

# Can Global Warming be Stopped?

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My background:

BS Physics, Rensselaer

NBS (NIST) in Radiation Physics

Elected office (County Council, MoCo)

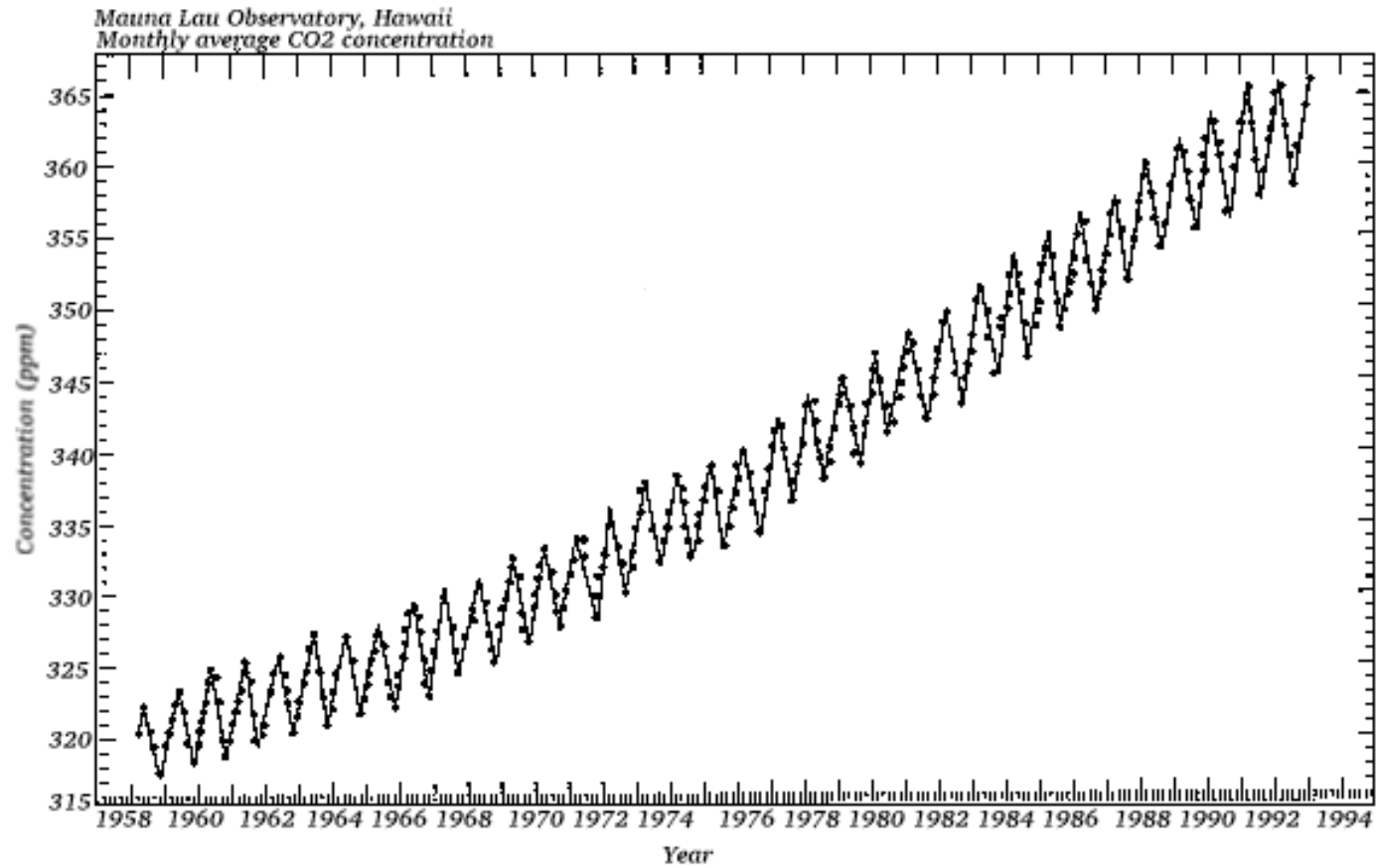
Mitre Corp, energy and environment issues

Dir. Env. Protection, MoCo

Ran astronomy observatory business w/wife

Retired, continuing astronomy, volunteer

# CO2 Atmosphere Concentration



My history re GW:

Sceptic re quality of climate models

Sources, sinks, non-anthro causes

Sceptic re quality of observational GW data

Direct (temperature, insolation, etc)

Indirect (historical record, isotope, ice core, etc)

Slowly converted by weight of evidence

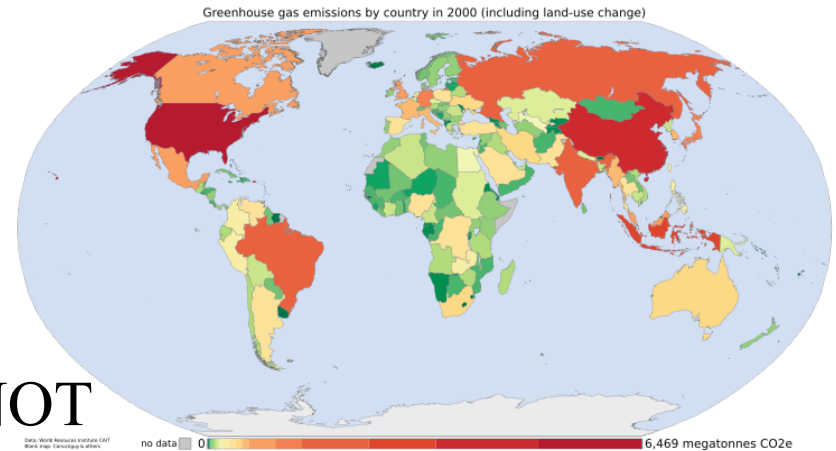
But...

Even if anthropo-GW is true...

We will see misconceptions:

The U.S. is the problem-NOT

Green actions will solve it-NOT



Incremental, pain-free solutions will work-NOT

My concern: is there a non-cataclysmic solution?

## Sources of Greenhouse Gasses

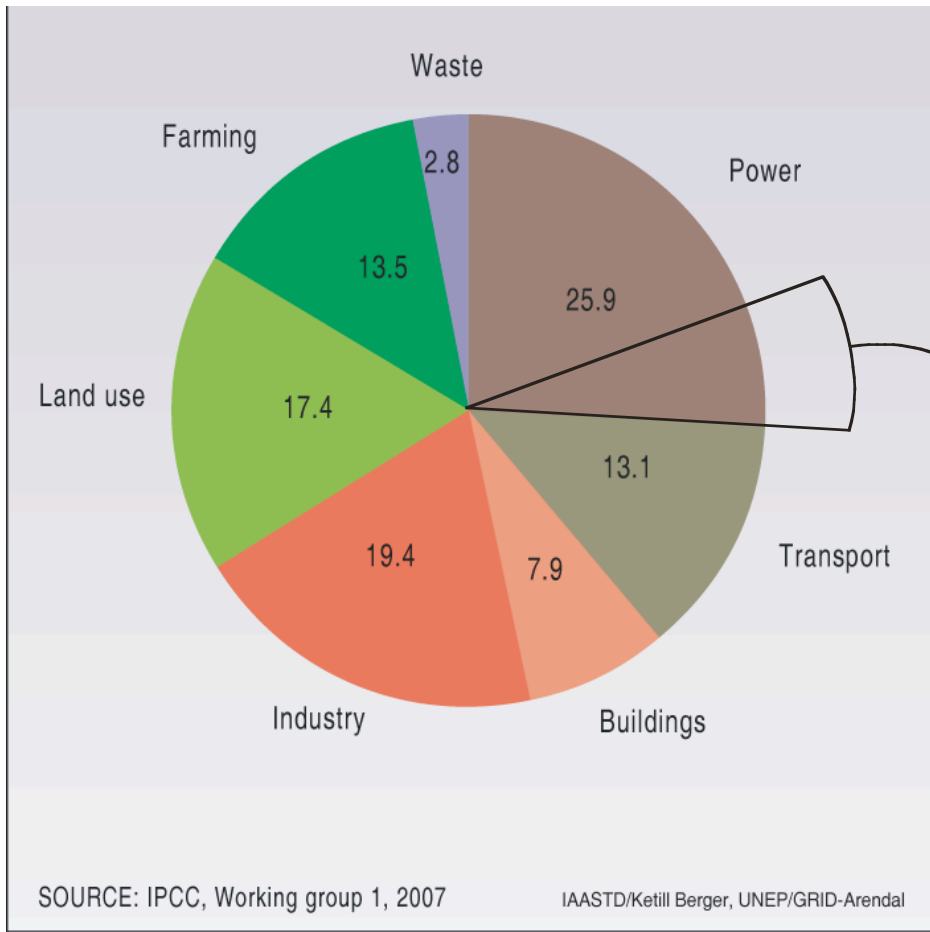
Natural (water vapor, methane, volcanoes, etc)

Fossil fuel burning (CO<sub>2</sub>, etc)

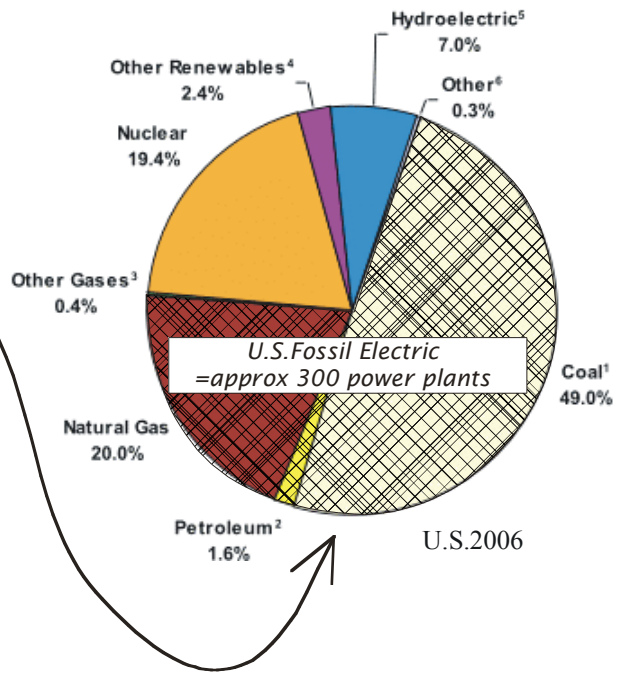
Forest clearing, land use changes

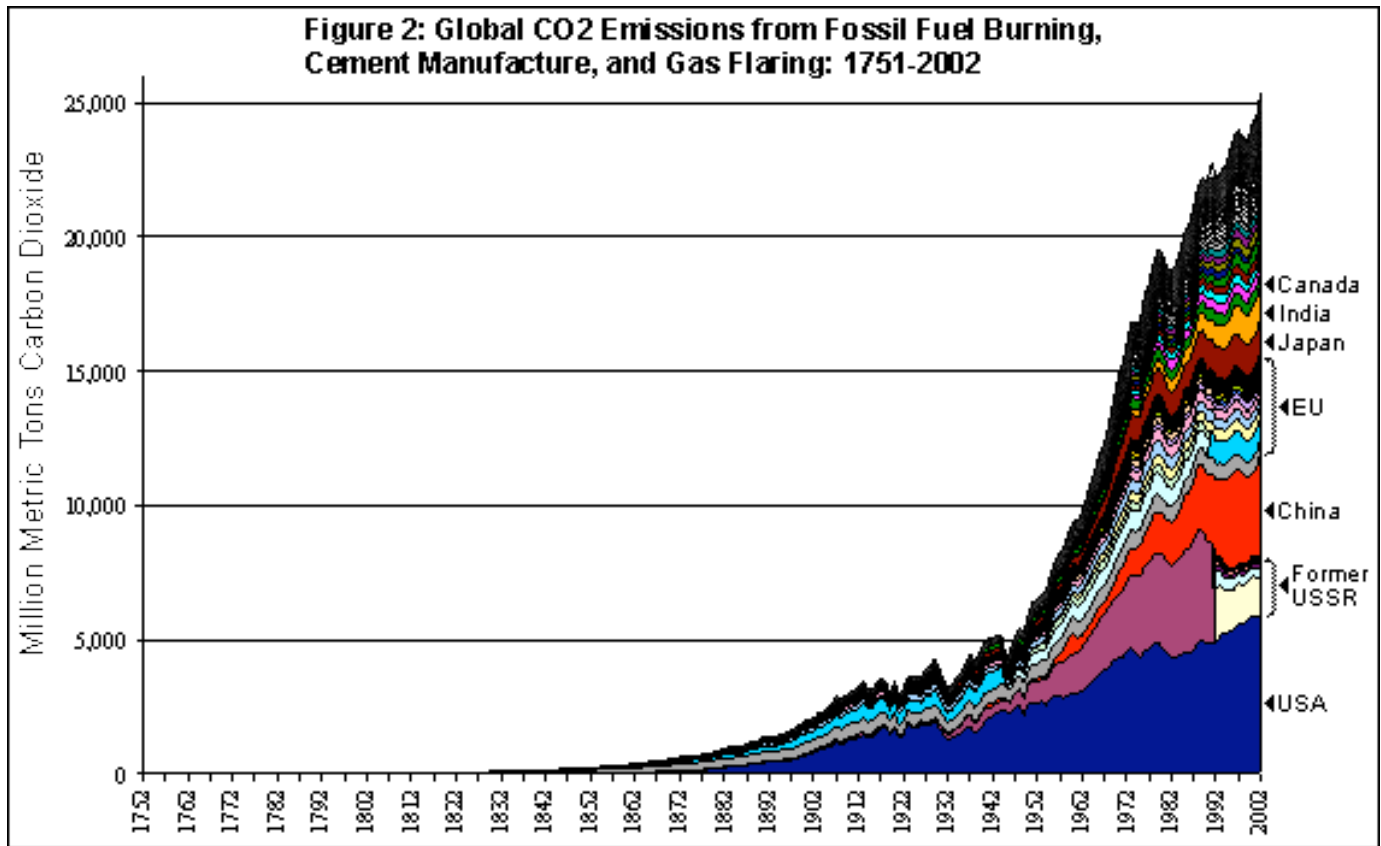
Food production (esp. animal husbandry)

# World GHG by Source Type



# U.S. Electric Mix







## Current Status

After >30 years, GHG still rising w/o diminution  
Fossil fuels, forest clearing, agriculture, food

Long GHG residence times (many decades)

Increasing concern about feedback effects

If GHG cut 80% by 2040 might prevent most GW

If don't, then won't..

Global Warming Solutions must account for

Temporal feasibility, includes

Technical and financial feasibility

Political and social feasibility

Global applicability

Ethics and morality

Temporal Challenge:

Cut GHG 80% in 30-40 years

Recast energy system in  
developed and developing world

Huge range of technologies, economics, politics,  
cultures

Is GW solution a high-tech problem?

**YES:**

Low tech “solution” means

Hunter/gather supports about 1-2 persons/sq mile, we now have  
>100: when we adopted agriculture, we committed to “high tech”  
society

Major reduction in living standards

Major fast population drops

There is no non-cataclysmic solution using return to lower tech

Ok, we must use high tech..

But does a GW solution

Require new “alternative” technologies

or

Require change in mix of current technology?

The issue is how fast we can change over: consider some past major infrastructure changes

Shift from water power to steam (coal)

Horses to automobiles/tractors

Family farm to Big farm

Telegraph to telephone

Manual to computer based systems

Canals to railroads to trucking

These were relatively easy (non-controversial),  
but all took way over 50 years

Why so long? It just takes time....

Existing investments to wear out

Cultural, social, training investments

Finding accommodations to changes (tech, eco, etc)

Clarifications of how new technology works

Learning/incorporating unintended consequences

All take time, none susceptible to eureka moments

New technology requires that we learn

How to do it, ALL the ins and outs (can't do w/o major market penetration)

Build all new financing, factories,  
engineering and technical training ,  
potential users, cultural changes, etc, etc

Identify advantages (generally easy, fast)

Identify dis-advantages (generally very hard, slow)



## Temporal Challenge Conclusion:

30-40 years not much time

thus

Must go with proven, known technologies  
with high market penetration

For much of world, only nuclear  
electricity and conservation are viable  
major sources (shift to breeders asap)

Alt tech as suitable to meet local conditions, niches

## Major impediments to realistic action:



Diversion of time and \$ into alternative energy schemes

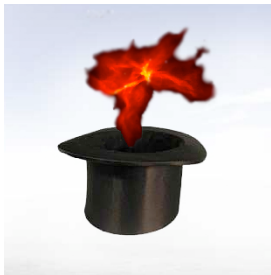
Pressure in countries to use cheap fossil fuels there for the taking



Uneven costs and benefits around world

No imminent, visible threat, it is all hypothetical

Frog in the Pot



Magical, non-evidence based thinking patterns

## Impediments-cont

Actions are by nation-states

Few natural incremental incentives

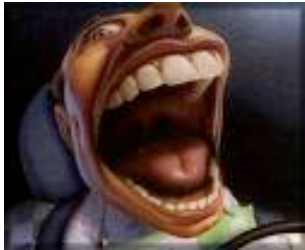
Rise of democracies opens endless debate

Difficulty in maintaining long attention

Entrenched interests (political, social, and economic)

Finite resources (talent, money) over long haul

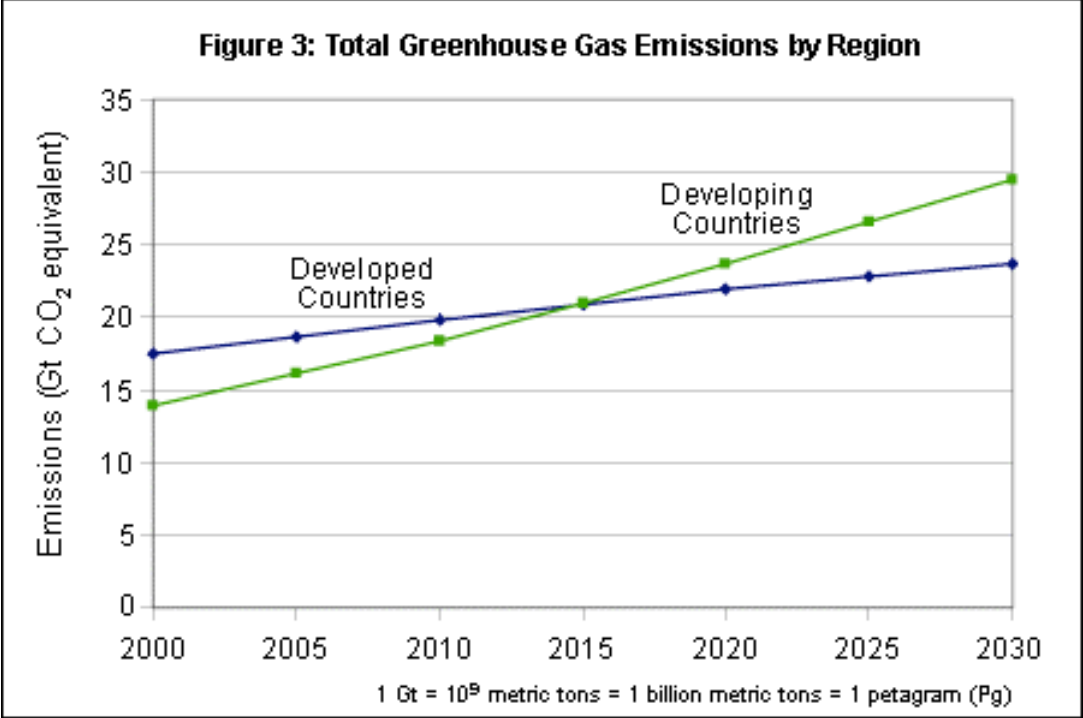
We know not all problems are solvable



And, there is no precedent in history for such an effort

But, suppose the world DOES shift to nuclear electricity and conservation (and appropriate other technologies), then what?

Let's look at the other issue:



$$GW = \sum (SOL * ER * POP)$$

SOL=standard of living, GNP

ER=emission rate (/person, /\$)

POP=population

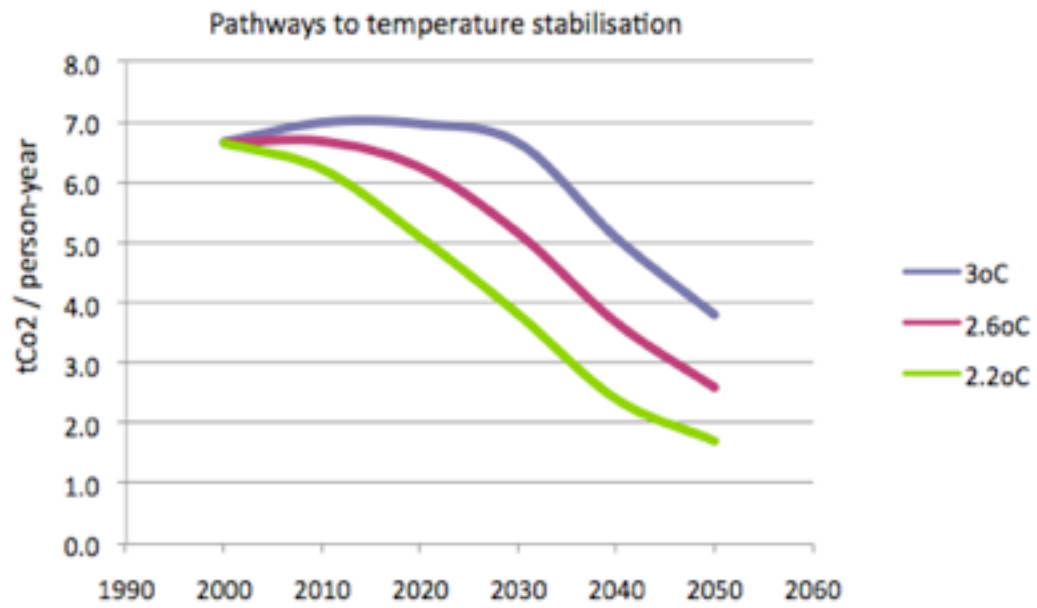
## Look at current populations and emissions:

	population (B)	GDP (\$T/yr)	Carbon (GT/yr)	gdp/person (\$K/person/yr)	carbon/person (T/yr)	carbon/gdp (GT/\$T)
US	0.3	14.0	6.0	46.7	20.0	0.4
China/India	2.4	4.2	6.3	1.8	2.6	1.5
Other	3.7	35.8	14.7	9.7	4.0	0.4
World	6.4	54.0	27.0	8.4	4.2	0.5
		Goal	8			

$$\text{Ratio} = 27/8 = 3$$

1GT=700 1GW nuclear plants

1GT=300,000 5MW windmills



2050, 9B people



## Some Scenarios:

	carbonmod1	Carbon Mod2	Carbon Mod3	carbonmod4	
	0.6	6.0	6.0	7.1	
	6.3	160.0	53.3	56.6	
	11.0	246.7	107.9	14.7	
	17.9	412.7	167.3	78.3	
Ratio x Goal	2.2	51.6	20.9	9.8	
	<p>Scenario:</p> <ol style="list-style-type: none"> <li>1. 90% less US carbon/person, 2/3 less in other, same in C/I</li> <li>2. All at current US GDP/person, current US carbon/person</li> <li>3. China at 1/3 our gdp/person, halfway c/person, Other in between</li> <li>4. Other gdp/person and Other carbon/gdp</li> </ol>				

## Conclusion:

World can barely avoid most GW if  
ALL reduce GHG by 80%

BUT: must keep POP and SOL constant  
(all must go to best ER)

ANY rise in SOL or POP will wipe out gains

## Moral/ethics issue

Must we keep 80% of world at very low SOL?

Shall we reduce population by x4 or so to allow increase in SOL? How?

How do we square this with our moral principles?

Is there a way out?