Contemporary Issues Regarding Climate Change and Solutions

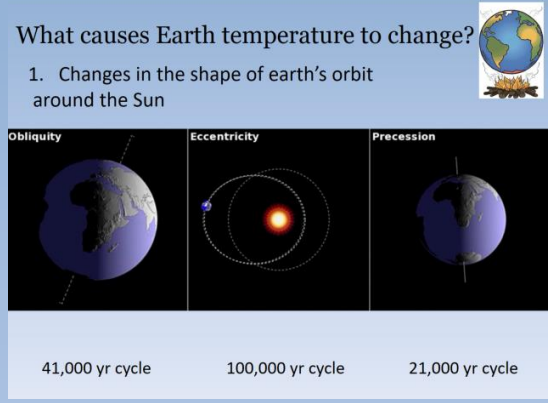
Paul Belanger, Ph.D.,
Geologist/Paleoclimatologist

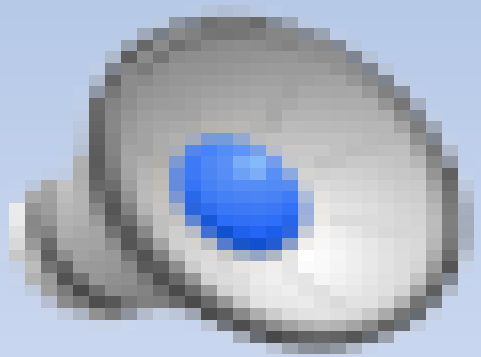
Tuesday October 17th , 2017:

- **Follow up: Population**
- **Contemporary Issues**
- **Denialism : email & next week**
- **Solutions: What can I/we do**
- **Solutions: Economic**

What causes Earth temperature to change?

1. Changes in the shape of earth's orbit around the Sun





41,000 yr cycle

100,000 yr cycle

21,000 yr cycle

What causes Earth temperature to change?

2. Green houses gases:

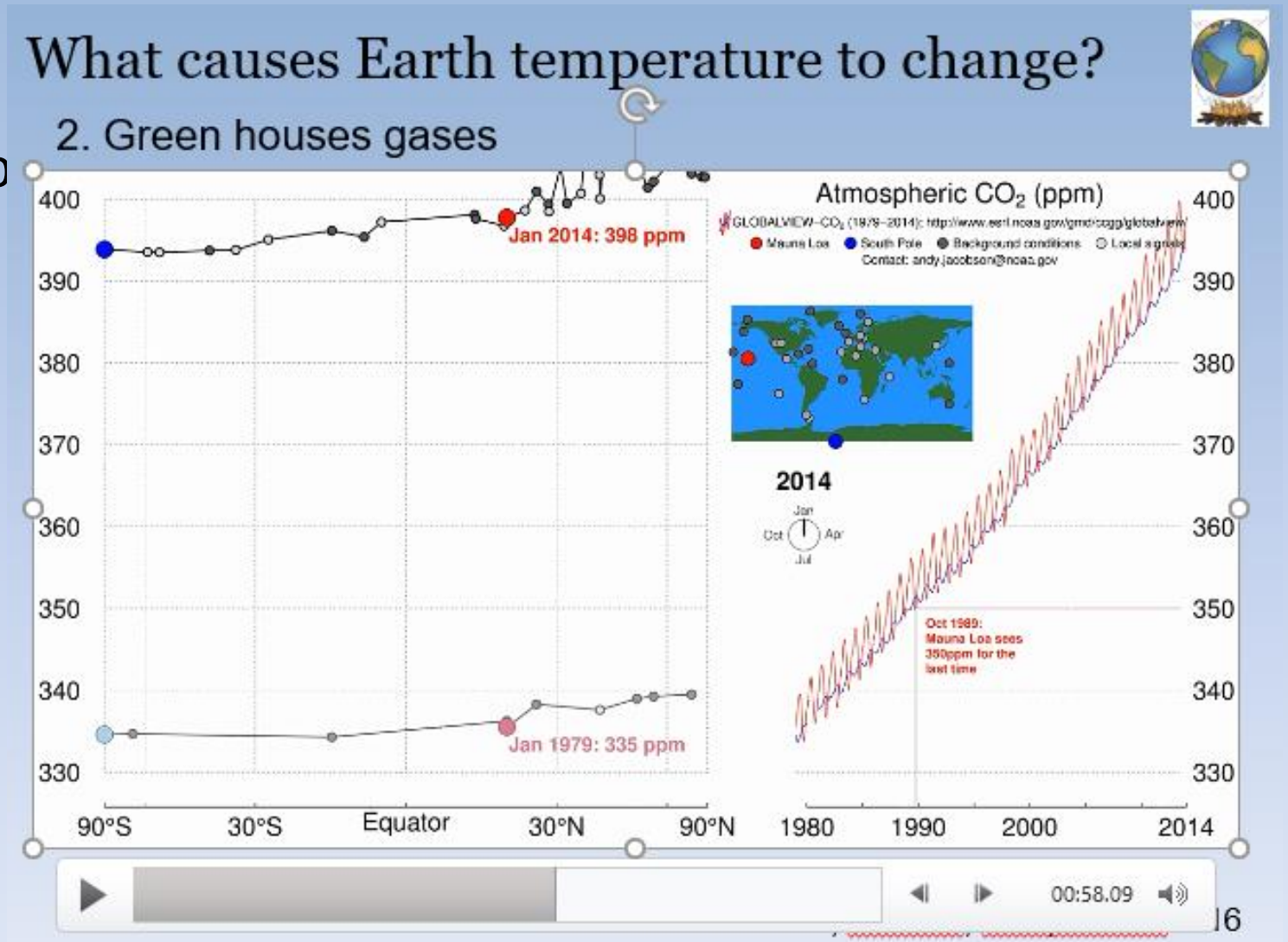
GO HERE FOR COOL ANIMATIONS

https://www.youtube.com/watch?v=gH6fQh9eAQE

NOAA 2016; Youtube, Pumphandle 2016

What causes Earth temperature to change?

Green ho

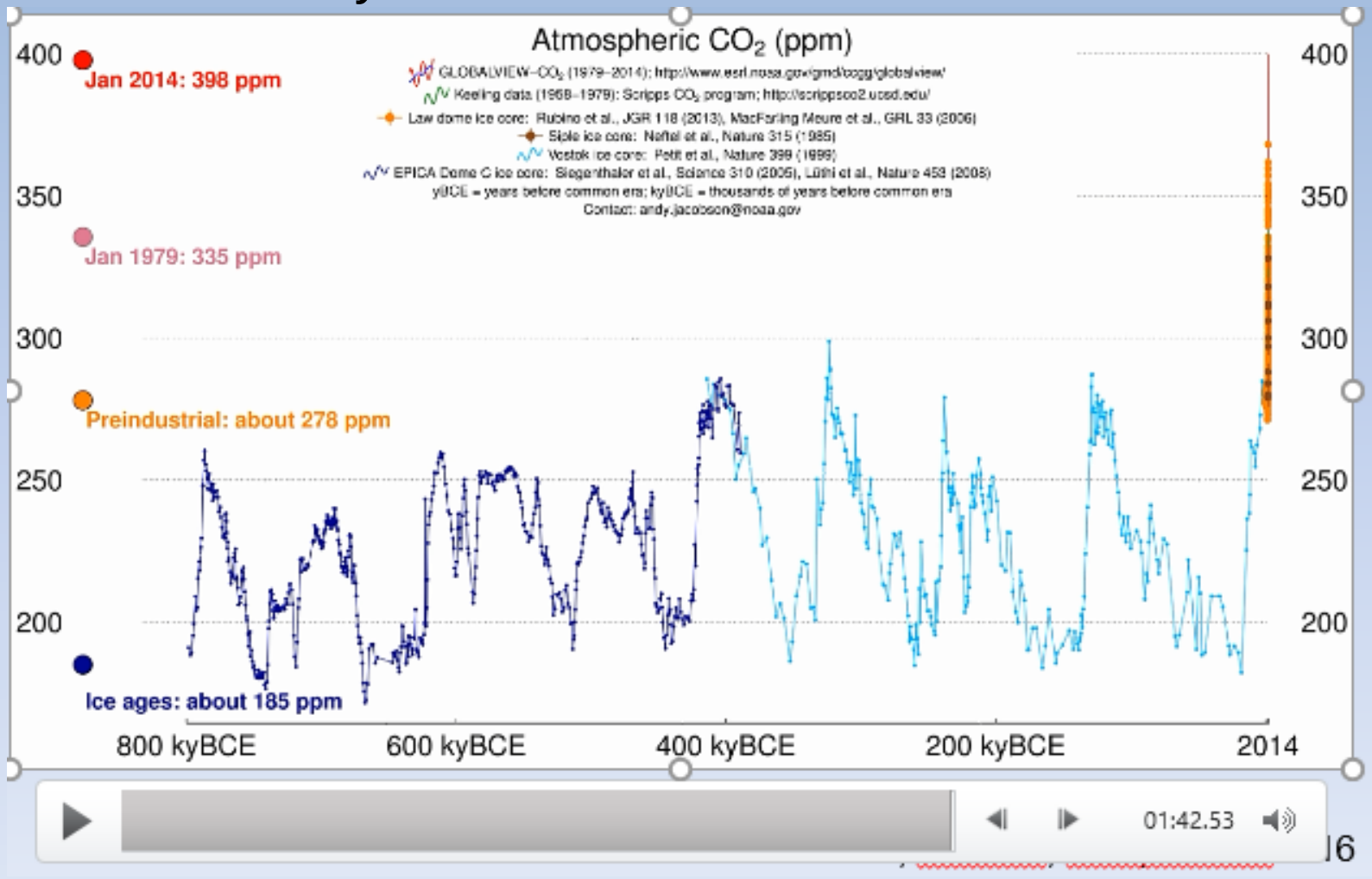


https://www.youtube.com/watch?v=gH6fQh9eAQE

NOAA 2016; Youtube, Pumphandle 2016

What causes Earth temperature to change?

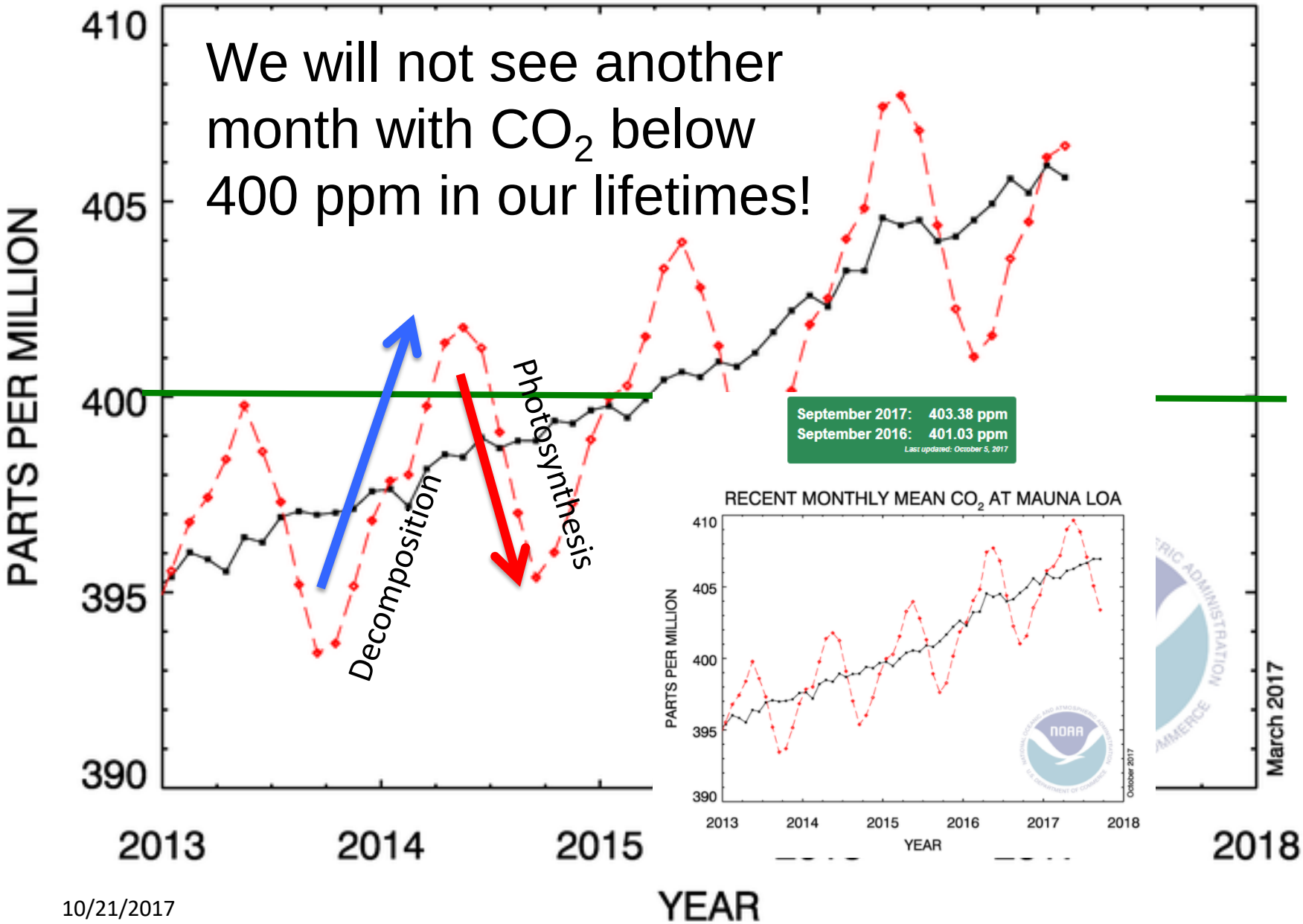
2. Green houses gases – pausing at last 35 years end, last 800,000 years



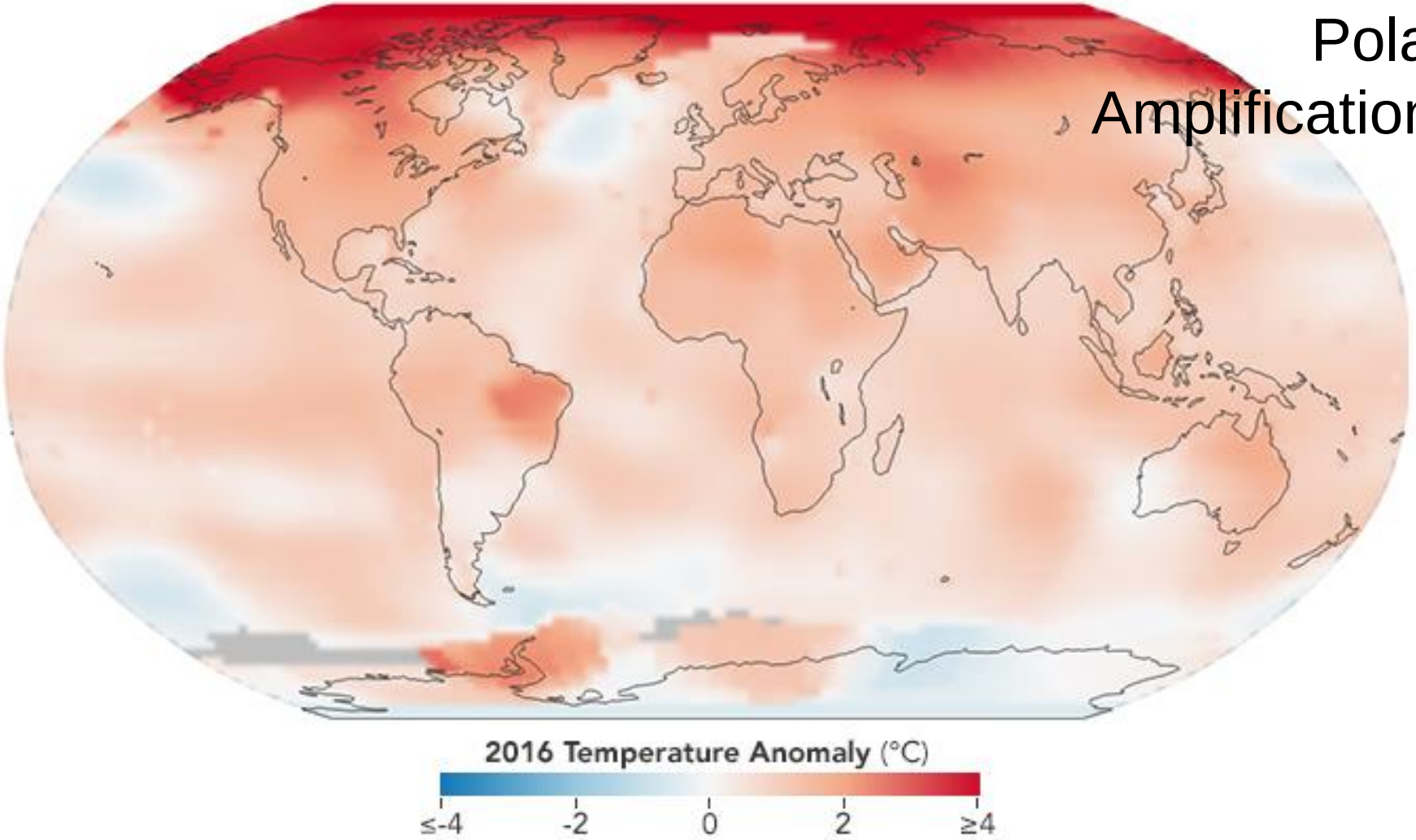
https://www.youtube.com/watch?v=gH6fQh9eAQE NOAA 2016; Youtube, Pumphandle 2016

RECENT MONTHLY MEAN CO_2 AT MAUNA LOA

We will not see another month with CO_2 below 400 ppm in our lifetimes!



Arctic Change → Temperatures are rising twice as fast as global average



https://earthobservatory.nasa.gov/IOTD/view.php?id=89469

The Anthropocene

- **PDF – Olli Anthropocene Oct 2017**
- **Bob Raynolds April 2017 talk**

Population – follow-up

- 4 PDFs documents for you to peruse depending on your interest:
  - Science Mag June 30, 2017: Estimating economic damage from climate change in the United States
  - UN World Fertility Report: 2007: UN World Fertility Report 2007:compilation of key indicators of fertility, nuptiality, contraceptive use and population policies regarding childbearing for 192 countries referring mostly to two periods: the 1970s and the latest year for which data are available
  - UN World Fertility Report 2012: Report_WFR2012
  - World population stabilization unlikely this century: Science-2014-Lee-229-34

Population – follow-up

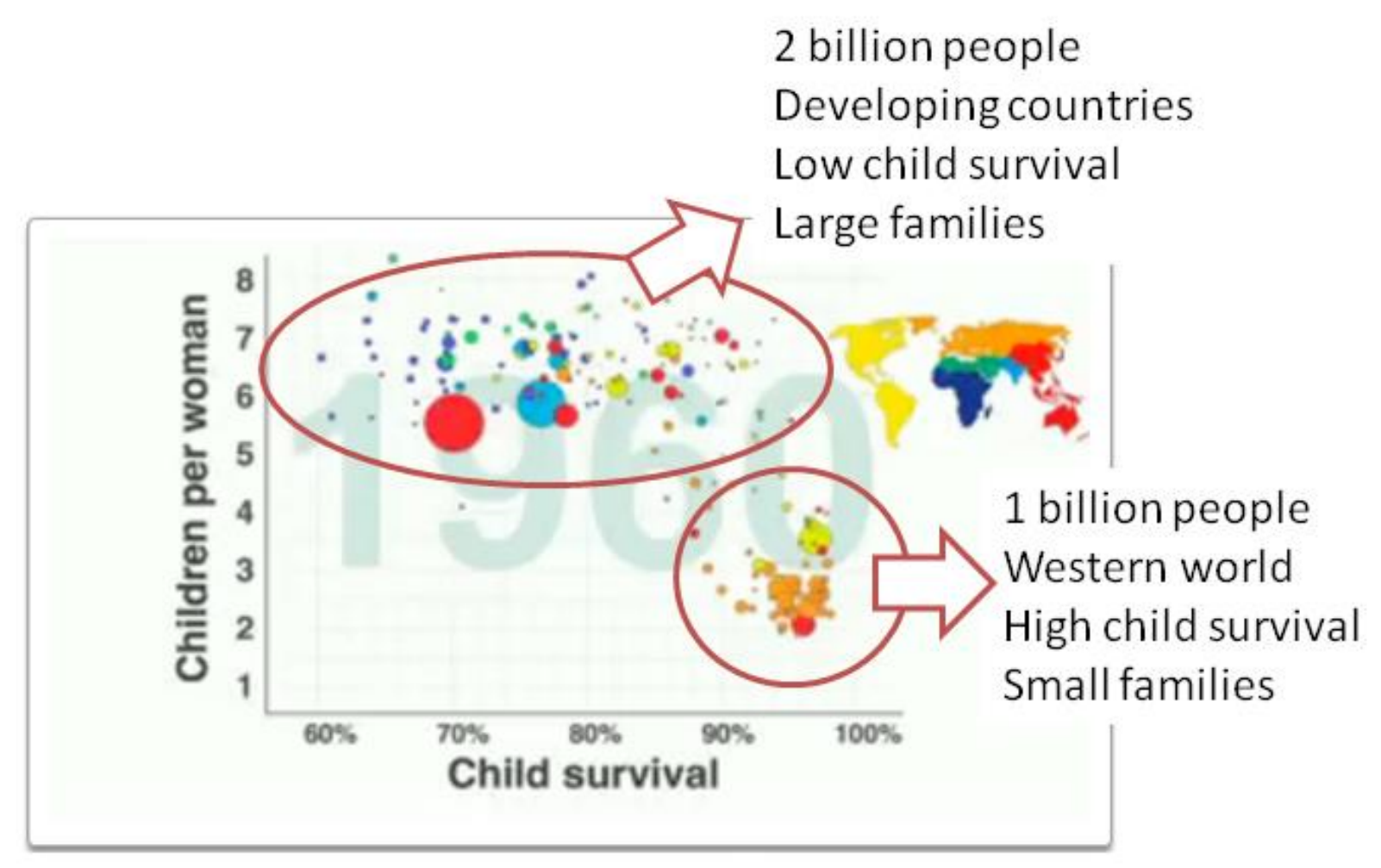
- HANS ROSLING: **Global population growth, box by box – sent in email**
- https://www.ted.com/talks/hans_rosling_on_global_population_growth/transcript?language=en#t-468462

Population – excellent blog & explanation

Visualizing how a population grows to 7 billion (NPR) https://youtu.be/VcSX4ytEfcE

https://jepoirrier.org/tag/population/

Population – excellent blog & explanation



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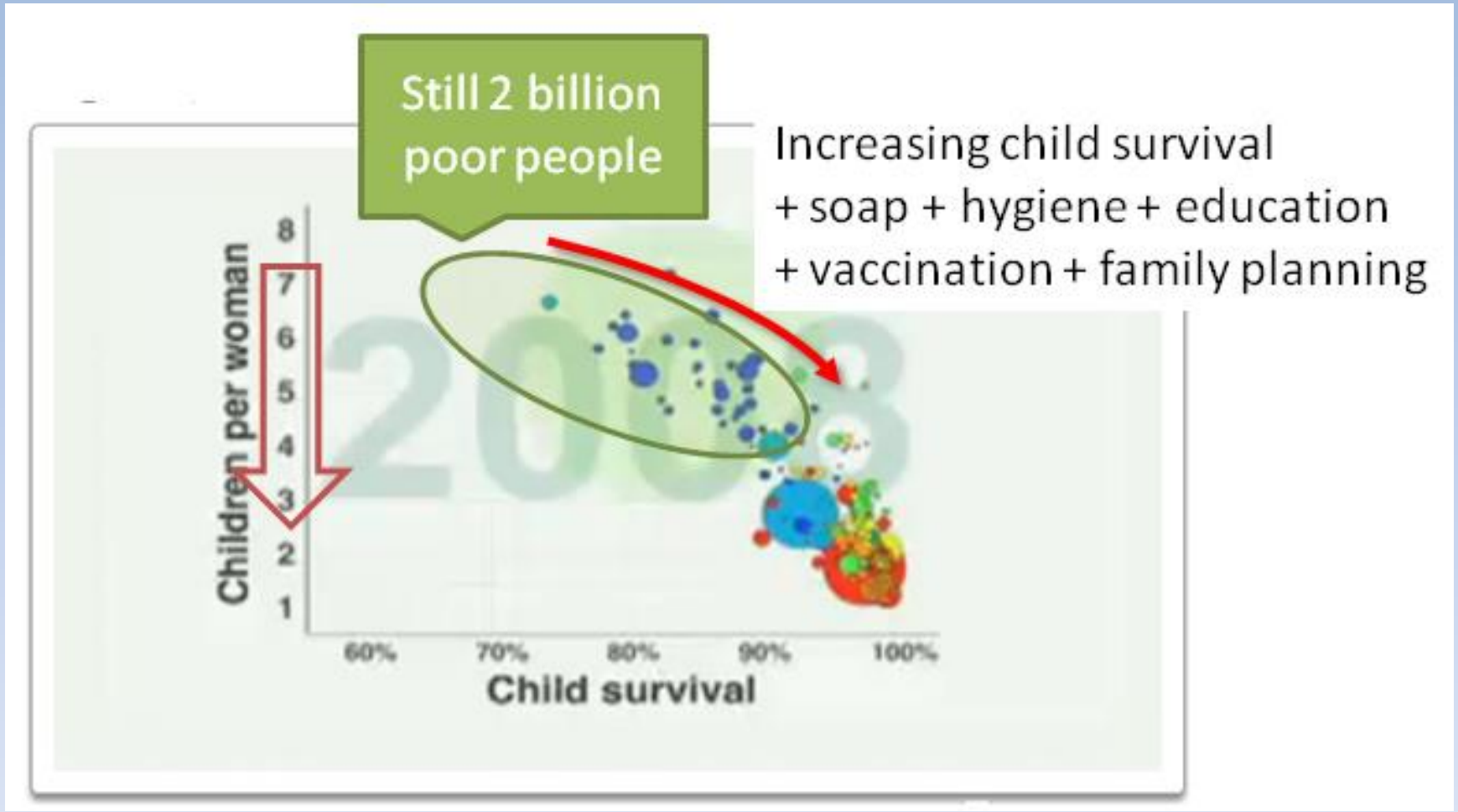
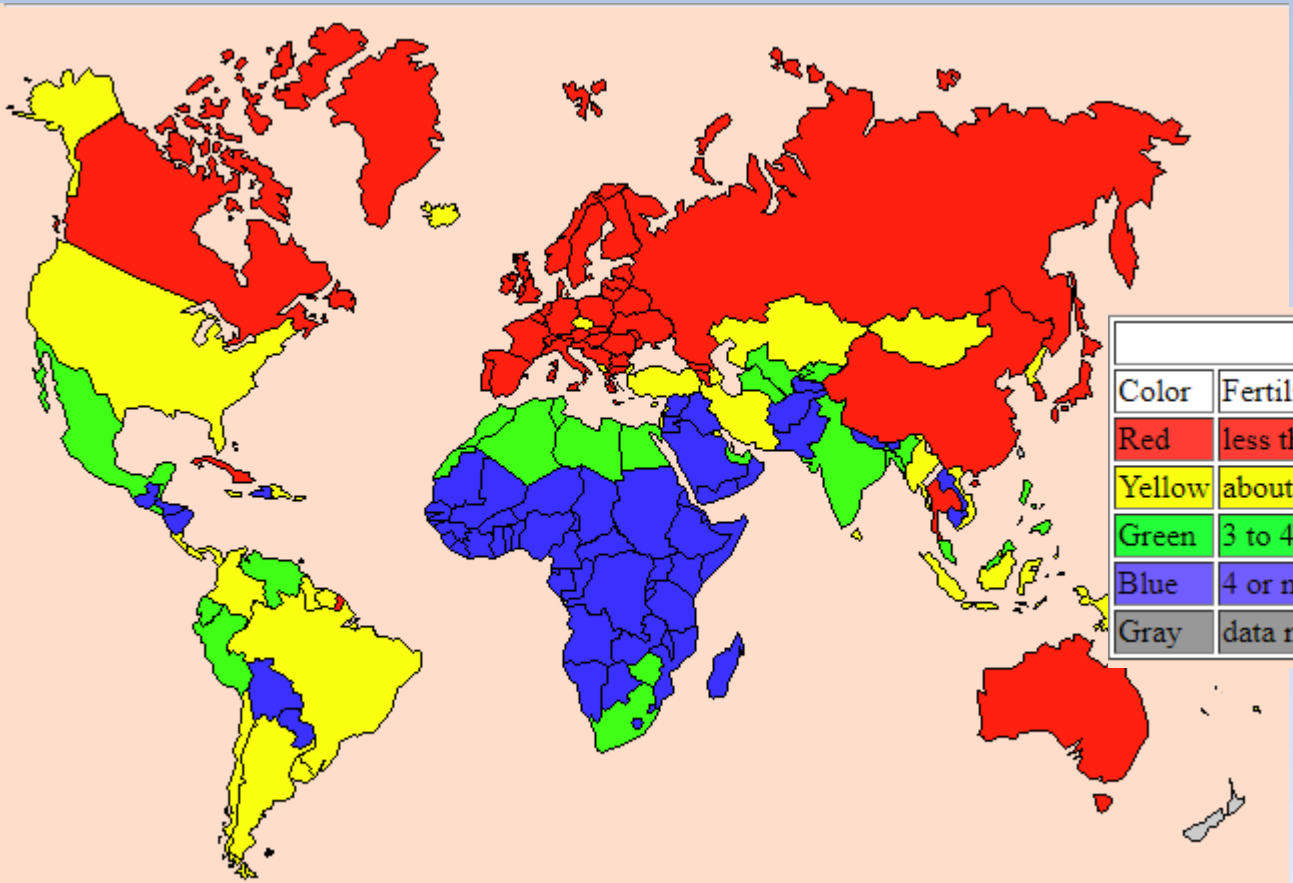
Population – excellent blog & explanation



https://jepoirrier.org/tag/population/

Fertility Rates (Children per Family) World Statistics

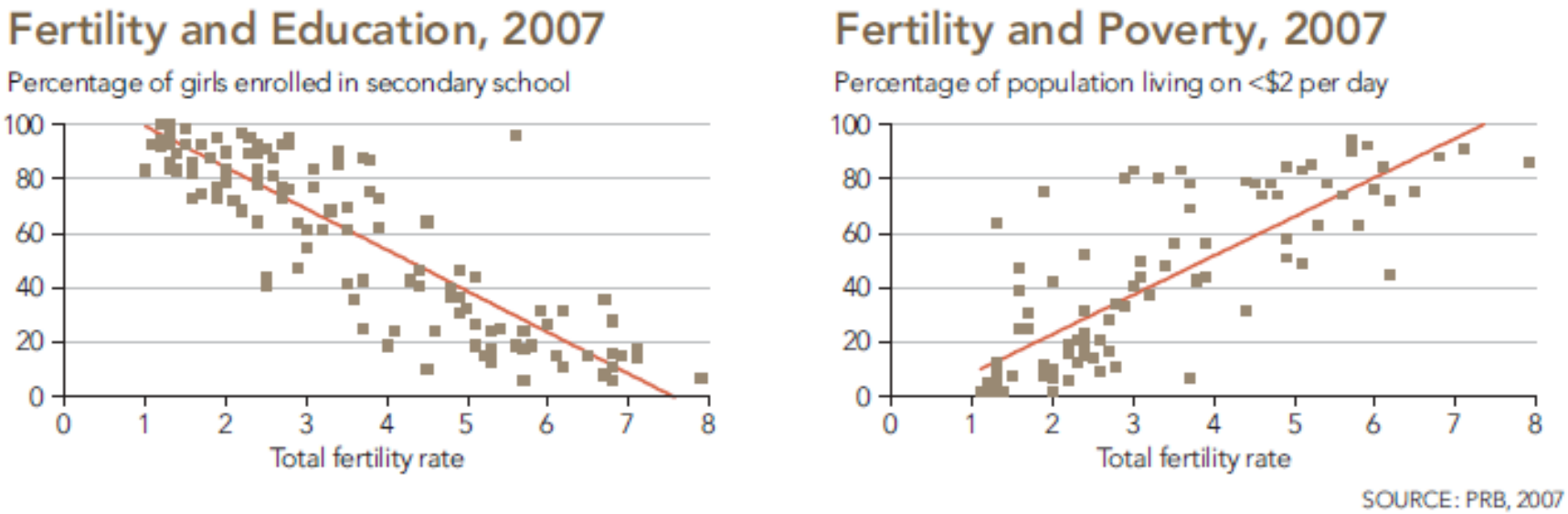
- http://www.pregnantpause.org/numbers/fertility.htm



Map Key		
Color	Fertility rate	Long-term impact
Red	less than 2	declining population
Yellow	about 2	stable population
Green	3 to 4	growing population
Blue	4 or more	rapidly growing population
Gray	data not available	

Population – excellent blog & explanation

Strong predictors. High fertility rates are associated with poverty and low levels of educational attainment for girls.



https://jepoirrier.org/tag/population/

LOCAL Contemporary NEWS

SUNNY, WARMER ▲64° ▼39° »9B • OCTOBER 15, 2017 • DENVERPOST.COM • © THE DENVER POST • $3 PRICE MAY VARY OUTSIDE METRO DENVER

POPULATION PROJECTIONS

Growth creates state of change

From roads to water, Colorado needs to address five key issues

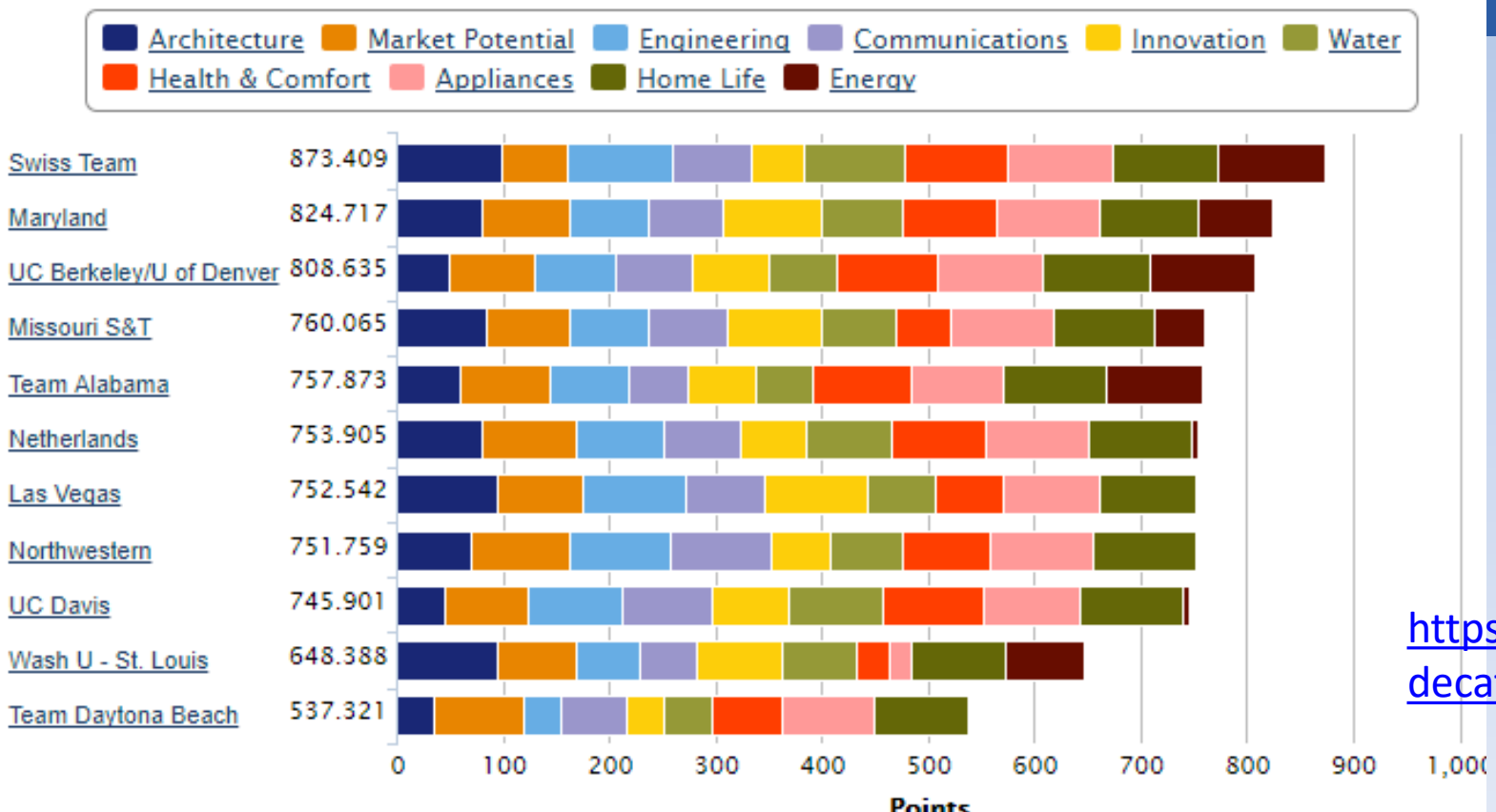
ue to grow. Traffic continues to slow. And warnings about the

- **Colorado's growing pains: From roads to water, here are 5 key issues as the state's population swells**
  - Traffic
  - Unaffordable Housing
  - Growing Older
  - Water Worries
  - Growing Divide: urban vs. rural

http://www.denverpost.com/2017/10/15/colorado-growing-population-issues/

Solar Decathlon

- Winners:

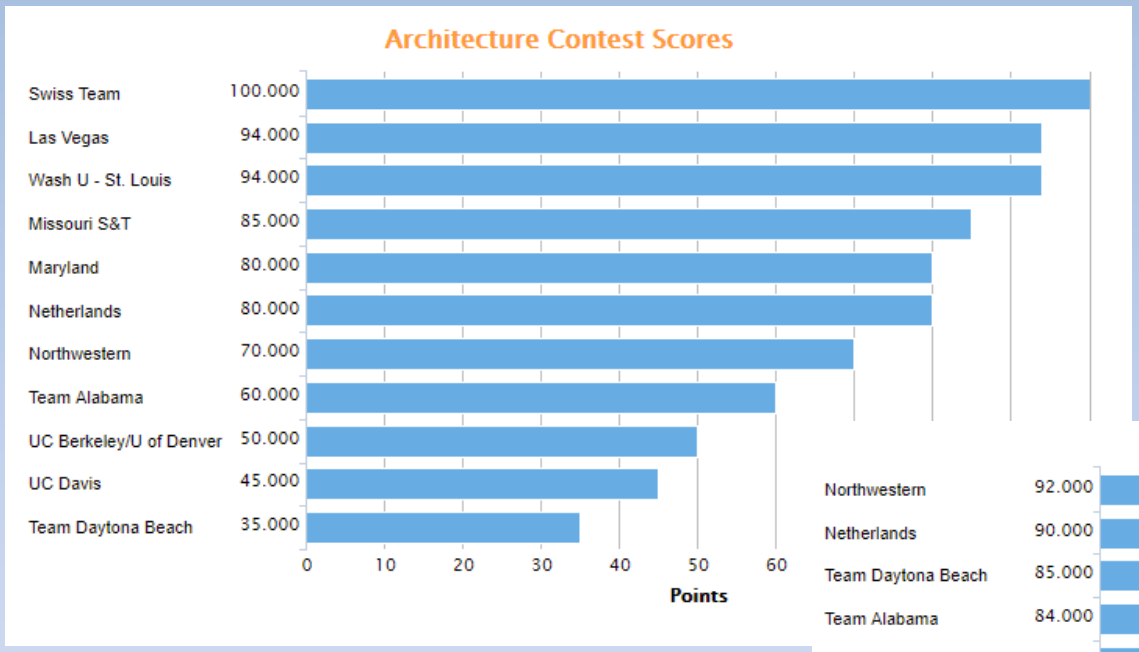


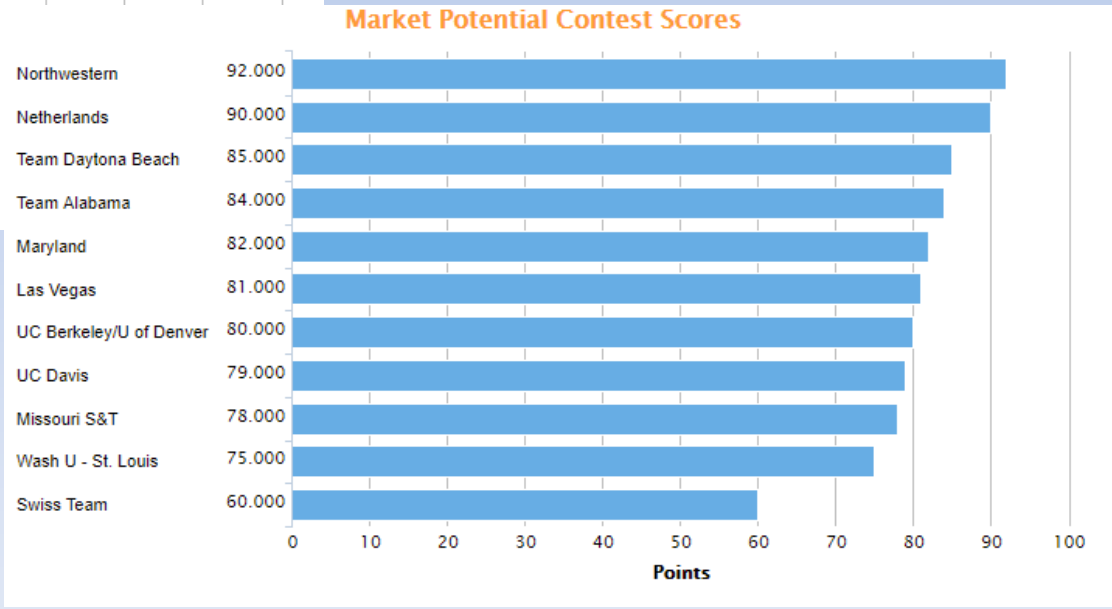
https://www.solardecathlon.gov/

Solar Decathlon

https://www.solardecathlon.gov/

- By Contest: Architecture & Market Potential

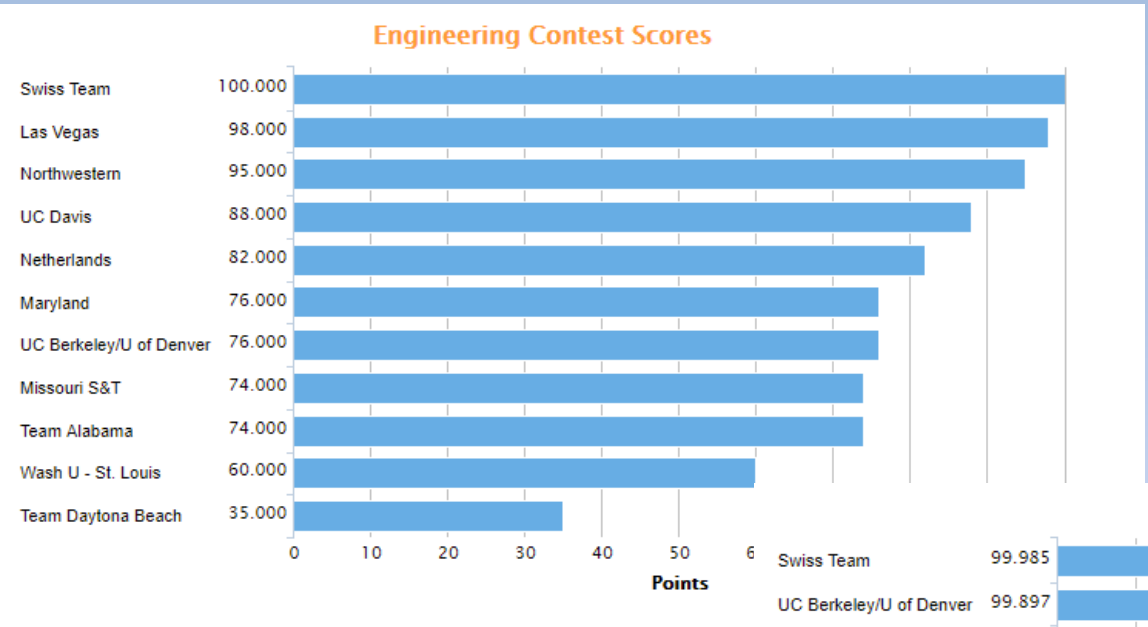


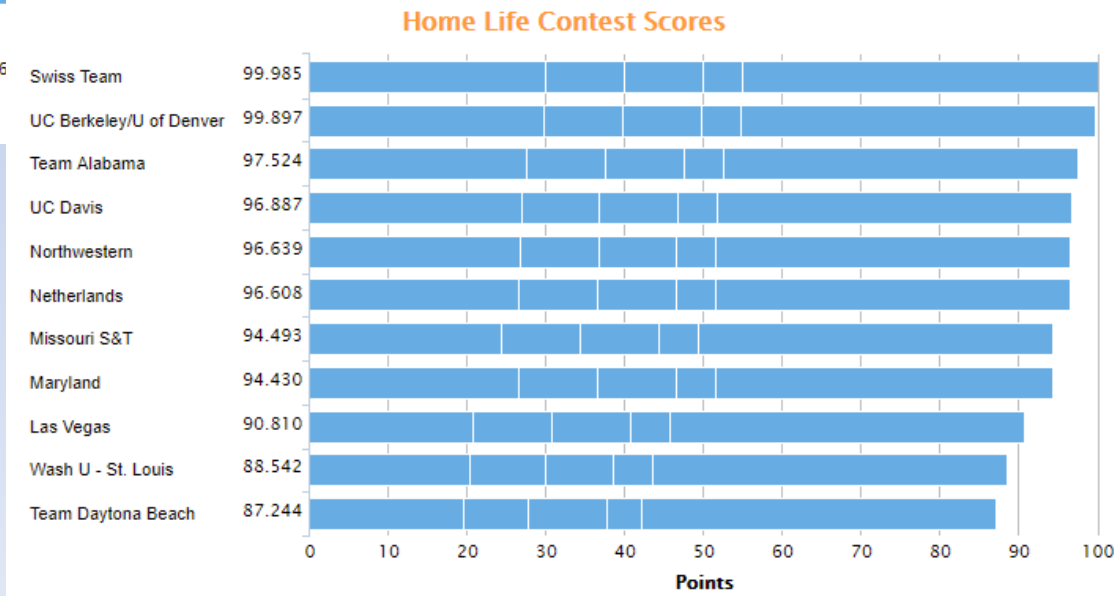


Solar Decathlon

https://www.solardecathlon.gov/

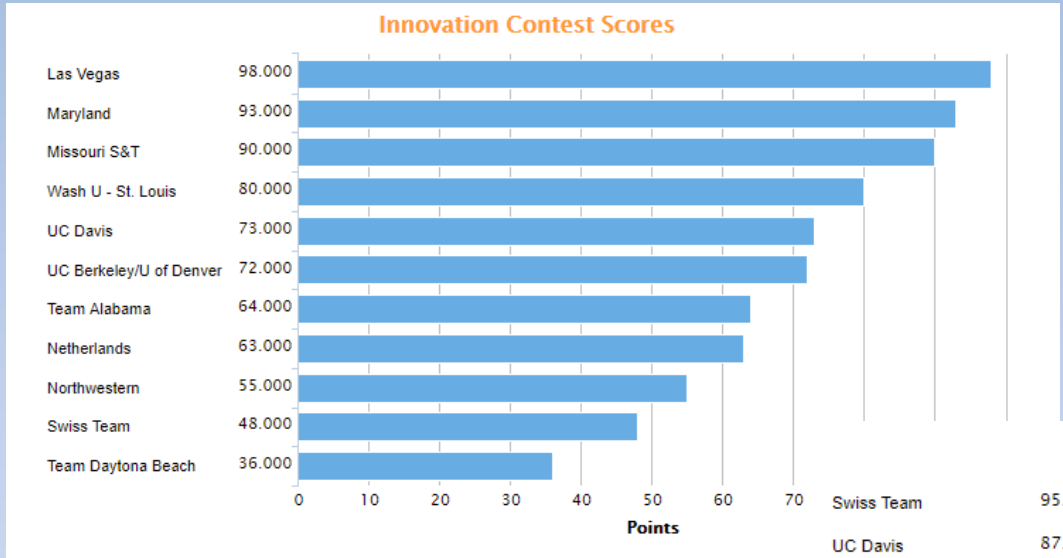
- By Contest: Engineering & Home Life

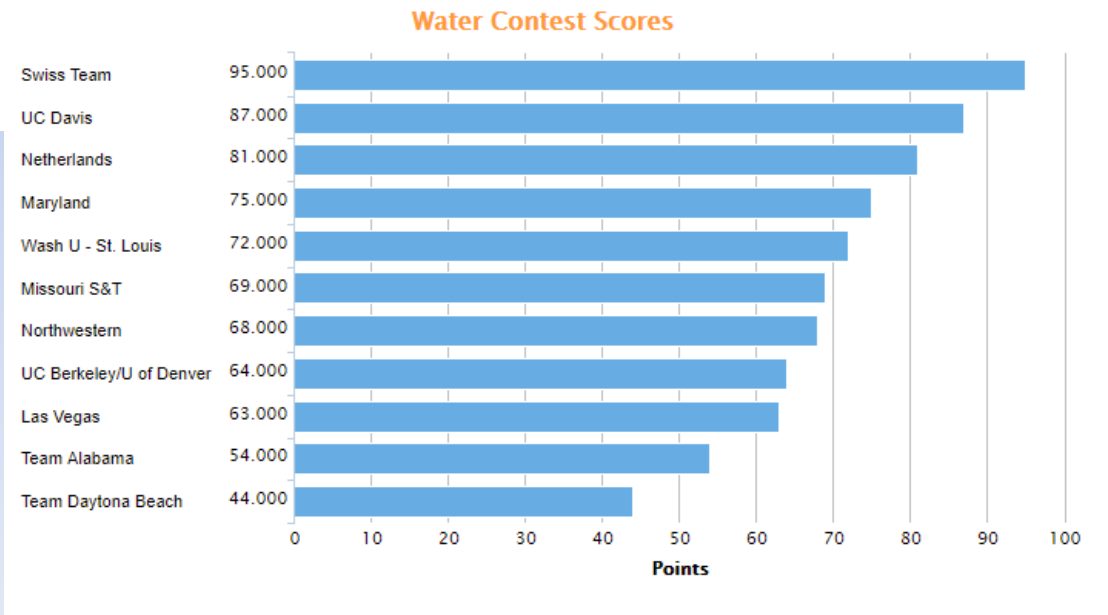




Solar Decathlon

Innovation and Water





As We Learn How Fragile the Electric Grid Is, 'Off-Grid' Gains Increased Appeal

REAL ESTATE TODAY

By JIM SMITH, Realtor®

News from our hurricane-ravaged states and from the Caribbean islands can be unsettling, even to those whose life and property weren't affected by these events. How would life be for ***you*** if you lost electricity for several weeks, or even months?

Without electricity, there is no refrigeration, and you can't even run a gas furnace to keep warm. If you live on well water, you couldn't run the electric well pump, so without a manual pump (which are still available) you'd be without water. Forget the internet and charging your cell phone. Gas stations wouldn't be able to pump gas, so you'd soon lose the use of your car or at, best, find long gas lines — unless you have an electric car powered by off-grid electricity.

Even before the devastating news from Puerto Rico, I'd been considering going off-grid in my Golden home, or at least buying a Tesla Powerwall battery pack as back-up to the electricity supplied by Xcel Energy. I have enough solar panels to power my home and my cars, but when the grid goes down, my solar panels are useless. With today's solar power systems, you're either on-grid or off-grid. I ***used*** to like to say that the grid is my battery. Now I'm not so confident of that. My home sends power to Xcel during the day then receives if from Xcel at night. As long as this give-and-take arrangement ("net metering") works as designed, it makes no sense to own your own battery. But what about when it ***doesn't*** work?

A friend and mentor of mine, Steve Stevens, has a home powered by Xcel, but also keeps a fully-charged battery pack in his garage so when there's a black-out he can throw a switch and run his home (and charge his cars) directly from the battery pack. His solar photovoltaic (PV) system will continue charging the battery pack during daylight hours, which is capable of providing enough electricity to live normally during the night .

I used to think such an investment was silly, but so, it could be argued, is flood insurance — that is, until you have a flood. I'm not considering flood insurance, but I am seriously considering buying "*electricity insurance*" in the form of a battery back-up system for my home and possibly for my real estate office.

Even a one-day power outage could spoil food in the refrigerator and freezer. Perhaps you've had that experience. Such a system would help to mitigate that risk.

Maybe you read, as I did, that Tesla has suspended the production of it new Tesla Semi so it can concentrate on making Powerwall units for Puerto Rico and other areas devastated by hurricanes. Presumably, Tesla is also sending the solar panels necessary to charge those battery packs.

It's also possible to get off the natural gas grid and heat your home with electricity. If you're skeptical, it's probably because when you think of electric heat, electric baseboard or "resistance heating" comes to mind.

Resistance heating involves the use of electric coils that get hot when connected to electricity. You'll find this same level of technology in the toaster sitting on your kitchen counter – an appliance invented in 1893. Modern electric heating, on the other hand, is accomplished by way of a heat pump. These devices use an electric compressor to extract heat from inside your house when it's hot (air conditioning) and extract heat from outdoors, even when it's below freezing, to heat your home in the winter.

This kind of heat pump is called an "air source" heat pump because it extracts heat from the outdoor air. A more expensive but more efficient heat pump extracts heat from the earth, which is a constant 55 degrees once you reach six feet below the surface in our latitude. It takes less electricity to extract heat from that 55-degree source than it does from the air, because the air is often much colder. Unfortunately, the cost of installing the vertical or horizontal wells required for a ground-source heat pump makes these systems much more expensive to install, though cheaper to operate.

Recently I wrote about "mini-splits," which are heat pumps common throughout Europe and Asia but that are just beginning to make their appearance in America. They will ultimately make our gas forced air furnaces and A/C units obsolete. They haven't been popular here because, without using ducts, you'd require one for each room. At right is a 12,000 BTU kit that I found online for only $645.

There are systems currently available that include up to four interior wall units (at the top in the image) that run off a single compressor for under $2,000. They both heat and cool, eliminating the need for a gas furnace plus separate A/C compressor and chiller unit.

Water can also be heated electrically using a heat pump water heater. Home Depot sells a 65-gallon Rheem model for $1,399 and claims "$4,500 in energy cost savings." It's important to put this model in unconditioned space — or in a room with outdoor air available. The reason is that the heat pump is transferring the heat from the room into the water, so it functions like an air conditioner wherever it is installed. If it's in a small room, that room can get very cold as your water gets hot! If your current furnace room has "combustion air" ducts supplying outdoor air to your gas furnace and hot water heater, those same ducts can provide the needed outdoor air when you convert to heat pumps. Just be sure to keep the door to this room closed — and not have louvered doors.

If you can also do without gas for cooking — and there are some great electric cooktops available now — you can get rid of your gas meter (saving the monthly grid connection fee) and live only off the sun.

This 6th Ave. West Home Has It All, Even a Man Cave

This lovely bi-level home at **14317 W. 4th Place** is located in walking distance of the light rail station serving 6th Avenue West and Red Rocks Community College. It has been beautifully updated with hardwood floors, maple cabinets, granite counters, vaulted ceiling and updated appliances. A heated and finished bonus room (or "man cave") is located behind the 2-car garage. The home sits on a large cul-de-sac lot adjoining Flora Way. The fenced yard includes a dog run with dog house and large wood deck. Top-rated Kyffin Elementary, which has a Gifted & Talented program, and the community swimming pool are a few blocks away, as is a vest-pocket park for the neighborhood hidden from street view. There are 4 bedrooms, 2 upstairs and 2 more downstairs, with 3 baths. You'll love the master bathroom! Watch a narrated video tour at **www.6thAveWestHome.com**. I will be holding it open this **Sunday, October 15th, 1-3 pm.**

Would You Like to See an Off-Grid Home?
The price was just reduced on one near Idaho Springs. See our other ad on Page 2
(Page 10 in the West Jeffco edition).

GOLDEN REAL ESTATE

Jim Smith
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Golden Real Estate, Inc.
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OFFICE PHONE: **303-302-3636**
EMAIL: **Jim@GoldenRealEstate.com**
WEBSITE: **www.GoldenRealEstate.com**
ARCHIVES: **www.JimSmithColumns.com**
17695 South Golden Road, Golden 80401

Contemporary Events: OFF-Grid Discussion by Jim Smith in DP HUB

http://www.denverpost.com/news/yourhub/

DP 10/15/2017 – George Will

The auto industry's opaque future

By George F. Will
Washington Post Writers Group

Bending metal, slapping on chrome and marketing an empowering product and status marker that mesmerized 20th century America, the automobile industry typified the Old Economy, of which General Motors was emblematic. As was its bankruptcy. Today, GM's CEO Mary Barra is wagering that the industry soon will be manufacturing New Economy products. They will incorporate technologies that will entice buyers whose sensibilities and expectations have been shaped by the kind of empowerment delivered by their smartphones, which arrived just 10 years ago.

GM's electric self-starter, which replaced hand cranks, was the last century's most transformative innovation. It arrived in 1912. Today, Cadillac offers hands-free driving, with advanced GPS mapping. An eye-tracking camera on the steering column monitors driver alertness, and the car nags the distracted driver back to attentiveness, which makes this technological marvel less of a convenience than the self-starter. Still, Barra is attempting an audacious balance between the demands of present consumers and radically different future demands. Or, more accurately, a future that governments, hostile to consumer sovereignty, intend to dictate.

China has announced, as have Britain and France, plans to ban, at an undetermined date, sales of vehicles powered by fossil fuels in their tanks. (Electric vehicles will be powered mostly by fossil-fuel-generated electricity.) In Shanghai in mid-September, Barra dissented: "I think it works best when, instead of mandating, consumers, not government dictates, should decide how cars are powered." But governments, and not just dictatorships, like to dictate, and companies

DP 10/12/2017 –

By **PETER HOLLEY** | The Washington Post
PUBLISHED: October 12, 2017 at 10:45 am |
UPDATED: October 12, 2017 at 10:49 am

BUSINESS

Why 2017 will go down as the beginning of the end of the internal combustion engine

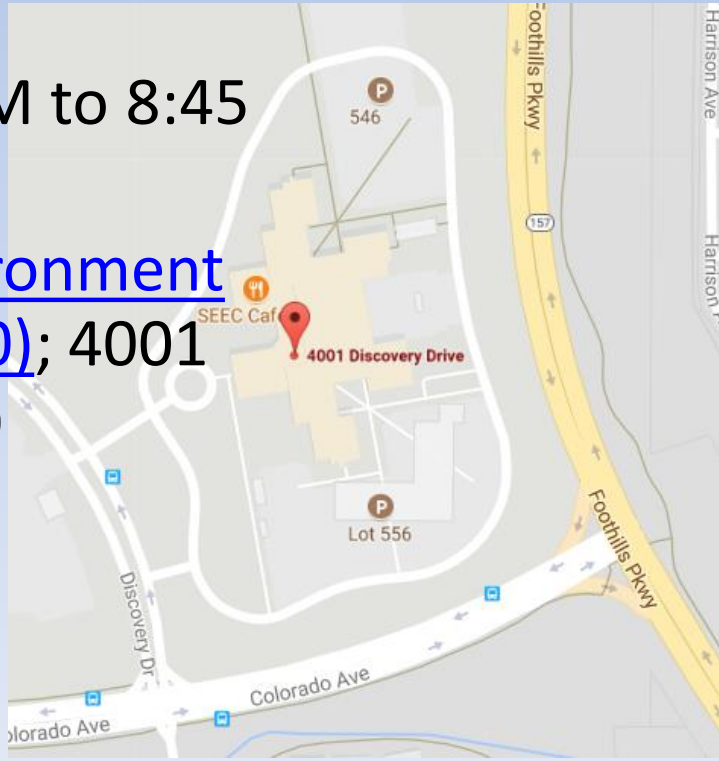
The tipping point, experts say, follows three developments, each rippling outward with economic and cultural consequences

http://www.denverpost.com/2017/10/12/2017-electric-cars-auto-sales/

Colorado Renewable Energy Society: TONIGHT IN BOULDER

- https://www.cres-energy.org/
- https://www.meetup.com/Boulder-Colorado-Renewable-Energy-Society-Meetup/events/243202354/?fromEmail=243202354&rv=me1

- **Alison Mason - Energy Storage for 100% Renewables on the Grid**
  - Tuesday, October 17, 2017: 6:45 PM to 8:45 PM
  - CU Sustainability, Energy, and Environment Complex (SEEC) - Auditorium (C120); 4001 Discovery Drive, Boulder, CO (map)



Colorado Renewable Energy Society: THIS THURSDAY @ Alliance Center

- https://www.cres-energy.org/
- https://www.meetup.com/Metro-Denver-CRES/events/243891101/

- **The Future is in Our Hands: How Can We Increase Solar in Colorado?**
  - Thursday, October 19, 2017; 6:30 PM to 8:30 PM
  - The Alliance Center, 1536 Wynkoop Street, 1st Floor , Denver, CO (map)

OLLI FRIDAY SERIES

- Anthropogenic Global Warming with Warren Hamilton Friday October 20th, 9:30-11:30

UNIVERSITY of DENVER
UNIVERSITY COLLEGE

OSHER LIFELONG LEARNING INSTITUTE

Join us at OLLI West for this week's Friday Speaker Series

Anthropogenic Global Warming

with Warren Hamilton

Friday, October 20th

9:30 - 11:30

in the Sanctuary at Jefferson Unitarian Church

The voluminous scientific evidence is unequivocal - The 40 billion metric tons of CO2, and significant amounts of other greenhouse gasses, that man dumps into the atmosphere each year cause global retention of extra solar heat. Warren will present a brief tour through global changes and consequences. Complex interactions and tipping points produce highly irregular responses and time delays confound detailed predictions, but effects are already large and will increase greatly.

Warren Hamilton, an OLLI Senior Facilitator, earned his PhD at UCLA. He had a long USGS career in regional and global geophysics, with time-outs for visiting professorships at Caltech, Yale, Amsterdam and UCSD/Scripps Institute of Oceanography. He is now a Distinguished Senior Scientist in the Geophysics Department of the Colorado School of Mines and continues research in how Earth and neighboring planets behave internally and have evolved. His many research honors include elected membership in the National Academy of Sciences, the Penrose

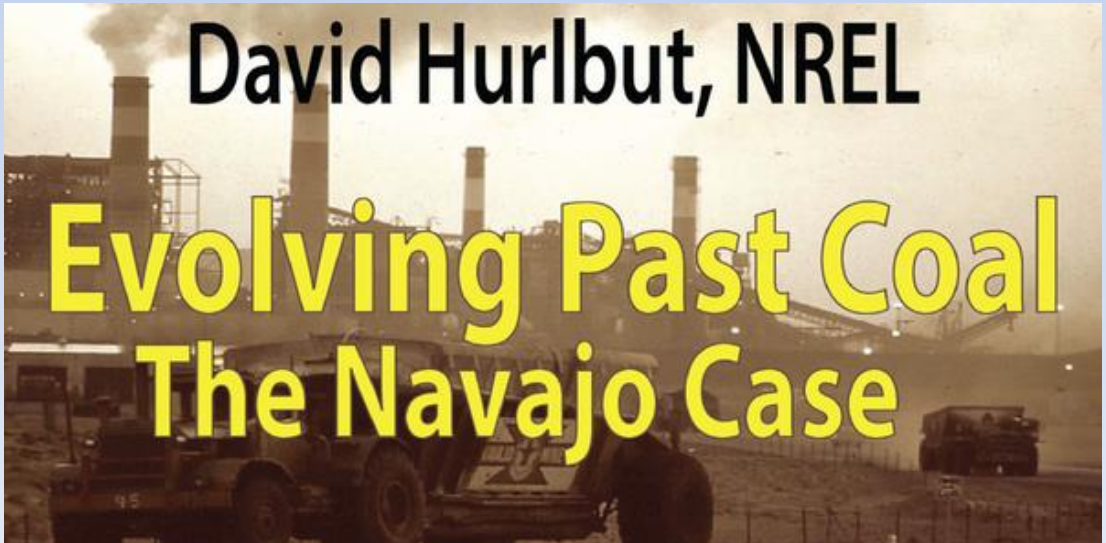
Slides available

http://campaign.r20.constantcontact.com/render?m=1103133034549&ca=0dc4b94e-aac5-4c92-84a2-9546b4d43bcb

Colorado Renewable Energy Society: put on your Calendar: October 26th

- https://www.cres-energy.org/
- https://www.meetup.com/J-CRES/events/243961082/

- Dave Hurlbut, NREL; Evolving Past
  - Thursday, October 26, 2017; 7:00 PM
  - Jefferson Unitarian Church; 14350 W. 32nd Ave. Golden, CO (map)



Colorado Renewable Energy Society – YouTube of selected talks:

https://www.youtube.com/channel/UCr81EUb2qVJVfmmlJMxEHVw

DENIALISM

- **Responding to Climate Change Deniers with Simple Facts and Logic**
  - A sequence of five questions and answers that can be used by scientists to communicate some simple concepts of climate change to broader audiences.
  - **By Dork Sahagianon 30 March 2017**
  - **SENDING VIA EMAIL**

More Next Week

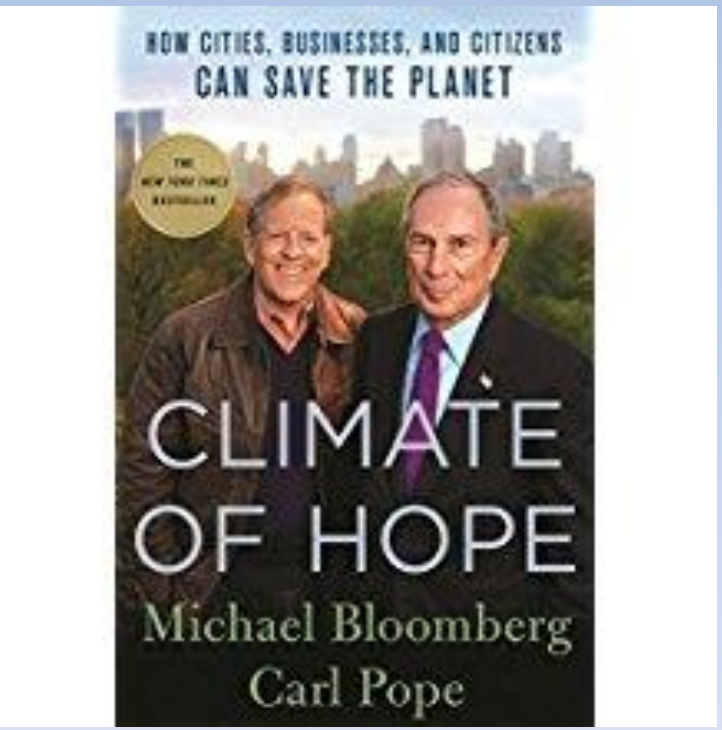
SOLUTIONS to Address Climate Change Issues: Implies an Acknowledgement that We Need to Do Something! WHAT?

- De-Carbonize our Energy Needs:
  - Electricity,
  - Transportation,
  - Farming,
  - Living (cooking/heating)
  - and Manufacturing

- Mitigate

- Adapt

Climate of Hope - Solutions



What Do I Do? (Personal)
What Do We Need to DO (Societal)

WHAT DO I DO		
	ACTIONS	ORGANIZATIONS
PERSONAL		
LOCAL		
CITY/COUNTY		
STATE		
REGIONAL		
NATIONAL		
GLOBAL		

SOLUTIONS:
WHAT ARE THE ECONOMICS DOING THAT?
CAN CAPITALISM SOLVE OUR ISSUES?
IF SO: HOW?
IF NOT: WHAT?

1. Economics
   - of doing nothing (solely adapting) vs. the economics of mitigation
   - Actuality: it WILL be a combination
2. Capitalism, GDP/growth based economics vs. “Herman Daly” economics (no-growth/steady-state)
3. Solutions? Paradigm shift? From we can’t/too expensive to WE CAN
4. There is promise, but at what cost? (One might be surprised).
   - Energy
   - Mitigation – Agricultural revolution/biofuels: Biochar for Carbon Dioxide Removal (CDR)

SOLUTIONS: To Be Covered Next Week

5. Geoengineering:
   - Solar Radiation Management (SRM) and
   - Carbon Dioxide Removal (CDR)
6. Biochar vs. BECCS solutions SEE MY BIOCHAR LINK IN OTHER PAGES: http://denverclimatestudygroup.com/?page_id=28
7. Efficiency – the single quickest way to reduce:
   - What NREL is doing: Efficiency, Solar, wind, other
8. Other strategies:
   - CCL – carbon fee/dividend
   - Cap and trade?
9. Gloom and Doom? NO! IT'S A CHALLENGE, and humanity has always been challenged and we are an adaptable species that has met the challenge over and over again!

1. Economics

- See Links Below & EEE links and AR5-WG2 on web page:
  - **Economic related reports:**
    - 2015 The Social Cost of Carbon study summary
    - 2007.03.18 Discount Rate and Climate Change DLC
  - **Stern Report**: sternreview_report_complete
  - Nordhaus briefly describes the "free rider" problem and his proffered solution as a lead-in to his recent review of the book, *Climate Shock*. Here's the link to the NY Review of Books website: http://www.nybooks.com/articles/archives/2015/jun/04/new-solution-climate-club/
  - Nordhaus produced a 30-slide PowerPoint version for his Presidential address to the AEA January. Available at http://carbon-price.com/wp-content/uploads/2015-01-04-Nordhaus-ClimateClubAEA-v2-slides.pdf
  - 2015-01-04-Nordhaus-ClimateClubAEA-v2-slides
  - **MIT**: GOOGLE LIST OF LINKS: ~~https://scholar.google.com/scholar?q=mit+report+on+climate+change+economics&hl=en&as_sdt=0&as_vis=1&oi=scholart&sa=X&ved=0CBsQgQMwAGoVChMIkMfkl8i9yAIVSuJjCh1x7wKk~~
  - **IPCC AR5 WG2**: http://www.ipcc.ch/report/ar5/wg2/#.UuAsbxDn9hE

Notes

- Stern/Nordhaus – promote support a high discount rate – doing something NOW
- IPCC acknowledges adaptation will be a must (the change is in the bank and accumulating interest)
- Bjorn Lomborg – Danish economist (not a denier) argues for spending later – i.e. no discount rate
  - https://en.wikipedia.org/wiki/Bj%C3%B8rn_Lomborg
  - http://www.desmogblog.com/bjorn-lomborg

- Which leads to whether or not we need a paradigm shift (#3)

2. Form of Government & Economic System: Growth vs. Steady-State

1. Economics
   - of doing nothing (solely adapting) vs. the economics of mitigation
   - Actuality: it WILL be a combination
2. Capitalism, GDP/growth based economics vs. “Herman Daly” economics (no-growth/steady-state)
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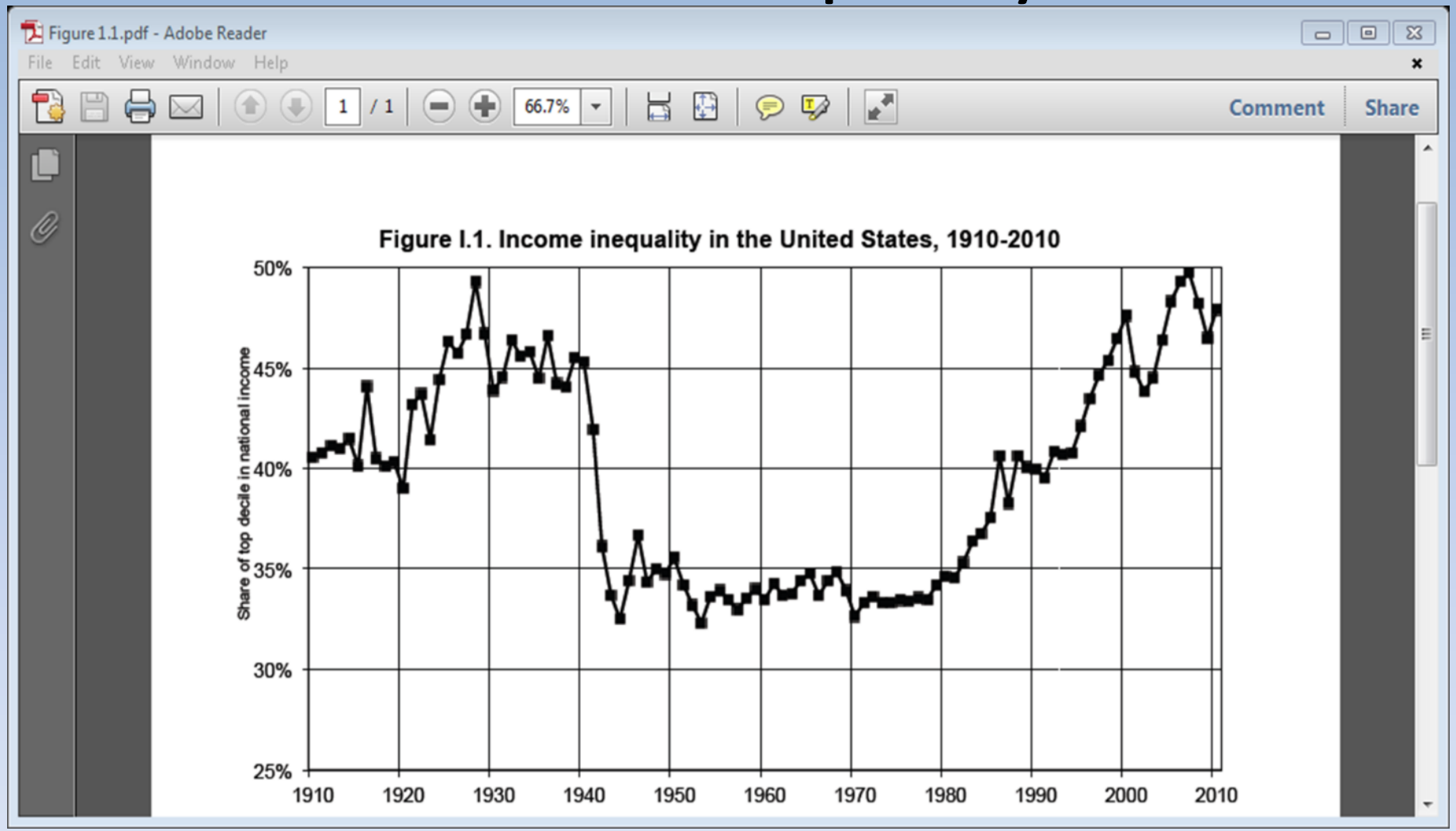
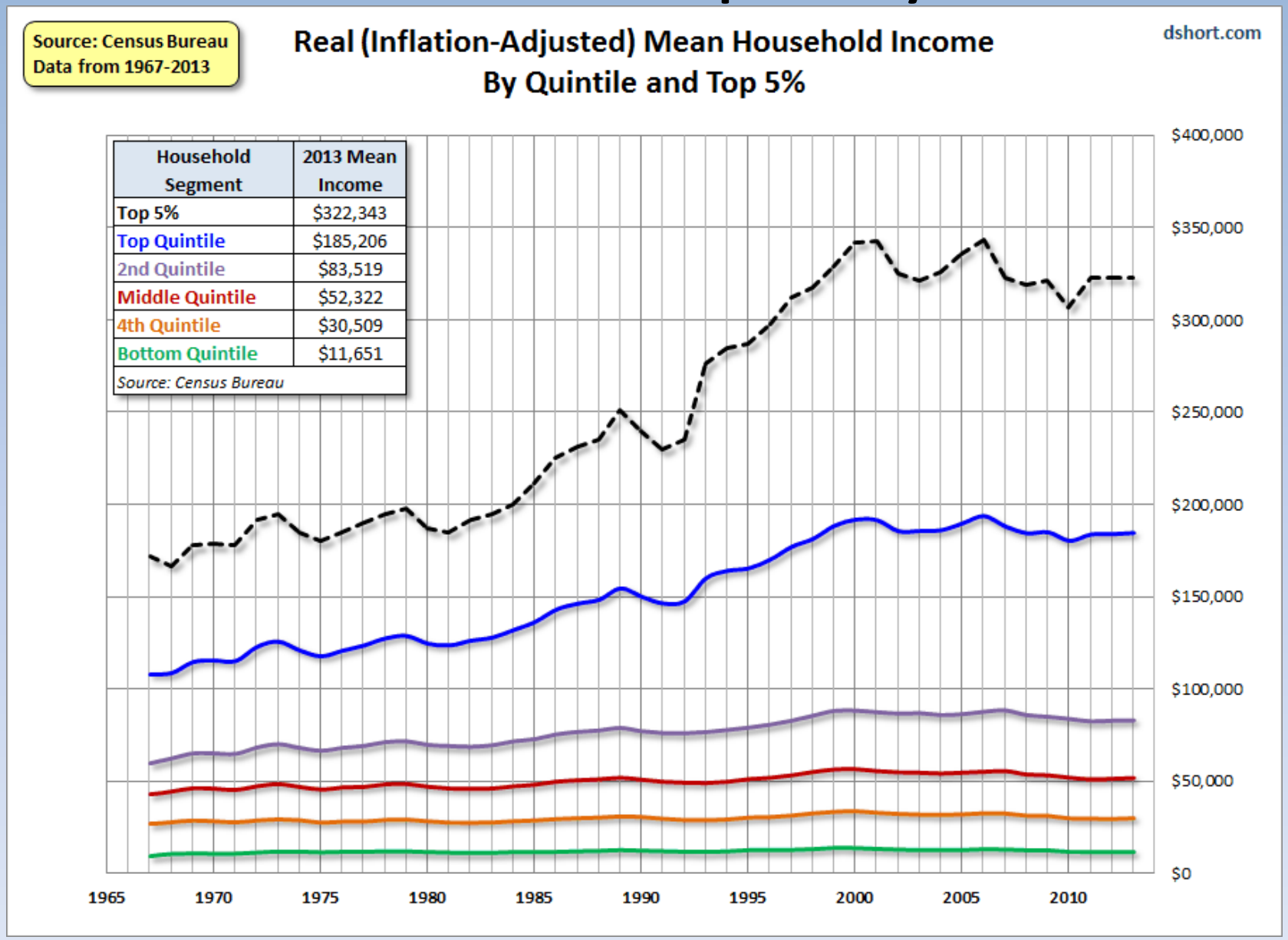
   - Mitigation – Agricultural revolution/biofuels: Biochar for Carbon Dioxide Removal (CDR)

Income Inequality



Courtesy of Gary Wyngarden: Capitalism vs. the Planet

Income Inequality



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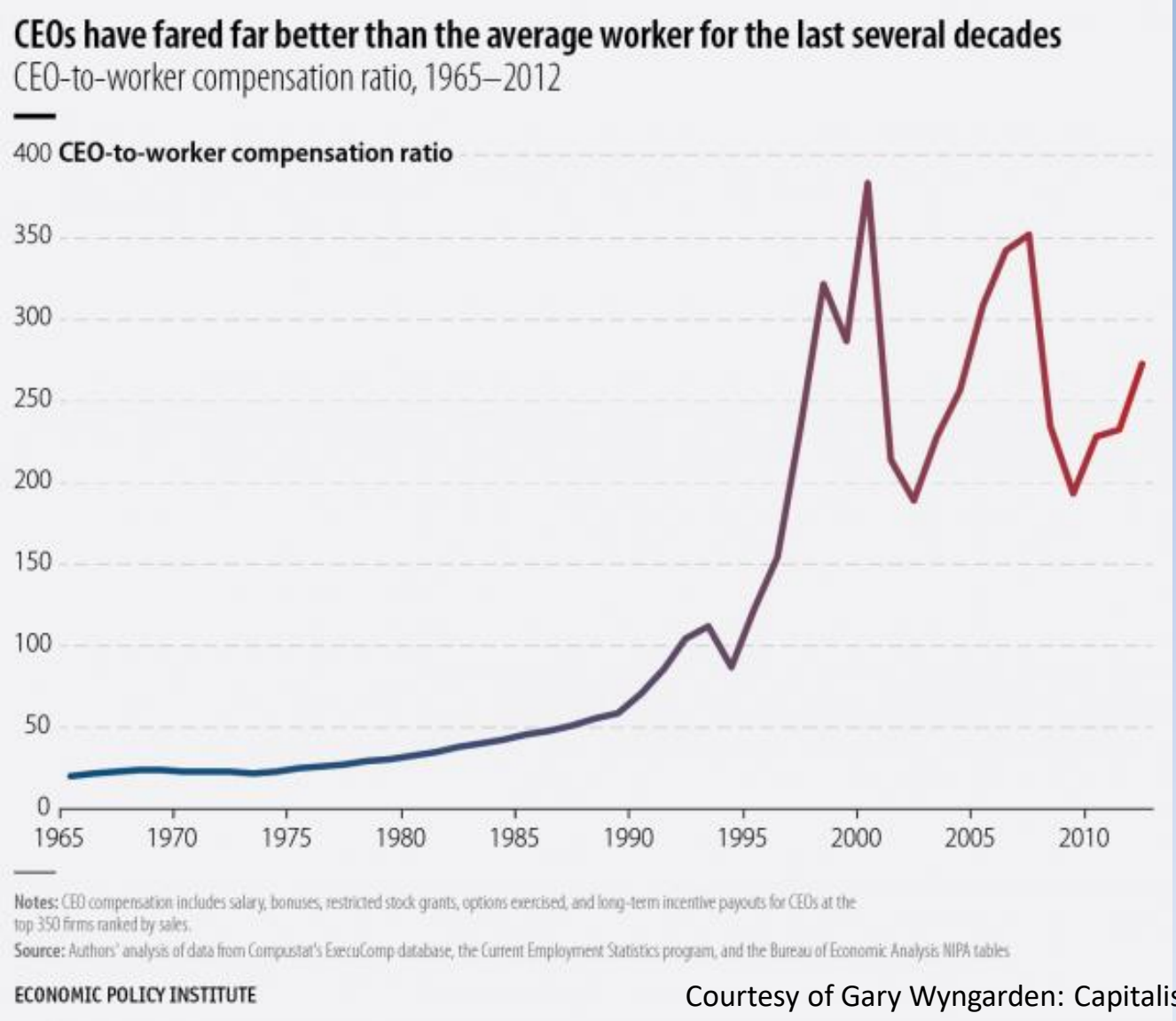
Income Inequality



Courtesy of Gary Wyngarden: Capitalism vs. the Planet

Global Footprint

see http://www.footprintnetwork.org/en/index.php/GFN/page/glossary

- Human activities consume resources and produce waste
- Ecological Footprint Accounting addresses whether the planet is large enough to keep up with the demands of humanity.
- Biocapacity represents the planet's biologically productive land areas including our forests, pastures, cropland and fisheries
- Biocapacity can then be compared with humanity's *demand* on nature: our **Ecological Footprint.** The Ecological Footprint represents the productive area required to provide the renewable resources humanity is using and to absorb its waste.

Global Footprint

- Our current global situation: *Since the 1970s, humanity has been in ecological overshoot with annual demand on resources exceeding what Earth can regenerate each year*.
- It now takes the Earth one year and six months to regenerate what we use in a year.
- We maintain this overshoot by liquidating the Earth's resources. Overshoot is a vastly underestimated threat to human well-being and the health of the planet, and one that is not adequately addressed.

Global Footprint

- For 9 billion people (midrange projection for 2050) to live at North American/Western European standards will require 5 planets.

Drawbacks of Capitalism

- Wealth and Income Distribution
- Largely ignoring the ecological impacts and biocapacity of the planet

Growth Dilemma

- Growth is unsustainable in its current form
- De-growth is unstable

How do different countries handle it?

- Japan:
- China:
- Malaysia:
- U.S.:
- Germany:
- Others:

Obama quoted in episode of Years of Living Dangerously (paraphrased): “It’s difficult in a Democracy to do something/pass something where the pay-back is 10 or more years out”

http://media.hhmi.org/hl/12Lect4.html

The solution: steady state economics?

- Herman Daly's steady state economics see:
  - https://en.wikipedia.org/wiki/Herman_Daly
  - http://steadystate.org/herman-daly/
  - http://steadystate.org/category/herman-daly/

The problem: how to effect that change

Paradigm shift in thinking

1. Economics
   - of doing nothing (solely adapting) vs. the economics of mitigation
   - Actual will likely be a combination
2. Capitalism, GDP/growth based economics vs. “Herman Daly” economics (no-growth/steady-state)
3. Solutions? Paradigm shift? From we can’t/too expensive to WE CAN
4. There is promise, but at what cost? (One might be surprised).
   - Energy
   - Mitigation – Agricultural revolution/biofuels: Biochar for Carbon Dioxide Removal (CDR)

Paradigm shift

- **Kerry Emanuel quote on p. 76:** "…costs may be high and those paying them are not likely to be serious beneficiaries of their own actions**. Indeed, there are few, if any, historical examples of civilizations consciously making sacrifices on behalf of descendents (sic) two or more generations removed**."
- That's what the discount rate is about. **In that regard we need a social paradigm shift**
  - If we are so concerned about leaving a national debt to our children and grandchildren, shouldn't we put the costs of climate change as part of that equation?
  - For those that don't accept climate change maybe it would be a good thing to limit CO2 into the atmosphere anyway, especially at the rates we are putting it into the atmosphere – BECAUSE OF OCEAN ACIDIFICATION issues and the law of unintended consequences!

End of class slides October 17th , 2017

https://i.kinja-img.com/gawker-media/image/upload/t_original/ihsllhptnnm4vb7wuvgq.jpg