organisms. Organic waste may include food waste, garden and park waste, non-hazardous wood waste and sludge, that can be processed through composting or anaerobic digestion. Disposed organic waste is the primary source of GHG emissions from the waste sector. When disposed of in a landfill, organic waste produces methane, a powerful GHG with 87 times the global warming potential of CO<sub>2</sub> in the first 20 years after its release.

## P

**Particulate matter**

A mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. Smaller particles are more harmful to health. PM<sub>2.5</sub> is a term for all particles with a diameter of <2.5 um (microns/micrometres). PM<sub>2.5</sub> and PM<sub>10</sub> are measured in concentrations of ug/m<sup>3</sup> (mass of particles per cubic meter of air).

**Paris Agreement**

An agreement reached under the United Nations Framework Convention on Climate Change (UNFCCC), adopted in December 2015 at the Conference of the Parties (COP) to the UNFCCC. The agreement was adopted by 196 signatories that commit to working together to limit the increase of global average temperature well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In Deadline 2020, science-based targets were developed for cities that aim to align with the global maximum target of 1.5°C temperature rise. Signatories commit to reducing their GHG emissions through Nationally Determined Contributions (NDCs), including regular reporting of emissions efforts and implementation reports.

**R**

<b>Recycling</b>	The process through which waste materials are converted into new materials, goods, and products. The recycling process starts by collecting and separating the recyclable materials in the waste stream and aggregating them for further processing.
<b>Renewable energy</b>	Energy that comes from resources which are naturally replenished on a human timescale, such as sunlight, wind, tides, waves, bioenergy, hydropower, and geothermal. Hydrogen is a renewable energy source when produced through electrolysis powered by renewable electricity.
<b>Residual emissions</b>	The emissions remaining after all technically and economically feasible opportunities to reduce emissions in all covered scopes and sectors have been implemented.
<b>Resilience</b>	The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.  City resilience describes the capacity of cities to function so that the people living and working in cities – particularly low-wealth and vulnerable people – survive and thrive no matter what stresses or shocks they encounter. Climate resilience is a subset of resilience describing the capacity of cities to respond to climate hazards and risks.
<b>Risk</b>	Dependent on the likelihood (sometimes referred to as probability) of an event multiplied with the hazard impacts (sometimes referred to as consequences).

**S**

<b>Scenarios</b>	Future greenhouse gas emissions and trends that are expected to occur given a defined set of assumptions. Multiple scenarios are often created for comparison and planning purposes. See also Baseline Forecast, Business-as-usual Scenario and Emissions Trajectory.
<b>Scope 1 emissions</b>	According to the GPC Protocol, GHG emissions from sources located within the city boundary.
<b>Scope 2 emissions</b>	According to the GPC Protocol, GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam, and/or cooling within the city boundary.
<b>Scope 3 emissions</b>	According to the GPC Protocol, all other GHG emissions, besides scope 1 and 2, that occur outside the city boundary as a result of activities taking place within the city boundary.
<b>Shocks and stresses</b>	Shocks are sudden events that threaten or impact a city’s immediate well-being such as earthquakes, fires, landslides, public health emergencies, civil unrest, or financial crises. Stresses are longer-term, chronic challenges that weaken natural, built, and economic or human resources such as inequity, crime, and violence or disparities in employment, health, and education.
<b>Social infrastructure</b>	The services and programs that support quality of life such as: recreation, day care, outreach to people experiencing houselessness, newcomer/ immigrant services, healthcare services, educational facilities, mobility options, and others.
<b>Sustainability</b>	The ability to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

<b>T</b>	
<b>Transit-oriented development</b>	A planning strategy that explicitly links land-use and transportation by focusing on mixed housing, employment, and commercial growth around transit nodes. TODs can reduce the number and length of vehicle trips by encouraging more bicycle/pedestrian and transit trips and can support transit investments by creating the density around stations to boost ridership. Also sometimes referred to as Transport-Oriented Development.
<b>Transportation demand management (TDM)</b>	Strategies to change travel behavior in order to reduce traffic congestion, increase safety and mobility, conserve energy, and reduce greenhouse gas emissions. Strategies may include ridesharing, telecommuting, park-and-ride programs, and alternative work schedules.
<b>U</b>	
<b>Urban agriculture</b>	Agriculture practices in urban areas that take the form of back-garden, rooftop, or balcony gardening, community gardening in vacant lots or parks, roadside agriculture, and livestock grazing in open space.
<b>Urban heat island (UHI) effect</b>	A measurable increase in ambient urban air temperatures resulting primarily from the replacement of vegetation with buildings, roads, and other heat-absorbing infrastructure. The heat island effect can result in significant temperature differences between rural and urban areas.
<b>V</b>	
<b>Vehicle miles traveled (VMT)</b>	A measurement of kilometers travelled by vehicles within a specified area for a specified time period. Also sometimes referred to as Vehicle Miles Travelled (VMT).
<b>Virtual power purchase agreement (PPA)</b>	A multi-year bilateral renewable energy contract that does not involve the physical delivery of energy from the vendor to the customer, creating geographic flexibility. Instead, the electricity produced from the renewable project flows directly into its local grid.
<b>Vulnerability</b>	The conditions determined by physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.
<b>W</b>	
<b>Waste diversion</b>	The process to prevent certain streams in solid waste from going to disposal to landfills or incineration, often with the intention of producing usable valuable by-products. Diversion includes source reduction, reuse, recycling, and treatments such as composting or anaerobic digestion.
<b>Waste generation</b>	The total amount of waste created within a city (or by a business or residence), including that which is disposed of and that which is diverted (i.e., recycled, donated, composted).
<b>Waste treatment</b>	The biological, chemical, or mechanical processing of specific waste streams to recover usable resources contained in the waste materials, reduce the environmental impact of such materials, and reduce the amount of waste that is disposed in landfills or treated by incinerators.
<b>Z</b>	
<b>Zero-emission vehicles (ZEV)</b>	Vehicles that produce no tailpipe emissions. Generally, ZEVs feature electric powertrains either from a battery or a hydrogen fuel cell. ZEVs may still be responsible for some greenhouse gas emissions, if the GHG content from the electricity generation comes from fossil fuel sources.

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