#### Climate Change: The Science and Solutions

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#### The Greenhouse Effect

Example of the Greenhouse Effect

The Sun's energy passes through the car's windshield.

This energy (heat) is trapped inside the car and cannot pass back through the windshield, causing the inside



## **Carbon dioxide** and the **temperature of our planet** from 800,000 years ago until the present day

400



#### **Evidence-** Temperature Proxies

- Tree rings
- Ice cores
- Fossil Pollen
- Ocean Sediments



#### Byrd Polar Research Lab at OSU



#### Ice Cores

- Ratio of Oxygen-16 to Oxygen-18
- Particulate matter with GC/MS for pollen, volcanic ash



Muir Glacier, Alaska: August 13, 1941 and August 31, 2004



This year's cracked the ominous milestone of <u>415 parts per million</u> (ppm) thanks to ever rising emissions from human activities.



#### Wallace Broecker- from 1974





#### 10 Indicators of a Human Fingerprint on Climate Change



#### **The Global Disparity in Carbon Footprints**

Per capita CO<sub>2</sub> emissions in the world's largest economies in 2016<sup>\*</sup> (in metric tons)



Countries chosen based on 2017 nominal GDP
 Sources: International Energy Agency, International Monetary Fund



#### Reactions

Carbon Cycle - Combustion, Metabolism CH₄ +  $0_2 -> CO_2 + H_2O + energy$ or oxygen carbon water (heat)  $C_{6}H_{12}O_{6}$ dioxide represents any fossil fuel, food,

organic matter

#### **US Electrical Generation**





#### Fracking





### Effects of Climate Change

- Human Health (heat stress, diseases)
- Ecosystems (loss of aquatic habitat, pests)
- Oceans (acidification, reef bleaching)
- Societal, Economic Impacts, and national security)

#### Days above 100 degrees by 2100



#### Ecosystems



#### Hatching and caterpillars



# Great Barrier Reef Mass bleaching in 2016 89% baby reef are dead



#### **Forest Fires**





#### Oceans

- More acidic
- Rising from thermal expansion
- Rising from melting ice sheets
- Storms cause more damage (storm surge)
- Erosion



#### Societal and Economic Impacts Ski Resorts

## Amount of snow in the West has dropped by 40% since 1980s



Impacts related to climate change are evident across regions and in many sectors important to **society**—such as human health, agricultural and food security

Crop Yields Decline under Higher Temperatures



#### **Base thoughts**

Military sites reporting climate-related\* problems September 2015



We have11 Years to stop a Climate Change catastrophe. Positive feedback loops accelerate temperature rise, whereas negative feedback loops decelerate it.



#### Positive loops in Climate change

- Albedo effect and melting of sea ice
- Methane hydrate in ice released as permafrost temperatures rise

#### Albedo Effect



#### Sea ice decreases



#### Methane hydrate- trapped in ice





#### Methane hydrate releases



#### Carbon Cycle and Climate Change



It was 84 degrees near the Arctic Ocean this weekend as carbon dioxide hit its highest level in human history



## Why $2^{\circ}C$

 The amount of average global temperature change if we doubled our pre-industrial revolution carbon dioxide levels



<b>1.5C</b>	VS	20
of warming		of warmin
Up to 1.1 months	Heatwaves	1.5 months
<ul><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li><li>♦</li>&lt;</ul>	<b>Freshwater</b> availability in the Mediterranean*	17%
	Heavy rainfall	7% 🤇
Wheat production down 9%	<b>Crop yields</b> in tropical regions*	Wheat production down
Maize production down		Maize production down
Soy production up		Soy production up
Rice production up		Rice production up
	— Sea level rise —	
∞ 40cm	by 2100 relative to 2000	50cm ~
	— Coral bleaching —	
of reefs at risk	from 2050 onwards	of reefs at risk

### Solutions

- Wind
- Solar
- Geothermal
- Reduce use of petrochemical products such as plastics
- Buy less
- Do not Waste foods

#### Wind Turbine in IOWA



Today, 314,000 wind turbines supply 4% of global electricity and can reduce CO2 by 84.6 Gigatons

#### Pokladnik 8.4 kW Solar PV System



#### Greta Thunberg



#### THANKS!

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