Air Quality/Energy

A Time of Unprecedented Change with Serious Consequences
A Key Time in Human History

- The world closes in on 7 billion people
- More technology options than ever before in history
- The most populous countries in the world are increasing their use of modern technology—China, India, Brazil
- With this increased affluence comes increased consumption
Air Quality Issues More Pervasive and Complex Than Ever Before

- Local criteria pollutant problems not solved in most cities in the U.S. or around the world
- Problems with toxics in the air continue
- Global air quality problems have become serious
  - Ozone depletion
  - Visibility reduction
  - Climate change
California economy loses $28 billion yearly to health effects of pollution

Most of the losses are attributable to 3,000 annual deaths, a Cal State Fullerton study says. The study underscores the economic benefits of meeting federal air quality standards.

Louis Sahagun  
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The California economy loses about $28 billion annually due to premature deaths and illnesses linked to ozone and particulates spewed from hundreds of locations in the South Coast and San Joaquin air basins, according to findings released Wednesday by a Cal State Fullerton research team.

Most of those costs, about $25 billion, are connected to roughly 3,000 smog-related deaths each year, but additional factors include work and school absences, emergency room visits, and asthma attacks and other respiratory illnesses, said team leader Jane Hall, a professor of economics and co-director of the university’s Institute for Economics and Environment Studies.
Air Quality is Not the Only Social Issue

• Water, Solid Waste, Sewage
• Food Availability
• Now: The Economy
What is going on?

Why are we not solving these problems?

How will these changes impact our future?
I do not have all of the answers, but I can point out a major consideration: CONSUMPTION!
Growing World Population

Per Capita Arable Land

It takes about 0.4 acres to raise enough variety of vegetables for one year for a typical human to eat.

U.S=1.3 acres/person/2007
(World Total Land=5.3)

1950=1.9
2000=0.8
2040=0.5
Modern Technology and the Desire to be More Comfortable
Results in an Increased Consumption of Energy and Materials

Consider the U.S.
In the U.S. we consume 4-5 times more energy per person than our grandparents.
With Improved Technology, why are we each using more energy?
U.S. Per Capita Home Sizes

Year

Sqft Per Person in House


0.00 100.00 200.00 300.00 400.00 500.00 600.00 700.00 800.00 900.00

35 m²

105 m²
Automobile Weight in the U.S.
How does world consumption compare with U.S. consumption today?
Per Person Energy Consumption

- U.S.: 100,000 kW-Hr/person/yr
- Developing Countries: 15,000 kW-Hr/person/yr
Examples of Average Daily Driving

- Lima, Peru
- Pune, India
- Nairobi, Kenya
- Mexico City, Mexico
- Almaty, Kazakhstan
- Santiago, Chile
- Sao Paulo, Brazil
- Beijing, China
- Shanghai, China
- Los Angeles, USA

Average Daily Use (km)
Average Engine Size in Passenger Fleet

- Almaty, Kazakhstan
- Los Angeles, USA
- Mexico City, Mexico
- Nairobi, Kenya
- Pune, India
- Santiago, Chile
The rest of the world appears to be moving toward U.S. consumption practices! (rich people in developing countries already consume similar to the U.S.)

What does this do to energy and food consumption?
Extrapolation of Passenger Vehicle Use

- U.S. engine size about 29% larger than vehicles in rest of world
- U.S. driving about 60% more per vehicle compared to other countries
- U.S. citizens own 0.44 vehicles per person. The rest of the world owns 0.062 vehicles per person
- If the rest of the world has vehicle ownership, driving, and engine size the same as the U.S. then gasoline consumption increases by 11.6 times present rates.
Extrapolated Petroleum Use

Proven reserves last 43 years

Present World Petroleum Use

Extrapolated Petroleum Use

Barrels Consumed per Day

0

200,000,000

400,000,000

600,000,000

800,000,000

1,000,000,000

1,200,000,000

11.6 Times

Proven reserves last 4 years
Extrapolation of total U.S. Energy Consumption

4.7 Times
Increased Meat Consumption and Pastureland if Same as U.S.

- Meat consumption increases by 5 times from 203 million tons to 800 million tons
- Arable land in the world: 19,600,000 km²
- Present world pastureland: 5,000,000 km²
- Needed pastureland: 20,000,000 km²
- This exceeds the arable land on earth
- It is possible to farm more intensely and on non-arable land but this requires increased energy consumption
World Food Shortages

As children starve, world struggles for solution
By John Blake

(CNN) -- Some mothers choose what their children will eat. Others choose which children will eat and which will die.

Those mothers forced to make the grim life-or-death choices are the impoverished women Patricia Wolff, executive director of Meds & Food for Kids, encounters during her frequent trips to Haiti.

Wolff says Haitians are so desperate for food that many mothers wait to name their newborns because so many infants die of malnourishment. Other Haitian mothers keep their children alive by parceling out food to them, but some make an excruciating choice when their food rationing fails, she says.

"It's horrible. They have to choose among their children," says Wolff, whose nonprofit group was formed to fight childhood malnutrition. "They try to keep them alive by feeding them, but sometimes they make the decision that this one has to go."

The Rev. Martin Luther King Jr. declared in his Nobel Peace Prize acceptance speech that "I have the audacity to believe that peoples everywhere can have three meals a day for their bodies." Four decades later, King's wish remains unfulfilled. The global food market's shelves are getting bare, hunger activists say -- and it will get worse.

• “Every time an American bites down on a steak or hamburger, they're contributing to global hunger, Roberts says. As other countries become more affluent, they're copying our meat-heavy diet. The problem: It takes so much grain and other resources to produce meat, he says. "If the rest of the world were to eat like we do, the planet would collapse," Roberts says. "There's been this unspoken assumption that the rest of the world won't eat meat like we do. That doesn't go over well in countries like China."
The Problems

• With increased consumption also comes increased waste (air, water, landfill)
• There is simply inadequate energy or food to support a world of 9 billion people (2045 projection) consuming like the present U.S.
• What do we do to address these problems?
Examples of Successful Efforts to Date
Clean Air/Water Act

• US Adopted Clean Air Act in 1968
• Made major improvements in 1977 and 1990
  – 99% cleaner cars, 75% cleaner factories, 60% cleaner trucks, now attempting to reduce emissions from trucks, ships, trains, airplanes, consumer products.
• Water cleaned up before releasing to ocean, rivers, or aquifers.
Changes in Ozone Violations in Los Angeles Region
Changes in PM10 Levels

Days Over State 24-Hour Standard vs. Year
Recent Health Finding

Drop in U.S. air pollution linked to longer lifespans

By Anne Harding

Americans are living longer because the air they breathe is getting cleaner, a new study suggests. The average drop in pollution seen across 57 metropolitan areas between 1980 and 2000 appears to have added nearly five more months to people's lives, according to a study published Wednesday in The New England Journal of Medicine.

Residents of cities that did the best job cleaning up air pollution showed the biggest jump in life span; for example, Pittsburgh's cleaner air meant people there could expect to live nearly 10 months longer.

"Here's a situation where we say, 'We think that improving our air quality should improve health and life expectancy,' and so we did it, in many cities more so than others," says lead researcher C. Arden Pope III, Ph.D., of Brigham Young University in Provo, Utah. "We wait a couple of decades and see if it really helps, and the answer is that it did, and that's good news."

Long-term exposure to dirty air -- specifically, the tiny specks known as fine-particulate air pollution -- shortens lives and contributes to cardiovascular and lung disease. Particulate matter is inhaled almost like a gas and is thought to raise blood pressure, heart attack risk, and the chance of heart disease-related death.

The American Heart Association and the American College of Cardiology recommends that heart patients avoid driving for two to three weeks after leaving the hospital to avoid pollution (and stress). Other research has suggested that a nonsmoker living in a polluted city has about the same risk of dying of heart disease as a former smoker. Health.com: 5 ways to keep pollution from harming your heart

Gas and diesel engines, coal-fired plants, steel mills, smelters, refineries, and other industrial processes involving burning at high temperatures produce these particles, which are no bigger than 2.5 microns across -- or about one-fourtieth the diameter of a human hair. "Those are the ones that can penetrate deeply into the lungs and cause most of the health problems," says Pope.

The Clean Air Act of 1970 set nationwide air quality standards and motor-vehicle emissions standards for the first time, and the federal government and some states have continued to take steps to tackle air pollution. Health.com: Both indoor and outdoor pollutants linked to heart problems

Thanks to these efforts, U.S. air quality has improved. Pope and his team decided to use U.S. data on fine-particulate matter concentrations and life expectancy from the late 1970s and the late 1990s as a "natural experiment" to determine whether cleaner air had any effect on health.

They plotted pollution data for 1979-1983 against 1978-1982 life expectancies for 217 counties within 61 metropolitan areas around

Carbon Dioxide Levels in Atmosphere
Efficiency Regulations

- Automobile fuel efficiency (CAFÉ) standards
- Appliance efficiency standards
- Portfolio standards
Automobile Efficiency

• Fuel use (CAFÉ) standards set in 1985 (only minor improvements since)

• Auto companies blocked attempts in to set further fuel economy standards

• California air agencies blocked from attempts to set fuel quality standards in 2005 and again in 2008

• Average fuel economy locked in at about 22 mpg for passenger cars and 17 mpg for light trucks by late 1980s and has not improved

• Many vehicles purchased by consumers were labeled as trucks to avoid the tighter fuel economy standards
Appliance Efficiency Standards

• A variety of appliance efficiency standards were set from 1978 to 2005 by California/New York first and then the federal government later (Still room for improvement)
• Standards for the refrigerator represent a good example
Energy Efficiency Regulation

Reduced the need for 42 new coal fired power plants
Portfolio Standards

• Set requirements for the amount of electricity produced from renewable sources
• 28 states have mandatory renewable portfolio standards
  – 30% is largest and belongs to Maine
  – 25% set for Oregon, Minnesota, New York, Illinois, Vermont, New Hampshire
  – 20% set for California, Nevada, New Mexico, Colorado
State laws are complex and some fractions on map represent interpretations of those standards. Most standards do not come into effect until 2020.
Where do we need to go?
Sustainable Per Capita Fossil Fuel Use

Needed Reduction = 87%
Emission Reduction Needs for U.S.

• Criteria pollution emissions must be reduced by another 50-70% to meet air quality standards in California. Per capita reductions based on 2050 population: 70-80% reduction.

• Climate change gases must be reduced by 20-30% according to some experts. Per capita reductions based on 2050 population and increased worldwide consumption: 80-90% reductions in non-renewable energy use.
Transportation

• Automobiles must get the equivalent of 80 miles per gallon of fossil fuel and reduce driving by 20% to stay with non-renewable fuels.
  – A gasoline hybrid vehicle increases mileage to 45 mpg with some vehicle downsizing. A diesel hybrid of the same size gets about 55 mpg. An electric vehicle from high efficiency fossil fuel plant gets equivalent of 67 mpg.

• Trucks and trains must make similar advances (trains are 40% more fuel efficient than trucks per ton of cargo moved)
Thoughts on Electricity Conservation

• No incandescent bulbs should be allowed. Get to LED lighting as fast as possible.
• Shut off lighting when rooms are not in use.
• Increase efficiency of air conditioning and reduce use by running buildings a little hotter.
• Cool/Heat only those rooms that need it.
• Increase efficiency of refrigerators. Reduce the amount of refrigeration in use.
• Make energy cost cover all of the externalities associated with its use.

These steps will leave us far short of an 80% reduction.
Electricity Production

• Increase electricity generation by renewable fuels to 60% of needs.

• Use high efficiency generation to make backup electricity (55% efficiency) with NOx emissions reduced by 95%

• Nuclear is typically a poor backup to wind and solar because it can not be easily started and stopped. Natural gas is probably the best option for solar and wind backup. Pumping into water storage can also be useful in many locations.
Renewable Fuel Option: Biofuel

• Present corn ethanol uses valuable cropland and is very inefficient way of getting energy.
• Considering food needs, use only waste products from food production or landfills for biofuel. (even this choice may reduce food for animals)
Renewable Fuel Option: Solar

• Expensive
• Varies with time of day
• One of the best long-term options
• Can be applied at the factory or home reducing transmission issues
Renewable Fuel Option: Wind

- Most cost effective of renewable fuels.
- Varies with time of day and year.
- Must address electricity transmission issues.
- Must address variation in wind production.
Other Options

• Geothermal
  – Good option where available
  – Little information on long-term impacts of water injection to use some geothermal (likely minimal problem)

• Nuclear
  – Poor backup for solar and wind
  – Significant waste storage issues
  – Slight concern over safety
CONCLUSION: There is much to be done over the next 40 years to address world consumption practices and it does not involve incremental change!

The sooner we start the easier it will be to reach goals.