Curtailment in the Context of Climate Change

February 20, 2016

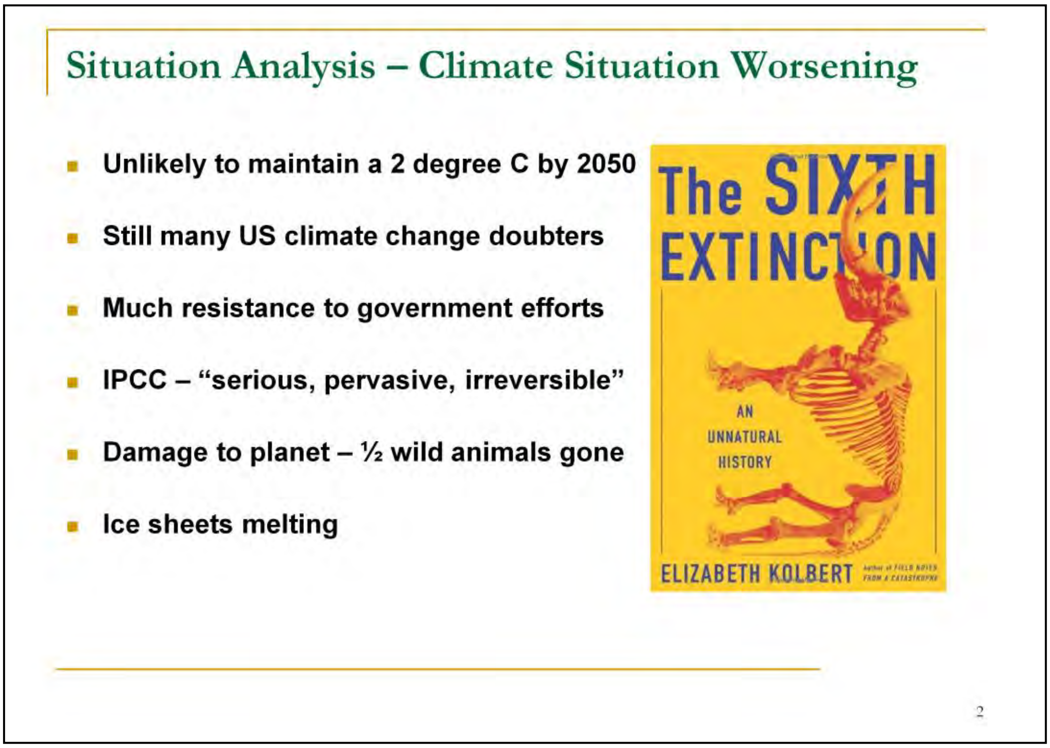
Developed by
Pat Murphy
Plan Curtail.org
P.O. Box 207
Yellow Springs, OH 45387

1

This presentation is about curtailment of fossil fuel use as a means to address climate change. It is not about efficiency, conservation, resilience, green, renewables or other frequently used terms. All of these are important but curtailment – that is, cutting back energy consumption to reduce CO_2 - is vital.

For fourteen years, my wife, Faith, and I have been searching for methods to mitigate the effects of climate change. This presentation is to give you the background of what we have done, to provide an up to date summary of mitigation efforts in key areas, and to provide a model for future planning and analysis.

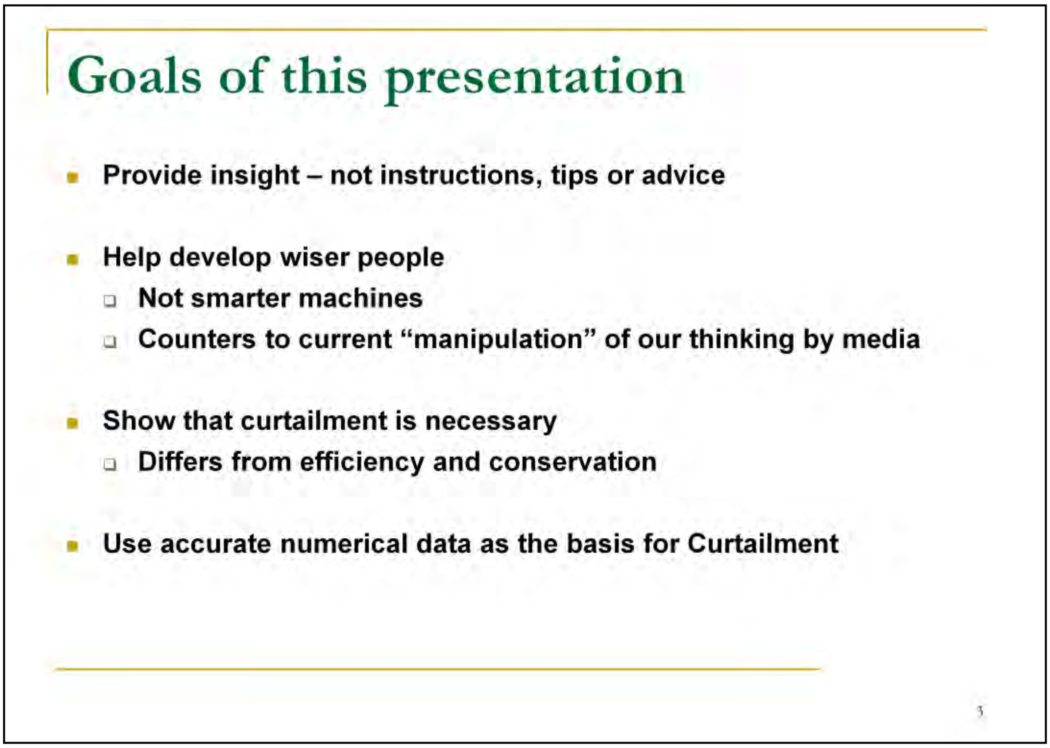
This is a complex problem and this presentation reflects that complexity. Einstein once said that a "*A scientific theory should be as simple as possible, but no simpler."* The presentation is as simple as possible considering what may be the most complex issue in human history.



The title of this book by Elizabeth Kolbert defines the ultimate risk of continuing our current way of life.

Over the last 14 years I have been advocating for a less industrial and more humane lifestyle. Community, a word that describes complex, powerful, long-term, sustaining relationships between people, has declined with the growth of industrialization. Environmental degradation and energy shortages go hand in hand with the industrial way of living. At the same time the world is experiencing increasing violence and exploitation as well as more inequity of wealth and income.

There are three common views about climate change. The first is that there is really no problem – life is getting better due to fossil fuel availability and the devices that burn it. The second view is that things are dangerous but a green renewable technology is ready to be deployed which will alleviate the problem. The third view is that the fossil fuel era cannot continue and other ways of low energy living must be developed. I am in that third group and propose that we commit to reducing our personal consumption of energy.



My goal is not to provide a list of specific activities to do or a set of products to buy, although those will be addressed. Rather it is to point the way to a new paradigm. Our problem is our culture – the accumulation of beliefs and desires of people in the developed world. We need a very different world view.

One of my objectives is to show that better more efficient machines – either black or green – while useful are not our best path. Machine dependence will simply make things worse. Currently it is hard for the average person to understand energy and CO_2 emissions. Most of media communication is marketing oriented – trying to control our minds through images and words. Educators are needed, not marketers. Otherwise people are confused and discouraged. They can be empowered with insight and understanding.

I have deliberately selected the term curtailment – a word which sometimes results in a negative reaction. People understand that this means difficult personal changes and they naturally resist. Reducing our fossil fuel consumption implies some hard times ahead and the need to change our way of living.

Our work always includes the numerical analysis of common measures associated with emissions. The depth of our analysis often leads to very unique conclusions.

Understanding Implies Measurements

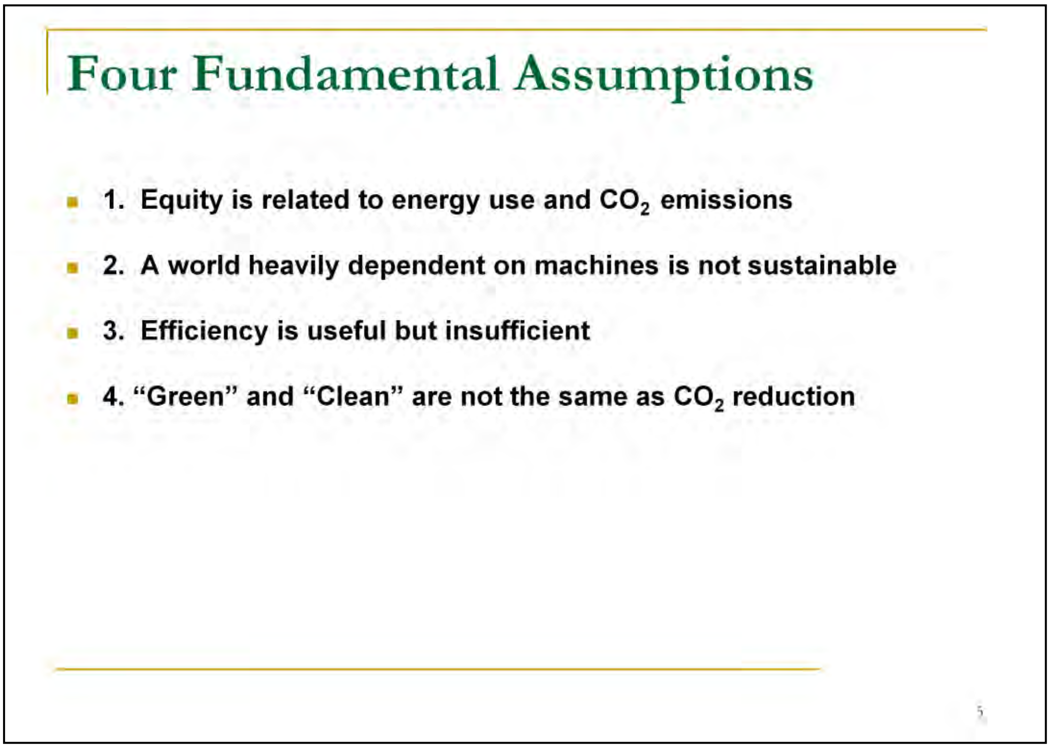
- **Lord Kelvin (1824-1907)**
  - **"To measure is to know."**
  - **"If you cannot measure it, you cannot improve it.“**
- **Peter Drucker**
  - **“If you can’t measure it, you can’t manage it”**
- **Some of our most severe problems are due to bad measurements**
  - **Without measurements the best rhetoric triumphs**
- **Another problem is using marketing rather than mathematics**
  - **Q - How much energy does that house use?**
    - **Marketing answer – Apple Green**
    - **Engineer answer – 10,000 kWh per year**

People must increase their numeracy skills in order to truly understand the underlying scientific information about the problems as well as the solutions. Lord Kelvin was an English physicist and engineer who lived in the 19^{th} century. He did important work on mathematical analysis of electricity and was known for the formulation of the first and second laws of thermodynamics, which are essentially the physical laws that govern the use of fossil fuels.

There is a constant pressure in our society to deny the reality of climate change and to provide counter arguments that will maintain a state of denial in Americans. Statistics are often deliberately misused.

We need to use numerical data in order to understand and make the best decisions.

The term green is used everywhere and confuses the core issue. The term lulls us to sleep and keeps us from taking action. We must insist on measurements for each energy consuming activity.



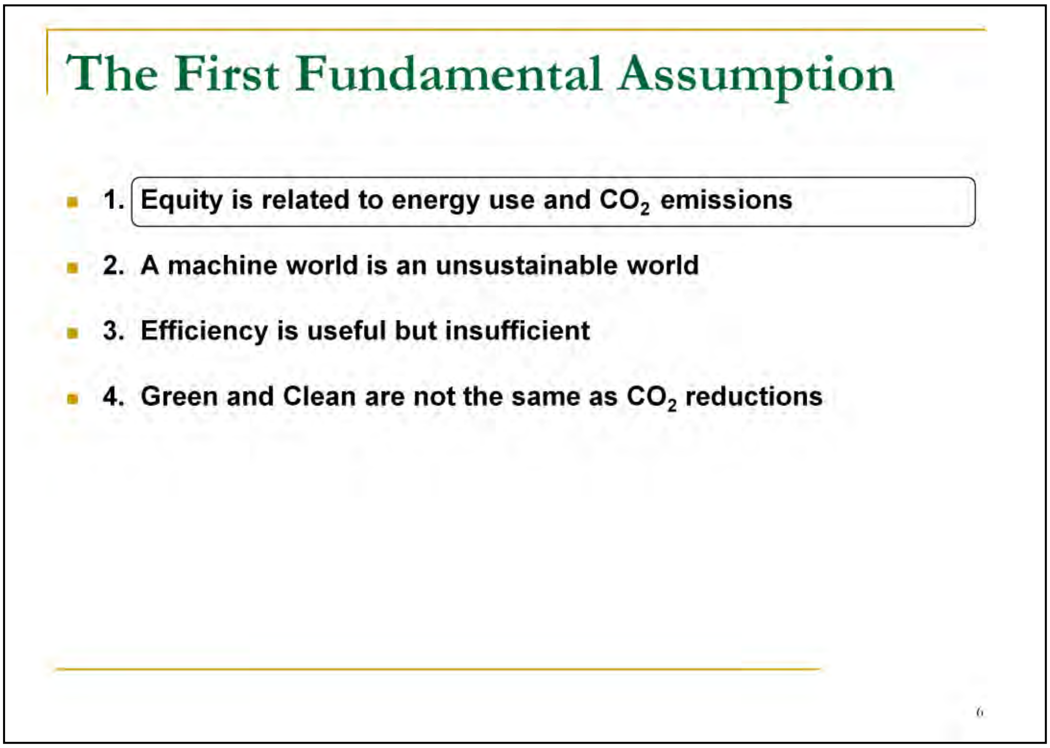
There are four fundamental assumptions that challenge the hope that we need not change. These justify the concept of curtailment and provide the basis for focusing on a low emissions way of living.

1. The first one analyzes the relationship between energy consumption, CO_2 generation, and our “so called” prosperity.

2. The second is that a machine world – our world of today – is an unsustainable world. Machines – engines, motors, power plants, electronics, heaters and chillers, etc. – all are built using energy. But most importantly they consume even more fossil fuel energy as they are used.

3. Efficiency is often called the fifth fuel. It is seen as purely good – but in fact, it is not an answer in and of itself. Efficiency without a cap simply leads to a small slowing down of the destruction. A focus on efficiency means we are constantly hoping for breakthroughs in machines and technologies that use energy, including cars, airplanes, and furnaces in our homes. The hope of an ultimate breakthrough must be challenged. I will show the limits of efficiency.

4. Finally the popular terms of Green or Clean do not provide measures of CO_2 reductions. They make us feel good temporarily. I will justify skepticism regarding their claims.

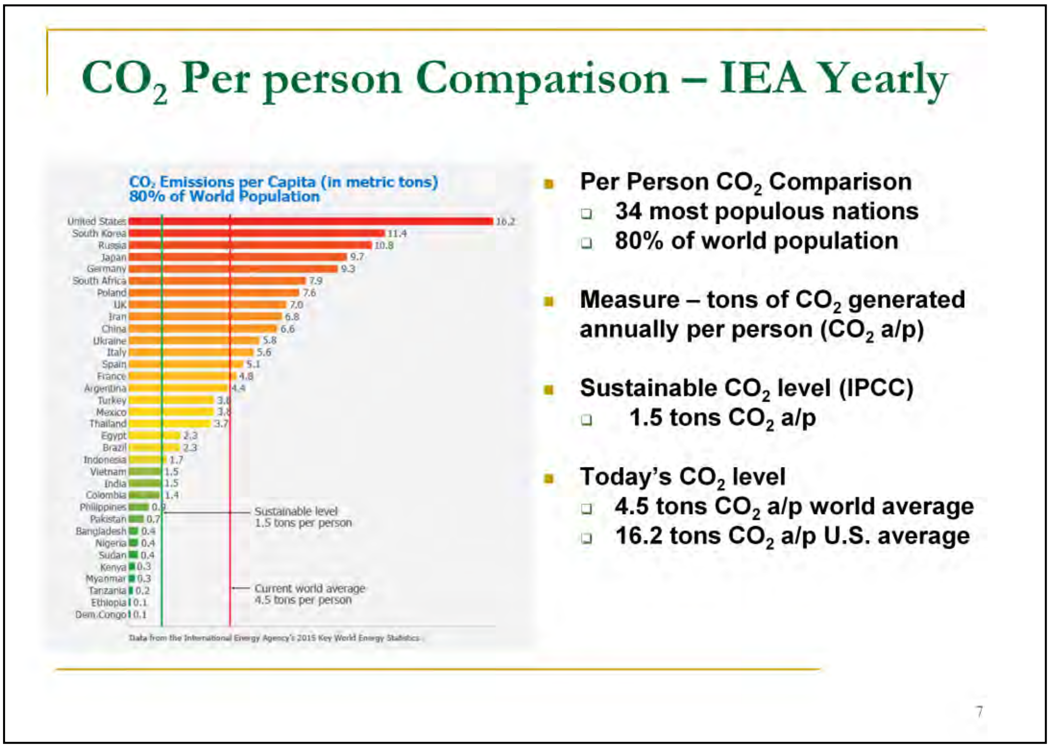


Many years ago I read the book “Energy and Equity” written by Ivan Illich. That book, and my own research, made it increasingly clear that the material wealth of a nation or a people is directly tied to the *quantity* of fossil fuels that a society consumes.

Thus, there is a strong correlation between energy, CO_2 emissions and our financial wealth.

To understand this is to realize that the threat to the planet and the human race is what we call prosperity, meaning increasing material wealth which leads to consuming more and more materials (including energy). To a great extent prosperity is the underlying cause of excessive CO_2 generation.

The next few charts describe the correlation.



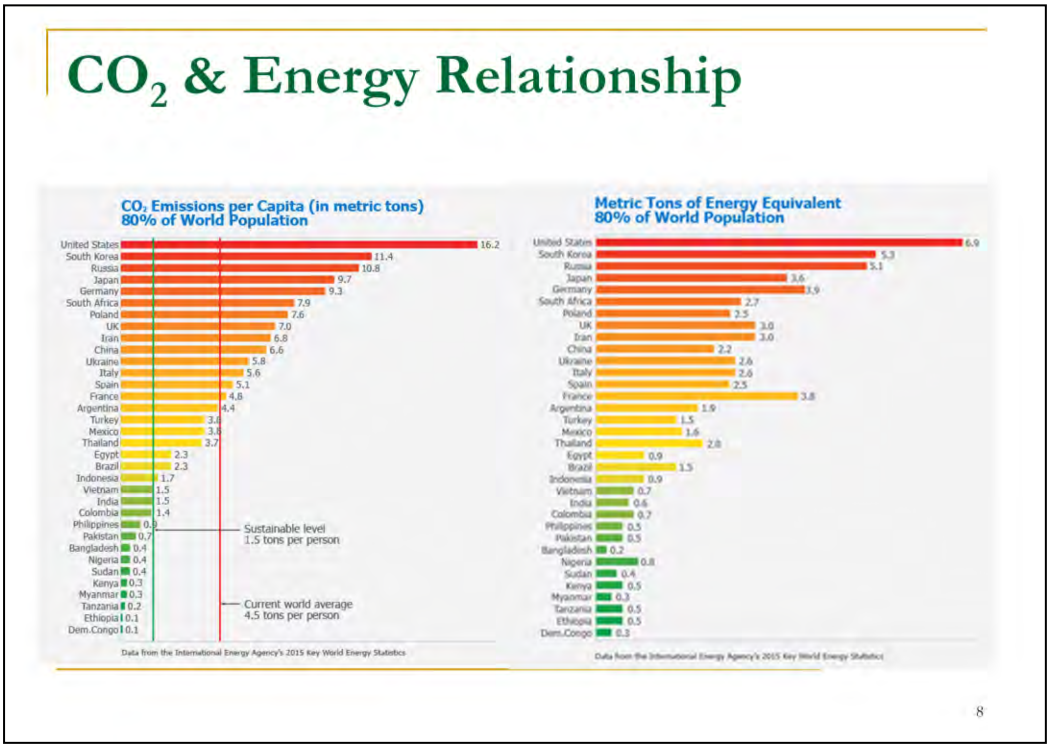
The bar chart above shows the annual metric tons of CO_2 emissions per person in the 34 most populous nations. These 34 nations include 80% of the world's population. This 34 nation subset is selected from roughly 200 nations in the world. The source for the data is the annual Key World Energy Statistics report published by the International Energy Agency. The list is ordered with the nations with the highest CO_2 per person at the top and the nations with the lowest CO_2 per person at the bottom.

Annual per person CO_2 emissions by country is a key statistic and quickly shows which nations are generating the most CO_2 and which are generating the least. Looking at this data from year to year also indicates which nations are improving and at what rate.

The graph includes two vertical lines. The line to the right represents the world average CO_2 emissions which is 4.5 tons per person. Note the US CO_2 contribution is 16.2 metric tons per person.

The vertical line on the left, identified with the words "Sustainable level 1.5 tons per person", shows the projected average CO_2 per person if emissions are cut 80% by 2050, a goal agreed to by almost all nations today.

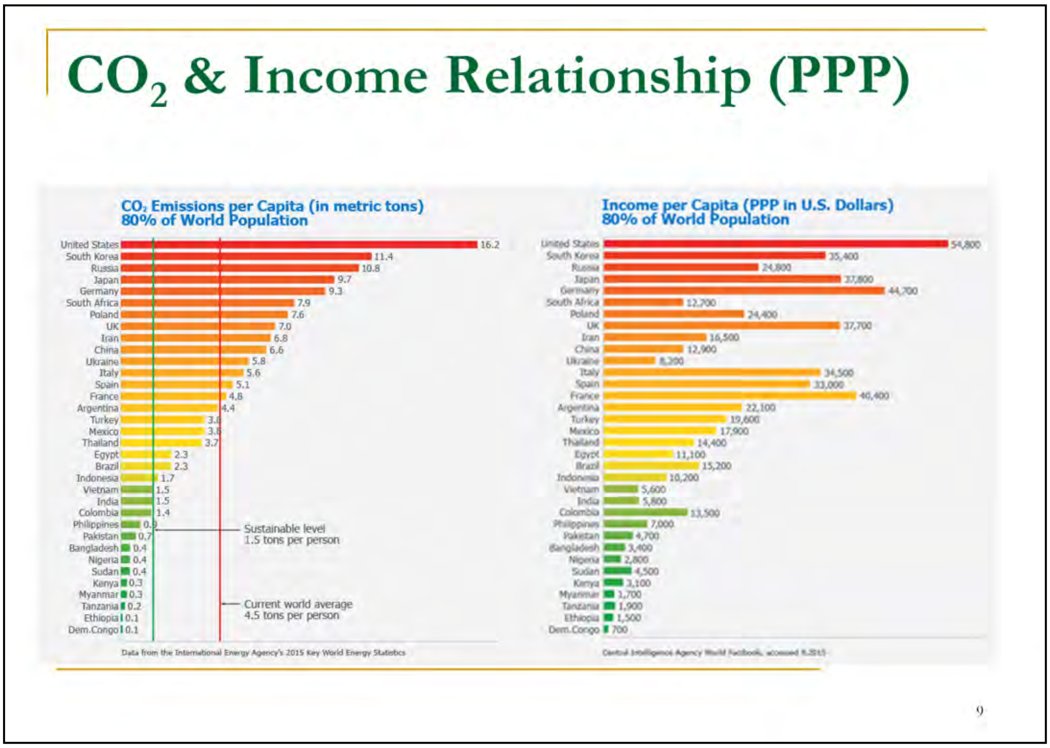
The next two charts will compare this chart to energy consumed and to income.



These charts show a correlation between consumption of fossil fuels and CO_2 emissions. The world average for CO_2 is 4.5 metric tons per person annually. The new chart on the right shows the energy use of the same nations. It is measured in metric tons of energy equivalent per person, rather than gallons of gasoline or kilowatt hours of electricity.

The CO_2 generated from a ton of energy is different for each nation because each country has a different mixture of fuels used to generate electricity. For example France generates less CO_2 for its energy use per person because it has so much nuclear power. It can also vary if a nation uses a significant amount of renewable energy.

The weight of CO_2 is 2.4 times the weight of the fossil fuel from which it came. The average annual use per person for all nations is 1.9 metric tons of energy. Multiplying these two numbers, 1.9 and 2.4, gives the 4.5 tons of CO_2 generated per person annually.

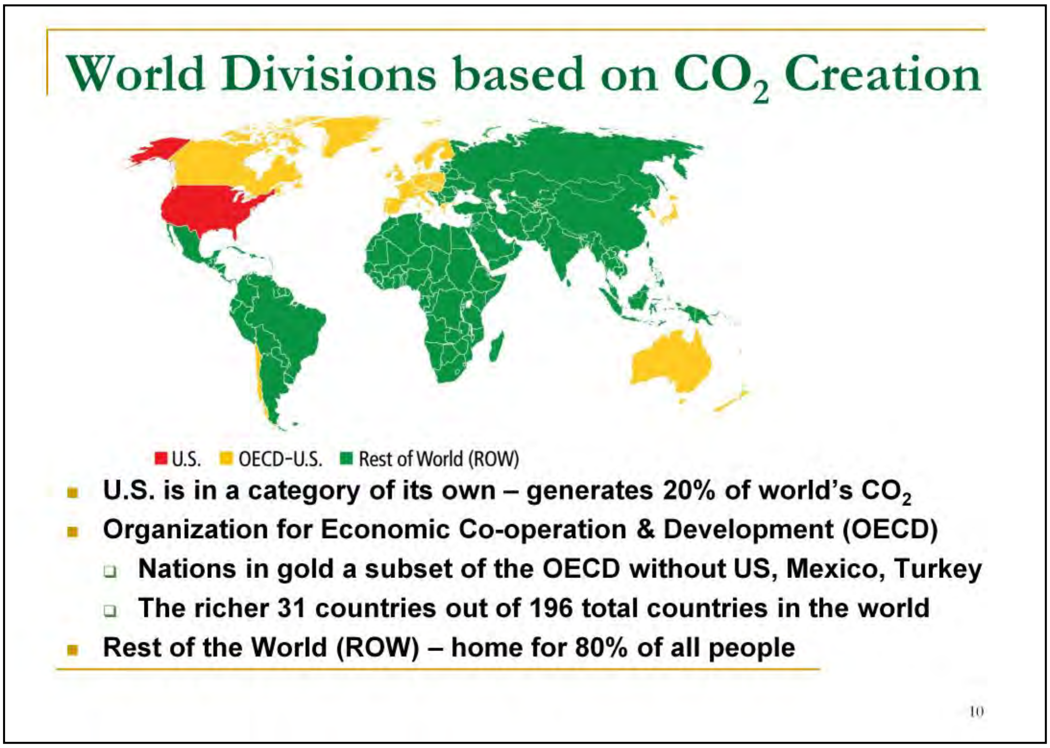


These two charts show the correlation between CO_2, which is the result of using fossil fuel energy, and income measured in PPP. PPP stands for “Purchasing Power Parity. The chart on the right shows the wide range of income of the 34 nations.

PPP does not directly correspond to emissions per capita. The variation is due to three things – the energy efficiency of each nation, political stability, and differences in culture. The right side chart shows that countries such as Russia, Poland, South Africa, Iran and the Ukraine are less prosperous even though they consume large amounts of energy.

These charts and the preceding ones also illustrates the strong correlation between economic success and fossil fuel energy consumption.

This chart and the preceding ones indicate the potential for worldwide violence as consuming countries attempt to maintain their advantage economically by controlling the fossil fuel energy they need to maintain their standard of living.



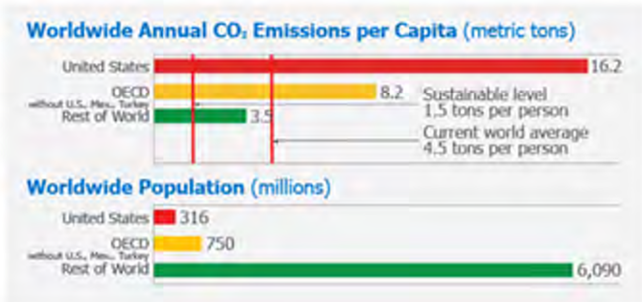
The preceding three charts showed the most populous 34 nations of the world containing 80% of the population. This chart shows all of the world's nations divided into three groups. The super rich United States, with about 5% of the world population, is placed in its own category. Its color is red.

The gold color represents the subset of rich nations. They are part of the Organization for Economic Cooperation and Development (OECD). The OECD was formed immediately after WW-II with 20 nations. It consists of mostly Europe, North America and rich Asia nations, including Japan and South Korea. The full OECD includes about 17% of the world's population.

This chart and the two that follow use a 31 nation subset of the full OECD. The subset excludes the US, Turkey and Mexico. Turkey and Mexico, being poor countries, are included in the Rest of the World category. The population of the subset of the OECD – that is, without the US, Turkey and Mexico - is 750 million people. This is about 10% of the world population. Its designation is OECD-U.S. This group plus the U.S. includes about 15% of the world population.

The Green color on the map represent the category of "Rest of the World." The Rest of the World group contains about 85% of the world population.

US/OECD$_{31}$ CO_2 Relative to Rest of World



- Large differences in CO_2 generation between rich and poor
- Third world, e.g. China & India, want rich countries to cut first

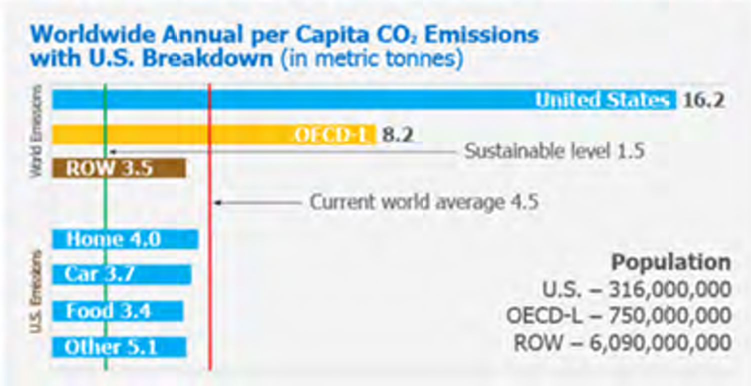
11

The top three bars of this chart show the per capita emissions from each of the three categories just described. The two vertical lines show the current world average emissions per person and the sustainable level of emissions per person discussed in earlier chart.

The bottom three bars show the population of the three categories.

The discrepancy between the three groups explains the view of the third world that richer nations should make the biggest CO_2 cuts because they have the greatest responsibility for past climate change.

US Key Categories Relative to Rest of World



- Illustrates "energy and emissions per capita inequity"
- Note: Our cars generate more CO_2 than ROW member's total
- "Goods and Services" represents much of embodied energy

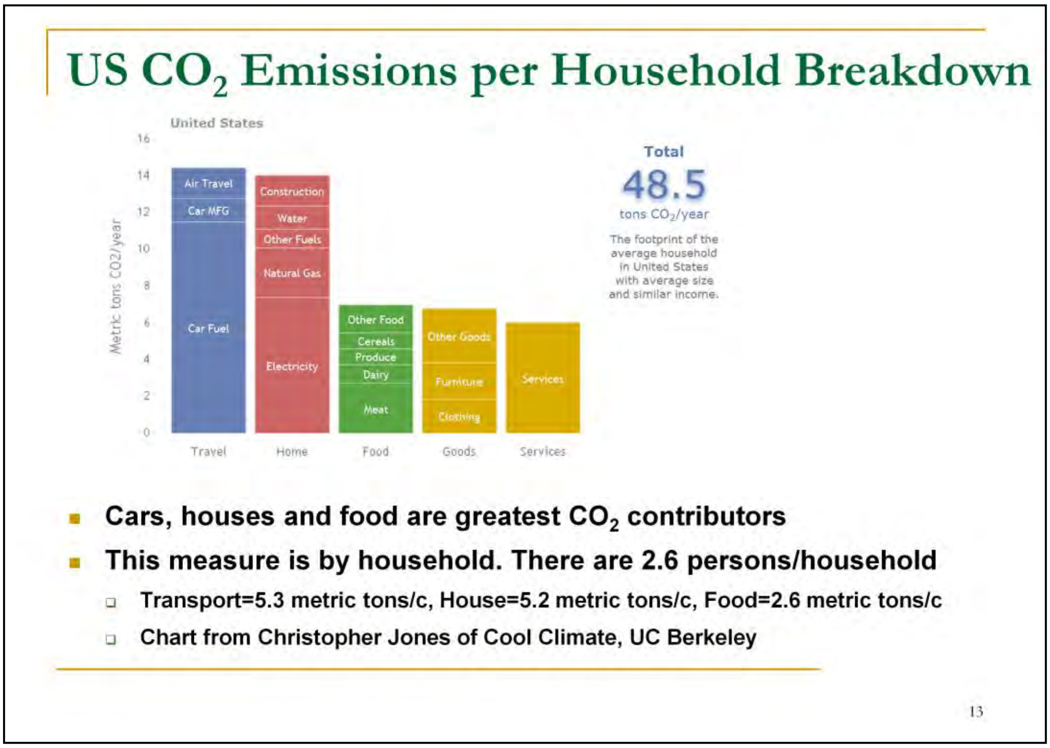
12

The bottom part of this chart divides the United States emissions of 16.2 tons into five subcategories – homes, cars, food, goods and services.

The amount of CO_2 generated annually per person for the five subcategories is next to the labels.

This chart illustrates a dangerous situation in the world. The U.S. is generating an inappropriate percentage of CO_2.

The division into the main household categories allows us to better measure our activities and determine which cuts will be most effective.



An expansion of the concept shown in the preceding chart has been done by Dr. Christopher Jones and Dr. Daniel Kammen of the Cool Climate Network at the University of California at Berkeley.

They subdivide the five divisions of travel, home, food, goods and services into subdivisions. Travel includes driving and flying. Home includes water natural gas and electricity. Food includes animal products, cereals and produce. Goods include clothing, medicines, household goods, personal goods and entertainment. Services include information, entertainment, health care and miscellaneous.

Note that the Travel column includes the energy to manufacture a car and the Home column includes the emissions generated from building a house. This approach is part of the discipline of Life Cycle Assessment, also known as “cradle to grave” analysis.

16.2 metric tons (US) vs. 1.5 metric tons (India) from “Material World – A Global Family Portrait ”

Unsustainable | **Sustainable**

14

These pictures are from the book Material World – a Global Family Portrait by Peter Menzel. They illustrate the gulf between the unsustainable energy rich world and the sustainable energy poor world. Poor also means sustainable which implies frugal energy consumption.

Sustainable may also imply a shorter lifespan. On average, Indians live until age 61. The average lifespan in the world is 66 years.

The average US lifespan is about 78 years.

16.2 metric tons (US) vs. 2.5 metric tons (Cuba)

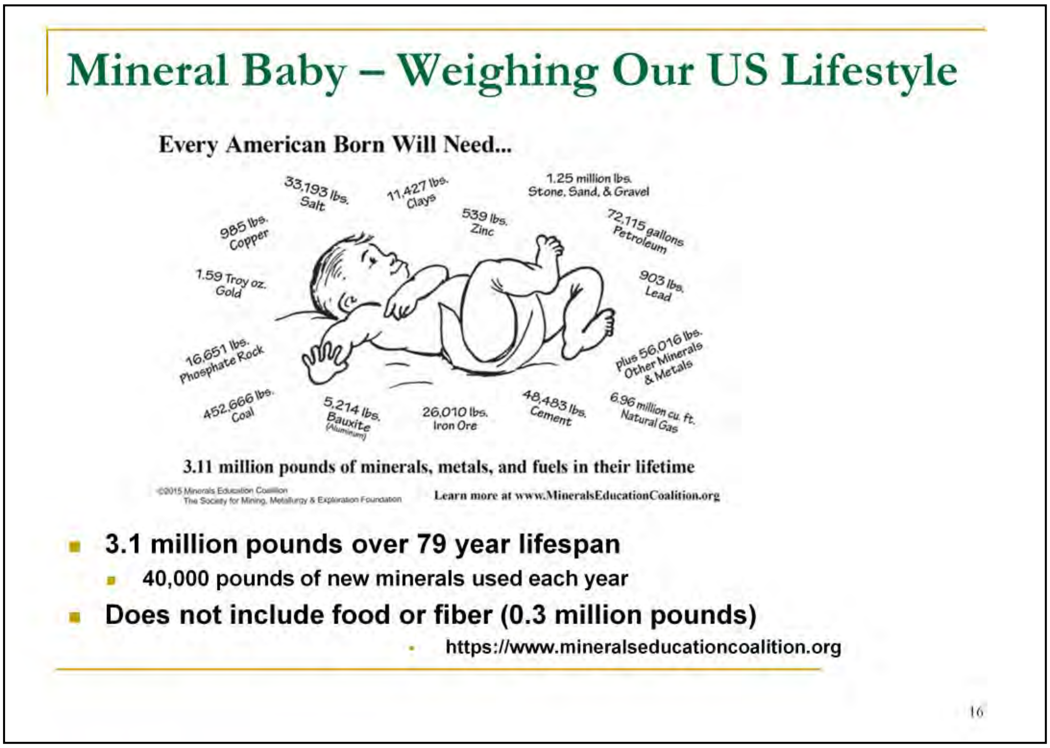
Unsustainable | **Almost Sustainable**

This shows a similar comparison between the US and Cuba. The average Cuban generates 86% less CO_2 than the average American on an annual basis.

Cubans have the same lifespan as people in the U.S. and a slightly lower infant mortality rate.

Cubans were forced to reduce their lifestyle due to the U.S. blockade/embargo created in the 1990s. The continuation of the embargo makes it hard for Cuba to increase per capita energy consumption.

Cuba has become a model for a low energy way of life. Material goods are fewer but free health care and education is provided to all its citizens.

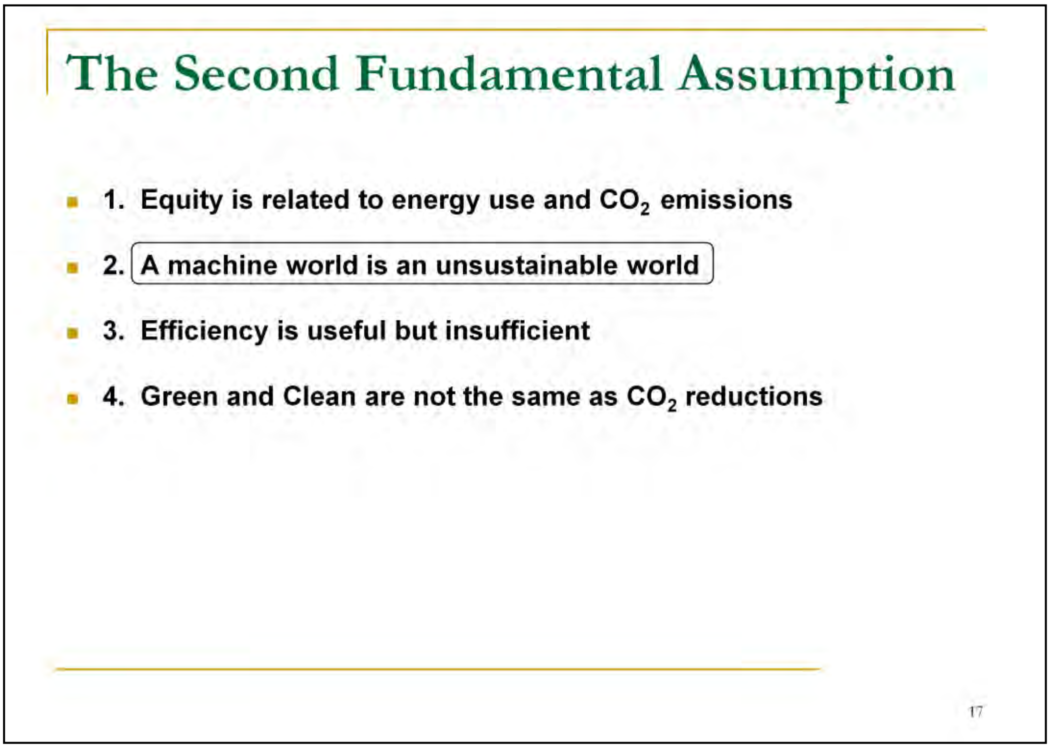


The private organization Mineral Education Coalition has developed the Mineral Baby graphic, which shows the breakdown of mineral use, including fossil fuels, consumed over the lifetime of the average American.

Food plants or plants used for making clothing such as cotton are not included. The weight of food and fiber is much less than minerals.

The chart shows the massive amount of materials we use over our lifetime to maintain our standard of living.

The Mineral Education Coalition updates this graphic yearly.



The first part of this presentation showed the wide gap between the rich and the poor of the world relative to CO_2 emissions and fossil fuel consumption. As the climate crisis worsens, it will be natural for the poorer 85% of the world to insist that the richer 15% bear the brunt of CO_2 emissions cuts. This could lead to world conflict.

This second key assumption is controversial. It goes against our most basic cultural belief – that the high tech world in which we Americans live is the best of all possible worlds and all people should aspire to it. The technology world of which we speak is more or less a set of machines which give us great power but at the expense of the environment, of which we are a part.

Will "Machine Technology" Save Us? Unlikely: More Technology Creates More CO_2

- **My Definition of Technology – "A number of unique machines that continuously create increasing volumes of CO_2 while slowly becoming more energy efficient."**

- **The average person knows little about the details of technology – they just use it.**

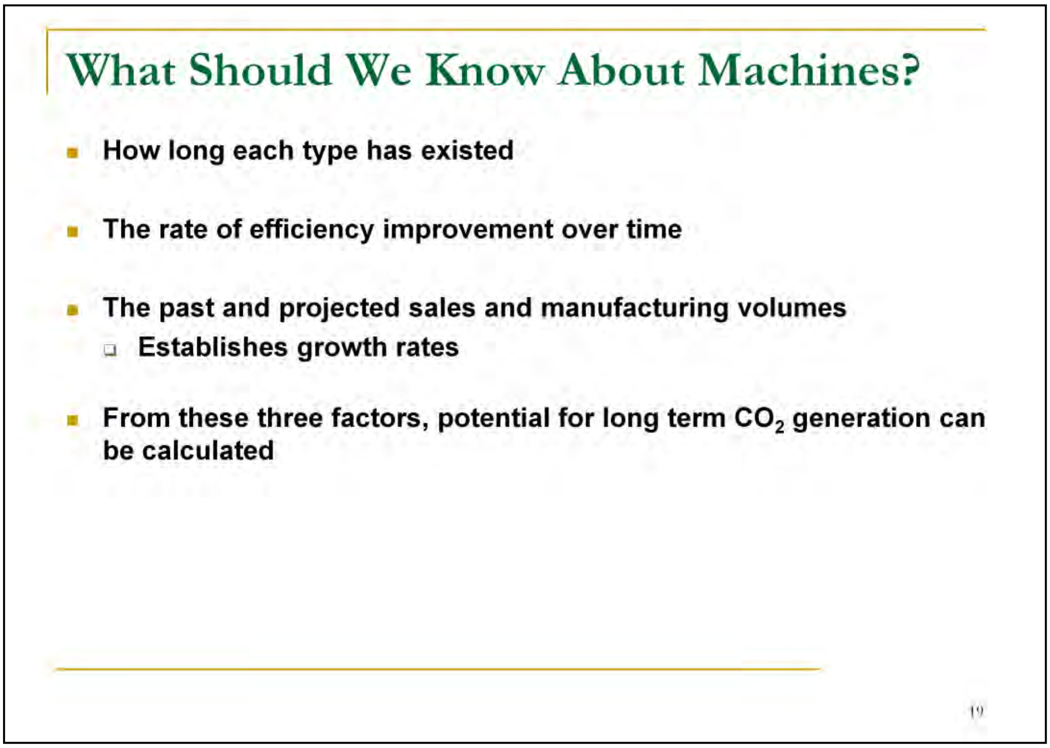
- **Thus we are susceptible to "green" propaganda and science fiction solutions.**

18

The term technology as used here describes energy using machines that consume fossil fuel to generate heat or movement. A few dozen of the thousands of machine types generate most of the CO_2. Machines always become more efficient over time, since research and development is part of every industrial organization. For example, R and D expenditures for automobiles is about $80 billion a year.

This section of the presentation discusses the mechanical world we have created. It does not include the topic of chemicals, which is another area for investigation. For example, the chemicals used in agriculture require energy in their manufacture and fossil fuel feedstock.

Few people understand the details of our machine based way of life. This leaves them more vulnerable to questionable solutions.



Analyzing machines in the context of energy and emissions is not too difficult.

One begins by asking three questions, each of which is fairly easy to answer, mostly with Internet access. The questions are:

What is the date of invention of the machine?

What is the historic annual improvement in efficiency?

What is the annual production volume?

These questions will be addressed for a series of machines in this presentation.

The Internal Combustion Engine

- **Invented 1886**
- **Efficiency Improvement: 1% yearly**
- **Sales Growth Rate: 2% annually**
- **Current world population: 1 billion cars**
- **Car population projection: 5 billion cars?**

20

The first car was invented in 1886. The annual Transportation Energy Data book produced by the Department of Energy shows the efficiency improvement on a yearly basis since 1970. The “BTUs per passenger mile” metric show about a 1% per year improvement.

The Sales growth rate of cars for the world is about 2% per year. This means that the sales rate cancels out the efficiency improvements.

There are currently 1 billion cars in the world. If the world had the same percent of population that own cars as in the US, there would be five billion cars in the world.

The First Energy Machine – Steam Engine Basis for the Industrial Revolution

- Inventors and date of invention
  - Thomas Newcoment (1712)
  - James Watt (1781)
- Efficiency Improvement: 1-2% annually
- Steam Engines are used by Power Plants
- There are tens of thousands in the world
- They power billions of motors and lights

21

The Steam Engine led to the Industrial revolution. Many of the original machines that produced electricity have been consolidated into several thousand large power plants and a few billion electric motors.

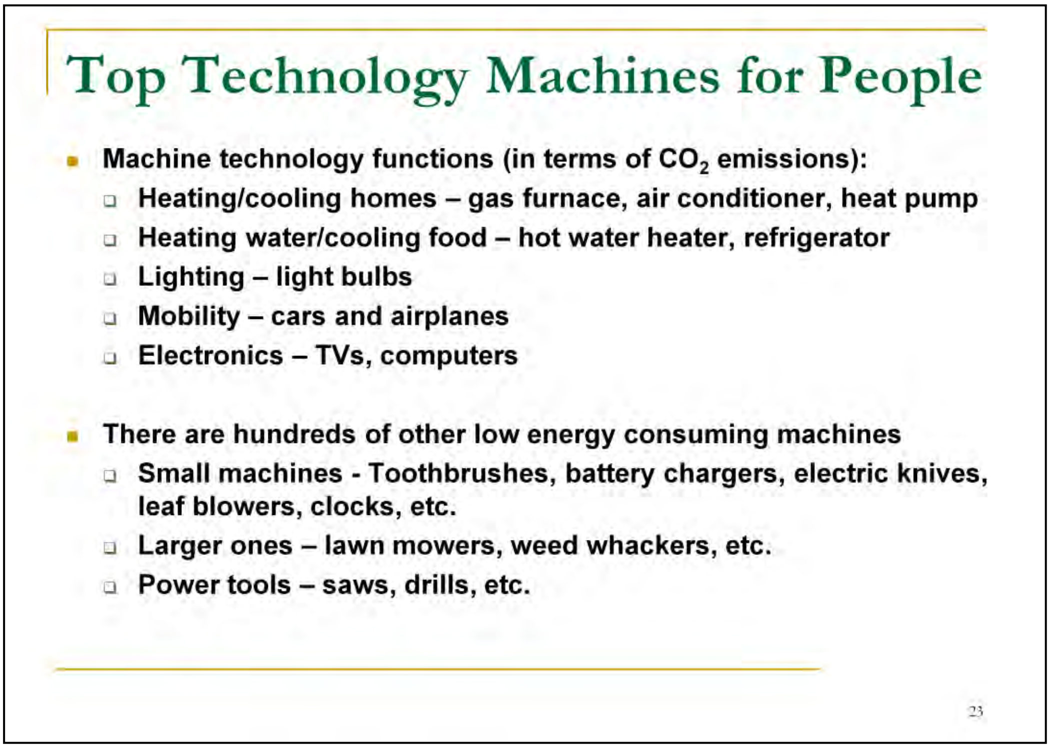
Originally steam engines did the work directly by complex systems of pulleys and belts. Today, steam is used to generate electricity which provides the energy for electric motors to do the work.

Key Energy Using Machines

- Automobile Engine – Karl Benz (1886) – 1.1 billion in use
- Jet Engine – Maxime Guillaume (1921) – 100,000s in use
- Air Conditioner – Willis Carrier (1902) – billions
- Forced Air Furnace – ? (1935) – billions
- Heat Pump – Peter von Rittinger (1856) – billions
- Refrigerator – Baltzar von Plater (1922) – billions
- Hot Water Heater – Edwin Ruud (1889) – billions

This chart shows dates and rough numbers for important energy using machines. Good data exists on cars and airplanes. Many of the others are not easily counted but many number in the billions.

Other machines include light bulbs, battery electric cars, nuclear power plants, clothes dryers, hand tools, etc.

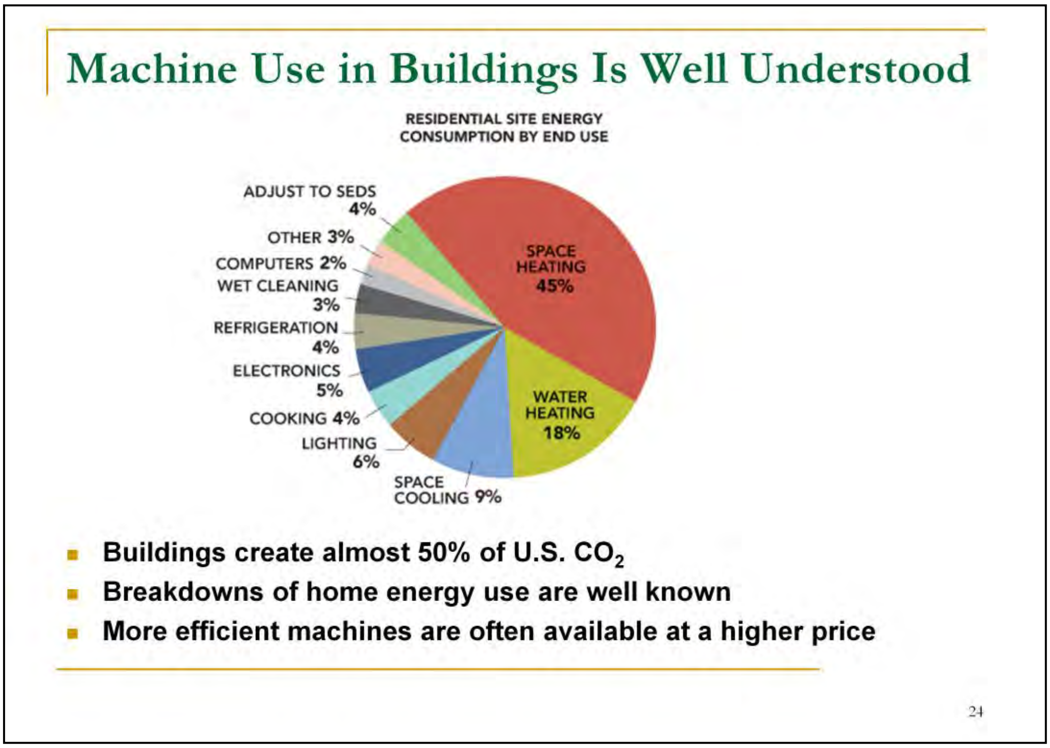


There are many different kinds of machines but the big energy consuming machines are well known. So called “climate control” includes heating, cooling and ventilating, and those machines are installed in every home and commercial building. Hot water heaters and refrigerators are also basic machines which consume energy. Light bulbs use a significant amount of energy. We also use a wide variety of different appliances.

Transportation is simple – cars and airplanes are the big consumers of energy for most of us.

Electronics cover a rapidly growing type of machine. Most homes have multiple TVs, many with high energy big screens. Most people have a smart phone.

There are many other machines that can be ignored for the time being because they use very little energy.



The individual has the most opportunity to cut their personal CO_2 emissions in the home.

This graph shows the distribution of energy consumed by machines for residential buildings. The functions are listed rather than the machine itself. Space heating implies a natural gas furnace or heat pump. Space cooling implies an air conditioner or heat pump. Cooking implies a natural gas or electric stove while wet clean implies a washing machine and a dryer.

A great deal of work has gone into residential buildings to reduce their emissions. For heating and cooling, better insulated and less leaky homes have been designed. At the same time gas furnaces and heat pumps have become more efficient. However, homes have become larger and each person is using more space which requires more heating and cooling. People are also using more electricity using machines than they did when homes were smaller.

Machine Breakthroughs Are Rare

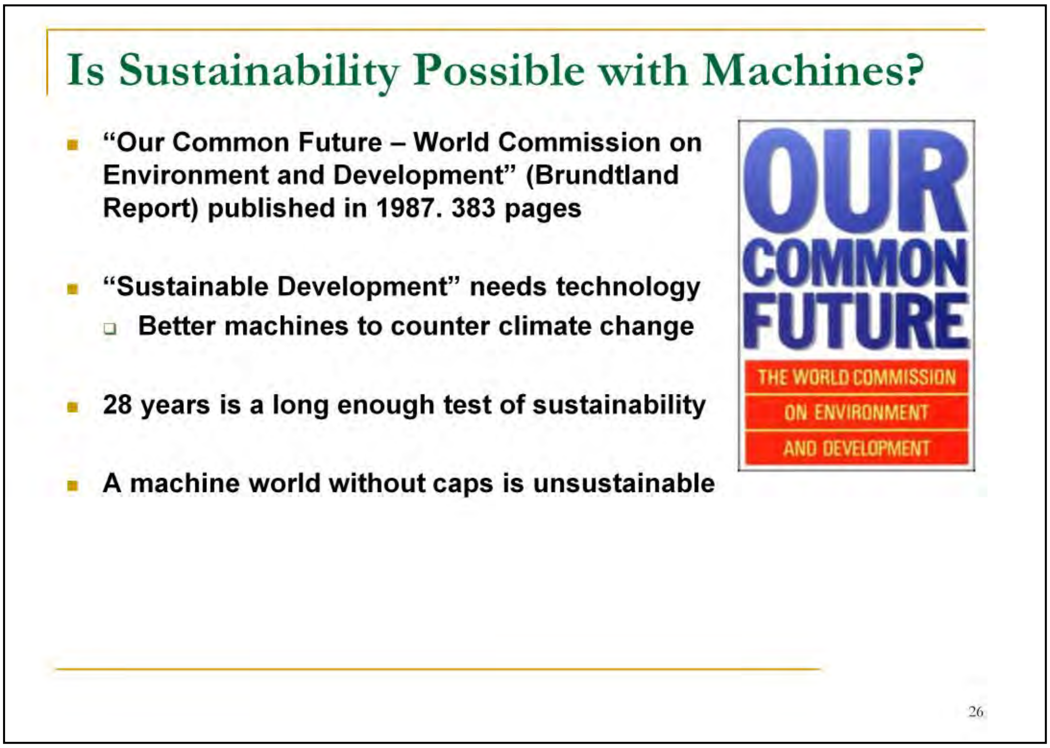
- **Heaters, chillers, engines, motors, TVs, radios – very old devices**
- **Newer technologies – like electronics and computers – use more energy**
- **Even recent breakthroughs are not "new"**
  - **First wind turbine – 1887**
  - **First computer – 1943**
  - **First solar cell – 1954**
- **World yearly R & D expenditures – about $1,000,000,000,000**
  - **Yet CO_2 emissions per person continue to rise each year**

25

I have already covered a good deal of information about machines. Furnaces, air conditioners, heat pumps, and light bulbs are limited in their potential for better efficiency. Electronics add load – that is, they require more energy be used.

Most of the technologies we use are also old. This includes the computer as well as the renewable energy systems of wind turbines and solar PV cells.

The size of the R and D budget for new and improved machines is very large. The result is an ever increasing number of machines and more CO_2 generated every year.



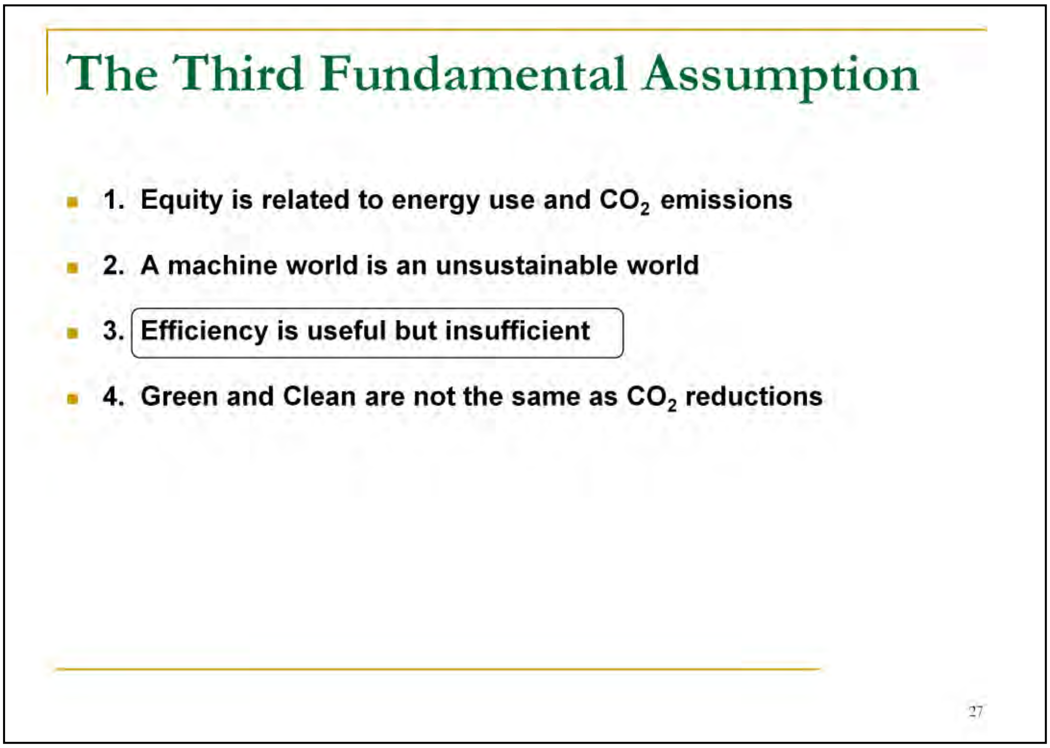
The "sustainability" movement began almost thirty years ago with the publication of the UN report called *Our Common Future*, also known as the Brundtland Report.

The Brundtland report noted that sustainability would require much more efficient machines.

Even though such machines were developed, consumption has been rising faster than machine efficiency.

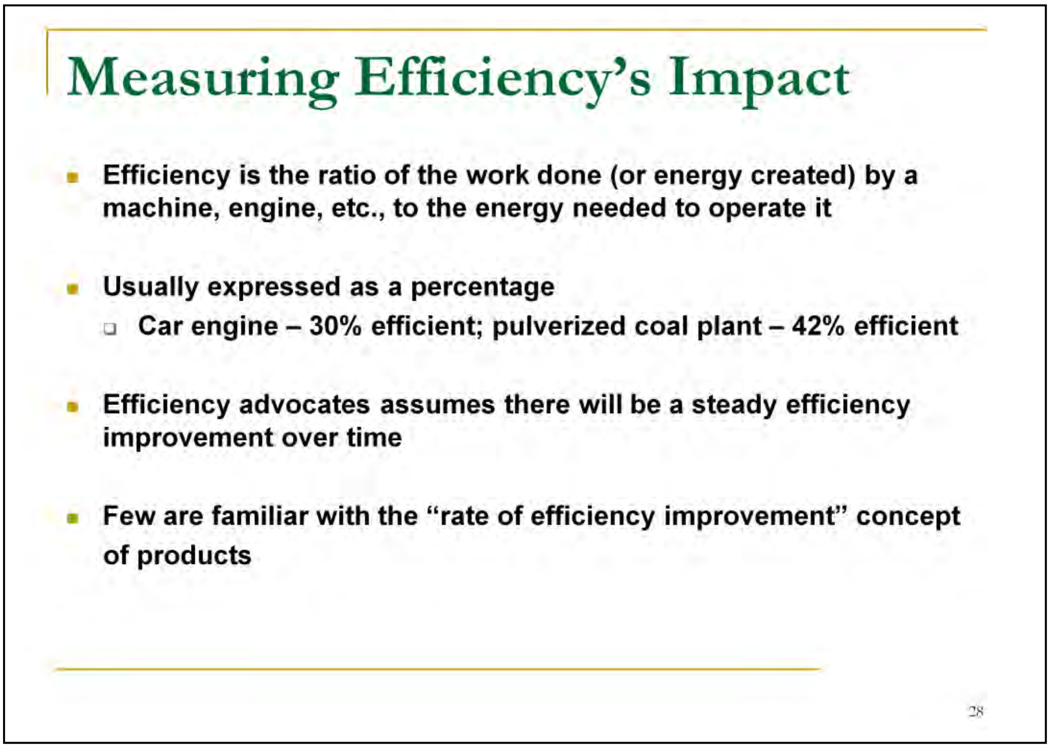
Since the Brundtland report, thousands of reports have been published but sustainability remains elusive.

A world dominated by energy using machines with no limits or caps placed on their use cannot ever be a sustainable world.



Efficiency has been called the fifth fuel. Yet a more detailed analysis challenges its effectiveness in a consumer society where economic growth is prioritized.

Economic growth for a nation requires more energy. An increased standard of living for an individual or a nation also requires more energy be consumed every year.

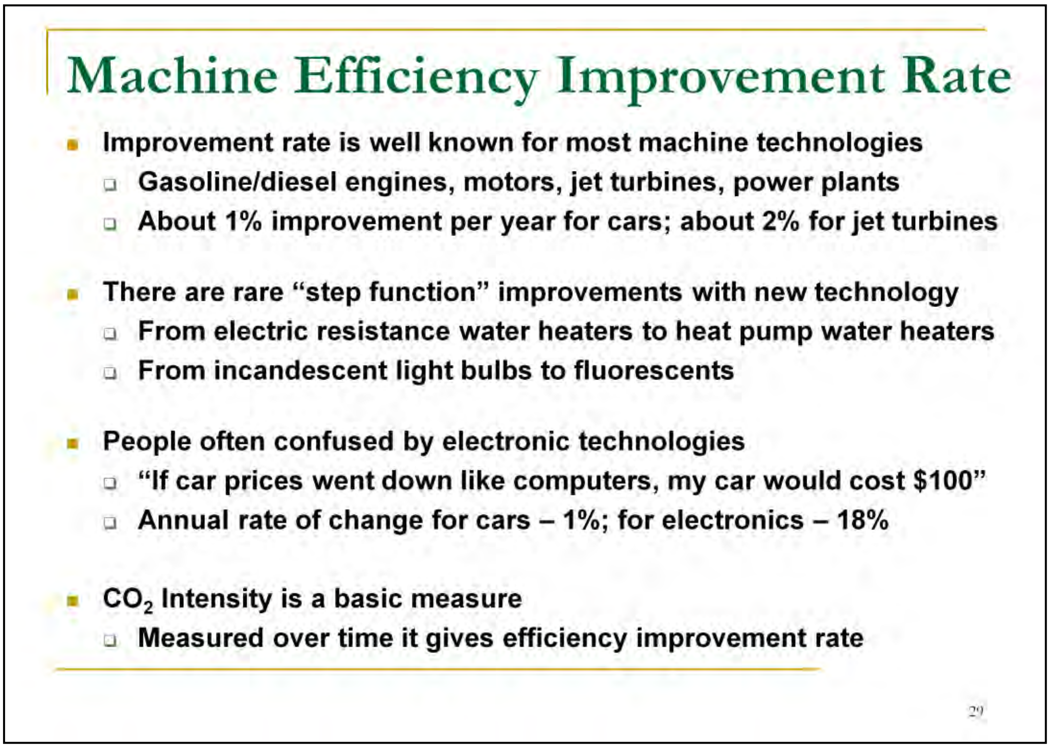


Machine efficiency is measured by how much of the energy contained in fossil fuels is used in heat or motion. It is usually expressed as a percentage.

Consumers should learn the different forms of efficiency ratings for different kinds of machines. There are shorthand ways of measuring efficiency such as miles per gallon for cars or SEER ratings for air conditioners. It requires study and analysis.

There has been and will always be a steady improvement in efficiency for almost every types of machines. But the rate of efficiency improvements is limited.

The rate of efficiency improvements is important to understand. It is typically given in terms of a percent improvement per year. For example car engines typically become more efficient at the rate of about 1% per year.



The improvement rate is well established for engines and machines of all kind, including power plants.

Dramatic changes in technology (step functions) occur relatively infrequently. For example the incandescent bulb was discovered in the middle of the 19^{th} century. Thomas Edison patented a version in 1879. Fluorescent lighting became available in the 1930s. The popular compact fluorescent, or CFL, arrived in 1976. Light emitting diodes or LEDS appeared in 2008.

The improvement rate for electronics is high – near 18% annually. Most machines are much lower, about 1-3% per year. People have sometimes assumed the efficiency rate of electronics should be applicable to other fields such as transportation.

The media rarely discuss efficiency in terms of "carbon intensity" or "energy intensity" or "emissions intensity" or "CO_2 intensity". By understanding these kinds of measures, one can better plan a curtailment strategy.

Technology Types Improve Differently

Airplane Price – $7 million (707) to $200 million (787)

Computer Price – $7 million (CDC 6600) to $700 (Apple IPAD)

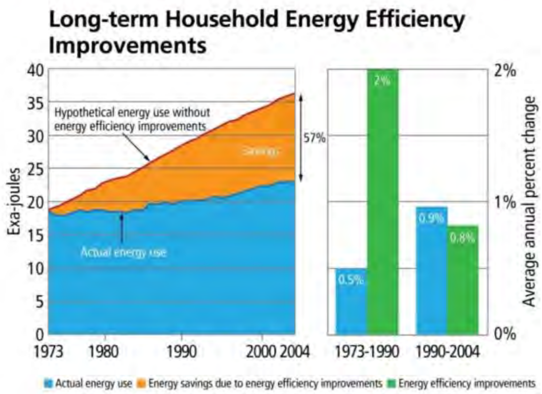
30

All technology efficiencies improve at different rates. The rate of improvement, often based on the volume of products produced, is measurable. The top two images show the change in efficiency and cost of two airplanes. The Boeing 707 cost $7 million in 1965 which would be equivalent to $51 million today. But better more efficient airplanes like the 787 cost about $200 million today. The 787 might be twice as efficient as the earlier 707. It flies at the same speed.

The bottom two images show two computers. The very large CDC 6600 supercomputer on the left cost $7 million in 1965. The IPAD on the lower right cost $700 and is much smaller and much faster.

Electronics have improved about 3 million percent over their 60 year life time (about 18% annually) while jet airplanes have improved only about 60% over a similar lifetime.

Household Efficiency Improvement Rates



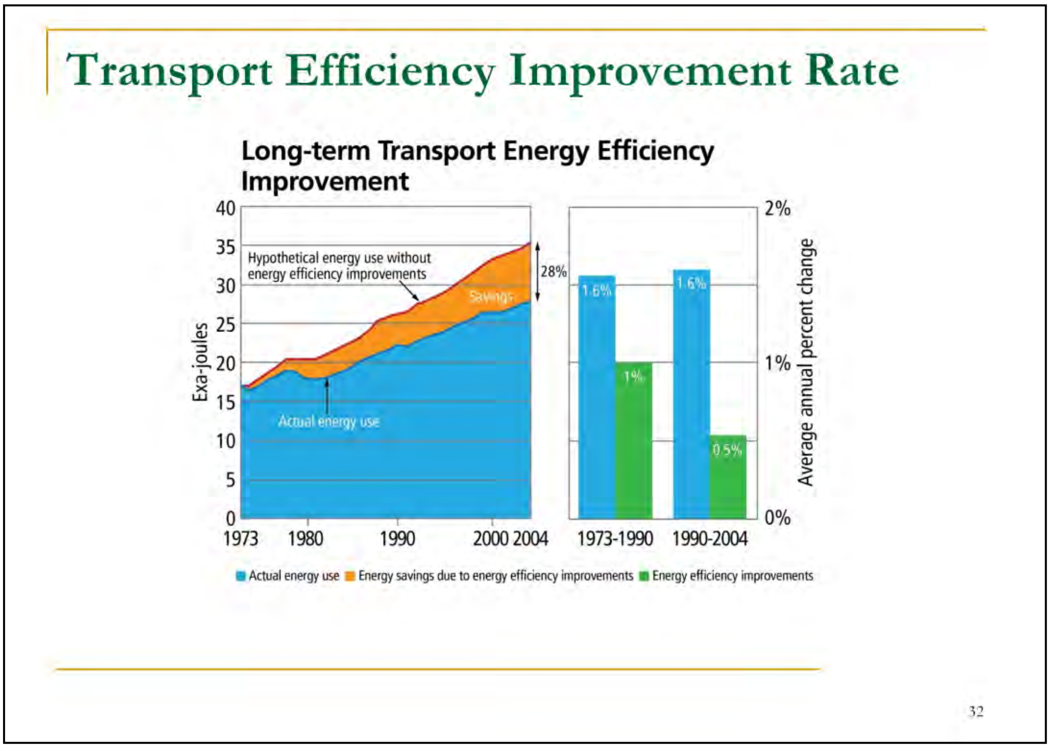
- **Note "Diminishing Rate of Return" in green on right side figure**
- **Note that consumption (left side figure) always goes up**
  - **Graphs from Energy Use in the New Millennium – Trends in IEA countries**

31

These charts shows the household energy efficiency improvement rates. The left hand graph shows the actual energy use in blue and the estimated energy efficiency savings in gold. Note there was a cumulative 57% savings over 30 years. Also note consumption is always rising.

The graphic on the right has two graphic bar pairs, one for the period 1973-1990 and one for the period 1990-2004. Each pair shows the average annual percent change for actual energy use (blue) and the annual percent change for energy efficient improvements (green). During the period 1973-1990 the actual energy use increased half a percent per year while the energy efficient improvement was 2% per year. In the second period, actual energy use increased while the energy efficient improvement rate declined from 2% to 0.8%.

This shows that the rate of energy efficient improvements is decreasing over time. This is often referred to as the law of diminishing returns.

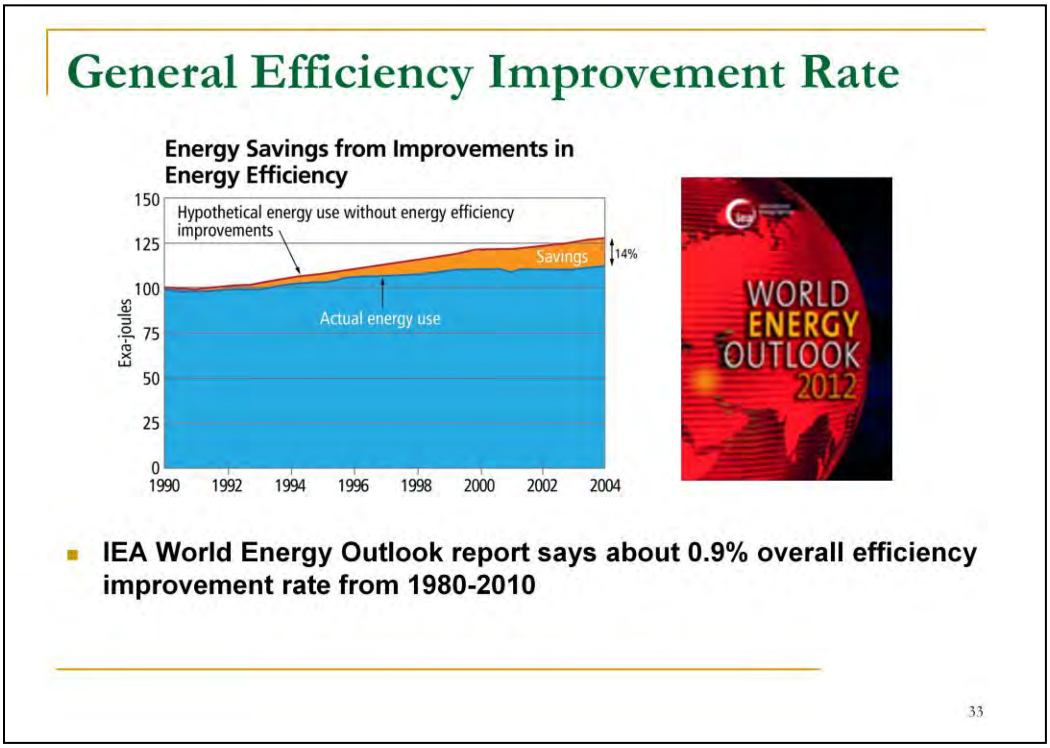


This chart shows efficiency improvement rates for transport. Energy efficiency improvements were less for transport than for households as shown in the preceding chart.

In terms of transport, actual energy use growth (in blue) for two periods as shown in the right hand graphic is about 1.6% per year. In terms of energy efficiency improvements (in green), the rate of improvement declined from 1% in the first period to one half percent in the second period.

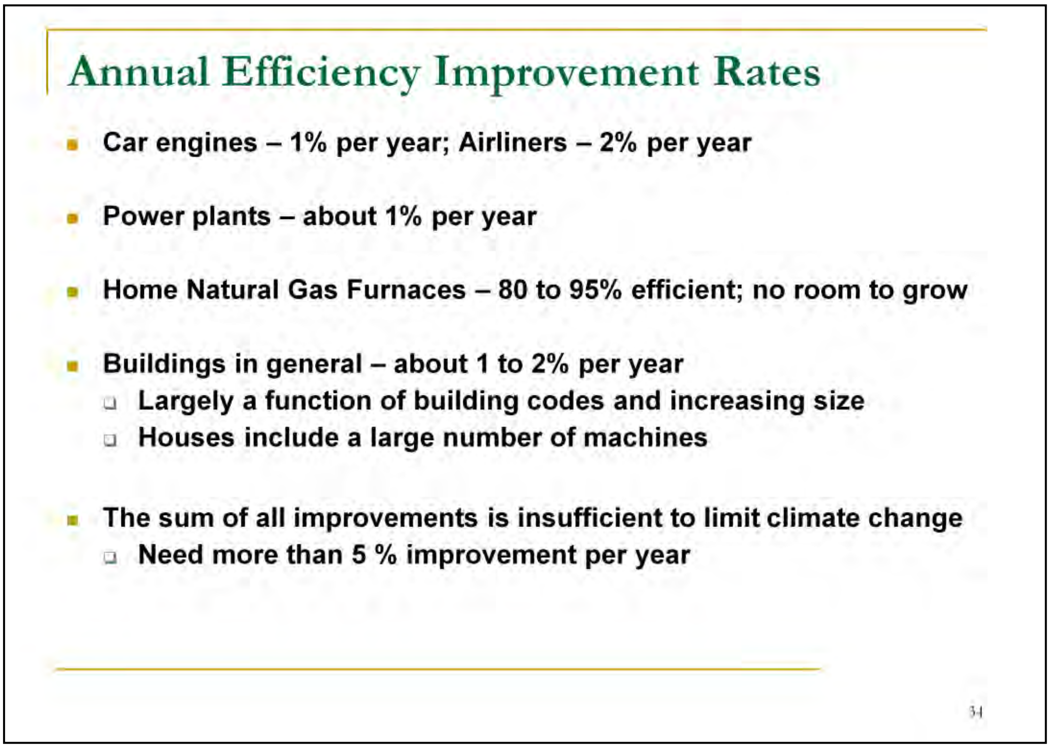
Note that this chart as well as the chart for household energy improvements show that energy use in total has increased in spite of savings from energy efficiency improvements. Unfortunately, the rate of efficiency improvement for both has declined.

As a result, the amount of CO_2 emissions from transport and homes has grown each year.



The general efficiency improvement rate for many applications is shown on the left hand side of this chart. The total energy savings is 14% over a 15 year period, less than one percent compounded per year. Roughly the same rate is given in the annual World Energy Outlook for 2012 for a longer period of years.

There is no reason to think that efficiency improvement rates are going to change very much in the future. Government programs might help, but time may show that all the US government funded programs for cars have had less effect than the Prius division of Toyota Motors. This is not an argument for free market versus government. It merely points out that the government may be better at some things – such as military and Medicare – but not so good in other things – such as mass producing efficient consumer products.



This chart lists some of the rates of efficiency improvements of important machines. When a machine such as a condensing natural gas furnace reaches 95% there is little room for improvement.

Buildings include a large number of machines. Most of building energy is expended for heating and cooling. The building envelope (exterior walls, roof and floor) is important, since a tight well insulated thicker envelope can reduce the energy load on furnaces and air conditioners.

Other machines in building that do not involve heating and cooling are not affected by the building envelope. Personal habits determine much of this kind of usage. Hot water, for example, is a major contributor to CO_2 emissions. Much shorter showers could make a positive difference. More efficient refrigerators are also important.

To reach the climate goals for 2050 we need energy improvements of over 5% per year. This will be difficult. However, renewables will offset some of the efficiency improvements required.

Current Efficiency of Major Machines

- Car engine: 20–35%, Measured in Miles per Gallon (MPG)
- Jet engine: 40%, Measured in kilometers per ton of fuel
- Power Plant: 32–45%, Measured in pounds of CO_2 created per kWh
- Home Heating Furnaces: 40% (electric), 90% (natural gas)
- Heat pumps: air conditioners, mini splits – Measured in SEERS
- Many more….. cooktops, electronics, razor, toothbrush, TVs

Efficiency is important. We are most familiar with its measure when we consider the miles per gallon for cars. On line energy sites show the efficiency of different airplanes should one wish to know his or her CO_2 from flying. Power plants should interest us because of the massive amount of CO_2 they generate.

Efficiency is limited – one cannot go beyond 100 percent. Even getting close to 50% is quite hard. There is a thermodynamic principle called the Carnot cycle, named after Nicolas Carnot - a French physicist of the 19^{th} century - which has to do with the amount of energy that can be converted from one type to another, such as coal to electricity. Scientists have tried to improve energy efficiency of machines for centuries but are limited by such physical laws.

Will Efficiency be Sufficient?

- Jevon's Curse (Paradox, Rebound Effect)
  - "It is a confusion of ideas to suppose that the economical use of fuel is equivalent to diminished consumption. The very contrary is the truth." from The Coal Question (1865)
- Increases in efficiency do not decrease total fuel consumption
  - Efficiency without a cap leads to increased CO_2 loads
- "Efficiency without Sufficiency is a lost cause" – S. Alexander
  - We must reduce our "Standard of Living"
- "Standard of Living" is not the same as "Quality of Life"

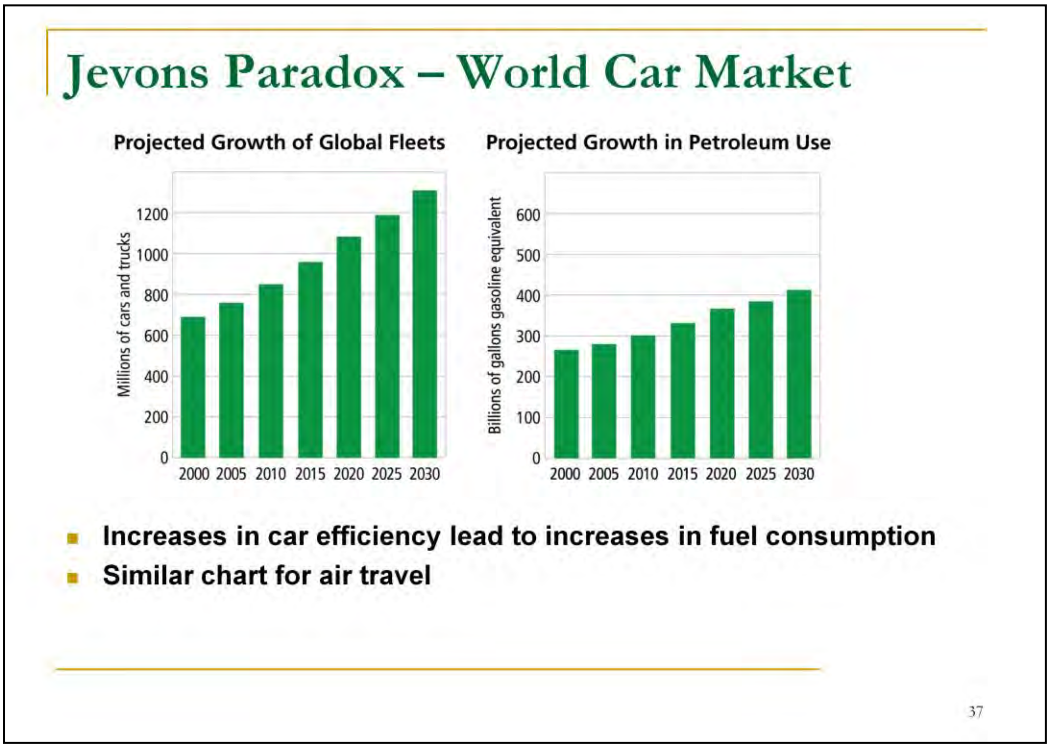
36

Economist William Stanley Jevons predicted increasing fossil fuel consumption resulting from efficiency in his book, *The Coal Question* (1865) when he was 30 years old. He predicted what we are experiencing today – that an increase in efficiency leads to more consumption.

Machine efficiency improvements lower the cost of fuels to operate the machine. This leads to lower consumer prices, which leads to increased purchases of machines, which lead to more fossil fuel consumption. For example, new small more efficient cars have led people in China and India to trade in their bicycles and motor scooters for automobiles.

This has been especially apparent since the end of world war II. Beginning then, a higher standard of living has been associated with increasing energy consumption.

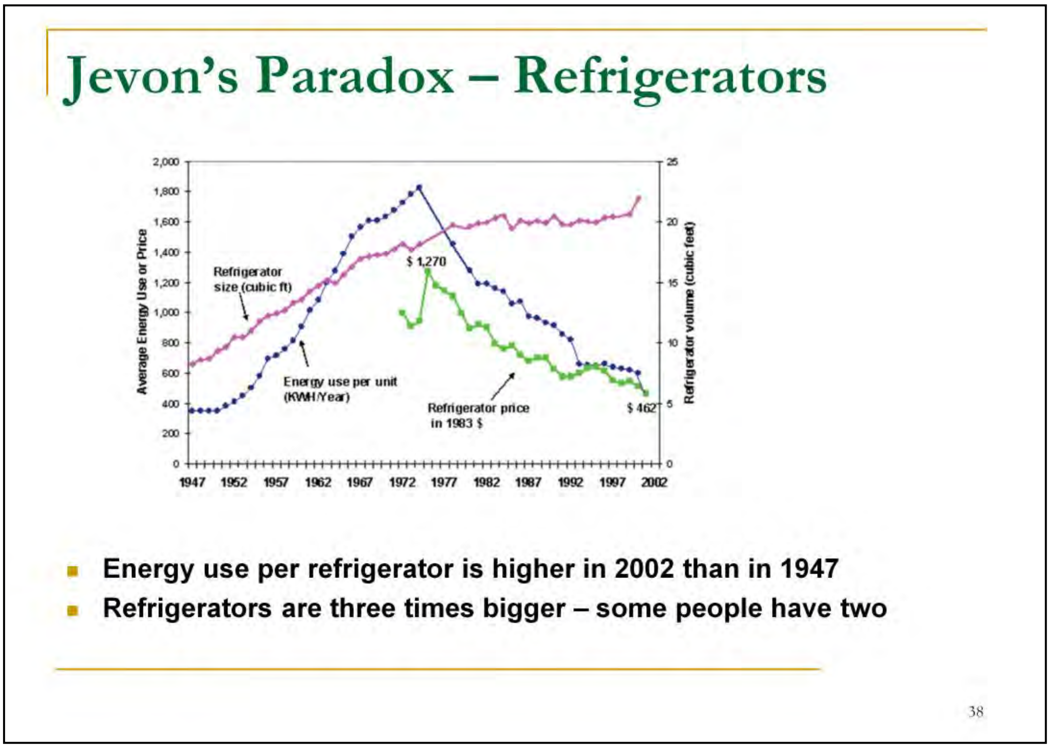
Until now we have ignored the problems that come from that rising consumption, particularly climate change. We will have to focus more on "quality of life" and focus less on "standard of living" resulting from increased fossil fuel usage.



Jevons paradox has been true for the automobile industry since its inception. Even after two decades of sales of hybrid cars and five years of sales of plug-in cars, car energy consumption has not decreased.

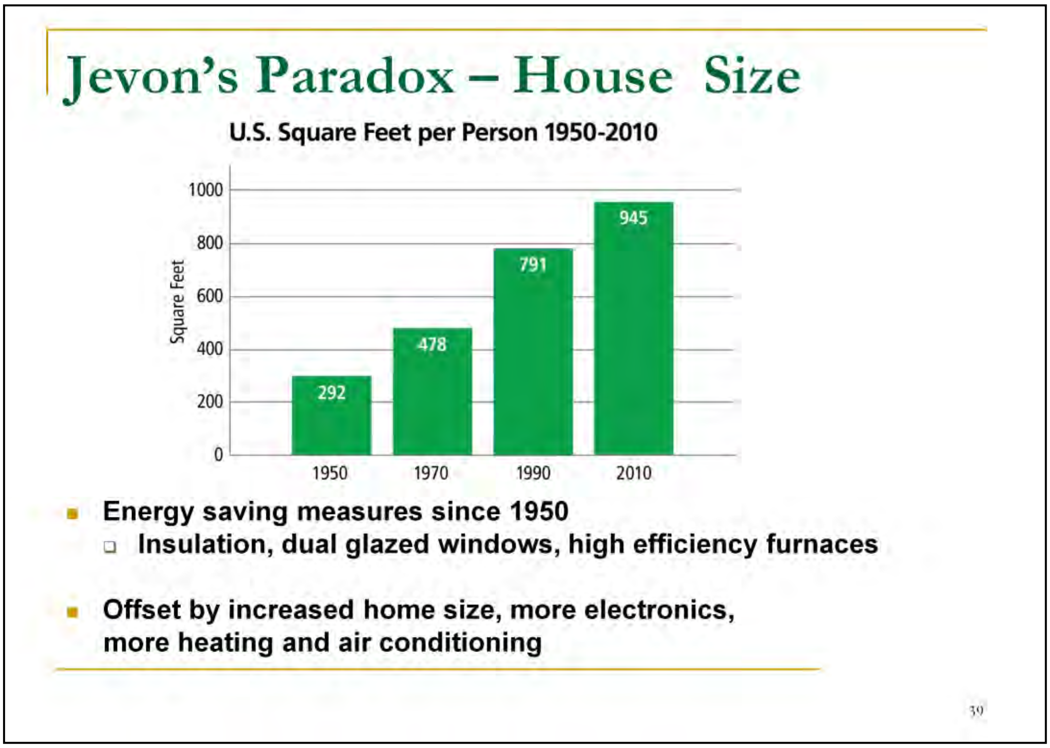
This is illustrated on the left graph by the projected growth in the worldwide manufacturing of cars. It estimates that the car population will double in a 30 year period. At the same time the cars will be more efficient. The right chart shows that the efficiency improvement does not lower total petroleum usage – it only decreases the rate of growth of consumption.

The downside of energy efficiency is that the free market encourages consumption and uses efficiency to lower the price of consumption.



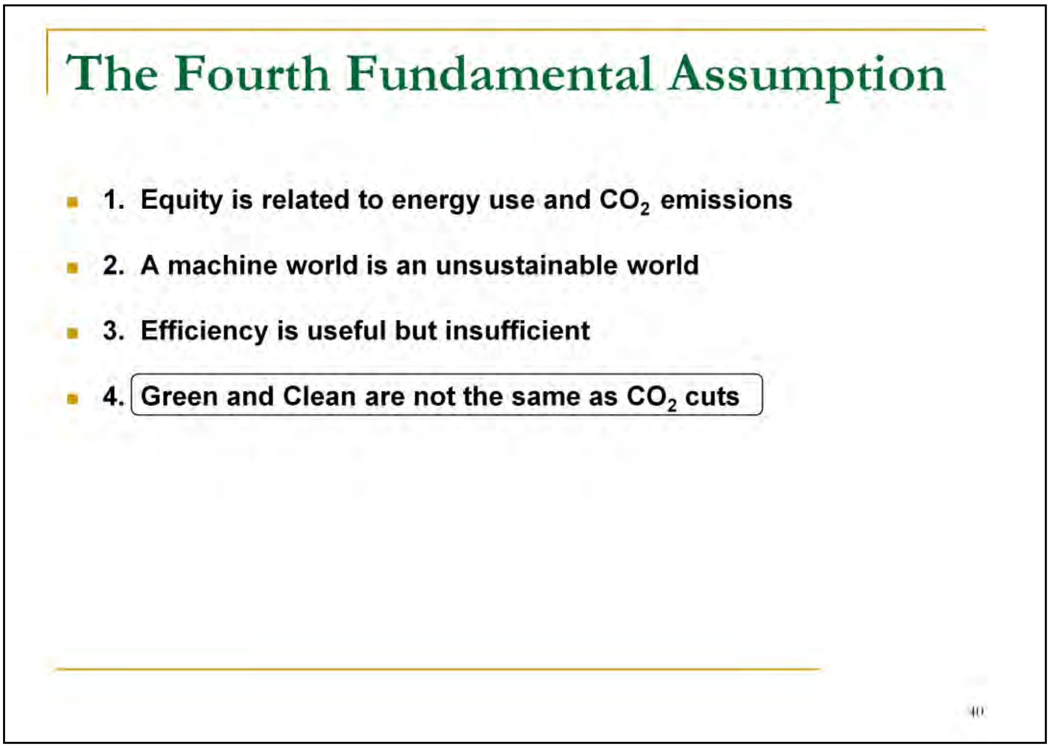
Refrigerator energy efficiency improvements rates have been higher than any other kind of machine, about 5% per year since the late 1970s. Refrigerators are based on heat pump technology which has been heavily funded, particularly in Japan.

This chart shows the rate of improvement in refrigerators since the late 1970s. But as the efficiency increased so did the size of the refrigerator. Now a modern refrigerator contains twice the cubic feet of an early model and so still uses more energy per year than earlier models. The price of refrigerators has declined which has led to some people buying two of them.



Houses became more efficient with better insulation. More efficient furnaces and air conditioners resulted in reduced CO_2 emissions. However, over a long period of time the emissions intensity per house has not dropped significantly. The reason is that the square feet per person has almost tripled. Houses are simply using more energy as efficiency increases because efficiency leads to larger homes.

Bigger houses also have more space for more and larger energy using machines. Reduced prices for machines has made it easier to acquire new ones. Most appliances and entertainment machines have grown in size, offsetting some of the efficiency gains.



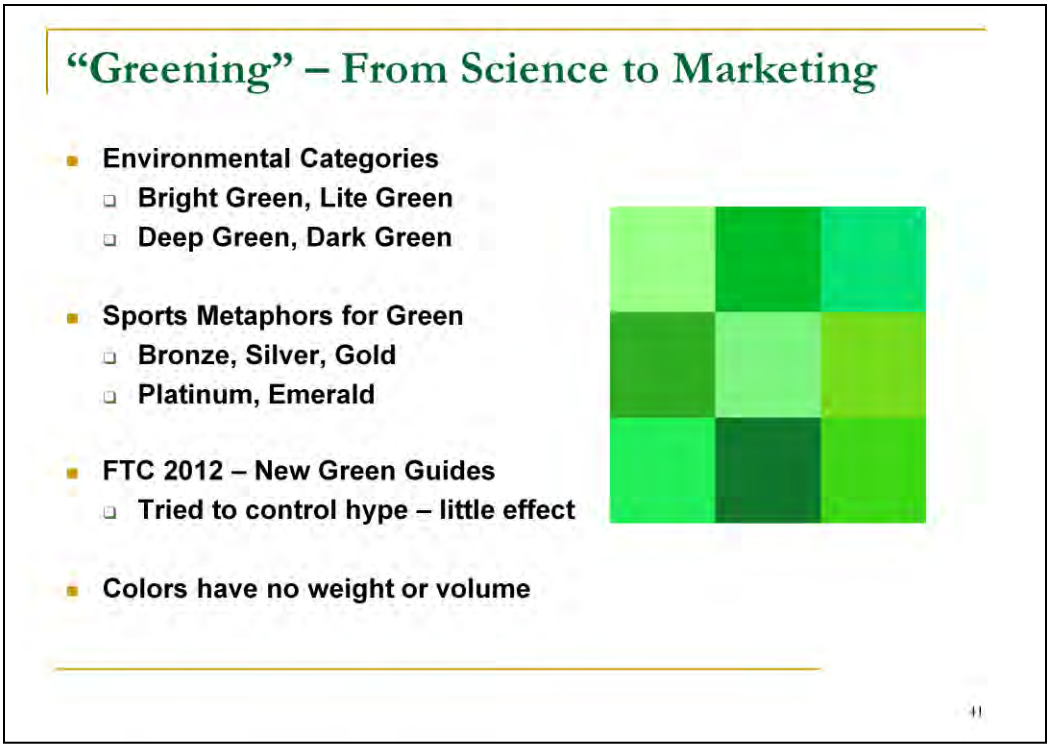
We hope for efficiency breakthroughs in energy using machines but they are infrequent.

Because of a strong commitment to electronics, we expect a major breakthrough to occur every few years. But electronics is a very different kind of machine.

Green and clean are terms without any connection to physical reality such as energy consumed or CO_2 generated. The words can and often do mean anything associated with environmental concerns. But without metrics the value of a green proposal is impossible to measure.

Greenwashing is a term that reflects the nature of green as an implied metric. Most people view green product marketing as somewhat of a scam and give little credence to its claims.

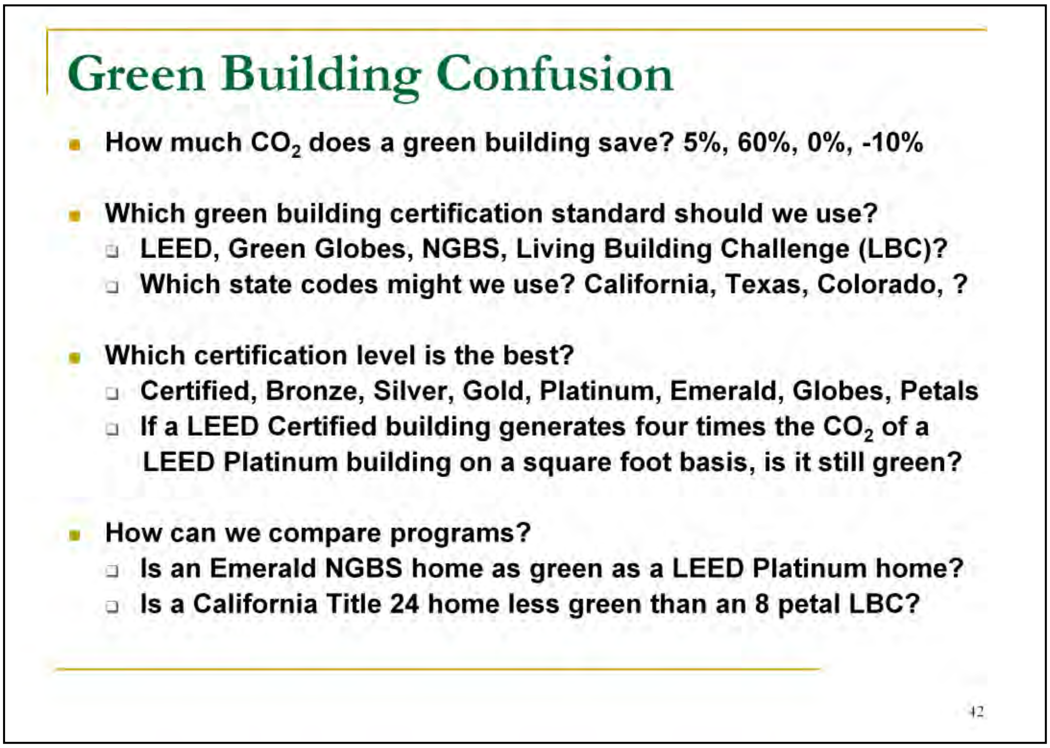
In recent years, the term “clean coal” has been popular referring to future plans for extracting CO_2 from the output of coal plants and pumping it into the ground. But this technology has not developed to a degree that it can be used universally. So coal plants today remain “dirty”.



Marketing is a strong force in the American economy. More money is spent per capita in the U.S. than in any other country in the world.

There are a limited set of parameters to describe environmental issues, such as CO_2 created, water used, land cleared, etc. Each issue will have its own particular measure. Without such a metric, the analysis and response for an issue is highly subjective. Climate change is a very complex scientific field with many subdivisions. To use a term like “green” has no relevance and confuses people.

For many years the Federal Trade Commission has attempted to control excessive marketing claims for environmental products. Its success has been limited. Sports metaphors are popular, particularly in building. This deliberate attempt to create an emotional response based on the nation’s interest in sporting activities has obscured the limited effect of building energy efficiency efforts.



The questions on this chart are very difficult or impossible to answer. If we want to know the amount of CO_2 saved, then we must measure the fuel used by the building and convert the different fuels consumed into CO_2 equivalents.

As far as green or energy efficient building standards, there are so many, each with its own grading system, that essentially a person simply picks one that appeals to them. All the various programs are different in focus so there cannot be a best one.

Certification levels are also arbitrary. Most people will select the lowest cost option to meet a specific performance goal. Such a goal may or may not be included in data about a building that can be shown to a potential buyer or renter.

Colors and metals are used to give some impression of a savings. But without measurements, the task is impossible. Independent studies of many green rating systems have shown that energy savings are less than predicted or promised.

Until an energy metric is adopted universally, such as energy intensity per square foot, consumers will continue to be uncertain and skeptical.

"Greening" Is a Form Of Manipulation

- **Avoids actually measuring emissions**
  - **Popular slogan "It doesn't have to cost more to be green"!**
- **Scientists and Engineers cannot compete with Green Marketing**
  - **Their solutions are more difficult and costly**
  - **Greenwashing often leads to emotional decisions**
- **Politicians can evade responsibility – "Go Green"!**
  - **Green is inexpensive – so popular; but often ineffective**
- **Allows the public to evade responsibility**

43

Green or greening is a methodology for denying the severity of the problems of building energy use. Commercial and residential buildings consume about 40% of all U.S. energy for operating their machines. 9% of the nations annual energy usage is for new buildings and building upgrades. Thus 49% of all CO_2 comes from constructing buildings and operating the machines in buildings. And buildings last a long time – several decades at least.

"Green building" was created to provide a way to appear environmentally correct. It offers a relatively inexpensive approach which avoids being held accountable for the CO_2 emissions associated with building construction and operation. It uses complex rating systems that provide a good feeling without being substantial.

By using such terms, politicians can appear supportive of efficient buildings without there being any measures of the actual performance. The public can also feel as if they are contributing without doing the hard work of determining if their actions are lowering CO_2, or are they simply cosmetic in nature.

We Must Create a Different World View

- Climate change is accelerating – we must take action NOW!
- We dare not wait any longer for techno-fixes
- It's time to take personal responsibility for the planet's future
  - Reduce CO_2 emissions from my home, my car, my food
- We cannot wait for others – or society as a whole – to change
  - We must "become the change we want to see in the world"
- It may take years for each of us to become effective at curtailing
  - Need a change in values to frugality, sufficiency, cooperation

44

The four preceding assumptions lead to five conclusions. First timing is critical – the situation is urgent. Every month another report emphasizes the danger.

Second waiting for breakthroughs of some type could be disastrous. Most of the claims for better machines or new energy sources have not realized.

Third we need to take personal responsibility. Spending too long attempting to organize others to make change discourages direct action.

Fourth any change in society could take decades. Change will only come when enough people commit to it and act on the commitment. It takes five-ten years to develop proficiency in any complex skill.

Finally becoming a curtailer is not a simple matter. It requires conserver values as well as a detailed knowledge of options and costs. Study and practice will be needed. Our character and skills will develop from the difficulties encountered when we make attempts to curtail.

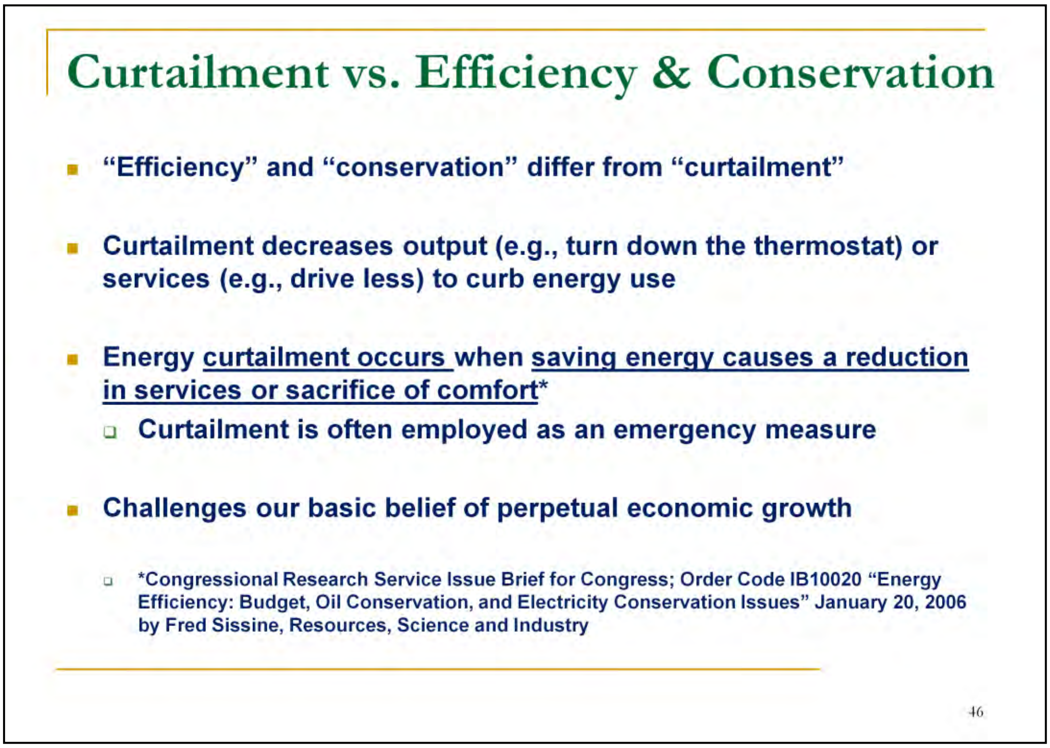
Curtailing Can be Confusing

- "…a desire to reduce carbon emissions, even combined with knowledge that doing so has net … benefits, is insufficient to yield effective action unless that person knows which actions will produce the benefits."
- "Available evidence indicates that although many householders are motivated, they lack the necessary knowledge to act."
- "Moreover, their beliefs about which actions are most beneficial are often mistaken, … "
  - From The Short List: The Most Effective Action U.S. Households Can Take to Curb Climate Change – Gerald T. Gardner and Paul C. Stern. Environment September/October 2008

The issues of energy and emissions are very complex. Once a person decides to directly address these issues in their personal life, they often find themselves in difficulty. Accurate clear information is not easily available. There are many contradictions and opposing techniques without clear measurements. The benefits are never as attractive as first presented. This is largely due to trying to make a complex problem simpler.

For example, the consumer must develop building knowledge in order to interact appropriately with building professionals. The building industry itself is divided on the subject of building energy saving. Building cost data is hard to come by and the labor pool for this kind of work is limited.

People also need to develop comprehensive knowledge about food. Understanding food sources and the CO_2 generated by different kinds of food will be a key skill.



Efficiency and conservation have been popular in the US for many decades. A strong belief in future technology limits people's actions to reduce their personal CO_2. Efficiency implies a savings without effort and conservation has been more associated with nature. Neither can provide the degree of reduction that is needed.

Curtailment assumes some personal sacrifice will be needed. People will have less energy and less comfort and less convenience. It will be difficult for some individuals to make the necessary sacrifices but as climate change worsens, the need will become more apparent.

The Curtailment Philosophy

- Creatively cutting energy use
- Accepting some inconvenience & discomfort
- Choosing a lower "material standard of living"
- Seeing low energy as "higher quality of life"
- Finding joy and satisfaction in low energy activities

47

Cuba is an example of a country that has dramatically limited energy use but which has a high quality of life. Life expectancy is the same as in the US while infant mortality rates are lower. Free health care and education protect Cubans from the ravages of a free market. Cooperation is valued over competition.

The climate crisis implies a level of inconvenience and discomfort that is far less than the discomfort that will come in a severely warming world.

Since standard of living is tied directly to energy consumption, it must be reduced. However, this need not be seen as a tragedy.

The alternative is a higher quality of life with the key component of that quality being cooperation and sharing.

Finally, there can be joy and happiness in an energy constrained world where relationships, people and the environment are more important than material goods.

Americans have been focused on improving their material standard of living since World War II. A new commitment is needed that focuses on the survival of the human species and the welfare of future generations.

A strong love for our planet must be inculcated. It will no longer be possible to view the planet as simply a source of resources. Courage will be required. There are already many people who are leading curtailing lifestyles that are satisfying. The most important attitude – cooperation - is contrary to the current values of competition. We can return to the attitudes of the 1930s and 1940s where cooperation and sharing were fundamental.

We have lost many analytical skills, resulting in increased manipulation of people by marketers. A frugal perspective, supported by good mental habits, will be important.

People must begin to invest in energy reduction efforts without waiting for government support. There are many examples of this such as the passive house movement. Without early adopters and risk takers, progress will be slow.

Some analytic skills – Calculability

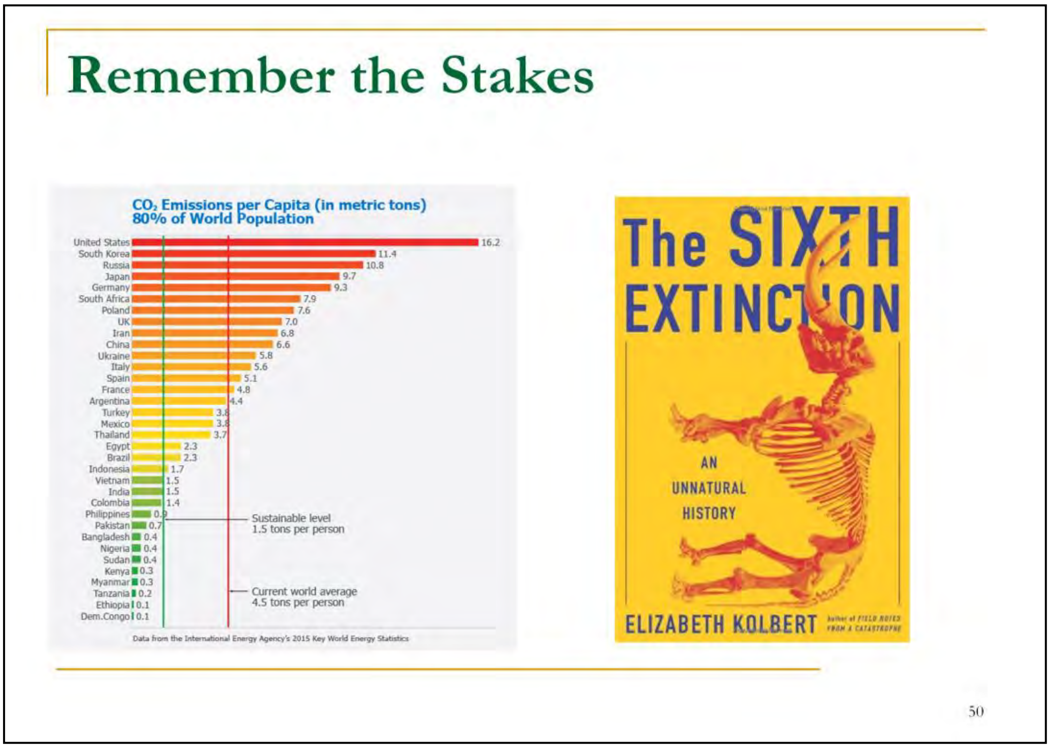
- Things to learn
  - Energy Return on Energy Investment (EROEI)
  - Material Takeoffs – particularly for buildings
  - Embodied Energy versus Operating Energy
  - Life Cycle Assessment
  - Measurement – grams (lbs.) of CO_2 per activity
- Habits to Develop
  - Counting BTUs (or therms or kwh or gallons or pounds)
- Sources to Use
  - Many are available in books, government reports and Internet

49

As noted earlier people are confused and uncertain as to what steps to take to cut their energy use. There are many dozens of possible actions to take and we need to develop the analytical skills to make the right choices. It is necessary to understand embodied versus operating energy, particularly for homes and cars. Life cycle assessment calculations will be helpful to determine housing and transportation options.

Measurement skills must be developed. Knowing the CO_2 created for every activity will be useful. And familiarity with different metrics will aid in understanding.

Analytical skills for evaluating contradictory information is important. Much of what is available is obtuse and confusing. For example a comment from an article *Rethinking the Meat Guzzler* dated 012714 says “Similarly, a study last year by the National Institute of Livestock and Grassland Science in Japan estimated that 2.2 pounds of beef is responsible for the equivalent amount of carbon dioxide emitted by the average European car every 155 miles, and burns enough energy to light a 100-watt bulb for nearly 20 days.” This kind of language is useless. A simple measure of CO_2 emitted for beef, cars, and lighting is all that is necessary.



The climate problem is deadly serious. It is appropriate that Americans take a leading role since Americans took the lead in creating this problem. The choice of consumerism, with its focus on money and material goods, is the basic cause. An alternative which focuses on caring for everyone in society, is the basic cause.

Einstein's Recommendation

- "We can't solve problems by using the same kind of thinking we used when we created them"
- We need new values & new thinking
  - Relationships are better than "stuff"
  - "Live simply so others may simply live"
  - Technology is not value neutral
- Curtailment is "right thinking" & "right action"

51

The world needs new thinking and new values. This new thinking does not require years of research and development but is found in the past when people had a different relationship with nature and with each other.

In my community and in my personal life, many of the necessary changes are already under way.

Pat Murphy
Plan Curtail
P.O Box 207
Yellow Springs, OH 45387
937 767-2103

www.plancurtail.org
pmurphy@plancurtail.org