

Global Warming and Climate Change

Tim Cooper

UFV

2018

Science 😊

Technology 😊

Economics 😊

Politics 😞



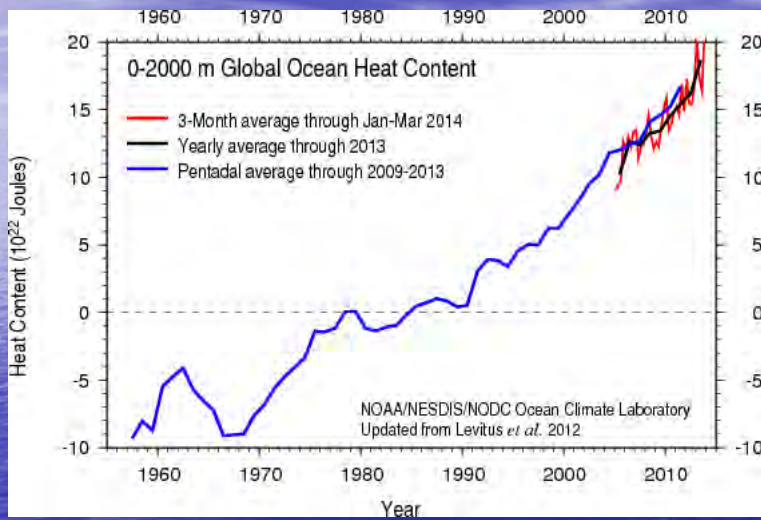
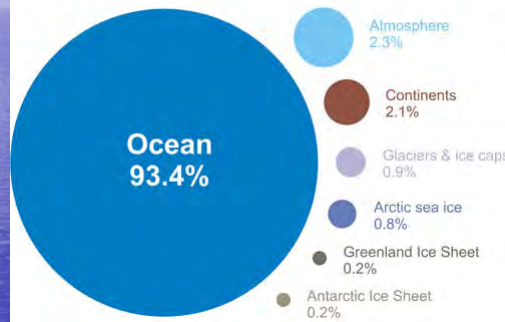
Science

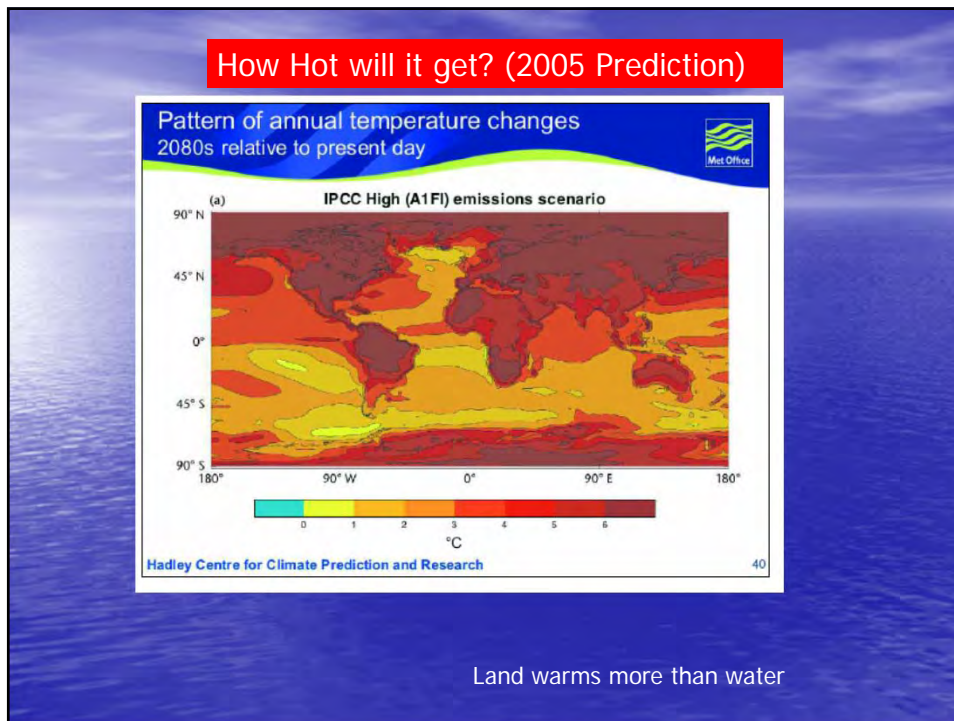
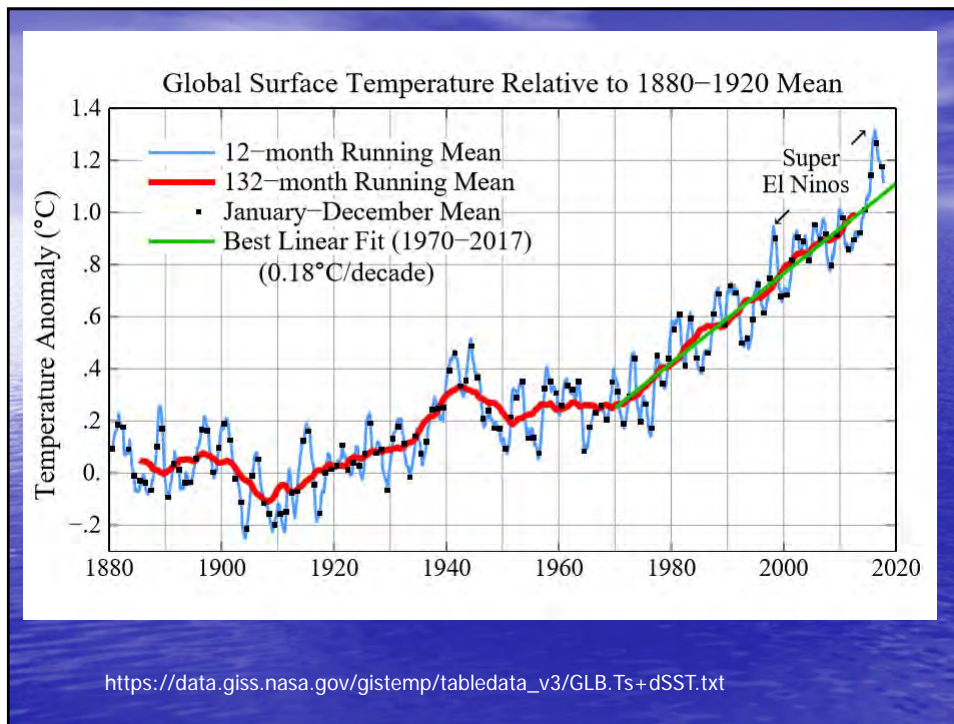


Satellites measure

- Heat from Sun to Earth
- Heat from Earth to Space
- -Subtract => Global Warming

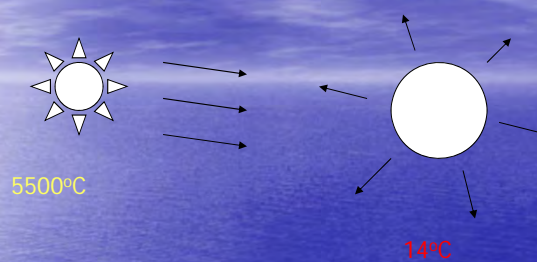
Where is global warming going?





Old Science

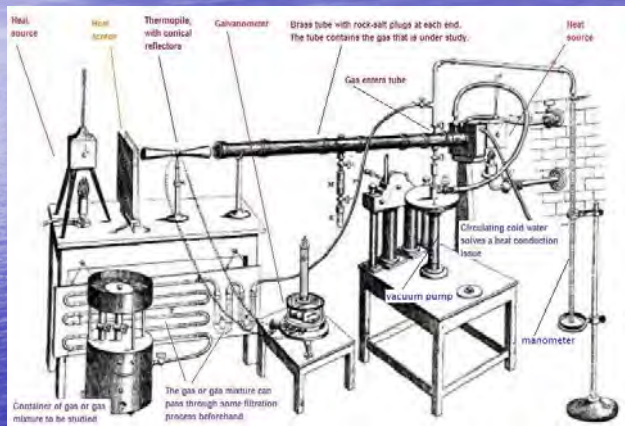
The Earth received energy from the Sun.



1824: Joseph Fourier Calculated Earth's temp to be -18°C
Experiment \Rightarrow average of $+14^{\circ}\text{C}$ Fourier Deduced...

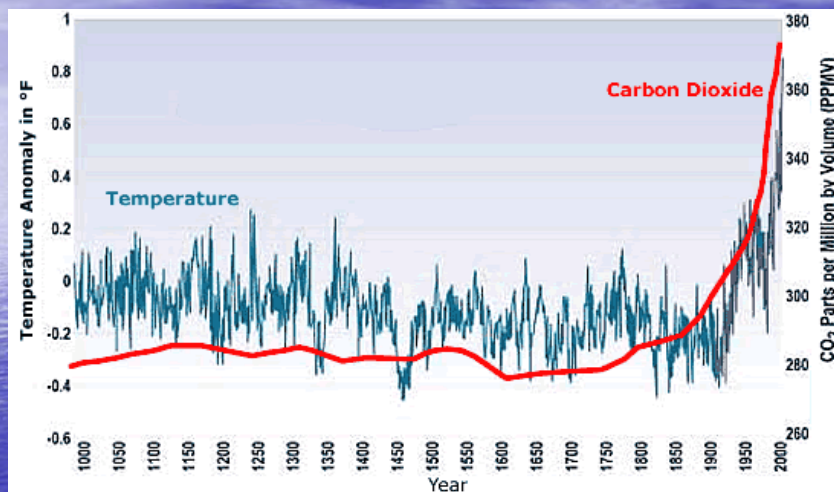
Something in the air is blocking heat escape!

John Tyndall measures the heat absorbing properties of carbon dioxide



1859

For the last 1000 years



411 ppm in June 2018

Where did the Carbon Dioxide come from?

Anthropogenic Greenhouse Effect



Coal (electricity)[1.8]



Oil (transportation)[1.3]



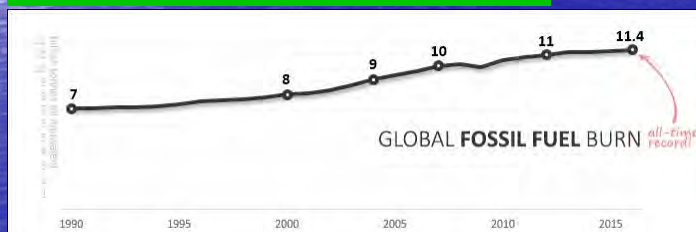
And Natural Gas[1.0]

Carbon-14 dating

Carbon Dioxide Flows (2005-2014)

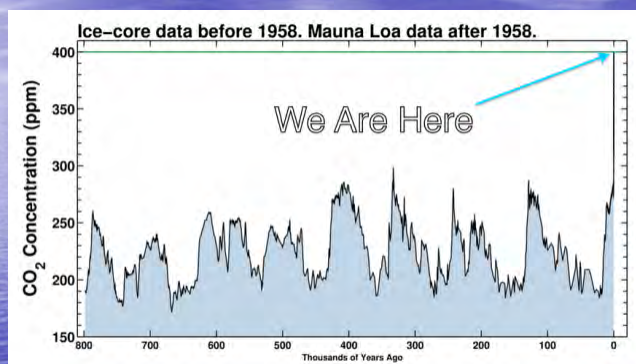
In 2014
9.9 GT Fossil Fuels and Cement
+ 0.9 GT Deforestation

Oceans absorb 2.8 GT
Land plants absorb 3.3 GT
Atmosphere accumulates 4.8GT



GLOBAL FOSSIL FUEL CONSUMPTION, 1990–2016. Billions of tonnes of oil equivalent. SOURCE: Sum of Oil, Gas and Coal consumption listed in BP Statistical Review of World Energy June 2017. CHART by Barry Saxilrage at VisualCarbon.org, June 2017.

Looking ahead by looking back...



The last time CO₂ was 400ppm : 3MYA, the Pliocene
Today CO₂ is increasing 200x faster than ever before

Pliocene(3MYA): (400ppm Carbon Dioxide)

Sea level was about 15-25m higher (and the temperature 2-3C warmer)

Why are London, NY, Shanghai and Chilliwack still here?

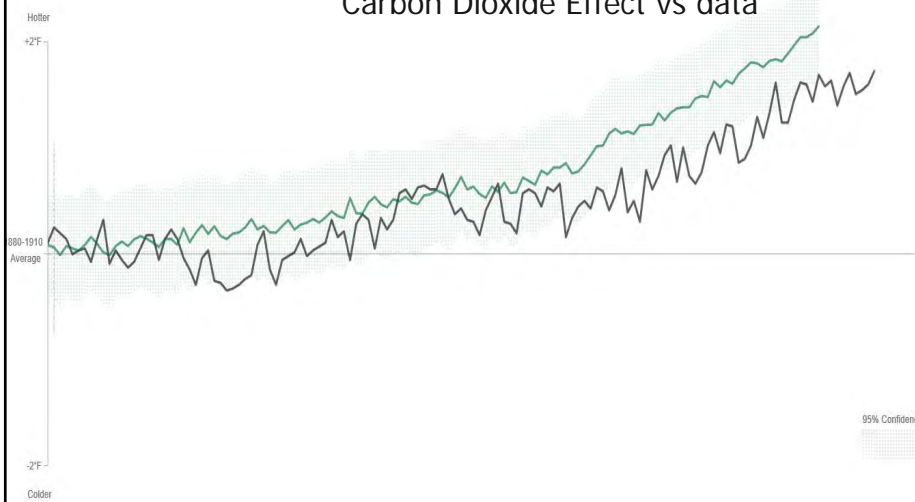
Other things that affect Climate

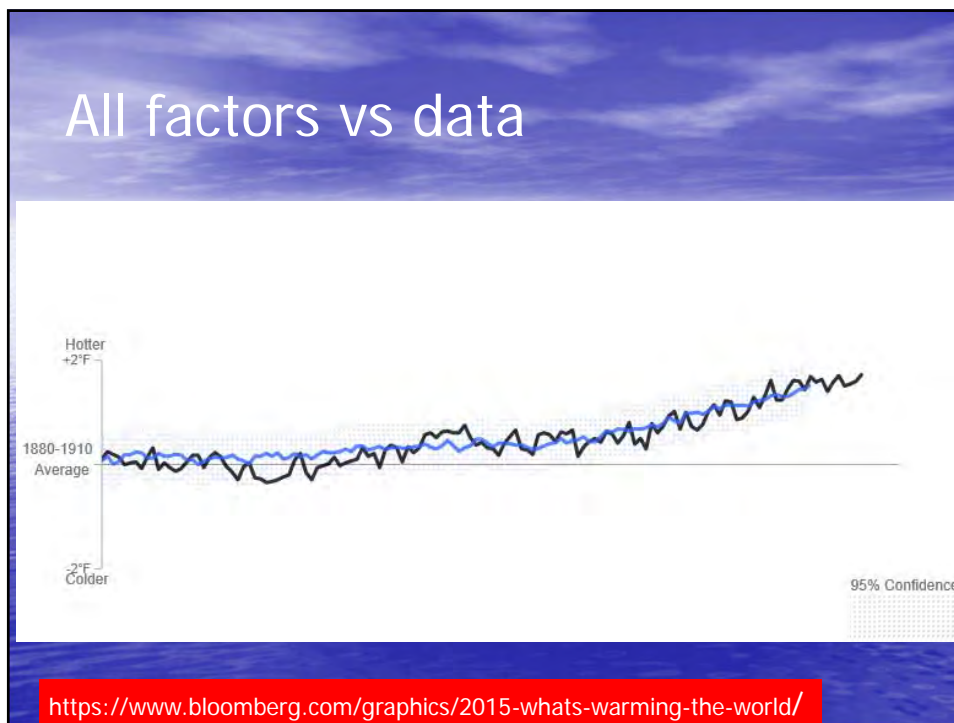
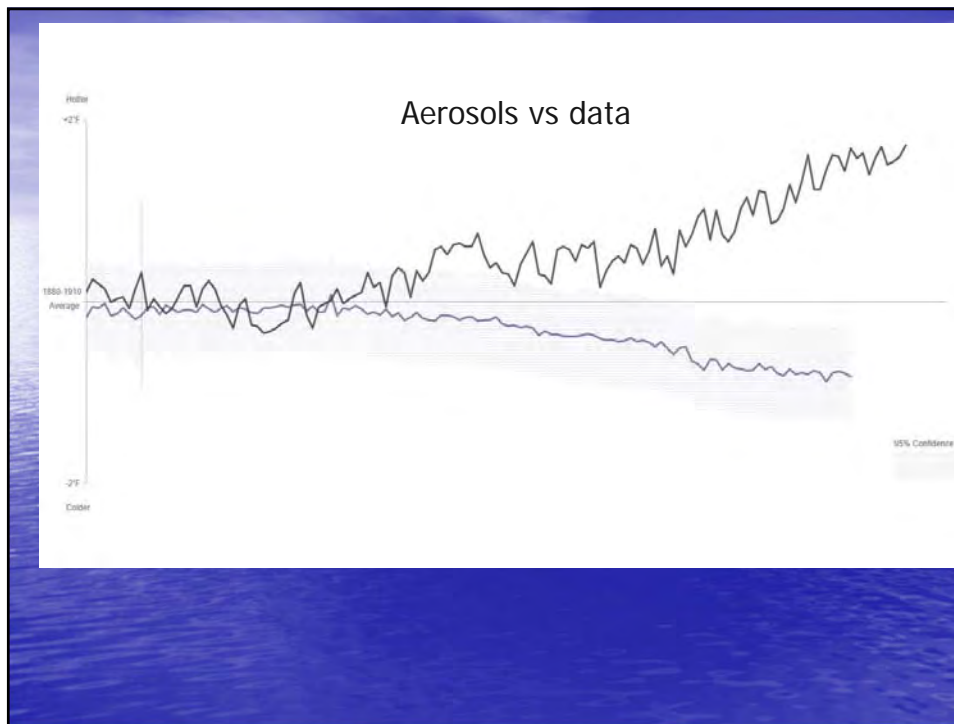
- Aerosols (Smogs)
- Methane
- Ice/Snow feedback
- Carbon dioxide in oceans feedback
- Soil Warming feedback
- Tundra Melting feedback(not in models)
- Water Vapour Feedback

Aerosols (aka Smogs)



Carbon Dioxide Effect vs data

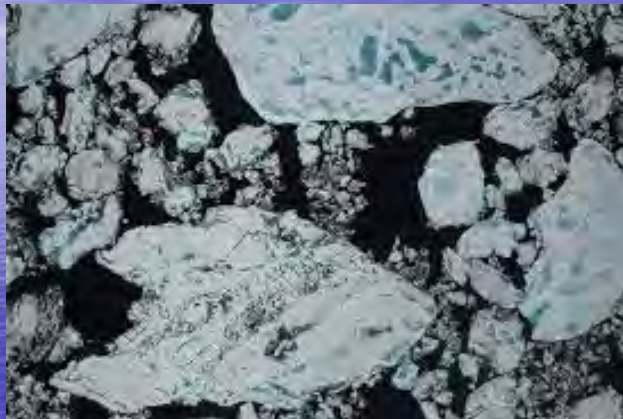




Carbon Dioxide isn't the only problem Methane traps heat too!

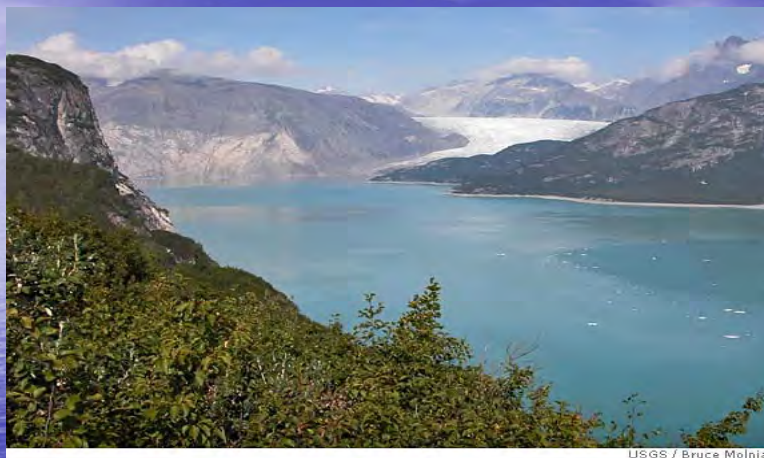
Over 100 years, one kg of methane traps
33x one kg of carbon dioxide.
And over 20 years about 86x
About 23% of the warming so far from Methane

Ice-Melt Feedback

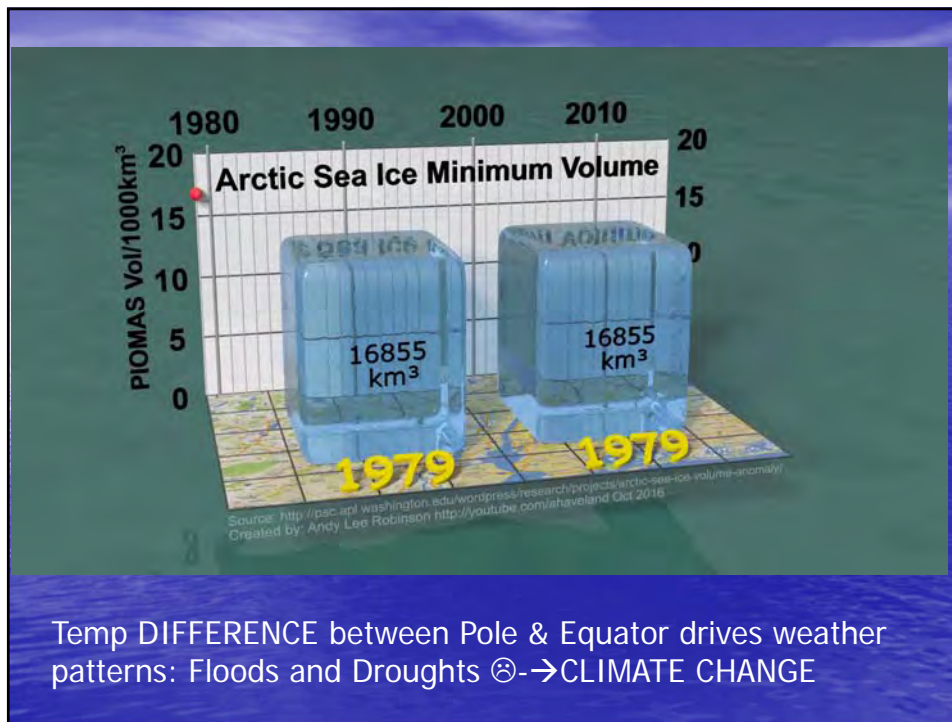




Rigg's Glacier: Muir Inlet. Alaska's Glacial Bay Nat. Pk;
(1941.. 70m feet thick)



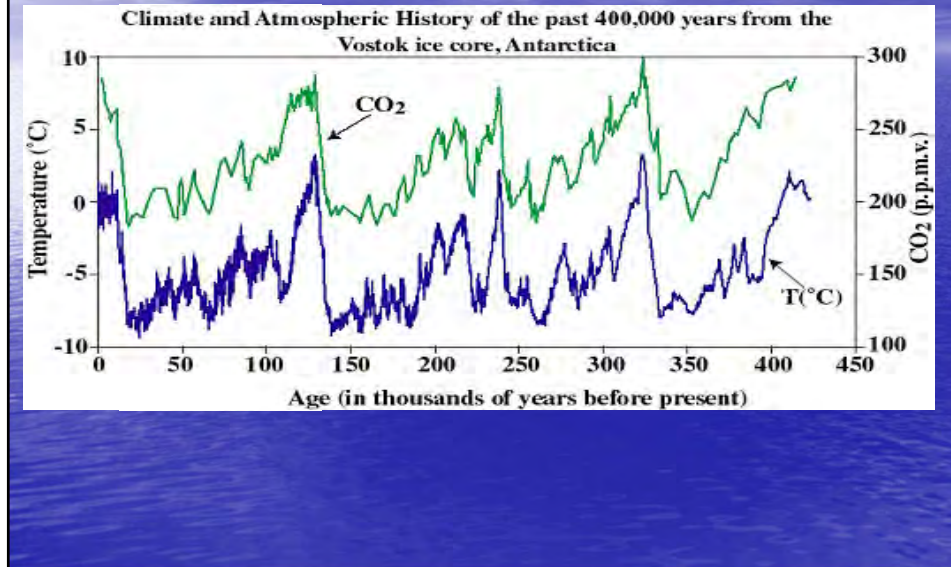
Rigg's Glacier in 2004: Absorbing the rays!



Trouble Ahead....

Carbon Dioxide dissolves less in warm water than cold

Carbon Dioxide from Oceans Feedback



Permafrost melting => decay => Methane/CO2

**1672 GTonnes of Carbon: note the compost effect.
Could triple the Carbon in the atmosphere!**



Politics ☹️

All countries' scientific councils

- Agree on three points
- The planet is warming
- We are causing it
- It is very, very dangerous

Who said...

"Climate Change is a Hoax invented by the Chinese to ruin our economy."

(Donald Trump)

Who said...

"Lowering carbon emissions would kneecap the economy"

(Stephen Harper)

Who said...

"A carbon tax is the worst tax ever"

(Doug Ford)

A recent IMF report estimates that Canada subsidises fossil fuels by \$34 Billion per year.

\$1 Billion Direct Federal Support (\$1.3?)

\$5 Billion Direct Provincial Support

\$28 Billion in Indirect Subsidies.

<http://www.imf.org/external/np/fad/subsidies/>

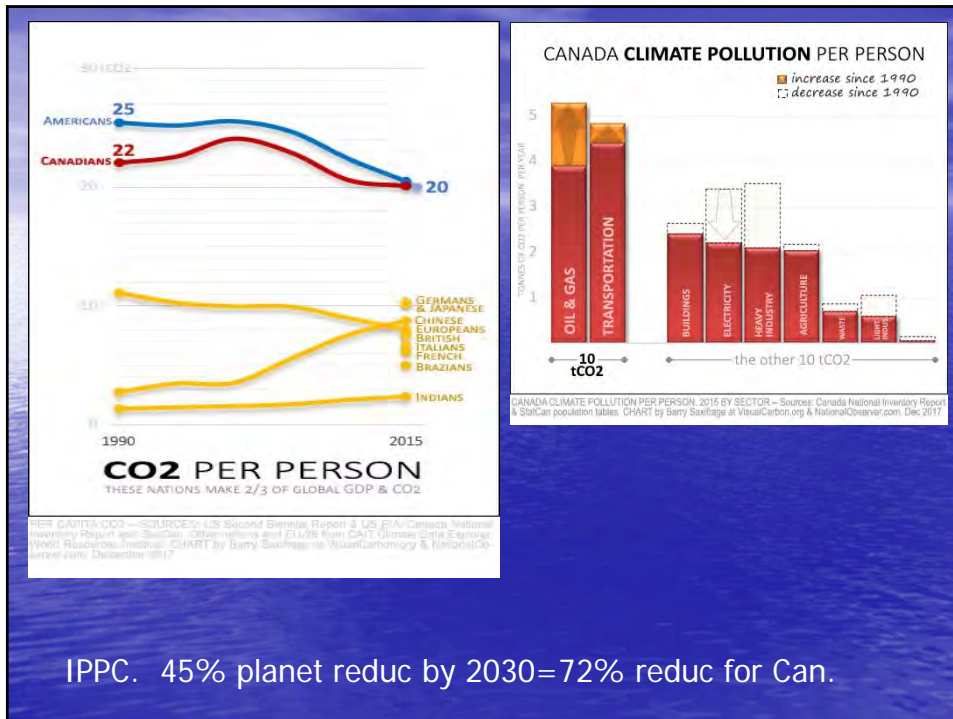
Climate Action Network Europe calculates...

Table 4: Climate Change Performance Index for OECD Member Countries

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
4	Denmark	75.23	17	Slovak Republic	63.17	40	Czech Republic	53.93
5	United Kingdom	69.66	18	Italy	62.90	42	New Zealand	53.49
6	Portugal	68.38	19	Germany	61.90	43	United States	52.93
7	Sweden	68.10	20	Mexico	61.50	45	Poland	52.69
8	Switzerland	66.17	22	Spain	60.37	47	Greece	51.50
10	France	65.90	23	Luxembourg	60.27	50	Japan	47.21
11	Hungary	65.17	24	Norway	59.32	53	Korea	46.66
12	Ireland	65.01	29	Austria	57.19	54	Turkey	46.47
13	Iceland	64.89	31	Netherlands	56.99	57	Australia	41.53
14	Belgium	64.65	32	Finland	56.57	58	Canada	40.39

© Germanwatch 2013
Germanwatch

Feb 2015



IPCC. 45% planet reduc by 2030=72% reduc for Can.

Economics

Tweaking the Tax System!

Use a Pigouvian system

- Tax people when they do bad (sin taxes)
- Don't tax them when they do good (create jobs, serve the public)

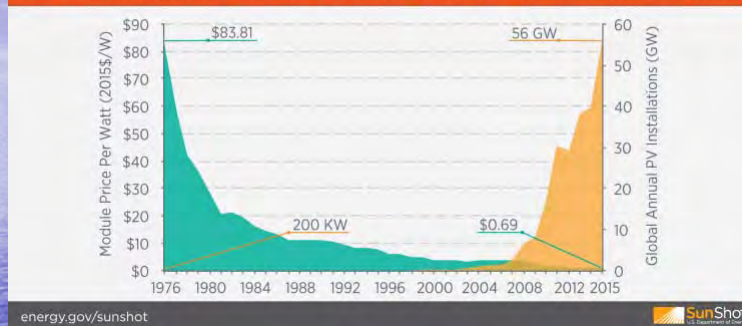
So reduce business and income taxes, and Start taxing pollution...i.e. a carbon tax.

Technology

Can we substitute for Fossil Fuels?

Solar Energy Progress up to 2015

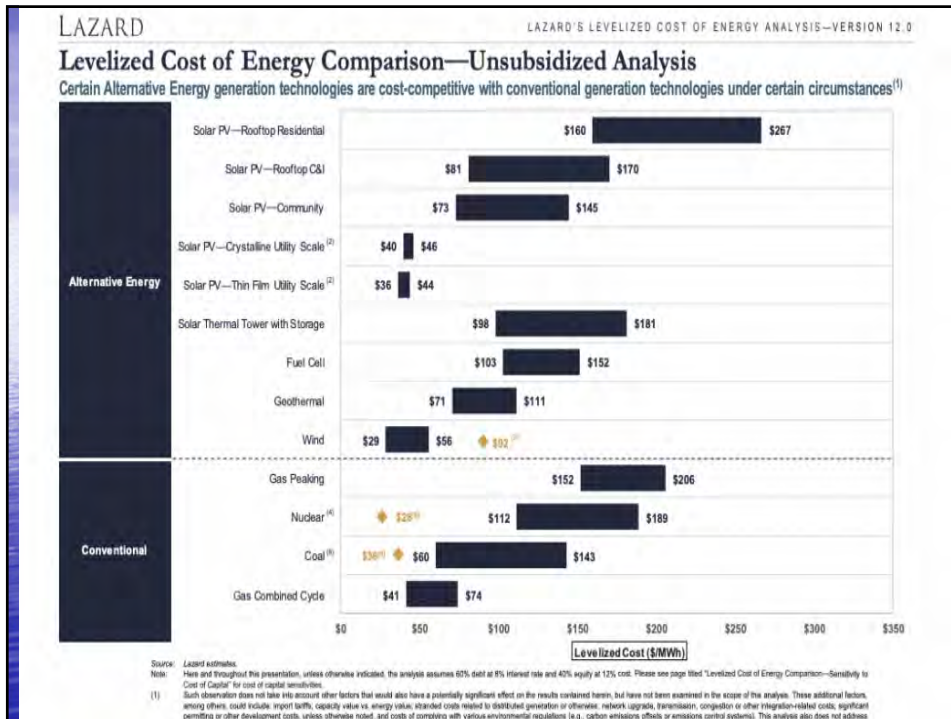
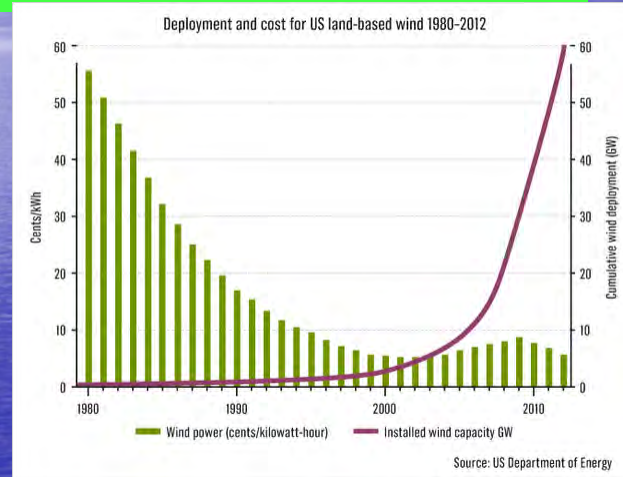
AS SOLAR MODULE COSTS DECLINE, ANNUAL INSTALLATIONS RISE



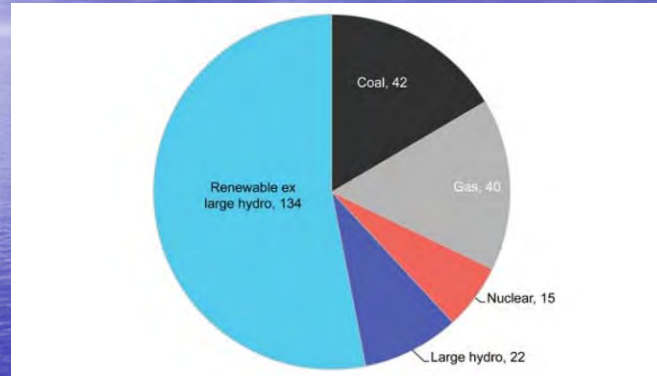
2019... Mexico 1.9c/kWhr!
(cite C... about 10c/kWhr)

2017... China installed 50GW of solar

Cost of Wind Energy



Global New Energy Generation Installed in 2015



70% renewable in 2017

JOBS

Alberta Tar Sands : 22,340 (2013)
Clean Energy 23,700(2013)

Source: Clean Energy Canada, 2014.

McDonalds Canada employs 80,000

Kinder Morgan Pipeline.. About 80 permanent jobs

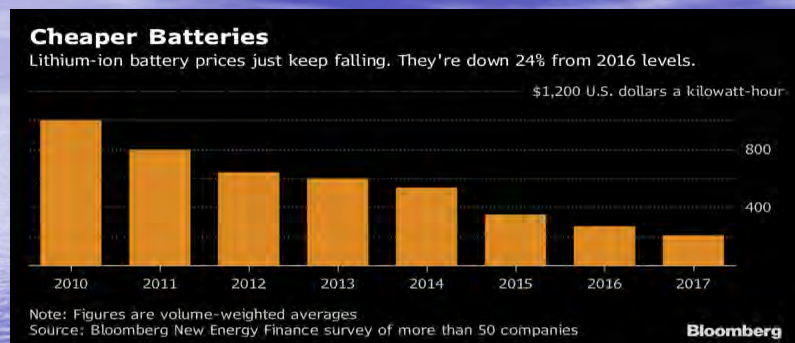
2017 : N. America wide now more jobs in solar than oil, coal & gas combined!

Transportation



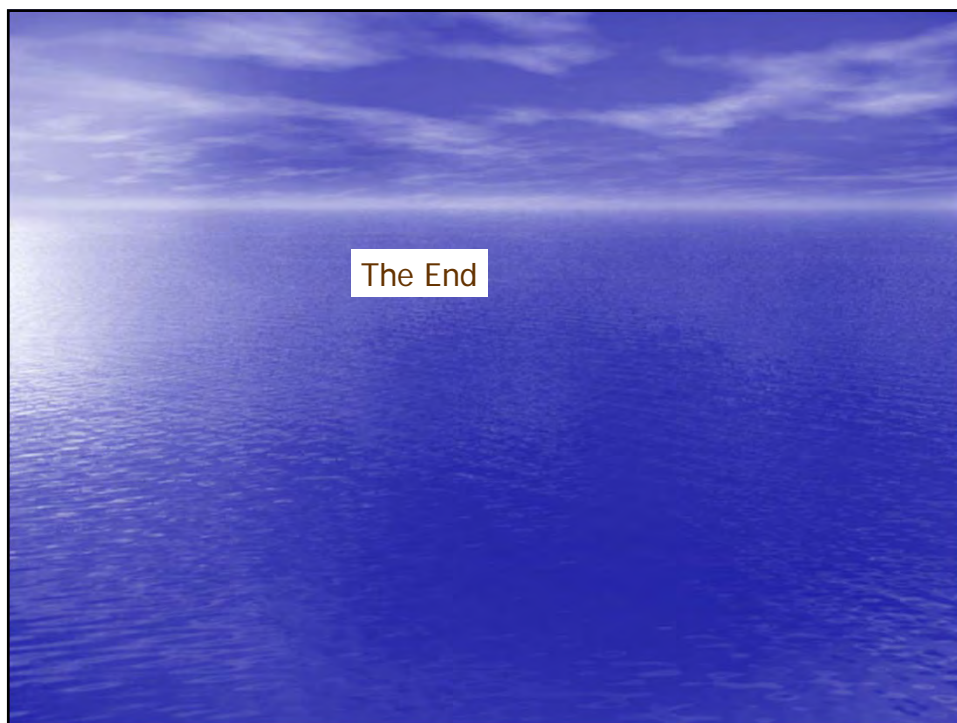
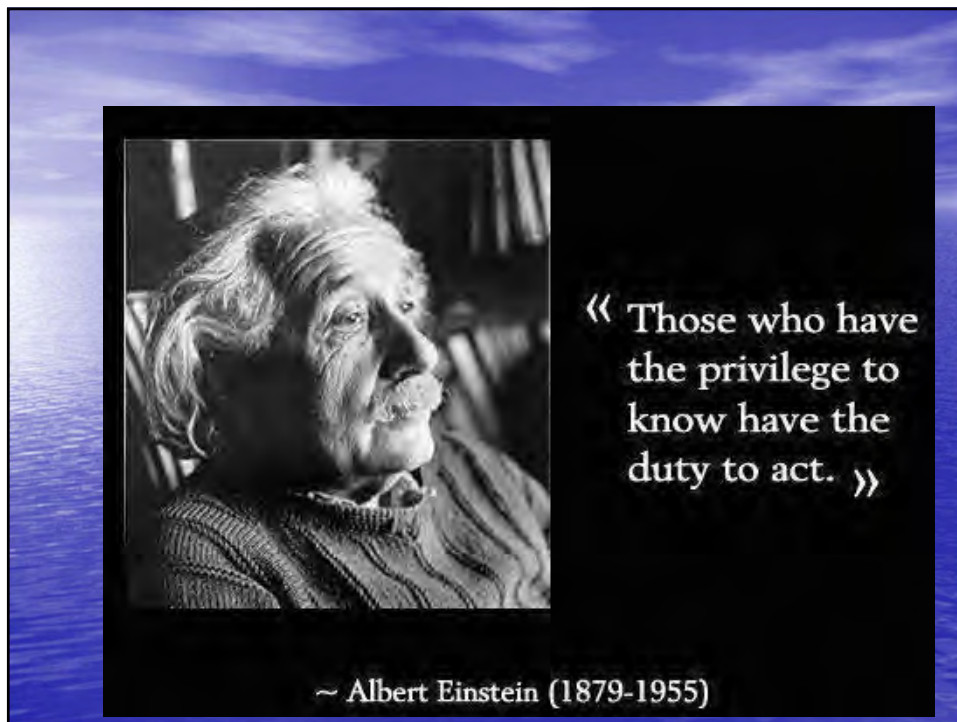
El Cheapo and his car

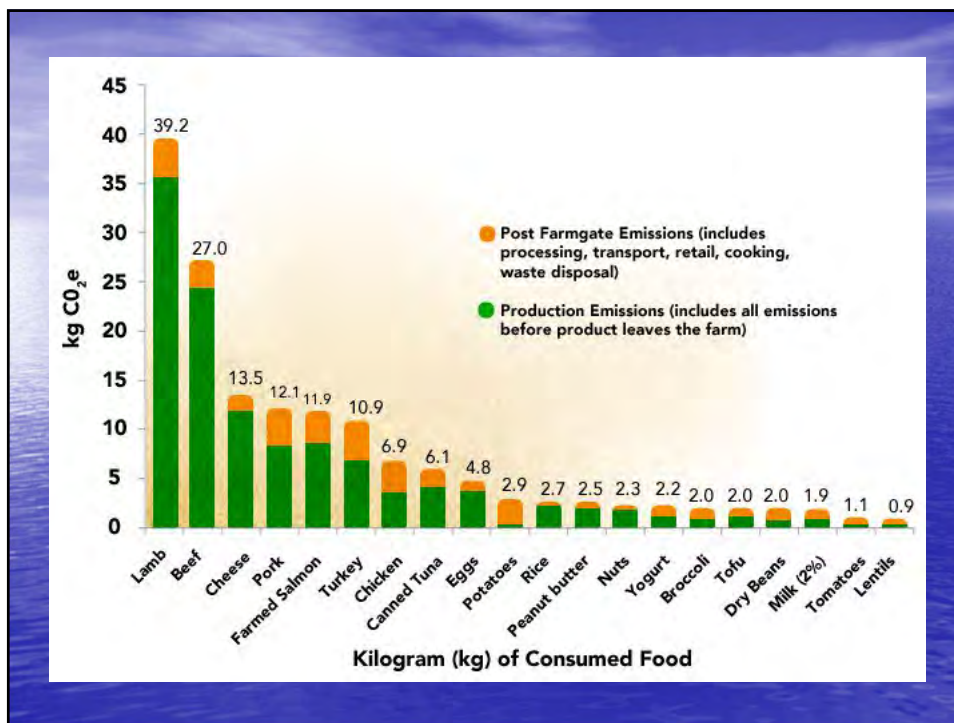
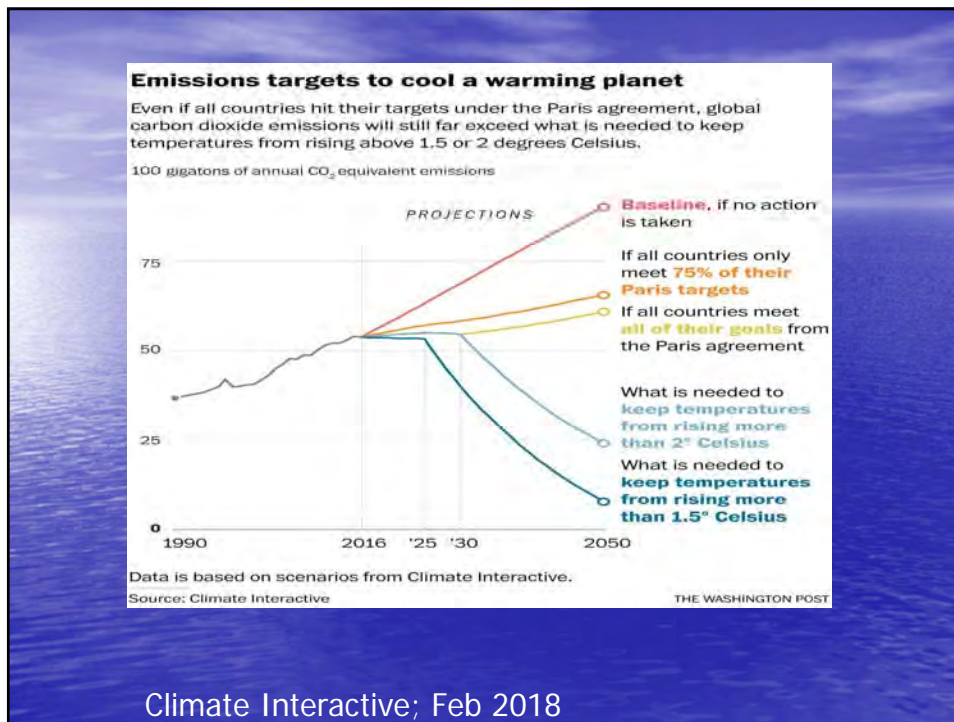
Why Electric Vehicles get cheaper...

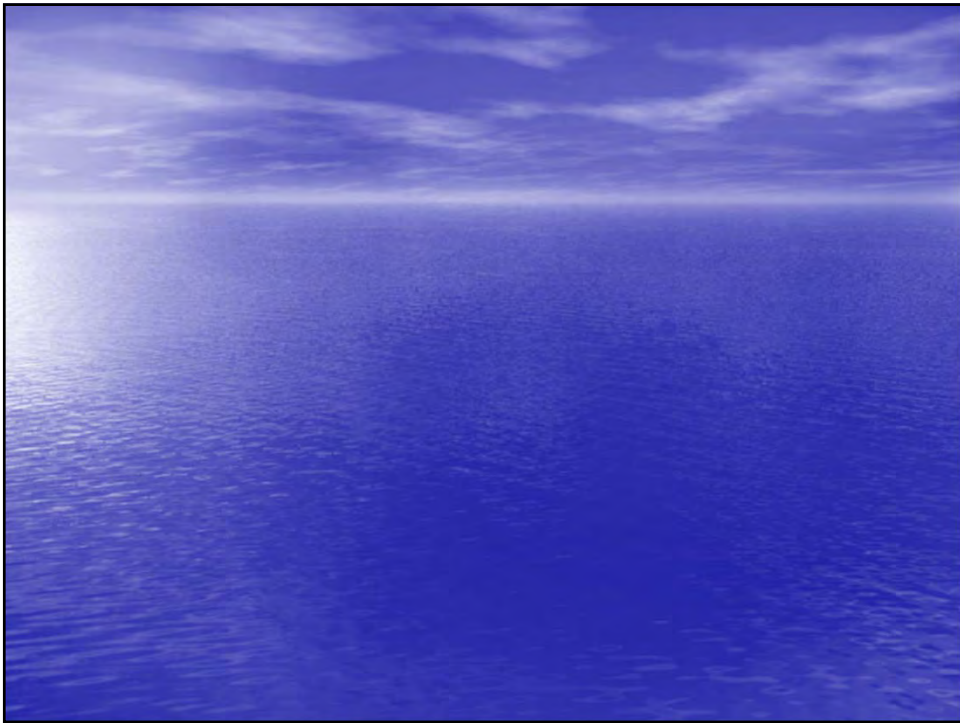
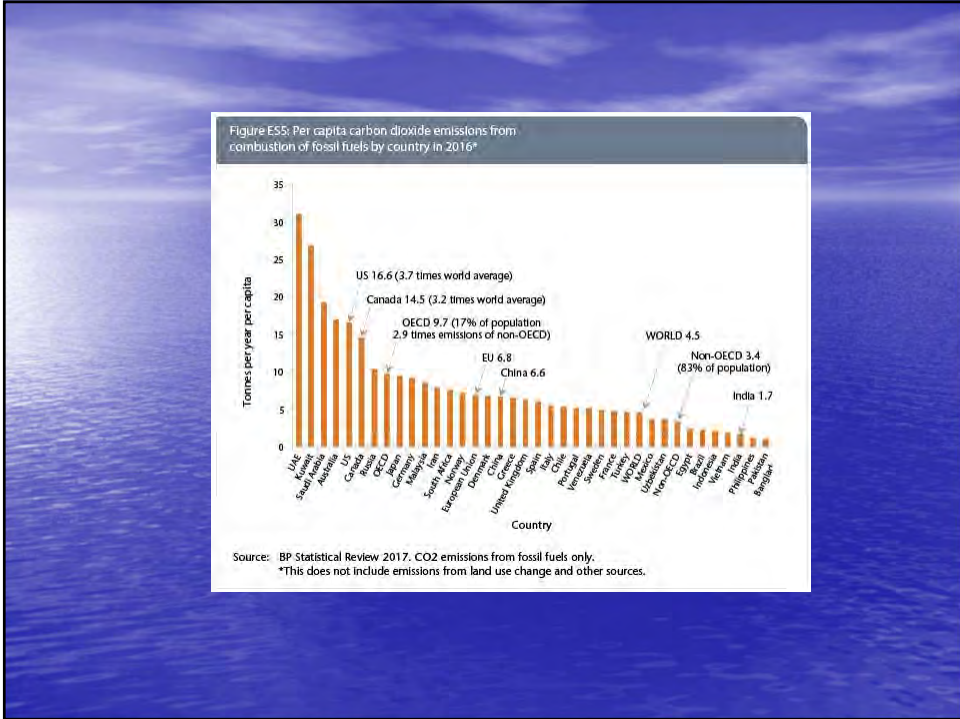


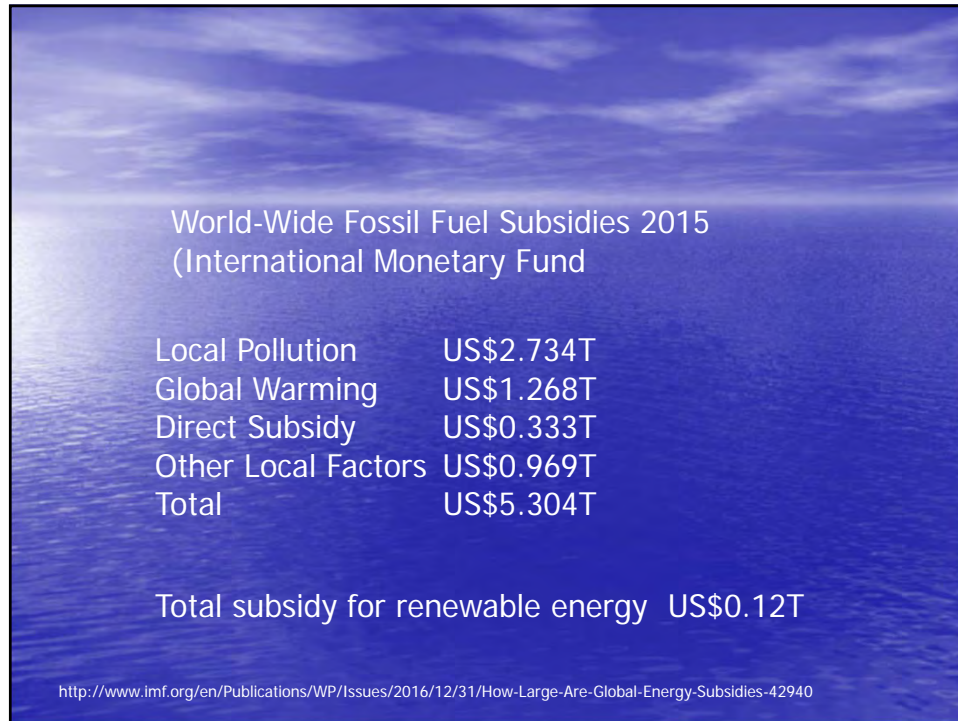
Industry Projection: <\$100 by 2020-2025

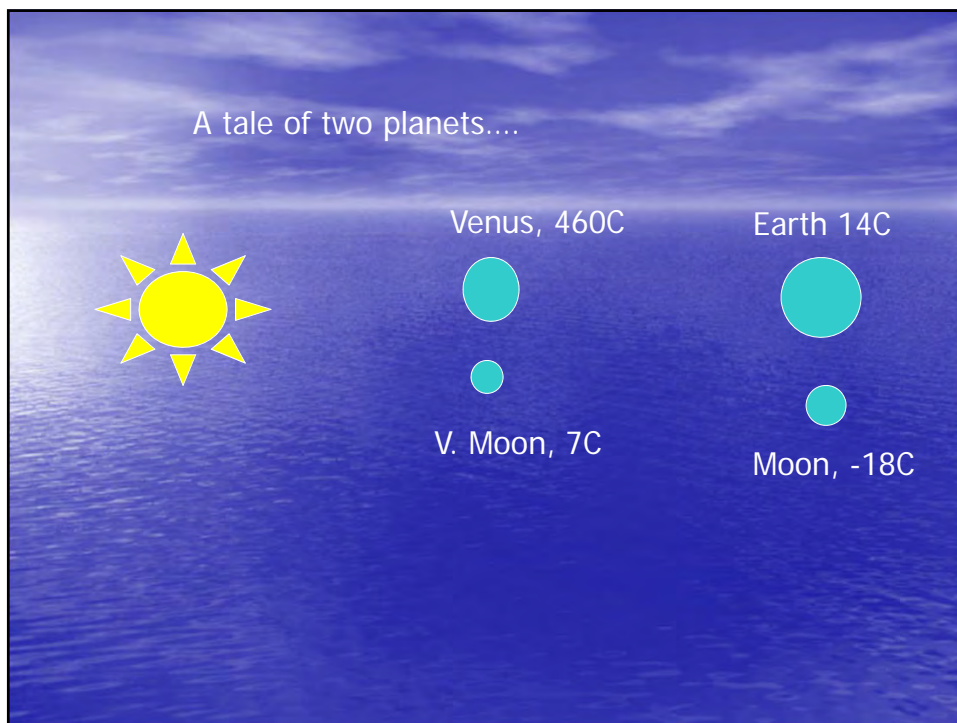
Britain, France, Germany, Norway, the Netherlands, Scotland and China have all announced they will eventually prohibit the sale of gas- and diesel-fuelled vehicles.



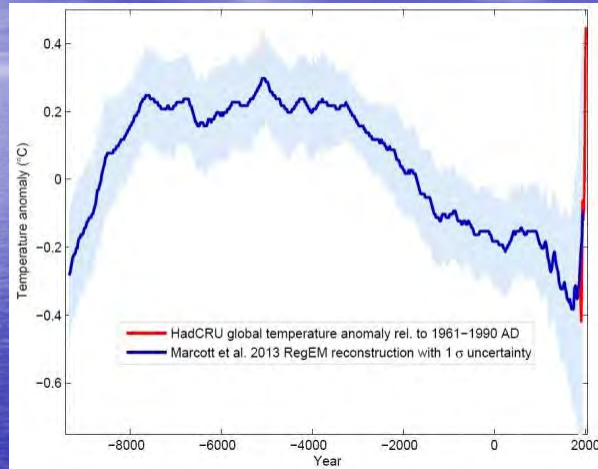








The Holocene; we should be going icy!



Generate Electricity From Wind!



Cost about the
Same as coal (4c/kWhr)
BUT
40,000/yr dead
from coal in US!!!!

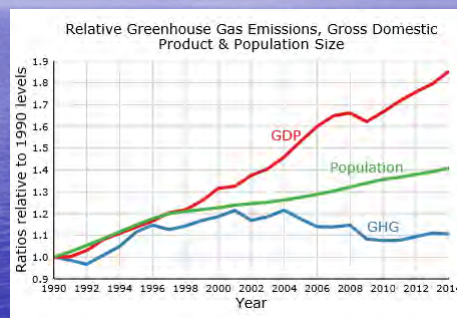
(Physicians for social
Responsibility)
4400/day in China killed!
Also 50,000/yr from oil

June '16. Mexico. 3c/kWhr

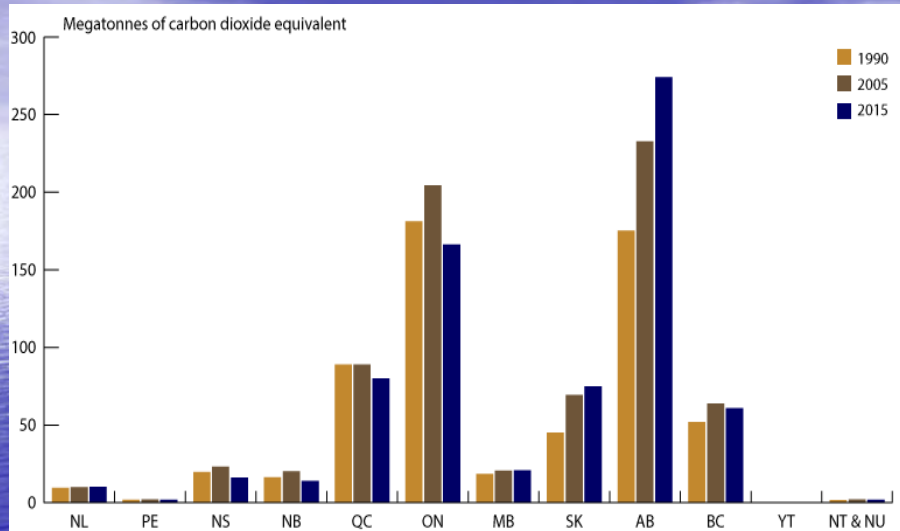
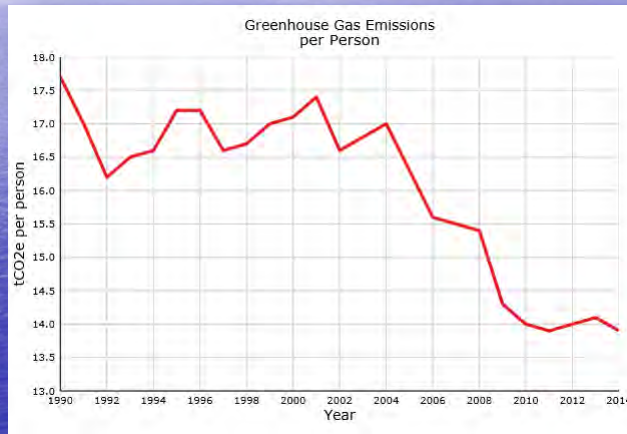
One year ago today (June 2017).

Alberta contracts for 600 MW of power from wind at 3.7c(cdn)/kW-hr.

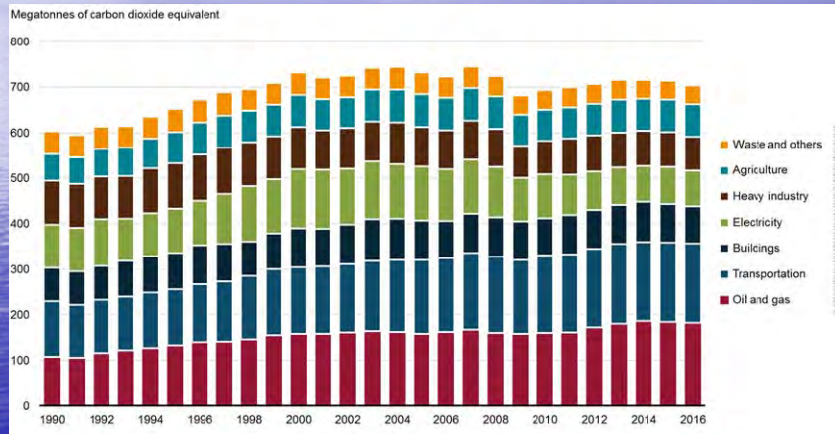
BC carbon dioxide emissions
(Environment Canada)



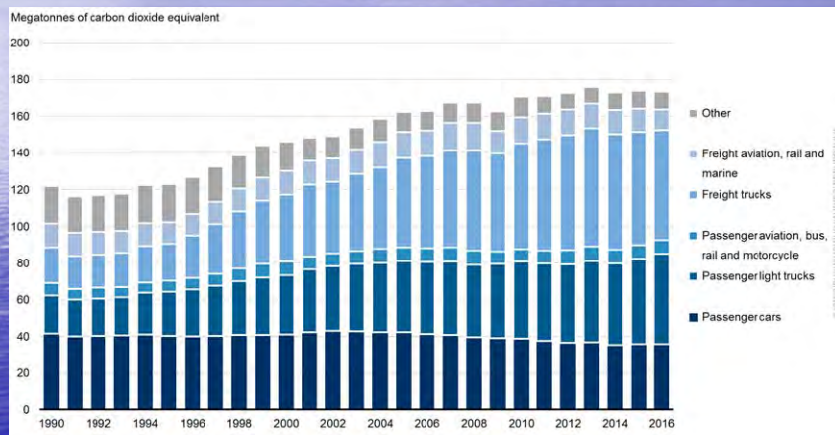
For BC



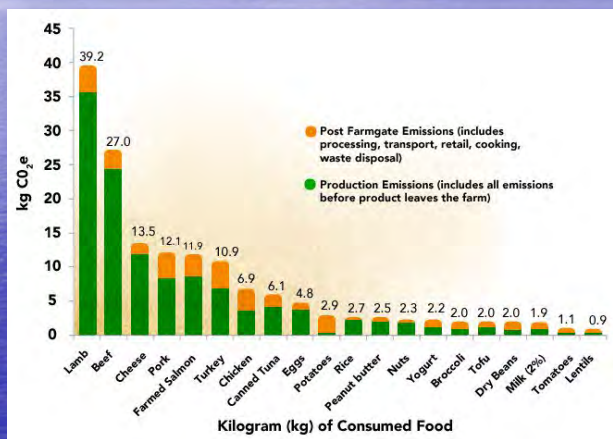
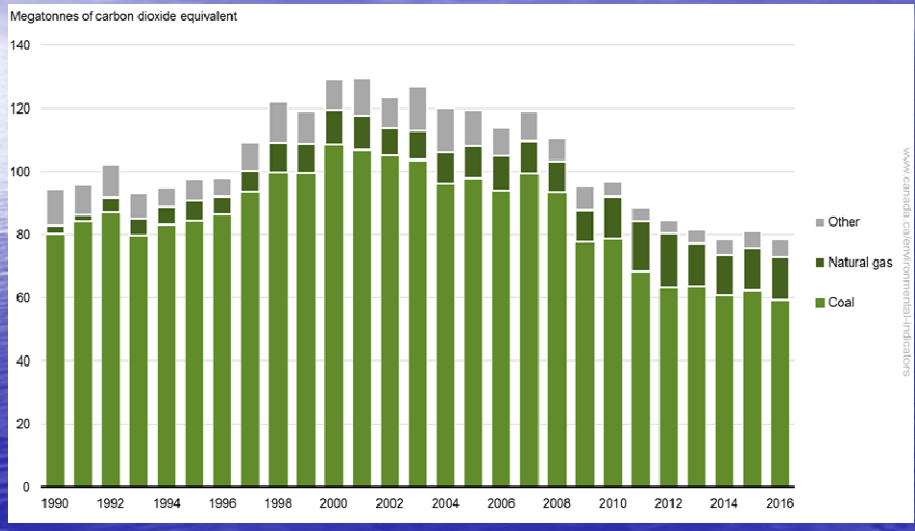
CDN Emissions by sector

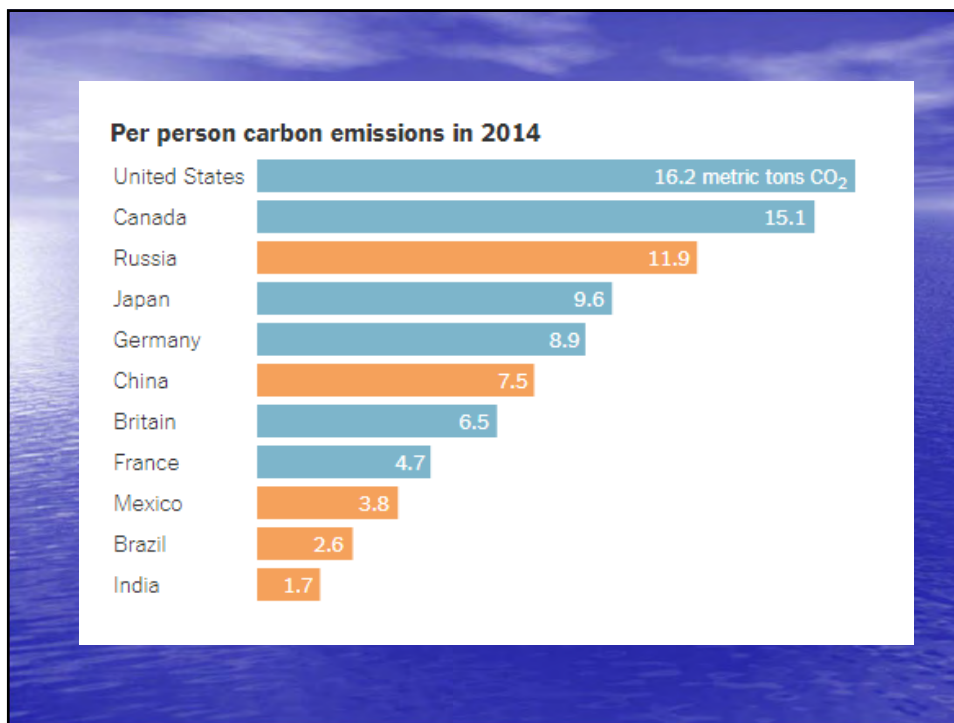
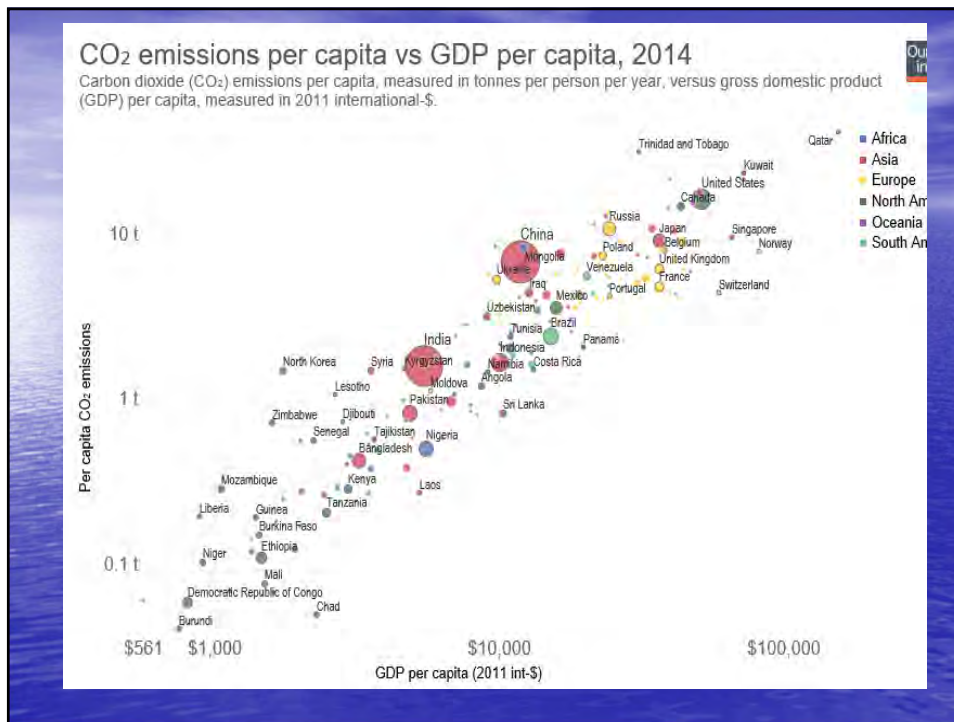


Cdn transport emissions.



Cdn electricity GHG





Lazard Ref.

- <https://www.lazard.com/media/450773/lazards-levelized-cost-of-energy-version-120-vfinal.pdf>