Climate Change
Health Problems & Healthy Solutions

The Institute of Medicine
11 September 2007

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
LIFE CYCLE ANALYSIS

OIL
- Exploration
- Extraction
- Transport Crude
- Refining
- Transport Refined

Petrochemicals
- Combustion

Spills & Leaks
- Benzene

MERCURY

Air Pollution
- Eutrophication
- NO\textsubscript{x}s

Acid Rain
- Warming Oceans
- Coral Reefs
- SLR

Climate Change
- Heatwaves
- EWEs
- Spread of EIDs
- Melting Polar Ice

Harm
- Marine Mammals
- Shore birds

Fisheries
- Consumers
- Livelihoods

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
LIFE CYCLE ANALYSIS

**COAL**

- **Mining**
  - US: 50/y past 3 yrs
- **Combustion**
  - NO$_x$S & SO$_x$S
  - O$_3$ & Brown haze

**Underground**

- Mountaintop Removal
  - Clear cutting – CO$_2$ Sink
    - Appalachia, Montana, Colombia, China

**Silicosis**

- Injuries
- Mortality

**Valleys & streams**

- 1000 miles buried

**Particulates**

- Mercury
- CO and CO$_2$

**HABs**

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
Stabilization Wedges

Energy Efficiency & Conservation
1. Public transport; plug-in hybrids
2. ‘Smart grid’ – distribution, storage, use
3. Green buildings
4. Conservation

Renewables
5. Wind
6. PV/Solar thermal
7. Geothermal
8. Biofuels

Natural Sinks
9. Forest mgmt/nurturing
10. Conservation tillage

Fossil Fuel-based
11. Switch from Coal to Nat. Gas
12. C Capture & Storage (CCS)
13. H₂ Fuel Cells
14. Coal-to-Liquid w/ CCS
15. Nuclear fission

No regrets
Study needed

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
Carbon Capture and Sequestration

- Power Station
- Vegetation
- Heavy Metals
- Coal
- Limestone Fractures
- Microbes
- Saline Aquifer
- Humans
- Oil Rig
- World Coal Institute

Carbon Capture and Sequestration involves capturing carbon dioxide (CO₂) from power stations, injecting it into underground reservoirs like coal beds or saline aquifers, and ideally storing it permanently.
BIOFUELS

EIO-LCA

Energy In and Out
Life Cycle Analysis

SOLAR ENERGY

BIOFUELS

Sugar
Corn/stalks
Switch grass
Farm waste
Grease

Fertilizers

Biodiesel

Ethanol

Fermentation

CO₂

NOₓs

Energy In

Greenhouse gases

Energy Out

Energy In and Out

Transport

Combustion

Land/Soils/Food production

Recycling

Peat and Carbon

Center for Health and the Global Environment
Harvard Medical School
Health and “The Yellow Cake Road”

- Mining: worker safety
- Milling: worker and community exposure
- Transport: safety, security
- Processing: worker and community exposure
- Energy plants: ground water contamination, accidents, cooling water and heat waves
- Temporary Storage:
  - US: "low level" waste, e.g., Savannah River worker and community exposure
  - Europe: plutonium reprocessed and stored worker and community exposure
- Long-term Storage: unsolved
  - One ‘Yucca Mountain’ q5-10 years

Security: thefts and attacks
HW Scenario

Nighttime & Winter Temps

Heatwaves and Climate Change

1. Probability
2. Frequency
3. Intensity
4. Duration
5. Breadth
6. Heat indices
7. TMINs
European Heatwave: Summer 2003

Temp 11°F >30yr average
6 std. dev. from the mean

Deaths: 21-35,000
- Crops & livestock: US$12.3 billion
- Wildfires: 1.2 million acres
- Nuclear plant shutdowns
- Hydropower reduced
- Alpine glaciers: 10% lost

-Schar Nature 2004

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
HW Scenario

Sector impacts

- Public health
- Municipal services
- Water
- Farms
- Forests
- Fisheries
- Energy
- Business interruptions
- Information system
- Financial markets
- Birth rates
- Social cohesion
**HW Scenario**

**Reactive Adaptation**

- **Back-up generators**
  - Fuel cells
- **A/C**
  - Malls
  - Movie theaters
- **Surge capacity**
  - Hotels
- **Transport**

- **Priority populations**
  - Old age and nursing homes
  - Psychiatric hospitals
  - Infants
- **Critical functions**
- **Treatment facilities**
- **Social networks**
- **Response teams**

» **Coordination**
HW Scenario

Prevention

‘Smart, Self-Healing Grid’

Solar roof at HBS

Co-Gen

Dist. Generation

Regional

Renewables

DG Cogen Plant at MIT

Central

Natural gas

Co-Gen

Geothermal → A/C

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
Green Buildings

Estimated Savings
- Respiratory disease: $6 to $14 billion
- Allergies and asthma: $1 to $4 billion
- Sick building syndrome: $10 to $30 billion
- Worker performance: $20 to $160 billion

Studies
- Schools with natural light:
  - 20% faster on math tests
  - 26% faster on reading tests
- Stores with natural light: 40% more sales
- Hospitals with better lighting & ventilation:
  improved patient outcomes

Lawrence Berkeley National Lab

Center for Health and the Global Environment
Harvard Medical School
Little vegetation or evaporation causes cities to remain warmer than the surrounding countryside.

CO$_2$ dome
Clean Energy

Optimizes Adaptation and Mitigation

Water
- Purification
- Pumping
- Irrigation
- Desalination

Cooking
- Clinics
- Schools
- Homes
- Computers

Distributed Generation
Financial Instruments for a Clean and Sustainable Energy Transition (FICSET)

Aligning Rewards and Regulations

- Private sector
  - Investments
  - Insurance
  - Ratings

- Public sector
  - Incentives
  - Infrastructure
  - R&D
  - Procurement practices

New Energy Plan

- Transport Utilities
- Buildings
- Corn Coal Nuclear Lobbies

“Sticks”

“Carrots”

TAXES, SUBSIDIES, FUNDS
REGULATIONS
INSTITUTIONAL FRAMEWORK

Public Health
Security
Economy
Climate Stability

THE ENGINE OF GROWTH for the 21st CENTURY

CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT
HARVARD MEDICAL SCHOOL
http://chge.med.harvard.edu

http://www.climatechangefutures.org