

# RESILIENT SAN DIEGO & A PLATFORM FOR OTHER CITIES

CAMERON BERNHARDT // BYRON TO // ERIN JOHNSON // VINCENT TONG



Image Source: Toolkit for Resilient Cities

BUILDING RESILIENT CITIES

# OUTLINE

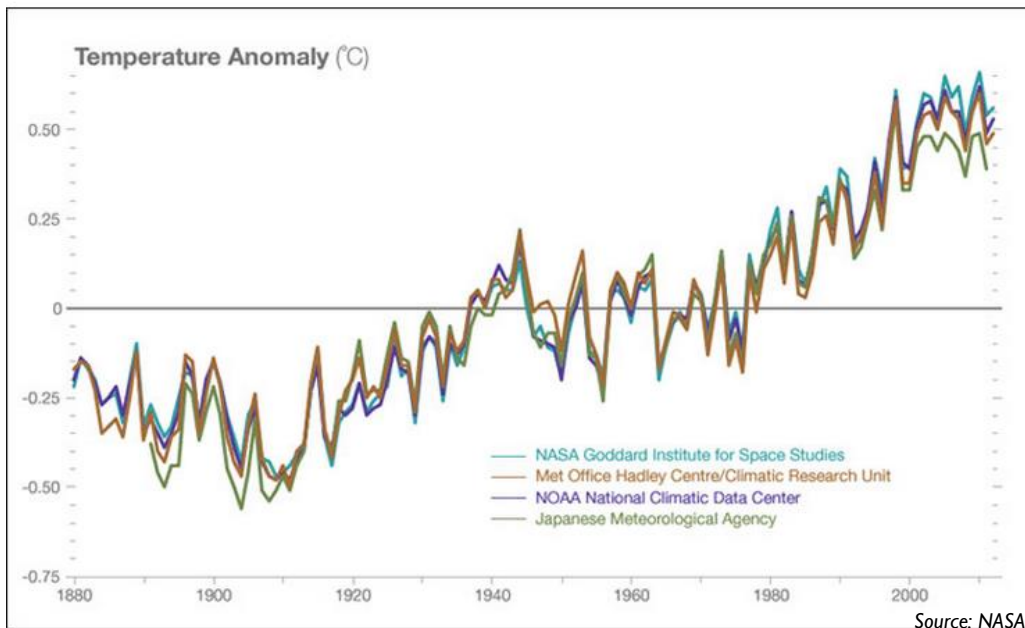
- **What is Resilience?**
- **Risks to San Diego**
- **Understanding San Diego**
- **Critical Systems**
  1. Transportation
  2. Water
  3. Agriculture
  4. Waste
  5. Health
  6. Energy
- **Conclusions**



Image Source: Engineers without Borders

# CLIMATE CHANGE

Consensus: 97% of climate scientists agree



84%

OF SAN DIEGO COUNTY RESIDENTS BELIEVE  
CLIMATE CHANGE IS HAPPENING



“The evidence is incontrovertible: **Global warming is occurring.** If no mitigating actions are taken, **significant disruptions** in the Earth’s physical and ecological systems, social systems, security and human health are likely to occur. We **must reduce emissions** of greenhouse gases *beginning now.*”

American Physical Society

Source: NASA

# WHAT IS RESILIENCY?

**Resilience** – “The capacity of individuals, communities, institutions, businesses and systems within a city to **survive, adapt, and grow** no matter what kinds of chronic stresses and acute shocks they experience.”

## 100 Resilient Cities' 5 Pillars of Resilience



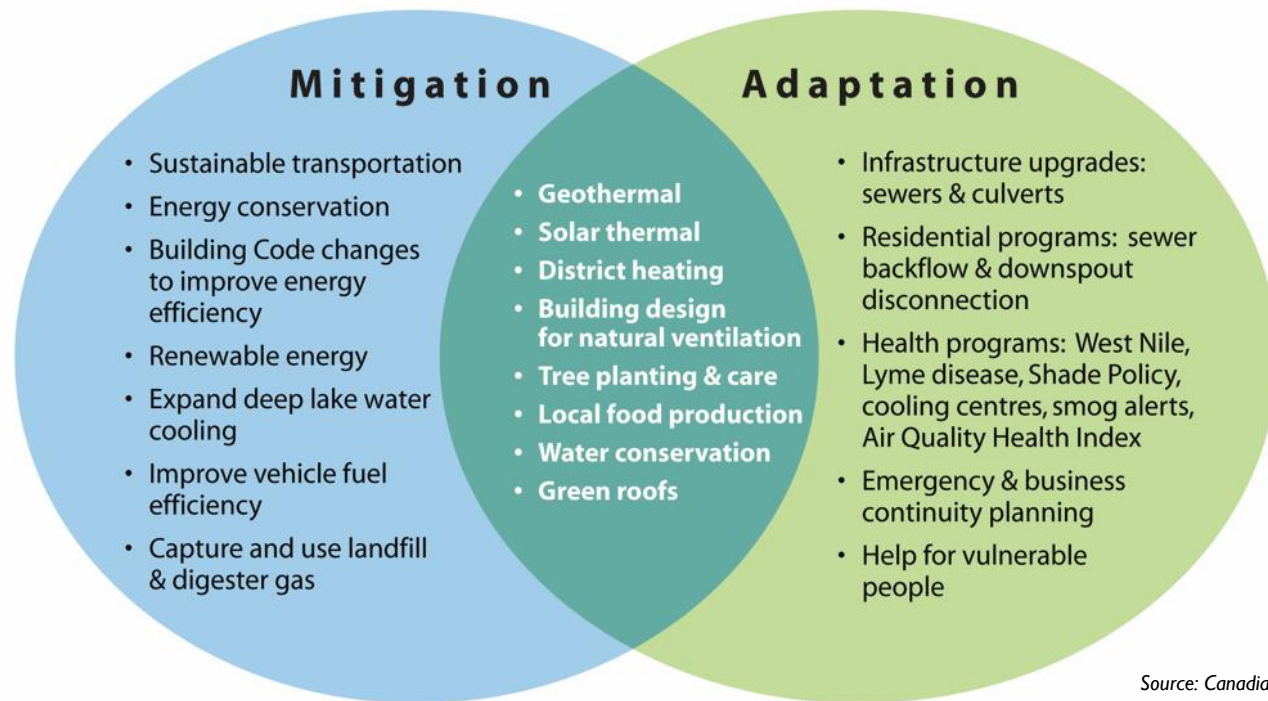
Source: 100 Resilient Cities



# SUSTAINABILITY + RESILIENCY

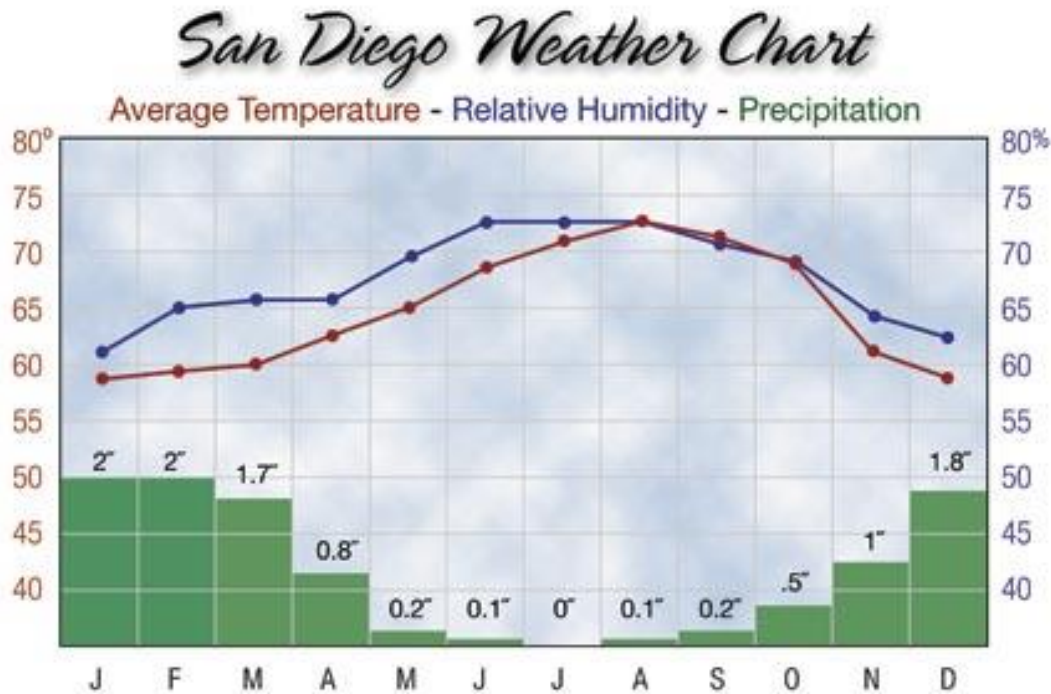
**Sustainability (Mitigation)** – Actions that **meet needs of present without compromising** the ability of future generations to meet their own needs.

**Resilience (Adaptation)** – Actions that increase **ability to respond** to negative impacts of climate change.



Source: Canadian Standard Association

# AMERICA'S FINEST CITY



If there is a single word that describes the San Diego region, it is "paradise." And this paradise is our home.

– Our Greater San Diego Vision 2012

If San Diego really is paradise, then why do we need to worry about climate change?

# RESILIENCY IN SAN DIEGO

“...San Diego is unique in the sense that we are vulnerable to a wide **variety of threats** all at the same time...Most cities have one big threat – a severe storm in New York, a flood in New Orleans, an earthquake in San Francisco. We must deal with **many threats** all at once and figure out how to increase our resiliency on all of them.”

**Bill Fulton**, San Diego Planning Director



Source: U-T San Diego

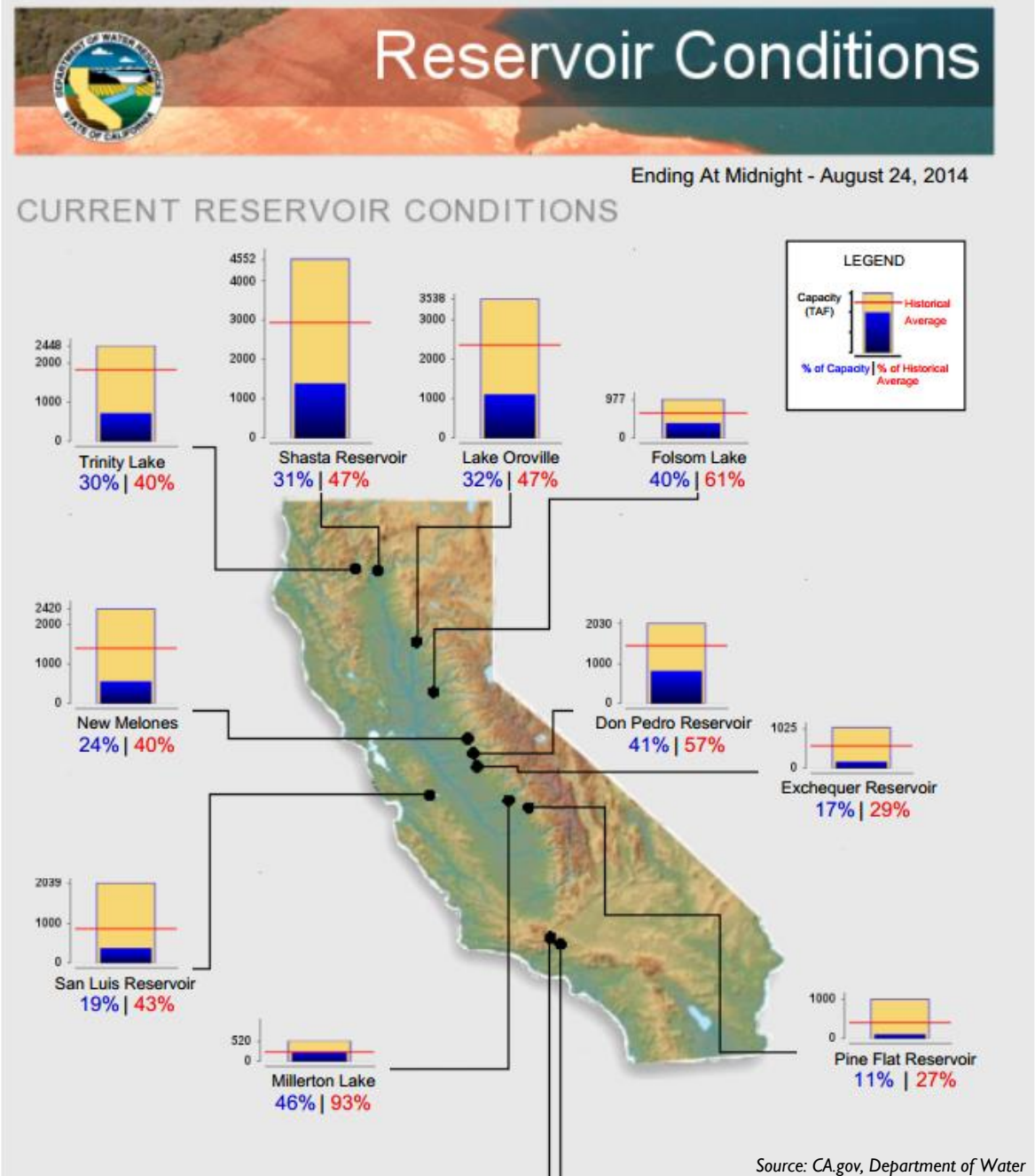
# EVALUATING OUR RISKS

	Frequency (1-5)	Duration (1-5)	Impact (1-5)	Human Loss (1-5)
<b>Drought</b>	4-5	4-5	4-5	1
<b>Wildfire</b>	4	3-4	3-4	2
<b>Flood</b>	1	2	3-4	1
<b>Extreme Temperature</b>	4-5	4-5	3	1
<b>Sea Level Rise</b>	1	4	3	1
<b>Bluff Erosion</b>	1	1	1	1



# DROUGHT

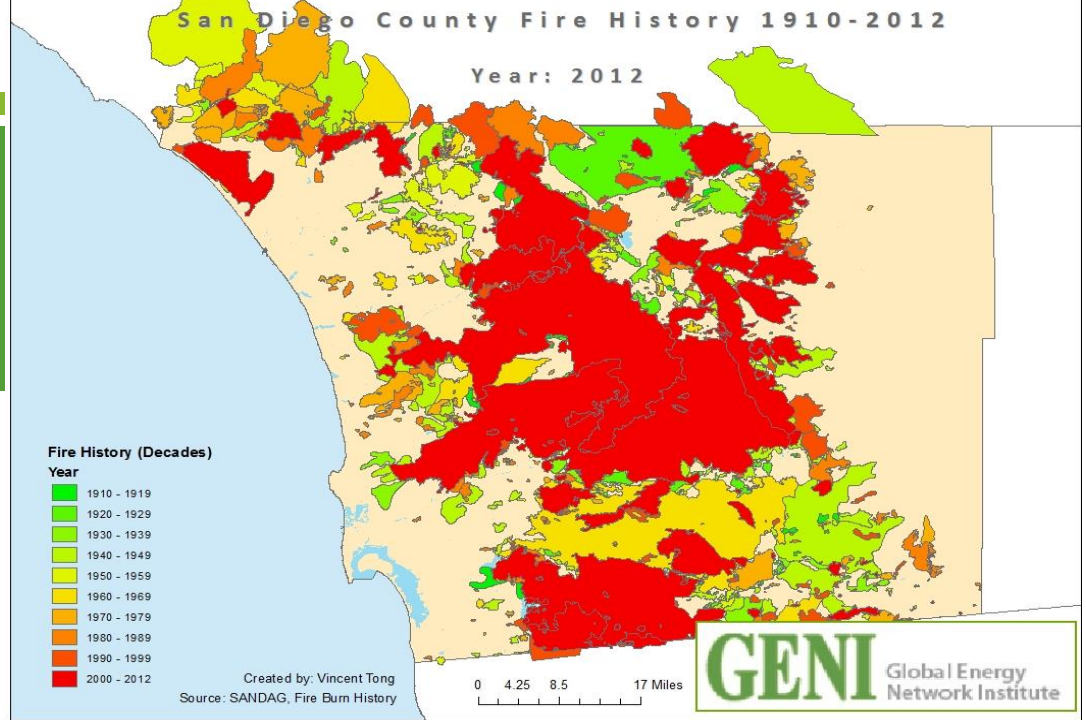
80% of San Diego's water resources are imported from either Northern California or the Colorado River. As drought affects those resources too, San Diego will be among the first to feel the full effects of drought.



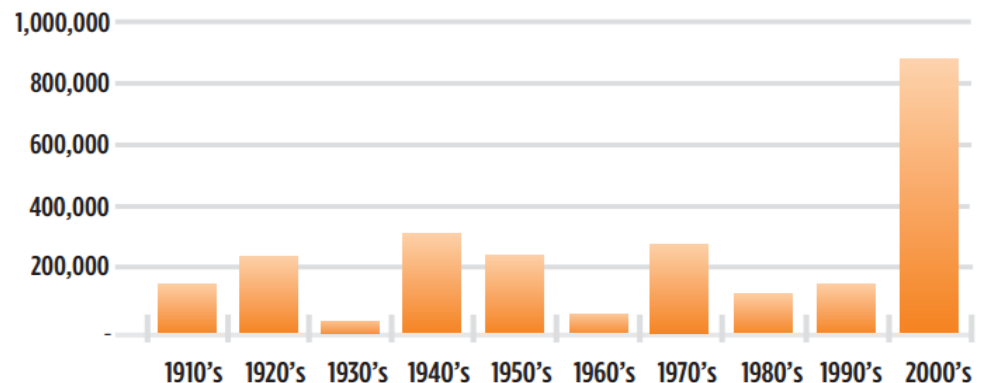
Source: CA.gov, Department of Water

# WILDFIRE

Fires have increased in both severity and frequency since 1910. Both the Cedar Fire (2003) and Witch Creek Fire (2007) rank among the 10 costliest fires in US history. Both fires occurred in the past decade and within San Diego County.



Total Acres Burned by Wildfires in San Diego County by Decade



Source: SD Foundation, Regional Wake-up Call

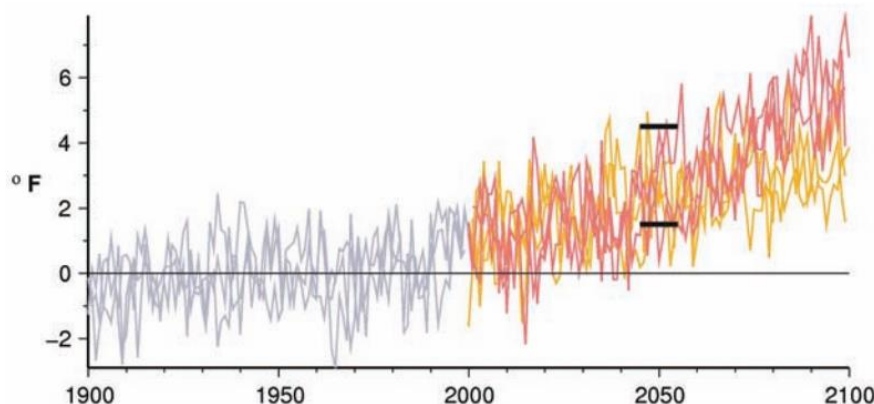
# EXTREME TEMPERATURE

## The Science and why it matter:

- In the next 40 years, global temperature could increase **twice as fast** as they have in the last 40 years; San Diego regional temperature increases are expected **to exceed** this trend.
- Expect **more days** of extreme high temperatures, and **longer** heat waves with **more humid** nights.
- Expect to experience **less frequent** but **more intense** rainstorms, and heavy flood events like 2010 flood in Mission Valley

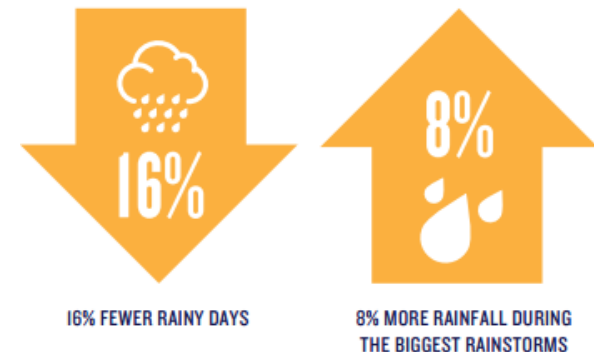
Source: CEP. 2050 is Calling Report

Projected temperature increase  
for San Diego County



Source: SD Foundation, Regional Wake-up Call

## WE EXPECT TO SEE CHANGES IN OUR REGION'S PRECIPITATION PATTERNS:



16% FEWER RAINY DAYS

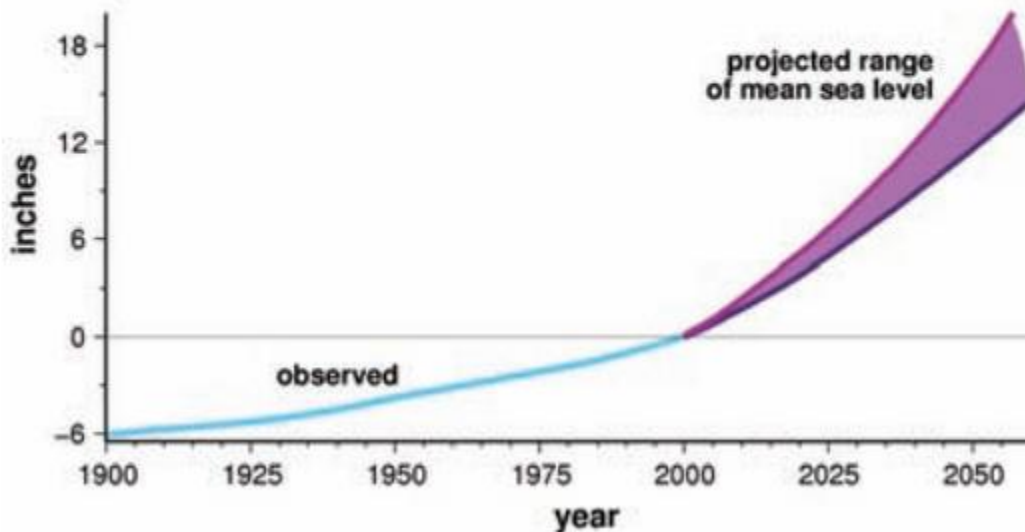
8% MORE RAINFALL DURING  
THE BIGGEST RAINSTORMS

Source: CEP. 2050 is Calling Report



# SEA LEVEL RISE

Projected sea level rise for San Diego County coastline over the next several decades



Source: SD Foundation, Regional Wake-up Call

According to a study by Climate Central:

**\$1.5 billion**

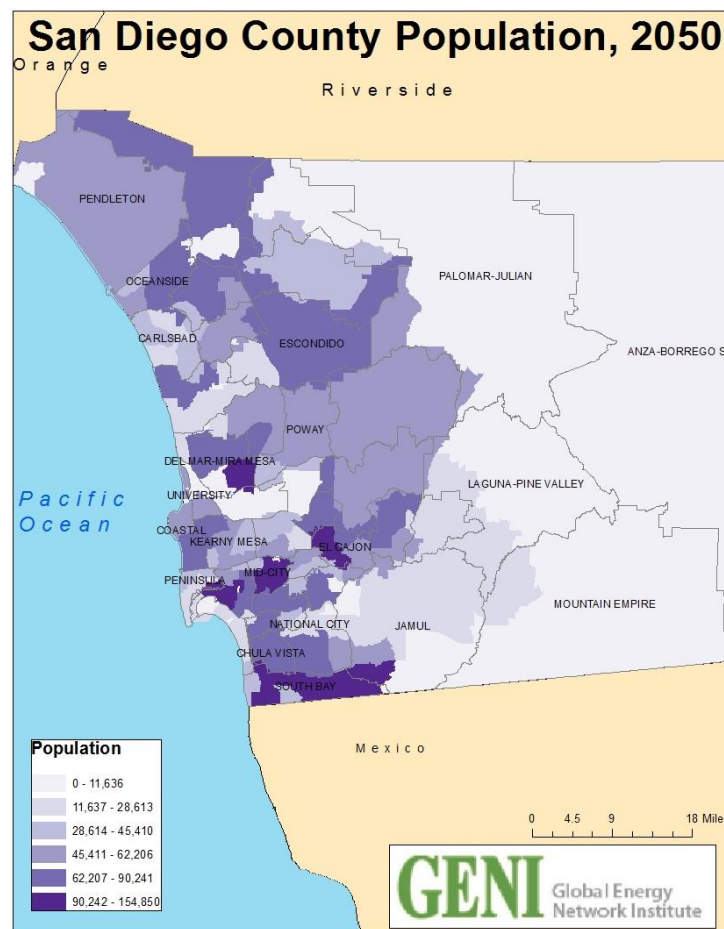
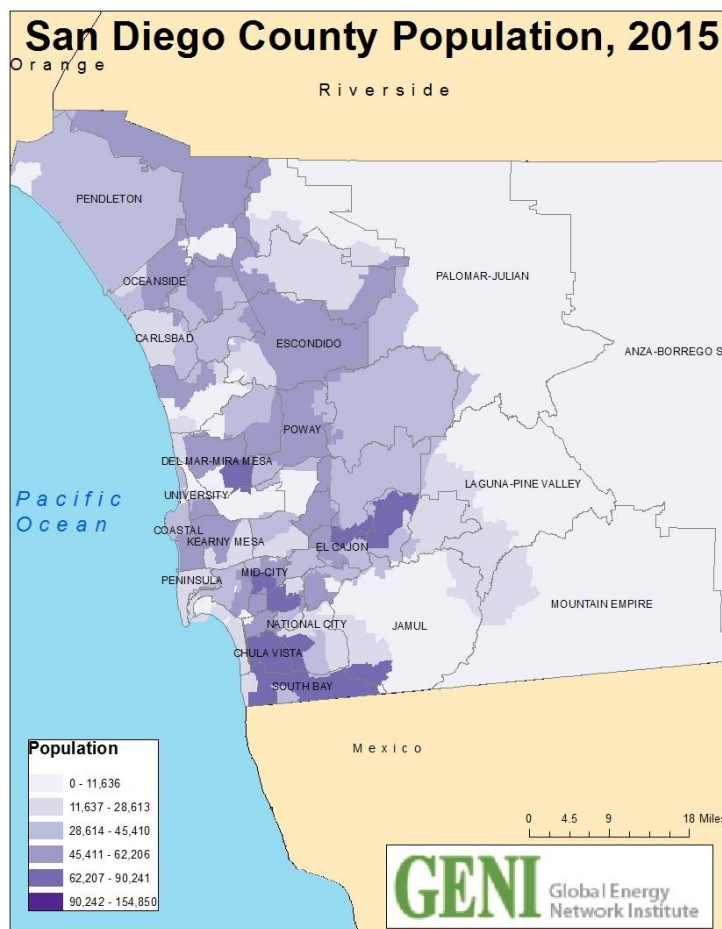
of real estate in San Diego County is less than 3 feet above the local high tide line and thus at increasing risk from coastal flooding.

Source: CEP, 2050 is Calling Report



# DEMOGRAPHICS: GROWING POPULATION

Source: SANDAG  
Created by: Vincent Tong



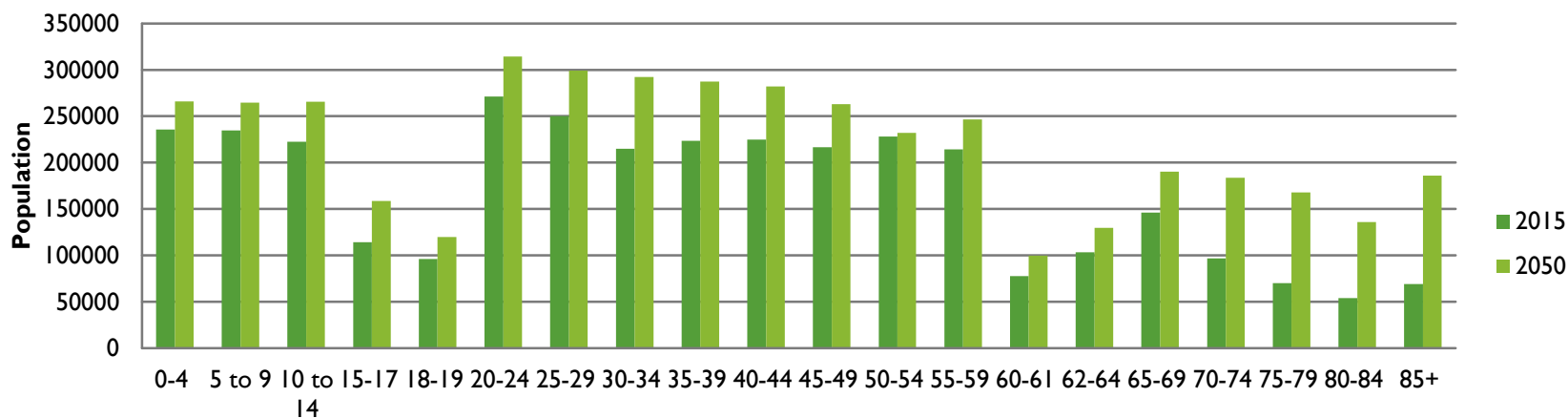


# DEMOGRAPHICS: CULTURAL DIVERSITY

Demographic Forecast (2011-2050)			
	2011	2050	% Change
White	1,495,582	1,549,069	<b>+3.6%</b>
Hispanic	1,010,784	1,881,719	<b>+86%</b>
Black	142,905	229,860	<b>+60.8%</b>
Asian	348,724	502,492	<b>+44%</b>
Other	117,815	197,210	<b>+67.4%</b>
Total	3,115,810	4,360,350	<b>+39.9%</b>

Source: SANDAG Data Warehouse Forecasts

# DEMOGRAPHICS: AN AGING POPULATION



Age Group	0-4	5-9	70-74	75-79	80-84	85+
2015	235,659	234,637	96,774	70,125	54,090	69,131
2050	266,027	264,675	183,685	167,985	135,903	185,952
% Change	+12.89%	+12.80%	+89.81%	+139.55%	+151.25%	+168.98%



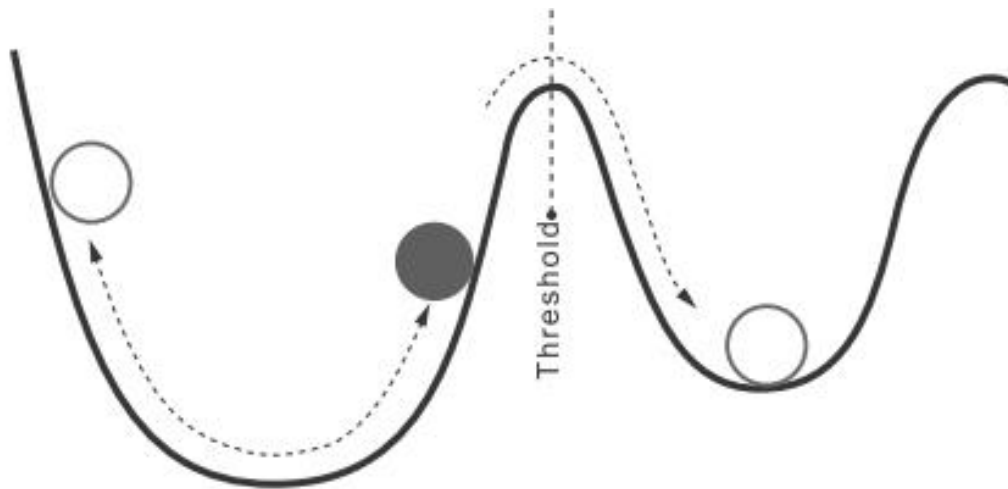
Image Source: gmw.cn

Source: SANDAG Data Warehouse Forecasts

# WHY RESILIENCY?

*“Every \$1 spent on hazard mitigation saves society an average of \$4.”*

Carl Hedde, Vice President, Munich Re



Ecological resilience concept

As our climate continues to changes we must consider whether we have **crossed the 'threshold' into a new stable state**. If that is the case, we must re-evaluate the policy & economic decisions we make to bounce back from disturbances. Otherwise, it's the taxpayers now, and future generations that will feel the full effects of our negligence.

# CRITICAL SYSTEMS AT RISK

Energy



Transportation



Water



Agriculture



Waste



Public Health





# RESILIENT TRANSPORTATION



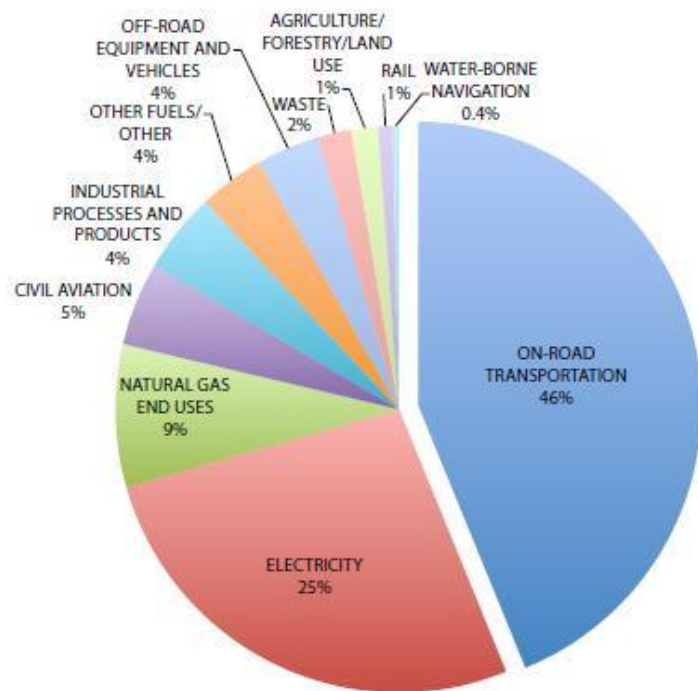
Image Source: Cincinnati Transforum



# TRANSIT IN SAN DIEGO

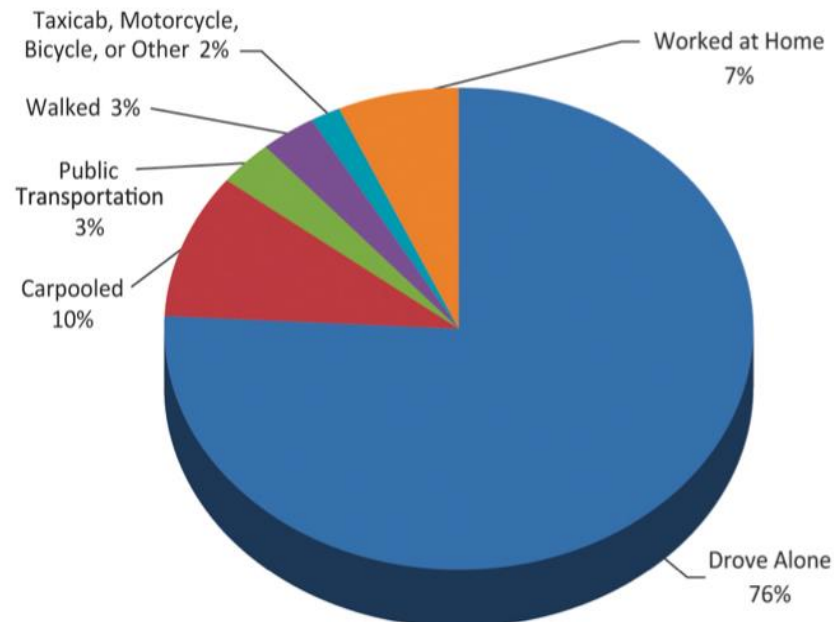
San Diego currently ranks **33<sup>rd</sup> in the nation** in terms of workforce access to transit. In 2012, public transportation accounted for only **2.7%** of the county's workforce commute. For these forty thousand people, the commute was **almost double** those that drove alone.

Figure 1. Greenhouse Gas Emissions, San Diego County, 2006



## TRANSPORTATION TO WORK

SAN DIEGO COUNTY, 2009



Source: Equinox Center. 2010: American Community Survey, 2009 (Table C08301)

# TRANSIT ORIENTED DEVELOPMENT (TOD)

- **Transit Oriented Development (TOD)** – “A type of community development that includes a mixture of housing, office, retail and/or other amenities integrated into a walkable neighborhood and located within a half mile of quality public transportation.”  
*Source: Reconnecting America*
- People on average are only willing to travel **30 min** to and from work.

- **Keys to TOD**

- 1) Transit system **faster than traffic**
- 2) Viable centers that are **dense enough** to service a transit system
- 3) Walk-able areas and cycling facilities
- 4) Guaranteed access at most times **without time wasted**
- 5) Phasing out freeways and phasing in congestion taxes
- 6) **Continual improvement** of vehicle engines // **Electric Vehicles**
- 7) Regional and local governance that can **enable visionary** green transport plans and funding schemes

*Source: Resilient Cities, Peter Newman*



Image Source: BAR Architects

# DRIVING PROGRESS

## ■ 2050 Regional Transportation Report

- Investing **\$214 billion** in local, state, and federal transportation funds over next 40 years
  - 36% Transit** (growing every decade) // **34% Highway Improvements** // **21% Local Roads & Streets**
- Adopted Sustainable Communities Strategy (SCS) required by **SB 375** which demands that GHG emissions reach state-mandated levels for 2020 and 2035.

Source: 2050 Regional Transportation Report, SANDAG

## ■ AB 118 – Alternative Fuels & Vehicles Technologies program

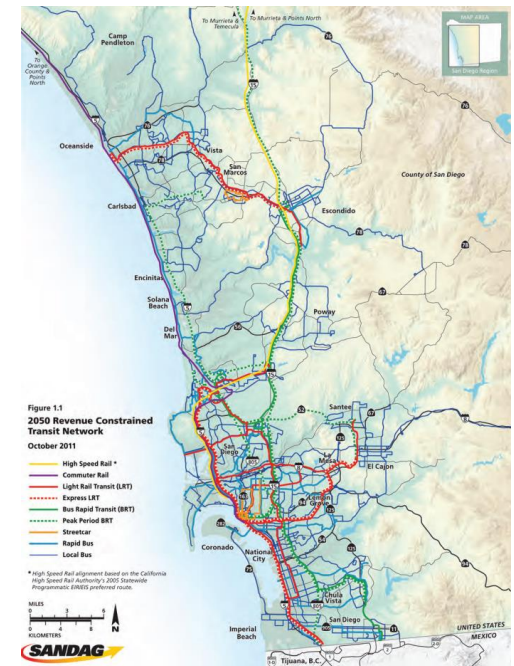
- Funding for public projects to develop & deploy new technologies
- Obama Admin – **54.5 miles/gallon** by 2025
- San Diego - **#5 market** for hybrids in USA

Source: White House

Source: Forbes, Who buys the most Hybrids

## ■ AB 1493 – Pavley Global Warming Bill

- GHG emission standards for passenger vehicles



# A PLATFORM FOR OTHER CITIES

## ■ Sustainable Communities

- Land use patterns for future employment & housing needs for 1.25 million residents & 400,000 new homes
- Focus housing and job growth in urbanized areas where there is existing & planned public transportation

## ■ Multi-Modal Transportation

- Double tracking COASTER & SPRINTER + extended services
- Trolley Enhancements – Mid coast trolley Extension // Tunnel in Downtown
- Bus Rapid Transit (BRT) along high-demand corridors

## ■ Transportation Systems Management (TSM)

- Ensure smooth flow of traffic, eliminate bottlenecks, and enhance public transit

## ■ Transportation Demand Management (TDM)

- Ridesharing (Carpooling, van-pooling, bus-pooling) // Promote bicycling, walking

## ■ Comprehensive Public Outreach and Involvement Program



Source: 2050 Regional Transportation Report, SANDAG



# RESILIENT WATER SYSTEM

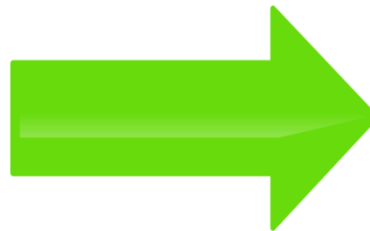




# CLIMATE CHANGE AFFECTING WATER SUPPLY

- **Air temperatures are increasing**
- **Less frequent and more severe rainfall**
- **Number of hot days per year are increasing**
- **Intensity and frequency of extreme weather events are increasing**

***Resulting in:***



- **Increased demand for water use**
- **Drought**
- **Wildfires**
- **Drier climate**
- **Evaporation of bodies of water**

**Overall Result: Reduction of water supply in San Diego**

# THE CURRENT WATER SITUATION

- San Diego as well as the rest of California is experiencing the largest drought it has endured within the past **150** year

Source: City of San Diego

**27,527** acres of land have burned in San Diego from the May 2014 wildfires

Source: U-T San Diego

Climate change and increased temperatures are reducing **rainfall**, **Colorado River flow**, and **Sierra Nevada Snowpack**, all sources from which San Diego derives 80% of its water.

Source: Cary Lowe, City of San Diego Water Policy Implementation Task Force

Source: City of San Diego

Nearly 80% of San Diego's water supply is imported and more than 50% of household water usage is for outdoor

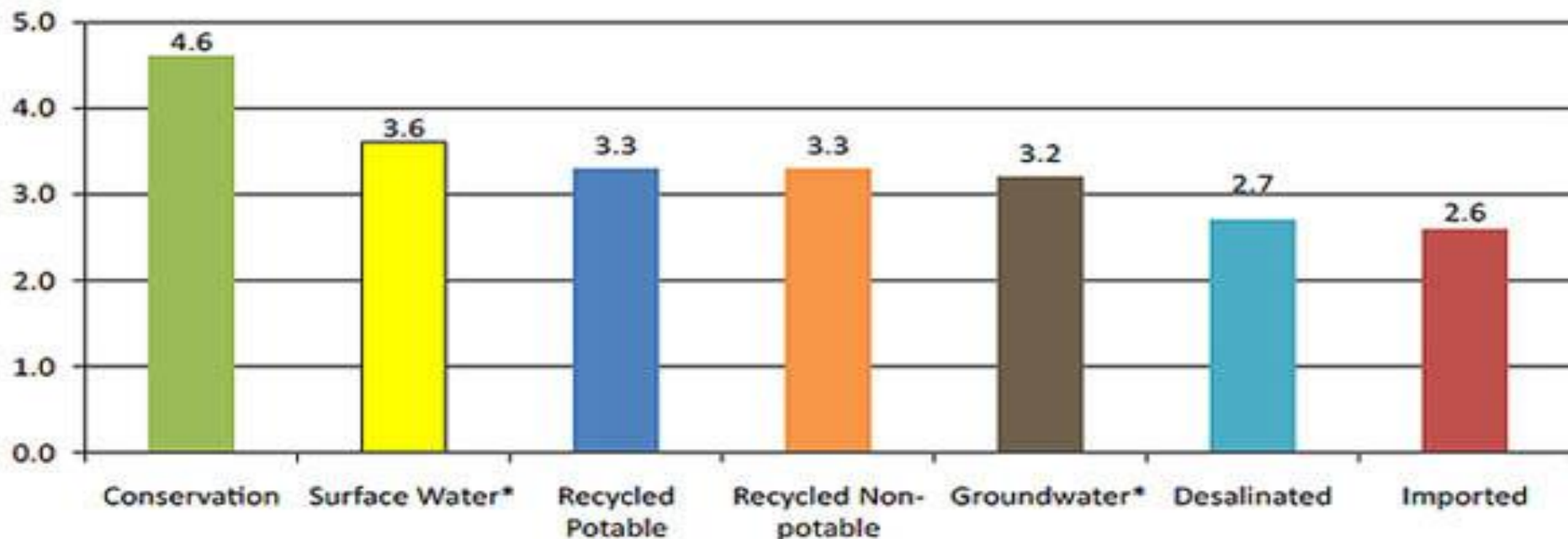
Source: Public Utilities Dept.

Source: Kiama Municipal Council

# HOW TO ADDRESS THE RISKS

Chart 6

Total Factor Rating of San Diego County's Water Alternatives



\*These sources do not have significant local capacity

Source: FBEI

San Diego can begin its journey toward water resiliency by **CONSERVING** existing water.

Source: Equinox Center



## CURRENT SOLUTIONS SAN DIEGO HAS REACHED



- Wastewater recycling
- Water diversification
- Storm water development plans
- Desalination





# RECYCLING WASTEWATER-NORTH COUNTY RECLAMATION PLANT

- First large scale reclamation plant
- Treats 30 million gallons of wastewater per day
- Non-potable water is used for irrigation

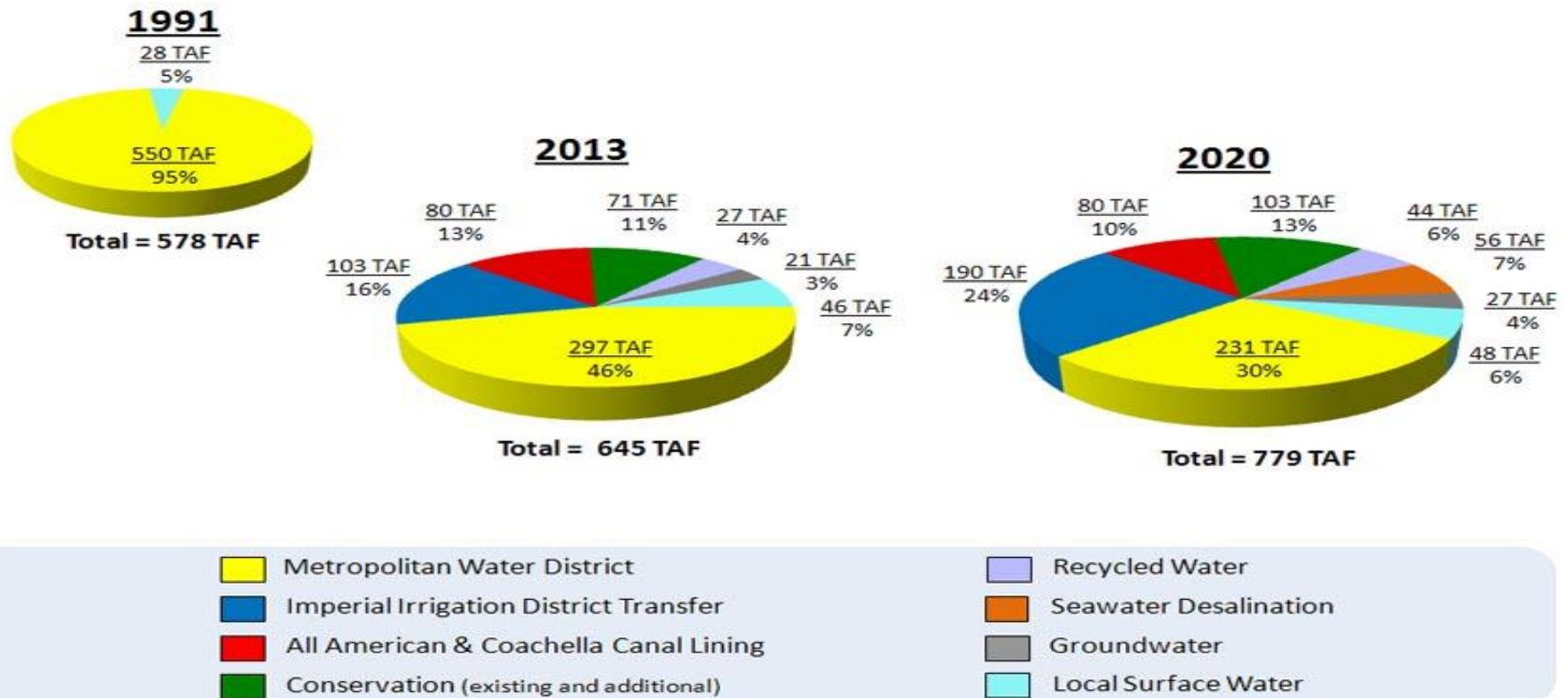


North County Reclamation Plant located in Mira Mesa

Source: City of San Diego Public Utilities

# WATER DIVERSIFICATION

## Increasing San Diego County's Water Supply Reliability through Supply Diversification



TAF=Thousand Acre-Feet

Source: San Diego County Water Authority

# STORM WATER DEVELOPMENT PLAN



## Purpose:

- Manages and prevents **urban runoff**, which is a huge threat to San Diego's water quality.

San Diego currently has two underground systems to manage storm water.

Source: San Diego Think Blue





# POSEIDON'S DESALINATION PLANT IN CARLSBAD

- This plant desalinates **50 million** gallons of seawater/day
- By 2020, **8%** of the total water supply for San Diego County will be provided by this plant, providing for **300,000** San Diegans



Source: The Carlsbad Desalination Project

Overall Result: Reliable and high quality water supply for San Diego County



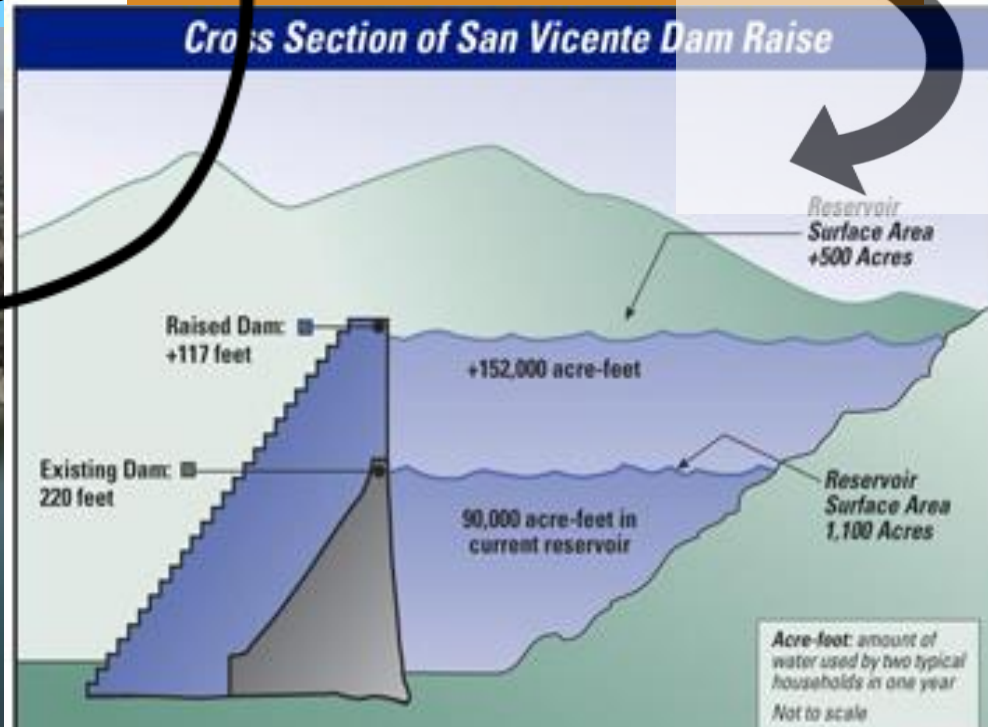
# SAN VICENTE DAM RAISE

**2009**

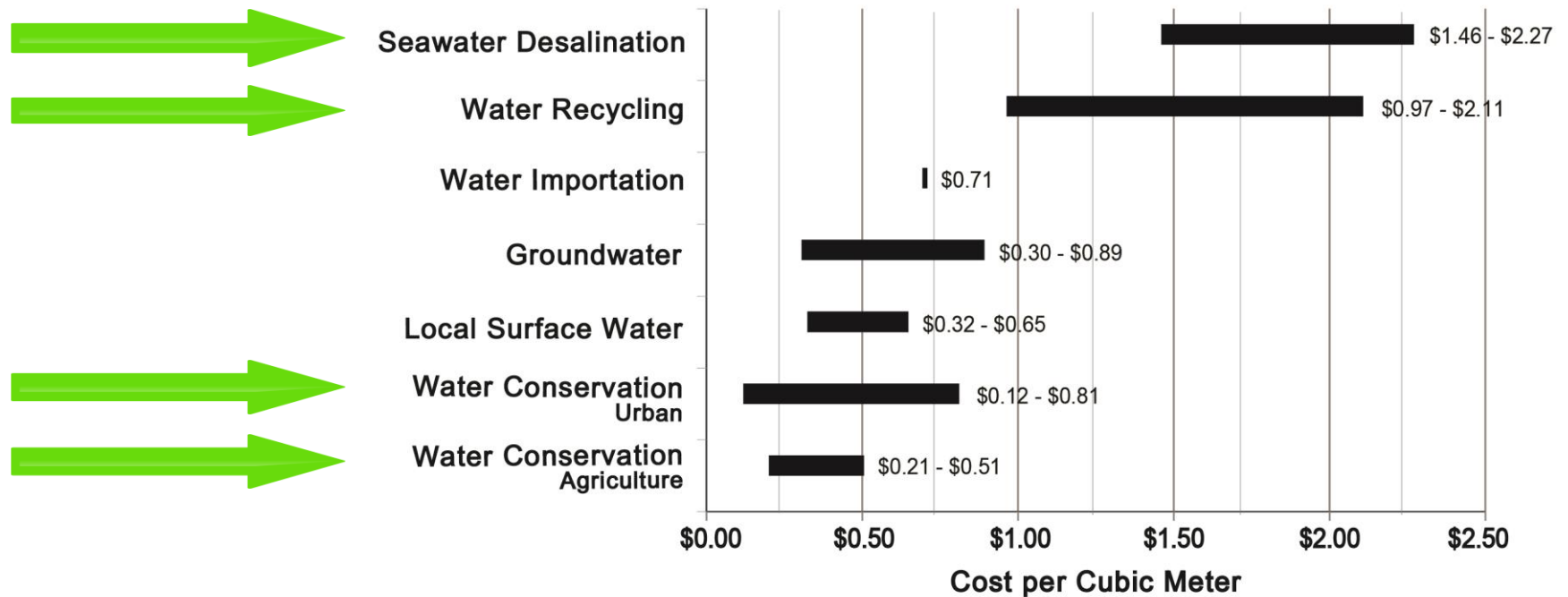
- The San Vicente Dam was originally created as a reservoir that stood at **220 feet**.
- It could store **90,000 acre feet** of water

**2013:**

The dam was raised another **117 feet**



# COMPARISON OF PRICES OF FUTURE WATER SUPPLY SOLUTIONS



Although these are all solutions, Urban and Agriculture water conservation are most cost effective

Source: Brian Richter The Nature Conservancy and University of Virginia



# Untapped Savings

21<sup>ST</sup> CENTURY SOLUTIONS  
FOR A SUSTAINABLE WATER  
SUPPLY FOR CALIFORNIA

Every year, California uses

**6 MILLION  
ACRE-FEET**

more water than our rivers and  
aquifers can sustainably provide

Every year, California  
could save up to

**14 MILLION  
ACRE-FEET**

of water to close this gap



That's enough water to irrigate  
all of the orchards, nuts, berries, vineyards,  
tomatoes, lettuces, rice, and vegetables grown  
in California, with water left over.

## Agricultural Efficiency: 5.6-6.6 MILLION ACRE-FEET

- Use smart irrigation scheduling to ensure crops are watered when they most need it
- Use deficit irrigation to limit water use at drought-tolerant growth stages
- Expand efficient drip and sprinkler irrigation technology

## Stormwater Capture: 0.4-0.6 MILLION ACRE-FEET

- Install rainwater barrels and cisterns at homes and businesses
- Recharge groundwater with stormwater runoff

## Water Reuse: 1.2-1.8 MILLION ACRE-FEET

- Use recycled water to irrigate landscapes and crops
- Install graywater systems to water lawns and flush toilets in homes and businesses
- Recharge groundwater with recycled water

## Urban Efficiency: 2.9-5.2 MILLION ACRE-FEET

- Replace unneeded turf grass with native and drought-tolerant plants
- Accelerate replacement of inefficient plumbing fixtures and appliances
- Find and fix water leakage in buildings and under streets
- Operate cooling towers more efficiently in factories and office buildings



Get the Drought Series Fact Sheets at:  
[www.nrdc.org/water/ca-water-supply-solutions.asp](http://www.nrdc.org/water/ca-water-supply-solutions.asp)  
[www.pacinst.org/publication/ca-water-supply-solutions](http://www.pacinst.org/publication/ca-water-supply-solutions)

\* 1 Million Acre-Feet is generally enough to supply  
2 million families for 1 year (until we all become more efficient!)



# RESILIENT AGRICULTURAL SYSTEM





# CLIMATE CHANGE AFFECTING AGRICULTURE

- **Air temperatures are increasing**
- **Less frequent and more severe rainfall**
- **Number of hot days per year are increasing**
- **Intensity and frequency of extreme weather events are increasing**

Resulting in:



- **Increased demand for water use**
- **Drought**
- **Wildfires**
- **Drier climate**

**Overall Result: Increased likelihood of crop failure**

# THE CURRENT AGRICULTURAL SITUATION



In the last four decades, wildfire season in the west has extended **three months longer** than usual.

Source: Anthony Westerling

As emissions increase, climate warms and various crop yields are expected to **decline**.

Source: US Global Change Research Program



San Diego county's average precipitation is only about **9-15 inches** of rainfall (expressed by the lighter area of the map).

Source: SANDAG precipitation

# FOOD SECURITY

“Food Security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”

*Source: Food and Agriculture Organization of the UN*



## We must have food security

“With world population that is projected to reach 9 billion by 2050, require 70 percent more food than we produce today, and a growing global middle class that is consuming more meat and dairy”, food security is crucial.

*Source: The Earth Institute Blog, Columbia University*



## SOLUTIONS - ORGANIC FOOD

The overall **goal** regarding organic food is to be able to **produce a lot** of it **inexpensively** so that the human population can access what is considered the healthiest produced food easily.

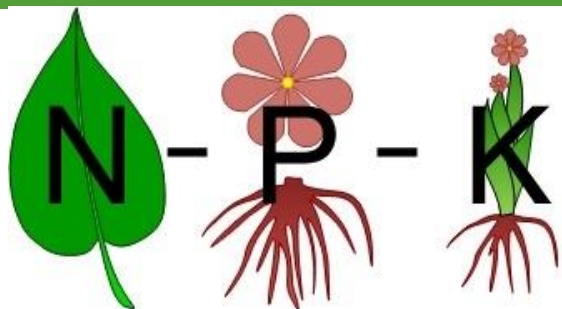


Although this goal is still in the process of being reached, **San Diego** makes sure that it **supports markets** that sell plenty of **organic** food including local farmer's markets, supermarkets and restaurants including Jimbo's Naturally!, Trader Joe's, Local Habit Restaurant, and many more.

Source: Non Gmo and Organic Restaurants



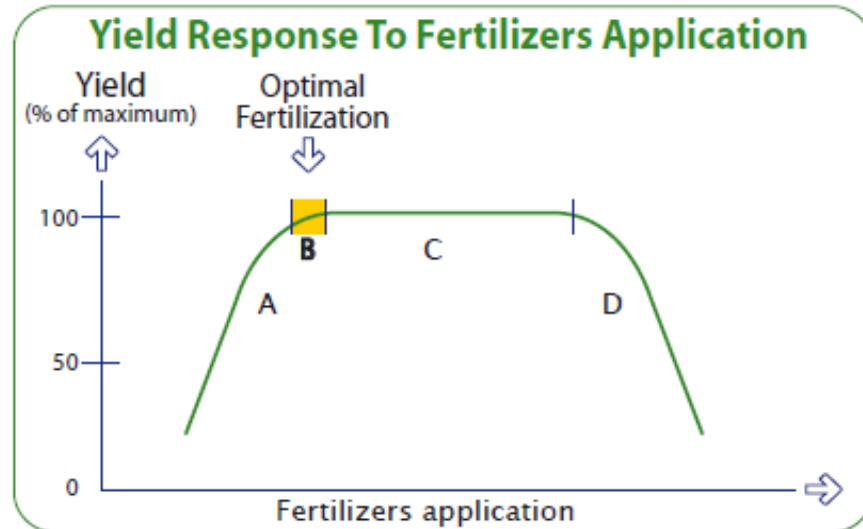
# SOLUTIONS - IMPROVED FERTILIZATION



“Improved irrigation and more intelligent use of fertilizers could increase agricultural production by as much as 70%.”

*Source: nature.com Virginia Gewin*

A	<b>Under Fertilization</b> Plant deficiencies – lower yields
B	<b>Optimal Fertilization</b> Optimal nutrient supply - Maximum efficiency
C	<b>Over Fertilization</b> Waste - no additional yield
D	<b>Excessive Fertilization</b> Toxicity and salinity damages – decreased yields



# SOLUTIONS-BIOFUELS



- Ethanol is biodegradable, non-toxic and water soluble.
- Reduces greenhouse gas and tailpipe emissions

Source: Renewable Fuels Association

Using ethanol instead of gasoline helps to reduce CO2 emissions by 34% on average.

Source: Renewable Fuels Association



- Recycles oil and provides San Diego with a high quality alternative fuel made from local resources.

Source: EIA



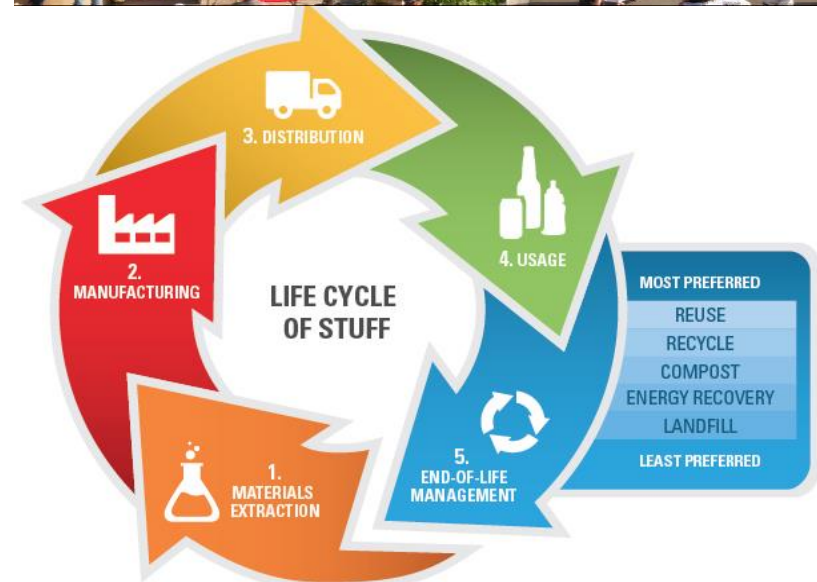
# AGRICULTURAL SOLUTIONS

**How to reduce your carbon footprint and improve food resiliency on a personal level:**

**Buy Local** – buying food produced close to home reduces carbon emissions from transportation, is fresher, and supports the local economy.

**Consume Responsibly**– choose biodegradable packages; processed foods use lots of energy and are prejudicial to health.

**Backyard Gardening** – one probably won't be able to live off of his or her backyard, but home gardening is a good way to understand food while making small difference.





# WASTE

## DESIGNING RESILIENT WASTE SYSTEMS

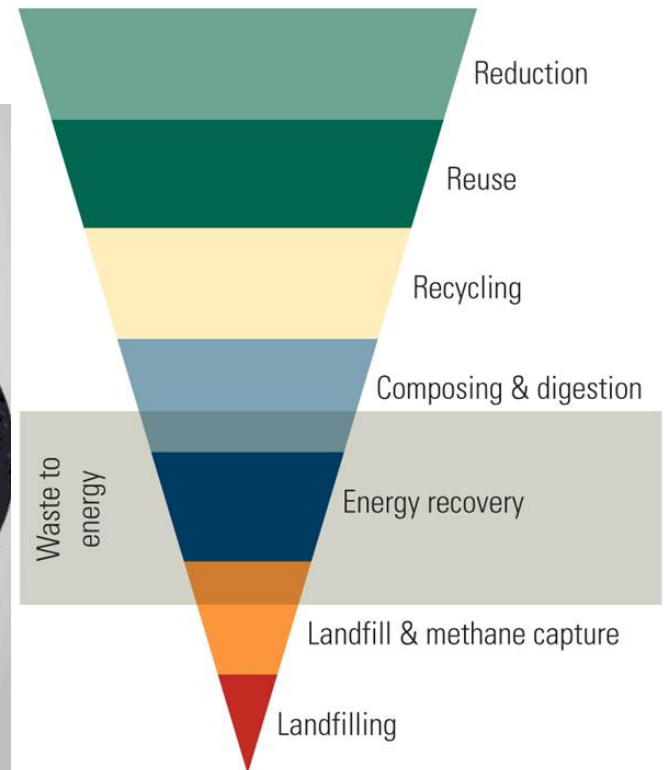




# QUICK FACTS ABOUT OUR WASTE AND PROPER WASTE MANAGEMENT

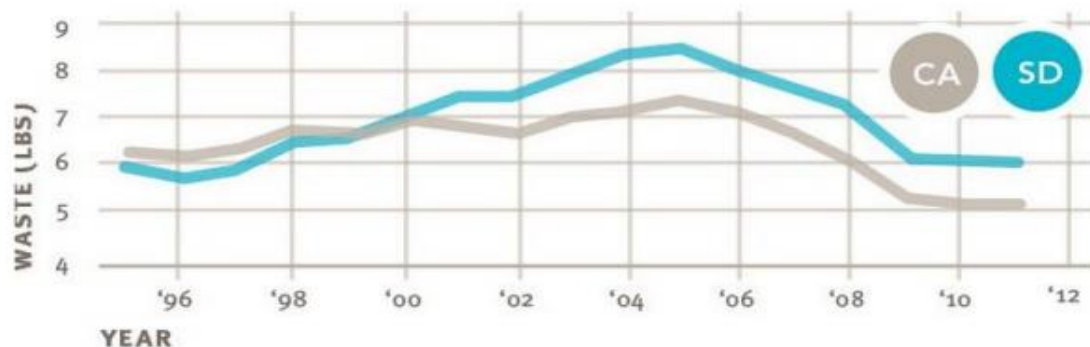


Source: EPA



**Environmental hierarchy for solid waste management**

# AVERAGE WASTE OF SAN DIEGO COUNTY



Since 2005, the average waste disposal per person in San Diego County has been declining.

SOURCE: EQUINOX CENTER, 2012; CALIFORNIA DEPARTMENT OF RESOURCES RECYCLING & RECOVER, 2012



San Diego County's average daily per capita waste disposal is higher than surrounding counties.

# SAN DIEGO'S PLAN FOR ZERO WASTE BY 2040

- San Diego hopes to recycle 100% of waste by 2040 and increase the recycling rate from the current 68% to 75% by 2020.
- The Miramar Landfill is almost at capacity and is scheduled to close in 2022.
- To design a city Zero Waste Plan, San Diego's Environmental Services Department is holding a series of meetings to engage residents and businesses to cover funding opportunities and programs that could be implemented to meet the city's goals



Source: Times of San Diego



# COMPOSTING IN SAN DIEGO THROUGH IMPLEMENTATION OF BROWN BINS

- There are many common household items that could be composted.
- Under the Compost Bin Voucher Program, the City of San Diego has partnered with Dixieline ProBuild to offer compost bins at a discounted rate for its residents.
- Applications for the program can be picked up at any Dixieline ProBuild location in the city.



Source: City of San Diego

# GREYWATER SYSTEM



Source: City of San Diego

# ECONOMICS OF GREYWATER USE

Simple residential greywater system costs (estimated costs):

Laundry to Landscape	Materials only → \$100 to \$250
	Full Installation → \$700 to \$2,000
Branched Drain	Materials only → \$200 to \$800
	Full installation → \$800 to \$3,000
Pumped-System	Materials only → \$400 to \$600
	Full installation → \$1,000 to \$3,000



FOR A SUSTAINABLE  
WATER CULTURE

\*\*High-end residential greywater system costs (estimated costs):

Sand filter to drip irrigation                      \$5,000 to \$10,000

(Depends on complexity of the plumbing and compatibility of existing drip irrigation system)



# RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

- EPA creates regulations to assure safe management and cleanup of hazardous waste.
- Goals of RCRA
  - Protect Communities and Environment
  - Clean up Land and Water
  - Conserve Resources
  - Partnering and Innovating
- Established framework for states to have municipal solid waste (MSW) management programs
- Developing waste regulations to prevent contamination from affecting local communities
- Restoring 18 million acres of contaminated land for reuse
- Increase the nation's MSW recycling rate from < 7% to ~ 35%

**RCRA's Cradle-to-Grave  
Hazardous Waste Management System**



Source: EPA



Source: DuraLabel

# PUBLIC HEALTH

## PLANNING FOR PUBLIC HEALTH STRESSES

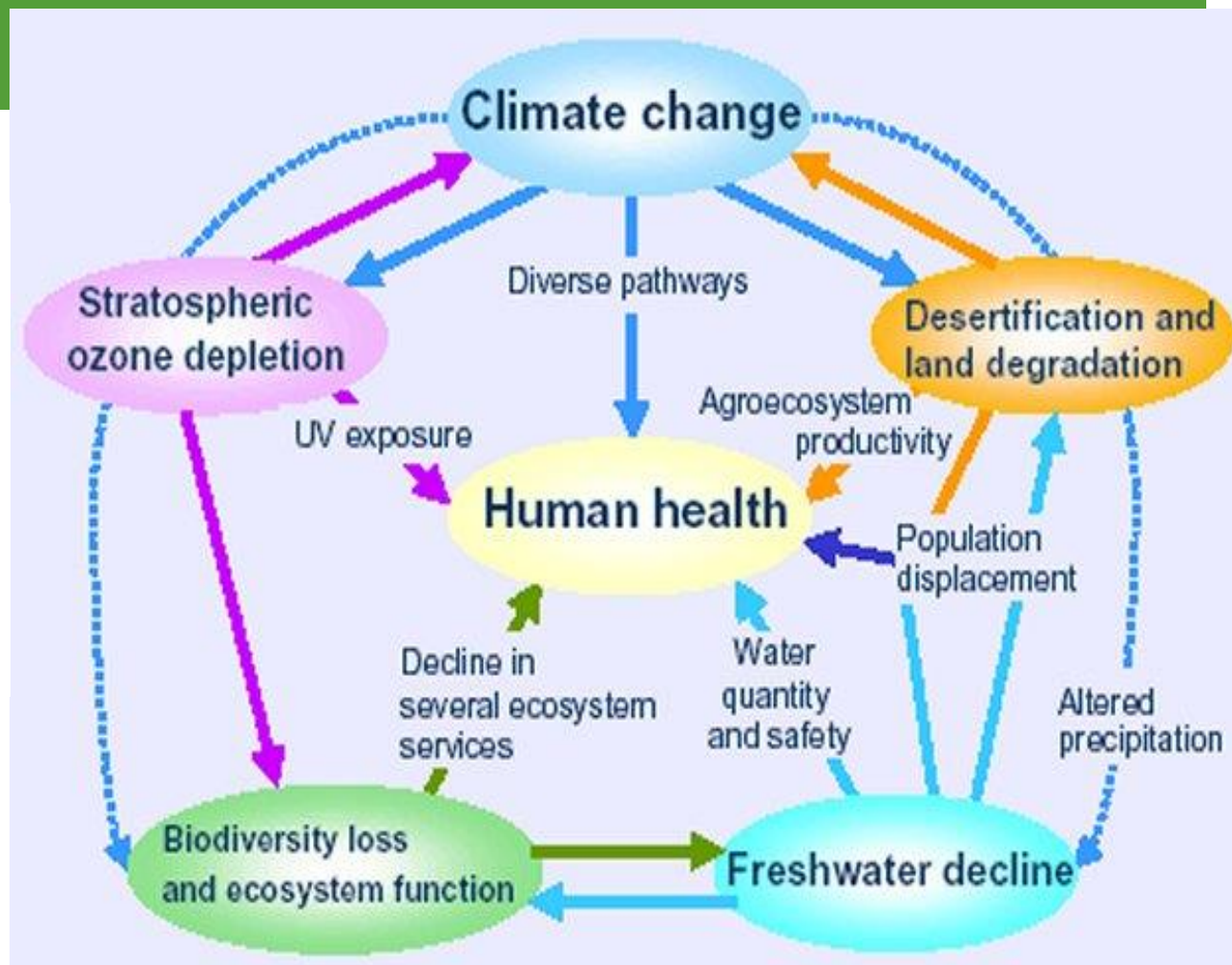


**Public Health**  
Prevent. Promote. Protect.



# IMPACT OF CLIMATE CHANGE ON PUBLIC HEALTH

- Climate change is a major driving force that causes health issues directly related to human health



Source: World Health Organization



# AIR POLLUTION IN SAN DIEGO

- Motor vehicles are San Diego's main source of air pollution and contributes 46% to greenhouse gases (GHGs).
- The 3.1 million San Diego residents drive 2.3 million vehicles, and collectively residents travel 87 miles/day.



Source: Equinox Center

Source: San Diego Air Pollution Control District

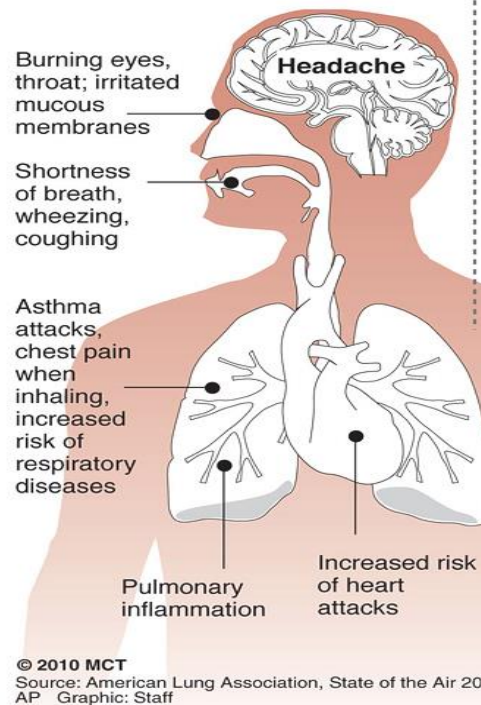
# EFFECTS OF AIR POLLUTION ON SAN DIEGO'S OZONE LAYER

- Breathing ozone at the ground level is extremely harmful.
- Ozone causes irritation of respiratory tract and damages lung lining and intensifies the effects of asthma.
- Ozone Episodes:
  - Stage I: Issue a smog alert when ozone levels reach 20 ppm
  - Stage II: Smog alert is issued when levels reach 35 ppm

## Why smog is harmful

Ozone, the main ingredient in smog, is one of the most widespread air pollutants and among the most dangerous.

### Effects on health



### How ozone forms

- 1 Oxygen** in the atmosphere  $O_2$
- 2 Nitric oxide**, byproduct of combustion  $NO$
- 3 Sunlight** breaks up nitric oxide
- 4 Ozone** formed by three oxygen atoms  $O_3$

### U.S. ozone limits

In parts per billion

• 1997-2008	<b>84</b>
• 2008-present	<b>75</b>
• New EPA proposal	<b>60-70</b>

Source: Yale Scientific

# COMBATTING AIR POLLUTION IN SAN DIEGO

- Expand the city's continuous asthma monitoring system
- Lower GHG emissions
  - Urban greening: grow low-pollen-producing plants
  - Use more public transit

Source: Asthma Foundation and California Department of Public Health



## Personal Solutions:

- Check pollen and daily air quality reports
- After spending time outdoors, wash face and hair to rid of pollen

Source: U.S. Department of Health and Human Services





# EFFECTS OF DROUGHT AND WILDFIRE ON PUBLIC HEALTH

## DROUGHT EFFECTS:

- Lack of quality drinking water
- Increased risk during recreational activities
- Negative effects on air quality
- Poorer living conditions in regards to energy, air quality, and hygiene
- Increased risk for serious illness and disease
- Poor food and nutrition

Source: Center for Disease Control and Prevention



## WILDFIRE EFFECTS:

- Wildfire smoke can lead to:
  - Coughing
  - Irritated sinuses and throat
  - Shortness of breath
  - Headaches
  - Stinging eyes
  - Aggravated asthma effects



# HELPFUL TIPS TO PROTECT AGAINST WILDFIRES

- Stay indoors
- Turn on A/C unit in home
- Do not use anything that has an open flame
- Drink plenty of fluids to stay hydrated, especially in the outdoors
- Purchase and change air filters
- Remove extra shrubbery
- Clean debris and leaves out of house gutters
- Create a “fuel-free” buffer zone of at least 50 feet around your house

Source: Air Pollution Control District and Firewise Communities



# SAN DIEGO COUNTY MANDATORY WATER RESTRICTIONS

## Stage II Drought Alert: Mandatory Water Restrictions (Effective since July 24, 2014)

City of San Diego Requirements:

- Water landscape **less than 3 times per week only** before **10 AM** and after **6 PM**

- Use handheld hose with a shut-off valve to wash car
- Only serve water at

restaurants upon customer

request

San Diego Government





# PRESIDENT OBAMA'S PLAN TO PROMOTE RESILIENCE IN PUBLIC HEALTH

- Department of Health and Human Services will partner with healthcare industry to give guidance on achieving a resilient medical system to climate impacts
- It will train public-health officials and community leaders to successfully communicate health risks and resilient actions to prepare the public for the effects of climate change

Source: White House



Source: U.S. Department of Health and Human Services



Source: Suffolk University Blogs

# RESILIENT ENERGY SYSTEMS



Kumeyaay Wind Farm

Source: Glenn Mosier

# BUILDING RESILIENT ENERGY SYSTEMS

*“Utilities shut down power lines as a **safety precaution** when **high wind speeds** exceed equipment design criteria.”*

- Morgan Lee, Energy and Green Business

- The primary climate change related risks for San Diego’s electricity grid are **drought**, **extreme temperature** and **wildfires**, which typically occur together.
- Climate change will **intensify** and **extend** the fire and drought seasons, placing larger strains on our electrical grid.
- Several of the October 2007 wildfires were triggered by **damaged power lines**.



Carlsbad during the peak of May 2014 wildfires.  
Source: The Associated Press, San Diego Union-Tribune



# RESILIENT ENERGY INFRASTRUCTURE

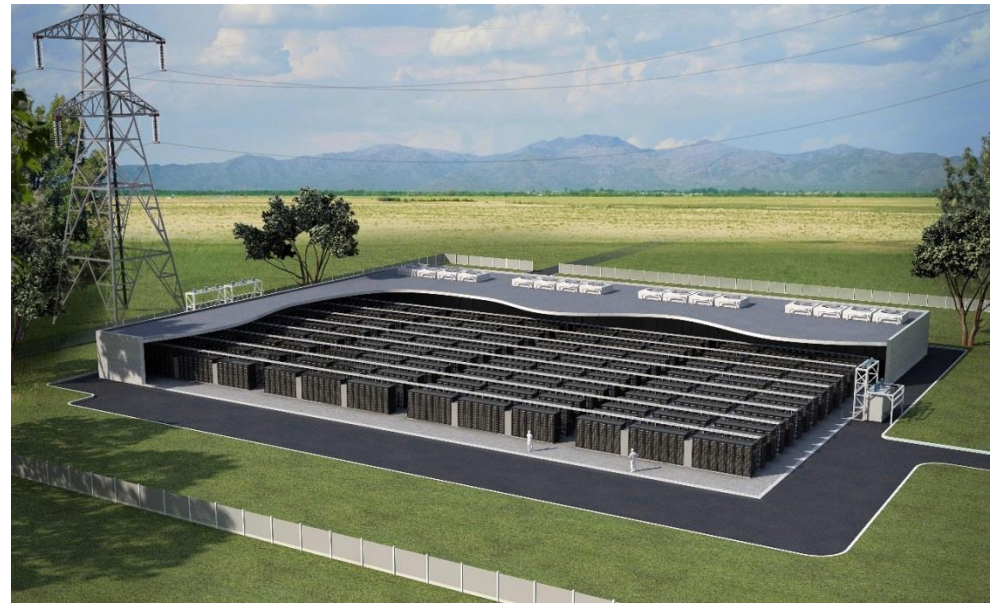


Power lines in the wake of Superstorm Sandy.  
Source: Julio Cortez/AP Photo

- One of our primary means for advancing resilience in our energy system is developing **resilient infrastructure**.
- The May 2014 fires left **thousands** of SDG&E customers without power for extended periods of time.
  - Fires tripped off **transmission lines**
  - **Circuits** were de-energized for safety
- How can we make our energy system more **shock-resistant**, as well as more **resilient**?

# ENERGY EFFICIENT SOLUTIONS

- In order to **maintain** or **return to** business as usual production in the wake of climate catastrophes...
  - Develop **reliable back-up systems** for grids
  - Incorporate **passive efficiency** principles for buildings
    - Natural ventilation
    - Water capture and storage
    - Reflective roofs and shading
  - Explore the potential of **distributed generation** and **microgrids** for increasing community resilience



A futuristic, grid-tied battery back-up system.  
Source: NEC Energy Solutions, Inc.

# MICROGRID DEVELOPMENT

- A form of distributed generation that can **disconnect** from larger utility grids for **isolated operation**
- Emerging technologies can be **more efficient** than both centralized grids and individual building applications
  - **Flexibility** and **scalability**
  - **Shorter transmission distance** requires less voltage transformation
  - Two-way transmission for increased **cost-effectiveness** and **reliability**
  - **Lower** greenhouse gas emissions
  - Less energy loss from **waste heat**



Photovoltaic “grove” on the roof of Hopkins garage.  
Source: University of California, San Diego

Sources: U.S. Green Building Council, Center for Climate and Energy Solutions



# POWER LINE BURIAL

## *Power Line Burial Basics*

- Widespread underground power line distribution technique
- Key pros and cons:
  - + **Aesthetically appealing** option
  - + **Mitigates wind** and **fire** issues
  - ⊖ Can be up to **five times more expensive** than conventional above-ground lines
  - ⊖ Typically **longer outage times** due to increased difficulty of sourcing outages

## *Utilities Undergrounding Program*

- The City relocates roughly **15 miles** of overhead utility lines underground annually.
- Approximately **\$54 million** is spent annually converting above-ground communication and power systems.
- Although we have been converting lines since 1970, roughly **1,000 miles remain** to convert.
  - The program estimates that nearly all residential areas will be **completed** in the next **54 years**.

Sources: San Diego Utilities Undergrounding Program, World Issues 360°

# RENEWABLE ENERGY INTEGRATION

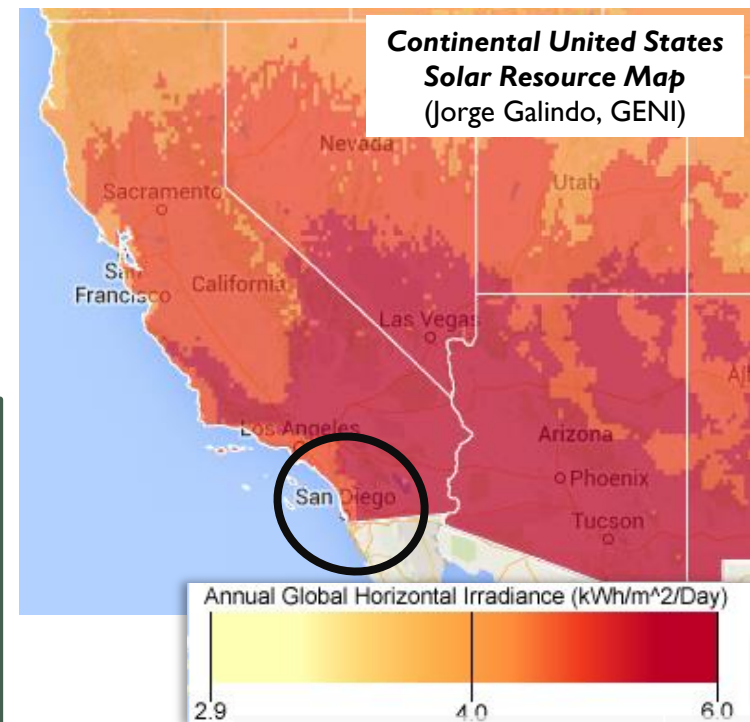
*“San Diego to achieve **33% renewable** energy this year.”*  
- SDG&E, San Diego Union-Tribune

- Projected compliance with California’s emissions reduction goal **6 years in advance**.
- Utility identifies sources of success as:
  - Quick integration of solar and wind **infrastructure**
  - Aggressive **research** and **development** strategies

SDG&E should...

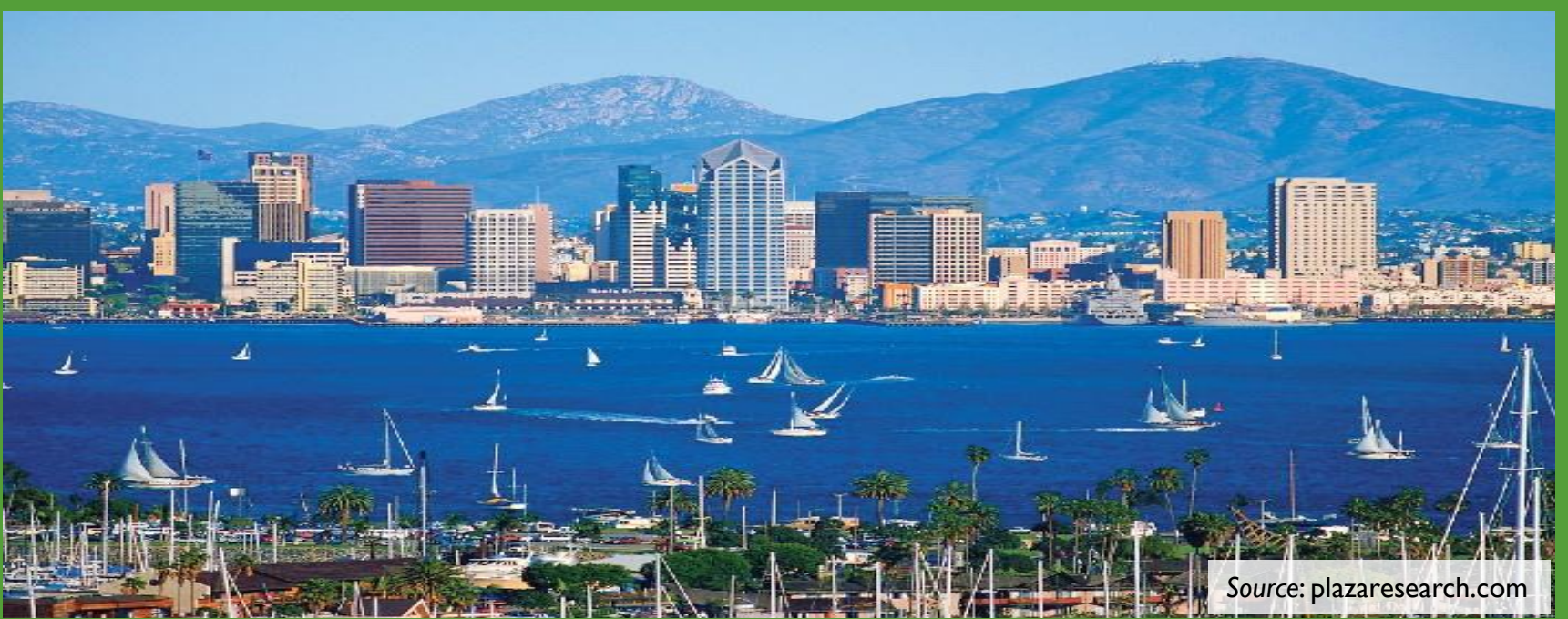
- Continue its leadership in renewable energy integration
- Consider strategies to begin phasing out natural gas
- Support grid decentralization & microgrid development

**San Diego has vast potential**  
for capturing solar irradiation.



# CONCLUSIONS

A SUMMARY OF SOME KEY LESSONS WE LEARNED THIS SUMMER AT GENI...





# SUSTAINABILITY AND RESILIENCY

*“As we learned in Superstorm Sandy, many of **the same design and operational principles that lead to greater sustainability can also lead to greater resilience.**”*

*- Clay Nesler, Vice President at Johnson Controls*

- Sustainability and resiliency are not mutually exclusive concepts.
  - Ideally, they should be **employed together** to achieve feasible and secure production.



Source: The Sustainable Tarry Towns

# LOWER DEMANDS ON NATURE

*The less we demand from nature, the more resilient we will be to nature's rejection of our demands.*

- **Reducing the amount of resources we consume** is crucial for advancing both sustainability and resiliency.

*“Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.”*

Garrett Hardin, The Tragedy of the Commons

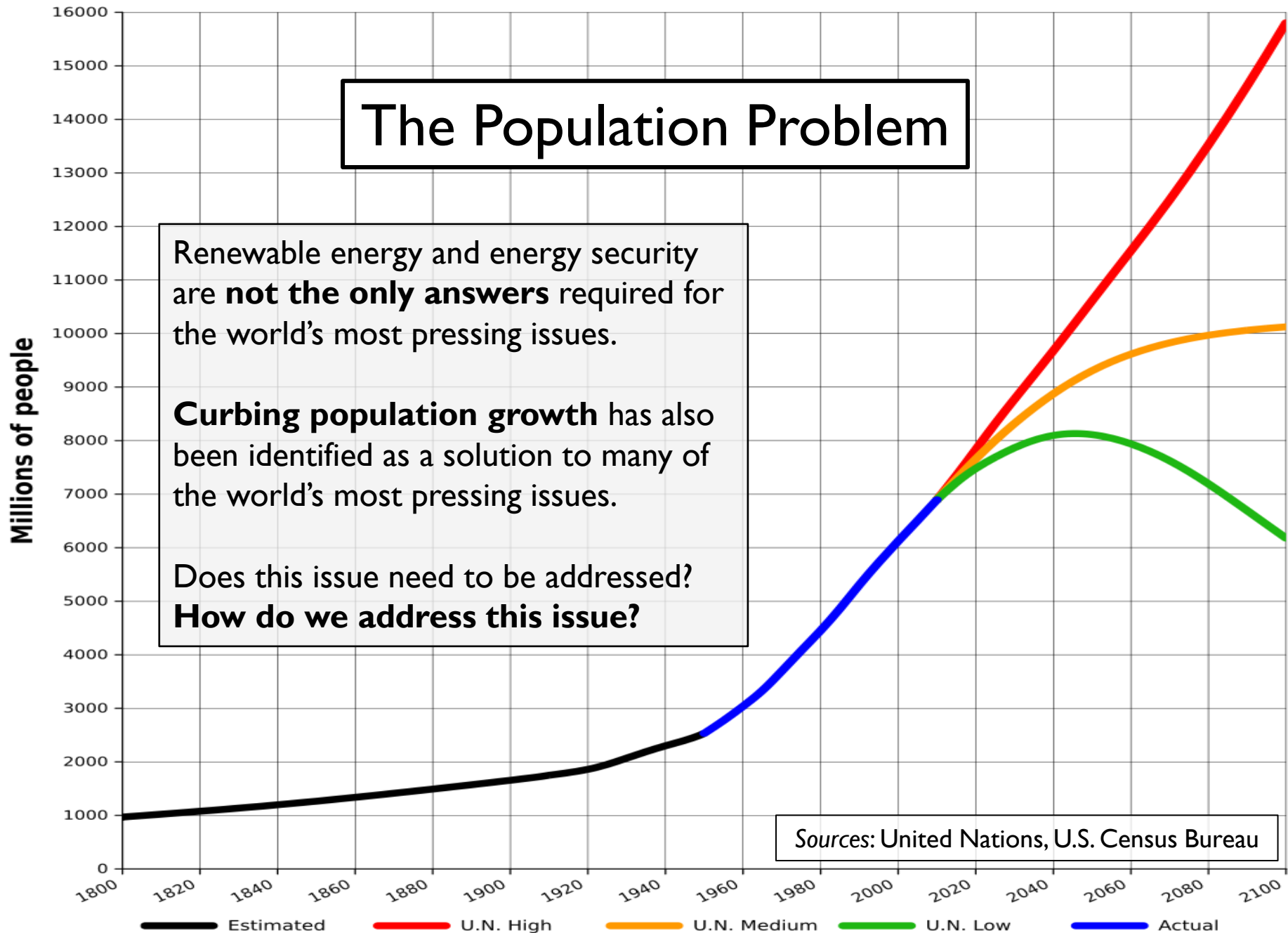
- Although this statement is controversial, it contains some **inconvenient truth**.

# The Population Problem

Renewable energy and energy security are **not the only answers** required for the world's most pressing issues.

**Curbing population growth** has also been identified as a solution to many of the world's most pressing issues.

Does this issue need to be addressed?  
**How do we address this issue?**





## *The Rockefeller Foundation Is Right*

- Their **five themes of resiliency** were present in nearly all of the research we conducted this summer.
  1. Constant Learning
  2. Rapid Rebound
  3. Limited or “Safe” Failure
  4. Flexibility
  5. Spare Capacity
- We should develop our systems with these concepts in mind.

## *Confined To Limited Resources*

- Currently, economic growth *depletes* **non-renewable** energy sources, such as fossil fuels, as its primary source of energy.
- Resources are a **primary constraint** for economic growth.
- The global transition to renewable energy will likely extend our ability to be economically productive.

## HOST AND SPONSOR

Host:



Sponsor:



# SPECIAL THANKS TO OUR PARTNERS

EQUINOX  
CENTER



UNITED NATIONS ASSOCIATION  
*of the United States of America*

A PROGRAM OF THE UNITED NATIONS FOUNDATION  
SAN DIEGO CHAPTER

Department of Geography





## FURTHER INFORMATION

### ■ Contact Information

- Cameron Bernhardt: cbernhardt15@cmc.edu
- Erin Johnson: erinjohnson145@gmail.com
- Byron To: byronktoby@gmail.com
- Vincent Tong: vdtong@gmail.com