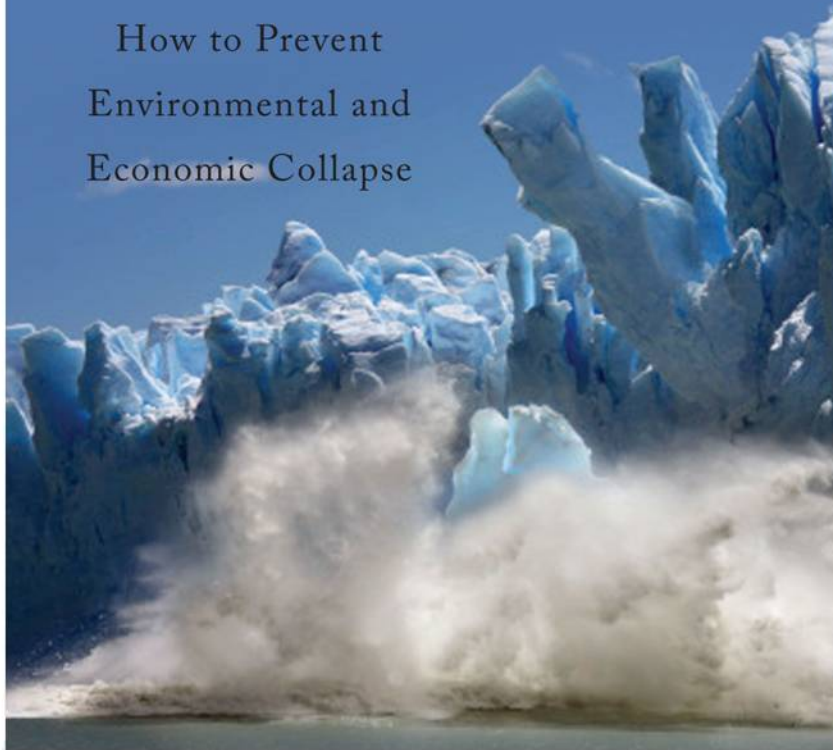


LESTER R. BROWN

WORLD ON THE EDGE

How to Prevent
Environmental and
Economic Collapse



**A Presentation for
*World on the Edge:
How To Prevent
Environmental and
Economic Collapse,*
a book by
Lester R. Brown**



EARTH POLICY INSTITUTE

Overview

A World on the Edge

- A Bright Economic Future?
- Warning of Collapse
- Three Indicators to Watch
- Precarious Global Food Situation: How Did We Get Here?
- Food Demand Growing
- Food Supply Tightening
- Watching the Clock

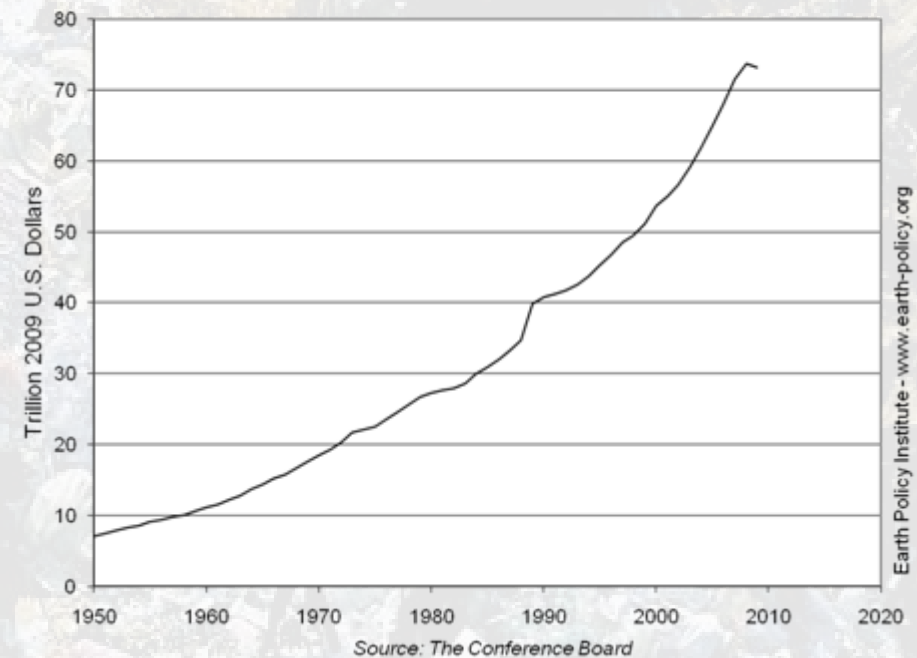
The Response: Plan B

- Plan B: Four Main Goals
- Stabilizing Population and Eradicating Poverty
- Restoring the Earth
- Climate Action Plan
- How Do We Get There?
- Plan B Budget
- A Wartime Mobilization
- Let's Get to Work

A Bright Economic Future?

- The global economy has grown nearly 10-fold since 1950
- Mainstream economists typically project 3% annual growth
- In this view, an illustrious economic past is extrapolated into a promising future...

Gross World Product, 1950-2009



Warning of Collapse

- In contrast, natural scientists see an economy destroying its natural supports
- Humanity is running up against the natural limits of aquifers, soils, fisheries, forests, even our atmosphere
- In system after system, our collective demands are overshooting what nature can provide

How can we assume that the growth of an economic system that is destroying its environmental supports can simply be projected into the long-term future?

A World on the Edge

- A gathering “perfect storm” of trends threatens to send civilization into economic and political chaos
- The 2010 extreme heat wave in Russia and record flooding in Pakistan are early warnings of the global consequences we can expect if we continue with business as usual

2010 Russian Heat Wave

Situation

- Average Moscow July temperature: 14°F above norm
- Number of fires starting every day in early August: 300-400
- Forest damage and restoration cost estimate: \$300 billion
- Total death count from heat wave and air pollution: >56,000
- Drop in the Russian grain harvest: down 40% to 60 million tons from recent annual harvests of 100 million tons

Fallout

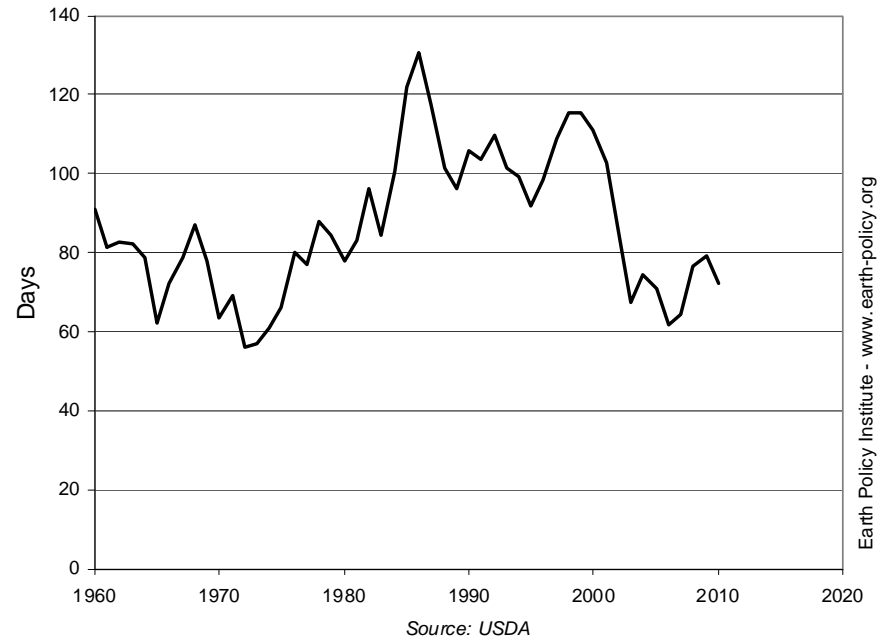
- In 2009, the Black Sea region contributed roughly ¼ of world wheat exports, but Russia has banned grain exports entirely through mid-2011
- Heat and drought decimated grass and hay growth, prompting the government to release 3 million tons of grain to supplement cattle feed; still, farmers have had to cull herds
- World wheat prices increase 60% over 2 months

The Russian heat wave is a powerful example of how a single event can quickly destabilize the global food economy.

Nightmare Scenario

- 40% drop in Russian grain harvest reduced world grain stocks from 79 days of consumption to 72 days
- But what if the heat wave were centered on Chicago and the much larger U.S. grain harvest dropped 40%?
- World grain stocks would plummet to record-low 52 days – well below the level that preceded the tripling of grain prices in 2007-08
- Would likely result in unprecedented food price inflation and food riots in scores of countries, toppling weaker governments

World Grain Stocks as Days of Consumption, 1960-2010



2010 Pakistan Flooding

Situation:

- Inundated 1/5 of the country
- Affected 20 million people
 - Killed 2,000 people
 - Damaged 2 million homes
- Drowned 1 million livestock
- Damaged 6 million acres of crops
- Washed away roads and bridges
- Most devastating natural disaster in Pakistan's history

Contributing Trends:

- In 1990, military budget was 44 times health and family planning budget, leaving population growth unchecked
- Humans and livestock stripped vegetation needed to contain rainfall
- 90% of the Indus basin's original forests are gone
- Record heat accelerated melting of Himalayan ice and snow, raising Indus levels

Pakistan provides an example of how the social and environmental trends we face on a global level can converge — with dangerous consequences.

Three Indicators to Watch

Economic



Social



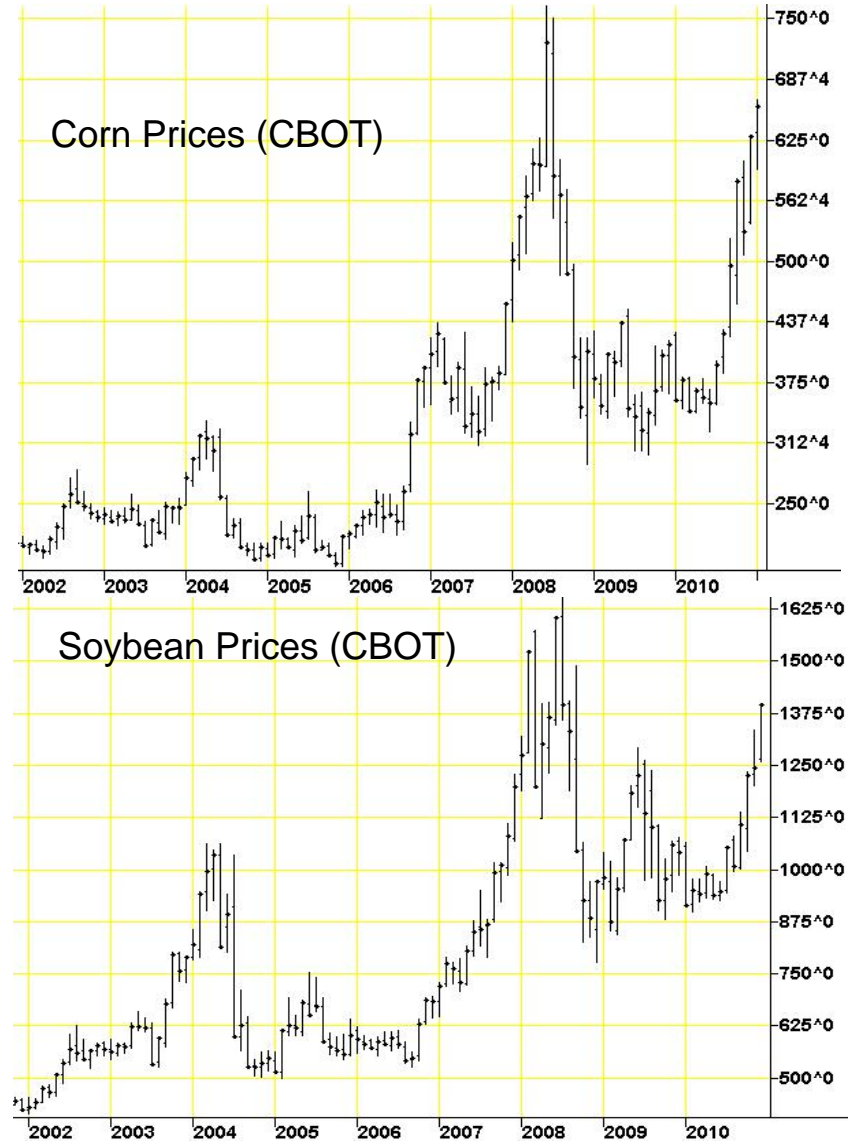
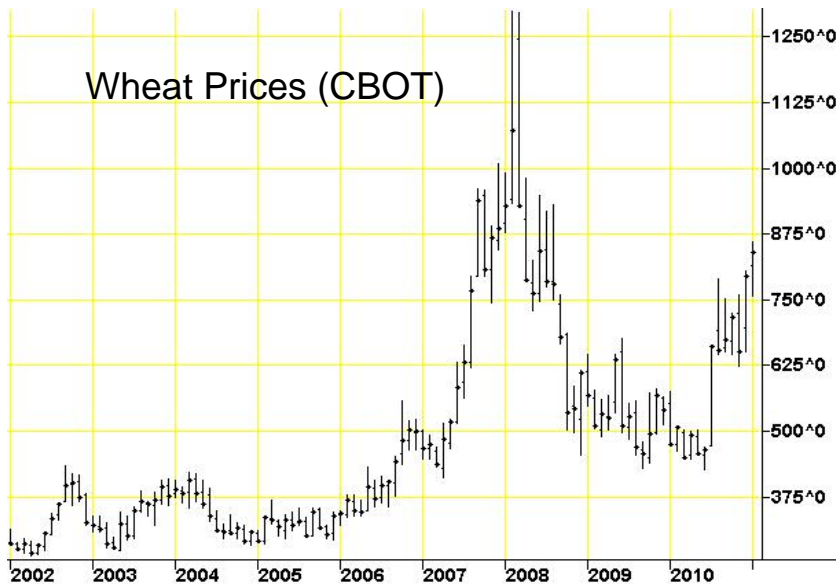
Political



These indicators help give a sense of how close to the edge our civilization may be.

Food Prices Soaring

Grain and soybean prices are fast approaching their peaks of 2007-08.



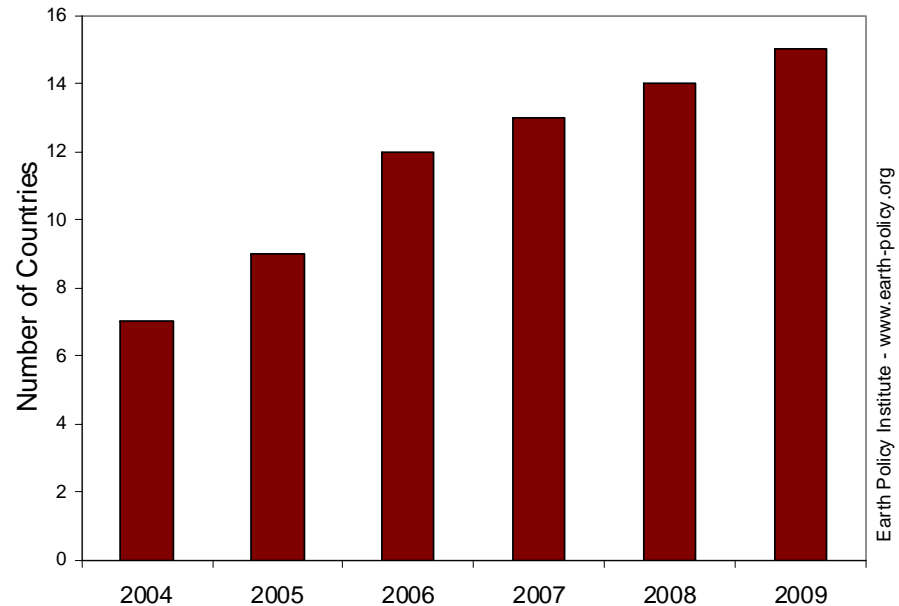
Hunger Rising

World hunger and malnutrition were on the decline for much of the late 20th century. But after falling to 788 million in the mid-1990s, the number of hungry people began to rise, reaching 915 million in 2008. In 2009 it jumped to over 1 billion. Crop failures caused by extreme weather events such as the 2010 Russian heat wave will make it harder to feed people around the world.

More States Failing

- States fail when governments lose control of part or all of their territory and can no longer ensure their people's security
- As pressures from population growth, water shortages, climate change, and food scarcity increase, state failure is both spreading and deepening

Number of High-Ranking Failing States, 2004-2009

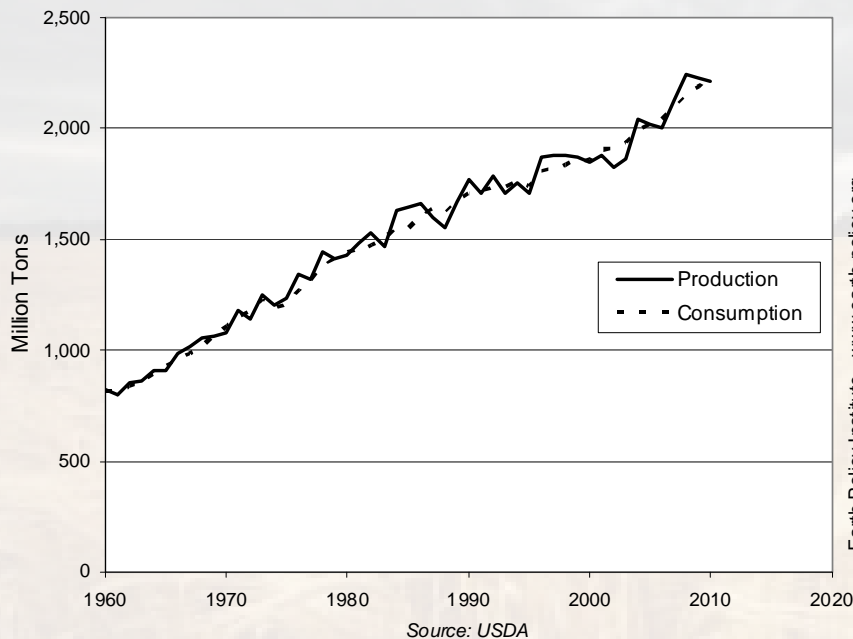


Source: EPI; Fund for Peace /Foreign Policy

How many states can fail before our global civilization begins to unravel?

Precarious Global Food Situation: How Did We Get Here?

**World Grain Production and Consumption,
1960-2010**



- Past food price spikes were event-driven, typically resolved with next harvest
- Now we face long-term trends that:
 - increase food demand
 - limit food production

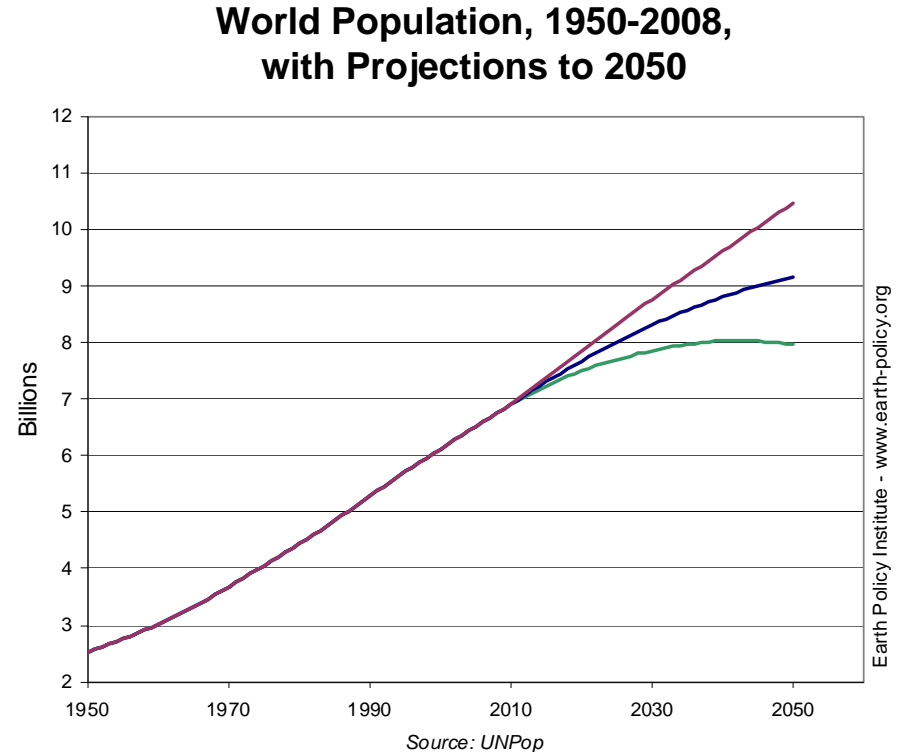
We are only one poor harvest away from chaos in world grain markets.

Food Demand Growing

- World population is increasing by 80 million annually
- Some 3 billion people are trying to move up the food chain and eat more grain-intensive livestock products
- Expanding biofuel production means that cars and people compete for crops

Population Pressures

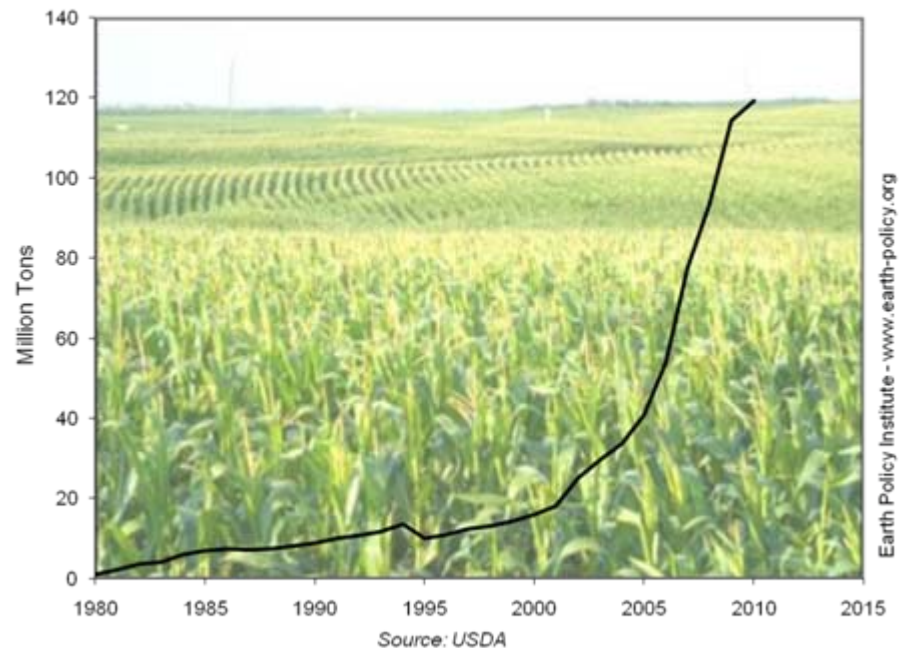
- Dense populations and their livestock herds degrade land, undermining food production
- Worldwide, 215 million women who want to plan their families lack access to family planning services
- Large families trap people in poverty



Food vs. Fuel

- Rising price of oil has made it profitable to turn grain into fuel
- More than one fourth of the U.S. grain crop is now going to ethanol
- U.S. ethanol euphoria helped double annual growth in global grain demand, raising food prices worldwide

Corn Used for Fuel Ethanol in the United States, 1980-2010



The grain needed to fill an SUV's 25-gallon tank with ethanol once could feed one person for an entire year.

Food Supply Tightening

- Growth in crop yields is slowing
- Cropland is being lost to non-farm uses
- Deserts are expanding
- Aquifers are being overpumped
- Extreme weather events and rising temperatures threaten harvests

Growth in Crop Yields Slowing

- From 1950-1990, average grain yields rose 2.2% per year; but from 1990-2010, they rose just 1.2% annually
- Wheat yields are plateauing in France, Germany, the United Kingdom, and Egypt, all important producers
- Japan's rice yields, close to 5 tons per hectare, have been flat for over a decade; those in China may also plateau as they approach the Japanese level

Raising grain yields is becoming more difficult as the backlog of unused agricultural technology shrinks.

Eroding Soils, Expanding Deserts

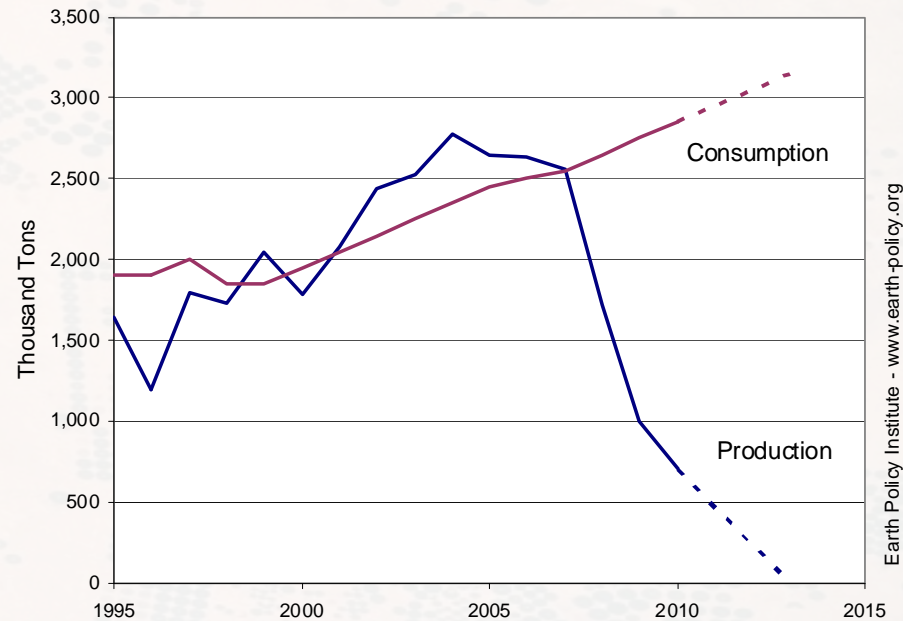
- Overplowing, overgrazing, and deforestation make soil vulnerable to wind and water erosion
- Roughly 1/3 of the world's cropland is now losing topsoil faster than it can be re-formed
- Topsoil loss reduces productivity, eventually leading farmers and herders to abandon their land
- Countries such as Lesotho, Haiti, Mongolia, and North Korea are losing the ability to feed themselves

We have yet to see the full effects of two giant dust bowls now forming: one in northwestern China and western Mongolia, and another in the Sahel of central Africa.

Saudi Arabia's Bursting Bubble

- Saudi Arabia became self-sufficient in wheat by tapping a non-replenishable aquifer to irrigate the desert
- In early 2008, the government announced the aquifer was largely depleted
- The population of nearly 30 million could be entirely dependent on imported grain by 2013

Wheat Production and Consumption in Saudi Arabia, 1995-2010, with Projection to 2013



Source: USDA; EPI

Earth Policy Institute - www.earth-policy.org

Saudi Arabia is the first country to publicly project how aquifer depletion will shrink its grain harvest.

Water Shortages

- Overpumping produces food bubbles that burst when water supplies dry up
- In the Arab Middle East, a collision between population growth and water supply is reducing regional grain harvests
- If multiple food bubbles burst at nearly the same time, the resulting food shortages could cause chaos

Countries Overpumping Aquifers in 2010

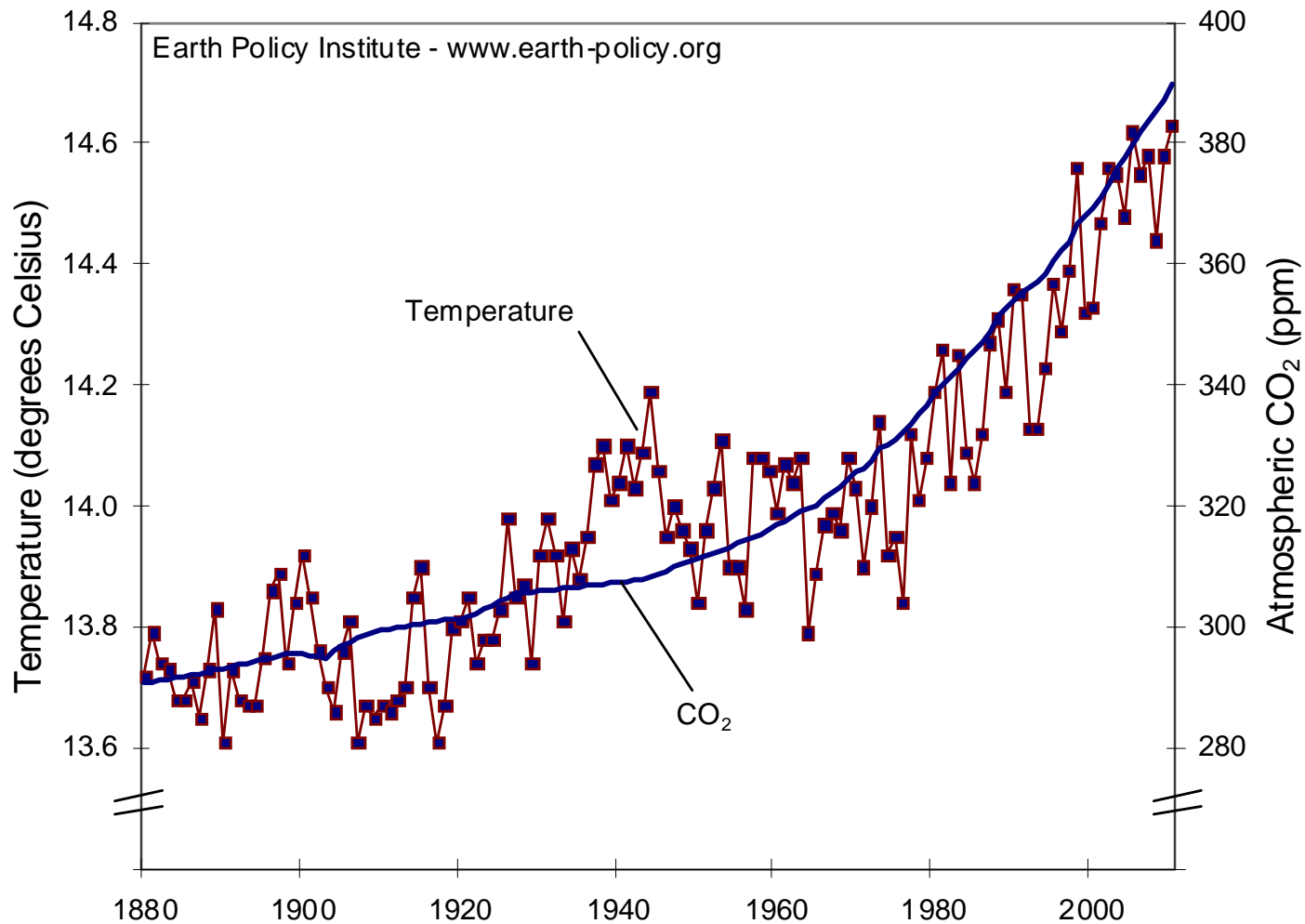
<u>Country</u>	<u>Population</u> Millions
Afghanistan	29
China	1,354
India	1,214
Iran	75
Iraq	31
Israel	7
Jordan	6
Lebanon	4
Mexico	111
Morocco	32
Pakistan	185
Saudi Arabia	26
South Korea	49
Spain	45
Syria	23
Tunisia	10
United States	318
Yemen	24
<u>Total</u>	<u>3,545</u>

Source: EPI with population data from UNPop

Climate Change

- The increasing concentration of carbon dioxide (CO₂) in the atmosphere, largely from burning fossil fuels (coal, oil, natural gas), and other greenhouse gases are driving a rise in global temperature and causing changes to our climate system
- Since the start of the Industrial Revolution, atmospheric CO₂ has risen from 280 parts per million to 389 parts per million

Average Global Temperature and Atmospheric Carbon Dioxide Concentrations, 1880-2010



Source: NASA GISS; NOAA ESRL; Worldwatch

Climate Change

- The Intergovernmental Panel on Climate Change (IPCC) projects earth's average temperature will rise 1.1 - 6.4°C (2.0 - 11.5°F) during this century
- Current trajectory is already outpacing projections
- As temperatures rise, glaciers and ice sheets melt, causing sea level to rise
- Extreme weather events, such as crop-withering heat waves, droughts, and powerful storms become more frequent and more intense
- For every 1°C rise in temperature above the optimum during the growing season, yields of wheat, rice, and corn drop 10 percent.

2010: A Year of Extremes

- 2010 tied with 2005 as the hottest year since recordkeeping began in 1880
- 19 countries set high-temperature records, most notably Pakistan, which hit 128.3 °F, a new record for all of Asia
- Extreme weather events included flooding in Pakistan and Australia, the heat wave in Russia, fires in Israel, and landslides in China

The number and severity of these events are symptomatic of instability in the climate system.

Glaciers Disappearing

- As temperatures rise, mountain glaciers are rapidly disappearing around the world
- Himalayan and Tibetan-Qinghai Plateau glaciers sustain the major rivers of Asia during the dry season, providing critical irrigation water for agriculture
- If melting continues at current rates, the flow of rivers like the Yellow, Yangtze, Ganges, and Indus could decline, causing wheat and rice harvests to plummet

Ice Sheets Melting

- Massive Greenland and West Antarctic ice sheets that together hold enough water to raise sea level 12 meters (39 feet) are melting at accelerating rates
- A 10-meter (33-foot) sea level rise would displace more than 600 million people
- Sea level could rise 2 meters (6 feet) by 2100
- Even a 1-meter rise in sea level would partially inundate crop-producing river deltas in countries such as Bangladesh and Viet Nam

Climate change threatens food security and could eventually create hundreds of millions of climate refugees.

Watching the Clock

- Nature is the timekeeper – no one knows for sure when it will be too late to address the trends of decline in time to avoid collapse
- Potential tipping points:
 - Can we close coal-fired power plants fast enough to save the Greenland ice sheet?
 - Can we address the root causes of high food prices and state failure before civilization begins to unravel?

Business as usual is not working – it's time for Plan B.

Plan B: Four Main Goals

1. Stabilizing Population
2. Eradicating Poverty
3. Restoring the Earth's Natural Support Systems
4. Stabilizing Climate

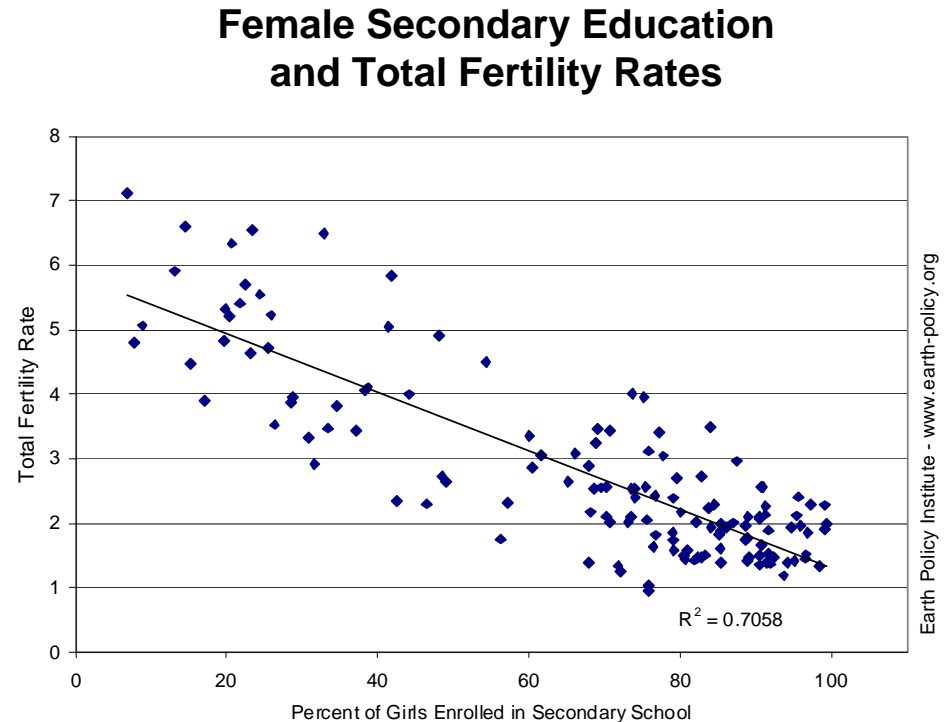
Stabilizing Population, Eradicating Poverty

- Universal primary education
- Eradication of adult illiteracy
- School lunch programs
- Aid to women, infants, and preschool children
- Reproductive health care and family planning services
- Universal basic health care

Total Additional Annual Cost = \$75 billion

The Poverty – Education – Population Connection

- School lunch programs help kids, especially girls, stay in school
- Girls who stay in school longer are likely to have fewer children
- Reducing family size helps lift families out of poverty



Source: EPI from UIS

Efforts to eliminate poverty and slow population growth reinforce each other—and they also help prevent state failure by addressing the root causes of instability.

Achieving Social Goals

- The number of elementary-school-aged children out of school around the world dropped from 106 million in 1999 to 69 million in 2008
- Soap operas raising public awareness in Mexico, Ethiopia, and other countries have helped increase literacy and decrease population growth
- Iran cut its rapid population growth rate from 4.2% in the early 1980s to 1.3% in 2006 through national literacy, health, and family planning programs
- Brazil's Bolsa Familia (family grant) program has significantly lowered poverty rates and reduced income inequality at the same time

Restoring the Earth

- Planting trees
- Protecting topsoil on cropland
- Restoring rangelands
- Restoring fisheries
- Stabilizing water tables
- Protecting biological diversity

Total Additional Annual Cost = \$110 billion

Earth Restoration Efforts

- Once almost treeless, South Korea has reforested 65% of its land
- If every country recycled paper at the South Korean rate (91%), the amount of wood pulp used for paper production would drop by over one third worldwide
- Over the last quarter-century the United States reduced soil erosion 40% by retiring cropland and practicing conservation tillage, while increasing the grain harvest 20%
- Within 2 years of restricting fishing in 6,600 square miles of marine reserves in the Gulf of Maine in the North Atlantic, fish population density rose 91%, average fish size went up 31%, and species diversity rose 20%

Climate Action Plan

Cut Global Net CO₂ Emissions 80% by 2020

Three components:

1. Raising energy efficiency and restructuring transportation
2. Replacing fossil fuels with renewables
3. Ending net deforestation and planting trees to sequester carbon

...to prevent global atmospheric CO₂ concentrations from exceeding 400 parts per million, minimizing future temperature rise.

Raising Energy Efficiency

- Buildings
 - Retrofits with better insulation and more efficient appliances can cut energy use by 20-50%
- Lighting
 - A worldwide switch to highly-efficient home, office, industrial, and street lighting would enable the world to close 705 of its 2,800 coal-fired power plants

Raising Energy Efficiency

- Appliances
 - Japan's Top Runner Program uses today's most efficient appliances to set tomorrow's standards; e.g. helped double computer efficiency
- Industry
 - Improving manufacturing efficiency for carbon emissions heavyweights (chemicals, petrochemicals, steel, and cement) offers major opportunities to curb energy demand

Restructuring Transportation

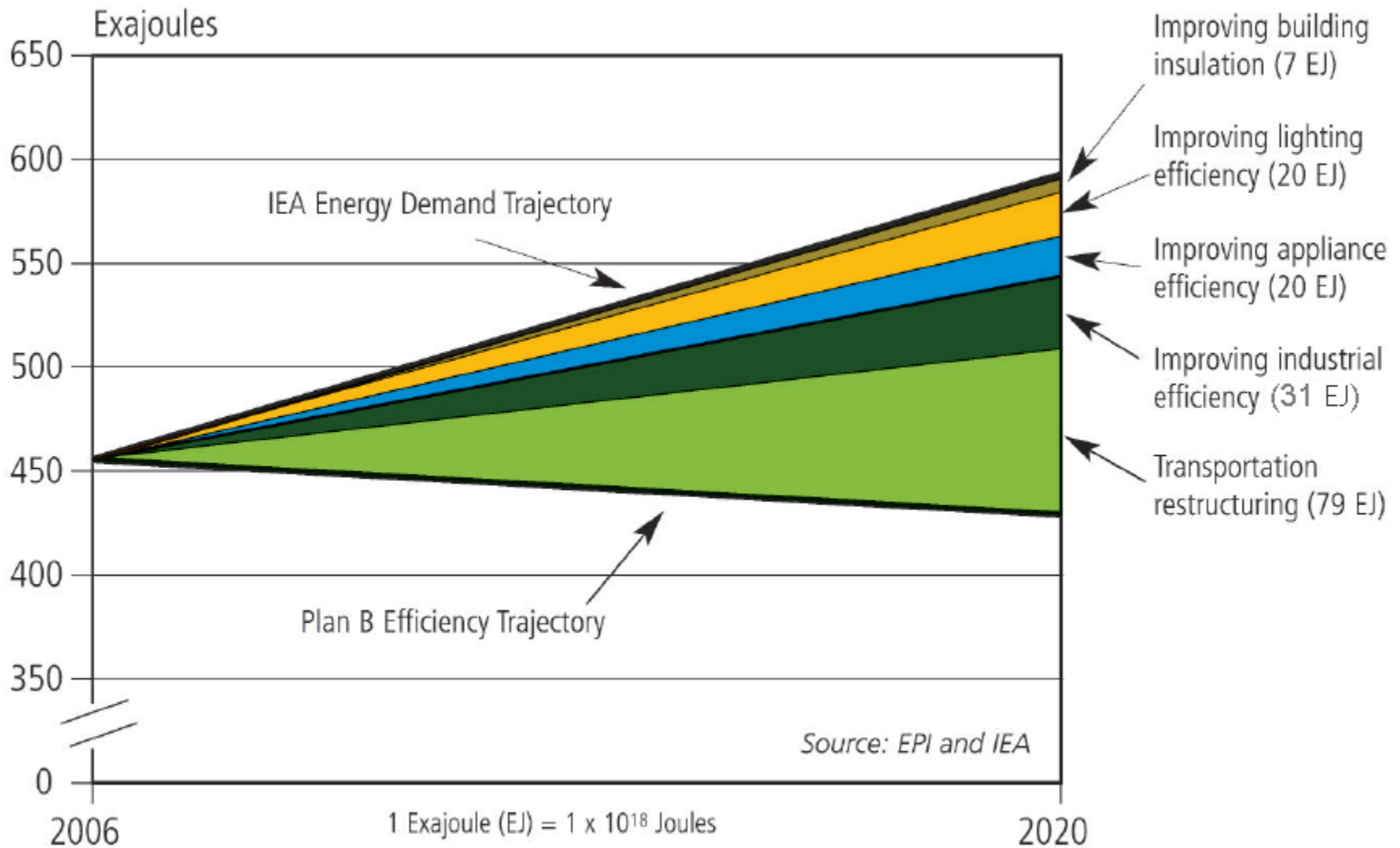
- Cities emphasizing underground rail, light rail, and bus rapid transit would save energy while making walking and cycling safer
- Intercity rail, including high-speed systems, can sharply reduce air and car travel
- Electrified transport systems curb oil dependence and reap big efficiency gains by moving to more localized energy sources and replacing inefficient internal combustion engines with electric motors
- Plug-in hybrid electric vehicles running primarily on emissions-free electricity would allow low-carbon commuting; drivers could charge up with wind power at a cost equivalent of less than \$1 per gallon of gasoline

Progress in Energy Efficiency and Transport

A person is riding a bicycle on a blue-painted bike lane. The background is a blurred city street with a white crosswalk. The title 'Progress in Energy Efficiency and Transport' is overlaid in white text at the top.

- Many countries, including Canada, the United States, and China, are phasing out inefficient light bulbs
- New efficiency standards for U.S. household and commercial products estimated to save consumers \$250-300 billion through 2030
- 36% of Copenhagen's commuters bike to work
- Japan's high-speed rail system moves hundreds of thousands of passengers each day
- U.S. car fleet began shrinking in size in 2009

Plan B Energy Efficiency Measures



Ramping Up Renewables

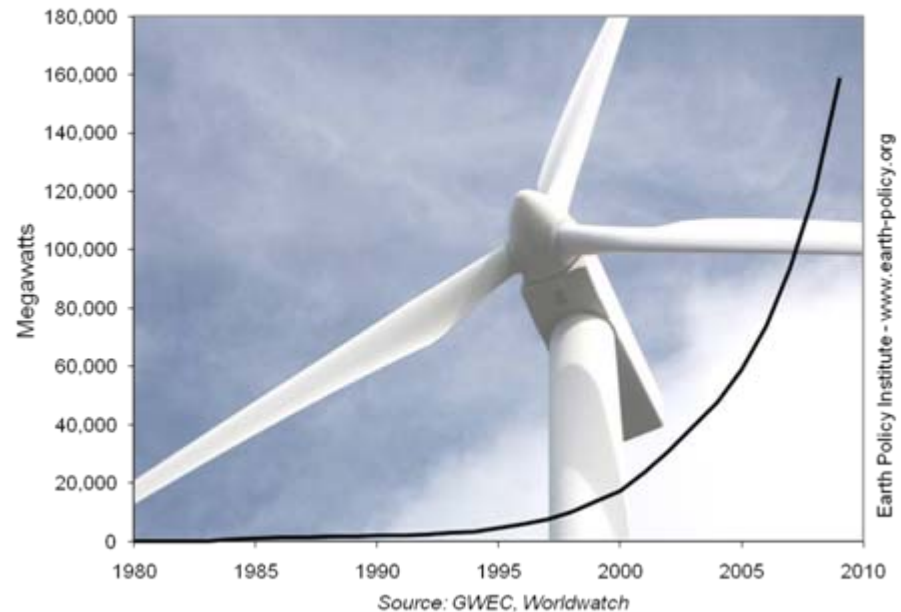
- Wind
- Solar
- Geothermal
- Other: Small-scale Hydro, Tidal and Wave Power, Biomass



Harnessing the Wind

- Centerpiece of Plan B energy economy
- Widespread – in every country
- Increasingly inexpensive
- Abundant – North Dakota, Kansas, and Texas alone could satisfy U.S. energy needs
- Plan B goal: 2 million 2-MW turbines installed by 2020

World Cumulative Installed Wind Power Capacity, 1980-2009



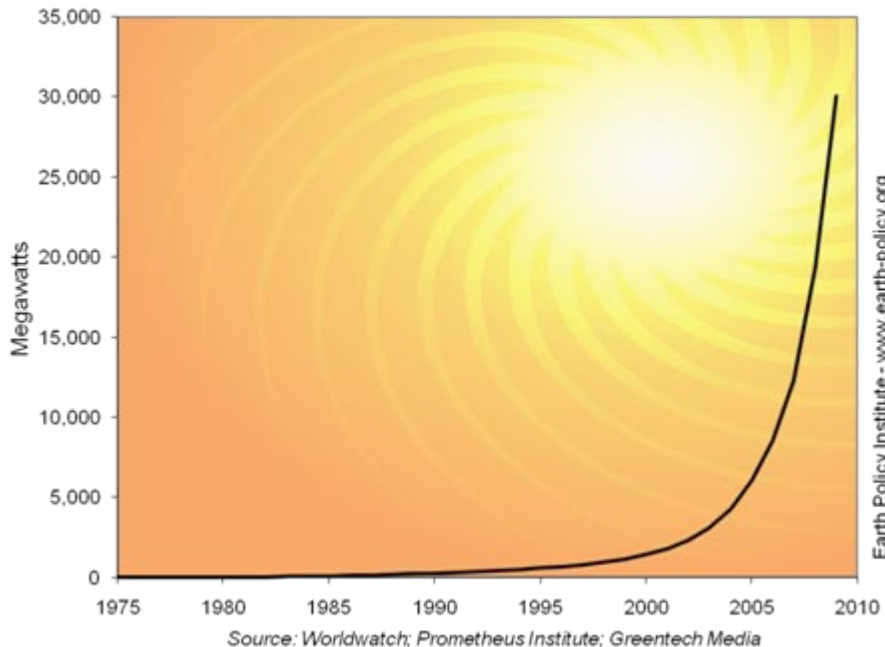
The idled capacity in the U.S. automobile industry alone would be sufficient to produce all of these wind turbines.

Wind Power Growing

- Denmark gets 21% of electricity from wind and aims to get 50% by 2025
- If all its wind farms projected for 2025 are completed, the U.S. state of Texas could meet 90% of electricity needs for its 25 million people
- China's Wind Base program – 7 wind mega-complexes in 6 wind-rich provinces – will exceed 130,000 MW when complete in 2020
- Scotland expects to get all of its electricity from renewables by 2025; most of the new capacity will be from offshore wind

The Power of the Sun

World Cumulative Photovoltaics Production,
1975-2009



- Technologies include photovoltaics (PV), solar thermal power plants, solar hot water and space heaters
- Sunlight hitting the earth in 1 hour could power global economy for 1 year
- Plan B goal: Solar heating and electricity each exceed 1 million MW installed capacity by 2020

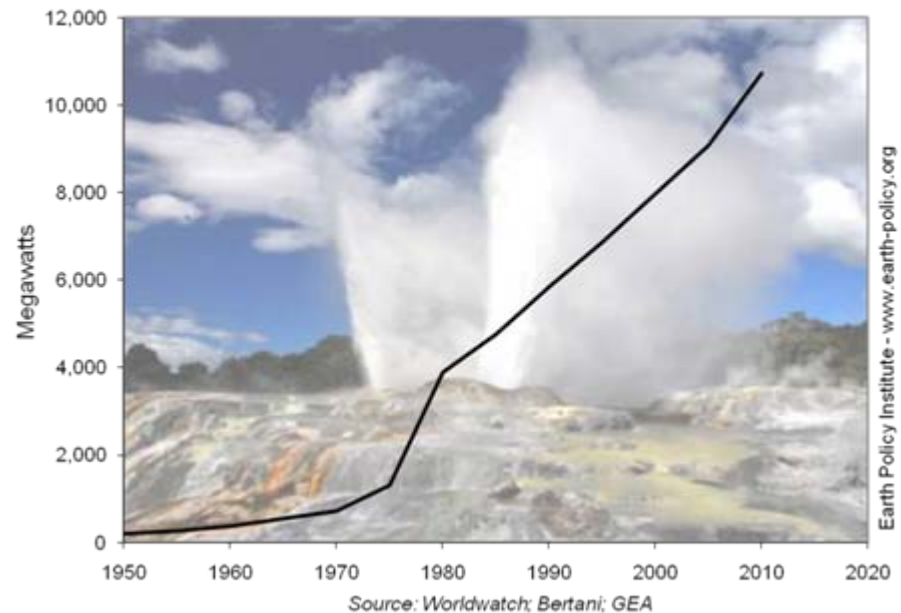
Solar Energy Heating Up

- PV installations growing at well over 30% annually
- With 10,000 MW of PV, Germany leads number two Spain by a factor of three
- Japan is planning 28,000 MW of PV by 2020
- The Desertec Industrial Initiative plans to use solar thermal power plants to harness solar resources of North Africa and Middle East, generating electricity for producer countries and for Europe
- In China, rooftop solar water heaters can supply enough hot water for 120 million households

Geothermal: Energy from the Earth

- Heat in the upper 6 miles of earth's crust contains 50,000 times the energy found in global oil and gas reserves
- Plan B goal: increase geothermal heating 5-fold to 500,000 thermal MW and geothermal electricity production 19-fold to 200,000 MW by 2020

World Cumulative Installed Geothermal Power Capacity, 1950-2010



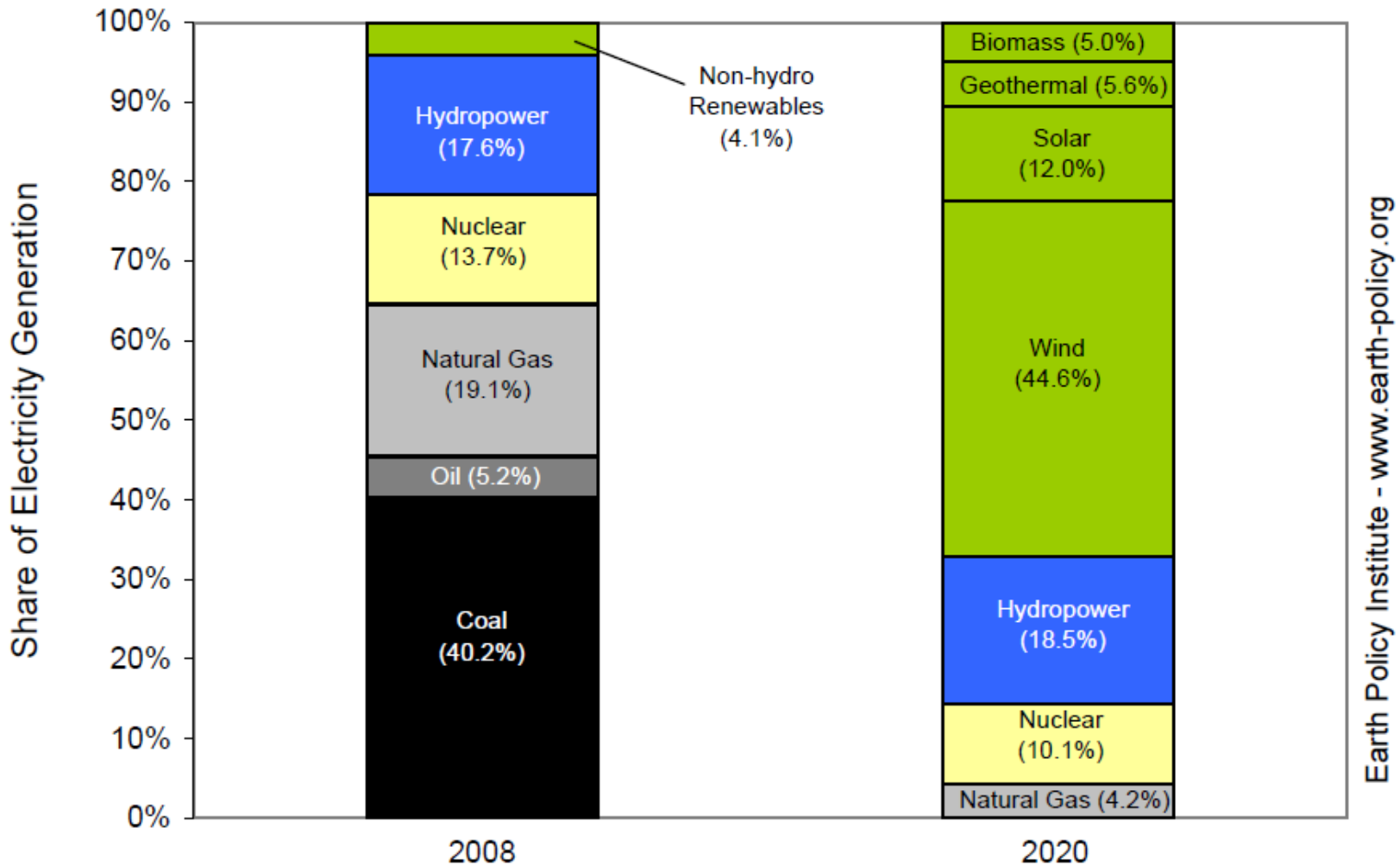
Realizing Geothermal's Potential

- In early 2010 the United States had 152 geothermal power projects under development, enough to triple existing capacity
- El Salvador gets 26% of its electricity from geothermal energy; Iceland 25%; the Philippines 18%
- 90% of Iceland's homes use geothermal heating
- Pertamina, Indonesia's state oil company, will develop much of the country's 6,900 MW planned geothermal capacity announced in 2008

Phasing Out Fossil Fuels: Hope from the United States

- Some 150 proposals for coal-fired power plants in the United States have been shelved since 2000
- Between 2007 and 2010, U.S. oil and coal consumption each dropped 8 percent
- At the same time, over 300 wind farms came online

World Electricity Generation by Source in 2008 and in the Plan B Economy of 2020



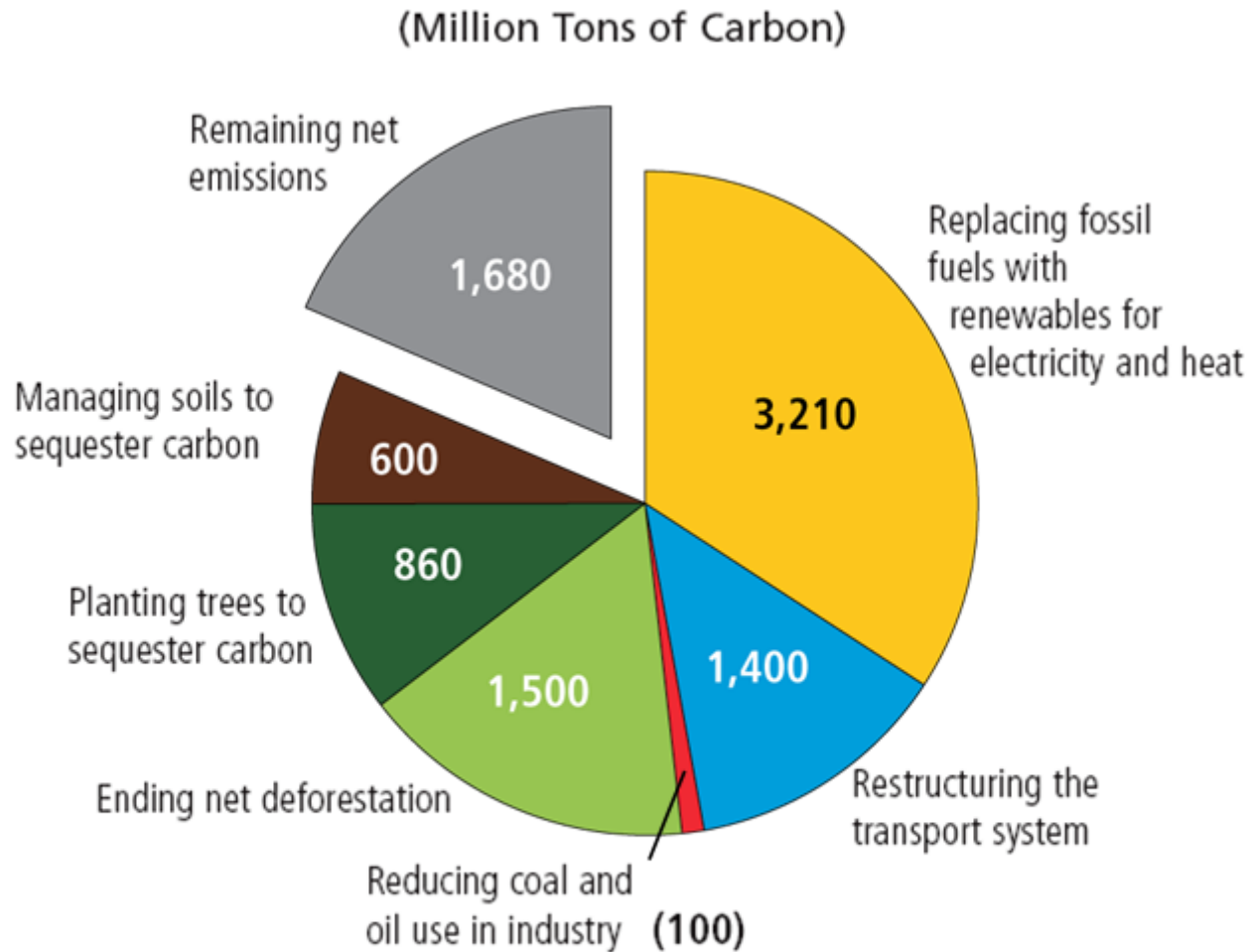
Source: EPI and IEA

Ending Net Deforestation, Planting Trees

- Ending net deforestation by 2020 will reduce annual CO₂ emissions by 1.5 billion tons of carbon
- Planting trees and adopting less-intensive farming and land management practices can stabilize soils and sequester carbon

Adding these measures to our renewable energy goals will allow us to reduce net CO₂ emissions 80% by 2020.

Plan B Carbon Dioxide Emissions Reduction Goals for 2020



Baseline Emissions (2006) = 9,350 Million Tons of Carbon

Source: EPI

How Do We Get There?

- Correct market failures
- Redefine security

A Dishonest Market

- The market omits many indirect costs of economic activity
- Fossil fuel prices do not reflect costs of climate change, environmental degradation, or health
- Fossil fuel subsidies further distort the market: in 2009, subsidies for production and use totaled roughly \$500 billion worldwide

Governments are shelling out nearly \$1.4 billion per day to further destabilize the earth's climate.

Toward an Honest Market

- Restructure taxes: offset carbon tax with reduction in income or payroll taxes
(Tax what you burn, not what you earn)
- Gradually raise tax on carbon emissions to reach \$200 per ton of carbon by 2020
 - A shift from labor to energy taxes in Germany reduced annual CO₂ emissions by 20 million tons and created 250,000 jobs between 1999 and 2003

Restructuring taxes and eliminating fossil fuel subsidies would drive the transition to a more honest economy.

Redefining Security

- One legacy of the 20th Century is a sense of security defined mostly in military terms
- But the principal threats to our security are no longer military in nature
- Climate volatility, emerging water shortages, spreading hunger, and failing states: these are the new threats to survival for our 21st Century civilization
- The challenge is to reorder fiscal priorities to match these new dangers

The Plan B Budget

Additional global annual expenditure needed to address the true threats to civilization:

Basic Social Goals \$75 billion

Restoring the Earth \$110 billion

Total Plan B Budget \$185 billion

The Plan B Budget, just 12 percent of annual military spending, is, in effect, the new security budget.

A Wartime Mobilization

An aerial photograph of a vast aircraft manufacturing plant, likely during World War II. The ground is filled with hundreds of aircraft, mostly bombers, parked on the tarmac. The perspective is from a high angle, looking down on the rows of planes stretching across the landscape.

- We have the technologies necessary to implement Plan B – what is needed now is the political will to do so
- Saving civilization will require urgent action on a large scale, but we've mobilized quickly before:
- Upon entering World War II, the U.S. mobilized resources and completely restructured its economy within months

Let's Get to Work

Saving civilization is not a spectator sport.

Lester R. Brown

- Lifestyle changes such as using more-efficient light bulbs are important, but not nearly enough
- Preventing environmental and economic collapse requires political action from all of us in order to effect broad social change
- Make sure your elected officials know what's important
- Note the successes of the U.S. grassroots movement in closing coal-fired power plants
- Take action in an area that concerns and excites you

The Choice is Ours

- Will we stay with business as usual and preside over an economy that continues to destroy its natural support systems until it destroys itself?

or

- Will we adopt Plan B and be the generation that changes direction, moving the world onto a path of sustained progress?

The choice is ours. It will be made by our generation, but it will affect life on earth for all generations to come.

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