

Climate Change Solutions

University of Massachusetts Lowell

April 5, 2016

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Outline of Presentation

- Introduction
- Some potential solutions
 - Benefits to the climate
 - Ancillary benefits
- Barriers to implementation
- Positive developments



Time to Shift from Climate Assessment to Solutions

- 2014 National Climate Assessment:
 - “Climate change is already affecting the American people in far-reaching ways.”
- United Nations: “Climate change is now affecting every country on every continent.”
- Hoesung Lee, leader of the U.N. Intergovernmental Panel on Climate Change:
 - The world must:
 - Achieve global peaking in a very short time
 - Reduce greenhouse gas (GHG) emissions at least 3% a year so that by 2100 we will achieve zero emissions



<http://nca2014.globalchange.gov/>

<http://www.un.org/sustainabledevelopment/climate-change-2/>

<http://www.theguardian.com/environment/2015/oct/12/new-ipcc-chief-calls-for-fresh-focus-on-climate-solutions-not-problems>

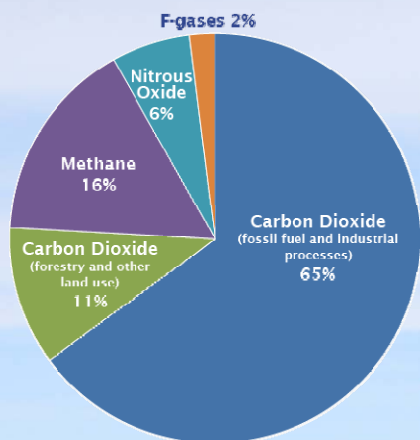
Governments Aren't Doing Enough

- United Nations Study - October 30, 2015
 - Assessed plans to limit GHGs submitted by 146 countries
 - Pledges are not enough to meet target of no more than 2 degrees Centigrade increase in global warming by the end of this century
 - Would deliver 3 degrees C increase
 - Better than current trends, which if unchecked would lead to 5 degrees C increase



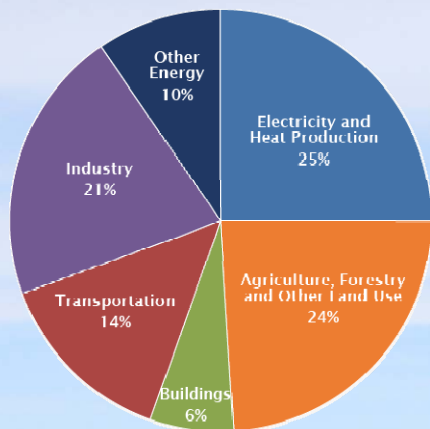
<http://www.theguardian.com/environment/2015/oct/30/worlds-climate-pledges-likely-to-lead-to-less-than-3c-of-warming-un>

Types of Greenhouse Gases (GHGs)



<http://www.epa.gov/climatechange/ghgemissions/global.html>

Sources of GHGs



<http://www.epa.gov/climatechange/ghgemissions/global.html>

Climate Change Solutions

- Two major types:
 - Coping with impacts of existing GHGs
 - Reducing new GHG emissions
- Both types of solutions are necessary
- Here, focus on reducing GHG emissions in ways that:
 - Aren't technically difficult
 - Don't require sacrifices from citizens
 - Could significantly reduce GHG emissions



An Engineering Approach

- Assess the problem - nature, extent, root causes
- Assess the risks
 - Then determine how much corrective action is needed
- ID full range of potential corrective actions
- Evaluate pros and cons of each
 - Include the “no action” alternative
- Compare and select the solutions to implement
- Plan implementation
- Implement and monitor
- Check that solutions worked



Think Green and Sustainable

- Actions must:
 - Get the job done – AND –
 - Minimize collateral damage
- Everything is interconnected in a web – consider the whole picture, including side effects on:
 - Environment – air, water, soil, food
 - Human health
 - Economy
 - Society
- Ideal solutions will be:
 - Effective on climate change
 - Easy to implement
 - Inexpensive
 - Free of negative side effects
 - With bonus positive side effects



Observation

- Some actions have negative effects in multiple areas
 - Example - burning trees to produce electricity releases CO₂ and:
 - Releases conventional air pollutants
 - Devastates rivers (cooling water)
 - Devastates forests
 - Requires hazardous jobs (e.g., logging)
 - Rips off rate-payers via subsidies
 - Harms local communities
- Some actions have multiple positive effects
 - Example - planting trees removes CO₂ and:
 - Provides shade
 - Cleans the air
 - Cleans water and moderates the water cycle
 - Stabilizes the soil
 - Creates wildlife habitat
 - Can create community and empowerment
- Replace a few bad things with a few good things to make a big difference



3 - Biomass Power Plant - Burlington VT



0 - No Action Alternative

- What is climate change costing us now?
 - Lives - by heat waves, wildfires, water problems, insect-borne disease, crop damage
 - Dislocation of populations
 - Money - examples:
 - Drought in western U.S. – >300 square miles of crop land not planted this year in CA's Central Valley
 - Damage from severe events: in 2012 Hurricane Sandy cost the U.S. \$65B and drought cost the U.S. \$35B
 - How we feel:
 - Fear of uncertain/worse future
 - Guilt that we are making a mess and should do more about it
 - Eroded confidence in our society, feeling we lack control
- Costs will grow as problem becomes more severe



1 – Phase Out Subsidies for Combustion-Based Energy

- Would affect all source categories of GHGs
- What are subsidies?
 - Government takes money from us via taxes
 - Gov gives this money to industries
 - We pay:
 - Retail price of something
 - **Plus** we pay the hidden subsidies
 - Alternatives receiving fewer subsidies
 - Disadvantaged – have to charge higher price
 - Customers choose the subsidized alternative
 - Competition is stifled
 - Apparently high prices of alternatives turn investors off



1 – Climate Benefits

- International Monetary Fund - 188 countries
 - Report estimates worldwide energy subsidies for petroleum, coal, natural gas, and electricity for 2015: **\$5.3 trillion** (\$5,300,000,000,000). This is equal to:
 - 6.5% of global gross domestic product (GDP = economic activity)
 - More than all the world's governments combined spend on health
 - Consists of 20% payments and 80% externalities
 - $\frac{3}{4}$ of the externalities are local environmental damages
 - $\frac{1}{4}$ of the externalities are global warming effects
 - Subsidy reform helps the climate because:
 - People use less energy if they know what they really pay
 - Clean and green alternatives can compete
 - Eliminating these subsidies would reduce global CO₂ emissions by **17%**

<https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf>

1 – Other Benefits

- Citizens fare better - from competition on a level playing field
- Potential for increased economic growth
 - Consumers have more money to spend
 - Government can use the saved money productively
- Increased energy security – we'll never run out of solar energy
- Cleaner environment
 - Less emission of conventional air pollutants
 - Less oil spills to land and water
 - Less damage from coal mining
- Better health
 - Could reduce premature deaths from local air pollution by >50%
 - Air pollution health problems cost **4%** of GDP in the 15 largest CO₂-emitting countries
 - Safer jobs



2 – Phase Out Subsidies for Agriculture

- U.S. ag subsidies during 1995-2012: \$292 billion
- Most goes to big industrial producers
 - **10% of farms** collected **75%** of all subsidies
 - **62%** of farms got nothing
- Few subsidies for fruits, vegetables, organic
- Removing ag subsidies
 - Level the playing field
 - Fruits, veg, organic cheaper



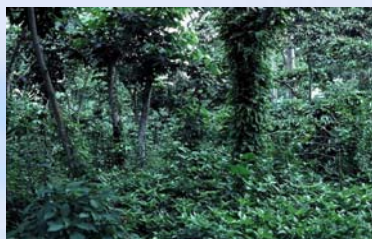
2 – Agricultural Subsidies (cont'd)

Largest expenditures in order of total dollars – U.S. ag subsidies during 1995-2012:

1	Corn Subsidies	11	Livestock Subsidies
2	Wheat Subsidies	12	Peanut Subsidies
3	Cotton Subsidies	13	Barley Subsidies
4	Conservation Reserve Program	14	Tobacco Subsidies
5	Soybean Subsidies	15	Sunflower Subsidies
6	Disaster Payments	16	Wetlands Reserve Program
7	Rice Subsidies	17	Canola Subsidies
8	Sorghum Subsidies	18	Oat Subsidies
9	Dairy Program Subsidies	19	Apple Subsidies
10	Env. Quality Incentive Program	20	Sugar Beet Subsidies

2 – Climate Benefits

- Industrial ag – high GHG emissions
 - Producing/applying energy-intensive fertilizers and pesticides
 - Irrigation practices
 - Tilling practices
 - Livestock management practices
 - Soil erosion
- Organic ag – cuts CO₂ **in half**
 - Maintains and increases soil fertility
 - Fewer high energy inputs
- U.N.: agriculture could become **carbon-neutral** in 20 years by worldwide switch to organic
 - Would reduce global GHG emissions by **some portion of the 24% land use emissions** (EPA pie chart)
- Studies show only organic can feed the world
- Organic farmer Joel Salatin: *“We don’t want subsidies for anybody, including ourselves.”*



2 – Other Benefits

Removing ag subsidies has additional benefits:

- Improved human health:
 - Diet includes more fruits and veg
 - Less toxic exposure (e.g., pesticides) – consumers, workers
 - More nutritious food (e.g., more trace minerals)
- Healthier wildlife (e.g., pollinators not killed by pesticides)
- Healthier soil, more water retention, less soil erosion
- Cleaner water, air, soil
- Lower health care costs
- Stronger local economies – smaller farms more able to compete



3 – Stop Deforestation

- Trees remove CO₂ and store it in wood and soil
 - U.S. forests remove **12%** of U.S. GHG emissions
 - Logging is a “double whammy”
 - Releases CO₂
 - Destroys future CO₂ capture capacity
 - Nearly every country subsidizes timber industry
 - Many countries subsidize biomass power plants
 - Devastating climate, environmental, human impacts
- Must preserve and restore forests, use wood wisely
 - Both temperate and rain forests
 - Brazil has reduced deforestation in the Amazon by 82%
 - Deforestation in U.S. quietly continues



<http://www.whitehouse.gov/sites/default/files/image/president27climateactionplan.pdf>

<http://www.reuters.com/article/2015/09/30/us-development-goals-forests-idUSKCN0RU0NF20150930>

3 - Deforestation



Windsor Jamb State Park, MA - 2008



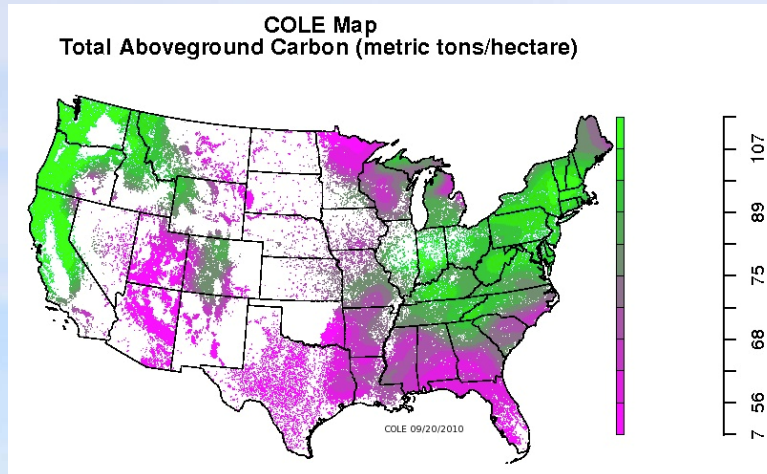
3 - Forests Storing Carbon

Quabbin Reservation, MA



3 - Forest Carbon Storage

<http://www.ncasi2.org/COLE/>



3 - Benefits

- Climate:
 - Reduce GHG emissions from deforestation – some **portion of the 24%** of global GHG (EPA)
 - Increase removal of CO₂ from atmosphere - **?%**
- Other:
 - Cleaner air and water
 - Less soil erosion
 - Wildlife habitat
 - Flood storage and water cycle moderation
 - Shade and temperature moderation
 - Nature and wilderness for humans
 - Inherent value of plants and animals in their own right



4 – Provide Access to Modern Contraception

- 2012 world population:
 - Growth = 80 million
 - Unintended pregnancies = 80 million
- Population would stabilize if women had the ability to prevent pregnancies they don't want



<http://www.newsweek.com/2014/12/26/fixing-crowded-earth-293024.html>

4 – Benefits of Access to Contraception

- Climate: **8% to 15%** reduction in global carbon emissions
- Other:
 - Improved health and quality of life
 - Economic growth (women can do more paid work)
 - Reduced habitat destruction
 - Reduced species extinctions
 - Reduced pollution
 - Saves money: \$1 spent on family planning saves \$6 on health care, immunization, education, and other services

5 – Energy Efficiency

- Wasting less energy through transmission, heat loss, and inefficient technology
- U.S. Dept. of Energy: “Energy efficiency is one of the easiest and most cost-effective ways to combat climate change.”
- Efficiency is the cheapest electricity resource:
 - ~1/3-1/2 the cost of new electricity generation
- Example opportunities for improving efficiency:
 - Improve the electric grid
 - Reduce “dracula load” = the electricity devices use when off
 - Stop flow of electricity when devices finish charging
 - Outdoor lights turn themselves off during daylight hours
 - More efficient transportation, buildings, appliances, equipment
 - Conserve water: e.g., water heating = 9% of residential electric use

<http://aceee.org/press/2014/03/new-report-finds-energy-efficiency-a>

5 – Benefits of Energy Efficiency

- Big opportunity in North America
 - North Americans use twice as much energy as Europeans
- Climate benefits: reduced GHG emissions
- Other benefits:
 - Cleaner air
 - Improved competitiveness of businesses
 - Reduced energy costs

6 - New Technologies

- We have the technologies we need – solar, etc.
- More deployment is needed
 - Will bring costs down
 - Help with financing large up-front costs
 - Stop propping up worse alternatives with subsidies
 - Tax carbon emissions
- Constant development
 - Better batteries
 - Solar roads?
 - Offshore wind



6 - Technology

- Solar is booming in the U.S.
 - Employs more people than the coal industry
 - 2015 added jobs 12x faster than the rest of the economy
 - For the third straight year, the solar workforce grew 20 percent in the United States, to >200,000 people
- Need to deploy wisely
 - e.g., avoid clear-cutting forests for solar farms



<http://thinkprogress.org/climate/2016/01/12/3737971/solar-job-growth/>

7 – Individual Actions

- Reduce senseless waste and save money
 - Turn lights and devices turn off when not in use
 - Use power strips to reduce “Dracula load”
 - Drive less, in well-maintained efficient vehicles not hauling around a lot of unnecessary stuff
 - Reduce food waste – 40% of all food in the U.S. is thrown away
 - Print and copy judiciously
 - Get off unwanted mailing lists
 - Conserve water
 - Recycle and reuse more

<http://www.imeche.org/knowledge/themes/environment/global-food>
<http://www.scientificamerican.com/article/10-solutions-for-climate-change/>



7 – Individual Actions

- Choose greener products – may pay more now and less later
 - Light-emitting diode (LED) light bulbs
 - Organic food, and less meat (esp. beef)
 - Energy-efficient vehicles, appliances, devices
 - Avoid single-use, unnecessary, and cheap products that won't last
 - Buy less packaging
 - Clean energy, e.g., rooftop solar



7 - House of My Neighbor in Her 80s



- Solar hot water
- Solar electric – supplies 2/3 of electricity needs of the house
 - Including recharging her electric car

7 – Individual Actions

- Conserve energy
 - Plug air leaks in homes
 - Programmable thermostats
 - Outdoor lights auto turn off
 - Low flow water devices, e.g., showerheads
 - Run full dishwasher loads, air dry
 - Run full clothes washer loads, cold water, air dry
 - Walk, bike, ride more
 - Telecommute more, live closer to work/school



7 – Individual Actions

- Outreach
 - Be an example
 - Educate
 - Let your politicians know your thoughts
 - Support non-profits – sign petitions, donate, participate
 - Defend clean energy, forests, sustainability
 - Push for sustainability at work/school/home
- Consider choosing a career that helps fix the climate problem



Barriers to Implementation

- Inertia, apathy, distracted by other problems
- Uncertainty about what to do
- Gradual nature – no decisive event says “act now”
- Huge incomprehensible scope and consequences
 - Global problem
 - Hard to imagine 4’, 10’, or more of sea level rise
- Time lag between implementing solutions and results
- Global gridlock:
 - Many countries refuse to act until others act
 - U.S. commitment has been weak
 - Despite U.S. having emitted more cumulative GHGs than any other country



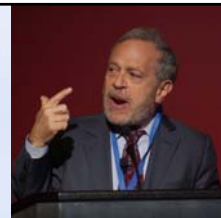
Barriers - continued

- Variable nature of climate and weather
- Many simply hope scientists are wrong
- Many hope we can wait to act
- Limiting beliefs – e.g.,
 - “Our society is incapable of fixing the problem”
 - “Citizens are powerless”
- Confusion created by vocal climate deniers:
 - Head of U.S. Senate Environment and Public Works Committee declared climate change to be “the greatest hoax played on mankind”
 - The U.S. is >10 years behind Europe



Barriers - continued

- Lobbying by special interests:
 - Influences government
 - Citizens become disillusioned with the government
 - Political economist Robert Reich: *“Many people have become deeply cynical about politics.... If we give up on politics, we give up on our democracy. And if we give up on democracy, we don’t stand a chance. That’s what the moneyed interests want.... Then they run everything, and they get everything.”*
- Disagreement over solutions
 - Fear that helping the climate will hurt the economy
 - Some prefer unproven quick-fix technologies later to acting now – e.g., blasting particles into the atmosphere to cool the planet
- Citizens are frazzled



Positive Developments

- 97% of scientists: humans are causing climate change
- Most American citizens support government action
- 2015 Paris Agreement - 195 countries adopted the first-ever universal, legally binding global climate deal
- Millions worldwide participated in the massive Peoples Climate March 9/2014 - in 162 countries
- American students are suing states and federal government
- President Obama's Clean Power Plan
- Individuals, companies, and state and local governments are reducing GHG emissions on their own

Example Cities Pledging to Achieve 100% Clean Energy within 35 Years

U.S.

- Aspen, Colorado
- San Diego, California
- San Jose, California
- San Francisco, California

International

- Copenhagen, Denmark
- Bonaire, The Caribbean
- Munich, Germany
- Isle of Wight, England
- Frankfurt, Germany

<http://www.mnn.com/earth-matters/energy/stories/10-cities-aiming-for-100-percent-clean-energy>

Companies Getting On Board

- >81 companies signed the American Business Act on Climate Pledge
 - Demonstrates their support for action on climate change
 - Have operations in all 50 states
 - Employ >9 million people
 - Have more than \$3T in annual revenue
 - Have a combined market capitalization of over \$5T
 - Examples: Apple, General Mills, Proctor & Gamble, Target, Walmart

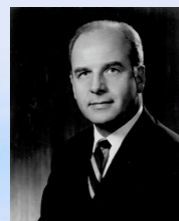
<https://www.whitehouse.gov/the-press-office/2015/10/19/fact-sheet-white-house-announces-commitments-american-business-act>

Could Addressing Climate Change Create an Economic Boom?

- U.S. Senator Gaylord Nelson:

“The economy is a wholly owned subsidiary of the environment.”
- Former Mexican President Felipe Calderón:

“Reducing greenhouse gas emissions requires action in the very same areas that throughout history have driven economic growth: investment in efficiency, infrastructure, and innovation.”



History Repeats Itself

- Medieval cities in Europe:
 - People threw biological wastes in the streets
 - Attracted rats, fleas, bubonic plague and other deadly diseases
 - People saw the connection and improved waste practices
 - Cities then flourished, and still do
- The Great Depression, then World War II, then economic boom and our throw-away society
- After the Great Recession, could war on GHGs create an economic boom and a green society?



Closing Thoughts

- Students need to lead in creating the future:
 - The late writer and social critic Kurt Vonnegut said in 2005:
 - “There are no plans at all for my grandchildren and my great grandchildren.”
- Climate change = opportunity to:
 - Advance our technology to the next level
 - Gets the job done AND is safe
 - Put people to work implementing solutions
 - Create an economic boom
- Barriers to implementing solutions are more political than technical
- Reducing GHG emissions fixes a lot of other problems too
 - Environmental
 - Health
 - Economic



<http://www.marketplace.org/2016/02/29/elections/secretary-future/secretary-future>

Links and Contact Info

- Presentation is based on two 2015 *Huffington Post* articles on climate change, which include links to references not cited in the slides:
 - http://www.huffingtonpost.com/ellen-moyer-phd/costeffective-solutions-t_b_6414052.html
 - http://www.huffingtonpost.com/ellen-moyer-phd/its-time-to-fix-the-climate-why-do-we-delay_b_6603254.html
- Consulting website: <http://www.ellen-moyer.com/>
- Writing/speaking website: <http://ellenmoyerphd.com/>
- Email: ellenmoyer@em-green.com

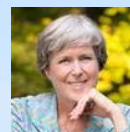


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