

Climate Change and Vulnerable Populations

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Dry-Run Definition of Vulnerability

- Exposure:
 - The character of climate change which an individual/population experiences
- Sensitivity:
 - The susceptibility to damage
- Adaptive capacity:
 - The ability to adjust to changes, to moderate potential damage, take advantage of opportunities, or cope with consequences.

2011, Japan, 9.1 magnitude earthquake followed by 30-foot wave tsunami damaged 6 nuclear reactors. 1/3 million people displaced: 22,000 deaths and missing



2015, Japan, worst flood in 60 yrs. Government mobilized 51 helicopters, 6000 rescuers. 100,000 displaced: 23 people missing,.

Outline

- Climate change exacerbates inequality
- Complexity of “vulnerability”
- Community response
- Government policy that helps Earth and vulnerable population



Inequality

Climate Change Worsens Social/Health Inequality

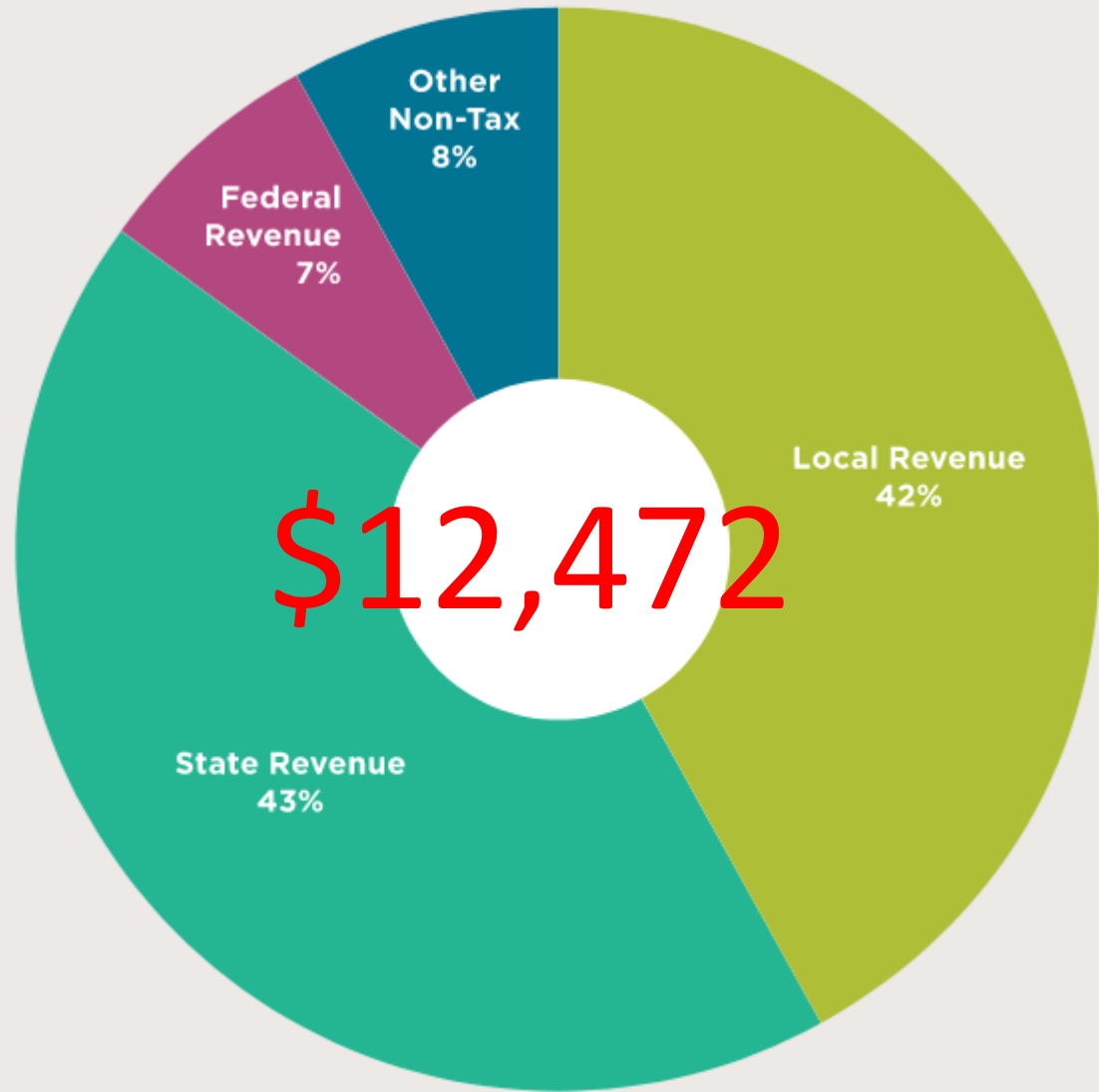
- Inequality among nations has narrowed in past 50 yrs
- Climate change dampened per capita incomes in the world's poorest countries up to 30% (India, Nigeria).
 - Developing countries are disproportionately in tropics
 - Heat increase devastates crops, labor, health
- Norway, big oil/gas producer, is 34% richer
- The young
 - Climate model predicts **88%** climate change burden born by children under age 5

Climate change worsens health/economic inequality

- In poverty, wealth concentrated in material forms, such as housing or livestock
 - Assets are more fragile.
- Livelihoods, agriculture and fishing, are climate-sensitive
 - Prone to environmental damage
 - The erosion of natural assets forces them to shift
 - From crop to hybrid crop-livestock agriculture
 - Wage labor
 - Alternative income may not be available



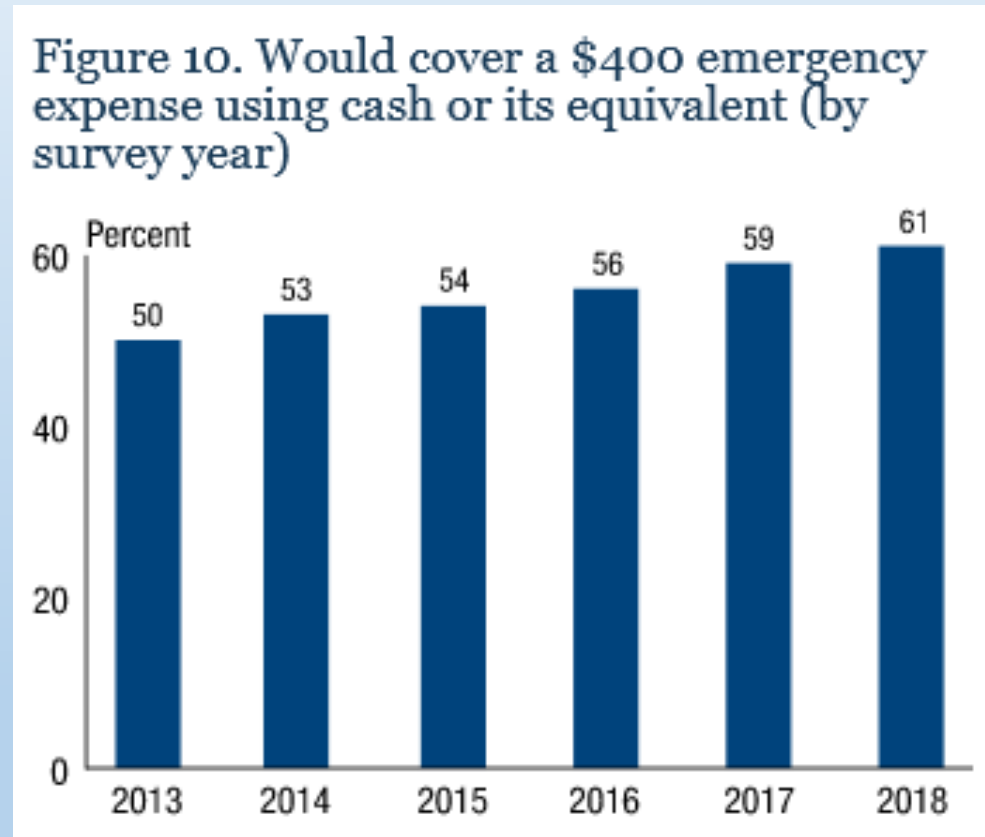
A 400 square foot flat can accommodate nearly 20 double-decker sealed bedspaces Credit: Benny Lam/SoCO



\$12,472

Problems at home:

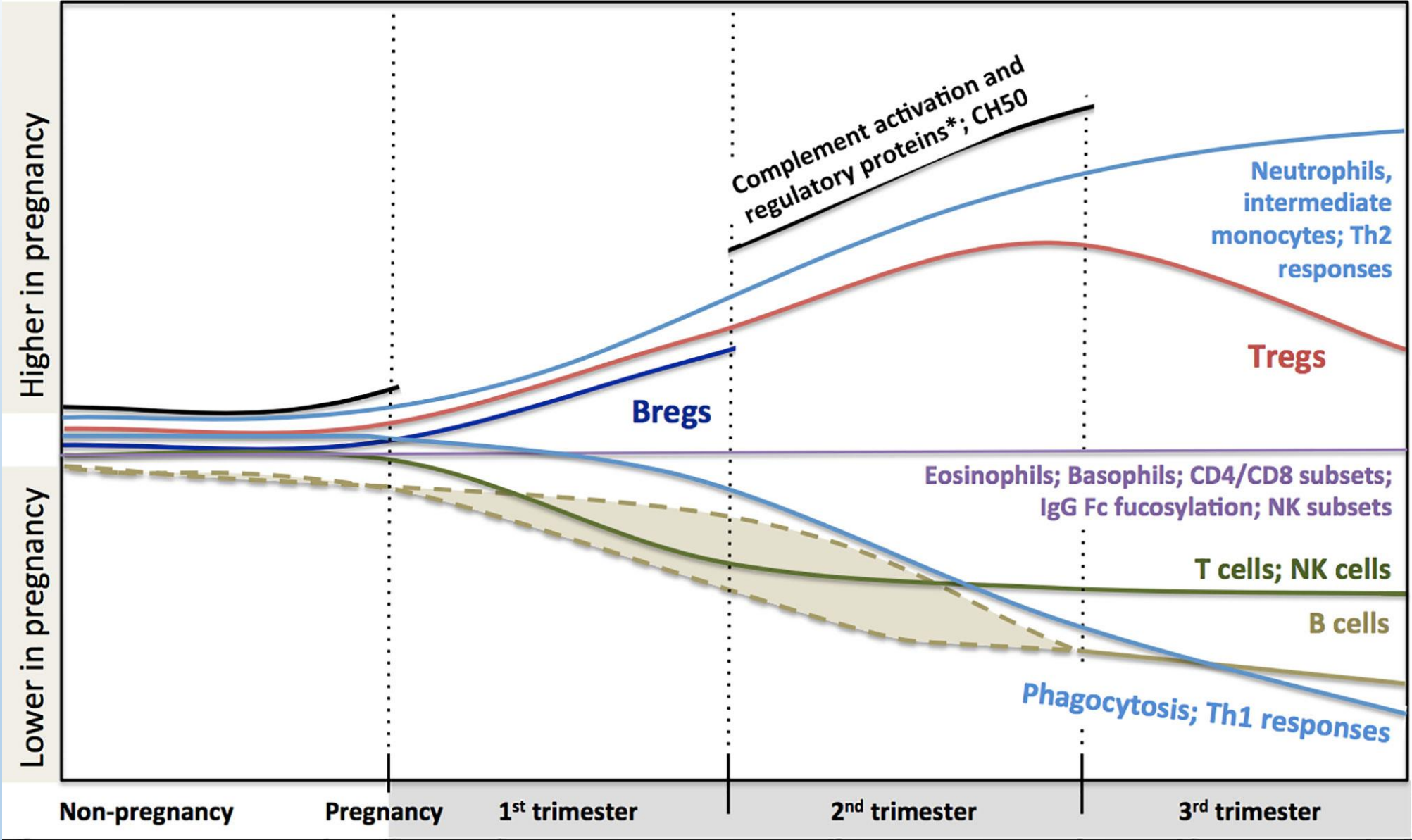
Fed stat: For a \$400 unexpected charge, 40% US population could not pay it w/o borrowing money or selling something.



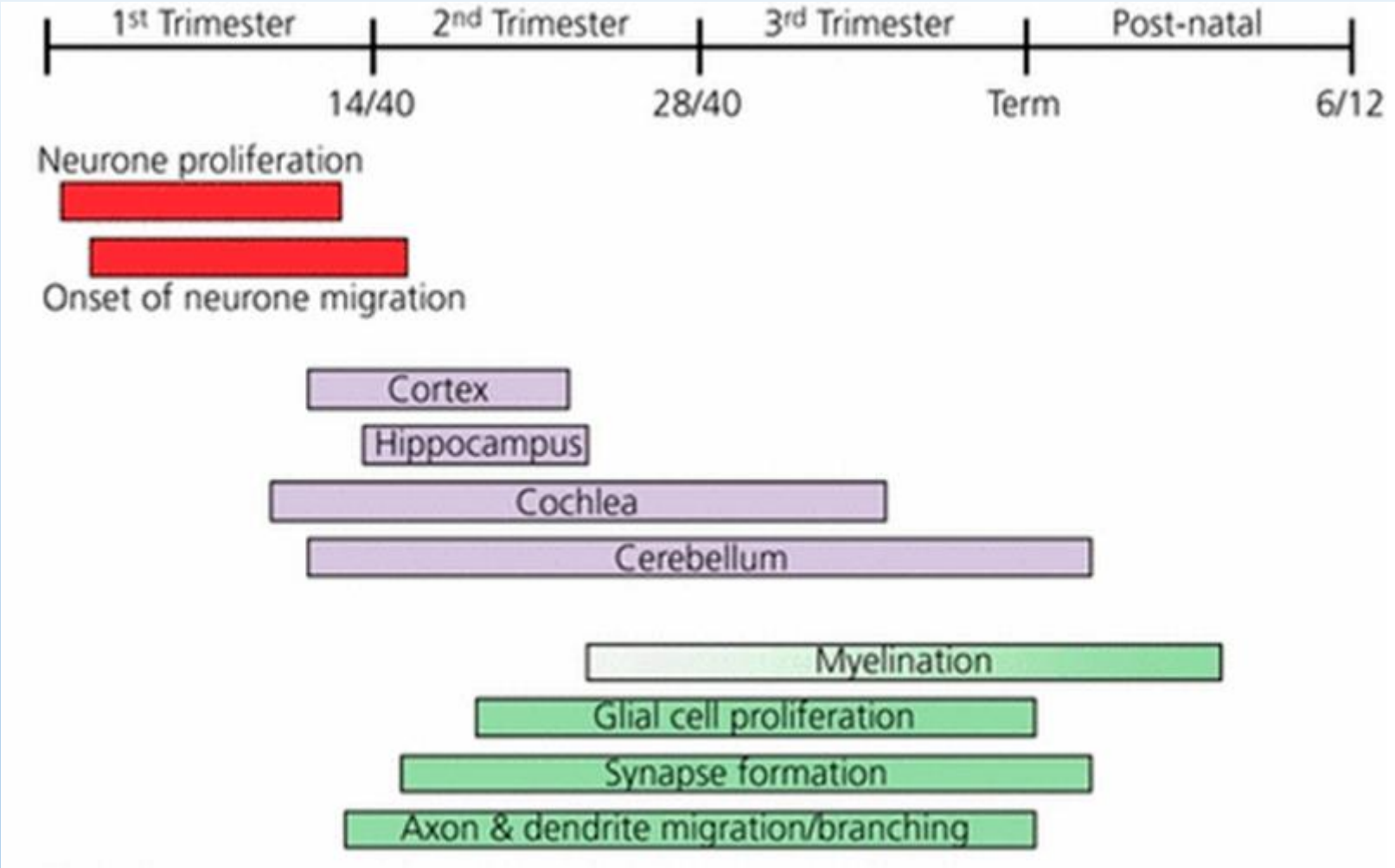
Biological Susceptibility: *It's Complicated*

- Pregnancy Immune ~~suppression~~ → modulation
 - Rising estradiol/progesterone, pro- alternate with anti-inflammation
- Impact on not one but two lives
- Safety and efficacy data on drugs and therapy lacking for “fear of the unknown”
- Access to clean water and adequate nutrition vital
 - Poor nutrition leads to low birth weight, delivery problem, newborn death, poor vaccine response

Maternal Immune Modulation

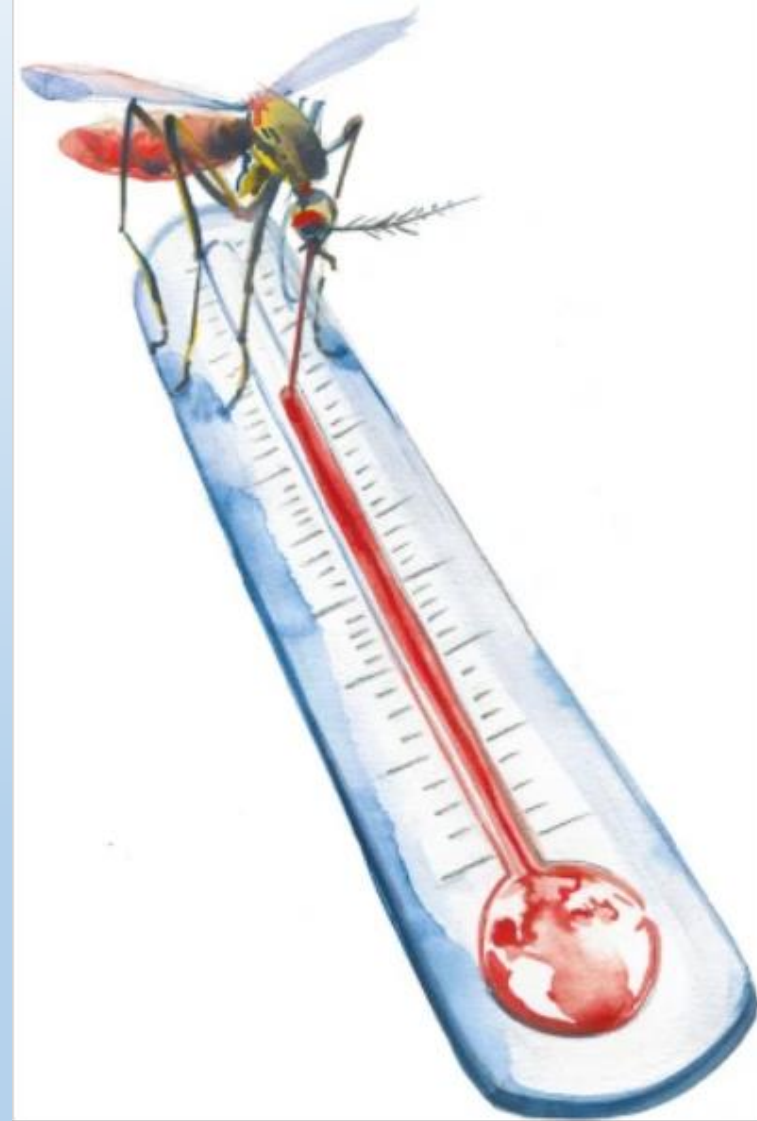


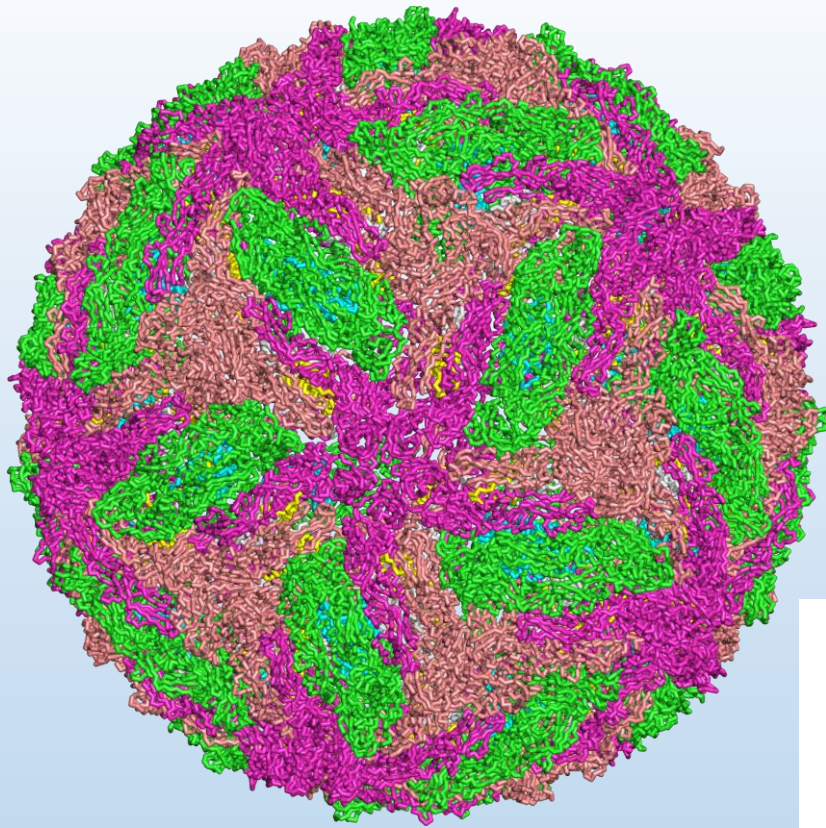
Fetal Neural Development



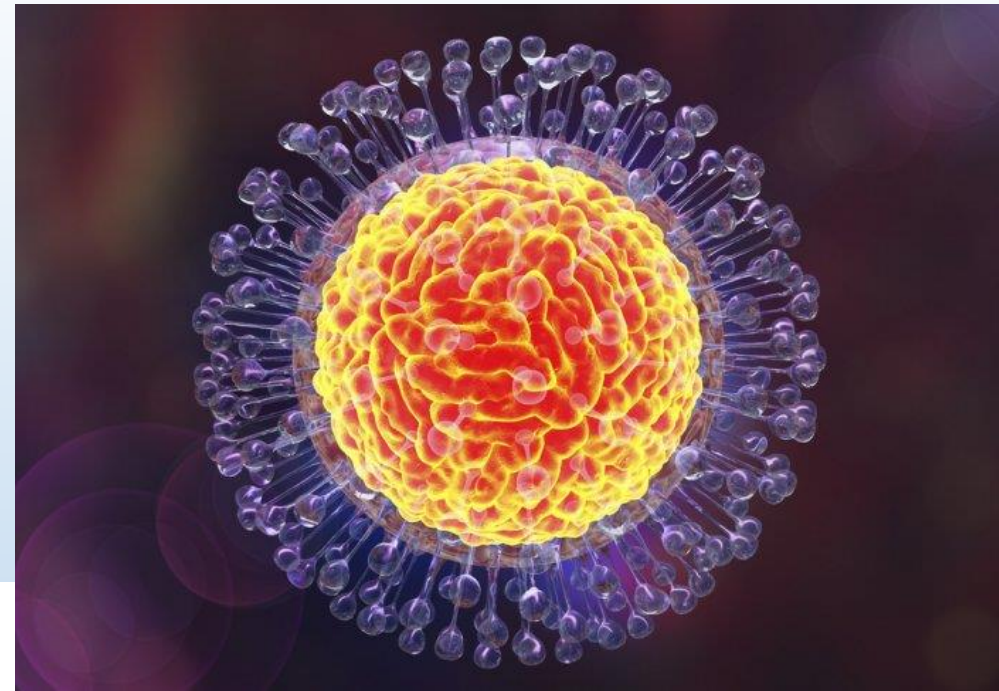
The Viral Hitchhikers of Aedes Mosquito

- Single-stranded RNA
 - Zika virus
 - Chikungunya virus
 - Dengue virus

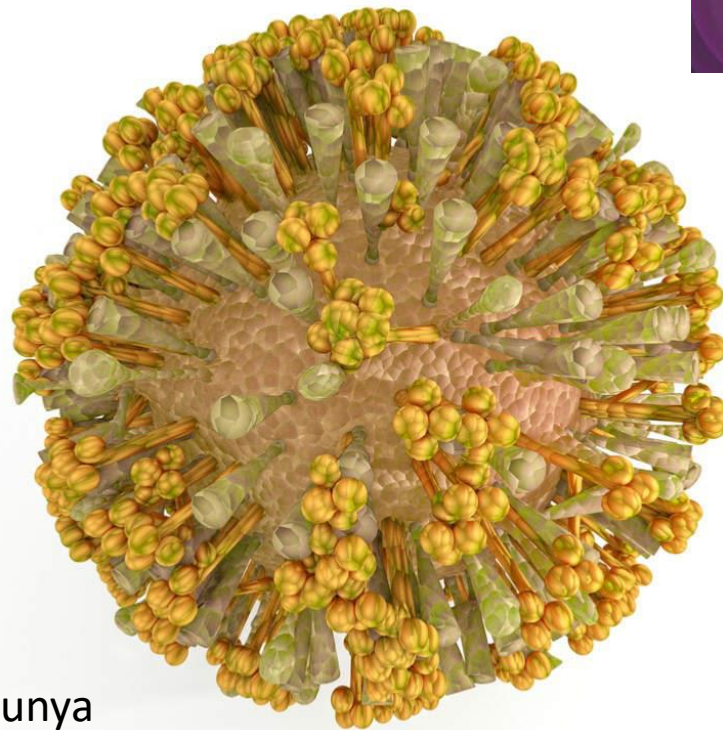




dengue



Zika



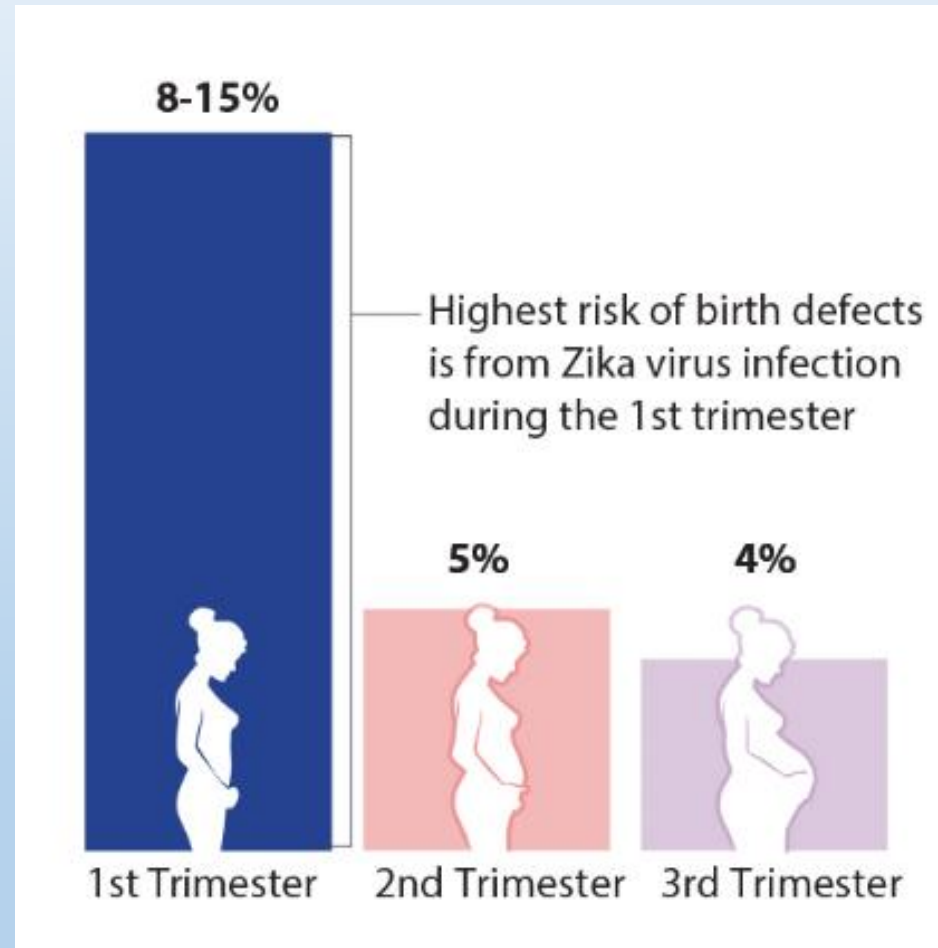
Chikungunya

Table 1

Pregnancy outcomes associated with arboviruses

	<i>Flaviviridae</i>		<i>Togaviridae</i>
	<i>Flavivirus</i>		<i>Alphavirus</i>
	ZIKV	DENV	CHIKV
Increased maternal complications	No	Yes	No
Sexual transmission	Yes	Not of public health significance	Not of public health significance
Transplacental transmission	Yes	yes	Yes, rare (3 cases)
Adverse pregnancy outcomes			
Fetal malformation	Yes; severe	No	No
Premature birth	No	Yes very likely related to severity of maternal disease	No
Fetal loss	Yes	Yes very likely related to severity of maternal disease	Yes, rare (3 cases)
SGA	Yes	No	No
Perinatal transmission	Yes, rare	Yes	Yes
Adverse neonatal outcomes			
Mild infection (e.g. rash, hepatitis, thrombocytopenia)	Yes	Yes	Yes
Severe disease (e.g. sepsis, encephalitis)	No	Yes, rare	Yes
Long-term sequelae	Yes; severe	No	Yes; severe

Confirmed Zika Virus Infection During Pregnancy: 5-10 % with Zika-Associated Birth Defects



Economic Susceptibility Paradox: Los Dos Laredos

- 1999, dengue outbreak
- Binational BIDS project
- Mexico border cities
 - Prosperous
- US border cities
 - Laredo, TX: 30% below poverty line
- Study
 - Random clusters of families
 - Finger-sticks
 - Mosquito survey in yards, patios
 - Questions on availability of air-conditioners, quality window screens, etc.



Table 1

Seroprevalence of anti-dengue immunoglobulin G (IgG) and IgM antibodies in Nuevo Laredo, Mexico, and Laredo, Texas, United States

	Nuevo Laredo	Laredo
Households	313	309
Serum samples	288	228
IgM prevalence	16% (12 to 20) ^a	1.3% (0 to 3) ^a
IgG prevalence	48% (41 to 55) ^a	23% (17 to 28) ^a

^aWeighted point estimate and (95% confidence interval).

Table 5

Estimated cost (US dollars) of air-conditioning a house in Texas vs. Taumalipas, Mexico

	Texas	Taumalipas
Cost per kilowatt hour (kWh)	0.06119	0.04863
Cost of 25,000 kWh	1,530	1,216
Per capita GDP ^a	34,288	5,014
Percentage of per capita GDP	4.5	24.2

Big difference

Findings:

1. 622 households studied
2. Breteau Index (the number of infested containers per 100 houses):
91 in Laredo vs 37 in Nuevo Laredo
3. Homes with air-conditioning:
82% in Laredo vs 24% in Nuevo Laredo

^aGDP, gross domestic product.

Emergency First-Responders:

See too much, hear too much

- Living in the communities they serve, they
 - Know the people
 - Identify with the victim's suffering
 - Overwhelmed by the number and scope of injuries
 - Deal with own loss
 - In a study of Coast Guard responders to Hurricanes Katrina and Rita
 - Local responders 3x depression compared to non-locals
- Off-season
 - Feel isolated, away from crew
 - No fire, no money
- 4 yr after large-scale response events: 13% to 18% suffers PTSD
- Worse if job includes fire/EMS, 37% contemplated suicide. 10 x rate of US adults (2015)

Firefighters Mental Health Crisis In Their Own Words

- "Don't call us 'Heroes'... when divorces, mental health problems and declining wages are the reality, we don't feel like heroes at all."
- Without the adrenaline rush, "You just feel flat all the time."
- "I have faith that God intervenes...And then it didn't happen."
- "You just feel defeated...The things that we used to do that worked ten years ago are no longer working anymore."



Warming Climate and Firefighting

- Longer, harder fire seasons
 - Climate change doubled the area burned across the American West 1984-2015
 - The west coast's record-breaking fire season in 2020, 5 of the state's 6 biggest blazes burned simultaneously (nearly four million acres scorched)
- California's forests vulnerable: >147 million **drought**-killed trees since 2010. Primed to burn.
- Days and nights are both warming; but **nighttime warming outpaces daytime** (2.6 F vs 1.8 F) for the past 125 years
- Problems: Firefighters work at night
 - Cooler air adds humidity. Fuel breaks.
 - Warmer nights keep dead leaves, logs dry
 - But flames that calm at night remain aggressively active

Mitigation:

1. Newsom: \$ 536 million to prevent wildfire
2. Advance plan and clear protocol for disaster
3. Training: Aware of personal vulnerability, signs of burnout, compassion fatigue
4. Committed mental health wellness program
5. Inmate firefighter program started in 1915. Paid \$2-5 per day. Extra \$1/hr if actively fighting the fire.



Inmate firefighters battle the Ferguson fire in Jerseydale, California, on July 22, 2018. (NOAH BERGER/AFP/Getty Images)

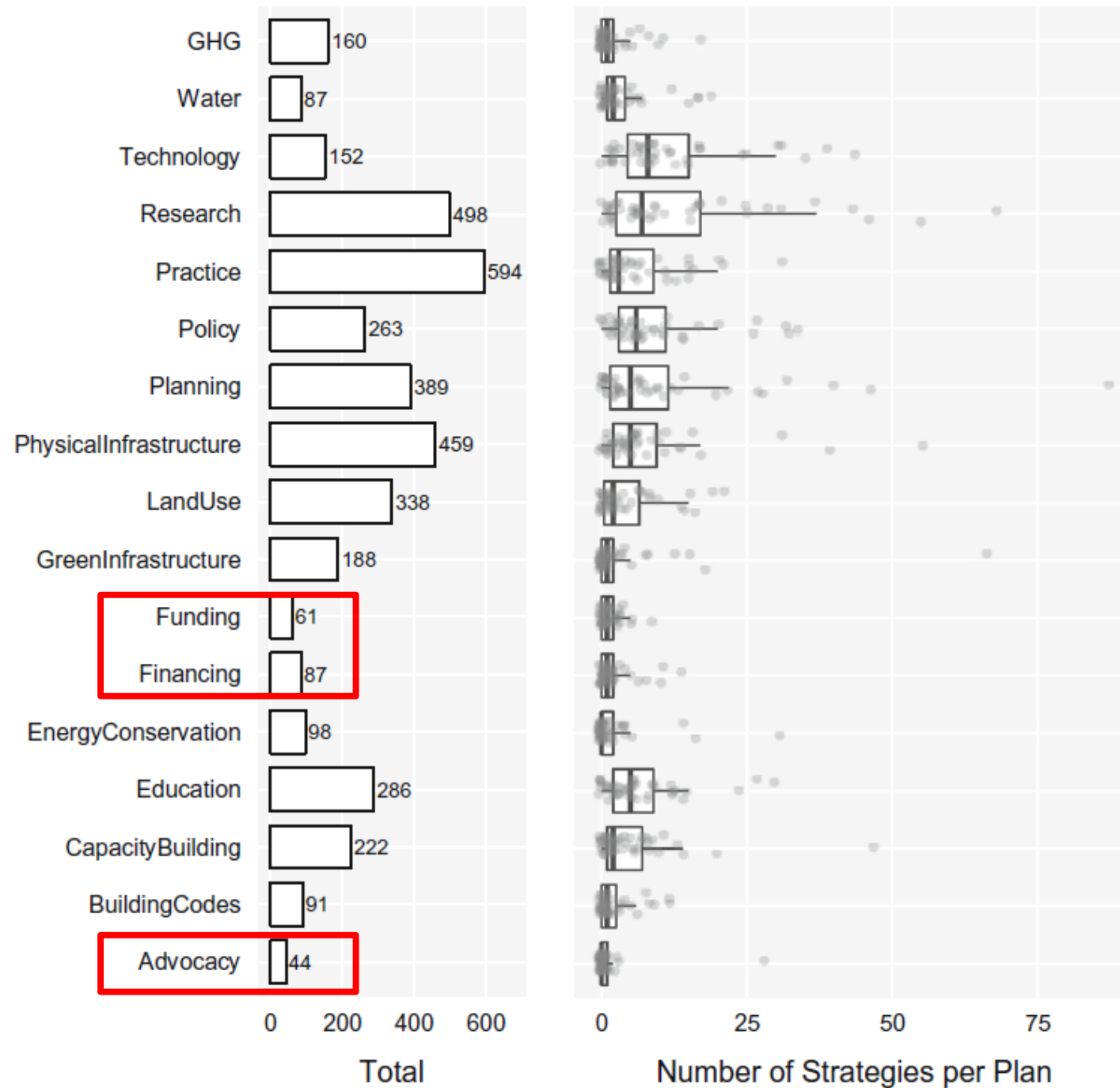
Regional Adaptation Plans To Build Resilience

- Climate-related impacts most pronounced at local level
- In US: 43 adaptation plans
 - Average 54 actions/plan: range 14 (Milwaukee) – 447 (Lee County, FL)
- Most plans lack details (Ex: 16% discussed cost)
- Average 5 out 16 metrics necessary for implementation (0 – 80%)

Guideline-Based Climate Adaptation Action

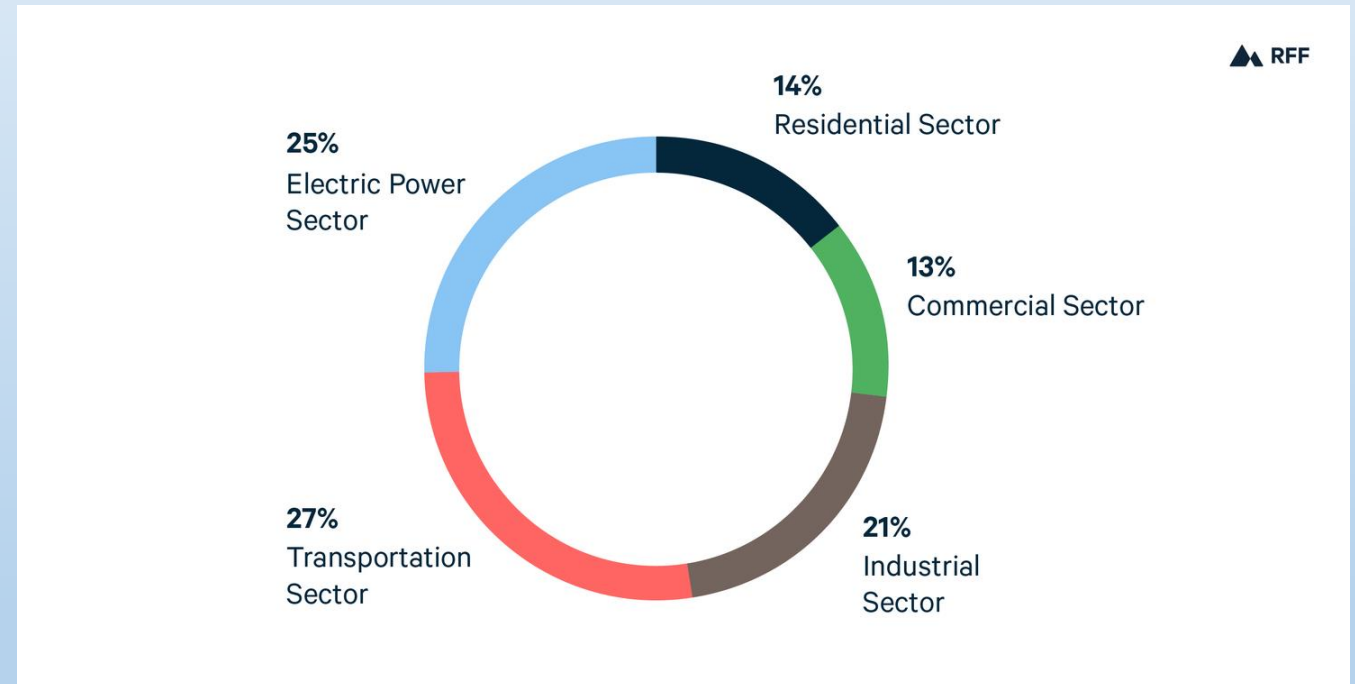
Climate driver	Impact	Suggested actions	Type
Extreme events	Storm surge	Preserve natural shorelines	Land use
		Protect and enhance natural breakwaters	Green infrastructure
		Install floodgates and other structural protection	Physical infrastructure
		Educate homeowners and members of the private sector	Education and outreach
		Create a no-build zone or district	Policy
		Strengthen buildings to prevent damage	Building codes
	Power outages	Create renewable energy systems for back-up power	Technology
		Strengthen energy infrastructure	Physical infrastructure
	Hurricanes/coastal storms	Conduct evacuation planning	Planning





My Vote: Carbon Sin Tax

- Carbon pricing: Charge emitters for the carbon dioxide (CO₂)
- Generate revenue
 - Discourage GHG emission
 - Encourage conservation
 - Generate funds
 - *Nobody asked but this is how I'd spend the money:*
 - *Plastic regulation/recycling*
 - *Education in climate change*
 - *Universal healthcare*

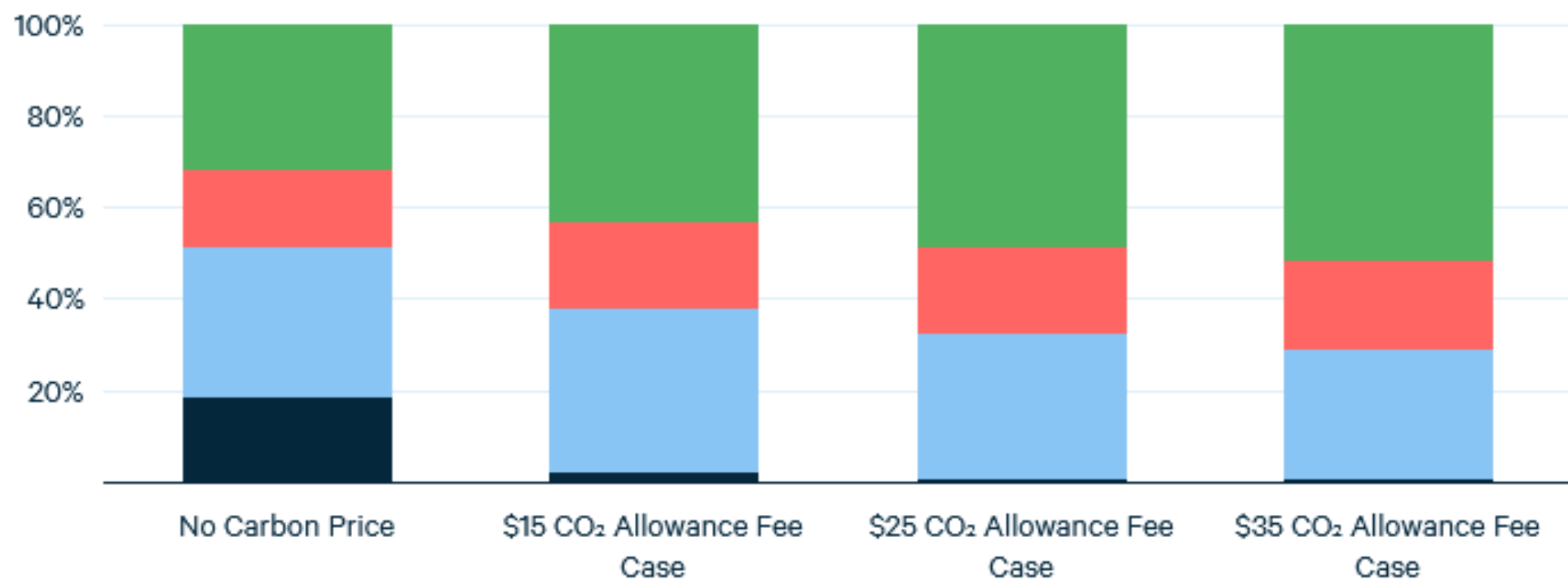


2018 United States Carbon Dioxide Emissions from Energy Consumption by Sector

Figure 2. US Electricity Generation Under Different Carbon Prices

Percentage of generation mix in 2030

● Coal ● Natural Gas ● Nuclear Power ● Renewable Sources

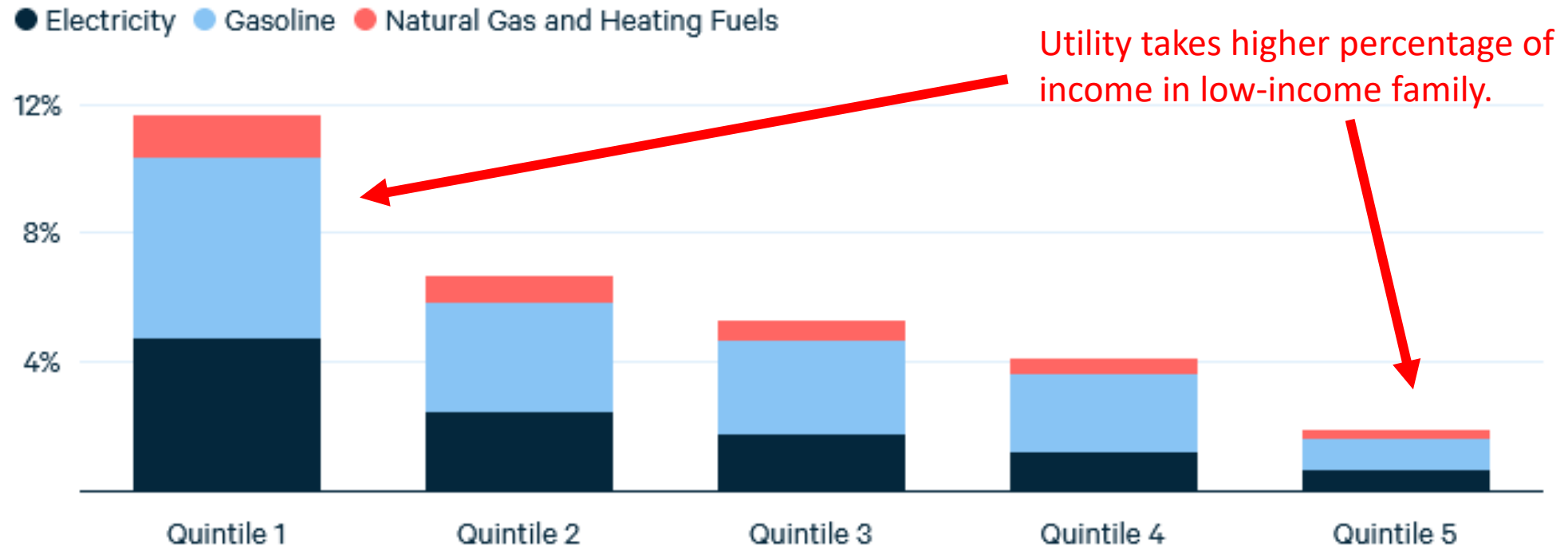


A negligible amount of generation comes from other sources.

Source: [AEO2020 Table 8](#)

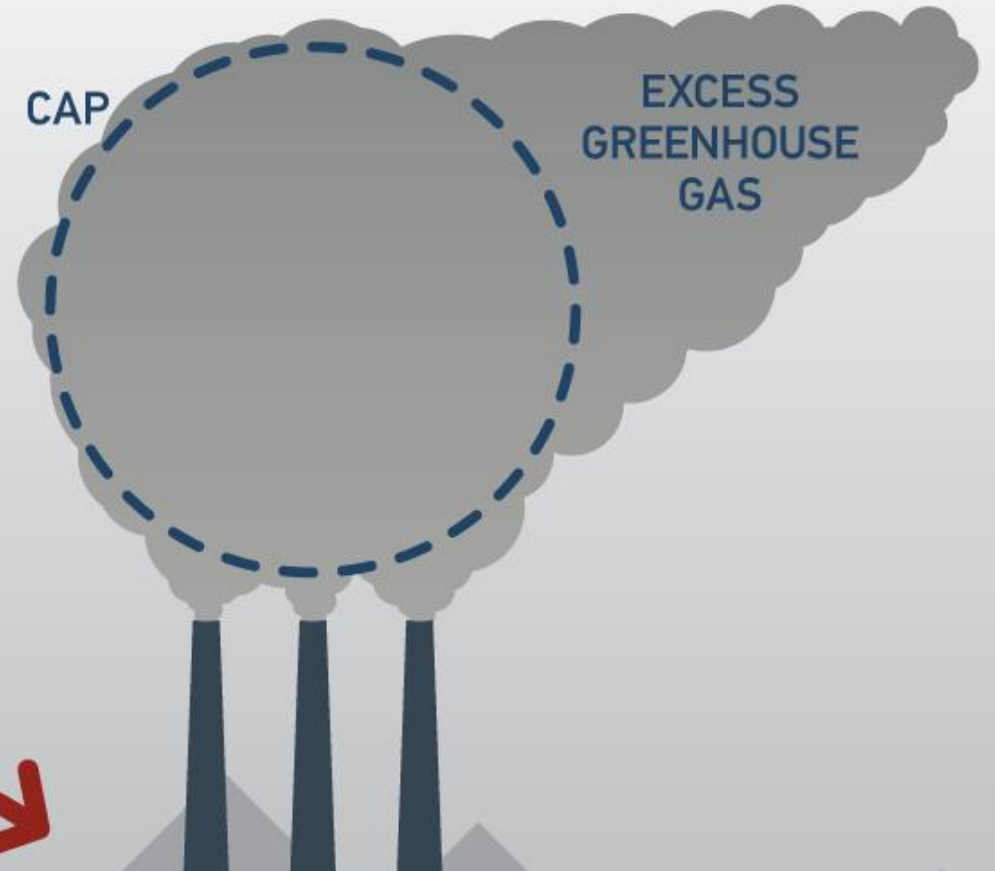
Figure 1. US Average Energy Expenditures by Income Quintile

Expenditures are shown as a percentage of pre-tax income.

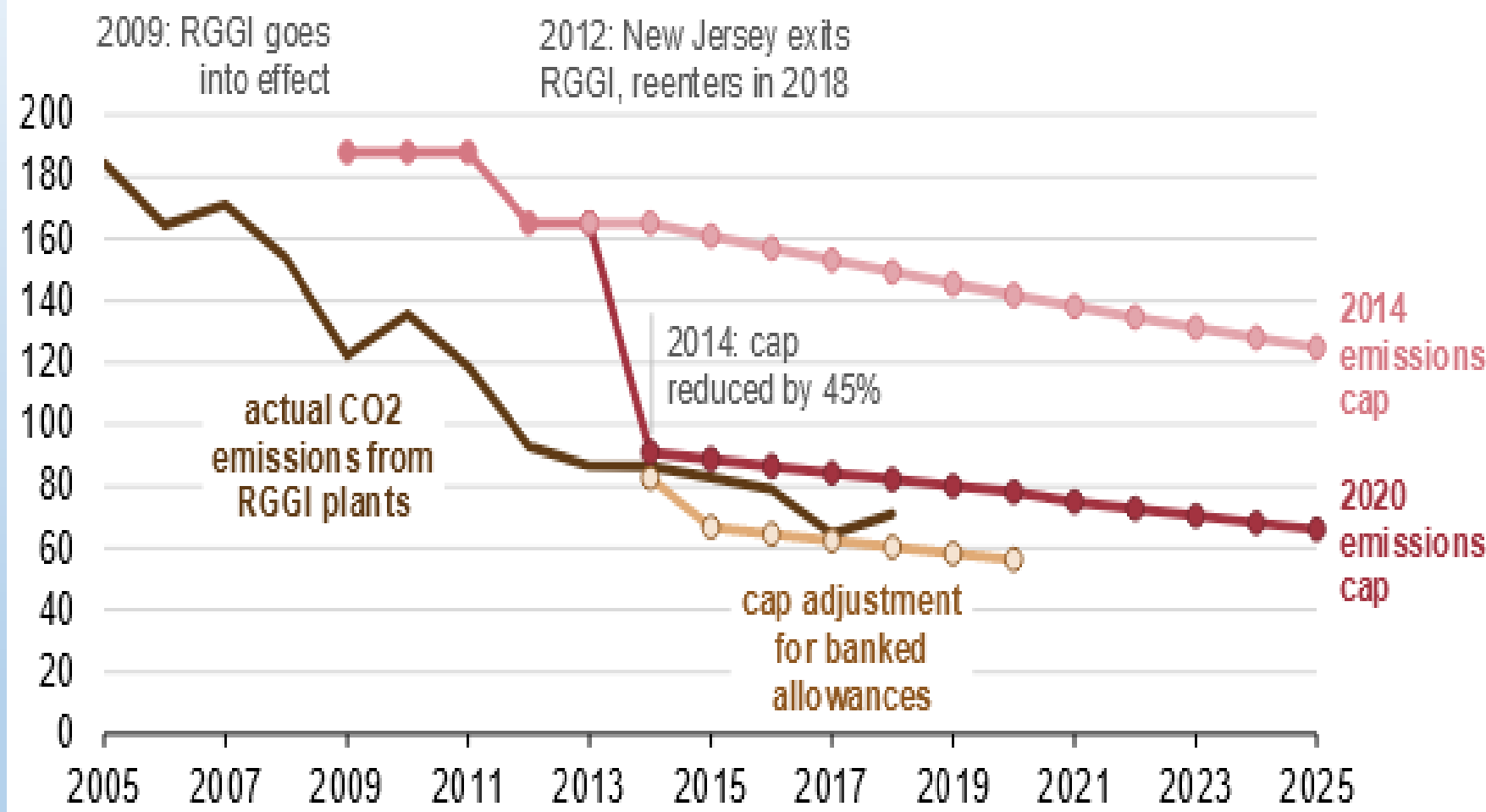


Source: 2010-2016 data from the Consumer Expenditure Survey, National Income and Product Accounts, and US Census. ▲ RFF

Carbon Cap-and-Trade

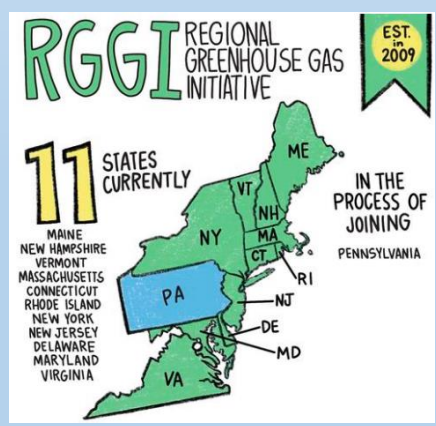


Regional Greenhouse Gas Initiative (RGGI) carbon dioxide (CO2) emissions and caps million short tons

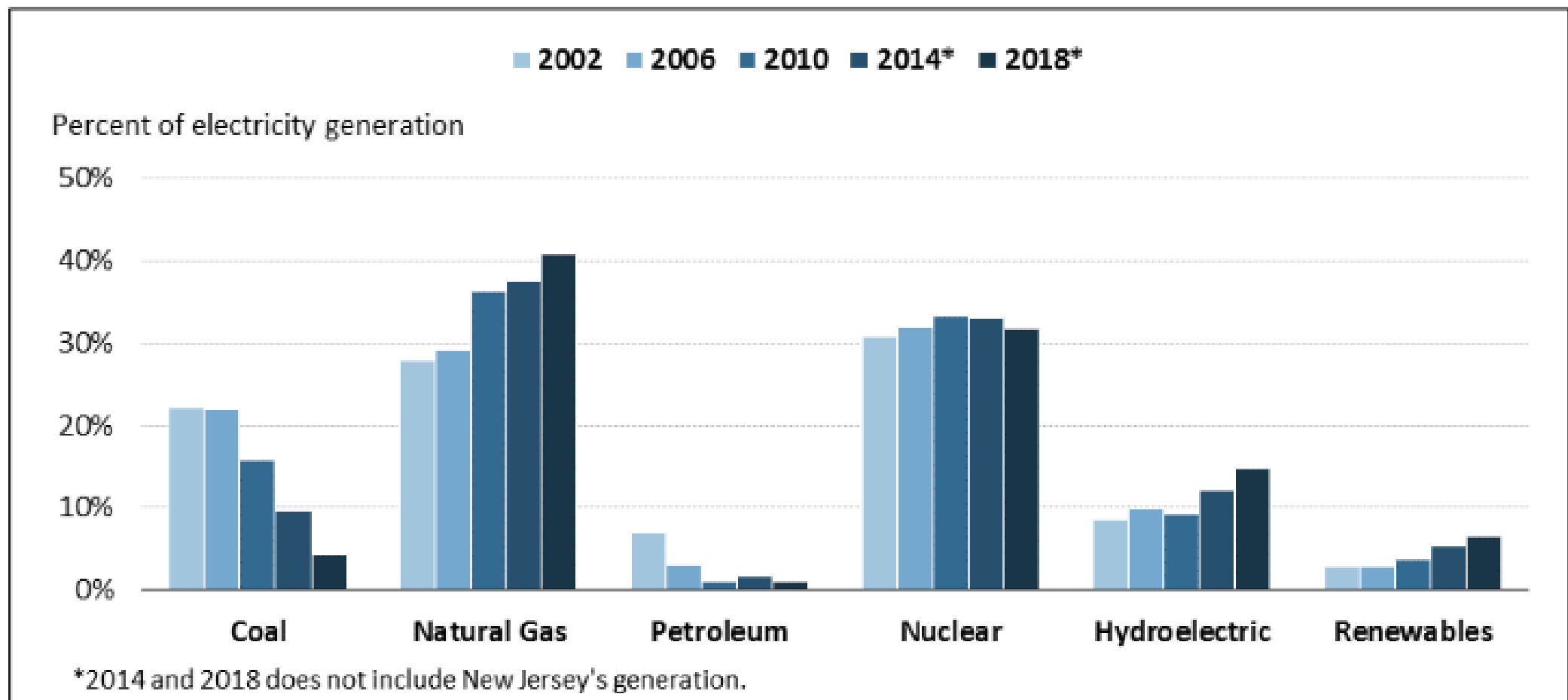


Source: U.S. Energy Information Administration, based on [Regional Greenhouse Gas Initiative](#) (RGGI)

- 11 states
- Initial 2009 cap higher than emission b/c projected CO2 inc
- **CO2 emissions down 50%**
- Net benefit: \$4.7 billion, 40,000 jobs-years from 2009-2017
- Funding: 50% energy efficiency, **19% bill assistance**, 4% renewable energy
- Health economic benefit of \$5.7 billion
 - Hundreds lives save
 - Thousands fewer asthma hospitalization
 - Lower rate pregnancy complications



RGGI States Electricity Generation by Energy Source



Source: Prepared by CRS; data from Energy Information Administration, "Net Generation for Electric Power."

Notes: Renewables include wind, solar, geothermal, and biomass sources. Some sources, including other gases and waste heat, are not included in the above figure, but these account for less than 1% of electricity generation.

Conclusion

- Climate change can make a bad situation so much worse for the vulnerable population
- Susceptibility for each individual/population is unique, complex, compounded
- Carbon tax brings cost to pollution—done right—can help vulnerable population

References

- https://health2016.globalchange.gov/low/ClimateHealth2016_FullReport_small.pdf

Resilience

- Mitig Adapt Strateg Glob Change (2017) 22:1249–1279

Vulnerable population

- https://health2016.globalchange.gov/low/ClimateHealth2016_FullReport_small.pdf (p. 247-264)
- <https://www.nytimes.com/2021/02/13/opinion/sunday/working-class-dignity.html?referringSource=articleShare> (help lumber, eat an owl; NYT opinion piece on homeless)

Elderly

- <https://agingconnected.org/report/>
- <https://www.nytimes.com/2021/02/28/technology/seniors-vaccines-technology.html?action=click&module=Top%20Stories&pgtype=Homepage>

Maternal-fetal Virus Transmission

- <https://www.cdc.gov/pregnancy/zika/data/index.html>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5214529/#R64>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7469740/>