

The Economics of Resiliency

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Outline

- Introduction and Background
 - America's economy relative to other countries
 - Comparison of California's economy to other states and countries
 - San Diego's economy relative to other counties
- Renewable Technologies
 - Accounting for emissions and costs
- Applying Resiliency in San Diego
 - Short-term economic costs vs. long-term environmental and economic benefits
 - Economically feasible and environmentally resilient systems
 - Case studies in San Diego

Introduction

Our economic context for resiliency with
national and regional comparisons

Development Indicators

- Gross Domestic Product (GDP) indicates the size of an economy, not the **health of a nation**.
- The United Nations (UN) attempted to *quantify* the health of a nation by establishing the **Human Development Index (HDI)**.
- This metric accounts for:
 - **Life Expectancy** Index
 - **Education** Index
 - **Income** Index

Source: United Nations Development Programme

GDP Leaders

- The United States has the **world's largest GDP**, and is sometimes considered the **most powerful nation** in the world.

(Atlantic Council, International Futures)

- GDP is an important metric for measuring the **growth of an economy**, and has a large influence on monetary policy.
- However, despite having the world's largest GDP **by far...**

Rank	Country		GDP (Millions of \$US)
1	United States		16,799,700
2	China		9,181,377
3	Japan		4,901,532
4	Germany		3,635,959
5	France		2,737,361
6	United Kingdom		2,535,761
7	Brazil		2,242,854
8	Russia		2,118,006
9	Italy		2,071,955
10	India		1,870,651
11	Canada		1,825,096
12	Australia		1,505,277
13	Spain		1,358,687
14	Mexico		1,258,544
15	South Korea		1,221,801

Source: International Monetary Fund (IMF), 2013

HDI Leaders

- ...the United States is ranked 5th for **Human Development Index**.
- *“The HDI was created to emphasize that **people and their capabilities** should be the **ultimate criteria** for **assessing the development** of a country, not economic growth alone...”*
– The United Nations
- China’s HDI is ranked 91st.

Rank	Country		HDI
1	Norway		0.944
2	Australia		0.933
3	Switzerland		0.917
4	Netherlands		0.915
5	United States		0.914
6	Germany		0.911
7	New Zealand		0.910
8	Canada		0.902
9	Singapore		0.901
10	Denmark		0.900
11	Ireland		0.899
12	Sweden		0.898
13	Iceland		0.895
14	United Kingdom		0.892
15	Hong Kong		0.891
15	South Korea		0.891

Source: UN Development Programme, 2013

Index of Economic Freedom

- *“Economic freedom is the **fundamental right** of every human **to control** his or her **own labor and property.**”*
 - The Heritage Foundation
- The index measures:
 - Rule of Law
 - Regulatory Efficiency
 - Limited Government
 - Open Markets
- Higher freedom is associated with:
 - Healthier societies
 - Human development
 - Cleaner environments
 - Poverty elimination
 - Greater per capita wealth
 - Democracy
- China’s freedom is ranked 137th.

Rank	Country		Score
1	Hong Kong		90.1
2	Singapore		89.4
3	Australia		82.0
4	Switzerland		81.6
5	New Zealand		81.2
6	Canada		80.2
7	Chile		78.7
8	Mauritius		76.5
9	Ireland		76.2
10	Denmark		76.1
11	Estonia		75.9
12	United States		75.5
13	Bahrain		75.1
14	United Kingdom		74.9
15	Netherlands		74.2

Source: The Heritage Foundation, 2014

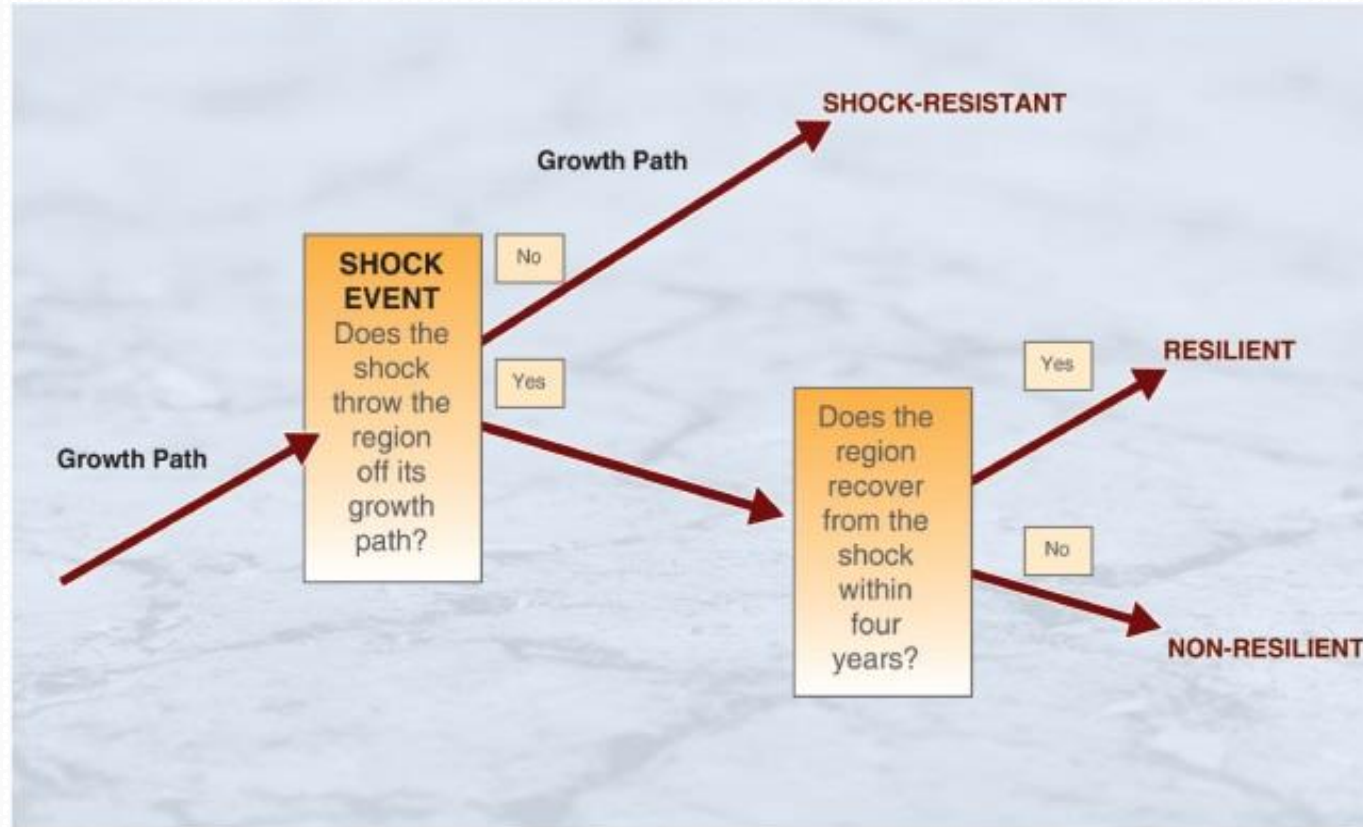
American Planning Association

- Observations from various metropolitan regions:
 - Standard resilience metrics resemble *general productivity metrics*
 - Age composition, years of education...
 - **Diversity** and **flexibility** of regional economy
 - *Quantity and type of industries* in a region
 - **Industrially strong city center** supports growth more than a vibrant suburban economy
 - Regions with **limited internal competition** suffer less adverse effects from economic shocks

Source: APA, "Conceptualizing and Measuring Resilience" (2012)

Identifying Resilient Growth

“...resilience is a process rather than an outcome.”



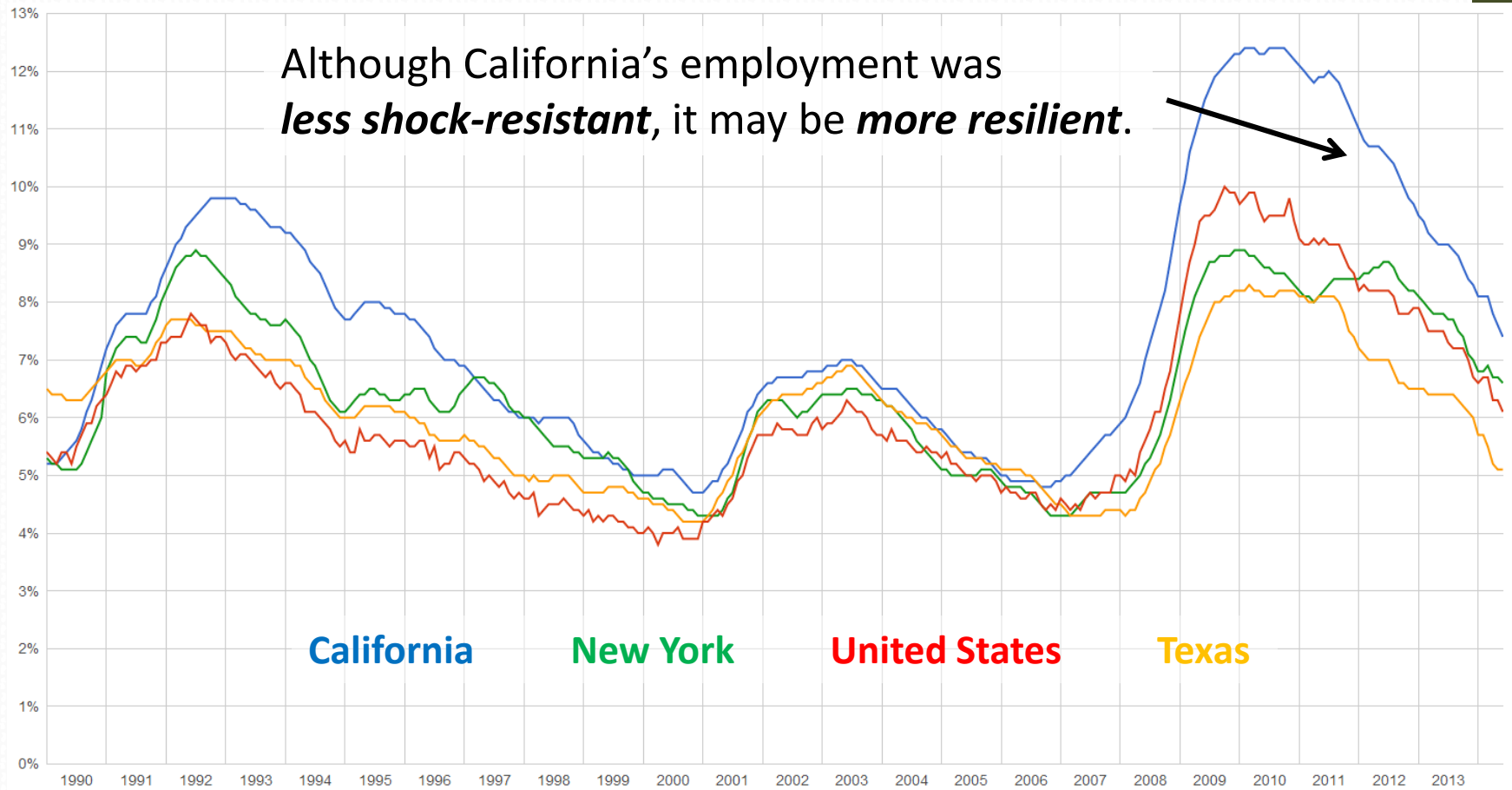
Source: MacArthur Foundation Research Network on Building Resilient Regions at University of California, Berkeley

California's Economy

- If the economies of US states were compared to the economies of countries, California would have the **8th largest economy** in the world (in terms of GDP).
- California's GDP accounts for 13.2% of the US's GDP.
- However...
 - For June 2014, California was tied for the **fifth-worst unemployment rate** in the nation at 7.4%.
 - In 2012, California was **fifteenth** in **per capita income** in the nation at \$44,980, just ahead of the national average.

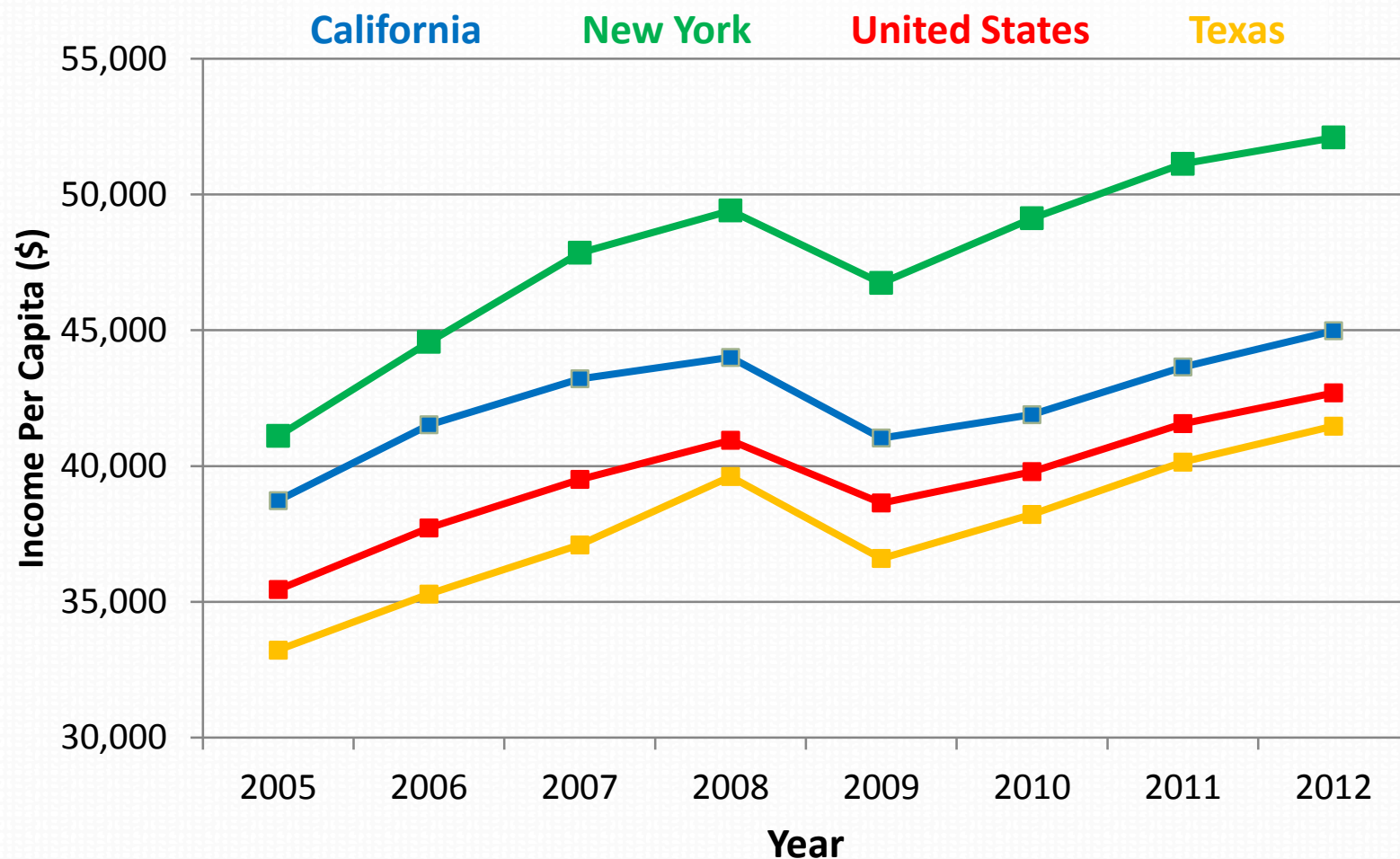
Sources: US Bureau of Economic Analysis (BEA), Bureau of Labor Statistics, International Monetary Fund, Bureau of Business and Economic Research

Selected Unemployment Rates



Source: Bureau of Labor Statistics

Selected Per Capita Personal Incomes



Source: Bureau of Business and Economic Research

California's Global Significance

- In 2012...
 - California emitted **458.68 million** tonnes of CO₂e...
 - ...while **31.6 billion** tonnes of CO₂e were emitted globally.
 - California accounted for **1.5%** of world emissions
 - The state ranked **14th in total CO₂ emissions** compared with other countries.
- California has **advanced its *resiliency and sustainability***
 - Global Warming Solutions Act, Scoping Plan
 - First multi-sector **cap-and-trade program** in North America
 - National leadership
 - **#2** state in CO₂e emissions per capita

Source: California Air Resources Board (CARB), International Energy Agency (IEA), UN

San Diego's Economy

- By metropolitan area...
- Consumer Price Index (CPI) - 2013

- Los Angeles 239.21
- **San Diego** 260.32
- San Francisco 245.02

Products in San Diego cost more than in Los Angeles and San Francisco.

- Unemployment Rate – June 2014

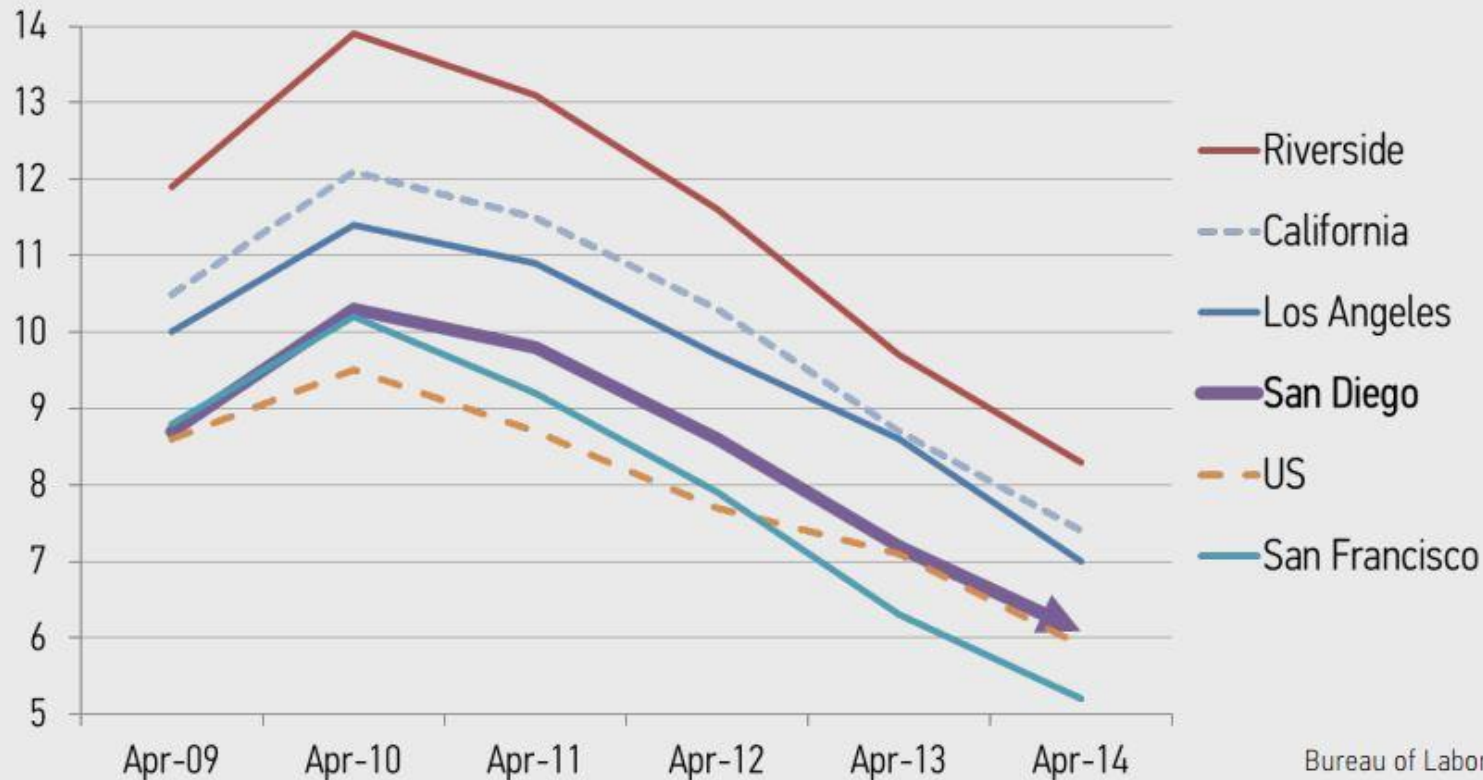
- Los Angeles 7.0%
- **San Diego** 6.1%
- San Francisco 5.2%

San Diego's unemployment rate has decreased more than California's since the 2008 financial recession.

Source: US Bureau of Labor Statistics,
San Diego Regional Chamber of Commerce

Selected Unemployment Rates

Unemployment Rate: California Comparison



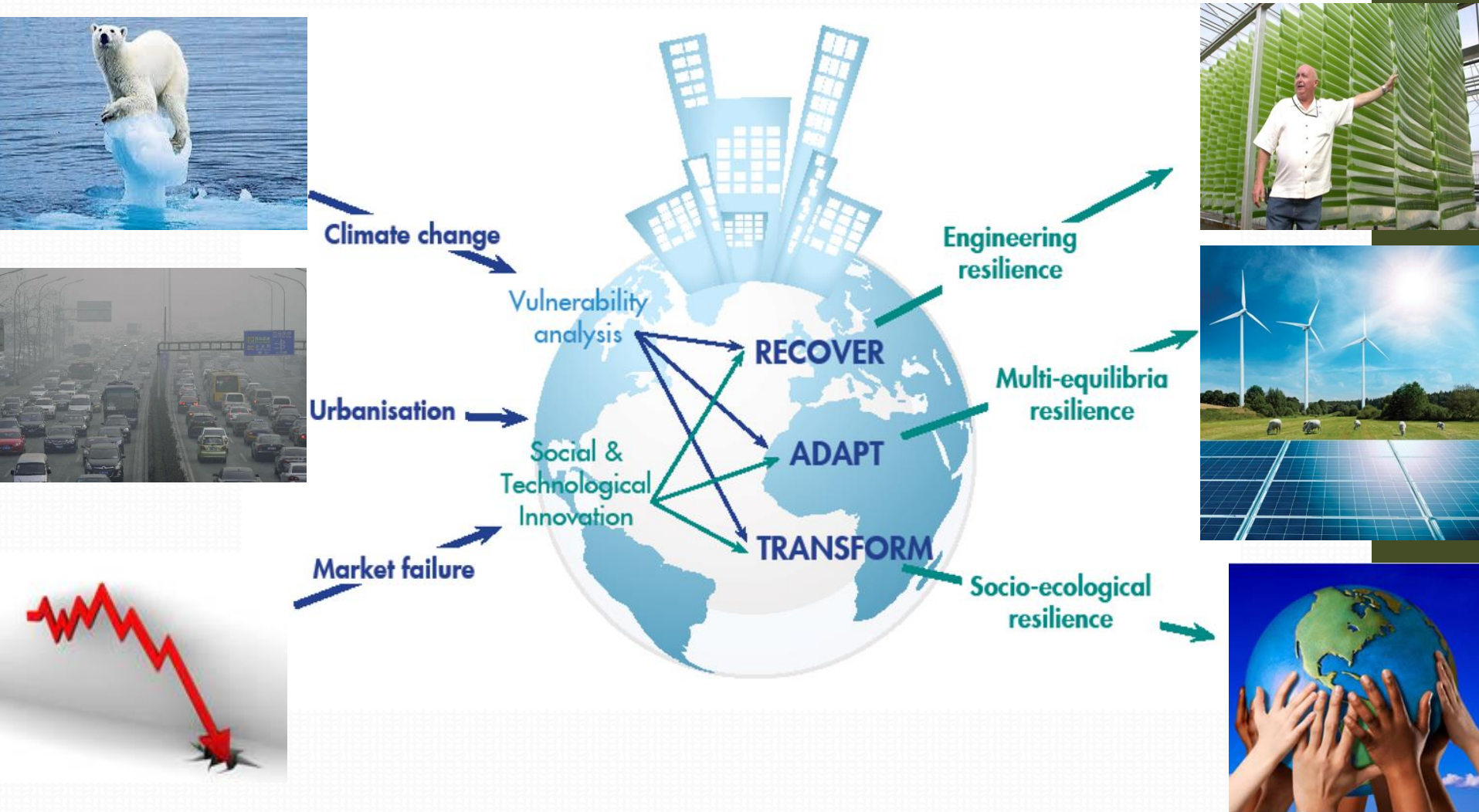
San Diego's employment was **less shock-resistant** than Los Angeles's and **less resilient** than San Francisco's.

Renewable Technologies

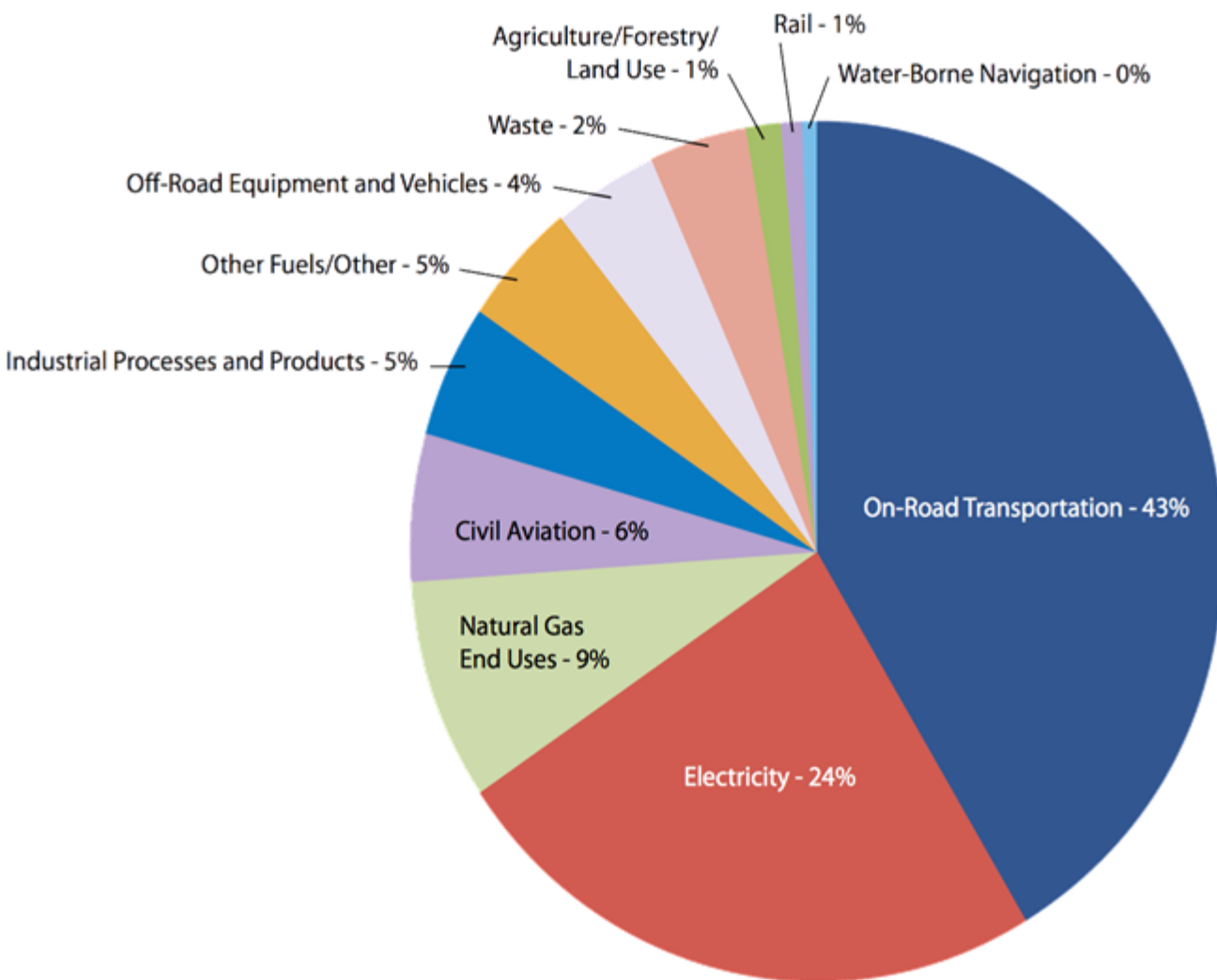
Identifying the economic costs and
environmental benefits of emerging technologies

Economics of New Technologies

Electric Cars, Fuel Efficiency, CO2 Emission



San Diego County Greenhouse Gas Emissions by Sector

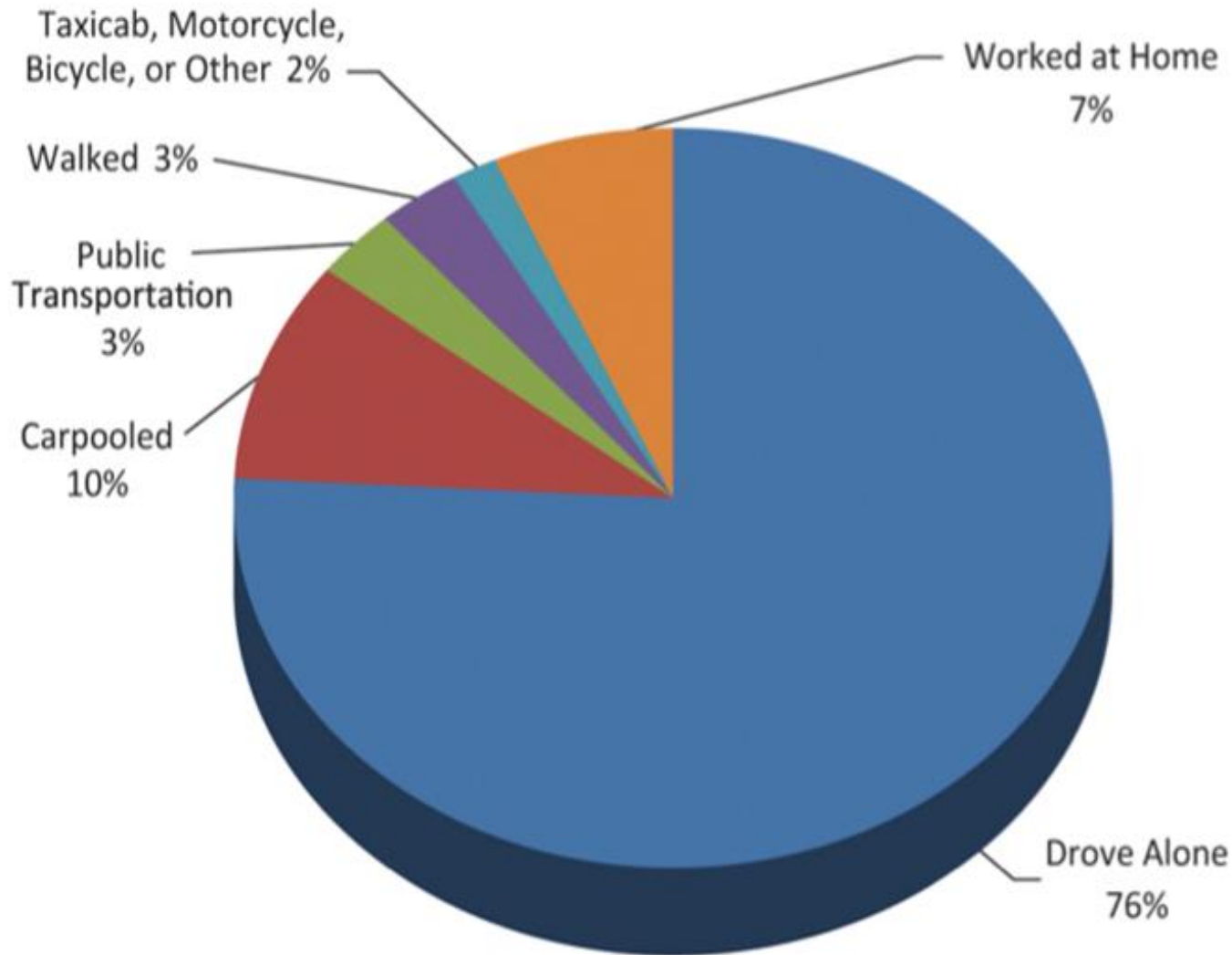


- 2/3 of greenhouse gas emissions in San Diego come from transportation and electricity generation.

Source: San Diego County GHG Inventory Executive Summary, 2010

TRANSPORTATION TO WORK

SAN DIEGO COUNTY, 2009



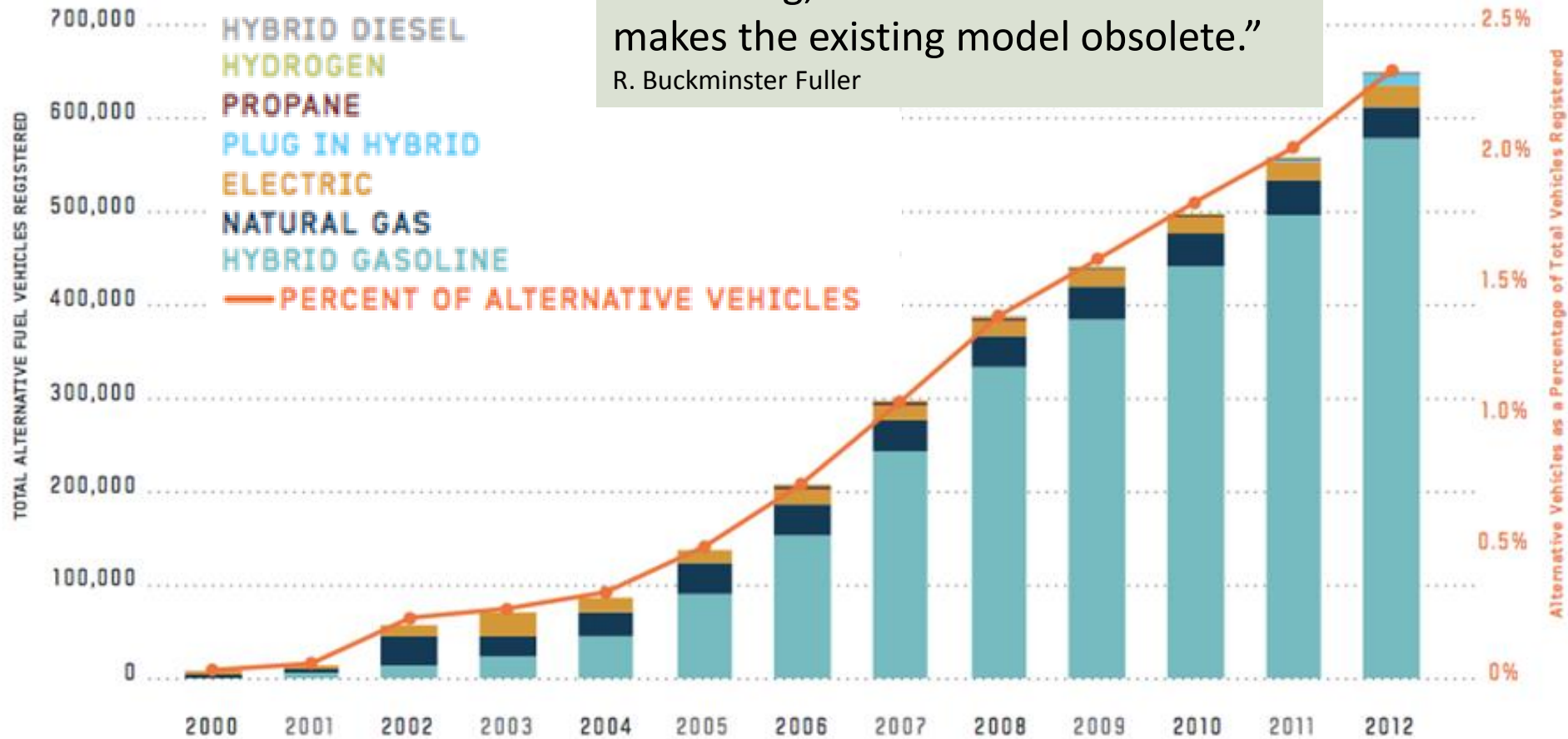
- 86% commute to work and most drive alone

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

TRENDS IN ALTERNATIVE FUEL VEHICLE REGISTRATIONS CALIFORNIA

“You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete.”

R. Buckminster Fuller



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX, Data Source: California Energy Commission, Analysis: Collaborative Economics

Economics of Electric Vehicles

Type of Car	MPG or MPkWh	Unit.	Miles per mon.	\$ per gallon or kWh	Cost per month	cost per year
Truck	15	MPG	1500	\$ 4.00	\$ 400	\$ 4,800
SUV	20	MPG	1500	\$ 4.00	\$ 300	\$ 3,600
Mid sedan	25	MPG	1500	\$ 4.00	\$ 240	\$ 2,880
Compact	30	MPG	1500	\$ 4.00	\$ 200	\$ 2,400
Hybrid	40	MPG	1500	\$ 4.00	\$ 100	\$ 1,800
Hybrid	50	MPG	1500	\$ 4.00	\$ 120	\$ 1,440
Leaf	3.333	MPkWh	1500	\$ 0.12	\$ 54.01	\$ 648
Volt	3.125	MPkWh	1500	\$ 0.12	\$ 58	\$ 691
Tesla	2.632	MPkWh	1500	\$ 0.12	\$ 69	\$ 820

Yearly cost to fuel

Gasoline-only
Based off
average 2012
compact getting
28.8 mpg



\$1,500

Plug-in hybrid electric

Runs on gas
and electricity
Based off Ford
Fusion PHEV



\$764

Battery-electric

Runs entirely
on electricity
Based off
Nissan LEAF

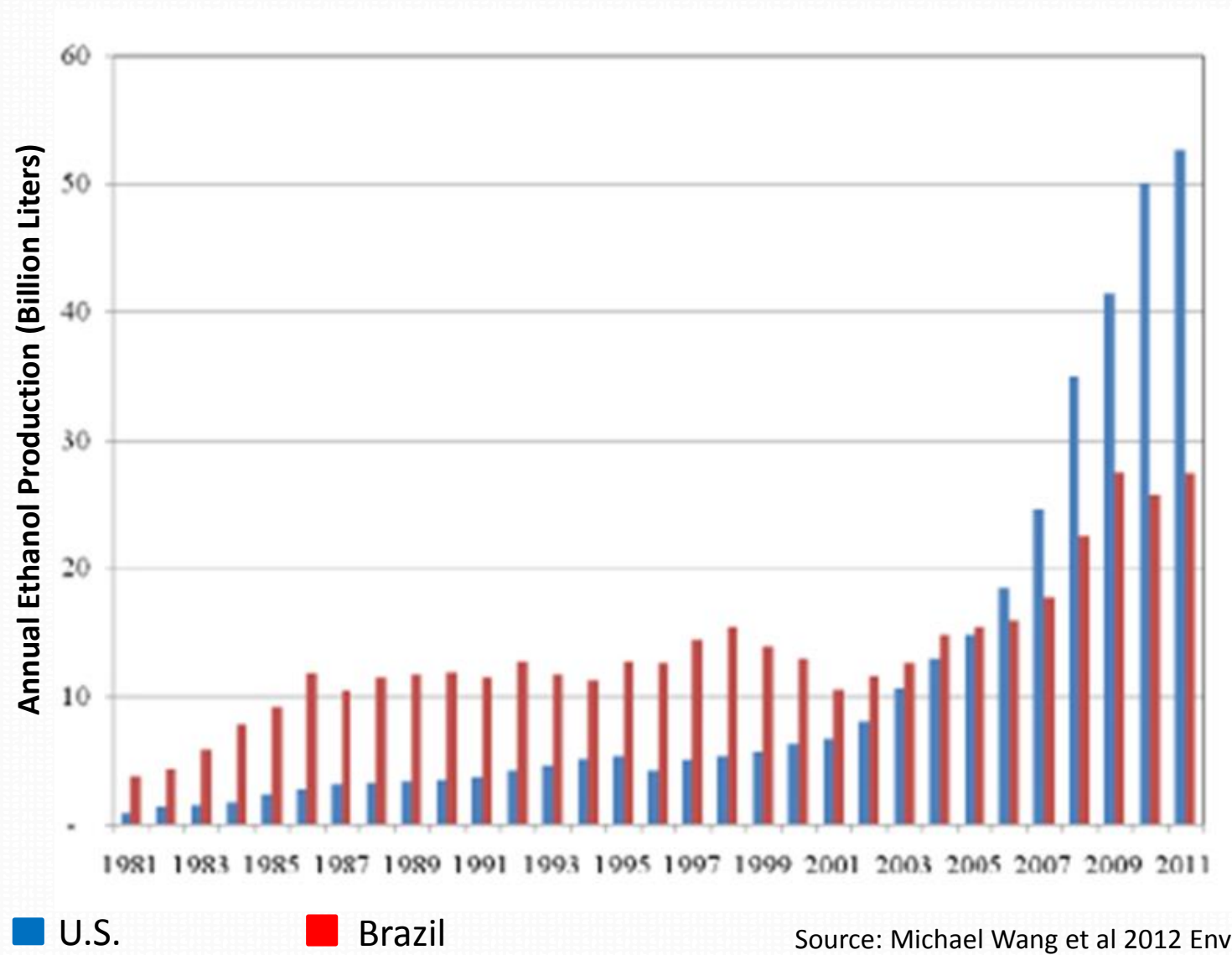


\$421

Source: Union of Concerned Scientists and Consumers Union THE STAR-LEDGER



Ethanol Production between 1981 and 2011 in the US and Brazil



Source: Michael Wang et al 2012 Environ. Res. Lett.

Ethanol Production: US and Brazil

The production of corn ethanol in the US has increased to more than 52 billion liters since the beginning of the US ethanol program in 1980. The increase after 2007, the year the Energy Independence and Security Act (EISA) came into effect, is remarkable.

Growth in the production of Brazilian sugarcane ethanol began in the 1970s when the Brazilian government began to promote its production.

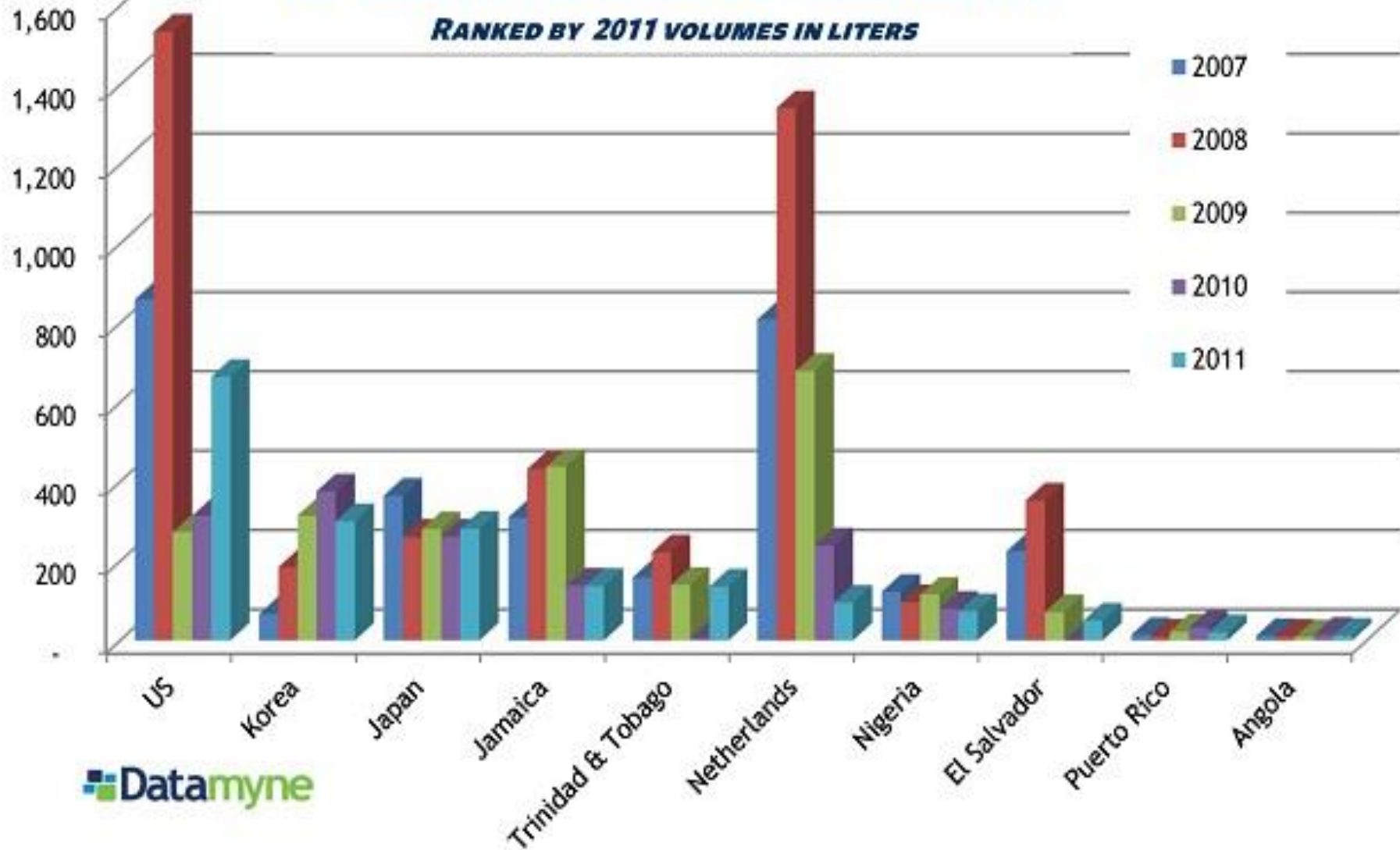
The most recent growth in sugarcane ethanol production, since 2001, has mainly resulted from the popularity of ethanol flexible-fuel vehicles and from the advantageous price of ethanol over gasoline in Brazil.



TOP MARKETS FOR BRAZIL'S ETHANOL EXPORTS

RANKED BY 2011 VOLUMES IN LITERS

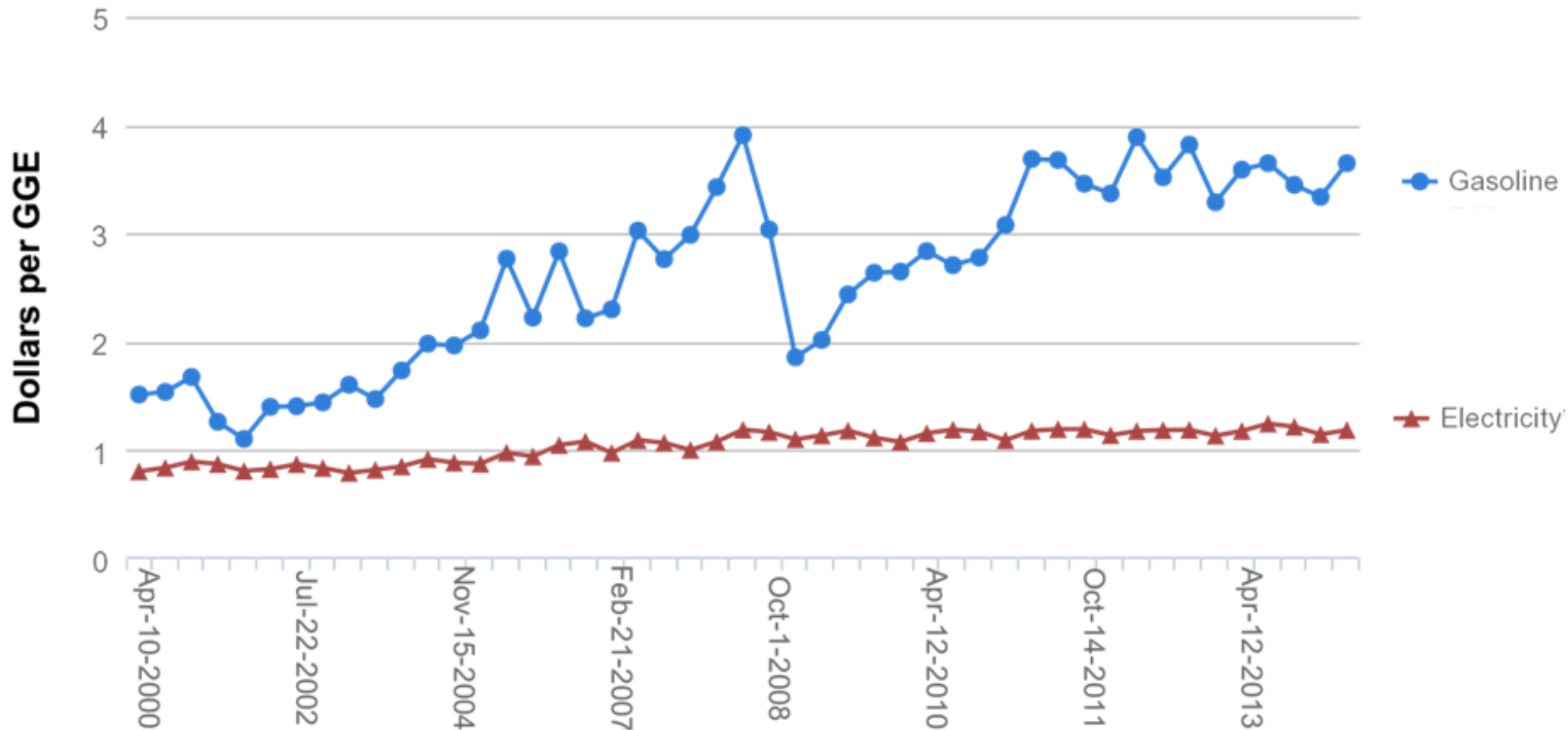
Millions



Datamyne

Due to increased US ethanol production, Brazilian exports have decreased over the past couple years.

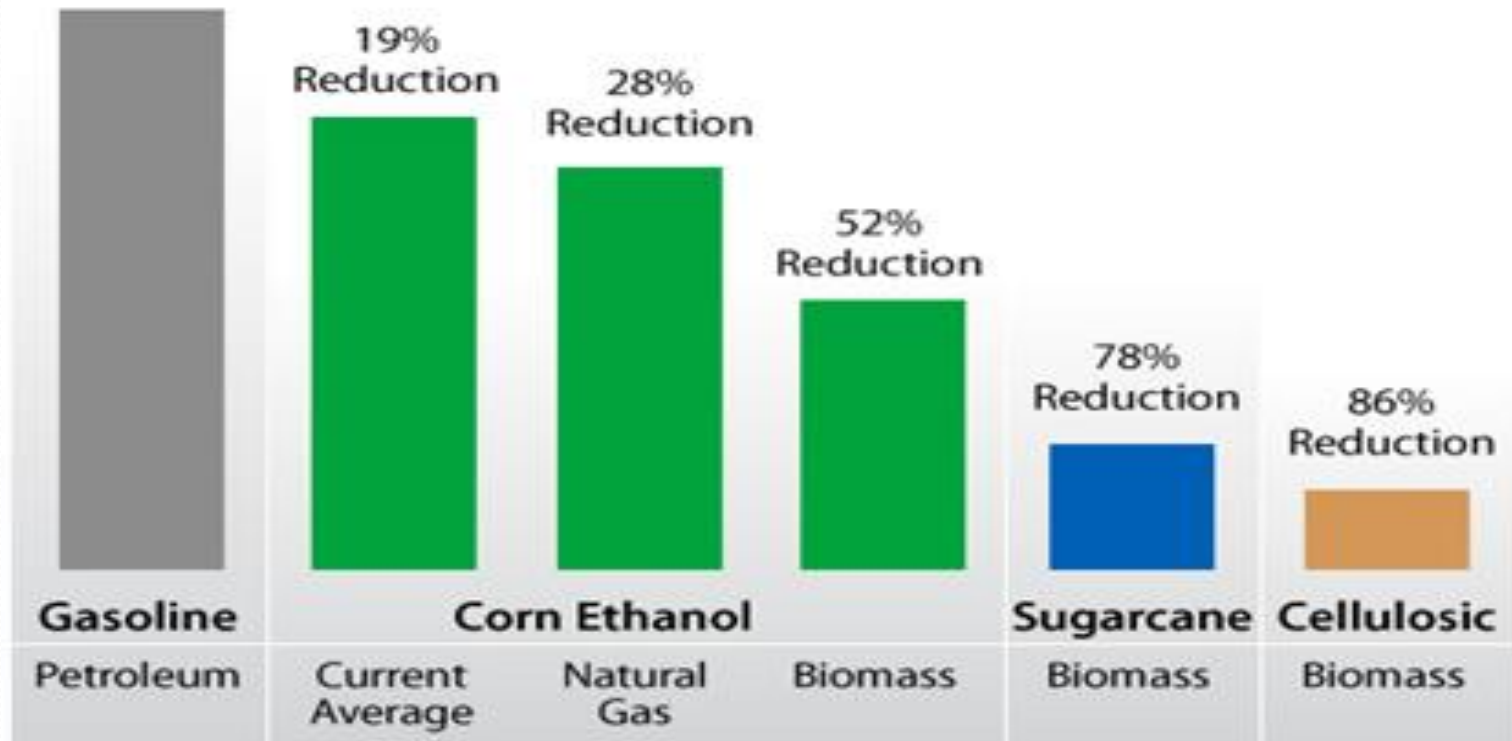
Average Retail Fuel Prices in the U.S.



Source: U.S. DOE Alternative Fuels Data Center

Gasoline prices are considerably more costly and volatile than electricity prices.

Greenhouse Gas Emissions of Transportation Fuels By Type of Energy Used Processing



A 2007 study by Argonne National Laboratory found that using corn-based ethanol instead of gasoline reduces life cycle GHG emissions by 19% to 52%, depending on the source of energy used during ethanol production.

Source: Life cycle Energy and Greenhouse Gas Emission Impacts of Different Corn Ethanol Plant Types (2007) and DOE Bioenergy Technologies Office

Greenhouse Gas Emission Analysis

Electric
Nissan Leaf



34 kWh/100 miles

VS.

Hybrid
Toyota Prius



2.5 Gallons/100 miles (40 MPG)

Calculations:

293 kWh = 200 lbs of CO₂ (Coal)

293 kWh = 117 lbs of CO₂ (Naturel gas)

Nissan Leaf emits:

23.2 lbs of CO₂ / 100 miles (Coal)

13.6 lbs of CO₂ / 100 miles (Naturel gas)

Calculations:

1 Gallon = 19.64 lbs of CO₂

2.5 Gallons = X

X = 49.1 lbs of CO₂

Toyota Prius emits approximately:

49.1 lbs of CO₂ / 100 miles

Source of Data: EIA

Car Sharing

A smart way to travel utilizing individual transportation, while reducing ownership costs and CO2 emissions.



- 0.41 per minute gas
- Included park it almost anywhere
- No reservation required
- No late fees
- Hundreds of cars
- Point-to-point carsharing

**CAR
2GO**



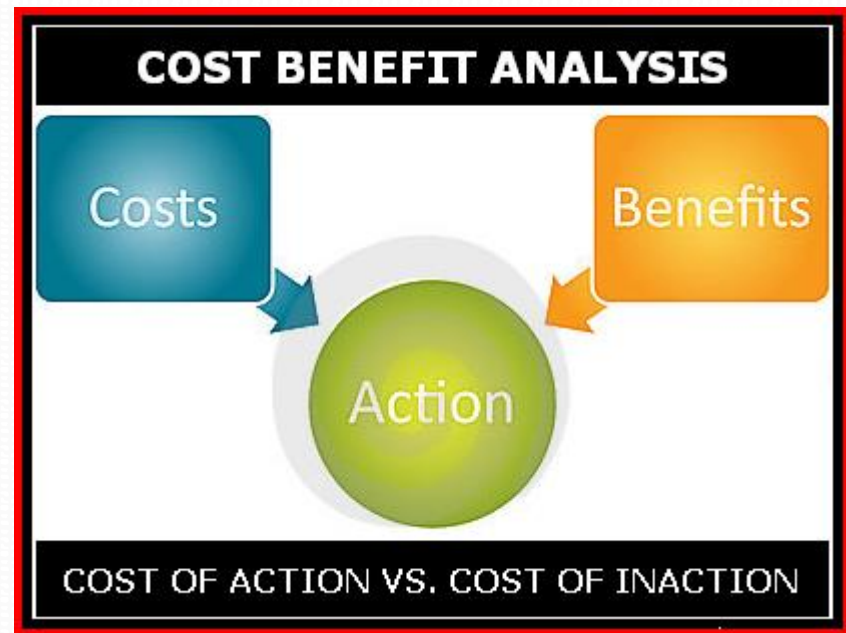
Applied Economics

The costs of climate change outweigh the economic benefits of inaction

Cost & Benefit

- At the end of the day, all decisions come down to whether the benefits of the action (financial, social, etc) outweigh the costs.

- Tied to Game Theory
 - If nobody else is investing in sustainable/resilient solutions, why should we?
 - Climate change is an international problem, why should the US take on the financial burden?



Reducing Pollution

- Negative Externalities
 - Emission of greenhouse gases damages others at no cost to the agent responsible for the externalities

Possible Solutions:

Carbon Taxes (Pigouvian)

- Emitters pay for their social costs of their actions
- Polluters know price to pay, but uncontrolled emissions
- Problem: People with money just pay the costs

Cap and Trade

- Limit number of licenses to emit a specified pollutant.
- Incentive to all players to reduce emissions
- Controlled amount of emissions, uncontrolled prices.

Source: Building a Green Economy, New York Times

American Clean Energy and Security Act

- Aka Waxman-Markey Bill
- Passed House, rejected by Senate
- Proposed cap and trade for GHGs
- Key Elements:
 - Required electric utility companies to reach 20% renewable by 2020
 - Subsidies
 - Renewable Energy: \$90 Billion by 2025
 - Carbon Capture and Sequestration: \$60 Billion
 - Technologies and research: \$40 Billion
 - Set GHG emission reduction targets for 2020 and 2050.



Source: Wikipedia

Action vs. Inaction

Cost of Action:

Congressional Budget Office

- “[Waxman-Markey] would reduce the projected average annual rate of growth of [GDP] between 2010 and 2050 by .03 to .009 percentage points.”
- Trim annual GDP growth from 2.4 to 2.31 percent at worst
- Strong climate change policy would leave American Economy 1.1-3.4% smaller in 2050 compared to business as usual.

Cost of Inaction

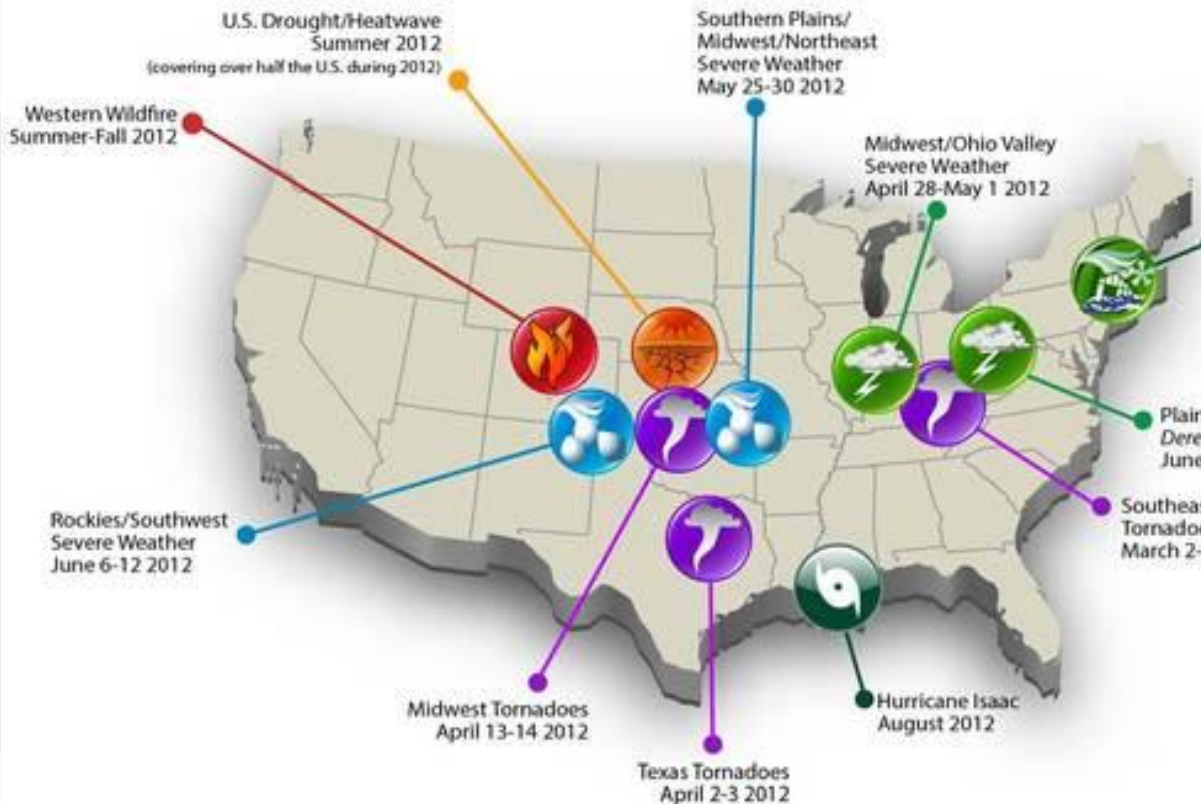
- +9 degree Fahrenheit increase by 2100
- Extreme weather, Changed precipitation patterns, Sea Level rise, shifting ocean currents
- William Nordhaus (Yale) predicts that unmitigated global warming will result in a 5% reduction in global GDP

Source: Building a Green Economy, New York Times

Who pays for Climate Change?

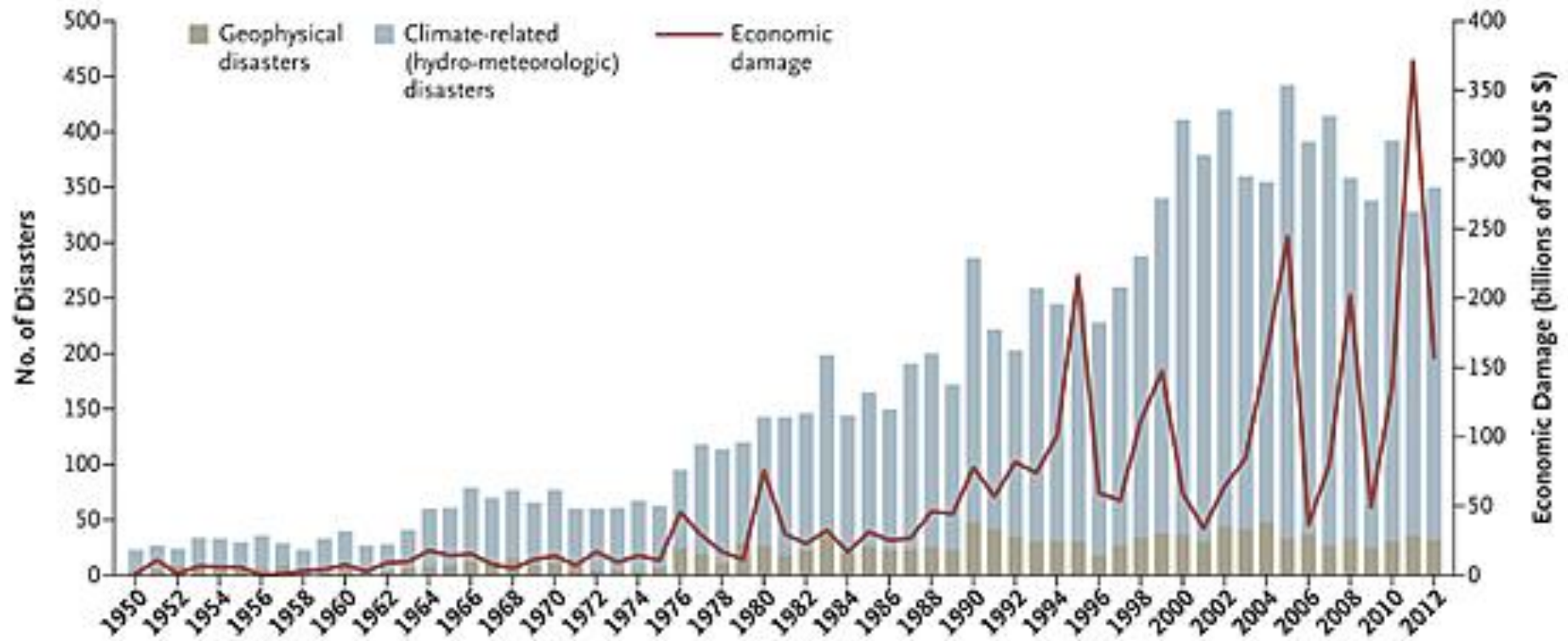
- America's taxpayers paid three times what private insurers paid to cover losses from extreme weather
- More American taxpayer dollars were spent on consequences of weather in 2012 than on education and transportation (\$139 Billion damages)

U.S. 2012 Billion-dollar Weather and Climate Disasters



Source: Natural Resource Defense Council

Climate Change & Natural Disasters



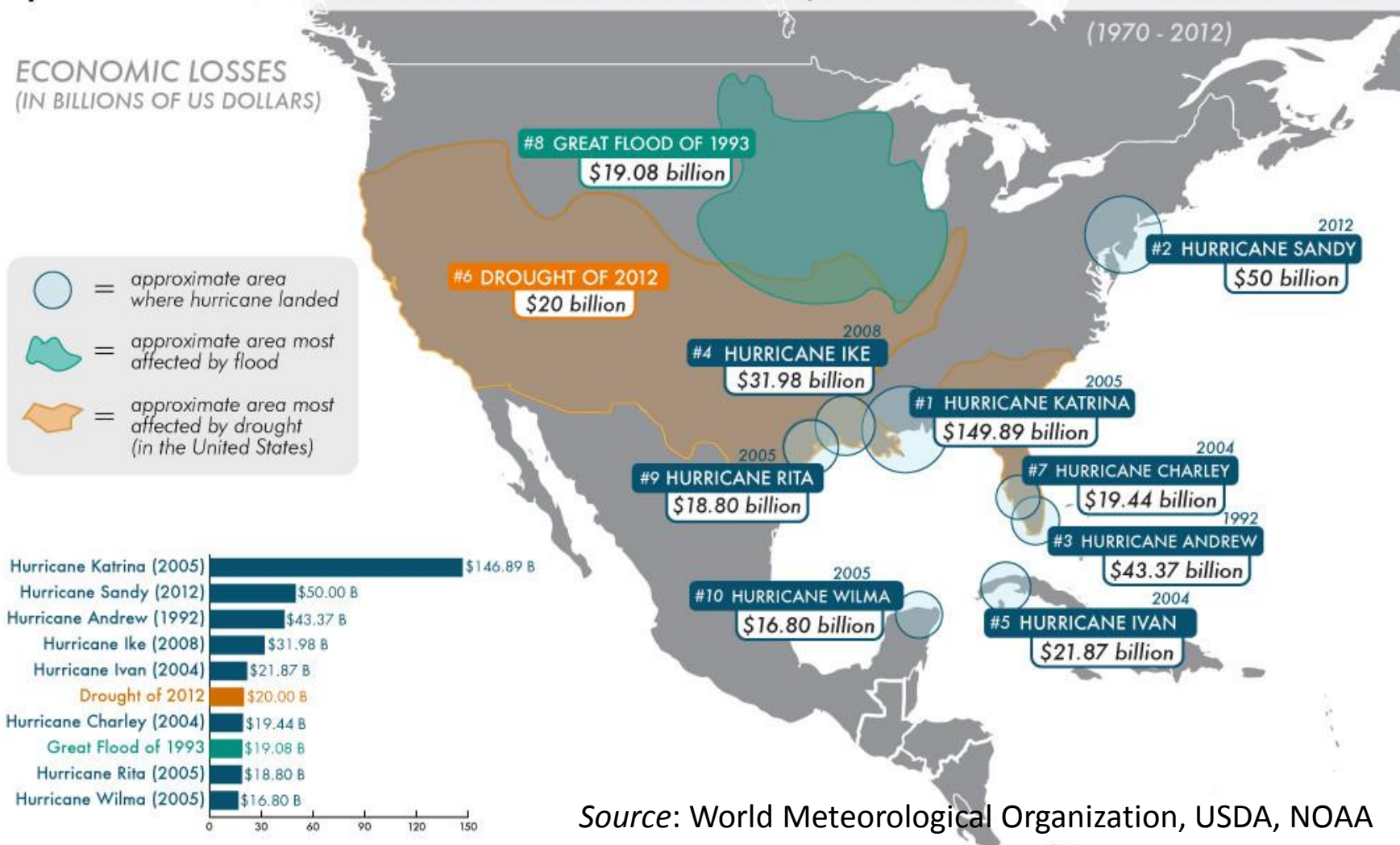
Source: Accuweather

Economic Effects of Natural Disasters

Top 10 Costliest Extreme Weather Events in North America, Central America & the Caribbean:

gp

ECONOMIC LOSSES
(IN BILLIONS OF US DOLLARS)



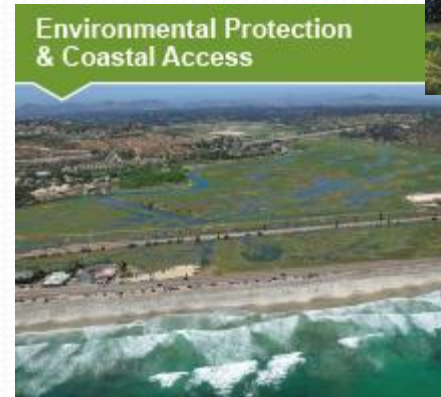
Source: World Meteorological Organization, USDA, NOAA

Resiliency Planning Challenges

- “Every \$1 spent on hazard mitigation saves society an average of \$4.” – Carl Hedde, Vice President, Munich Re
- Key Challenges
 - Securing funds for adaptation
 - Integrating adaptation into existing work
 - Gaining commitment from political decision makers
 - Lack of economic growth
 - Fixed infrastructure
 - Obtaining accurate scientific data
 - Generating interest among businesses

Source: Urban Climate Adaptation Planning, MIT

North Coast Corridor (NCC) Program



Source: Keep San Diego Moving, Transnet

North Coast Corridor (NCC) Program

- Better Environment for the Future (2010-2040)
 - Add Express Lanes on I-5 & other enhancements
 - Upgrade coastal rail and transit system
 - Enhance six lagoons and improve coastal access
 - Addition of 23 miles of bicycle and pedestrian path
 - \$200 Million to preserve, enhance and protect coastal habitats
 - Replace old bridges with modern structures
- Total Coast: ~\$6.5 Billion
 - Paid through combination of federal, state, and local funds.
 - Part of *TransNet*, tax incentive for transportation projects in the region

Source: Keep San Diego Moving, Transnet

Highway Expansion

- I-5 Express Lanes Project
 - Part of North Coast Corridor Public Works Plan / Transportation Restoration Enhancement Program (PWP/TREP)
 - Submitted by Caltrans and SANDAG
 - The addition of two Express Lanes in each direction for a 27 mile stretch of I-5 between La Jolla Village Drive and Harbor Drive in Oceanside.
 - Early Cost Estimation ~\$3.3 Billion

Source: Keep San Diego Moving, Transnet



Express Lanes



- Proposed Benefits
 - Smart Lanes, Price changes to ensure that lanes remain congestion free. Fee ranges from \$0.50 to \$8.00 depending on congestion and time of day.
 - Express Lanes encourage transit alternatives.
 - Generate funds to further improve transit corridor
 - I-15 project generates enough revenue to fund transit service improvements.
- Perceived Negatives
 - Perpetuates use of single occupancy vehicle.
 - Inadequate GHG reduction
 - Funding could be used towards transit oriented development

Source: Keep San Diego Moving, Transnet

Trolley Expansion

- Mid-Coast Corridor Transit Project
 - Extend service from Sante Fe Depot to University City communities.
 - Supposed to “enhance direct public access to other regional activity centers and improve travel options to employment, education, medical, and retail centers for corridor residents, commuters, and visitors.”
 - Project costs: ~\$1.7 Billion
 - *Transnet* providing 50% match to federal New Starts funding.
- Trolley Overview
 - Existing 53 stations on 53.5 miles of track
 - 3% of San Diegans use Public Transit
 - 122,400 daily ridership
 - Stalling rider numbers



Source: SANDAG

Bike Infrastructure

- Facts

- 1.3% of San Diegans commute to work by bicycle
- 509 miles of bike path
- 97.2% of injuries reported occurred without dedicated lane
- 3 Types: Bike Lane, Routes, Path.



Source: City of San Diego, UTSandiego

Future of Biking

Moving Forward

- San Diego Bicycle Master Plan Update 2013 recommends an additional 595 miles of bike lanes, double the current amount
- ~\$312 million for full build out
- \$200 million funding approved by SANDAG in 2013
- Cost of 1 mile of bike path: up to \$1 million



Source: City of San Diego, UTSandiego

San Vicente Dam

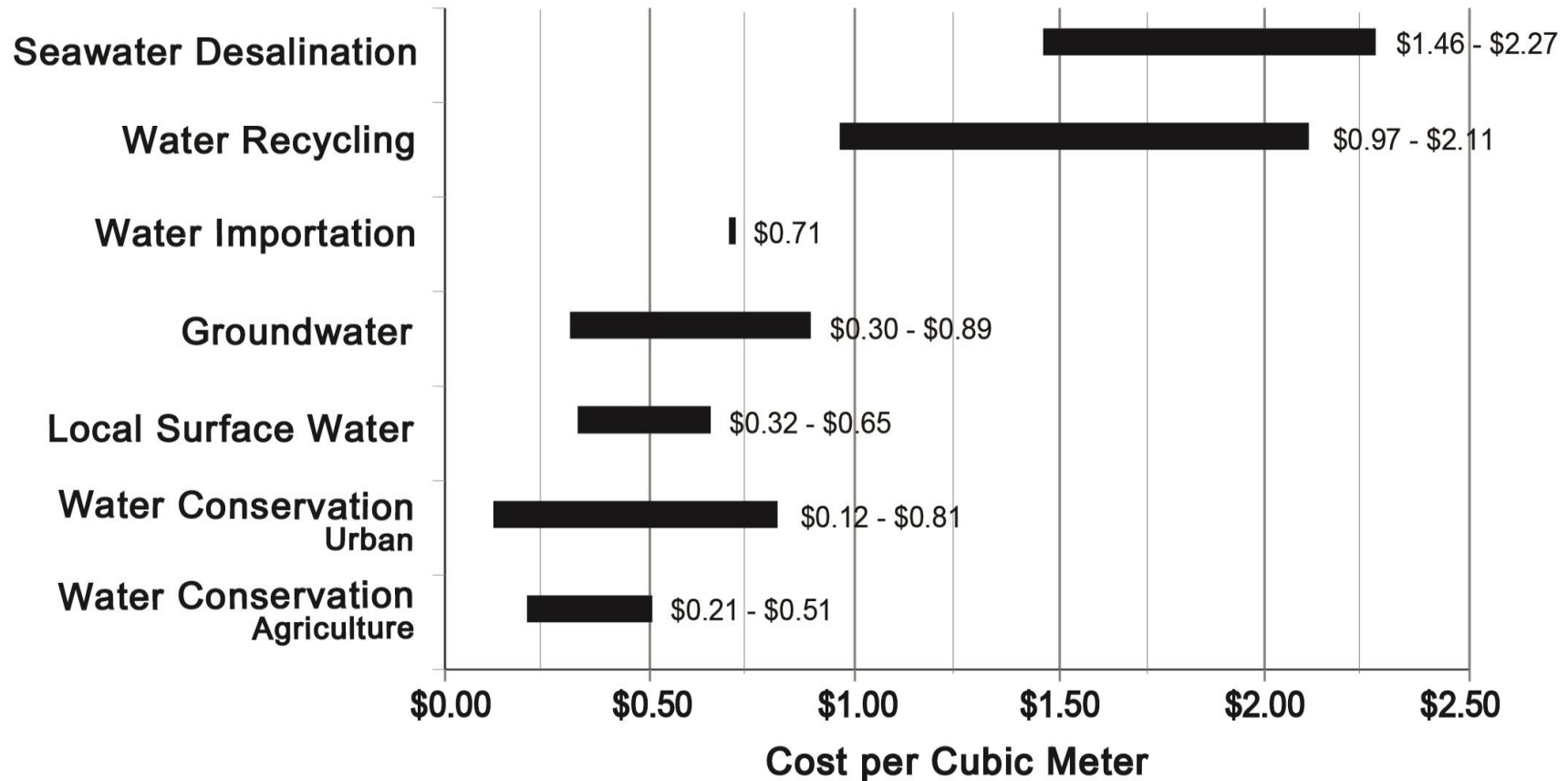
An aerial photograph of the San Vicente Dam, a large concrete structure spanning a deep canyon. The reservoir behind the dam is a deep blue, winding through the arid, brownish-yellow hills. In the foreground, there's a construction or maintenance area with various vehicles, equipment, and some buildings. The surrounding landscape is rugged with sparse vegetation and distant mountain ranges under a clear sky.

Water Storage – San Vicente Dam Raise

- ▶ Increased lake capacity by 150,000 AF from 90,000 AF
- ▶ Total project cost - \$568 million
- ▶ Construction completed early 2013
- ▶ Depending upon rainfall and water supply and demand, will take 2 – 5 years to fill to capacity

Source: SDCWA

Comparison of Prices of Future Water Supply Solutions



All of these are solutions but urban and agriculture water conservation are the most cost effective.

Source: Brian Richter The Nature Conservancy and University of Virginia

Carlsbad Desalination Plant



- Cost: 700 million dollars + Financing costs = Around \$1 Billion
 - An increase of \$11.40/month when the project comes on line in 2016
 - Estimated an increase of \$5 – 7 per month by 2016 due to the increasing cost of electricity.
- Provide around 50 gallons of water per day – 7-10% of San Diego region's drinking water

Source: City of Carlsbad

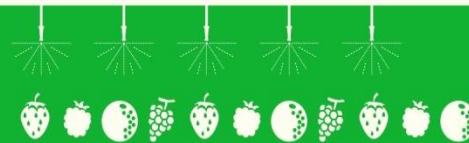
Every year, California uses

**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

**14 million acre-feet
(total potential savings) =**

- enough to serve 20 cities the size of Los Angeles every year
- enough to fill Shasta Lake—California's largest reservoir—three times

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



Agriculture

Irrigation Systems

- The right amount of water has to reach the right area at the right time.

High Capital Investment for Sprinkler and Micro-irrigations

- First-step improvements, changing on-farm management practices and installing new irrigation water delivery systems
- Conversion to Drip irrigations: \$500 - \$2000 per acre

System	Method	Description
Surface (Gravity)	Flood	Water is diverted from ditches to fields or pastures
	Furrow	Water is channeled down furrows for row crops or fruit trees
	Border	Water is applied to sloping strips of fields bordered by ridges
	Surge	Valves control delivery of water to fields in intermittent surges
Sprinkler (Pressurized)	Pivot & linear systems	High pressure
		Medium pressure
		Low pressure
	Side rolls	Mobile pipelines deliver water across fields using sprinklers
	Solid set	Pipes placed on fields deliver water from raised sprinkler heads
Micro-irrigation (Pressurized)	Surface	Emitters along pipes or hoses deliver water directly to the soil surface
	Sub-surface	Emitters along pipes or hoses deliver water below the soil surface
	Micro-sprinklers	Emitters on short risers or suspended by drop tubes sprinkle or spray water above the soil surface

Source: Salas et al. 2006

Agriculture

Efficiency Improvements

- Reduction in operation costs and/or increase in crop revenue

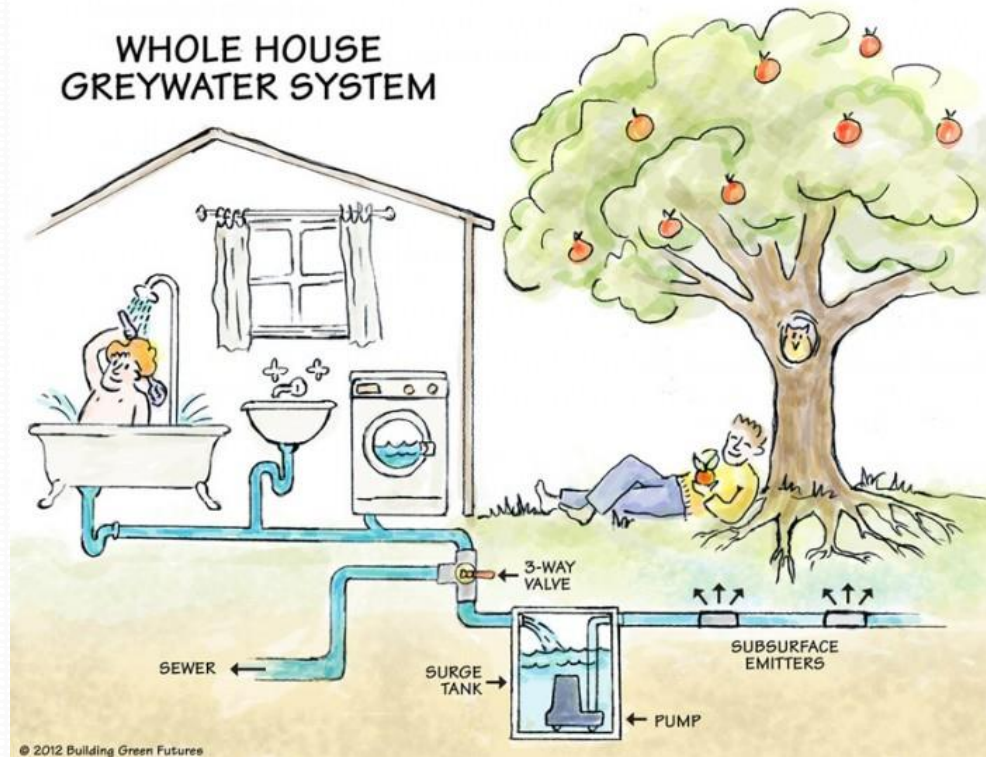
[Drip micro irrigation](#)

Type of Irrigation System	Efficiency
Flood	
Basin	85%
Border	77.5%
Furrow	67.5%
Wild Flooding	60%
Gravity	75%
Average	73%
Sprinkler	
Hand Move or Portable	70%
Center Pivot and Linear	82.5%
Move	
Solid Set or Permanent	75%
Side Roll Sprinkler	70%
LEPA (Low Energy	90%
Precision Application)	
Average	78%
Drip /Micro irrigation	
Surface Drip	87.5%
Buried Drip	90%
Subirrigation	90%
Micro Sprinkler	87.5%
Average	89%
Note: Efficiency is defined here as the volume of irrigation water beneficially used (equal to evapotranspiration) divided by the volume of irrigation water applied minus change in storage of irrigation water.	

Source: Salas et al. 2006

Water Reuse

Water reuse is expanding, driven in part by the drought but also by efforts to develop a more reliable, local water supply



Greywater



Low tech, simple residential greywater system costs Roughly Averages:

Laundry to Landscape

Materials only: \$100 – 250

Full Installation: \$700 – 2,000

Branched Drain

Materials only: \$200 - 800

Full Installation: \$800 – 3,000

Pumped-System

Materials only: \$400 - 600

Full Installation: \$1,000 – 3,000

High-end, high tech residential greywater system costs Roughly Averages:

Sand filter to drip irrigation

\$ 5,000 – 10,000

depending on the complexity of the plumbing and compatibility of existing drip irrigation system

Source: Greywater Action

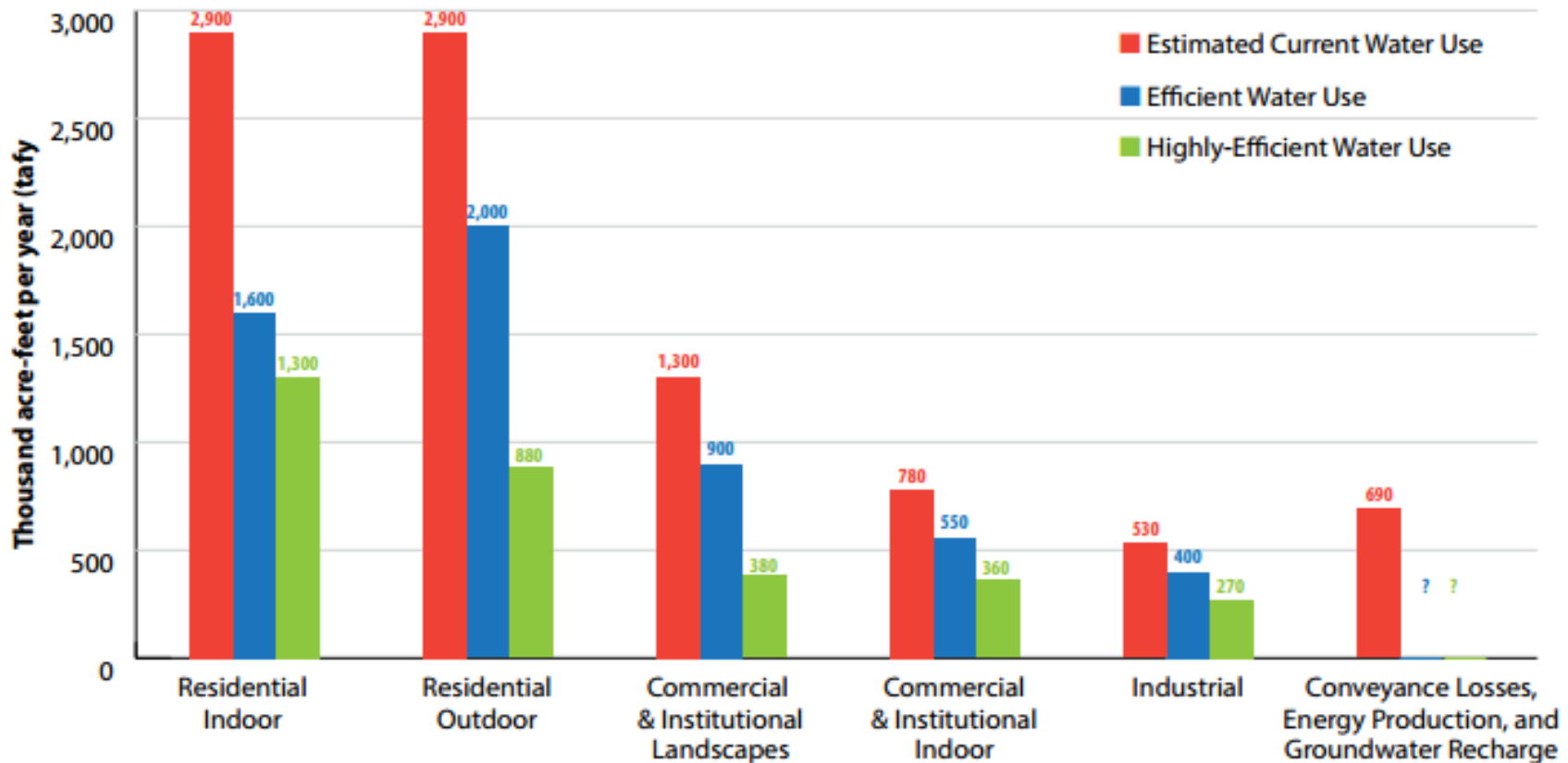
Urban Water Conservation

Table 1. Water budget for one person using efficient appliances and fixtures

End Use	Assumptions	Gallons per person per day
Leaks	Reduced to zero	0
Toilets	4.8 flushes per day @ 1.28 gallons per flush	6.1
Clothes washer	2.3 loads per week @ 14.4 gallons per load	4.7
Shower	4.7 showers per week for 8.7 minutes each with conserving showerhead rated at 2.0 gpm and throttle factor of 72% for actual flow rate of 1.44 gpm	8.4
Bath	2.24 baths per week @ 18 gallons each	5.8
Faucets	10.1 minutes per day at an average flow rate of 0.64 gpm	6.5
Dishwasher	0.85 times per week @ 3.5 gallons per load	0.4
Total	Efficient Household Water Budget	32

Source: nrdc

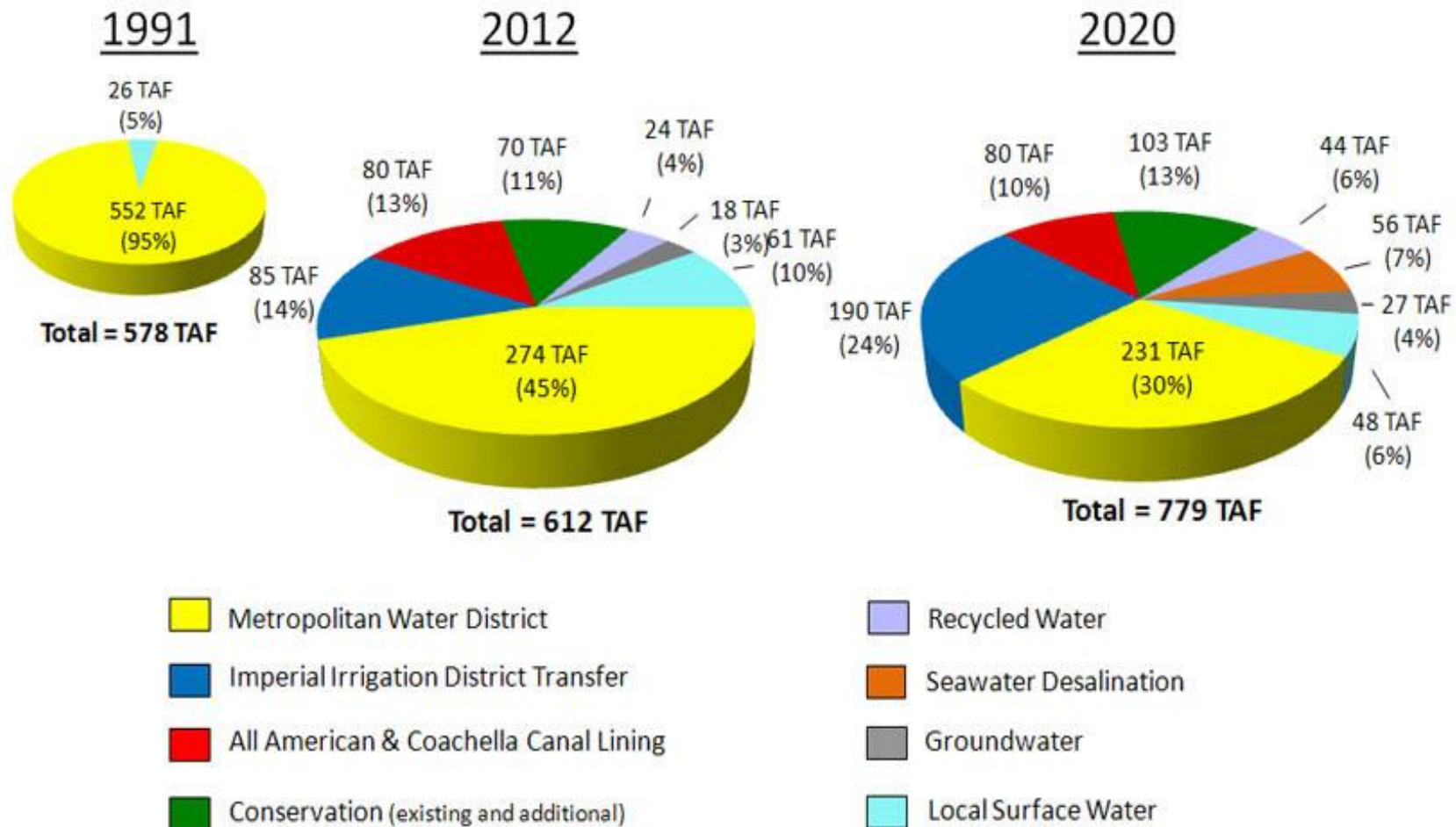
Urban Water Conversation



Note: We did not evaluate water savings in the areas of conveyance, energy production, and groundwater recharge, which account for 8 percent of withdrawals for urban water use in California.

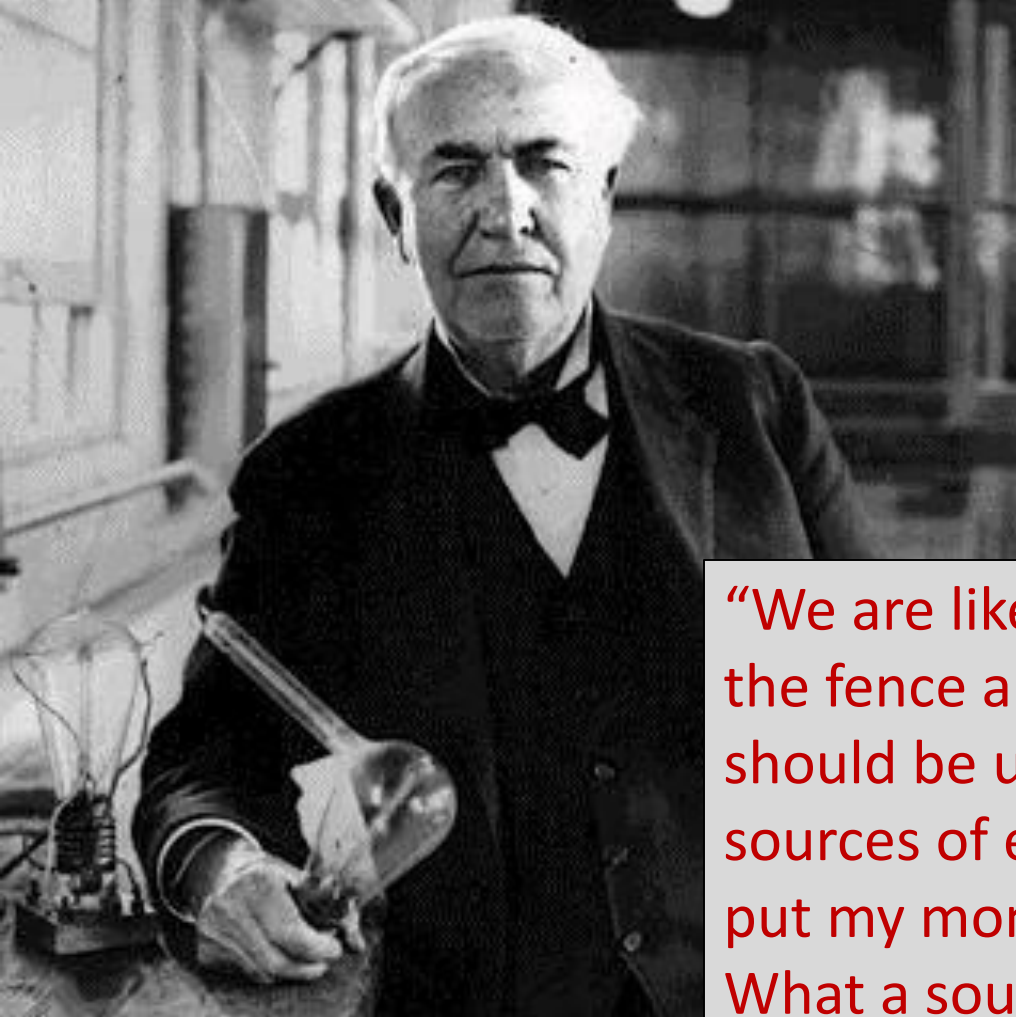
Source: nrdc

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



TAF=Thousand Acre-Feet

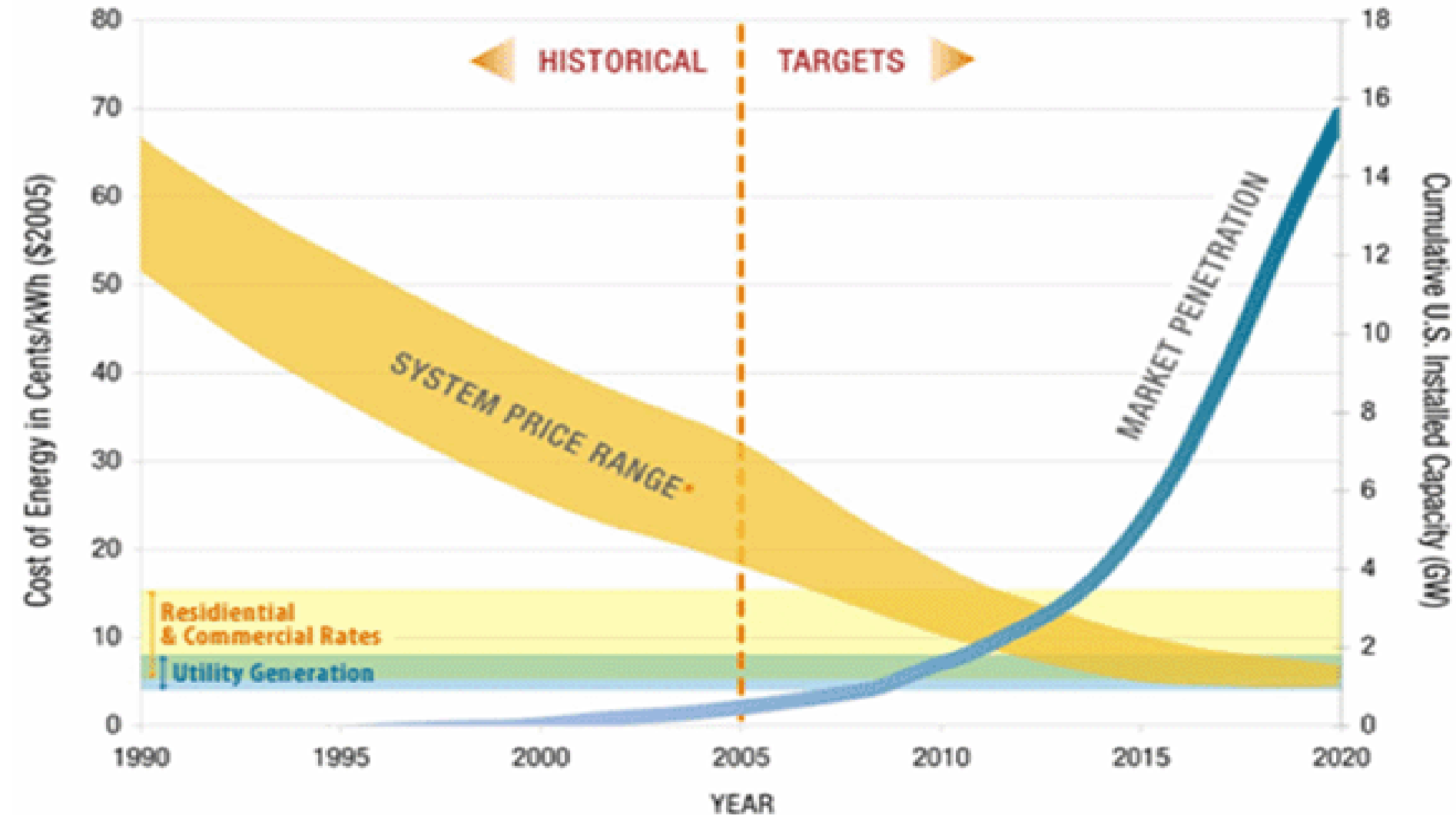
Source: SDCWA



Solar Energy

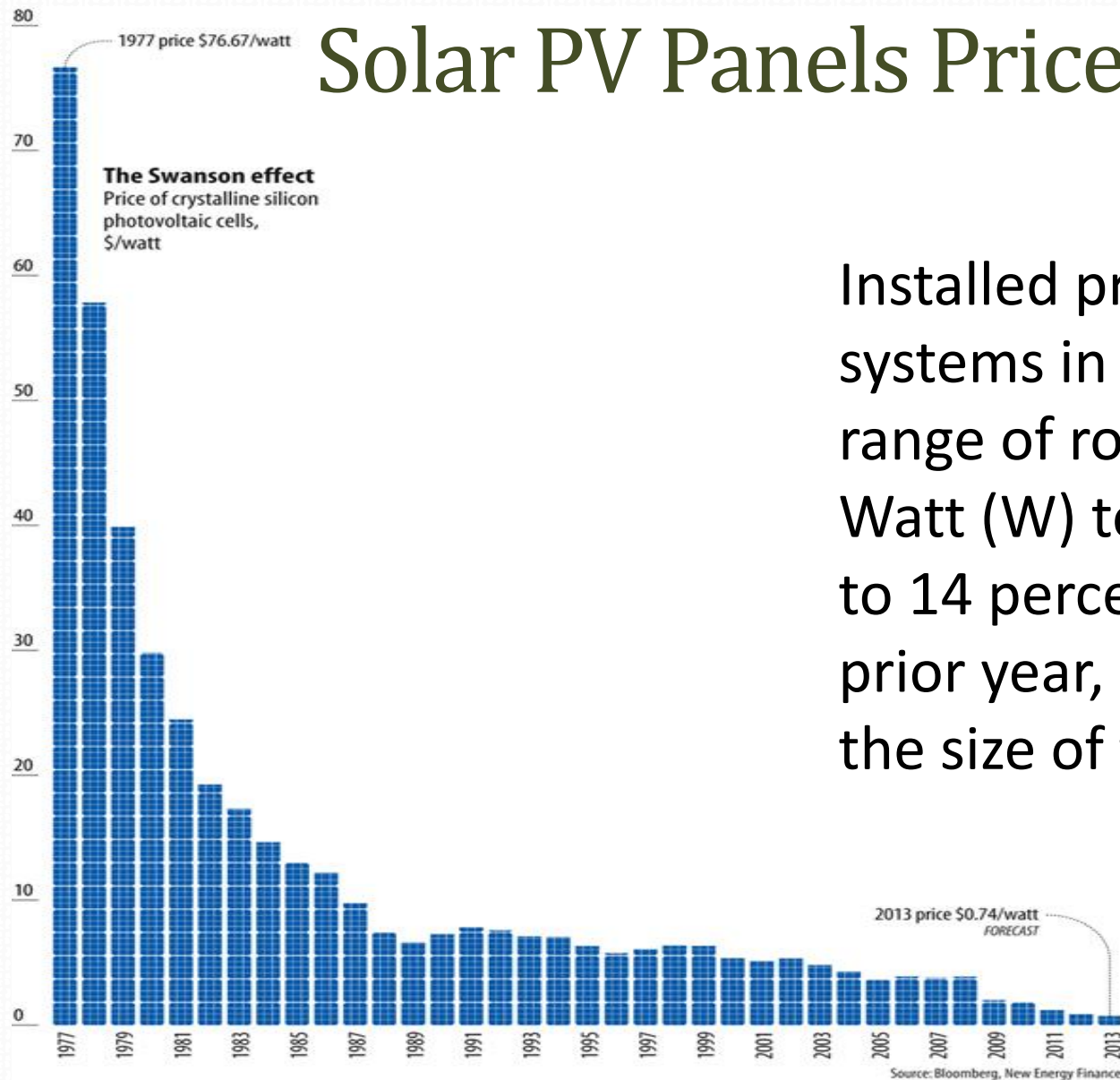
“We are like tenant farmers chopping down the fence around our house for fuel when we should be using Nature's inexhaustible sources of energy — sun, wind and tide... I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that.” – Thomas Alva Edison

Solar Grid Parity



Source: U.S. Department of Energy

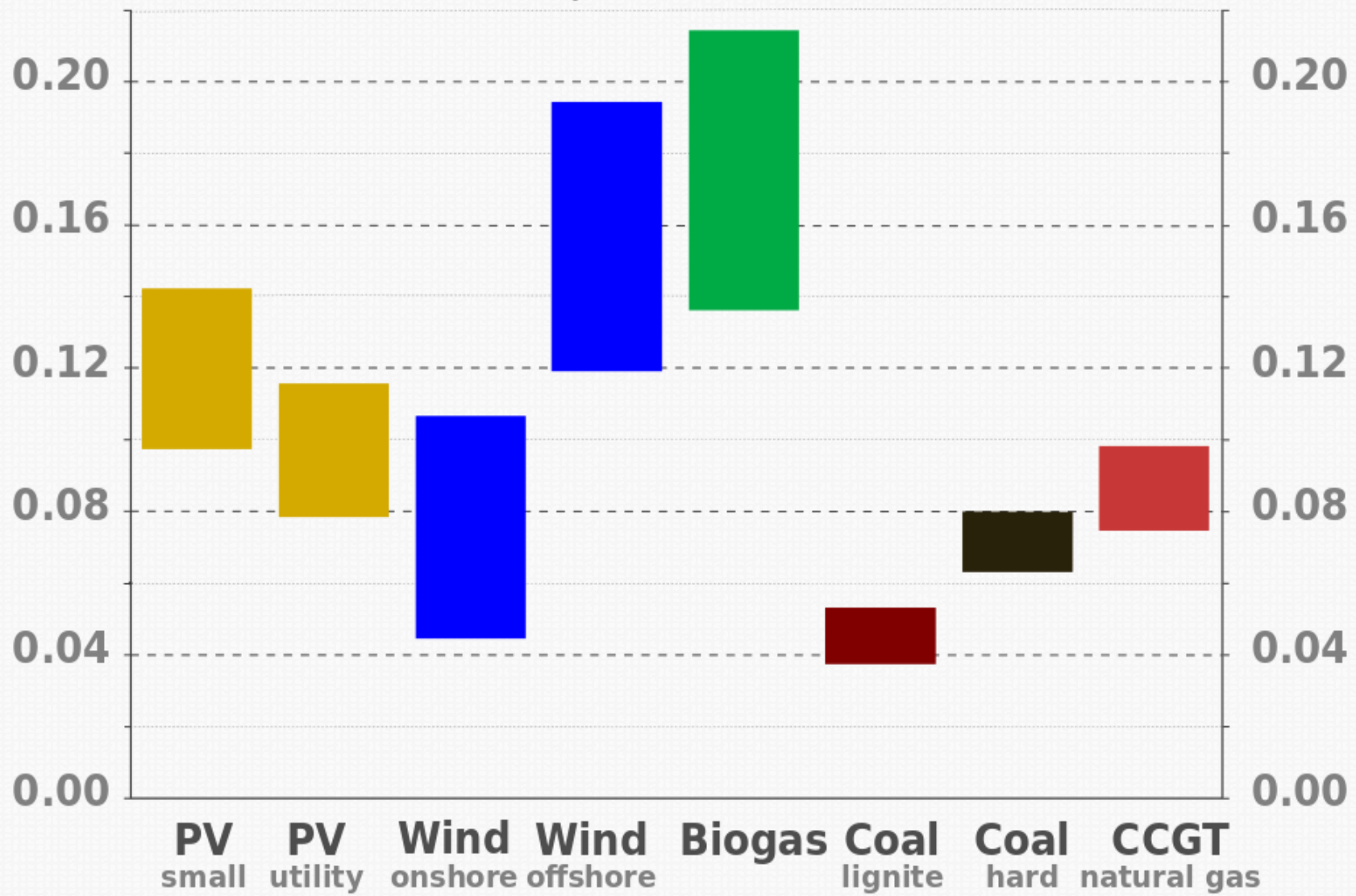
Solar PV Panels Price Drop



Installed prices for PV systems in 2012 fell by a range of roughly \$0.30 per Watt (W) to \$0.90/W, or 6 to 14 percent, from the prior year, depending on the size of the system.

Levelized Cost of Electricity in € per kWh

Source: Fraunhofer ISE, Germany November 2013



Cost of Residential Solar Power

- Depending on the location and design of your system, the typical home installation ranges from **3 to 7 kilowatts** and costs between **\$18,000 to \$40,000** to purchase.
- Homeowners can receive 30% off the cost of solar in the form of a federal energy tax credit.
 - The California Solar Initiative
- Property Assessed Clean Energy Programs (PACE)
 - Residential and commercial property owners within participating areas can finance 100% of their project and pay it back over time as a voluntary property tax assessment through their existing property tax bill.

Source: Sunrun, PACE

Case Study: California Apartment Complex with Solar Hot Water

Utility	PG&E
Min.Daily Demand @ 80% BTU	1,875,150
Est. Water Storage Requirements	3,000 Gallons
# of Free Hot Water 7000 collectors:	66 panels
Roof area required:	3,500 sq. ft
Est. gas bill for hot water before solar:	\$16,000/year
Est. Cost <i>before</i> rebate, incl. engineering	\$180,000
Estimated California Rebate:	\$ -86,000
Estimated 30% Federal Tax Credit:	\$ -54,000*
Estimated Net System Cost:	\$40,000
Estimated Payback time:	About 3 yrs!
CO2 Saved from the environment over 25 years:	3 Metric Tons

Source: Free Hot Water

Los Vecinos Apartments

- LEED-Certified Platinum
 - Ceiling fans and natural ventilation
 - Tank-less water heaters
 - Energy Star appliances
- 100% solar powered -93 KW system
- Annual Savings
 - Electricity: 15,300 KWh
 - Gas: 3,600 therms
 - Water: 1,200,000 gallons
- 42-unit green housing
- Eligible resident's income
 - \$16,600 – \$58,800



Source: SDG&E

American Recovery and Reinvestment Act in 2009

Carlsbad	\$938,900	National City	\$561,700
Chula Vista	\$1,974,300	Oceanside	\$1,571,100
Coronado	\$125,762	Poway	\$212,800
Del Mar	\$25,000	San Diego	\$12,541,700
El Cajon	\$881,100	The San Diego County	\$5,140,200
Encinitas	\$554,200	San Marcos	\$738,800
Escondido	\$1,273,300	Santee	\$480,300
Imperial Beach	\$145,393	Solana Beach	\$70,365
La Mesa	\$506,200	Vista	\$849,300
Lemon Grove	\$132,374	TOTAL	\$28,722,794

Allocation of Energy Efficiency and Conservation Block Grant Funding in San Diego County

Source: San Diego Foundation

Summary

- Currently, economic growth *depletes* **non-renewable** energy sources, such as fossil fuels, as its primary source of energy.
- Resources are the **primary constraint** for economic growth.
- The size of the US economy suggests that it has great **economic potential** for resilient development. We need to place a greater emphasis on building resiliently.
- The actions that California will take toward resiliency will have a **large influence** on the US economy, due to California's size.

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