Climate Change
Solutions/Policy Options
October 29, 2019

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Executive Director
The Healthy Environment Alliance of Utah
www.healutah.org

Climate Changes Health and Health Equity
Fall 2019 Community Read/Journal Club Discussion
Eccles Health Sciences Library
Office of Health Equity and Inclusion
Or,
as Mark Twain once said
Everyone Talks About the Weather
But No One Does
Anything About It
Actually he plagiarized it. False News!
Healthy Environmental ALliance of Utah

Air Quality
- Established as a 501c3 in 1999
- 20,000 Supporters
- $500,000 annual budget
  - 50% Foundation Grants
  - 50% Supporter Donations
- 6.5 FTE staff
- 10 Member Board
- Content Expert Advisors

Renewable Energy & Climate Change

Radioactive Waste
Scott’s Medical Career

University of Utah Department of Pediatrics (12 yrs) ->

Utah State Department of Health (12 yrs) ->

MountainStar Healthcare (8 yrs) ->

Retired (2 yrs) ->

HEAL Utah (2 yrs) - Why?
Climate Change Solutions/Policy Options
<table>
<thead>
<tr>
<th>Greenhouse gas</th>
<th>Chemical formula</th>
<th>Major sources</th>
<th>Global Warming Potential, 100-year comparison</th>
<th>Atmospheric Lifetime (years)</th>
<th>Pre-industrial concentration (ppb)</th>
<th>2011 concentration (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>CO2</td>
<td>Fossil fuel combustion; Deforestation; Cement production</td>
<td>1</td>
<td>100*</td>
<td>278,000</td>
<td>390,000 (in 2011)</td>
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<tr>
<td>Methane</td>
<td>CH4</td>
<td>Fossil fuel production; Agriculture; Landfills</td>
<td>25</td>
<td>12</td>
<td>722</td>
<td>1,803 (in 2011)</td>
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<tr>
<td>Nitrous Oxide</td>
<td>N2O</td>
<td>Fertilizer application; Fossil fuel and biomass combustion; Industrial processes</td>
<td>298</td>
<td>114</td>
<td>271</td>
<td>324 (in 2011)</td>
</tr>
<tr>
<td>Chlorofluorocarbon-12 (CFC-12)</td>
<td>CCl2F2</td>
<td>Refrigerants</td>
<td>10,900</td>
<td>100</td>
<td>0</td>
<td>0.527</td>
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<tr>
<td>Hydrofluorocarbon-23 (HFC-23)</td>
<td>CHF3</td>
<td>Refrigerants</td>
<td>14,800</td>
<td>270</td>
<td>0</td>
<td>0.024</td>
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<tr>
<td>Sulfur Hexafluoride</td>
<td>SF6</td>
<td>Electricity transmission</td>
<td>22,800</td>
<td>3,200</td>
<td>0</td>
<td>0.0073</td>
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<tr>
<td>Nitrogen Trifluoride</td>
<td>NF3</td>
<td>Semiconductor manufacturing</td>
<td>17,200</td>
<td>740</td>
<td>0</td>
<td>0.00086</td>
</tr>
</tbody>
</table>
The Global Disparity in Carbon Footprints
Per capita CO₂ emissions in the world’s largest economies in 2016° (in metric tons)

<table>
<thead>
<tr>
<th>Country</th>
<th>CO₂ Emissions (metric tons)</th>
</tr>
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<tbody>
<tr>
<td>United States</td>
<td>14.95t</td>
</tr>
<tr>
<td>Canada</td>
<td>14.91t</td>
</tr>
<tr>
<td>South Korea</td>
<td>11.50t</td>
</tr>
<tr>
<td>Russia</td>
<td>9.97t</td>
</tr>
<tr>
<td>Japan</td>
<td>9.04t</td>
</tr>
<tr>
<td>Germany</td>
<td>8.88t</td>
</tr>
<tr>
<td>China</td>
<td>6.57t</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5.65t</td>
</tr>
<tr>
<td>Italy</td>
<td>5.37t</td>
</tr>
<tr>
<td>France</td>
<td>4.38t</td>
</tr>
<tr>
<td>Brazil</td>
<td>2.01t</td>
</tr>
<tr>
<td>India</td>
<td>1.57t</td>
</tr>
<tr>
<td>World OECD</td>
<td>4.35t</td>
</tr>
</tbody>
</table>

* countries chosen based on 2017 nominal GDP

Sources: International Energy Agency, International Monetary Fund
Figure 4: Energy-related CO₂ emissions by sector

Million metric tons

- **Power**
- **Transportation**
- **Industry**
- **Buildings**

Source: Rhodium US Climate Service
UNCHARTED TERRITORY
400,000 Years of Carbon Dioxide

Intergovernmental Panel on Climate Change (IPCC) Report 5-2013 Report 6-2022

Representative Concentration Pathways (RCPs)

IPCC-
Intergovernmental Panel on Climate Change
Report 5- 2013
Report 6-2022

RCPs-
Representative Concentration Pathways

https://medium.com/@davidfurphy/what-on-earth-is-an-rcp-bbb206dde26
Health Impacts of Climate Change

**Figure 1: Climate Change is Harming the Health of Americans.**

**Increased Anthropogenic Greenhouse Gas Emissions**

- **Climate Pressures**
  - Increasing temperatures
  - More extreme weather
  - Rising sea levels
  - Extremes of precipitation

- **Exposure Pathways**
  - Extreme heat & heatwaves
  - Air pollution (PM2.5 & NOx)
  - Water contamination
  - Changes in vector ecology
  - Increasing allergens
  - Food supply and quality
  - Population displacement

**Health Outcomes**

- Heat stress & heat stroke
- Respiratory disease
- Cardiovascular disease
- Gastrointestinal illness
- Vector-borne diseases (Lyme, West Nile, Zika)
- Mental health illness/worsening mental health
- Adverse birth outcomes
- Physical trauma and death

- Populations especially vulnerable are children, older adults, pregnant women, those with chronic medical conditions, those with lower socioeconomic status, outdoor workers, and racial minorities.

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**Figure 2: Extreme Heat is Harming the Health of Americans.**

**How Can Extreme Heat Impact Health?**

- **Brain**
  - Decreases mental health problems
  - Increases aggression and violence
  - Increases cardiovascular illness (e.g., stroke)

- **Heart**
  - Increases cardiovascular disease, such as heart attacks

- **Lungs**
  - Increases respiratory disease, such as asthma attacks
  - Oxide concentrations increase at higher temperatures and further worsen respiratory disease

- **Kidneys**
  - Increases renal disease, such as kidney failure

- **Pregnancy**
  - Increases in preterm births
  - Adverse birth outcomes such as low birth weight and infant death

- **Physical Trauma and Death**
  - Leads to heat exhaustion and heat stroke
  - Increases emergency department visits and hospitalizations
  - Leads to death

Figure created for Brief by M. Lee (Climate Nexus).
The Krebs Cycle of Climate Change Health Impacts
So the Scientific Consensus is that the Planet has a Bad Disease With a Bad Prognosis.

What Treatment(s) Might Be Effective?
First, though

Is This Scope of Economic/Social/Political Change Even Possible?
Environmental Policy Solution Success Stories
Case Study- Acid Rain

• The Problem: Several decades ago, sulfur dioxide from coal-fired power plants was creating harmful acid rain killing aquatic life and forests. Traditional regulation would have simply directed every plant owner to cut pollution by a specific amount in a specific way, an expensive and often ineffective solution.

• The Policy Solution: A cap-and-trade approach was written into the 1990 Clean Air Act. It required overall sulfur emissions be cut in half, but would let each company decide how to do it. Power plants that cut their pollution more than required could sell the extra allowances.

• The Results: Sulfur emissions went down faster than predicted and at one-fourth of the projected cost. Cap and trade was so effective and affordable that The Economist magazine called it the "greatest green success story of the decade."
Environmental Policy Solution Success Stories
Case Study- The Hole in the Ozone

• The Problem:
  • In 1985, scientists discovered a large area of thinning of the atmospheric ozone layer above Antarctica.
  • This blanket of ozone, or O3, blocks most of the sun's high-frequency ultraviolet rays that can cause skin cancer and cataracts in humans, as well as reproductive problems in fish, crabs, frogs, and even in the single-celled phytoplankton at the bottom of the ocean food chain.
  • Chlorofluorocarbons (CFCs) released from refrigerants and aerosol sprays that persisted for decades in the atmosphere were generating free chorine atoms that pulled ozone molecules apart.
  • Studies suggested that, without an intervention, the Earth’s entire ozone layer would have collapsed by 2050, leading to 280 million extra cases of skin cancer as well as a spike in cataracts and other health problems.
Environmental Policy Solution Success Stories

Case Study- The Hole in the Ozone

• The Policy Solution: the Montreal Protocol of 1987, a pact to phase out the use of CFCs and restore the ozone layer was eventually signed by every country in the United Nations—the first UN treaty to achieve universal ratification.

• The Results: The hole in the ozone is now the smallest it’s been in 30 years. A complete rebound seems imminent. Some scientists project that by 2080 global ozone will return to 1950s levels.
Solution Lists
Environmental Defense Fund

- Limit Power Plant Pollution
- Prioritize China’s Pollution Problem
- Expand Carbon Markets Worldwide
- Unleash Clean Energy in the U.S.
- End Fossil Fuel Subsidies
- Unlock the Profit of Living Rainforests
- Stop Methane Leaks
- Cut Deadly Soot
- Phase Out Super Polluting HFCs
- Reduce Fertilizer Pollution
Solutions Lists
Project Drawdown
Paul Hawkin
(Smith & Hawkin)

Research organization that reviews, analyses, and identifies the most viable global climate solutions

“Stopping global warming is possible, with solutions that exist today.”

Top 100 Prioritized Strategies
https://www.drawdown.org/solutions
Drawdown solution #1: Refrigerant Management 😞

The Kilgali Amendment to the Montreal Protocol phases out HFCs over the next 30 years. Ratified by 72 countries - but not the United States ... not yet.
## Solutions- Project Drawdown

[https://www.drawdown.org/solutions](https://www.drawdown.org/solutions)

### Solutions by Rank

<table>
<thead>
<tr>
<th>Rank</th>
<th>Solution</th>
<th>Sector</th>
<th>TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)</th>
<th>NET COST (BILLIONS US $)</th>
<th>SAVINGS (BILLIONS US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Refrigerant Management</td>
<td>Materials</td>
<td>89.74</td>
<td>N/A</td>
<td>-902.77</td>
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<tr>
<td>2</td>
<td>Wind Turbines (Onshore)</td>
<td>Electricity Generation</td>
<td>84.60</td>
<td>$1,225.37</td>
<td>$7,425.00</td>
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<tr>
<td>3</td>
<td>Reduced Food Waste</td>
<td>Food</td>
<td>70.53</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>4</td>
<td>Plant-Rich Diet</td>
<td>Food</td>
<td>66.11</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>5</td>
<td>Tropical Forests</td>
<td>Land Use</td>
<td>61.23</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>6</td>
<td>Educating Girls</td>
<td>Women and Girls</td>
<td>51.48</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>7</td>
<td>Family Planning</td>
<td>Women and Girls</td>
<td>51.48</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>8</td>
<td>Solar Farms</td>
<td>Electricity Generation</td>
<td>36.90</td>
<td>$-80.60</td>
<td>$5,023.84</td>
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<td>9</td>
<td>Silvopasture</td>
<td>Food</td>
<td>31.19</td>
<td>$41.59</td>
<td>$699.37</td>
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<tr>
<td>10</td>
<td>Rooftop Solar</td>
<td>Electricity Generation</td>
<td>24.60</td>
<td>$453.14</td>
<td>$3,457.63</td>
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</tbody>
</table>
Pathways to Deep Decarbonization in the United States

Climate Change Lifestyle Solutions- Energy Star
Government-backed symbol for energy efficiency
https://www.energystar.gov/

- Overall program
  - 60,000 products with ES rating
  - 2800 products with “most efficient” rating
  - $100 billion annual market
  - Products are related to 600,000 jobs
  - Consumer financial incentives

- 2017
  - 300m products + 300m light bulbs purchased
  - 130 million tons of greenhouse gases (GHG)

- Residential
  - Certified homes
    - 2 million since 1995
    - 1/10 new homes in 2018
    - 2017 = 3 million tons of GHG
  - Appliances, windows, insulation

- Commercial
  - ES Energy Portfolio Manager
    - 25% of all U.S. commercial properties
    - 2017 = 110 million tons of GHG

- Industrial
  - Bakeries, pharma plants, steel mills
  - 2017 = 40 million tons of GHG
Climate Change Lifestyle Solutions - Automobile Ratings

• Greenhouse Gas (GHG) ratings
  • CO$_2$ (90%)
  • Methane
  • NO$_x$
  • Hydrofluorocarbons

• Smog ratings
  • Volatile organic compounds (VOCs)
  • NO$_x$
  • CO
  • Particulates
  • Formaldehyde

https://www.epa.gov/greenvehicles/greenhouse-gas-rating
<table>
<thead>
<tr>
<th>Rating</th>
<th>MPG (gas)</th>
<th>CO₂ (g/mile)</th>
<th>Make and model</th>
<th>Specifications</th>
<th>MPG city b,c</th>
<th>MPG hwy b,c</th>
<th>Green Score</th>
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<tbody>
<tr>
<td>10</td>
<td>&gt;=44</td>
<td>0-204</td>
<td>Mercedes-Benz smart EQ fortwo Coupe</td>
<td>Electric (Li-Ion)</td>
<td>3.8</td>
<td>2.9</td>
<td>68</td>
</tr>
<tr>
<td>9</td>
<td>38-43</td>
<td>205-237</td>
<td>Hyundai Ioniq Electric</td>
<td>Electric (Li-Ion)</td>
<td>4.7</td>
<td>3.8</td>
<td>67</td>
</tr>
<tr>
<td>8</td>
<td>33-37</td>
<td>238-273</td>
<td>Toyota Prius Primed</td>
<td>Electric (Li-Ion) / 1.8L 4, auto CVT</td>
<td>4.3 / 55</td>
<td>3.6 / 54</td>
<td>65</td>
</tr>
<tr>
<td>7</td>
<td>30-32</td>
<td>274-301</td>
<td>Hyundai Ioniq Blue</td>
<td>1.6L 4, auto</td>
<td>57</td>
<td>59</td>
<td>65</td>
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<td>6</td>
<td>27-29</td>
<td>302-335</td>
<td>BMW i32</td>
<td>Electric (Li-Ion)</td>
<td>3.7</td>
<td>3.0</td>
<td>65</td>
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<td>5</td>
<td>23-26</td>
<td>338-395</td>
<td>Toyota Prius Eco</td>
<td>1.8L 4, auto CVT</td>
<td>58</td>
<td>53</td>
<td>64</td>
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<td>4</td>
<td>20-22</td>
<td>396-456</td>
<td>Honda Clarity Electric</td>
<td>Electric (Li-Ion)</td>
<td>3.7</td>
<td>3.1</td>
<td>64</td>
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<td>17-19</td>
<td>457-539</td>
<td>Kia Soul Electric</td>
<td>Electric (Li-Ion)</td>
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<td>2.8</td>
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<td>15-16</td>
<td>540-613</td>
<td>Nissan Leaf</td>
<td>Electric (Li-Ion)</td>
<td>3.7</td>
<td>3.0</td>
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<td>1</td>
<td>&lt;=14</td>
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<td>Honda Insight</td>
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<td>55</td>
<td>49</td>
<td>63</td>
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<td></td>
<td></td>
<td></td>
<td>Hyundai Kona Electric</td>
<td>Electric (Li-Ion)</td>
<td>4.1</td>
<td>3.2</td>
<td>63</td>
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<td></td>
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<td></td>
<td>Volkswagen e-Golf</td>
<td>Electric (Li-Ion)</td>
<td>3.7</td>
<td>3.3</td>
<td>62</td>
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<tr>
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<td></td>
<td></td>
<td>Toyota Camry Hybrid LE</td>
<td>2.5L 4, auto CVT</td>
<td>51</td>
<td>53</td>
<td>62</td>
</tr>
</tbody>
</table>
Are Electric Vehicles Really Better For The Environment?

https://www.forbes.com/sites/jamesellsmoor/2019/05/20/are-electric-vehicles-really-better-for-the-environment/#5d3f254d76d2

A report by Carbon Brief shows that across Europe and the United States, electric vehicles contribute less to climate change than conventional vehicles. [-] CARBON BRIEF
Solutions- Physician Influence

Office/ Hospital Operations

• Energy Efficiency
• Renewable Energy
• Water Efficiency
• Solid Waste & Recycling
• Drug Disposal & Chemicals
• Transportation & Commuting
• Healthy Foods

Patient Education

• Incorporate into patient visits
  • Relate to patient’s situation
  • Posters, Brochures, Fact Sheets
  [American College of Physicians Fact Sheet](https://www.mygreendoctor.org)

• Colleagues
  • Presentations
  • Informal Conversations

• Family & Friends
Rocky Mountain Power/ PacifiCorp
Energy Sources

- 56.39% coal
- 15.44% natural gas
- 8.80% wind
- 5.15% hydro
- 3.79% solar
- 0.39% geothermal
- 0.34% biomass
- 9.75% miscellaneous
Rocky Mountain Power/ PacifiCorp Energy Sources

- 2019 Integrated Resources Plan
- 20 year plan
- Updated every 2 years
- Announced the intended closure of 83% of its coal units by 2038
- Oregon, Washington, and California plan to stop paying for coal by 2025
- RMP could shift coal costs to Utah rate-payers and renewable costs to other states.
Municipalities with 100% Renewable Goals

Across the US

• 9 States
• 11 Counties
• 141 Cities & Towns
  • 6 towns are already at 100%
• Various target dates
• Various phase-in strategies

• 1 in 5 or 70 million people

Utah

• Salt Lake City (2032)
• Park City (2032)
• Summit County (2032)
• Cottonwood Heights (2032)
• Holladay (2030)
• Moab (2032)

HB 411- 2019 Utah Leg Session

https://www.sierraclub.org/ready-for-100/commitments
2018 Utah Legislature- H.C.R. 7
Concurrent Resolution on Environmental and Economic Stewardship

• Initiated by students from Logan late in the 2017 session
  • recognizes the need for responsible stewardship and prudent management of natural resources;
  • recognizes the impacts of a changing climate on Utah citizens;
  • expresses commitment to create and support economically viable and broadly supported solutions, including in rural communities;
  • encourages the use and analysis of sound science to understand the causes and impacts of local and regional climates;
  • encourages resilient ecosystems that can better adapt to our changing environment; and
  • encourages the reduction of emissions through incentives and the support of growth in technologies and services that enlarge the economy.

• Passed the House 51/21/3
• Passed the Senate 23/3/3

• https://le.utah.gov/~2018/bills/static/HCR007.html
2020 Utah Legislature- Securitization

• Rocky Mountain Power is disincentivized to close coal plants
  • Paying down long-term debt
  • Paid off through consumer utility rates
  • ROI is based on keeping plants open through their initial useful life projection
  • Operating them longer increases RMPs ROI

• Closing coal plants early creates “stranded assets”

• Can be turned into recycled capital using securitization
  • RMP “securitizes” the stranded asset by issuing a bond to investors
  • AAA rated bond, guaranteed return due to ratepayer obligation
  • Freed up capital is recycled into the development of large, renewable energy sources
  • Lower interest rate, lower operating costs,
  • Emissions reduced, consumer utility rates don’t increase, share prices remain stable,
  additional funds for community transition
Energy Storage- Utility Scale

- Compressed Air Energy Storage
- Flywheels
- Flow Batteries
- Pumped Hydro Power
- Thermal
- Solid-State Batteries

https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage.pdf
Energy Storage - Residential Scale

https://www.greentechmedia.com/articles/read/led-by-surging-residential-sector-q2-us-energy-storage-deployments-grow-200#gs.pblFbM
Nuclear Power is NOT a necessary component of the solution climate change

• Long lag time from planning to operations
  • 10-20 years vs. 4-7 for wind and solar
• Cost
  • 5 times more per Kw than on-shore wind
• Weapons Proliferation Risk
• Meltdown Risk
• Mining Lung Cancer Risk
• Carbon-Equivalent Emissions
• “Baseload” reliability
  • natural gas, hydropower, or batteries ramp up 5 to 100 times faster
Land Use Solutions

- Tropical Forests
- Cover Crops
- Grazing
- Desertification
- Fugitive Dust
- Fertilizer
- Food Waste
- Active management

Land is Both a Powerful Sink and Emitter of Carbon Dioxide Emissions

- Land Produces 5.2 GtCO₂ a year
- Land Sequesters 11.2 GtCO₂ a year
- Net Benefit of 6 GtCO₂ a year

Total Annual GHG Emissions from the United States

Note: Values are an average over 2007-2016
Source: IPCC Special Report on Climate Change and Land

WORLD RESOURCES INSTITUTE
Carbon Capture and Storage (CCS)

- Captured from emission source
  - absorption with amines
  - adsorption
  - membrane gas
- Transport
  - Pipeline
  - Ships
- Storage
  - Deep geologic- gas
  - Biologic metabolism
    - Algae or bacteria
  - Mineral conversion- solid
    - Reacts with metal oxides to form stable carbonates
- Promoted by fossil fuel industry
- Normal innovation curve
  - low cost in 2077
  - widespread adoption by 2100
Energy Innovation and Carbon Dividend Act
HR 763- Rep. Deutch (R-Florida) & 68 co-sponsors

• Places a steadily rising fee on carbon emissions
  • Starts at $15/metric ton, increases by $10/metric ton each year
  • Assessed as close to the source as possible- mine, refinery, first pipeline, port
• Gives 100% of the fees minus administrative costs back to households each month.
  • Average dividend for a family of 4 = $3500/year
• Uses a border adjustment to levelize trade and discourage business relocation.
• Pauses the EPA authority to regulate the CO2 and equivalent emissions covered by the fee for the first 10 years after the policy is enacted.
  • Auto mileage standards regulation would continue.
Energy Innovation and Carbon Dividend Act
HR 763

• Reduces carbon emissions by 40% over the first 12 years.
• Creates 2.1 million new jobs
• 350,000 pollution-related deaths prevented
• Supported by 3500 economists
• Bipartisan

https://citizensclimatelobby.org/basics-carbon-fee-dividend/
https://energyinnovationact.org/how-it-works/

• Climate Leadership Council- Baker/Shultz version

https://www.clcouncil.org/our-plan/
Mitt Romney/ Pierre Dilecto

- Focused on climate change while Governor of Massachusetts from 2003-2007.
- Then downplayed/reversed his “position” initially as presidential candidate.
- Has once again repeatedly made public statements since as early as 2012 that “climate change is real and humans are contributing to it”.
- Has indicated that he is open to a carbon tax.
- Believes that India and China are the key to a real solution.
- Is one of three Republicans in the bi-partisan Senate climate caucus.
Questions or Comments?
Project Drawdown

https://www.drawdown.org/solutions

• Data collection
  • -> Modeling
    • Against a reference case that assumes little change over the next thirty years
  • -> 80 Ranked Solutions
    • Deployable
    • Economically viable
    • Scalable
    • “No Regrets”- make sense to take regardless of their climate impact since they have intrinsic benefits to communities and economies.
      • improve lives
      • create jobs
      • restore the environment
      • enhance security
      • generate resilience
      • advance human health

• Scenarios
  • Plausible Scenario: the case in which solutions on the Drawdown list are adopted at a realistically vigorous rate over the time period under investigation, adjusting for estimated economic and population growth.
  • Drawdown Scenario: the case in which the adoption of solutions is optimized to achieve drawdown by 2050.
  • Optimum Scenario: the case in which solutions achieve their maximum potential, fully replacing conventional technologies and practices within a limited, competitive market.
## Health Impacts of Climate Change

<table>
<thead>
<tr>
<th>Climate Driver</th>
<th>Exposure</th>
<th>Health Outcome</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extreme Heat</strong></td>
<td>More frequent, severe, prolonged heat events</td>
<td>Elevated temperatures</td>
<td>Rising temperatures will lead to an increase in heat-related deaths and illnesses.</td>
</tr>
<tr>
<td><strong>Outdoor Air Quality</strong></td>
<td>Increasing temperatures and changing precipitation patterns</td>
<td>Worsened air quality (ozone, particulate matter, and higher pollen counts)</td>
<td>Rising temperatures and wildfires and decreasing precipitation will lead to increases in ozone and particulate matter, elevating the risks of cardiovascular and respiratory illnesses and death.</td>
</tr>
<tr>
<td><strong>Flooding</strong></td>
<td>Rising sea level and more frequent or intense extreme precipitation, hurricanes, and storm surge events</td>
<td>Contaminated water, debris, and disruptions to essential infrastructure</td>
<td>Increased coastal and inland flooding exposes populations to a range of negative health impacts before, during, and after events.</td>
</tr>
<tr>
<td><strong>Vector-Borne Infection (Lyme Disease)</strong></td>
<td>Changes in temperature extremes and seasonal weather patterns</td>
<td>Earlier and geographically expanded tick activity</td>
<td>Ticks will show earlier seasonal activity and a generally northward range expansion, increasing risk of human exposure to Lyme disease-causing bacteria.</td>
</tr>
<tr>
<td><strong>Water-Related Infection (Vibrio vulnificus)</strong></td>
<td>Rising sea surface temperature, changes in precipitation and runoff affecting coastal salinity</td>
<td>Recreational water or shellfish contaminated with Vibrio vulnificus</td>
<td>Increases in water temperatures will alter timing and location of Vibrio vulnificus growth, increasing exposure and risk of waterborne illness.</td>
</tr>
<tr>
<td><strong>Food-Related Infection (Salmonella)</strong></td>
<td>Increases in temperature, humidity, and season length</td>
<td>Increased growth of pathogens, seasonal shifts in incidence of Salmonella exposure</td>
<td>Rising temperatures increase Salmonella prevalence in food; longer seasons and warming winters increase risk of exposure and infection.</td>
</tr>
<tr>
<td><strong>Mental Health and Well-Being</strong></td>
<td>Climate change impacts, especially extreme weather</td>
<td>Level of exposure to traumatic events, like disasters</td>
<td>Changes in exposure to climate- or weather-related disasters cause or exacerbate stress and mental health consequences, with greater risk for certain populations.</td>
</tr>
</tbody>
</table>
Health Impacts of Climate Change

Refrigerant management
This cumulative total for Saudi Aramco is comparable to the annual emissions of six modern-day Chinas.