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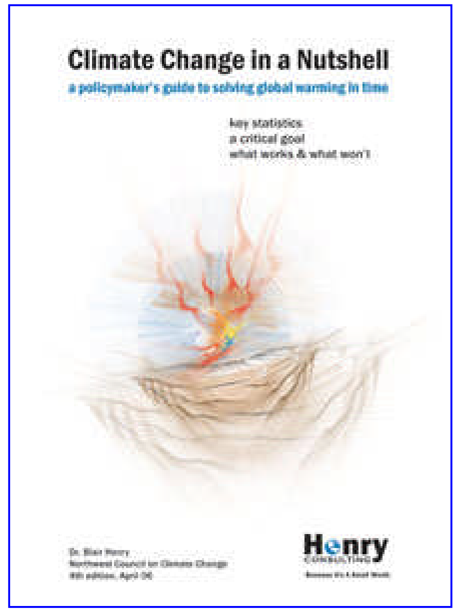
Climate Change in a Nutshell

a policymaker's guide
to solving global warming in time

- **- key statistics**
- **- a critical goal**
- **- what works & what won't**

(4th edition, April 2006)

> ***"The best summary of climate change I've ever seen."***
> Hon. John Turner, lead U.S. State Department negotiator on climate change



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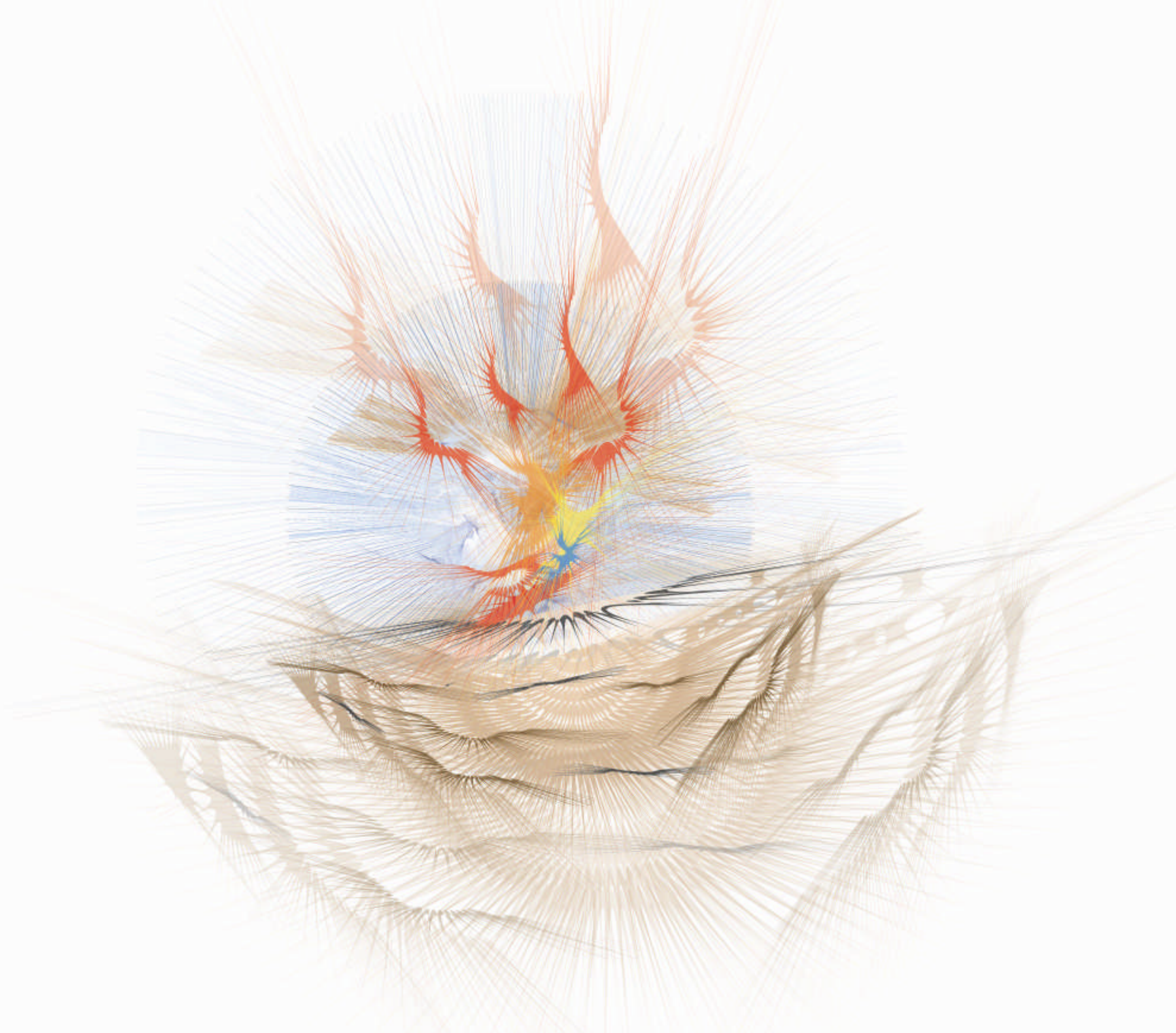

Dr. Blair Henry
Northwest Council on Climate Change
4th edition, April 06

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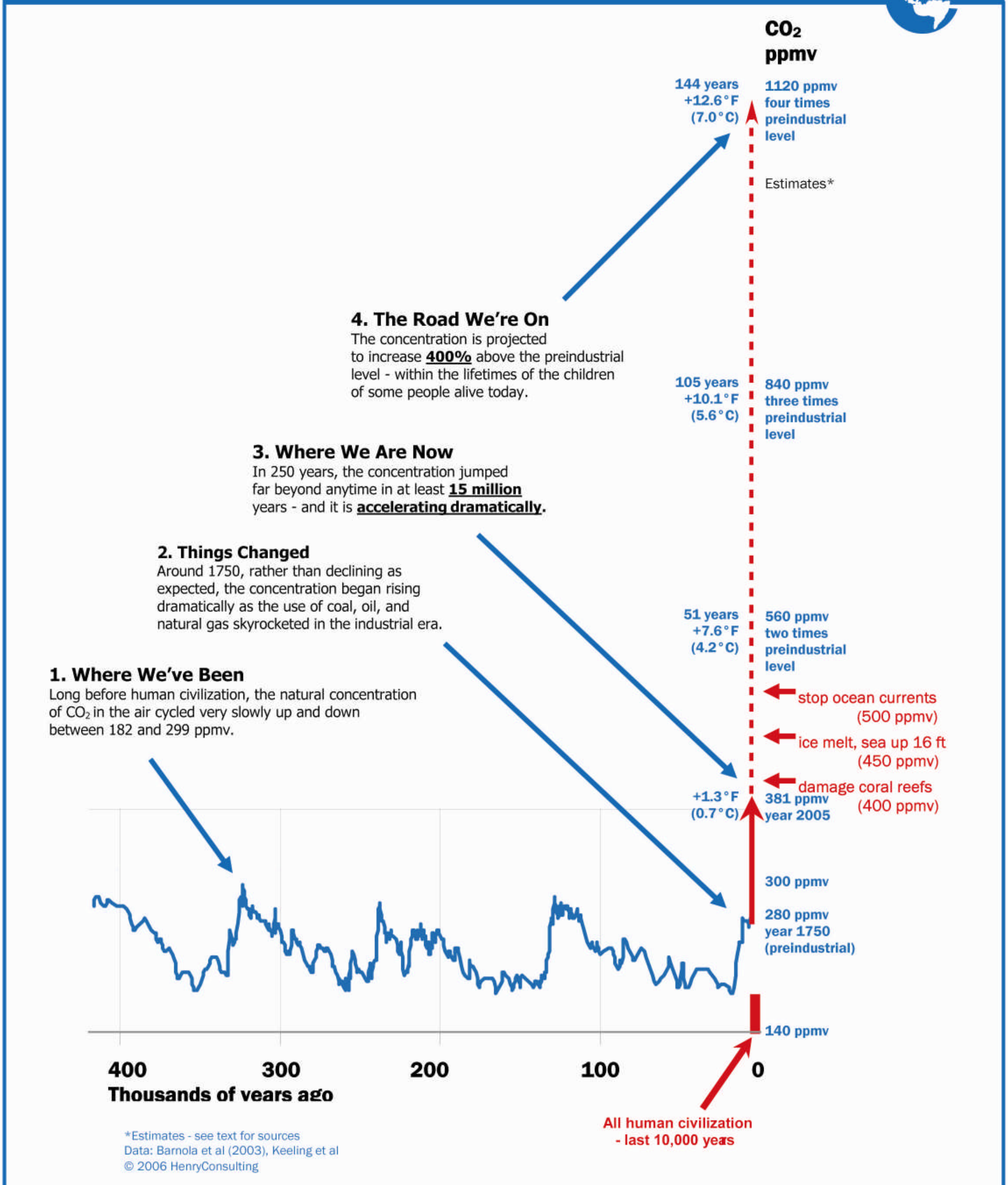
Atmospheric Concentration of Carbon Dioxide (CO_2)

in parts per million volume (ppmv)



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Climate Change in a Nutshell

a policymaker's guide to solving global warming in time

key statistics - a critical goal - what works & what won't

Dr. Blair Henry [1]
Northwest Council on Climate Change [2]
4th edition, Apr 06

> "The best summary of climate change I've ever seen"
> Honorable John F. Turner, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, U.S. State Department

Introduction

This is a short, plain-English summary of billions of dollars of research, hundreds of studies and my ten years as an attorney working on climate change.

This is based upon the work of the world's most qualified experts[3] and has been reviewed by leading scientists. This is designed to provide reliable, updated information to American policymakers committed to "solving global warming in time"[4]– defined here as limiting the increase in average global surface temperature to 3.6°F or 2.0°C above the year 1750 – the preindustrial period. This is currently projected to require a maximum concentration of atmospheric carbon dioxide (CO_2) of 400 parts per million volume (ppmv) – and the atmosphere was already at 381 ppmv in 2005.

This goal is very aggressive and is based upon projections[5] of prospective impacts that, if proven accurate, are likely to be irreversible, including:

- Severe damage to coral reefs - above 400 ppmv
- Disintegration of West Antarctic ice sheet – and eventual sea level rise of 13 to 20 feet - above 450 ppmv
- Shutdown of some major ocean currents - near 500 ppmv

It's critical the human community align immediately on a common global goal - accounting for the various uncertainties and threats. Once a goal is chosen, the necessary actions become apparent. Proposed goals are provided in Section 2.5.

American policymakers now have the greatest opportunity any human beings have ever had to make an extraordinarily valuable contribution to billions of people and millions of species for thousands of years.

There is simply no legitimate doubt

1. Global warming is already underway.
2. Human activities are the primary cause.
3. We're quickly running out of time to prevent extraordinary damages.
4. We're not on track to solve this in time.
6. Once a goal is chosen, the necessary actions become apparent.

The need to quickly reduce greenhouse gases has already been acknowledged by no less than

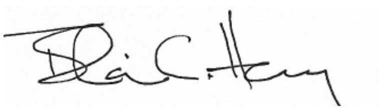
1. Governments representing 98% of the world's population – including the United States.
2. Every major national academy of science.
3. Over 140 state & local governments within the United States.

4. Over 88 major insurance companies.
5. Over 66 major American corporations.
6. Over 7 major international oil companies.[6]

This is organized as follows:

American measures are used and emissions are provided in "U.S. tons of carbon dioxide equivalent (CO_2e)" - with metric equivalents in the endnotes. A key to abbreviations and conversions is provided.

If you don't find what you are looking for, or you find an error, please contact me. Updated editions will be available online at www.nwclimate.org and www.HenryConsulting.biz. Suggestions and questions are welcome!!



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Key Buzzwords & Conversions

C - carbon
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent, standardized measure of greenhouse gases
Gt - gigatonne
= one billion metric tonnes
= 1000 teragrams (Tg)
MMTC - million metric tonnes of carbon
MMTCE – million metric tonnes of carbon equivalent
metric tonne - 2200 pounds
Pg - petagram
= one quadrillion grams
= one billion metric tonnes
= one gigatonne
ppmv - parts per million volume
Tg - teragram
= one trillion grams
= one million metric tonnes
US ton - 2000 pounds

kilo = thousand
mega = million
giga = billion
tera - trillion
peta - quadrillion

To Convert	Multiply
C to CO_2	C x 3.6666
CO_2 to C	CO_2 x.27
grams to lbs	gr x.002205
lbs to grams	lbs by 453.6
metric tonnes to US tons	tonnes by 1.102
US tons to metric tonnes	ton by .907

1.0 THE PROBLEM – THE SCIENTIFIC FACTS & PROJECTIONS

1.1 Definitions: Global Warming and Climate Change

Global Warming

- The human-caused heating of the Earth's surface, atmosphere and oceans.
- Predicted over 100 years ago by Dr. Svante Arrhenius , the world's first Nobel Prize winning chemist.[7]
- Does not mean it will get hotter everywhere right away – some areas are projected to get cooler first.
- Does mean the climate and weather will become disrupted, skewed or unusual.

Climate Change

- The more comprehensive description of what will happen as the climate and weather changes due to an overall global warming.

1.2 How Global Warming Works

- The atmosphere consists mostly nitrogen and oxygen.
- Also contains dozens of very small, but extremely powerful, amounts of 'greenhouse gases'.[8]
- Greenhouse gases act like an insulating blanket trapping heat near the Earth.
- Most greenhouse gases occur naturally including water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).
- Some greenhouse gases are necessary to keep the Earth's temperature mild.
- The system becomes destabilized when large amounts of new human-caused gases are added.

1.3 Greenhouse Gases - What's Normal

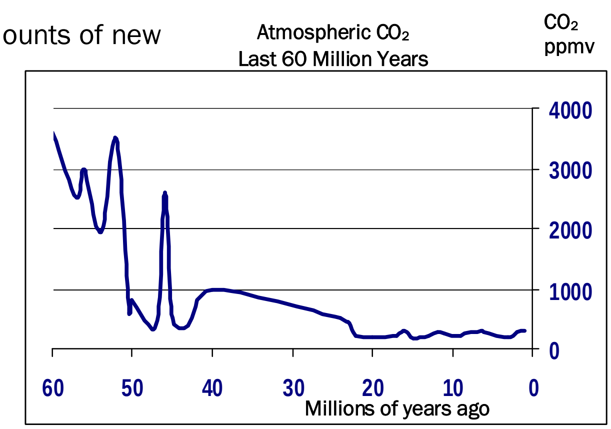
(a) Long Before Humans [9]

- Over 35 million years ago, the concentration of atmospheric CO_2 was three times what it is today - the planet was much warmer and there was no permanent ice anywhere.
- Since then, most of the CO_2 has been absorbed by the oceans, plants and soil and stored underground as fossil fuels - coal, oil and natural
- gas – the planet cooled and the ice caps formed.
- Over the last 15 million years, long before humans, the concentration of atmospheric CO_2 has been below 300 ppmv - until the last 100 years.

(b) Last Half Million Years [10]

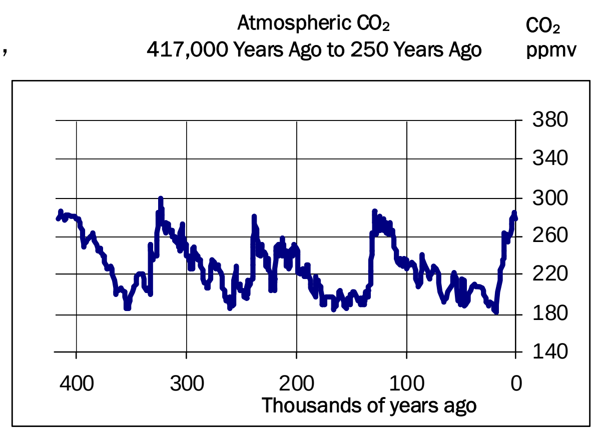
- Over the last 417,000 years, the concentration of atmospheric CO_2 has gone up and down in a very slow cycle between 182 and 299 ppmv.
- This swing of 117 ppmv has been enough to change the average surface temperature by

Atmospheric CO_2
Last 60 Million Years



Pearson, Palmer (2003)

Atmospheric CO_2
417,000 Years Ago to 250 Years Ago



Barnola et al (2003)

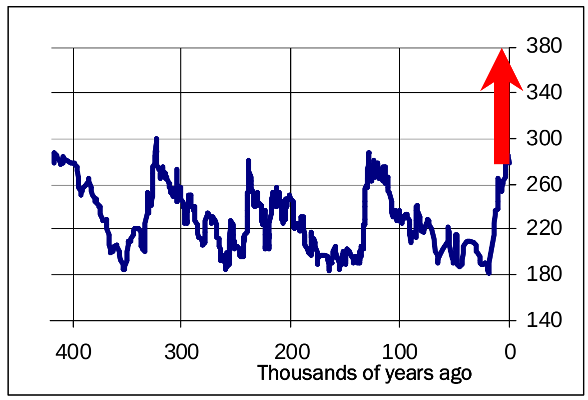
7 to 9°F - starting and ending all major ice ages during that period.

(c) All of Human Civilization – The Last 10,000 Years

- Modern human ancestors appeared about 195,000 years ago.
- All of human <u>civilization</u> occurred in the last 10,000 years - during the last half of a typical warming period.
- If the natural cycle had continued as it has for the last 417,000 years, the warming period should have peaked by about now and a long, slow cooling period of about 130,000 years would have begun.[11]
- That's **not** what happened - the atmosphere did not to begin to cool – rather it began to heat rapidly and dramatically.

1.4 The Destabilizing Human Influence – The Last 250 Years

Atmospheric CO_2
417,000 Years Ago to Today



- The use of fossil fuels – coal, oil and natural gas – has skyrocketed over the last 250 years since the preindustrial period.
- The concentration of atmospheric CO_2 rose 101 ppmv – up 35% from 280 ppmv to 381 ppmv.[12]
- There is no evidence this amount of change was caused by volcanoes[13], the Sun, or changes in the Earth's orbit.
- There is very convincing evidence this change was caused by human activities.
- The Earth's upper oceans, plants and soil naturally emit, and then re-absorb, about **485 billion US tons** of CO_2 (120 billion metric tonnes of carbon) a year.[14]
- Humans now add about **30 billion new US tons** of **CO_2** or its equivalent (7.4 billion metric tonnes of carbon) every year[15] - this additional 6% destabilizes the climate globally.[16]
- About half of this additional CO_2 is absorbed by the upper oceans, plants and soil.
- The other half of the additional CO_2 remains in the atmosphere for many centuries, only slowly being transformed into ocean sediments and long-lived soil carbon.
- The elevated CO_2 that remains in the air increases the trapping of heat and disrupts the climate and weather for hundreds of years after being released.[17]
- It's unclear how long the oceans, plants and soils continue to absorb the increasing amounts of CO_2.[18]
- The emissions of greenhouses gases are increasing dramatically every year.

The CO_2 naturally emits and re-absorbs every year: 485 billion US tons

The additional human-caused CO_2 every year: 30 billion US tons

About half goes into the oceans and plants. The other half remains in the air – trapping more heat

(a) How Fossil Fuel Combustion Works

- Fossil fuels – coal, oil, natural gas – consist of energy from sunlight stored by plants over millions of years.
- The carbon (C) makes a fossil fuel a fuel.
- Burning a fossil fuel requires considerable of oxygen (O) from the air.
- The global oxygen inventory of oxygen is decreasing due to the burning of fossil fuels.

- Additional oxygen is also likely to be lost as the oceans become more acidic due to increased CO_2 and loss of marine life.[19]
- During combustion, the carbon (C) attaches to oxygen (O) creating either carbon monoxide (CO) or carbon dioxide (CO_2) – and CO eventually becomes CO_2 in the atmosphere.
- CO_2 is the most prevalent of the human-caused greenhouse gases.
- Burning one pound of coal creates 2.2 pounds of CO_2 – or 2.2 times its own weight.[20]
- Burning one pound of gasoline creates 3.3 pounds of CO_2 - or 3.3 times its own weight.[21] – and each gallon of gasoline weighing about 6 pounds emits about 19.6 pounds of CO_2.
- Per unit of energy produced, gasoline, used primarily in the transportation sector, emits far less CO_2 than coal used primarily in the electricity sector.

(b) Sources of Human-Caused Destabilizing Greenhouse Gases (approximate)[22]

- 76% from the burning of fossil fuels - coal, oil and natural gas.
- 20% from deforestation, agriculture and other land uses.
- 3% from cement production, chemicals, etc.

Over three quarters of all destabilizing greenhouse gases are from the burning of fossil fuels

(c) The Primary Human-Caused Greenhouse Gases (approximate)[23]

- 86% carbon dioxide (CO_2).
- 11% methane-natural gas (CH_4).
- 2% nitrous oxide (N_2O).
- 1% other gases.

(d) The Long Impact of the Gases

- Different gases trap different amount of heat and have different lifetimes in the atmosphere[24]
- The most prevalent human-induced greenhouse gas, CO_2, traps heat for hundreds to thousands of years.[25]
- Eventually the heat transfers from the air to the oceans and the oceans warm, expand, and rise for many <u>centuries</u> after the release of the gases.
- This is compounded with the additional melting of ice in Greenland and Antarctica which will add to the rise in sea level.
- <u>There is simply no doubt</u> actions taken today, or not taken today, will specifically and measurably impact the quality of life for billions of people and millions of species for thousands of years.

Greenhouse gases impact the air and oceans for <u>hundreds</u> of years after being released

1.5 The Rate of Change

(a) Last 250 years [26]

- From 1750 to 2005, the atmospheric concentration of CO_2 jumped 35% - or 101 ppmv - from 280 to 381 ppmv.
- This is the first time in at least 15 million years the concentration of CO_2 has reached or exceeded 300 ppmv.

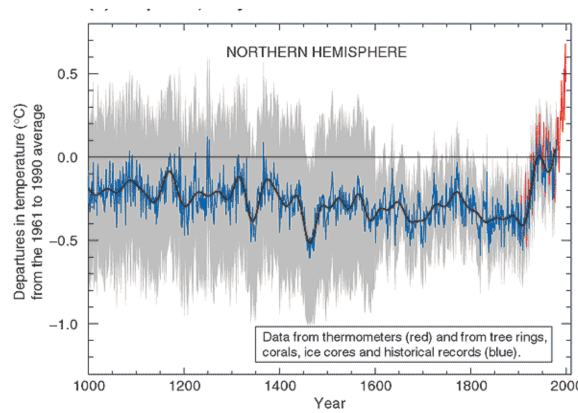
(b) Last 100 years[27]

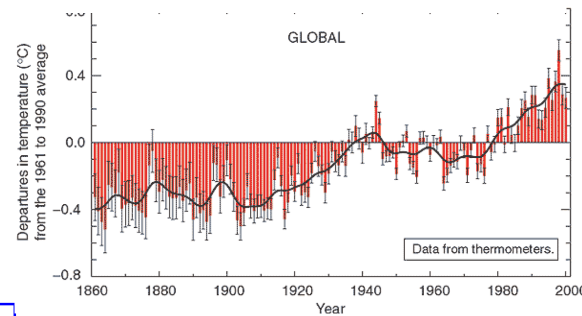
- The average global surface temperature has increased 1.1°F (0.6°C).
- Sea level has risen approximately 4-8 inches.

(c) Last 25 years[28]

- The average global surface temperature has risen dramatically over the last 125 years, with <u>half</u> of the increased warming occurring in the last 25 years - when 19 of the 20 hottest years were recorded.
- 1997 set a new global record.
- 1998 set another global record.
- 2001 joined the top four hottest years on record.
- 2002 became the 2nd hottest year on record.
- 2003 became the 3rd hottest year on record.
- 2004 became the 4th hottest year on record.
- 2005 has now moved into either 1st or 2nd place.

Variations of the Earth Surface Temperature - IPCC-TAR (2001)





(d) The Dramatic, Accelerating Rate of Growth of Emissions

- Despite international agreements to reduce emissions,[29] humans continue to add about 30 billion new US tons of CO_2e into the air every year – and the rate of growth is accelerating rapidly.[30]
- Emissions from fossil fuels[31] are projected to increase **81%** above 1990 levels by the year 2025.[32]
- Global emissions are <u>accelerating</u> at a rate of about <u>24 additional US tons of CO_2e every single second:</u>[33]

Rate of Growth of Emissions (US tons CO2e)

Global	United States	
2.48% a year	1.00% a year	
24	2.4	tons per second
1411	144	tons per minute
85,000	8,670	tons per hour
2 million	209,000	tons per day
743	76 million	tons per year

A medium-sized coal plant, 500 MW, emits about <u>8 million</u> tons/year

19 of the 20 hottest years on record occurred in the last 25 years

(e) The Dramatic Growth of Atmospheric CO_2[34]

- About half of the 30 billion new US tons of greenhouse gases emitted each year are absorbed by the oceans, soils and plants.
- The remaining half remains in the air, increasing the concentration of CO_2 and trapping more heat.[35]
- It's unclear how long the oceans and plants can continue to absorb this additional amount of CO_2.
- From 1983 to 2005, the <u>atmospheric concentration</u> of CO_2 rose at a rate of <u>2.4 ppmv</u> per year– or **eleven times** the rate of growth for the preceding 230 years.

Accelerating Rate of Growth in Concentration of Atmospheric CO_2

Years	CO_2 (ppmv)	No. Years	Increase	Average/Yr
1750-1983	279 to 328	223	49 ppmv	.22 ppmv
1983-2005	328 to 381	23	54 ppmv	2.40 ppmv

Emissions are <u>increasing</u> at over 85,000 tons an hour

The concentration of CO_2 <u>rose 10 times</u> faster in the last 20 years than in the previous 230 years

(f) Greenhouse Gas Emissions Per Person [36]

- Each person in the world emits an average of <u>4.8</u> US tons of CO_2e a year – and is increasing at a rate of about 2.48% per year.
- Each person in the U.S. emits an average of <u>26.5</u> US tons of CO_2e a year – more than **5 times** the global average – and is increasing at rate of about 1.00% per year..

1.6 THE PROJECTIONS [37]

(a) Global Emissions of Greenhouse Gases

- Global greenhouse gas <u>emissions</u> are projected to increase about <u>2.48% a year</u> through 2015 and then 1.6% a year through 2025.[38]
- That's an average increase of about 750 million US tons of CO_{2e} a year through 2015.

(b) Atmospheric Concentration of Carbon Dioxide (CO_2)

- The atmospheric <u>concentration</u> of CO_2 is now projected to increase at a rate of <u>0.75% and 1.00% per year</u>[39] or approximately 3 to 4 ppmv.
- At an increase of 0.75% per year, the CO2 concentration will be near
  400 ppmv in 2012 – eight years from now - reefs
  450 ppmv in 2028 – twenty-two years from now - ice sheets
  500 ppmv in 2042 – thirty-six years from now –currents
  560 ppmv in 2057 – fifty-one years from now

(c) Global Temperature, Precipitation, Sea Level [40]

Five years ago in 2001, the qualified, mainstream scientific community projected:

	<u>Last 200 Years</u>	<u>Next 100 Years</u>
CO_2 concentration	up 101 ppmv (35%)	up at least another 179 ppmv to 560ppmv
temperatures	up 1.3°F	up at least another 2.5°F to 10.5°F
sea level	up 7-11 inches	up another 4 to 35 inches, more thereafter

However, since then, emissions and atmospheric concentrations of CO_{2a} are rising faster than expected. See Section 2.5 for other projections.

(d) United States [41]

Five years ago in 2001, the qualified, mainstream scientific community projected:

- The impacts become greater and arrive more quickly the further north and the further inland.
- On average, the changes in temperatures and precipitation in the United States are expected to be greater than the globe as a whole.

	<u>Last 100 Years</u>	<u>Next 100 Years</u>
temperatures	up 1.0°F	up another 5°F to 9°F
sea level	up 4-8 inches	up another 4 to 35 inches, more thereafter
precipitation	more extreme rains	more extreme rains more evaporation more droughts and floods

However, since then, emissions and atmospheric concentrations of CO_{2a} are rising faster than expected.

(e) Alaska - A Key Precursor [42]

- The northern most state in the United States, Alaska, is experiencing the greatest warming – with an average statewide increase of about 5˚F increase since the 1960s.
- Winters in the interior have warmed about 8˚F.
- 30% increase in precipitation between 1968- 1990 on most of state.
- Growing season lengthened more than 13 days - in just 50 years.
- There has been a melting of the permafrost, sinking of highways and buildings, a loss of foundation for trees, migration of plants and animals, as well as increased forests fires and insects.
- The Arctic Council - eight countries, six Indigenous organizations, and 18 national academies of science, provided released major report: Impacts of a Warming Arctic.
- Arctic temperatures have risen at nearly **twice** the rate as in the rest of the world and much larger changes projected with worldwide implications.[43]
- The Upper Midwest of the United States is projected to be the next hardest hit – most northern and inland.

(f) Other States within the United States

For reports on the actual and projected impacts on various states within the United State, see:

- U.S. National Assessment on the Potential Consequences of Climate Change and Variability www.usgcrp.gov/usgcrp/nacc/
- U.S. Environmental Protection Agency http://yosemite.epa.gov/oar/globalwarming.nsf/content/coun-unitedstates.html?OpenDocument&Flash=yes
- Union of Concerned Scientists www.ucsusa.org
- National Wildlife Federation www.nwf.org/globalwarming/states.cfm

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2.0 WHAT'S NEEDED IMMEDIATELY– TIMELY GOAL, RELIABLE PLAN

2.1 The Desperate Need to Align on a Timely Goal

> **You just can't win if you don't know where the goal is.**
> **- J. J. Chisholm**

- Major, irreversible impacts are now projected in the short-term – see Section 2.5 below
- The science and the avenues for solving global warming are well known.
- The most important missing elements are a common global goal and reliable plan.
- "You just can't win if you don't know where the goal is."
- And the goal must be global - while many jurisdictions have adopted goals, the inaction of single large emitter can easily offset the work of the other jurisdictions.
- Once a goal is established, then it can then be determined how much needs to be reduced by when - and then prioritize the most cost-effective options.
- While over 97% of the governments in the world, including the U.S., have agreed "greenhouse gas concentrations must be stabilized at a level that would prevent dangerous human interference with the

climate system"[44] - and some have come up with targets - no government has publicly declared what it deems as a "safe" level of stabilization.

- A number of countries, states, cities and businesses have declared goals that go far beyond the Kyoto goal[45] - such as requiring an 80% reduction of greenhouse below 1990 levels by 2050 – however, without similar or more aggressive cooperation by the other jurisdictions in the world, these goals, in the long run, may be effectively meaningless.
- Emissions are **increasing rapidly** –about **2.4% a year.**[46]
- Over the last 23 years, the atmospheric concentration of CO_2 has been rising at an average rate of **2.40 ppmv per year** [247]– and this rate projected to go much higher.[48]
- The atmospheric concentration of CO_2 is expected to be twice the preindustrial levels of 280 ppmv before the end of the century - and we're on track to go far beyond that - toward a quadrupling of 1120 ppmv by 2150 at an increase of 0.75% a year.[49]

2.2 Highly Dangerous Wildcards - Potential Catastrophic "Surprises"

- There are also a number of highly dangerous "surprises" or "thresholds" that are not usually taken into account in the projections.
- Each could trigger a dramatic acceleration of the adverse impacts of global warming and highlight the immediate need for a timely goal:
  (a) **Accelerated melting of the Greenland and Antarctic ice sheets** - UNDERWAY.[50]
  (b) **Slowing of ocean currents especially near Northern Europe** - UNDERWAY.[51]
  (c) **Melting permafrost and large-scale release of CO_2 and methane** in the arctic - UNDERWAY.
  (d) **Increased forest fires** - UNDERWAY.
  (e) **Release of methane from ocean floor** - NO EVIDENCE TO DATE

2.3 The Types of Goal

Most global goals proposed today focus on one or more of the following measurables – all of which are related:

a. Limiting the atmospheric concentration of greenhouse gases
   Usually between 350 and 560 ppmv.

b. Limiting the increase in atmospheric temperature
   Usually between 1.8°F and 5.4°F (1°C to 3°C) above pre-industrial levels.

c. Eliminating or offsetting all emissions
   Often known as **CarbonNeutral** - defined here as reducing emissions as much as possible and then permanently and verifiably offsetting all remaining emissions.

The first two goals address the gases remaining in the atmosphere. However, it is not clear they address the other half of the emissions which are absorbed by the oceans, plants and soils – dangerously changing the chemistry of the oceans and also adding more carbon to plants and soils to be re-released later into the air later.

2.4 Putting the Goals in Perspective

- The only international goal to date, the 1997 Kyoto Protocol, strives to reduce emissions by the greatest emitting countries to about 5% below 1990 levels by 2012.
- This is less than 10% of what would be required to stabilize atmospheric CO_2 at a level of 560 ppmv - the highest and most dangerous proposed goal. Adopting this goal would require
  (a) stopping the growth of emissions globally before 2040, and
  (b) reducing emissions **80-90% thereafter** - eliminating fossil fuels.

Comparing the Amount of Change

	Increase in CO_2	Increase in Temp Since 1750	
change over **last 256 years**	+101 ppmv (280 to 381)	1.3°F	0.7°C
next 51 years - by 2057 (twice preindustrial level)	+179 ppmv (381 to 560)	7.6°F	5.2°C
next 54 years - by 2111 (triple preindustrial level)	+280 ppmv (560 to 840)	10.1°F	5.6°C
next 39 years - by 2150 (quadruple preindustrial level)	+280 ppmv (840 to 1120)	12.6°F	7.0°C

Based on growth of 0.75% per year

2.5 Proposed Goals to Date [52]

The following proposed goals begin with the least damaging:

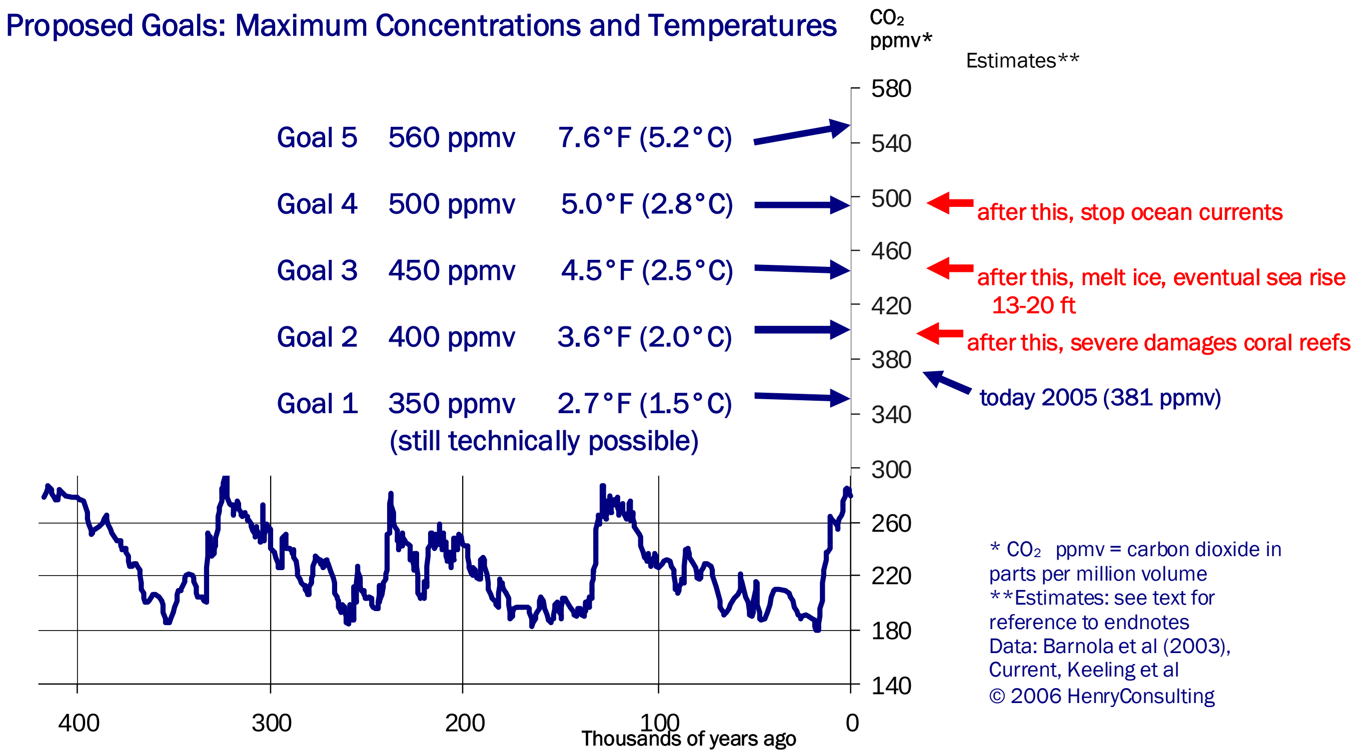
Goal 1 - 350 ppmv (still possible despite being at 381 ppmv in 2005)
Est. maximum temperature increase of about **2.7°F** or **1.5°C** above the preindustrial level. Proposed by Drs. Azar, Henning, Schneider.[53]

Goal 2- 400 ppmv
Est. maximum temperature increase of about **3.6°F** or **2.0°C** above the preindustrial level. **After this, more severe damage to coral reefs.** Proposed by International Climate Change Taskforce, Dr. Holdren, and many Europeans.

Goal 3 - 450 ppmv
Est. maximum temperature increase of about **4.5°F** or **2.5°C** above the preindustrial level.[54] **After this, melting of Antarctic and Greenland ice sheets – eventual sea level rise near 16 feet.**[55]

Goal 4 - 500 ppmv
Est. maximum temperature increase of about **5.0°F** or **2.8°C** above the preindustrial level. **After this, more likely to stop ocean currents.** Avenues proposed by Drs. Pacala, Socolow.[56]

Goal 5 - 560 ppmv – a doubling of the preindustrial level.
Est. maximum temperature increase of about **7.6°F** or **5.2°C** above the preindustrial level.



2.6 The Time to Align on a Goal is Now

- Greenhouse gases will continue to heat the air and oceans for hundreds of years after release.[57]
- Critical to align on a timely and meaningful goal very, very quickly – by 2008 or less, if possible.

2.7 Courage

- Courage is required.
- An increasing number of governments and businesses have been demonstrating courage.
- in defending the U.S. space program, President Kennedy said: "(a boy) and his friends would make their way across the countryside, and when they came to an orchard wall that seemed too high and too doubtful to try and too difficult to permit their voyage to continue, they took off their hats and tossed them over the wall -- and then they had no choice but to follow them. This Nation has **tossed its cap over the wall** of space, and we have **no choice but to follow it.** Whatever the difficulties, they will be overcome...and **we shall then explore the wonders on the other side.**" [58]
- Rather than beginning with where US policymakers think they can stop the growth of global warming, the world would be better served by policymakers deciding where they want increased global warming to stop – and then committing the resources to accomplish that.

2.8 Commitment

- Commitment is also required.
- "Until one is committed, there is hesitancy, the chance to draw back, always ineffectiveness. Concerning all acts of initiative (and creation), there is one elementary truth the ignorance of which kills countless ideas and splendid plans: that the moment one definitely commits oneself, the providence moves too. A whole stream of events issues from the decision, raising in one's favor all manner of unforeseen incidents, meetings and material assistance, which no man could have dreamt would have come his way. I learned a deep respect for one of Goethe's couplets: Whatever you can do or dream you can, begin it. Boldness has genius, power and magic in it!" W.H. Murray

2.9 After the Courage, the Commitment and the Goal – A Reliable Plan

- Once a goal has been selected, the next steps begin to reveal themselves.
- A number of tools are available – inventories, projections, costs, incentives.
- The single most effective step worldwide would be the United States quickly stepping up to the plate in a powerful, effective way.[59]
- Americans with 4% of the world's population emit about 25% of the gases - 7.6 billion US tons CO_2.[60] and they risen 13% above 1990 levels by 2003 – an average increase of about 62 million new US tons a year.[61]

2.10 What's Next

- Align on a goal American policymakers <u>want</u> to see accomplished – rather than what they <u>think</u> can be accomplished.
- Have the 'stabilization experts' determine what would need to be reduced by when to meet the goal.
- Have the "solution experts" identify the most cost-effective solutions.
- Then determine what, if any, incentives will be required – and recommend them.

3.0 SOLUTIONS IN THE ELECTRICITY SECTOR

- Just two sectors, electricity and transportation, produce over 80% of the human-caused greenhouse gases.
- Just these two sectors will be discussed here.

3.1 Reducing Waste

- Large subsidies to fossil fuels make them seem less expensive than they really are – reducing incentives to save fuel and demand more efficient technologies.[62]
- Americans consume over <u>five times</u> the global average of energy - about <u>twice</u> as much per person as many other industrialized countries[63] - and the U.S. **wastes** more energy in a year than Japan **uses** in a year.[64]

Americans <u>waste</u> more energy in a year than the entire country of Japan <u>uses</u> in a year

3.2 Shifting Subsidies from Highly Polluting Fuels to Clean Fuels

- At least $14 billion of subsidies a year go to fossil fuels in the United States[65]

- slashing those subsidies is projected to decrease U.S. greenhouse gas emissions to a level of 16% below 1990 emissions.
- U.S. subsidies to highly polluting fuels are at least 10 times greater than to clean fuels
- Transferring subsidies from highly polluting fuels to clean fuels at a reliable rate, say 10% a year for ten years, would make an enormous difference by encouraging clean energy production and reducing greenhouse gas emissions.

3.3 Replacing Coal with Clean Fuels

- Coal is by far the most polluting fossil fuel commonly used in the world today – emitting far more greenhouse gases per unit of energy than any other fuel.[66]
- More than 50% of all U.S. electricity comes from coal.
- The cost to "clean" coal is enormous and is uneconomical.
- Global warming cannot be stopped without either replacing coal or making the collection, transportation and storage of CO_2 economical.
- The oldest and dirtiest coal plants currently produce electricity for about 2¢a kilowatt-hour.
- Newer coal plants produce electricity for about 4¢a kilowatt-hour or more.
- Further, as coal plants are further required to reduce their emissions of toxic chemicals, fine particulates, and greenhouse gases, it's unlikely coal can produce electricity for less than 14¢a kilowatt-hour.
- The cost to capture, transport and store greenhouse gases from coal is far greater than the cost of the coal itself.

CO_2 Emissions from Various Power Sources

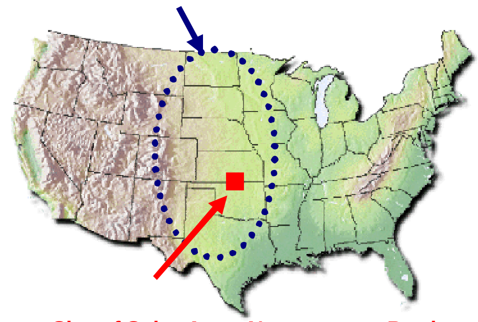
Fuel Only*	CO_2 Emissions (million tons/yr)	Equivalent Number of Cars	Miscellaneous
lignite coal	8.2	1,464,000	
bituminous coal	7.8	1,393,000	
natural gas (NG)	5.0	893,000	
combined cycle NG turbine	3.0	536,000	
hydroelectric	- 0 -	- 0 -	no additional available
wind	- 0 -	- 0 -	
solar	- 0 -	- 0 -	
geothermal	- 0 -	- 0 -	
nuclear	- 0 -	- 0 -	expensive, hazardous waste

This is for a 1000 megawatt power plant . To calculate emissions for a different size plant, multiply by the percentage of the other plant. Example: for a 600 MW plant, multiply the above by 0.6 or 60%
* Generally does not include the emissions created in preparing the fuel, equipment or facilities.

Sources[67]

- Clean wind energy from the Midwest could produce up to **2.5 times** the electricity used in the entire United States – most for under 4¢a kilowatt-hour.[68]
- Europe has safely and reliably integrated up to 25% of its electricity from clean, intermittent sources such as wind and solar.
- An array of **solar panels** 100 miles square, using current technology, could produce all the electricity used in the U.S. for under 5¢ a kilowatt-hour.[69]

Enough Wind Energy to Produce 2.5 Times the Electricity Used in the Entire United States



Size of Solar Array Necessary to Produce All the Electricity Used in Entire United States

- Nuclear fuel itself creates no greenhouse gases.
- However, even with enormous subsidies, there is little or no evidence electricity from nuclear fuels can compete with many of the large untapped clean energy sources based on both cost and timeliness.
- There it also little evidence the public is willing to deal with the dangers of nuclear power plants and the generation, collection, transportation and storage of the long-term hazardous wastes.

Approximate Cost of Producing Electricity

Old coal plants – higher polluting	2.0¢ kilowatt-hour	projected to increase
Wind energy	**2.5¢ kilowatt-hour**	**projected to decrease**
New coal plants	4.0¢ kilowatt-hour	projected to increase
Natural gas	6.0¢ kilowatt-hour	projected to increase
Solar energy	**14.0¢ kilowatt-hour**	**projected to decrease**
New nuclear	unknown	no new plants in 30 years

3.4 Requiring Emitters to Cleanup or Offset Their Emissions

- Emitters of greenhouse gases can be required to either eliminate or "offset" their emissions.[70]
- "Offsetting" means the emitter pays someone else to reduce or eliminate greenhouse gas emissions on their behalf - "emissions trading" markets are underway around the world.
- The current cost of offsetting emissions on the global market is higher than the American market where emitters can permanently and verifiably offset their emissions for about \$2-3 per U.S. ton of CO_2e.
- At \$5 per US ton of CO_2e, the typical American could offset ALL of his or her emissions from his or her house and car for about **\$100 a year**[71]– about \$54 a year for the home and about \$46 a year for the vehicle.
- At \$5 per US ton of CO_2e, the cost of all offset all the greenhouse gases from gasoline is 5¢ a gallon or about 2%of the cost.

\$100 a year: Approximate costs to offset ALL your greenhouse gases

Home with electric heat from a coal power plant plus one car averaging 20.4 mpg, at \$5 per US ton of CO_2

3.5 Requiring Clean Fuels

- By December 2004, 19 states, representing half the U.S population, require utilities to provide a minimum amount of electricity from clean fuels - known as a "renewable portfolio standard" or "RPS".

- A recent RPS mandate in Texas resulted in that state quickly becoming the 2nd largest producer of wind energy resulting in billions of dollars of clean energy development.

3.6 Combining Purchasing

- Large purchasers can get together and combine their purchasing to drive down the cost of producing most clean fuels.
- The federal government itself 2% of all of the nation's electricity.

3.7 Litigation

- Litigation is designed to hold people to account for actions which are deemed to unfairly injure others – and to serve as a deterrent to negligent, reckless and dangerous behavior.
- Burning fossil fuels creates most of the world's air pollution and hundreds of thousands of deaths a year.[72]
- The insurance industry also projects an additional $300 billion a year in property damages resulting from the climate change caused primarily by burning fossil fuels - up 1500% from the $20 billion a year in the 1980's.[73]
- Many states, cities and other organizations have begun lawsuits – most against the U.S. government for the failure to adequately address greenhouse gases. Some states have sued the federal government over the federal government's failure to regulate greenhouse gases and the prohibition against action by the states in promoting cleaner vehicles.[74]

4.0 SOLUTIONS IN THE TRANSPORTATION SECTOR

To reduce greenhouse gases from transportation you must replace fossil fuels - gasoline, diesel and bunker oil - or use less of them.

- One gallon of gasoline weighs about 6 pounds and creates 19.6 lbs of CO_2.[75]
- Currently only about 1% of the energy in a gallon of gasoline actually moves the driver down the road – another 12% of the energy from the gasoline moves the vehicle down the road – and the remaining 87% of the energy in gasoline is wasted – primarily to heat.[76]
- Weight is the key obstacle to fuel economy – and it's been proven SUV's and light trucks can be made lighter and more fuel efficient without a loss of safety.[77]

4.1 Reducing Waste – Making Gasoline Mileage Standards Work

- Congress sets the minimum gasoline mileage for vehicles – known as the "CAFE" standards.[78]
- Congress has made few significant attempts to require increased gasoline mileage for vehicles – and has prevented other jurisdictions in the country from doing so. [79]
- Today's car averages about 20.7 miles per gallon - less than cars before the 1973 oil embargo and less than the Model T.
- Over 70 years ago in 1935, the German Chancellor ordered car manufacturers to create a safe, affordable car that could seat four and get 40 mpg. They created with the largest selling car in the history of the world – the Volkswagen Beetle.

- By removing one sentence from the federal CAFÉ law, the 'preemption clause' which allows the federal government to preempt any other state or local laws, Congress would provide states and other governments to innovate in reducing greenhouse gas emissions.
- Indeed, California, the 7th largest economy in the world, has already filed a lawsuit asking the courts to set aside the federal prohibition against state and local action in supporting cleaner vehicles.[80]

4.2 Shifting Subsidies from Highly Polluting Fuels to Clean Fuels

- See 3.4 above.
- When people understand and pay the real cost of gasoline, they naturally demand and buy cleaner technologies.
- In other major industrialized countries where gasoline prices are 2-3 times higher than in the U.S., the citizens have demanded, and received, more efficient and cleaner vehicles.
- In May 2004, both the chief executives of General Motors and Ford argued for higher gasoline taxes to Congress to encourage the purchase of higher mileage vehicles.[81]

4.3 Hybrid Vehicles

- The National Academy of Sciences[82], the American Physical Society and other experts[83] concluded hybrid vehicle technology is by far the most effective and timely way to reduce greenhouse gases - not hydrogen technology - and should be vigorously pursued.
- Most 'hybrids'" have a gasoline engine and an electric motor but do not need to be plugged into an outlet.[84]
- There are currently three hybrids from Toyota and Honda which average between 47 and 56 mpg - more than twice the national average of 20.7 mpg.[85]
- Each of these hybrids reduces <u>all</u> pollutants associated with cars <u>more than 62%</u> over the average car.[86]
- Hybrids reduce far more emissions than natural gas vehicles.
- Hybrids cost about $23,000 – less than the national average – and the buyer receives a substantial federal tax deduction of between $2000 and $3400.[87]
- Hybrids save about $585 a year, or about $50 a month, in gasoline alone.

Reducing CO_2 from Cars

	CO_2	Reduction
Average U.S. car	9.2 tons a year	--
2005 Toyota Prius Hybrid	3.4 tons a year	59%
2005 Ford Taurus E-85 98% ethanol, 15% gasoline (higher fuel cost)	6.6 tons a year	26%

4.4 Ethanol

- Ethanol is a fuel made from vegetable matter - usually corn.
- It takes 1.5 gallons of ethanol to provide the same energy as 1 gallon of gasoline.

Henry CONSULTING
Because It's A Small World.

- Making ethanol requires large amounts of electricity – most from coal power plants - emitting more CO_2.
- Until very recently, making ethanol created more greenhouse gases than it reduced.
- Since Feb 05, new technologies allow for the production of ethanol from corn which reduces greenhouse gas emissions by 18% to 29%.
- Ethanol from woodier sources such as trees reduces greenhouse gases about 85%
- A blend of 10% ethanol from corn and 90% gasoline (E10) reduces greenhouse gases about 3% per mile.
- A blend of 85% ethanol from corn and 15% gasoline (E85) reduces greenhouse gases about 31% per mile.[88]

4.5 Requiring Emitters to Cleanup or Offset Their Emissions

About <u>$46 a year</u> to offset ALL the greenhouse gases from the typical American passenger <u>car</u> (20.4 mpg)

- Burning one gallon of gasoline creates 19.6 pounds of CO_2.
- The typical American car creates about 9.2 tons of greenhouse gases a year.
- Emitters can be required to either eliminate, reduce or “offset” their emissions.[89]
- “Offsetting” means the emitter pays someone else to reduce or eliminate greenhouse gas.
  emissions on their behalf - “emissions trading” markets are underway around the world.
- The current cost of offsetting emissions on the global market is higher than the American market where emitters can permanently and verifiably offset their emissions for about $2-3 per U.S. ton of CO_2e.
- At $5 per US ton of CO_2e, the typical American could offset <u>ALL</u> of his or her emissions from his or her house and car for about <u>$100 a year</u>[90]– about $54 a year for the home and about $46 a year for the vehicle.
- At $5 per US ton of CO_2e, the cost of all offset all the greenhouse gases from gasoline is 5¢ a gallon or about 2%of the cost.

4.6 Requiring Clean Fuels

- ‘Biofuels’ include ethanol from corn and oil from soy into gasoline or diesel.
- Some bio-fuels do <u>not</u> reduce greenhouse gases because of the use of coal electricity.
- Biofuels can reduce greenhouse gases if made from clean power sources such as wind or solar.
- Hydrogen is not seriously considered in the scientific community as a timely resource – see 5.3.

4.7 Combining Purchasing

See 3.6 above.

4.8 Litigation

See 3.7 above.

5.0 WHAT WILL WORK – BUT IS TOO SMALL OR NOT IN TIME

There is a very short period of time to act on climate change. While each of the following could make some impact, the impact of each is either too small or too far away to make a truly meaningful difference in the short term required.

5.1 The Capture of CO_2 by Trees, Plants and Soil

- Deforestation immediately releases large amounts of CO_2 – primarily from the root structure and soil - and should be stopped as soon as possible because it makes up a sizeable portion of the global emissions.
- While forests, plants and soils do capture carbon from the air, it is very slow, not real large compared to the emissions, and is almost always temporary.
- The vast majority of the carbon stored in trees, plants and soil returns to the air when trees and plants die and the soil is cultivated.
- It also takes about 2-4 million years for the remaining carbon stored by trees and plants to turn back into coal, oil or natural gas, and be returned safely underground.
- It would take approximately 1900 square miles (43 miles x 43 miles) of new tropical forest to offset the CO_2 emissions from one medium sized US coal power plant – and that will only be temporarily.[91]

5.2 Capturing, Transporting & Storing Carbon

- Burning 1 pound of coal emits an average of 2.2 pounds of CO_2.
- Burning 1 gallon of gasoline emits an average of 3.3 times its own weight in CO_2
- Storing the CO_2 from fossil fuels takes more room, requires more energy, and is typically more expensive than the fuel itself.
- The cost of trapping, capturing, transporting and storing the CO_2 from a coal power plant is many times more expensive than the coal itself – often estimated at $100 to $220 for each ton of coal costing about $20.

Cost of coal: $20 a ton

Cost to capture, store and transport CO_2 emitted from one ton of coal: $100 to $220

5.3 Hydrogen

While hydrogen has been promoted as being able to make a significant difference in addressing global warming, there remains no scientific evidence that hydrogen can make any appreciable impact within the next 20-35 years[92] - and by then, it will likely be too late to stabilize concentrations at a high level of 560 ppmv or less.

- Hydrogen is enormously inefficient, expensive, and highly polluting unless made from clean, renewable fuels.
- The technology is over 150 years old – much older than gasoline engine technology – and while more than $15 billion has been spent on fuel cell research, only one fuel cell has proven commercially significant - and that was only after a government subsidy to lower the cost.

5.4 Natural Gas in Vehicles

- Switching to a car that uses natural gas reduces a relatively small amount of CO_2 – often less than 5%.[93]
- A natural gas car often costs about $4000-5000 more than a conventional car and is expensive to retrofit, fueling stations are difficult to find, and most fleet managers have been reluctant to utilize natural gas systems.
- The amount of change projected from natural gas vehicles is insignificant compared to the amount of change required to stabilize atmospheric CO_2 concentrations at any level deemed safe.

Detailed endnotes follow

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[2] **The Northwest Council on Climate Change**
www.nwclimate.org

[3] **Preeminent Authorities**
The information presented here is based primarily upon on the best scientific studies in the world - all of which are referenced by the lead collector of such studies, the Intergovernmental Panel on Climate Change ("IPCC"), an arm of the United Nations. The IPCC regularly brings together thousands of the world's best scientists to review and summarize the leading, peer-reviewed, scientific research. The IPCC is a very inclusive process with every interested party, including well-publicized skeptics, naysayers and the fossil fuel industries actively participating in the review process.

(1) The Intergovernmental Panel on Climate Change (IPCC) was established 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess
(1) scientific, technical and socio-economic information relevant for the understanding of climate change
(2) its potential impacts and
(3) options for adaptation and mitigation.
The IPCC periodically collects, reviews and reports on hundreds of the world's major, peer reviewed, international, scientific articles related to climate change. The IPCC provides the scientific evidence to the international negotiating body, known as the Conference of the Parties (COP) which was established to implement The United Nations Framework Convention on Climate Change (UNFCCC). The First Assessment Report was published 1990. The Second Assessment Report was issued in 1995.

(2) The United Nations Framework Convention on Climate Change (UNFCCC) is the international agreement negotiated in 1992 at the World Environmental Summit in Rio de Janeiro. Over 97% of the countries of the world, including the United States, have signed the UNFCCC. The Kyoto Protocol negotiated in 1997 by the Conference of the Parties at what's known as "COP-3" requires by 2008-2012 that most signatory countries reduce their greenhouse gas emissions by an average of 5% below their 1990 levels. http://unfccc.int

(3) U.S. Climate Action Report (U.S. Department of State, May 2002) - The United States of America's Third National Communication under the United Nations Framework Convention on Climate Change is the United State's most recent report made pursuant to the UNFCCC treaty. Here, the United States is required to regularly report its emissions and intended actions. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsUSClimateActionReport.html

(4) The United States National Assessment on the Potential Consequences of Climate Change and Variability was conducted under the auspices of ten U.S. federal agencies and was published in 2000 agencies in response to the enactment of the United States Global Change Research Act of 1990 signed by President George H.W. Bush. This law requires, among other things, that a comprehensive review of the prospective impacts of climate change on the United States be prepared every four years. http://www.usgcrp.gov/usgcrp/nacc/default.htm

(5) The United States National Academy of Sciences in June 2001, at the request of U.S. President George W. Bush, issued a report **"Climate Change Science: An Analysis of Some Key Questions"** by a committee of the National Research Council, characterizing the global warming trend over the last 100 years, examining what may be in store for the 21st century, and the extent to which warming may be attributable to human activity. The committee was made up of 11 of the nation's top climate scientists, including seven members of the National Academy of Sciences, one of whom is a Nobel Prize winner. http://www4.nationalacademies.org/onpi/webextra.nsf/web/climate?OpenDocument
See also http://www.nap.edu/html/climatechange/port February 25, 2003
http://www4.nationalacademies.org/news.nsf/isbn/0309088658?OpenDocument

(6) The United States Environmental Protection Agency website contains a wealth of valuable materials. http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

[4] **"Solving global warming in time"** is defined here as limiting the increase in average global surface temperature during the industrial period to **3.6°F** - or 2.0°C – and it has already risen 1.4°F. That appears to require a limiting of atmospheric carbon dioxide (CO2) concentrations to **400 parts per million volume (ppmv)** – and we're already at 381 ppmv.

[5] **Projected Dire Impacts**
See endnotes associated with Section 2.5 Proposed Goals

[6] **A Partial List of Key, Informed Organizations and Individuals Acknowledging Climate Change**
Index:

(1) Administration of Current U.S. President George W. Bush
(2) U.S. Government Agencies
(3) U.S. States
(4) U.S. Local Governments
(5) U.S. Federal Laws
(6) Countries in the World
(7) Major Oil Companies
(8) Major International Insurance Companies
(9) Major American Corporations
(10) The Republican National Committee
(11) Republicans for Environmental Protection
(12) The International Scientific Community
(13) U.S. Senators
(14) U.S House of Representatives
(15) Various National Academies of Science

(1) Administration of Current U.S. President George W. Bush
President George W. Bush http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html June 11, 2001

http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BNPYJ/$File/ch1.pdf
http://www.whitehouse.gov/news/releases/2001/06/climatechange.pdf
http://www.whitehouse.gov/news/releases/2001/07/20010713-2.html July 13, 2001

Executive Office of the President of the United States, Office of Science and Technology Policy, Dr. John Marburger, Director http://www.ostp.gov/html/02_7_11.html
President's Council on Environmental Quality
http://www.mms.gov/eppd/compliance/nepa/procedures/climate/considerations.htm
Administrator, Environmental Protection Agency, Christine Todd Whitman, "*The fact is that climate change associated with greenhouse gases has an effect on every aspect of our daily lives. The environmental and economic benefits that stem from controlling greenhouse gases are enormous."*
Secretary, U.S. Department of Energy, Spencer Abraham, December 2002, Climate Change

Conference, Washington DC www.climatescience.gov
Administrator, NASA, Sean O'Keefe, December 2002, Climate Change Conference, Washington DC www.climatescience.gov
Deputy Secretary, U.S. Department of Commerce, Dr. Samuel Bodman, December 2002, Climate Change Conference, Washington www.climatescience.gov

(2) U.S. Government Agencies (14)
"Long-term observations confirm that our climate is now changing at a rapid rate. Over the 20th century, the average annual US temperature has risen by almost 1°F (0.6°C) and precipitation has increased nationally by 5 to 10%, mostly due to increases in heavy downpours. These trends are most apparent over the past few decades. The science indicates that the warming in the 21st century will be significantly larger than in the 20th century. Scenarios examined in this Assessment, which assume no major interventions to reduce continued growth of world greenhouse gas emissions, indicate that temperatures in the US will rise by about 5-9°F (3-5°C) on average in the next 100 years, which is more than the projected global increase. This rise is very likely to be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions." "Climate Change Impacts on the United States, The Potential Consequences of Climate Variability and Change, Overview: Summary. Climate Change and Our Nation, By the National Assessment Synthesis Team, US Global Change Research Program
Published in 2000, sponsored by
- U.S. Department of Agriculture
- U.S. Department of Commerce
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Health and Human
- U.S. Department of Interior
- U.S. Department of State
- U.S. Environmental Protection Agency
- The National Aeronautics and Space Administration
- The National Science Foundation
- The Smithsonian Institution
- www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewsummary.htm

National Aeronautics and Space Administration
- http://gcmd3.gsfc.nasa.gov/Resources/FAQs/glob_warmfaq.html
- http://earthobservatory.nasa.gov/Library/GlobalWarming/
- www.gsfc.nasa.gov/topstory/20020820climate50.htm

U.S. Agency for International Development
- http://www.usaid.gov/environment/climate_change.html

U.S. Department of Agriculture - Global Change Program Office (GCPO)
- www.usda.gov/oce/gcpo/Commerce

U.S. Department of Commerce - National Oceanographic and Atmospheric Administration
"The greenhouse effect is unquestionably real… Human activity has been increasing the concentration of greenhouse gases in the atmosphere. There is no scientific debate on this point… Global surface temperatures have increased.."
- http://www.ncdc.noaa.gov/ol/climate/globalwarming.html
- www.noaa.gov/greenhouse.html
- http://gcmd.nasa.gov/Resources/Learning/data.html

U.S. Department of Defense - Department of Navy
- http://navyseic.dt.navy.mil/climate/climate.htmEnergy

U.S. Department of Energy
- http://www.eren.doe.gov/consumerinfo/refbriefs/tpgcc.html
- http://cdiac.ornl.gov/pns/faq.html
- http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html
- http://www.eia.doe.gov/oiaf/1605/2nd_broc.html

U.S. Department of Health & Human Services
- http://ehp.niehs.nih.gov/topic/global/patz-full.html

U.S. Department of the Interior - U.S. Geological Survey - EROS Data Center International Program
- http://edcintl.cr.usgs.gov/carbonsequestration.html

U.S. Department of State
"Global climate change is the premier environmental challenge and opportunity of the 21st century…Addressing this issue is one of the United States' greatest imperatives, for this and future generations. Recognizing the solid foundation of climate science, the U.S. Government is committed to strong and sensible action to reduce greenhouse gas emissions--including realistic and binding emissions targets."
- http://www.state.gov/www/global/global_issues/climate/index.html
- http://usinfo.state.gov/topical/global/climate/
- http://www.state.gov/www/global/global_issues/climate/index.html
- http://www.state.gov/g/oes/climate/

U.S. Department of Transportation - Center for Climate Change and Environmental Forecasting
- http://climate.volpe.dot.gov/trans.html

U.S. Environmental Protection Agency
- http://www.epa.gov/globalwarming

http://yosemite.epa.gov/oar/globalwarming

U.S. Global Change Research Information Office

http://www.gcrio.org/ipcc/qa/cover.shtml

U.S. Global Change Research Program

www.usgcrp.gov

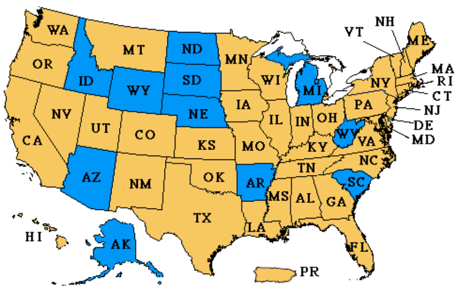
http://www.globalchange.gov/

(3) States Within the United States

States Having Completed Greenhouse Gas Inventories (39)

Tan - states completing greenhouse gas Inventories

http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateGHGInventories.html



States Enacting Laws Related to Climate Change or Greenhouse Gases

Arizona (clean energy development)
California (vehicle emissions, clean energy development)
Connecticut (clean energy development)
Georgia (transportation)
Hawaii (clean energy development)
Illinois (carbon sequestration)
Iowa (clean energy development)
Maine (clean energy development)
Massachusetts (mandatory gas mitigation, clean energy development, CO_2 as air pollutant)
Minnesota (clean energy development, forestry)
Nebraska (carbon sequestration)
Nevada (clean energy development)
New Hampshire (mandatory gas mitigation, CO_2 as air pollutant)
New Jersey (voluntary gas reductions, clean energy development)
New Mexico (clean energy development)
New York (clean energy development)
North Carolina (CO_2 as air pollutant)
North Dakota (carbon sequestration)
Oklahoma (carbon sequestration)
Oregon (mandatory gas mitigation)
Pennsylvania (clean energy development)
Texas (clean energy development)
Washington (climate center)
Wisconsin (clean energy development, gas reporting)
Wyoming (carbon sequestration)
www.pewclimate.org/projects/states_greenhouse.pdf

(4) Local Governments Within the United States (152)

"There is growing global consensus among the world's scientists, national governments, and many business leaders that the rising accumulation of greenhouse gases in the atmosphere is impacting the global climate." Signed by at least 152 local governments within United States.
www3.iclei.org/us/participants.cfm

Alachua County, FL
Albuquerque, NM
Amherst, MA
Ann Arbor & Washtenaw County, MI
Arcata, CA
Arlington County, VA
Arlington, MA
Ashland, OR
Aspen, CO
Hartford, CT
Healdsburg, CA
Hennepin County, MN
Hillsborough County, FL
Honolulu, HI
Huntington, NY
Ithaca, NY
Philadelphia, PA
Portland (Maine), ME
Portland, OR
Prince George's County, MD
Ramsey County, MN
Riviera Beach, FL
Rohnert Park, CA

Atlanta, GA
Augusta, ME
Austin, TX
Barnstable, MA
Berkeley, CA
Boston, MA
Boulder, CO
Brattleboro, VT
Bridgeport, CT
Brookline, MA
Broward County, FL
Buffalo, NY
Burien, WA
Burlington, VT
Cambridge, MA
Carrboro, NC
CCRPA, CT
Chapel Hill, NC
Charleston, SC
Chicago, IL
Chittenden County, VT
Chula Vista, CA
Cloverdale, CA
College Park, MD
Corvallis, OR
Cotati, CA
Dane County, WI
Davis, CA
Decatur, GA
Delta County, MI
Denver, CO
Duluth, MN
Durham, NC
Fairfax, CA
Fairfield, CT
Falmouth, MA
Farmington, ME
Fort Collins, CO
Gainesville, FL
Georgetown, SC
Gloucester, MA
Hamden, CT
Hamilton, NJ
Jefferson County, KY
Keene, NH
King County, WA
Lenox, MA
Little Rock, AR
Los Angeles, CA
Louisville-Jefferson County, KY
Lynn, MA
Madison, WI
Maplewood, NJ
Marin County, CA
Medford, MA
Memphis, TN
Mesa, AZ
Miami Beach, FL
Miami-Dade County, FL
Middlebury, VT
Milwaukee, WI
Minneapolis, MN
Missoula, MT
Montgomery County, MD
Mount Rainer, MD
Mount Vernon, NY
Multnomah County, OR
Nashua, NH
Natick, MA
New Britain, CT
New Haven, CT
New Orleans, LA
New Rochelle, NY
New York, NY
Newark, NJ
Newton, MA
Northampton, MA
Novato, CA
Oakland, CA
Olympia, WA
Orange County (FL), FL
Orange County (NC), NC
Orange County, FL
Overland Park, KS
Pawtucket, RI
Petaluma, CA
Sacramento, CA
Saint Paul, MN
Salem, MA
Salt Lake City, UT
San Anselmo, CA
San Antonio, TX
San Diego, CA
San Francisco, CA
San Jose, CA
Santa Cruz, CA
Santa Fe, NM
Santa Monica, CA
Santa Rosa, CA
Saratoga Springs, NY
Schenectady County, NY
Seattle, WA
Sebastopol, CA
Shutesbury, MA
Somerville, MA
Sonoma County, CA
Sonoma, CA
Spokane Co., WA
Spokane, WA
Springfield, MA
Stamford, CT
Suffolk County, NY
Syracuse, NY
Tacoma, WA
Takoma Park, MD
Tampa, FL
Toledo, OH
Tompkins County, NY
Tucson, AZ
Washtenaw County, MI
Watertown, MA
West Chester, PA
West Hollywood, CA
Westchester County, NY
Weston, CT
Williamstown, MA
Windham, CT
Windsor, CA
Worcester, MA

(5) U.S. Federal Laws (3)

(1) Global Change Research Act of 1990 was enacted by Congress and signed into law by President George H. W. Bush (P.L. 101-606) creating the U.S. Global Change Research Program (USGCRP). The federal USGCRP agencies support research on the interactions of natural and human-induced changes in the global environment and their implications for society. All of the federal agencies supporting relevant research programs participate in the program which was renamed as the Climate Change Science Program (CCSP) under President George W. Bush.

(2) Energy Policy Act of 1992 requires Department of Energy to collect information US

greenhouse gas emissions

(3) The United Nations Framework Convention on Climate Change (UNFCCC**)** was signed by the United States on June 12, 1992 and ratified by the U.S. Senate on October 15, 1992. The Convention went into force on March 21, 1994. The Convention requires quadrennial reports by the signatories, including the United States, on emissions and activities to address them http://unfccc.int/

(6) Countries in the World (186 or 97% of total)
As of September 2002, 186 of the 192 countries in the world, or 97%, are parties to the United Nations Framework Convention on Climate Change (UNFCCC) http://unfccc.int/ ***"** The ultimate objective…is to achieve…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."* **The United Nations Framework Convention on Climate Change 1992** http://unfccc.int/resource/convkp.html

(7) Major Oil Companies (7)

Amoco (see BP - see below)
British Petroleum (BP) http://www.bp.com/centres/press/stanford/index.asp
Chevron Texaco
http://www.chevrontexaco.com/social_responsibility/environment/global_climate.asp
ExxonMobil (UK)
http://www.exxonmobil.co.uk/UK-English/Newsroom/UK_NR_VP_Viewpoint_Environment.asp
Royal Dutch Shell http://www.shell.com/home/Framework?siteId=shellreport2002-en&FC1=&FC2=%2FLeftHandNav%3FLeftNavState%3D7&FC3=%2Fshellreport2002-en%2Fhtml%2Fiwgen%2Fcase_studies%2Fcs_progress_on_climate_change.html&FC4=&FC5
Shell Canada http://www.shell.ca/code/values/climate/climate_asop.html
Sunoco http://www.suncor.com/bins/content_page.asp?cid=4-18-368

(8) Major International Insurance Companies (88 from 26 countries)
"Global warming must be curbed at all cost." Dr. Gerhard Berz, MunichRe (the world's largest reinsurer) - Feb 3, 2001, Reuters
"Climate change could bankrupt the industry." Frank Nutter, President, American Reinsurance Association
More than 88 insurance companies from 26 countries have signed the United Nations Environment Programme 'Insurance Industry Initiative for the Environment': *"We are committed to …address key issues such as…climate change"*

1. Aachener Rückversicherung (mergered with Employers Re), Germany
2. Aachener und Münchener Versicherung, Germany
3. ACE Insurance, Japan ***
4. Achmea Group, The Netherlands
5. AEGIS Insurance Company Ltd., South Africa
6. Alecta, Sweden +
7. Aviva Plc., United Kingdom****
8. AXA Group,France
9. Bangkok Insurance Public Company Limited, Thailand
10. Basler Versicherungs Gesellschaft, Switzerland
11. Bayerische Beamten Versicherung AG, Germany
12. City Insurance Company, Russia
13. Co-operative Insurance Society ltd., United Kingdom
14. Delvag Luftfahrtversicherungs AG, Germany
15. Dominion of Canada General Insurance Company, Canada
16. Elvia Versicherungen, Switzerland
17. Employers Reinsurance Corporation, United States of America
18. Energogarant Ltd., Russia
19. Folksam, Sweden
20. La Fondiaria Assicurazioni S.p.A., Italy

45. National Corporation of Tanzania Ltd., Tanzania
46. Nipponkoa Insurance Co.Ltd., Japan
47. NPI, United Kingdom *
48. Nürnberger Allgemeine Versicherung, Germany *
49. Oeco Capital Lebensversicherung AG, Germany
50. Overseas Union Insurance Limited, Singapore
51. Pool Español de Riesgos Medioambientales, Spain
52. QBE Insurance Group Ltd., Australia
53. Rentenanstalt/ Swiss Life, Switzerland *
54. Rheinland Versicherungen, Germany *
55. Riunione Adriatica di Sicurata, Italy *
56. Rosno Insurance Company, Russia
57. R&V Versicherungsgruppe, Germany
58. Sampo Group, Finland
59. Schweizerische Mobiliar, Switzerland
60. Sibrosso Insurance Co., Russia
61. Skandia Insurance Company Ltd., Sweden
62. SOGAZ Co.Ltd., Russia
63. Sompo Japan Insurance Inc., Japan ++++
64. SOREMA, France

21. Gegenseitigkeit Versicherung Oldenburg, Germany*
22. Generali Assicurazioni Generali S.p.A., Italy*
23. Gerling Konzern, Germany *
24. Grupo Fortuna SA, Argentina
25. Helvetia Patria Versicherungen, Switzerland *
26. HSB Group, Inc., USA*
27. Hyundai Marine and Fire Insurance Co.Ltd., South Korea
28. Imperio S.A., Portugal
29. Independent Insurance Company Ltd., United Kingdom *
30. Industrial Insurance Company, Russia.
31. Insurance Australia Group, Australia
32. Interpolis, The Netherlands
33. Iron Trades Insurance Group, United Kingdom
34. Istituto Nazionale delle Assicurazioni, Italy
35. JI Accident & Fire Insurance Co. Ltd., Japan
36. KPA AB, Sweden *
37. Landesschadenhilfe Versicherung VaG, Germany
38. Legal and General Group Plc., United Kingdom *
39. Lider Insurance Company, Russia
40. Mannheimer Versicherungen, Germany
41. MAPFRE Mutualidad de Seguros y Reaseguros a Prima Fija's, Spain
42. Mitsui Sumitomo Insurance Co.Ltd., Japan +++
43. Muenchener Rueckversicherungs_Gesellschaft (Munich Re), Germany*
44. MUSINI, Sociedad Mutua de Seguros y Reaseguros a Prima Fija, Spain
65. Sovereign Assurance, New Zealand
66. Spasskiye Vorota Insurance Group, Russia
67. Storebrand, Norway *
68. Stuttgarter Allgemeine Versicherung, Germany
69. Stuttgarter Lebensversicherung AG, Germany
70. Sumitomo Marine & Fire Insurance Co.(Europe)Ltd, United Kingdom
71. Sumitomo Marine & Pool Insurance, Indonesia
72. Sumitomo Property & Casualty insurance Co., Hong Kong
73. Swiss Reinsurance Company, Switzerland*
74. Swiss Union General Insurance Company, Switzerland
75. Tapiola Insurance Group, Finland
76. Tokio Marine & Fire Insurance Co. Ltd., Japan *
77. Tower Insurance, New Zealand ++Trygg Hansa, Sweden *
78. Trygg Hansa, Sweden
79. Vaudoise Générale Compagnie d'Assurances, Switzerland
80. Vereinte Versicherung AG, Germany
81. Victoria Versicherungen, Germany*
82. VJV Volksfürsorge Jupiter Allg.Versicherungs_AG, Austria
83. Volksfürsorge Holding AG, Germany
84. WASA Försäkring, Sweden
85. Wiener Städtische Allgemeine, Austria
86. Winterthur Versicherungen, Switzerland *
87. Württembergische Versicherung AG, Germany *
88. Zurich Insurance Company, Switzerland*

http://unepfi.net/iii/statemen.htm www.ictsd.org/html/review5.3.htm

(9) Major Corporations (66)
"There is sufficient evidence of climate change, and the threat of climate change is significant enough to warrant a response" Business Council for Sustainable Energy http://www.bcse.org 39 businesses, trade associations and organizations including American Gas Association, Honeywell, Lockheed Marietta, Los Angeles Water/Power, Maytag, Sacramento Municipal Utility District, Trane
"We believe that one of our most serious challenges at home and abroad will be addressing global climate change.." Business Environmental Leadership Council, Pew Climate Center, www.pewclimate.org/belc/statement.cfm
27 corporations including Alcoa, American Electric Power, Boeing, British Petroleum, CH2MHill, Du Pont, Georgia Pacific, Intel, Ontario Power Generation, PG & E Corporation, Shell Oil, Sunoco, Toyota, United Technologies, Weyerhaeuser, Whirlpool, Wisconsin Electric

(10) The Republican National Committee *"President Bush Is Committed To Combating Global Warming" www.rnc.org/attacks/attacks-environment.htm*

(11) Republicans for Environmental Protection "Global climate change is the pre-eminent environmental issue that America and the rest of the world will face in the 21st century" REPAmerica http://www.repamerica.org/policy/climate.html

(12) The International Scientific Community
"The overwhelming majority of scientific experts, whilst recognizing that scientific uncertainties exist, nonetheless believe that human-induced climate change is inevitable…The question is not whether climate will change in response to human activities, but rather how much, how fast and where"

Intergovernmental Panel on Climate Change (IPCC) http://www.ipcc.ch/about/about.htm

(13) U.S. Senate
October 7, 1992 - U.S. Senate ratifies the international treaty signed by U.S. President George H.W. Bush, the United Nations Framework Convention on Climate Change (138 Cong. Rec. 33521-27) The United States proclaims an objective of stabilizing greenhouse gas concentrations in the atmosphere at levels that would prevent global warming and indicated it would adopt protocols to the Convention in order to achieve that objective. www.ncseonline.org/nle/crsreports/climate/clim-15.cfm

July 25, 1997 - U.S. Senate passes Byrd-Hagel Resolution by a vote of 95-0 (S. RES. 98**,** [Report No. 105-54] a few months prior to the landmark US greenhouse gas conference in Kyoto, Japan. Despite passing the UNFCCC treaty in 1992, U.S. Senate now claims it would not support the Kyoto Protocol without mandatory greenhouse gas reductions by the poorer, less developed countries of the world. www.nationalcenter.org/KyotoSenate.html The Kyoto Protocol was signed by President William J. Clinton, however, the U.S. Senate has never voted to ratify it.

October 30, 2003 – U. S. Senate fails to adopt the Climate Stewardship Act, S. 139, sponsored by Senator John McCain (R-Ariz.) and Senator Joseph Lieberman (D-Conn.) The bill would take the first steps toward limiting heat-trapping gas emissions in the United States. Passage fails by 8 votes, 43 to 55. Votes follow.
U.S. Senators by Home State: Yea –sought greenhouse gas reductions; Nay –opposed greenhouse gas reductions

Alabama:	Sessions (R-AL), **Nay**	Shelby (R-AL), **Nay**
Alaska:	Murkowski (R-AK), **Nay**	Stevens (R-AK), **Nay**
Arizona:	Kyl (R-AZ), **Nay**	McCain (R-AZ), **Yea**
Arkansas:	Lincoln (D-AR), **Nay**	Pryor (D-AR), **Nay**
California:	Boxer (D-CA), **Yea**	Feinstein (D-CA), **Yea**
Colorado:	Allard (R-CO), **Nay**	Campbell (R-CO), **Nay**
Connecticut:	Dodd (D-CT), **Yea**	Lieberman (D-CT), **Yea**
Delaware:	Biden (D-DE), **Yea**	Carper (D-DE), **Yea**
Florida:	Graham (D-FL), **Yea**	Nelson (D-FL), **Yea**
Georgia:	Chambliss (R-GA), **Nay**	Miller (D-GA), **Nay**
Hawaii:	Akaka (D-HI), **Yea**	Inouye (D-HI), **Yea**
Idaho:	Craig (R-ID), **Nay**	Crapo (R-ID), **Nay**
Illinois:	Durbin (D-IL), **Yea**	Fitzgerald (R-IL), **Nay**
Indiana:	Bayh (D-IN), **Yea**	Lugar (R-IN), **Yea**
Iowa:	Grassley (R-IA), **Nay**	Harkin (D-IA), **Yea**
Kansas:	Brownback (R-KS), **Nay**	Roberts (R-KS), **Nay**
Kentucky:	Bunning (R-KY), **Nay**	McConnell (R-KY), **Nay**
Louisiana:	Breaux (D-LA), **Nay**	Landrieu (D-LA), **Nay**
Maine:	Collins (R-ME), **Yea**	Snowe (R-ME), **Yea**
Maryland:	Mikulski (D-MD), **Yea**	Sarbanes (D-MD), **Yea**
Massachusetts:	Kennedy (D-MA), **Yea**	Kerry (D-MA), **Yea**
Michigan:	Levin (D-MI), **Nay**	Stabenow (D-MI), **Yea**
Minnesota:	Coleman (R-MN), **Nay**	Dayton (D-MN), **Yea**
Mississippi:	Cochran (R-MS), **Nay**	Lott (R-MS), **Nay**
Missouri:	Bond (R-MO), **Nay**	Talent (R-MO), **Nay**
Montana:	Baucus (D-MT), **Nay**	Burns (R-MT), **Nay**
Nebraska:	Hagel (R-NE), **Nay**	Nelson (D-NE), **Not Voting**
Nevada:	Ensign (R-NV), **Nay**	Reid (D-NV), **Yea**
New Hampshire:	Gregg (R-NH), **Yea**	Sununu (R-NH), **Nay**
New Jersey:	Corzine (D-NJ), **Yea**	Lautenberg (D-NJ), **Yea**
New Mexico:	Bingaman (D-NM), **Yea**	Domenici (R-NM), **Nay**
New York:	Clinton (D-NY), **Yea**	Schumer (D-NY), **Yea**
North Carolina:	Dole (R-NC), **Nay**	Edwards (D-NC), **Not Voting**
North Dakota:	Conrad (D-ND), **Nay**	Dorgan (D-ND), **Nay**
Ohio:	DeWine (R-OH), **Nay**	Voinovich (R-OH), **Nay**
Oklahoma:	Inhofe (R-OK), **Nay**	Nickles (R-OK), **Nay**
Oregon:	Smith (R-OR), **Nay**	Wyden (D-OR), **Yea**
Pennsylvania:	Santorum (R-PA), **Nay**	Specter (R-PA), **Nay**
Rhode Island:	Chafee (R-RI), **Yea**	Reed (D-RI), **Yea**
South Carolina:	Graham (R-SC), **Nay**	Hollings (D-SC), **Yea**

South Dakota:	Daschle (D-SD), **Yea**	Johnson (D-SD), **Yea**
Tennessee:	Alexander (R-TN), **Nay**	Frist (R-TN), **Nay**
Texas:	Cornyn (R-TX), **Nay**	Hutchison (R-TX), **Nay**
Utah:	Bennett (R-UT), **Nay**	Hatch (R-UT), **Nay**
Vermont:	Jeffords (I-VT), **Yea**	Leahy (D-VT), **Yea**
Virginia:	Allen (R-VA), **Nay**	Warner (R-VA), **Nay**
Washington:	Cantwell (D-WA), **Yea**	Murray (D-WA), **Yea**
West Virginia:	Byrd (D-WV), **Nay**	Rockefeller (D-WV), **Yea**
Wisconsin:	Feingold (D-WI), **Yea**	Kohl (D-WI), **Yea**
Wyoming:	Enzi (R-WY), **Nay**	Thomas (R-WY), **Nay**

http://www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=108&session=1&vote=00420#position

June 21-22, 2005 - U.S. Senate voted on four climate change-related amendments to the Energy Bill (H.R. 6),
(1) The Hagel Amendment (Passed 66 to 29) - Sponsored by Senator Chuck Hagel (R-NE), this amendment provides for incentives for the deployment of technology that reduces greenhouse gas emissions intensity and promotes the adoption of these technologies in developing countries. The amendment does not establish any goals or targets for greenhouse gas emission intensity reductions. For a breakdown of how senators voted see:
www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=109&session=1&vote=00144

(2) The McCain Amendment (Rejected 38 - 60) - Sponsored by Senator John McCain (R-AZ) and Joe Lieberman (D-CT), this amendment proposed an economy-wide cap on carbon emissions that would modestly curb the growth of heat-trapping emissions between 2010 and 2020. It also included a technology innovation package, which includes subsidies for construction for new nuclear power plants, solar, clean coal and biofuels facilities. For a breakdown of how senators voted see:
www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=109&session=1&vote=00148

(3) The Bingaman Amendment (Passed by voice vote) - Sponsored by Senator Jeff Bingaman (D-NM), this amendment expressed that it is the Sense of the Senate that "Congress should enact a comprehensive and effective national program of mandatory, market-based limits and incentives on emissions of greenhouse gases that slow, stop, and reverse the growth of such emissions ... " (see full text below).
This amendment was cosponsored by a bipartisan collection of lawmakers including six Republicans, six Democrats, and one independent. A motion to table this amendment, which would have essentially killed it, failed by a vote of 44 to 53. This vote - for the first time - puts the majority of senators on record as supporting mandatory measures to reduce heat-trapping emissions. For a breakdown of how senators voted on the motion to table (No vote = support for mandatory limits), see:
www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=109&session=1&vote=00149

(4) The Kerry Amendment (Rejected 46 to 49) - Sponsored by Senator John Kerry (D-MA), this amendment expressed that it is the Sense of the Senate that the United States needs "to address global climate change through comprehensive and cost-effective national measures and through the negotiation of fair and binding international commitments under the United Nations Framework Convention on Climate Change." For a breakdown of how senators voted see:
www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=109&session=1&vote=00151

The following U.S. Senators have publicly addressed greenhouses and/or climate change:
Daniel Akaka (D-HI) http://www.senate.gov/~akaka/releases/99/03/1999329453.html
Joe Biden (D-DE) http://foreign.senate.gov/Democratic/press/01/010801.html
Christopher Bond (R-MO) http://hagel.senate.gov/Press/pressapp/releases/record.cfm?id=177856
Barbara Boxed, (D-CA)
http://www.ucar.edu/oga/news_updates/washington_updates/wash_update_7-17-02.htm
Sam Brownback (R-KS) http://brownback.senate.gov/LICarbonFarmText.htm
Robert Byrd (D-WV) http://byrd.senate.gov/byrd_issues/byrd_climate/byrd_climate.html
Tom Carper (D-DE) http://epw.senate.gov/Releases/release_02-04-03-a.htm
Susan Collins, (R-ME) http://www.truthout.org/docs_01/0128.Kerry.Collins.ENV.htm
Jon Corzine, (D-NJ) http://corzine.senate.gov/press_office/record.cfm?id=190298
Larry Craig (R-ID) http://hagel.senate.gov/Press/pressapp/releases/record.cfm?id=177856
"Global warming is a serious issue…It has been my position that the issue of climate change is complicated and real, and that we must pay attention to it," Reuters 11/19/00
Pete Domenici (R-NM) http://hagel.senate.gov/Press/pressapp/releases/record.cfm?id=177856

Chuck Hagel (R-NE) http://hagel.senate.gov/Press/pressapp/releases/record.cfm?id=177856
"Global warming is a serious issue…It has been my position that the issue of climate change is complicated and real, and that we must pay attention to it," Reuters 11/19/00
Jim Jeffords, (I-VT) http://jeffords.senate.gov/~jeffords/press/02/06/06262002pollution_statement.html
John Kerrey (D-MA) http://commerce.senate.gov/hearings/071102Kerry.pdf
Patrick Leahy (D0VT) http://leahy.senate.gov/issues/environment/envprotection.html
Joe Lieberman (D-CT) http://www.senate.gov/~lieberman/press/03/01/2003108655.html
John McCain (R-AZ) http://www.senate.gov/~lieberman/press/03/01/2003108655.html
Ben Nelson (R-NE) http://bennelson.senate.gov/2002/releases/climatechangepassage.htm
Bill Nelson (D-FL) American Inst. of Physics Bulletin of Science Policy Number 62: May 14, 2003
http://www.aip.org/gov
Pat Roberts, (R-KS) http://hagel.senate.gov/Press/pressapp/releases/record.cfm?id=177856
Ted Stevens (R-AK) http://arcticcircle.uconn.edu/NatResources/Globalchange/stevens.htm
Ron Wyden (D-OR)

(14) U.S House of Representatives
Members of U.S. House of Representatives Climate Change Caucus
Co Chairs: John Olver (MA), Wayne Gilchrest (MD)

Abercrombie, Neil (HI)	Hastings, Alcee (FL)	Olver, John (MA)
Allen, Thomas (ME)	Hinchey, Maurice (NY)	Pallone, Frank Jr. (NJ)
Baird, Brian (WA)	Holt, Rush (NJ)	Pascrell, Bill, Jr. (NJ)
Baldwin, Tammy (WI)	Inslee, Jay (WA)	Payne, Donald (NJ)
Blumenauer, Earl (OR)	Israel, Steve (NY)	Pelosi, Nancy (CA)
Boehlert, Sherwood (NY)	Johnson, Eddie Bernice (TX)	Price, David (NC)
Butterfield, G.K. (NC)	Johnson, Nancy (CT)	Rothman, Steve (NJ)
Capuano, Mike (MA)	Kind, Ron (WI)	Sanchez, Loretta (CA)
Carson, Brad (OK)	Kirk, Mark Steven (IL)	Sanders, Bernard (VT)
Castle, Michael (DE)	Lantos, Tom (CA)	Shays, Christopher (CT)
Clay, William Lacy (MO)	Leach, Jim (IA)	Simmons, Robert (CT)
Conyers, John (MI)	Lee, Barbara (CA)	Solis, Hilda (CA)
Davis, Susan (CA)	Lofgren, Zoe (CA)	Tierney, John (MA)
Delahunt, William (MA)	Maloney, Carolyn (NY)	Udall, Mark (CO)
DeLauro, Rosa (CT)	Markey, Ed (MA)	Udall, Tom (NM)
Dicks, Norm (WA)	McCarthy, Karen (MO)	Van Hollen, Chris (MD)
Doggett, Lloyd (TX)	McDermott, Jim (WA)	Visclosky, Peter (IN)
Eshoo, Anna (CA)	McGovern, James (MA)	Waxman, Henry (CA)
Farr, Sam (CA)	Menendez, Robert (NJ)	Weiner, Anthony (NY)
Faleomavaega, Eni (AS)	Miller, George (CA)	Wexler, Robert (FL)
Filner, Bob (CA)	Neal, Richard (MA)	Woolsey, Lynn (CA)
Gilchrest, Wayne (MD)	Oberstar, James (MN)	Wu, David (OR
Gutierrez, Luis (IL)		

www.house.gov/olver/climatechange/

(15) National Academies of Science
June 2005
www.nwf.org/nwfwebadmin/binaryVault/Joint%20Science%20Academies%20Statement,%206-05.pdf

[7] **Warning Published in 1896**
Dr. Svante Arrhenius (1859-1927) "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground" *Philosophical Magazine* 41, 237 (1896)
www.nobel.se/chemistry/laureates/1903/arrhenius-bio.html

[8] **The 'Greenhouse Gases'**
There are dozens of 'greenhouse gases' that together make up less than 4/100ths of 1% of the atmosphere. Nevertheless, they are extremely powerful and influence the atmospheric temperature of the entire planet.

(1) Names There are dozens of greenhouses gases. However, only three make up over 95% of the human caused warming:
(1) Carbon Dioxide (CO2) released through the extraction and burning of fossil fuels (oil, natural gas, and coal) and wood products as well as from sold waste. **(2) Methane (CH4)** released through the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. **(3) Nitrous Oxide (N2O)** is released through agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. The next three major gases are often referred to as the "F gases" because they all contain fluorine gas. These are very powerful greenhouse gases used and created in industrial processes: (4) *hydrofluorocarbons* (HFCs) (5) *perfluorocarbons* (PFCs), and (6) *sulfur hexafluoride* (SF6). For a complete list of gases, see The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, Chapter 4: Atmospheric Chemistry and Greenhouse Gases 4.1.1 Sources of Greenhouse Gases
www.grida.no/climate/ipcc_tar/wg1/130.htm

(2) The Relative Climatic Influence of the Gases
Each greenhouse gas traps different amounts of heat over different lengths of time. To *compare the impacts* of the gases, a ***"global warming potential"*** or ***"GWP"*** has been calculated for each gas. CO2 (CO2) is the most prevalent gas and the excess concentration caused by human activities exerts a warming influence for hundreds of years. Considering its influence out to 100 years, it has been given a GWP value of 1. Per unit mass, the human-induced increment to the methane concentration traps more heat over a hundred-year interval and has been assigned a GWP of 23. This means methane traps about 23 times as much heat as the same amount of CO2 over a period of 100 years. Nitrous oxide (N2O) has a GWP of 296, meaning it traps about 296 times as much heat as the same amount of CO2 over this period. Source: The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, Chapter 4: Atmospheric Chemistry and Greenhouse Gases 4.1.1 Sources of Greenhouse Gases www.grida.no/climate/ipcc_tar/wg1/130.htm

(3) CO2 Equivalents
To *compare the amount* of greenhouse gases, CO2 was again used as the standard since it is the most plentiful. Every other gas then is converted into its **"CO2 equivalent"** or **"CO2e".** To determine the CO2e, multiply the amount of the gas by its GWP. Examples:1 tonne of CO2 (CO2) times a GWP of 1 = 1 tonne CO2e; 1 tonne of methane (CH4) times a GWP of 23 = 23 tonnes CO2e; 1 tonne of nitrous oxide (N2O) times a GWP of 296 = 296 tonnes CO2e.
Most reporting of greenhouse gases is done with the metric system, often in terms such as "million of metric tonnes of carbon" (MMTC) or "million metric tonnes of CO2 equivalents" (MMTCO2e). Also note that due to the added weight of oxygen atoms, CO2 (CO2) weighs 3.66 times more than carbon (C).

[9] **Last Time the Planet Was Really Hot**
One hundred million years ago, the Earth's temperature was 36°-72°F warmer in the polar regions, although only a few degrees warmer around the equator. Evidence suggests that during warm Cretaceous periods, levels of atmospheric CO2 were high. (Barron, et. al., 1985.) Models indicate that CO2 may have been four to six times the pre-industrial levels. (Otto-Bliesner, et. Al., 2001.) U.S. Department of Commerce, National Oceanographic and Atmospheric Administration
http://www.ngdc.noaa.gov/paleo/ctl/cliscibeyond.html

We estimate CO2 concentrations of more than 2,000 ppm from about 60 to 52 million years ago million years ago and an erratic decline between 55 and 40 Million years ago, and atmospheric CO2 concentrations appear to have remained below 500 ppm for the last 24 million years**. Pearson, P.N. and M.R. Palmer, 2003**, Reconstructed 60 Million Year Atmospheric CO2 Concentration Data, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series # 2003-069. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.
www1.ncdc.noaa.gov/pub/data/paleo/climate_forcing/trace_gases/pearson2000_co2.txt
See also Science p695 17 Aug 00, Paul Pearson et al

[10] **Amount of Change 417,000 Years**
Historical Carbon Dioxide Record from the Vostok Ice Core (Antarctica)
Barnola, Raynaud, Lorius, Barkov http://cdiac.esd.ornl.gov/trends/co2/vostok.htm

[11] **Near the End of the Expected Heating Period**
"Recent analyses suggest that the Northern Hemisphere climate of the past 1,000 years was characterized by an irregular but steady cooling, followed by a strong warming during the 20th century…Based on these analyses, the warmth of the late 20th century appears to have been unprecedented during the millennium. The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis 1.2.2 Natural Variability of Climate
http://www.grida.no/climate/ipcc_tar/wg1/042.htm Source:, The Intergovernmental Panel on Climate

Change , Climate Change 2001: Working Group I: The Scientific Basis, Section 1.3.1 Human Influence on the Climate System

[12] **Amount of Change Last 250 Years**
"Before the Industrial Era, circa 1750, atmospheric CO2 (CO_2) concentration was 280 ± 10 ppm for several thousand years. It has risen continuously since then…The present atmospheric CO_2 concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years." The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, Executive Summary www.grida.no/climate/ipcc_tar/wg1/096.htm
See also Section 3.2.3.2 Uptake of anthropogenic CO_2
www.grida.no/climate/ipcc_tar/wg1/105.htm#fig32
Lorius and Oeschger, 1994, Institute on Climate and Planets, Goddard Institute of Space Studies, National Aeronautics and Space Administration, The Greenhouse Effect, Greenhouse Gases, and Global Warming, Harvey Augenbraun, Elaine Matthews, and David Sarma, 3. Past Oscillations in CO2 and Methane Concentrations http://icp.giss.nasa.gov/research/methane/greenhouse.html

[13] **Emissions from Volcanoes**
Volcanoes worldwide are generally estimated to emit between emit between 20 and 50 million tonnes of CO2 a year. That represents less than 1% of the 8 billion tonnes of CO2 added each year by human beings." Emissions due to vulcanism are estimated as 0.02 to 0.05 PgC/yr: (Williams et al., 1992; Bickle, 1994)." One "PgC" is a petagram of carbon and equals one gigatonne "Gt" which equals one billion tonnes. The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, 3.1 Introduction http://www.grida.no/climate/ipcc_tar/wg1/097.htm

[14] **The Natural, Balanced CO2 Cycle**
The atmosphere currently contains about 730 billion metric tonnes of carbon and the oceans contain about 38,000 billion metric tonnes of carbon. The Earth also naturally releases and then re-absorbs about 120 billion metric tonnes of carbon - also known as the natural carbon cycle. The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, Section 3.1, Introduction http://www.grida.no/climate/ipcc_tar/wg1/097.htm See also U.S. Department of Energy www.eia.doe.gov/oiaf/1605/ggccebro/chpater1.html
Conversion: 485 billion US tons of CO2 is equal to 132.2 billion US tons of carbon, 440 billion metric tonnes of CO2 and 120 billion metric tonnes of carbon.

[15] **Current Greenhouse Gas Emissions**
Conversion: 30 billion US tons of CO equals 8.2 billion US tons of carbon, 27.1 billion metric tonnes of CO2 or 7.4 billion metric tonnes of carbon United Nations Environment Programme
www.grida.no/db/maps/collection/climate6/

[16] **Global CO2 Emissions– Natural and Non-Natural**

Global CO2 Emissions

	metric tonnes C (billions)	**metric tonnes CO2e (billions**	**US tons C (billions)**	**US tons CO2e (billions)**	**% of total**
calculation		b x 3.6666	b x 1.102	d x 3.6666	
Global-natural	120	440	132	485	94%
Global-human (Feb 06)	7.4	27.2	8.2	29.9	6%

Sources: Global-natural: The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, Section 3.1, Introduction
www.grida.no/climate/ipcc_tar/wg1/097.htm; Global-human: United Nations Environment Programme www.grida.no/db/maps/collection/climate6/

[17] **Absorbing Half of Non-Naturally Occurring Emissions**
"Atmospheric CO_2 is, however, increasing only at about half the rate of fossil fuel emissions; the rest of the CO_2 emitted either dissolves in sea water and mixes into the deep ocean, or is taken up by terrestrial ecosystems." The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis 3.1 Introduction www.grida.no/climate/ipcc_tar/wg1/097.htm
See also U.S. Department o Energy www.eia.doe.gov/oiaf/1605/gg98rpt/tbl2.html

[18] **New Destabilizing Emissions**
"The rate of increase of atmospheric CO_2 content was 3.3 ± 0.1 PgC/yr during 1980 to 1989 and 3.2 ± 0.1 PgC/yr from 1990 to 1999. "PgC" is a petagram of carbon and equals one gigatonne "Gt" which equals one billion tones. The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, Executive Summary
www.grida.no/climate/ipcc_tar/wg1/096.htm

[19] **Oxygen Loss**

Source: Dr. Mike MacCracken, former director, U.S. Global Change Research Program
www.usgcrp.gov

[20] **CO2 emissions from Coal**
There are four types of coal used to make over half electricity in the United States – about 90% of which is bituminous and subbituminous. Each coal varies in the amount of CO2 and energy it generates. On average, each ton of coal emits about 2.2 tons of CO2. Lignite coal is the lowest, dirtiest and least efficient form of coal. It also requires about twice as much to lignite to produce the same amount of electricity as the other coals.

type of coal	pounds of CO2 per US ton	pounds of CO per pound of coal	pounds of CO2 per million BTUs
anthracite	3852.16	1.926	227.4
bituminous	4931.30	2.466	205.3
subbituminous	3715.90	1.858	212.7
Lignite	2791.60	1.396	215.4

Source: U.S. Department of Energy. Fuel and Energy Source Codes and Emissions Coefficients
www.eia.doe.gov/oiaf/1605/factors.html

[21] **CO2 Emissions from Gasoline**
One gallon of gasoline weighs about 6.3 pounds and is about 85%, or 5.4 pounds, of carbon. During combustion, carbon combines with oxygen to create CO2. Each pound of carbon becomes 3.666 pounds of CO2. The 5.4 pounds of carbon in one gallon of gasoline becomes 19.6 pounds of CO2. (5.4 x 3.6666 = 19.6)

[22] **Sources of Human Caused CO2 Each Year (1990's)**

6.1 billion tons fossil fuels	76%
1.6 billion tons deforestation, land practices	20%
0.2 billion tons cement, etc.	3%
8.0 billion tons total	

"Current anthropogenic emissions of CO_2 are primarily the result of the consumption of energy from fossil fuels…annual global emissions from fossil fuel burning and cement production… reaching a maximum in 1997 of 6.6 PgC/yr (0.2 PgC/yr of this was from cement production)…Estimated emissions rose from 6.1 PgC/yr in 1990 to 6.5 PgC/yr in 1999. The average value of emissions in the 1990s was 6.3 ± 0.4 PgC/yr." The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, 3.4 Anthropogenic Sources of CO_2, 3.4.1 Emissions from Fossil Fuel Burning and Cement Production www.grida.no/climate/ipcc_tar/wg1/109.htm

"About 10 to 30% of the current total anthropogenic emissions of CO_2 are estimated to be caused by land-use conversion…to 1.7 ± 0.8 PgC/yr (Houghton, 2000)…The annual flux of carbon from land-use change for the period from 1990 to 1995 has been estimated to be 1.6 PgC/yr from 1990 to 1995, consisting of a source of 1.7 PgC/yr in the tropics and a small sink in temperate and boreal areas (Houghton, 2000). PgC is a petagram of carbon and equals one gigatonne "Gt" which equals one billion tonnes The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, 3.4 Anthropogenic Sources of CO_2, 3.4.2 Consequences of Land-use Change www.grida.no/climate/ipcc_tar/wg1/109.htm

[23] **U.S. Emissions of Greenhouse Gases By Gas(1994)**
Based on Global Warming Potential ("GWP") and measured in million metric tonnes of carbon equivalent)

1431 MMTCe CO2	86%
178 MMTCe CH4 methane	11%
40 MMTCe N20 nitrous oxide	2%
23 MMTCe HFCs/PFCs	1%

US Department of Energy, Energy Information Administration, Table ES2.
www.eia.doe.gov/oiaf/1605/gg96rpt/exec.htm#tbles2

[24] **Length of Heat-Trapping**
The atmospheric persistence of the human-induced increment has varying has various lengths. Further, while a molecule of CO2 injected into the atmosphere will cycle out in about 4 years, it will be replaced in the atmosphere by another molecule coming out of the upper ocean or biosphere—so the net effect is a long time constant for CO2—so persistence of a major part of the human-induced increment for a few centuries, and of some of it for many millennia.

[25] **Lifetimes of Various Greenhouse Gases**
The Intergovernmental Panel on Climate Change, Climate Change 2001: Working Group I: The Scientific Basis, 4.1.1 Sources of Greenhouse Gases
www.grida.no/climate/ipcc_tar/wg1/130.htm#tab41a

[26] **Amount of Change 420,000 Years**
"Before the Industrial Era, circa 1750, atmospheric CO2 (CO_2) concentration was 280 ± 10 ppm for several thousand years. It has risen continuously since then…The present atmospheric CO_2

concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years." The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, Executive Summary www.grida.no/climate/ipcc_tar/wg1/096.htm

[27] **Change in Last 100 years**
The global average surface temperature has increased over the 20th century by about 1.1°F (0.6°C). Global average sea level rose between 4 and 8 inches (0.1 and 0.2 meters) during the 20th century Intergovernmental Panel on Climate Change – TAR www.grida.no/climate/ipcc_tar/wg1/005.htm

[28] **Average Global Surface Temperature Between 1880 and 2004**
www.ncdc.noaa.gov/oa/climate/research/anomalies/anomalies.html
Mean Global Average Temperature Increase - 1860 to 2002
Source: National Climatic Data Center,
http://lwf.ncdc.noaa.gov/oa/climate/research/anomalies/anomalies.html
1998 Average Global *Surface Temperature*
U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA), National Climatic Data Center Center (NCDC)
http://lwf.ncdc.noaa.gov/oa/climate/research/2003/ann/global.html#Gtemp
Global Temperature Records
LONDON (Reuters) - February 11, 2003 - Global temperatures have kept rising and 2002 was one of the warmest years on record while many greenhouse gases reached their highest ever levels in 2001, a British government report said Tuesday. Data analyzed by the UK Meteorological Office's Hadley Center for Climate Prediction and Research found that last year (2002) joined 2001 and 1998 as the top three warmest since records began in 1860." 1997 is now the fourth warmest on record.
2003 Average Global Surface Temperature
Global temperatures in 2003 were 0.56°C (1.01°F) above the long-term (1880-2003) average**, ranking 2003 the second warmest year on record, which tied 2002. The warmest year on record is 1998 with an anomaly of +0.63°C (+1.13°F). Land temperatures in 2003 were 0.83°C (1.50°F) above average, ranking third in the period of record while ocean temperatures ranked as second warmest with 0.44°C (0.80°F) above the 1880-2003 mean. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC)
http://lwf.ncdc.noaa.gov/oa/climate/research/2003/ann/global.html#Gtemp
2004 Average Global Surface Temperature
U.S. Department of Commerce, National Oceanographic and Atmospheric Administration (NOAA), National Climatic Data Center Center (NCDC)
www.ncdc.noaa.gov/oa/climate/research/2004/ann/ann04.html See also NASA Goddard Institute for Space Studies http://data.giss.nasa.gov/gistemp/2004/
2004 meteorological year was the fourth warmest year in the period of accurate instrumental data (since the late 1800s) -0.48°C above the climatological mean (1951-1980 average)

[29] **The United Nations Framework Convention on Climate Change (UNFCCC)**
As of September 2002, 186 of the 192 countries in the world, or 97% of the total, are parties to the United Nations Framework Convention on Climate Change (UNFCCC) http://unfccc.int/ *"Article 2…The ultimate objective…is to achieve…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."* The text of the UNFCCC was adopted on May 9, 1992. By June 19, 1993, the Convention had 166 signatures. The United States signed the Convention on June 12, 1992 and ratified it po04[on October 15, 1992. The Convention entered into force on March 21,1994. http://unfccc.int/resource/convkp.html

[30] **Current Greenhouse Gas Emissions**
Conversions: 29.9 billion US tons of CO2 equals 27.1 billion metric tones and 18.7 US tons equals 17 metric tonnes. United Nations Environment Programme www.grida.no/db/maps/collection/climate6/

[31] **Fossil Fuel Contribution**
Fossil fuels added approximately 290 billion tons of new carbon, or 1063 billion tons of CO2, into the atmosphere since near the year 1750 – half of which has occurred since the mid 1970s. S*ource:* Marland, G., T.A. Boden, and R. J. Andres. 2005. Global, Regional, and National CO_2 Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. http://cdiac.esd.ornl.gov/trends/emis/tre_glob.htm The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, Executive Summary www.grida.no/climate/ipcc_tar/wg1/096.htm

[32] **Projected Increase in CO2e Emissions from Fossil Fuels**
…. world emissions from the consumption of fossil fuels are expected to grow at an average rate of 2.0 percent per year from 2002 to 2025. Emissions in 2025 are projected to total 38,790 million metric tons, exceeding 1990 levels by 81 percent. U.S. Department of Energy, Energy Information Agency (EIA), International Energy Outlook 2005 (IEO2005)) www.eia.doe.gov/oiaf/ieo/emissions.html

[33] **Rate of Growth in Human Emissions Globally**

	metric tonnes C (billions)	metric tonnes CO2e (billions)	US tons C (billions)	US tons CO2e (billions)
calculation	b	b x 3.6666	b x 1.102	d x 3.6666
Global-human-Feb 06 (billions)	7.4	27.2	8.2	29.9
annual percentage increase	2.48%	2.48%	2.48%	2.48%
each year (millions)	184	674	203	743
each day (millions)	0.50	1.84	0.55	2.03
sach hour (thousands)	21	77	23	85
each minute	349	1281	385	1411
each second	5.8	21.3	6.4	23.5

By February 2006, total global CO_2 emissions from human activity was 29.9 billion US tons year (7.4 billion metric tonnes of C). United Nations Environment Programme www.grida.no/db/maps/collection/climate6/ The U.S. government projects global carbon dioxide emissions to rise from 26.8 billion US tons (24.4 billion metric tons) in 2002 to 36.6 billion US tons (33.2 billion metric tons) in 2015. That's an average annual increase of 2.48% a year compounded annually. U.S. Department of Energy, Energy Information Agency (EIA), International Energy Outlook 2005 (IEO2005) www.eia.doe.gov/oiaf/ieo/emissions.html, the growth rate of emissions

Global rate of Growth

US tons CO_2e	metric tonnes C	
743 million	184 million	a year
2 million	.50 million	a day
85,000	21,000	an hour
1,411	349	a minute
24	5.8	a second

[34] **Rate of Growth of Atmospheric CO2 Concentrations**
The atmospheric level of CO2 in the year 1750 was near 279 ppmv. The atmospheric level of CO2 in the year 1983 was near 328 ppmv. That increase of of 49 ppmv over 233 years averaged.22 ppmv/yr. The atmospheric level of CO2 in the year 2004 was near 377. That increase of 49 ppmv over 21 years averaged 2.33 ppmv/yr. Source: Historical CO_2 record from the Siple Station ice core- A. Neftel, H. Friedli, E. Moor, H. Lötscher, H. Oeschger, U. Siegenthaler, and B. Stauffer http://cdiac.esd.ornl.gov/ftp/trends/co2/siple2.013 and Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii - C.D. Keeling et al http://cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2

[35] The Intergovernmental Panel on Climate Change , Climate Change 2001: Working Group I: The Scientific Basis, Executive Summary www.grida.no/climate/ipcc_tar/wg1/096.htm

[36] **Carbon Dioxide Emissions per Person**

Global vs. US Emissions	metric tonnes C (billions)	metric tonnes CO2e (billions)	US tons C (billions)	US tons CO2e (billions)	population (billions)
	b	b x 3.6666	b x 1.102	d x 3.6666	
World - total (Feb 06)	7.4	27.2	8.2	29.9	6.3
United States - total (2003)	1.9	6.9	2.1	7.6	0.29
World - per capita (tons/tonnes)	1.2	4.3	1.3	4.8	
United States - per capita (tons/tonnes)	6.5	23.8	7.2	26.2	

Global Emissions
By February 2006, total global CO_2 emissions from human activity was 29.9 billion US tons year (7.4 billion metric tonnes of C). United Nations Environment Programme www.grida.no/db/maps/collection/climate6/
US Emissions
In 2003, total US greenhouse gas emissions was 6,900.2 TgCO2e (6.9 billion metric tonnes or 7.6 billion US tons), up 13% from 1990, up 0.6% from 2002 (42.2 TgCO2e – or 42.2 million metric tonnes)

US Emissions Inventory 2005, Inventory Of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003, Final Version, (April 2005), EPA 430-R-05-003
http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR69V528/$File/05executivesummary.pdf

Population
On February 4, 2002, the global population was 6.3 billion people. United States Census Bureau, http://blue.census.gov/cgi-bin/ipc/popclockw

[37] **The Projections**
See endnotes from Section 2.5 Proposed Goals to Date

[38] **Projected Global CO2e Emissions**
World carbon dioxide emissions are projected to rise from 26.8 billion US tons (24.4 billion metric tons) in 2002 to 36.6 billion US tons (33.2 billion metric tons) in 2015. On average, this is an increase of 2.48% per uear compounded annually. U.S. Department of Energy, Energy Information Agency (EIA), International Energy Outlook 2005 (IEO2005)) www.eia.doe.gov/oiaf/ieo/emissions.html

[39] **Projected ppmv**
Atmospheric concentrations of CO2 increases an average of 2.33 ppmv from 1983-2004. That's .62% of 377 ppmv in 2004.

The Kyoto Protocol
Known as the Third Conference of the Parties, or "COP-3", of the UNFCCC process, was enacted in December 1997. On average. the developed countries, as the primary sources of current destabilizing emissions, agreed to reduce their emissions by about 5% below 1990 levels by 2008-2012. The Protocol became effective in 2005 when 55 industrialized countries, representing 55% of the world's greenhouse gas emissions in 1990, approved the agreement. This included, but is not limited to including, Canada, China, the entire European Community, India, Japan, Malaysia, Mexico, New Zealand, Norway, Poland, South Africa, Sweden, Russia and the United Kingdom. While the United States did sign the Kyoto Protocol on December 12, 1998, it has not been submitted to the United States Senate for ratification. President George W. Bush later withdrew the United States from participating in the negotiations. http://unfccc.int/resource/kpstats.pdf

[40] **Projected Global Change**
Sea Level Rise
"Warmer temperatures are expected to raise sea level by expanding ocean water, melting mountain glaciers, and melting parts of the Greenland Ice Sheet. Warmer temperatures also increase precipitation… Snowfall over Greenland and Antarctica is expected to increase by about 5 percent for every 1°F warming in temperatures. Increased snowfall tends to cause sea level to drop if the snow does not melt during the following summer, because the only other place 323for the water to be is the ocean. (The amount of water in the atmosphere is less than the water it takes to raise the oceans one millimeter). Considering all of these factors, the IPCC estimates that sea level will rise 9 to 88 cm by the year 2100. A recent EPA study estimated that global sea level has a 50 percent chance of rising 45 cm (1-1/2 ft) by the year 2100, but a 1-in-100 chance of a rise of about 110 cm (over 3-1/2 ft).
http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateFutureClimateSeaLevel.html

Global Temperature - Last 150 Years
The Intergovernmental Panel on Climate Change "Climate Change 2001: The Scientific Basis" Summary for Policymakers http://www.grida.no/climate/ipcc_tar/wg1/005.htm#figspm1

Mean Global Average Temperature Increase - 1860 to 2002
Source: National Climatic Data Center,
http://lwf.ncdc.noaa.gov/oa/climate/research/anomalies/anomalies.html

Global Sea Level Rise - Last 150 Years
The Intergovernmental Panel on Climate Change "Climate Change 2001: The Scientific Basis" Summary for Policymakers http://www.grida.no/climate/ipcc_tar/wg1/005.htm#figspm1

Global - Projected Emissions Next 100 Years
This projected concentration of greenhouse gases used the middle scenario of the seven scenarios, A1B, at about 690 ppmv by 2100. This is lower than the average of the high scenario, A1FI at near 950 ppmv, and the low scenario, B1 at near 525 ppmv, which would be 740 ppmv by 2100. Projections beyond 2100 are an extension of the rate applied above.

Global - Projected Temperatures Next 100 Years
The Intergovernmental Panel on Climate Change "Climate Change 2001: The Scientific Basis" Technical Summary, F.3 Projections of Future Changes in Temperature
http://www.grida.no/climate/ipcc_tar/wg1/031.htm

Global - Projected Precipitation Next 100 Years

The Intergovernmental Panel on Climate Change "Climate Change 2001: The Scientific Basis" Technical Summary, F.4 Projections of Future Changes in Precipitation http://www.grida.no/climate/ipcc_tar/wg1/032.htm

Global - Projected Sea Level Rise Next 100 Years
The Intergovernmental Panel on Climate Change "Climate Change 2001: The Scientific Basis" Technical Summary, F.9 Projections of Future Changes in Sea Level http://www.grida.no/climate/ipcc_tar/wg1/034.htm See also United States Environmental Protection Agency http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateFutureClimateSeaLevel.html

[41] **Projected U.S. Changes**
National Assessment Synthesis Team, "Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change" US Global Change Research Program - Published in 2000 - Overview, Summary, page 6

[42] **Alaska**
National Assessment Synthesis Team, "Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change" US Global Change Research Program - Published in 2000 - Overview, Summary, page 13, also see Overview www.usgcrp.gov/usgcrp/nacc/education/alaska/ak-edu-2.htm#Historical%20Climate%20Trends

[43] **Arctic Climate Impact Assessment**
In November 2004, The Arctic Council, consisting of eight Arctic countries, six Indigenous Peoples organizations, and the International Arctic Science Committee (IASC) representing 18 national academies of science released its report *Impacts of a Warming Arctic*. http://www.acia.uaf.edu/ The report indicates that during past few decades, temperatures in the Arctic have risen at nearly twice the rate as in the rest of the world, much larger changes projected and the implications are worldwide. http://www.ucsusa.org/global_environment/global_warming/page.cfm?pageID=1545

Observed changes in the Arctic over the last century
Temperature**:** up 3.6 to 5.4°F in Alaska and Siberia, down 1.8°F over southern Greenland, over past 50 years. Sea ice: decreased 15 to 20% in late summer over past 30 years. Glaciers: shrinking. Vegetation**:** sharp declines in white spruce, the most valuable timber species. Marine Animals: ice-free years of 1967, 1981, 2000, 2001, 2002 resulted in no surviving seal pups in Canada's Gulf of St. Lawrence. Fisheries**:** Warming in the Bering Sea after 1977 has increased the herring, Pacific cod, skates, and flatfish species, and Pacific salmon commercial catches have been high since 1980. Indigenous Culture**:** Peary caribou populations on Canadian arctic islands plummeted from 26,000 in 1961 to 1000 by 1997, affecting people whose culture is intertwined with caribou.

Projected changes in the Arctic over the next century
Temperature**:** projected to increase 3.6°F by 2050 and 8°F by 2100 north of 60° latitude. 1Sea ice: decrease by at least 50% by 2100. Glaciers: long-term melting of the Greenland ice sheet. Vegetation: Forests expand northward - beneficial effect overwhelmed by the release of large stores of methane and carbon dioxide as tundra regions thaw. Marine Animals**:** Ringed seals are entirely dependent on sea-ice for their survival and will be the most vulnerable to reduced sea-ice projections. Polar bears are also dependent on sea ice and their preferred diet is almost exclusively Ringed seal. If there is almost complete loss of summer sea-ice polar bears may not survive as a species. Fisheries**:** Warming may improve fish stocks of cod and herring but threaten cold water stocks such as northern shrimp. Indigenous Culture**:** Caribou and reindeer depend on tundra vegetation, and will be affected as projected vegetation zones shift northward and the tundra area diminishes significantly. The shifts in terrestrial and in particular marine species dependent on sea ice threaten traditional food sources for indigenous people. Navigation: The Northern Sea Route navigation season is likely to increase from the current 20 to 30 days per year to almost 100 days per year by 2080.

The ACIA report projects that combined land-based Arctic ice melt will contribute a little over an inch of sea level rise over the next 60 years and nearly 3 inches by 2100.

The IPCC 2001 report, based on the full range of emissions scenarios, projected an overall global sea-level rise of between 4 inches and 3 feet by the end of this century. The bulk of this sea-level rise is based on the thermal expansion of the ocean from warming. In light of the new data presented in the ACIA report, scientists will be able to better project the Arctic contribution to expected global sea-level rise. Although a couple of inches may not sound like a significant increase in sea level, consider that low-lying coastal areas, such as parts of Louisiana or Bangladesh, are very vulnerable to every inch of sea-level rise.

[44] **Stabilization of Greenhouse Gas Concentrations**
Article 2 of the UN Framework Convention on Climate Change (UNFCCC) states that: "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The Framework Convention on Climate Change further suggests that "Such a level should be achieved within a time frame sufficient • to allow ecosystems to adapt naturally to climate change, • to ensure that food production is not threatened and •to enable economic development to proceed in a sustainable manner."

[45] **Various CO2 Reduction Goals**
Swedish CO2 Reduction Goal - emission reductions of 30% by 2020 and between 60-80% by 2050
www.euractiv.com/Article?tcmuri=tcm:29-148891-16&type=News
The Bayer Group Goal - reduce its greenhouse gas emissions by 53% below 1990 levels by 2010, an ambitious target beyond the potential demands of Kyoto. By following a number of large initiatives planned and followed at the highest levels of the corporation, by 2004 Bayer was able to reduce greenhouse gas emissions by 60%, even as overall production increased 16%.
www.theclimategroup.org/index.php?pid=592
State of Oregon Goal - reduce emissions 75% below 1990 levels by 2050
http://egov.oregon.gov/ENERGY/GBLWRM/docs/GWReport-FInal.pdf
State of California Goal - reduce emissions 80% below 1990 levels by 2050
http://www.caprep.com/0605010.htm

[46] **Projected Global CO2e Emissions**
World carbon dioxide emissions are projected to rise from 26.8 billion US tons, or 24.4 billion metric tons, in 2002 to 36.6 billion US tons, or 33.2 billion metric tons, in 2015 and 42.8 billion US tons, or 38.8 billion metric tons, in 2025…. world carbon dioxide emissions from the consumption of fossil fuels are expected to grow at an average rate of 2.0 percent per year from 2002 to 2025. Emissions in 2025 are projected to total 38,790 million metric tons, exceeding 1990 levels by 81 percent. Combustion of petroleum products contributes 5,454 million metric tons to the projected increase from 2002, coal 5,353 million metric tons, and natural gas 3,540 million metric tons . Although coal use is projected to grow at a slower rate than natural gas use over the projection period, coal is a more carbon-intensive fuel than natural gas. As a result, the increment in carbon dioxide emissions from coal combustion is larger than the increment in emissions from natural gas. U.S. Department of Energy, Energy Information Agency (EIA), International Energy Outlook 2005 (IEO2005)) www.eia.doe.gov/oiaf/ieo/emissions.html

[47] **Rate of Growth of Atmospheric CO2 Concentrations**
The atmospheric level of CO2 in the year 1750 was near 279 ppmv. The atmospheric level of CO2 in the year 1983 was near 328 ppmv. That increase of of 49 ppmv over 233 years averaged.22 ppmv/yr. The atmospheric level of CO2 in the year 2004 was near 377. That increase of 49 ppmv over 21 years averaged 2.33 ppmv/yr. Source: Historical CO_2 record from the Siple Station ice core- A. Neftel, H. Friedli, E. Moor, H. Lötscher, H. Oeschger, U. Siegenthaler, and B. Stauffer
http://cdiac.esd.ornl.gov/ftp/trends/co2/siple2.013 and Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii - C.D. Keeling et al
http://cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2

[48] **Rate of Growth of Atmospheric CO2 Concentrations**
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http://cdiac.esd.ornl.gov/ftp/trends/co2/siple2.013 and Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory, Hawaii - C.D. Keeling et al
http://cdiac.esd.ornl.gov/ftp/trends/co2/maunaloa.co2

[49] **Projected Dates Various CO2 Concentrations Will Be Met**

rate of growth	0.5%/yr	0.62%/yr	0.75%/yr	1.00%/yr
ppmv				
560, "2x"	2083	2068	2057	2044
840, "3x"	2165	2134	2111	2085
1120 "4x"	2222	2180	2150	2114

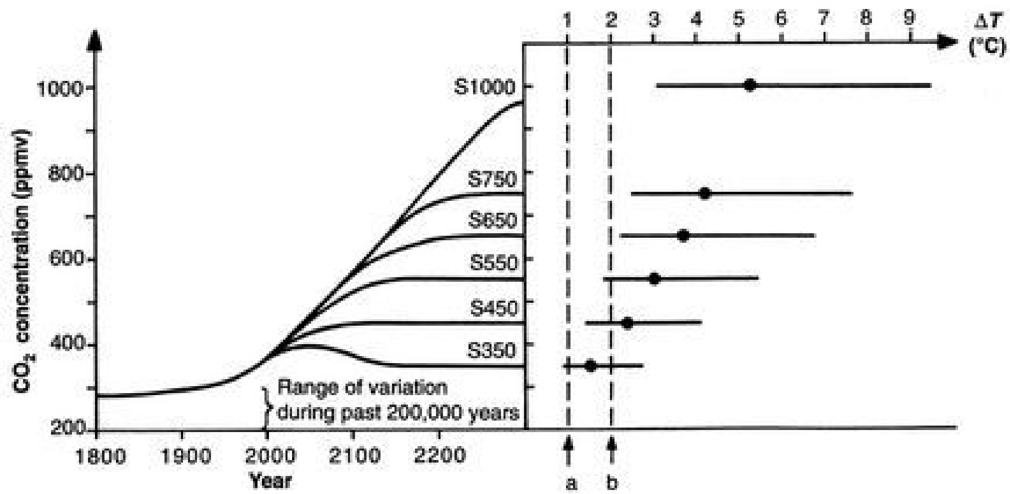
Beginning with 377 ppmv in 2004, compounded annually.

[50] **Melting of Greenland Ice Sheets**
Cooperative Institute for Research in Environmental Sciences(CIRES), National Snow and Ice Data Center (NSIDC), University of Colorado http://nsidc.org/news/press/20021207_seaice.html
"Can we Defuse the Global Warming Time Bomb? Hansen, Scientific American (2004)
http://www.sciam.com/media/pdf/hansen.pdf
http://www.wws.princeton.edu/step/people/Oppenheimer%20and%20Alley%20II%20published.pdf
http://www.earthinstitute.columbia.edu/news/2004/storyhansen1.html

[51] **Slowing of Ocean Currents**
See Climate Change – Dangerous Climate Impacts and the Kyoto Protocol, Science 296(5575): 1971-72, O'Neill and Oppenheimer (2002)
See Keller et al (2004) http://www.geosc.psu.edu/~kkeller/Keller_et_al_JEEM_2004.pdf
See New York Times, June 8, 2004 http://www.nytimes.com/2004/06/08/science/earth/08gree.html?th

[52] **Proposed Goals to Date**

The following chart provides an estimate of the increase in global surface level temperature (top right) at various atmospheric concentrations of CO2 (far left). Projections here are based on the following unless noted differently below. Source: Schneider, Climate Policy, Post-Normal Science http://stephenschneider.stanford.edu/Climate/Climate_Policy/CliPolFrameset.html



Goal 1 : Stabilize Atmospheric CO2 at 350 ppmv, Max. Temperature Increase of 2.7°F (1.5°C)
Analysis suggests that a value nearer to 350 ppmv should be adopted, until it can be proven that a higher value is safe. Targets for Stabilization of Atmospheric CO2$_2$, **Christian Azar, * Henning Rodhe** www.sciencemag.org/cgi/content/short/276/5320/1818 (1997) The global temperature increase for an atmospheric CO_2 concentration of 550ppm will only stay below 2°C if the climate sensitivity is on the very low end of the IPCC's estimates…It appears that in order to have a very high probability of keeping the global temperature changes within the range of natural fluctuations that have occurred during the past few millennia (roughly 1°C), the climate sensitivity has to be low or the atmospheric CO_2 concentration has to be stabilized at around 350ppm (i.e., below current levels)…the projections shown in the *IPCC stabilization scenarios* suggest that the global climate policy community should not dismiss policies that lead to eventual stabilization in the range of 350-400 ppm. Dr. Stephen Schneider, Climate Policy, Post-Normal Science
http://stephenschneider.stanford.edu/Climate/Climate_Policy/CliPolFrameset.html

Goal 2: **Maximum 400 ppmv, Maximum Temperature Increase of 3.6°F (2.0°C)**

International Climate Change Taskforce (2005) citing Baer (2004) Meeting the Climate Challenge: Recommendations of the International Climate Change Taskforce International Climate Change Taskforce. Meeting the Climate Challenge: Recommendations of the International Climate Change Taskforce. Institute for Public Policy Research, Center for American Progress, and Australia Institute, January 2005. Belfer Center for Science and International Affairs Science, Technology, and Public Policy Program www.americanprogress.org/climate

Goal 3: Maximum 450 ppmv, Maximum Temperature Increase 4.5°F or 2.5°C
from chart above

Goal 4: Maximum 500 ppmv, Maximum Temperature Increase 5.0°F or 2.8°C
from chart above
A Plan for Stabilizing Atmospheric CO2 Concentrations at 500 ppmv Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, Science, August 13, 2004, Drs. Stephen Pacala and Robert Socolow, Princeton University, Carbon Mitigation Initiative www.princeton.edu/pr/news/04/q3/0812-carbon.htm Aug. 12, 2004 Media contact: Steven Schultz, (609) 258-5729, sschultz@princeton.edu; Roberta Hotinski, (609) 258-7523, hotinski@princeton.edu Editors: Photos, graphics and a background document are available at: http://www.princeton.edu/pr/news/04/q3/0812-carbon/

Goal 5: Maximum 560 ppmv (twice preindustrial level) , Max. Temp. Increase 7.6°F or 4.2°C
The Intergovernmental Panel on Climate Change (IPCC) in its Third Assessmetn Report (TAR) in 2001 projected that a doubling of the preindustrial level of 280 ppmv of atmospheric CO2 to near 560 ppmv would produce an increase in average global surface temperature from the year 1860 of between 1.4°C and 5.8°C. The midrange is 3.6°C. This, plus an increase of 0.6°C from 1860, results in a total increase of 4.2°C or 7.6°F since the preindustrial period near 1750.

The Projections
Projections are provided primarily in three areas: projected CO_2 concentrations, projected temperatures and projected impacts.

Change in Global Average Surface Temperature
(1) Business-as-usual projections based on projected growth of 0.75% per year
When we'll hit various levels of CO_2 AND estimated temps and impacts

PPMV	Year	#YearsFrom2006	Temp above Preindustrial		Impacts
280	1750	--	1.1°F	0.6°C	
54	1990	--			
377	2004-today		1.4	0.7	
400	2012	6			reefs - 1.0
450	2028	22			ice sheets2.0
500	2042	36			oceans 3.0
560	2057-2x	51	7.6	3.6	
840	2111-3x	105	9.5	5.3	
1120	2150-4x	144	12.6	7.0	

(2) Summary Chart

Year	Atmospheric Concentration CO2 (ppmv)	Projected Increase Temp (°F)	Projected Increase Temp (°C)	Sources	Projected Number of Years to Attain at 0.75% a year	Projected Impacts
	1200 ppmv	9.9	5.5 above preindustrial	Rahmstorf, Ganopolski (1999)		
2150	1120 ppmv (4x preindustrial level of 280 ppmv))	12.6	7.0 above preindustrial	Manabe, Stouffer(1993)	146	
2111	840 ppmv (3x preindustrial level)	9.5	5.3	(mid-estimate between 2x and 4x)	107	
2057	560 ppmv (2x preindustrial level)	7.6	4.2 above preindustrial (3.6 midrange of 1.4-5.8 + 0.6)	IPCC-TAR	53	
		7.7	4.3°C above preindustrial	Rahmstorf, Ganopolski (1999)		
			3.7 above preindustrial (3.0 + 0.7)	O'Neill, Oppenheimer (2002)		Maximum to avoid shutdown of ocean "conveyer belt"
		6.3	3.5 above preindustrial	Manabe, Stouffer(1993)		
	450		2.7 above preindustrial (2.0 + 0.7)	O'Neill, Oppenheimer (2002)		Maximum to avoid disintegration of West Antarctic ice sheet – sea level rise of 13 to 16 feet (4-6 meters)
		4.7	2.6 above preindustrial (2.0 + 0.6)	Hadley Center (1999)		
		4.7	2.6 above preindustrial (2.0 + 0.6)	NCAR(1999)		
2042	500				38	
2028	450				24	

			1.7 above preindustrial (1.0 + 0.7)	O'Neill, Oppenheimer (2002)		Maximum to avoid severe dmage to coreal reefs
2012	400				8	
2004	377	1.4	0.7 above` preindustrial	Hadley (2004)		
1990 (actual)	354	1.1	0.6 above preindustrial	Rahmstorf, Ganopolski (1999), Keelign et al		
1860 (actual)	280	Base level	Base level	IPCC-TAR		
1750 (est)	280	Preindustrial	Preindustrial	IPCC-TAR		

Azar, Rodhe (1997) Targets for Stabilization of Atmospheric $CO2_2$
Analysis suggests that a value nearer to 350 ppmv should be adopted, until it can be proven that a higher value is safe. www.sciencemag.org/cgi/content/short/276/5320/1818 (1997)

German Advisory Council on Global Change (1995)
see WBGU below

GFDL - Geophysical Fluid Dynamics Laboratory, Princeton University Forrestal Campus
Climate Impact of Quadrupling Atmospheric CO_2 GFDL (May 04)
http://www.gfdl.noaa.gov/%7Etk/climate_dynamics/climate_impact_webpage.html

Hadley Centre (1999)
"Climate Change and Its Impacts: Stabilisation of CO2 in the Atmosphere," The Hadley Centre for Climate Prediction and Research, The Meteorological Office (UK), October 1999.
http://www.metoffice.com/research/hadleycentre/models/modeldata.html

- A rise of 2 °C above the present day (1990 level) is expected by the 2050s with unmitigated emissions
- A rise of 3 °C above the present day (1990 level) is expected by the 2080's with unmitigated emissions

http://www.metoffice.com/research/hadleycentre/pubs/brochures/B1999/intro_key_findings.html

Hasselmann (2003)
K. Hasselmann, et al., "The Challenge of Long-Term Climate Change," Science 302 (12 Dec. 2003): 1923-1925.
This scenario results in a peak CO2 concentration of quadruple the pre-industrial level in about 2200 and a peak temperature increase of about 4º C in early 23rd century,
IPCC(2001)

IPCC-TAR(2001)
Intergovernmental Panel on Climate Change, Third Assessment Report (TAR) Climate Change 2001: Synthesis Report, Summary for Policymakers
http://www.grida.no/climate/ipcc_tar/vol4/english/009.htm
Intergovernmental Panel on Climate Change (Third Assessment Report – TAR), Climate Change 2001: Working Group I, Summary for Policymakers www.grida.no/climate/ipcc_tar/vol4/english/012.htm
Projections using the SRES emissions scenarios in a range of climate models result in an increase in globally averaged surface temperature of 1.4 to 5.8°C [midpoint of 3.6°C]over the period 1990 to 2100**.**

ICCT (2005)
International Climate Change Taskforce", Meeting the Climate Challenge – Recommendations of the International Climate Change Taskforce", January 2005 Institute for Public Policy Research, Center for American Progress, and Australia Institute, January 2005. Belfer Center for Science and International Affairs Science, Technology, and Public Policy Program
Max 2.0°C or 3.6F° above pre-industrial levels or about 400 ppmv
G8 countries 25% all electricity from renewables by 2025
http://www.tai.org.au/Publications_Files/Papers&Sub_Files/Meeting%20the%20Climate%20Challenge%20FV.pdf

Manabe, Stouffer (1993)
S. Manabe and R.J. Stouffer, "Century-scale effects of increased atmospheric CO2 on the ocean-atmosphere system," Nature, 364 (6434), p. 215_218, 15 July 1993).

NCAR (1999)
NCAR Climate Model Projections for 21st Century: Earth Warms by 3.6 Degrees F; Winter Rain/Snow Increases 40% in Southwest and Great Plains
http://www.ucar.edu/communications/newsreleases/1999/csm.html

"business-as-usual" increase in greenhouse gases in which atmospheric carbon dioxide doubles over the next century

Global average temperature climbs by 3.6 degrees F (2 degrees C) for business as usual

Nordhaus, Boyer (2000)
Warming the world: economic models of global warming. The MIT Press, Cambridge, Mass**.**

O`Neill, Oppenheimer (2002)
Dangerous climate impacts and the Kyoto Protocol. *Science* 14 June 2002:
Vol. 296. no. 5575, pp. 1971 - 1972
If stop at

1°C above 1990, likely prevent severe damage to coral reefs

2°C above 1990, likely prevent disintegration of West Antarctic ice sheet (raise sea level 13-20 feet (4-6 meters) or

3°C above 1990 over 100 years, likely prevent shutdown of ocean thermohaline effect

If stabilize at

450 ppmv, might prevent disintegration of West Antarctic ice sheet

450 ppmv likely prevent shutdown of ocean thermohaline effect

"Delay until 2020 risks foreclosing the option of stabilizing concentrations at 450 ppmv"

Pacala, Socolow (2004)
Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, Science, August 13, 2004, Drs. Stephen Pacala and Robert Socolow, Princeton University, Carbon Mitigation Initiative www.princeton.edu/pr/news/04/q3/0812-carbon.htm A Plan for Stabilizing Atmospheric CO2 Concentrations at 500 ppmv: www.princeton.edu/pr/news/04/q3/0812-carbon/

Pollack (1998)
http://www.ncdc.noaa.gov/paleo/globalwarming/paleolast.html

Rahmstorf, Ganopolski (1999)
Average global temperature increase of about 0.6°C between from 1860 and 1990 (Houghton et al). Under "business-as-usual" projections (IPCC scenario IS92e) the total temp increase from 1860 will be 4.3°C by 560 ppmv and will reach 1200 ppmv by about 2150 near 5.5°C. Long-Term Global Warming Scenarios Computed With An Efficient Coupled Climate Model. Stefan Rahmstorf And Andrey Ganopolski. Potsdam Institute for Climate Research, Climatic Change 43: 353–367, 1999.
www.pik-potsdam.de/~stefan/ Publications/Journals/rg99.pdf

Schneider (2005)
Analysis suggests that a value nearer to 350 ppmv should be adopted, until it can be proven that a higher value is safe. Targets for Stabilization of Atmospheric CO2$_{2,}$ **Christian Azar,** [*] **Henning Rodhe** www.sciencemag.org/cgi/content/short/276/5320/1818 (1997) The global temperature increase for an atmospheric CO_2 concentration of 550ppm will only stay below 2^{o}C if the climate sensitivity is on the very low end of the IPCC's estimates…It appears that in order to have a very high probability of keeping the global temperature changes within the range of natural fluctuations that have occurred during the past few millennia (roughly 1^{o}C), the climate sensitivity has to be low or the atmospheric CO_2 concentration has to be stabilized at around 350ppm (i.e., below current levels)…the projections shown in the *IPCC stabilization scenarios* suggest that the global climate policy community should not dismiss policies that lead to eventual stabilization in the range of 350-400 ppm. Dr. Stephen Schneider, Climate Policy, Post-Normal Science
http://stephenschneider.stanford.edu/Climate/Climate_Policy/CliPolFrameset.html

WBGU (1995)
German Advisory Council on Global Change (WBGU) (1995) Scenarios for the derivation of global CO_2 reduction targets and implementation Strategies. Bremerhaven, Germany (March).

[53] **Target: Stabilizing Atmospheric CO2 at 350 ppmv**
Analysis suggests that a value nearer to 350 ppmv should be adopted, until it can be proven that a higher value is safe. Targets for Stabilization of Atmospheric CO2$_{2,}$ Christian Azar, [*] Henning Rodhe www.sciencemag.org/cgi/content/short/276/5320/1818 (1997) The global temperature increase for an atmospheric CO_2 concentration of 550ppm will only stay below 2^{o}C if the climate sensitivity is on the very low end of the IPCC's estimates…It appears that in order to have a very high probability of keeping the global temperature changes within the range of natural fluctuations that have occurred during the past few millennia (roughly 1^{o}C), the climate sensitivity has to be low or the atmospheric CO_2 concentration has to be stabilized at around 350ppm (i.e., below current levels)…the projections shown in the *IPCC stabilization scenarios* suggest that the global climate policy community should not dismiss policies that lead to eventual stabilization in the range of 350-400 ppm. Dr. Stephen Schneider, Climate Policy, Post-Normal Science
http://stephenschneider.stanford.edu/Climate/Climate_Policy/CliPolFrameset.html

[54] **Goal – A Maximum Increase of Average Surface Temperature of 3.6°F or 2.0°C**

The No. 1 recommendation of 10 "A long-term objective be established to prevent global average temperature from rising more than 2°C (3.6°F) above the pre-industrial level" Meeting the Climate Challenge – Recommendations of the International Climate Change Taskforce", January 2005 http://www.tai.org.au/Publications_Files/Papers&Sub_Files/Meeting%20the%20Climate%20Challenge%20FV.pdf

[55] **Sea Level Rise after 450 ppmv**
There is a time lag between the time greenhouse gases are released and the time they quit impacting the environment. The projected rise in sea levels during the 21st century, 4 to 35 inches, is primarily a result of greenhouse gases emitted over the last 2-3 centuries.

Greenhouse gases emitted today will continue to trap heat and expand the oceans hundreds of years from now.

Greenhouse gases emitted in the future will also continue to trap heat and expand the oceans for hundreds of years beyond that.

One credible projection indicates that if the concentration of atmospheric CO2 does not stabilize at a level of 450 ppmv or less, and its at 381 ppmv now, there is a substantial chance there will be significant melting of the Antarctic and Greenland ice sheets resulting in a sea level rise of near 4 to 6 meters – or 13.2 to 19.6 feet with a midpoint near 16 feet.

While sea level is not expected to rise by 16 feet immediately, and it could under some scenarios, if the concentrations are not stabilized at 450 ppmv or less, the rise is likely be irreversible.
Source: O'Neill, Oppenheimer (2002)Dangerous climate impacts and the Kyoto Protocol. *Science* 14 June 2002:
Vol. 296. no. 5575, pp. 1971 - 1972
If stop at
    1°C above 1990, likely prevent severe damage to coral reefs
    2°C above 1990, likely prevent disintegration of West Antarctic ice sheet (raise sea level 13-20 feet (4-6 meters) or
    3°C above 1990 over 100 years, likely prevent shutdown of ocean thermohaline effect
If stabilize at
    450 ppmv, might prevent disintegration of West Antarctic ice sheet
    450 ppmv likely prevent shutdown of ocean thermohaline effect
"Delay until 2020 risks foreclosing the option of stabilizing concentrations at 450 ppmv"

[56] A Plan for Stabilizing Atmospheric CO2 Concentrations at 500 ppmv
Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, Science, August 13, 2004, Drs. Stephen Pacala and Robert Socolow, Princeton University, Carbon Mitigation Initiative www.princeton.edu/pr/news/04/q3/0812-carbon.htm Aug. 12, 2004 Media contact: Steven Schultz, (609) 258-5729, sschultz@princeton.edu; Roberta Hotinski, (609) 258-7523, hotinski@princeton.edu Editors: Photos, graphics and a background document are available at: http://www.princeton.edu/pr/news/04/q3/0812-carbon/

[57] **Timelag or Inertia of Impacts**
After stabilization of the atmospheric concentration of CO_2 and other greenhouse gases, surface air temperature is projected to continue to rise by a few tenths of a degree per century for a century or more, while sea level is projected to continue to rise for many centuries. Intergovernment Panel on Climate Change, Climate Change 2001, Synthesis Report
www.grida.no/climate/ipcc_tar/vol4/english/009.htm

[58] **The Power of Throwing Your Cap Over the Wall**
President Kennedy faced enormous cynicism and ridicule when he proposed the U.S. space program, now the envy of the world. His following vision for the space program could easily be adopted by the United States in addressing global climate change.

"I have spoken about the New Frontier…It refers… to this Nation's place in history, to the fact that we do stand on the edge of a great new era, filled with both crisis and opportunity, an era to be characterized by achievement and by challenge. It is an era which calls for action and for the best efforts of all those who would test the unknown and the uncertain in every phase of human endeavor. It is a time for pathfinders and pioneers…I think the United States should be a leader. A country as rich and powerful as this which bears so many burdens and responsibilities, which has so many opportunities, should be second to none.…Many weeks and months and years of long, tedious work lie ahead. There will be setbacks and frustrations and disappointments. There will be, as there always are, pressures in this country to do less in this area as in so many others, and temptations to do something else that is perhaps easier. But this research here must go on. This space effort must go on. The conquest of space must and will go ahead. That much we know. That much we can say with confidence and conviction…Frank O'Connor, the Irish writer, tells in one of his books how, as a boy, he and his friends would make their way across the countryside, and when they came to an orchard wall that seemed too high and too doubtful to try and too difficult to permit their voyage to continue,

they took off their hats and tossed them over the wall--and then they had no choice but to follow them. This Nation has tossed its cap over the wall of space, and we have no choice but to follow it. Whatever the difficulties, they will be overcome. Whatever the hazards, they must be guarded against…with the help and support of all Americans, we will climb this wall with safety and with speed-and we shall then explore the wonders on the other side." Remarks at the Dedication of the Aerospace Medical Health Center President John F. Kennedy, San Antonio, Texas November 21, 1963
http://www.jfklibrary.org/jfk_san_antonio_11-21-63.html

[59] **Business Response**
HSBC, one of the world largest banks, announced in 2005 it would become "carbon neutral" over the next few years even though it may cost the bank up to $7 million to do so.

[60] **United States Greenhouse Gas Emissions**

Global vs. US Emissions	metric tonnes C (billions) b	metric tonnes CO2e (billions) b x 3.6666	US tons C (billions) b x 1.102	US tons CO2e (billions) d x 3.6666	population (billions)
World - total (Feb 06)	7.4	27.2	8.2	29.9	6.3
United States - total (2003)	1.9	6.9	2.1	7.6	0.29
World - per capita (tons/tonnes)	1.2	4.3	1.3	4.8	
United States - per capita (tons/tonnes)	6.5	23.8	7.2	26.2	

Global Emissions
By February 2006, total global CO_2 emissions from human activity was 29.9 billion US tons year (7.4 billion metric tonnes of C). United Nations Environment Programme
www.grida.no/db/maps/collection/climate6/
US Emissions
In 2003, total US greenhouse gas emissions was 6,900.2 TgCO2e (6.9 billion metric tonnes or 7.6 billion US tons), up 13% from 1990, up 0.6% from 2002 (42.2 TgCO2e – or 42.2 million metric tonnes) US Emissions Inventory 2005, Inventory Of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003, Final Version, (April 2005), EPA 430-R-05-003
http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR69V528/$File/05executivesummary.pdf
Population
On February 4, 2002, the global population was 6.3 billion people. United States Census Bureau,
http://blue.census.gov/cgi-bin/ipc/popclockw

[61] **Increased US Emissions**
U.S. Department of Energy, Energy Information Agency (EIA), International Energy Outlook 2005 (IEO2005) www.eia.doe.gov/oiaf/ieo/emissions.html

[62] **U.S Wasted Energy**
About 58% of all U.S. energy consumed is deemed "lost" while only about 36% is deemed "useful" Source: U.S. Energy Flow Trends – 2002, Lawrence Livermore National Laboratory, June 2004
http://eed.llnl.gov/flow/02flow.php

[63] **Energy Use Per Capita (2003)**

	quadrillion btu	population (millions)	% world population	btu per capita	compare to United States
World	420.98	6,477,450,857	100%	64,991,616,192	20%
Australia	5.14	20,090,000	0.3%	255,848,680,936	77%
Canada	13.48	32,805,000	0.5%	410,912,970,584	124%
China	45.48	1,306,314,000	20.2%	34,815,519,087	10%
France	11.24	60,656,000	0.9%	185,307,306,779	56%
Germany	14.24	82,431,000	1.3%	172,750,542,878	52%
Japan	22.42	127,417,000	2.0%	175,957,682,256	53%

Russia	29.06	143,420,000	2.2%	202,621,670,618	61%
United Kingdom	9.83	60,441,000	0.9%	162,637,944,442	49%
United States	98.31	295,734,000	4.6%	332,427,113,555	100%

Table 11.3 World Primary Energy Consumption by Region, 1994-2003,
www.eia.doe.gov/emeu/aer/txt/stb1103.xls
www.census.gov/ipc/www/idbsum.html (2005)
www.prb.org/

[64] **US Waste v Japan**
Quoted at Kyoto greenhouse gas conference, COP-3, 1997

[65] **Subsidies to Fossil Fuels**
Types of Subsidies
There are numerous types of subsidies to fossil fuels including, but not limited to, tax policies supply credits, exemptions, deferrals, preferential rates, loans, loan guarantees, exclusions, deductions, research and development programs, depletion allowances, accelerated depreciation, risk insurance and regulatory costs (p65).
Fossil Fuel Subsidies
Fossil fuels is the third most heavily subsidized sector in the world - after roads and agriculture (p66). Subsidies to fossil fuels are conservatively estimated at $14 billion a year in the United States, $5.9 billion a year in Canada and $10 billion a year in Western Europe (p85)
Greenhouse Gases
Slashing subsidies to fossil fuels is estimated to reduce U.S. greenhouse gas emissions to 16% below 1990 levels (p70)
Source: Perverse Subsidies, by Norman Myers and Jennifer Kent (2001)

[66] **CO2 Emissions by Source of Electricity**

	Col 1 - typical carbon content	Col 2 - typical energy per pound (BTUs)	Col 3 - typical lbs CO2 per BTU (source 1)	Col 4 - typical Btu per kWh (HHV) (source 2)	Col 5 - typical lbs CO2 per kWh (col 3 x col 4)	Col 6 - typical lbs CO2/US ton (source1)
Lignite Coal	30%	6,000	0.0002154	10,300	2.219	2791.6
Subbituminous Coal	40%	9,000	0.0002127	10,300	2.191	3,715.9
Bituminous Coal	60%	13,000	0.0002053	10,300	2.115	4,931.0
Anthracite Coal	90%	14,000	0.0002274	10,300	2.342	3,852.0
Oil			0.0001614	11,500	1.856	
Natural Gas.			0.0001153	11,600	1.337	
CombCycle Nat. G.			0.0001153	7,300	0.841	

Sources: (1) U.S. Department of Energy. Fuel and Energy Source Codes and Emissions Coefficients www.eia.doe.gov/oiaf/1605/factors.html
(2) Oregon Energy Office

[67] **Emissions from Power Plants**
Assumes a typical plant operating 85% of the time or 7450 hours a year.

[68] **Coal and Wind**
There is enough wind energy potential in the Midwest United States to produce three times the entire current amount of electricity used in the United States. Midwest wind can often be produced at less than 2.5 cents a kilowatt-hour while a new coal power plant cannot come in less than 4.0 cents a kilowatt-hour. Sources: American Wind Energy Association www.awea.org, US. Dept of Energy (USDOE), Pacific Northwest National Laboratory (PNNL), National Renewable Energy Laboratory (NREL) www.nrel.gov
Northern States Power Company (Xcel)

[69] **Solar Panel Providing Doubling U.S. Electricity Production**
An array of solar panels using currently technology 100 miles square could produce all the electricity used in the entire United States.: U.S. Department of Energy, National Renewable Energy Laboratory www.nrel.gov/ncpv/thin_film/docs/enough_sunshine.ppt#1 "The total electricity demand for the United States today could be supplied by PV systems covering only 0.4% of the nation in a

high-sunlight area such as the Desert Southwest — an area about 100 miles by 100 miles. www.nrel.gov/ncpv/value.html See also www.darelldd.com/ev/solar.htm

PV Calculations
Courtesy of, and verified by, by Guy Dauncey and Patrick Mazza "Stormy Weather: 101 Solutions to Global Climate Change p260 Solar Energy endnote 1, New Society Publishers, www.newsociety.com

Using solar radiation data from the Union of Concerned Scientists - www.ucsusa.org/energy/brief.soalr.html

Using the Solar Radiation Map of the United States which shows the sunlight factor for each geographic area, www.homepower.com/solmap.htm

U.S. electricity demand (1997) = 3,570 terrawatt hours (tWh) or
Depending on your location in the United States,
    a typical solar panel[69] = one square meter[69] - or a little less than 11 square feet
    operating at standard efficiency = 15%,
    generates = 2.5 - 7.5 average kilowatt hours (kWh) of electricity each day
So, how big an array would you need to generate all the electricity used in the entire United States
    divide the US electricity use - 3,570 terrawatt (or quadrillion) hours or 3,570,000,000,000,000 wH
    by the electricity produced by the average panel - 5 kWh a day = 750 terrawatt hours
    and multiply that by the size of each penal - a square meter or 11 square feet = 8250
    and divide that by the number of square feet in a square mile -
1 gW = 1 billion watts or 1,000,000,000
1 tW - 1000 gW or I trillion watts or 1,000,000,000,000

Maximum energy from the sun (noon, on a clear day) = 1,000 watts (1 kW) per square meter[69] - or about 11 square feet
Daily average energy from the sun for your location: apply the historically based "Average Daily Solar Radiation" factor for your location, see www.homepower.com/solmap.htm
That tells you the average amount of energy from the sun received by that location per day:
Example 1: Eastern Washington State gets between 4000 and 5000 watt hours per day per square meter - or 4-5 kilowatt hours (kWh) per day
Example 2: Western Washington State gets between 2500-400 watt hrs or 2.5-4 kWh/day/square meter

[70] **Mandatory Offsets of Greenhouse Gas Emissions**
In April 2004, the State of Washington implemented the nation's most rigorous rules requiring all new electricity plants to mitigate or offset 20% of their greenhouse gas emissions.

[71] **The Cost of Offsetting Your Greenhouse Gas Emissions**
An emitter of greenhouse gases can "offset" his or her emissions by paying another entity to reduce or eliminate the same amount of greenhouses the emitter created from another source. The cost is determined by independent "carbon" or "emissions trading" markets and is usually measured in terms of "US dollars per US ton of carbon dioxide equivalent" or "USD per US ton CO2e". That price can range from $5 to $40 per ton. Typical prices today for permanent offsetting in the United States are near $5 per ton. Most predict they will increase.

Currently, a typical American can offset **ALL** the greenhouse emissions from his or her house and car for **about $100 per year**. It's much lower for people elsewhere as they use far less energy than Americans.

(a) Calculations - Electricity
The typical American home uses about 10,000 kilowatt-hours of electricity a year. Over half of all US electricity is made from coal – the most polluting fuel commonly used in the world today. A typical American coal power plant emits about 2.15 pounds of CO2 for every kilowatt-hour (kWh) of electricity produced. Therefore, a typical American home, in a worst case scenario – using an electric furnace using 100% electricity from coal – using 10,000 kWh of electricity a year will create about 21,500 pounds of CO2 (2.15 x 10,000 = 21,500) or **10.8 tons of CO2 a year** (21,500 / 2000 = 10.75). If the cost of offsetting CO2 is $5 per US ton, then the total cost per year is about $54 (5 x 10.75 = 54) or an increase of less than **7% a year** on electricity costing 8.0¢ per kWh (10,000 kWh a year x 8.0¢ per kWh = $800/year; 54 / 800 = 6.75%). If the cost of offsetting CO2 is $10 per US ton, then the total cost per year is about $108 (10 x 10.75 = 107.50) or an increase of about 13% a year on electricity costing 8.0¢ per kWh (10,000 kWh a year x 8.0¢ per kWh = $800/year; 107.50/800 = 13.4%)

(b) Calculations – Car
(1) Full Fuel Cycle - A typical American car averages 20.7 miles per gallon. The United State Environmental Protection Agency in www.fueleconomy.gov indicates a car averaging 21 mpg, such as a 2005 Crown Victoria, causes **9.2 tons** of CO2 based on the gasoline and the other gas-causing factors that went into building the car and developing the fuel. . If the cost of offsetting CO2 is $5 per

US ton, then the total cost per year is about $46 (5 x 9.2 = 46) and the additional cost is 8¢ per gallon (46 / 571 = 8) or about 3.2% on the cost of the gasoline at $2.50 per gallon.

(2) Gasoline Only - A typical American car averages 20.7 miles per gallon, is driven an average of 12,000 miles per year and burns about 571 gallons of gasoline per year (12,000 / 21 = 571); One gallon of gasoline weighs about 6.3 pounds and is about 85% , or 5.4 pounds, of carbon. During combustion, carbon combines with oxygen to create CO2. Each pound of carbon becomes 3.666 pounds of CO2. The 5.4 pounds of carbon in one gallon of gasoline becomes 19.6 pounds of CO2. (5.4 x 3.6666 = 19.6) Therefore, a car burning 571 gallons of gasoline a year creates about 11,192 pounds of CO2 a year (571 x 19.6 = 11,192) or **5.6 tons** of CO2 (11,192 / 2000 = 5.6) from the gasoline alone. If the cost of offsetting CO2 is $5 per US ton, then the total cost per year is about $28 (5 x 5.6 = 28) and the additional cost is 4.9¢ per gallon (28 / 571 = 4.9) or about 2% on the cost of the gasoline at $2.50 per gallon.

The cost of offsetting a typical airline flight is about $13 a flight.

	US Tons CO2e	$/ton	total	increase
Electricity – all coal	10.8	$5	$54	7%
Average car – 20.7 mpg	9.2	$5	$46	3%

[72] **Deaths from Fossil Fuels**
Climate Change: Hidden Health Benefits of Greenhouse Gas Mitigation, Luis Cifuentes, Victor H. Borja-Aburto, Nelson Gouveia, George Thurston, Devra Lee Davis, Science magazine, August 17, 2001 www.whensmokeranlikewater.com/publications/scientific/Science2.html

[73] **Insurance Claims**
Munich Re, the international re-insurance giant

[74] **Legal Action**
(1) Attorneys General of 11 states threatened to sue the federal government for not implementing stronger measures limiting greenhouse gas emissions - AK, CA, CT, MA, ME, MD, NH, NJ, NY, RI, VT – Jul 2002. Source: James Sterngold, New York Times
(2) Attorneys General for seven states announced they are suing the federal government for its failure to regulate CO_2 under the Clean Air Act – CT, MA, ME, NJ, NY, RI, WA - Feb 03. Source: Notification letter to EPA Administrator Whitman: www.oag.state.ny.us
(3) Boulder, CO, and Oakland, CA, as well as two other US cities and two non-governmental organizations sued two U.S. government agencies demanding they assess the total impact of the projects on climate change– Aug 02. Source: See www.climatelawsuit.org
Scientific American, February 2003, p 14
(4) Some small island states are expected to go out of existence due to sea level rise caused overwhelmingly by the industrialized countries – watch for claims related to "environmental genocide".
(5) At least one regional organization representing native populations, and at least four other major organizations are considering lawsuits against large emitters of greenhouse gases.
(6) The United States Securities and Exchange Commission has agreed to create a searchable database allowing investors to track environmental liabilities, such as the potential risks of pollution – 2004. Source: SEC to Improve Tracking of Companies' Environmental Liabilities Source: Ethical Corporation NEW YORK, N.Y., July 27, 2004 - According to a report by the US Government Accountability Office, the SEC has agreed to create a searchable database available through its website that will allow investors and analysts to track environmental liabilities, such as clean-up costs, fines and potential risks from pollution and hazardous materials
www.greenbiz.com/news/news_third.cfm?NewsID=26989
(7) Eight states, CA, CT, IA, NJ, NY, RI, VT, WI, and New York City announced plans to sue major electric utilities as the country's biggest emitters of CO_2 and demand "substantial cuts" which they say "pose serious threats to our health, our economy and our environment" – Jul 04. Source: See New York Times - June 11, 2004 "Much of Coastal U.S. May Follow California on Car Emissions**"** By Danny Hakim http://www.nytimes.com/2004/06/11/business/11auto.html?th
(8) A lawsuit in Montana claims coal power plants emitting greenhouse gases violate a provision in the state's Constitution requiring the state to maintain a clean environment for future generations – Jul 04.

[76] **Fuel Economy**
U.S. Environmental Protection Agency www.fueleconomy.gov

[77] **Greener SUVs**
Union of Concerned Scientists, *Greener SUVs: A Blueprint for Cleaner, More Efficient Light Trucks,* outlines how SUVs can be designed to lessen their environmental effects. This report shows that automakers can design SUVs that meet stricter air pollution and fuel economy standards without sacrificing performance or substantially raising cost.
www.ucsusa.org/clean_vehicles/cars_and_suvs/page.cfm?pageID=226

[78] **The Corporate Average Fuel Economy (CAFE) Standards**
The passenger car standard, currently 27.5 mpg, has not been increased since the 1986 model year. The light truck standard is set annually and is significantly lower than that fro passenger cars. The Energy Policy and Conservation Act of 1975 required passenger car and light truck manufacturers to meet CAFE standards. The CAFE standards are applied on a fleet-wide basis for each manufacturer; i.e., the fuel economy ratings for a manufacturer's entire line of passenger cars must average at least 27.5 mpg for the manufacturer to comply with the standard. [If a manufacturer does not meet the standard, it is liable for a civil penalty of $5.00 for each 0.1 mpg its fleet falls below the standard, multiplied by the number of vehicles it produces. For example, if a manufacturer produces 2 million cars in a particular model year, and its CAFE falls 0.5 mpg below the standard, it would be liable for a civil penalty of $50 million.] For light trucks (including vans and sport utility vehicles), the 1993 CAFE standard was 20.3 mpg. The 1994 and 1995 CAFE standards are 20.5 mpg and 20.6 mpg respectively. Manufacturers earn "credits" for exceeding CAFE standards, and these credits can be used to offset fuel economy shortfalls in the three previous and/or three subsequent model years. They can also be penalized for failure to meet the standard. http://www.ita.doc.gov/td/auto/cafe.html

[79] **Federal Prohibition of State Attempts to Support Fuel Efficient Vehicles**
In California in 2002, Chrysler and other car manufacturers sued to stop California from encouraging to high mileage "hybrid" vehicles. The U.S. Attorney has weighed in on behalf of the federal government and President George W. Bush and is forcefully arguing that "Congress also expressly pre-empted any state laws or regulations relating to fuel economy standards" pursuant to federal law 49 USC 32919(a) thereby prohibiting California from supporting higher mileage vehicles. Source: See *Central Valley Chrysler* case www.4cleanair.org/members/committee/mobile/amicusbr.pdf www.prestongates.com/publications/newsletter.asp?pubID=353 Federal law 49 USC 32919(
1a) "Preemption **(a) General. -** When an average fuel economy standard prescribed under this chapter is in effect, a State or a political subdivision of a State may not adopt or enforce a law or regulation related to fuel economy standards or average fuel economy standards for automobiles covered by an average fuel economy standard under this chapter.
(b) Requirements Must Be Identical. - When a requirement under section 32908 of this title is in effect, a State or a political subdivision of a State may adopt or enforce a law or regulation on disclosure of fuel economy or fuel operating costs for an automobile covered by section 32908 only if the law or regulation is identical to that requirement. **(c) State and** Political Subdivision Automobiles. - A State or a political subdivision of a State may prescribe requirements for fuel economy for automobiles obtained for its own use.

[80] **State Regulation of Greenhouse Gas Emissions in Cars**
New York Times - June 11, 2004 "Much of Coastal U.S. May Follow California on Car Emissions**"** By Danny Hakim www.nytimes.com/2004/06/11/business/11auto.html?th

[81] **Automakers Support Higher Gasoline Taxes**
New York Times – May 9, 2004 by Danny Hakim "Robert A. Lutz, GM's vice chairman, often likens fuel regulations to tackling the nation's problem with obesity by forcing clothing manufacturers to produce smaller sizes. His point is this: As long as gasoline is cheaper than bottled water, fuel economy will not matter to car buyers. www.contracostatimes.com/mld/cctimes/8626053.htm?1c

[82] "Of course, there are other strategies for reducing oil imports and CO2 emissions, and thus the DOE should keep a balanced portfolio of R&D efforts to continue to explore supply-and-demand alternatives that do not depend heavily on hydrogen. If battery technology improved dramatically, for example, all-electric vehicles might become the preferred alternative. Furthermore, hybrid electric vehicle technology is commercially available today, and benefits from this technology can therefore be realized immediately." Executive Summary, page 2.

[83] **Experts on Hydrogen and Hybrid Vehicles**
"On a full-fuel-cycle basis, fuel cell vehicles have a higher total energy use per mile than conventional gasoline cars. This is caused by the significant energy loss during the creation of the hydrogen. The energy loss is so large that even the improved mpg of FCVs is not enough to offset the losses. On the other hand, the current three hybrid gasoline-electric options whether fueled by either reformulated gasoline, compressed natural or low sulfur diesel achieve 30-40% reductions in total energy use. p 22 Dr. Michael Wang, Argonne National Laboratory.

"Hybrid gasoline-electric vehicles today are, such as the Toyota Prius, are already much more efficient that traditional internal combustion engine vehicles and nearly efficient as projected fuel cell vehicles (assuming fuel cells achieve their performance targets)" "The Hype about Hydrogen: Fact and Fiction in the Race to Save the Planet" p7 by Joseph Romm (2004) Executive Director, Center for Energy and Climate Solutions, www.cool-companies.org Former United States Principal Deputy Assistant Secretary of Energy, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy.

[84] **Plug-In Hybrids**
Some other vehicles known as plug in hybrids, and the plug-in flex-fuel hybrids, will use electricity from stationary sources as a storage device for in the event renewable fuels are not available.

[85] **Hybrid Vehicles**
In 2005, the most prevalent hybrid gasoline-electric vehicle were the Toyota Prius, Honda Civic Hybrid and Honda Insight. Each usually costs less than $23,000 a year, less than the national average, and each qualifies for a $2000 federal income tax deduction. Fleet prices have been near $18,500. These three vehicles average between 47 and 56 miles per gallon and emit between 3.5 and 4.1 tons of greenhouse gases a year. For a side-by-side comparison, see U.S. Environmental Protection Agency, www.fueleconomy.gov and www.fueleconomy.gov/feg/hybrid_sbs.shtml

Vehicle	miles per gallon	Gallons per year	CO2/year	Fuel cost/year
2005 Honda Insight	56	268	3.5 tons	$601
2005 Toyota Prius	55	273	3.5 tons	$612
2005 Honda Civic hybrid	47	319	4.1 tons	$716

[86] **Typical greenhouse gas emissions from average U.S. car: 9.2 tons of CO2 a year**
The U.S. fleet currently averages about 20.7 mpg. This is about the same mileage as a 2005 Ford Crown Victoria at 21 mpg. The Crown Victoria driven 15,000 miles a year, 45% of the time on the highway and 55% of the time in the city, produces 7.0 tons, or 14,000 pounds, of CO2 a year from the gasoline alone. When adding in the additional greenhouse used in making the car, the federal government's 'full fuel cycle' model, the car produces 9.2 tons, or **18,400 pounds**, of greenhouse gases a year - an increase of 31%. Source: U.S. Department of Energy, GREET Model, Argonne National Laboratory, U.S. Environmental Protection Agency, www.fueleconomy.gov

Vehicle	miles per gallon	Gallons per year	CO2/yea	Fuel cost/year
2005 Ford Crown Victoria	21	714	7.0 tons gas only	$1471
2005 Ford Crown Victoria	21	714	9.2 tons total	$1471

[88] **Ethanol**
'An Update of Energy and Greenhouse Emissions Impacts of Fuel Ethanol' by Dr. Michael Wang, Center for Transportation Research, Argonne National Laboratory – Feb 05

[89] **Mandatory Offsets of Greenhouse Gas Emissions**
In April 2004, the State of Washington implemented the nation's most rigorous rules requiring all new electricity plants to mitigate or offset 20% of their greenhouse gas emissions.

[90] **The Cost of Offsetting Your Greenhouse Gas Emissions**
An emitter of greenhouse gases can "offset" his or her emissions by paying another entity to reduce or eliminate the same amount of greenhouses the emitter created from another source. The cost is determined by independent "carbon" or "emissions trading" markets and is usually measured in terms of "US dollars per US ton of carbon dioxide equivalent" or "USD per US ton CO2e". That price can range from $5 to $40 per ton. Typical prices today for permanent offsetting in the United States are near $5 per ton. Most predict they will increase.

Currently, a typical American can offset **ALL** the greenhouse emissions from his or her house and car for **about $100 per year**. It's much lower for people elsewhere as they use far less energy than Americans.

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The typical American home uses about 10,000 kilowatt-hours of electricity a year. Over half of all US electricity is made from coal – the most polluting fuel commonly used in the world today. A typical American coal power plant emits about 2.15 pounds of CO2 for every kilowatt-hour (kWh) of electricity produced. Therefore, a typical American home, in a worst case scenario – using an electric furnace using 100% electricity from coal – using 10,000 kWh of electricity a year will create about 21,500 pounds of CO2 (2.15 x 10,000 = 21,500) or **10.8 tons of CO2 a year** (21,500 / 2000 = 10.75). If the cost of offsetting CO2 is $5 per US ton, then the total cost per year is about $54 (5 x 10.75 = 54) or an increase of less than **7% a year** on electricity costing 8.0¢ per kWh (10,000 kWh a year x 8.0¢ per kWh = $800/year; 54 / 800 = 6.75%). If the cost of offsetting CO2 is $10 per US ton, then the total cost per year is about $108 (10 x 10.75 = 107.50) or an increase of about 13% a year on electricity costing 8.0¢ per kWh (10,000 kWh a year x 8.0¢ per kWh = $800/year; 107.50/800 = 13.4%)

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(5.4 x 3.6666 = 19.6) Therefore, a car burning 571 gallons of gasoline a year creates about 11,192 pounds of CO2 a year (571 x 19.6 = 11,192) or **5.6 tons** of CO2 (11,192 / 2000 = 5.6) from the gasoline alone. If the cost of offsetting CO2 is $5 per US ton, then the total cost per year is about $28 (5 x 5.6 = 28) and the additional cost is 4.9¢ per gallon (28 / 571 = 4.9) or about 2% on the cost of the gasoline at $2.50 per gallon.

The cost of offsetting a typical airline flight is about $13 a flight.

	US Tons CO2e	$/ton	total	increase
Electricity – all coal	10.8	$5	$54	7%
Average car – 20.7 mpg	9.2	$5	$46	3%

[91] **Carbon and Forests**
According to one UN Report, **t**ropical forests can retain 15 metric tons CO2 per hectare per year. www.greenbiz.com/news/news_gen.cfm?NewsID=30712&CFID=14229431&CFTOKEN=71206494
There are 259 hectares to a square mile. Therefore one square mile of tropical forest retains 3885 metric tonnes of C02 per year (259 x 25) and 4274 US tons of CO2 per year (3885 x 1.1)
One square mile of tropical forest retaining **4274 US tons of C02 a year** is the equivalent emissions associated with 465 average American passenger cars a year. (4274 div. by 9.2 tons) One standard sized US coal plant of 500 MW emits about **8,000,000 US tons of CO2 per year** or the equivalent emission associated with 870,000 average American passenger cars a year (8,000,000 div by 9.2). Therefore it would take a one forest of 1871 square miles to offset the emissions from one medium sized US coal power plant. (8,000,000 div by 4271) and that is approximately 43 x 43 miles.

[92] **"Most people would rather commit suicide than do the arithmetic"**
Modified from a quote by the former Science Advisor to the President of the United States, Dr. John H, Gibbons, 1993-1998, Director, Office of Technology Assessment, 1979-1993. The exact quote is "mankind would rather commit suicide than learn arithmetic" Foreword, "The Hype about Hydrogen: Fact and Fiction in the Race to Save the Planet" by Joseph Romm (2004) p xi

[93] **Environmental Results of Alternative Fuel Vehicles**
Comparison: gasoline vehicle vs. natural gas vehicle vs. hybrid vehicle
The typical Honda Civic is already a vehicle with very high gasoline mileage at about 37 mpg. Switching from a conventional 2005 Honda Civic using gasoline to a 2005 Honda Civic using natural gas decrease greenhouse gas emissions by **less than 2%.** Switching from a conventional 2005 Honda Civic using gasoline to a 2005 Honda Civic gasoline-electric hybrid decreases all pollution including greenhouse gases by 21%. Source: U.S. Environmental Protection Agency www.fueleconomy.gov

Vehicle	Engine	Mileage	CO2/year	Fuel Cost/year
2005 Honda Civic	gasoline	37 mpg	5.2 tons	$834
2005 Honda Civic	natural gas	32 mpg	5.1 tons	$493
2005 Honda Civic	hybrid gas/elec	47 mpg	4.1 tons	$658

Comparison: gasoline vehicle vs. 10% ethanol vehicle v. 85% ethanol vehicle
Ethanol vehicles range from using 10% ethanol mixed with 90% gasoline to 85% ethanol mixed with 15% gasoline. Vehicles using 10% ethanol reduce greenhouse gas emissions by only **3%.** Source: 'An Update of Energy and Greenhouse Emissions Impacts of Fuel Ethanol', Dr. Michael Wang, Center for Transportation Research, Argonne National Laboratory – Feb 05; U.S. Environmental Protection Agency www.fueleconomy.gov

Vehicle	Fuel	Mileage	CO2/year	Fuel Cost/year
2005 Ford Taurus	gasoline	22	8.5	$1529
2005 Ford Taurus	10% ethanol, 90% gasoline		8.2	
2005 Ford Taurus	85% ethanol, 15% gasoline	17	6.2	$1455

[end]

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