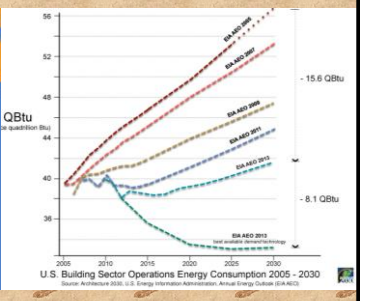
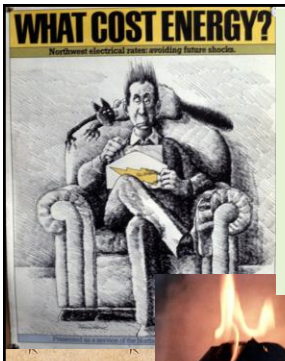
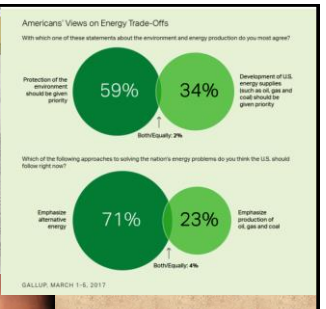
Fuel Sources and Designers



Ed Mazria & Architecture2030

1





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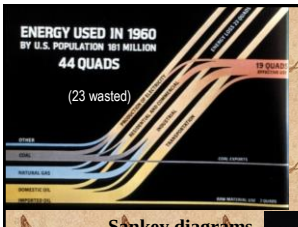
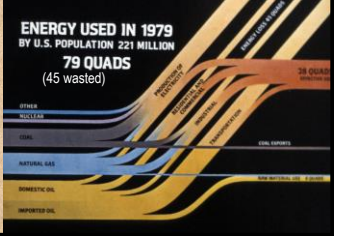


0.24 quads/million people
52% wasted
1st Law Efficiency = 48%

Sankey diagrams

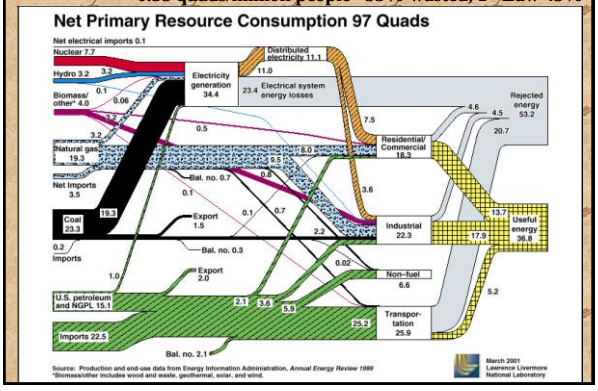


0.36 quads/million people
57% wasted
1st Law Efficiency = 43%

3

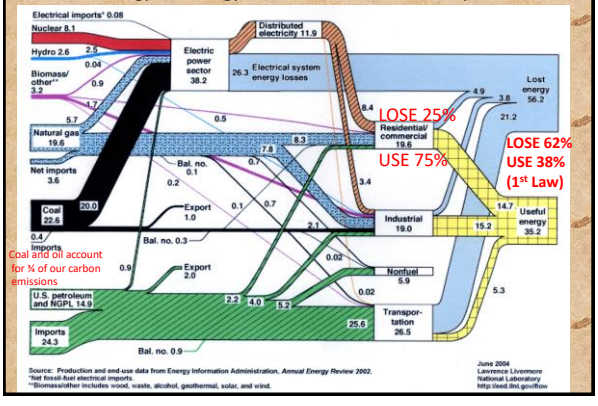
1999 U.S. population 280 million

0.35 quads/million people 55% wasted, 1st Law 45%



4

Primary Energy Flow in the U.S. shows huge energy losses, scant use of renewable energy. US energy use 2004: ~92Quads; 0.32 quads/million



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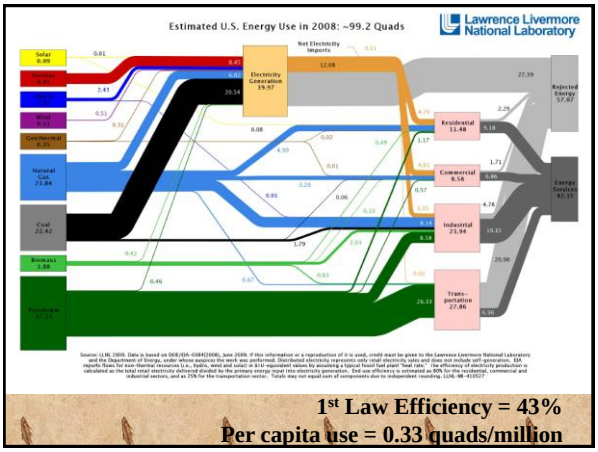
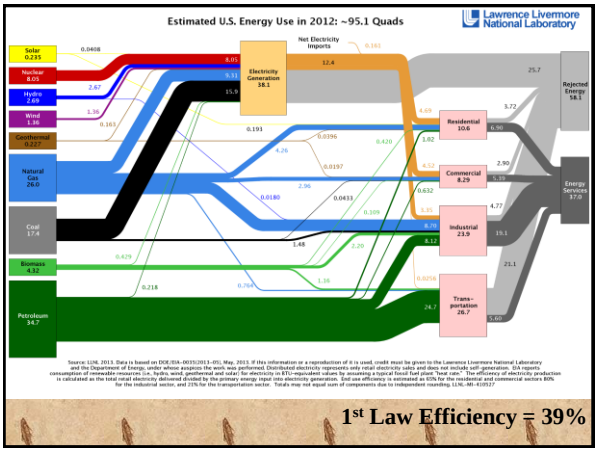


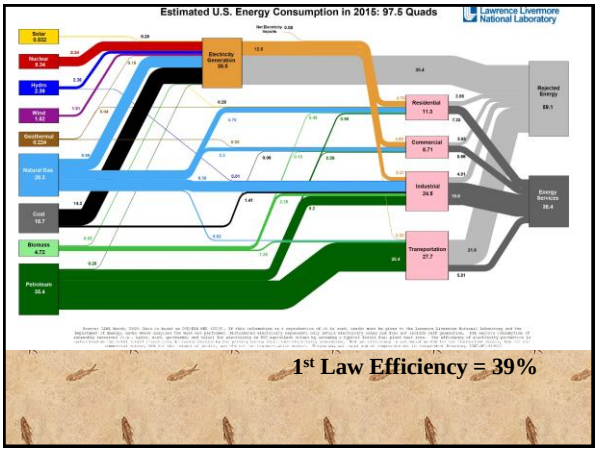
1st Law Efficiency = 43%

Per capita use = 0.33 quads/million

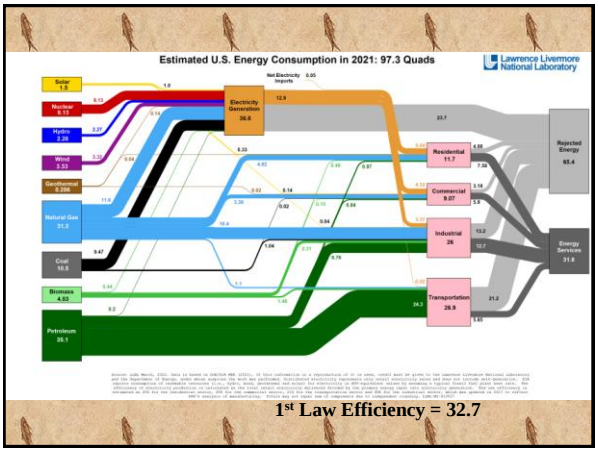
6


Estimated U.S. Energy Use in 2012: ~95.1 Quads
Lawrence Livermore National Laboratory
Solar 0.235
Nuclear 8.05
Hydro 2.69
Wind 1.36
Geothermal 0.227
Natural Gas 26.0
Coal 17.4
Biomass 4.32
Petroleum 34.7
Electricity Generation 38.1
Net Electricity Imports
Residential 10.6
Commercial 8.29
Industrial 23.9
Trans-portation 26.7
Rejected Energy 58.1
Energy Services 37.0
1st Law Efficiency = 39%

7


Estimated U.S. Energy Consumption in 2015: 97.5 Quads
Lawrence Livermore National Laboratory
Solar 0.932
Nuclear 8.34
Hydro 2.38
Wind 1.82
Geothermal 0.224
Natural Gas 26.5
Coal 16.7
Biomass 4.72
Petroleum 36.4
Electricity Generation 36.3
Residential 11.3
Commercial 8.71
Industrial 24.8
Transportation 27.7
Rejected Energy 59.1
Energy Services 38.4
1st Law Efficiency = 39%

8


Estimated U.S. Energy Consumption in 2021: 97.3 Quads
Lawrence Livermore National Laboratory
Solar 1.8
Nuclear 8.13
Hydro 2.28
Wind 3.33
Geothermal 0.206
Natural Gas 31.2
Coal 10.8
Biomass 4.83
Petroleum 35.1
Electricity Generation 36.6
Residential 11.7
Commercial 9.07
Industrial 26
Transportation 26.9
Rejected Energy 63.4
Energy Services 33.8
1st Law Efficiency = 32.7

9

The fossil fuel spike in historic perspective:

So what's next?

UK Just Went Without Coal Power for the First Time Since 1880s

April 24, 2017

By Anna Hirtenstein and Andrew Reierson, Bloomberg

- 50% gas
- 30% renewables
- 20% nuclear

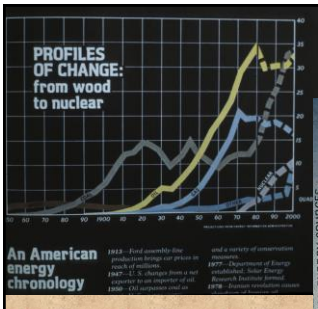
The U.K. had its first full day without burning coal to make electricity since the Industrial Revolution more than a century ago, according to grid operator National Grid Plc.

"Friday 21st April 2017 was the first 24-hour period since the 1880s where Great Britain went without coal-fired power stations," the National Grid control room said in a Twitter post confirming the achievement announced earlier.

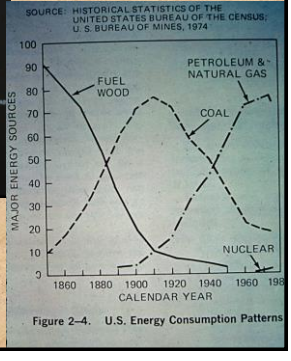
The country is getting half of its electricity from gas power plants, 30 percent from renewables and interconnectors and the remainder from nuclear plants, according to Duncan Burt, head of operate the system at National Grid.

The U.K. was an early adopter of renewable energy and has more offshore wind turbines installed than any other country, as well as fields of solar panels with as much capacity as seven nuclear reactors. The government aims to switch off all coal plants by 2025.

10



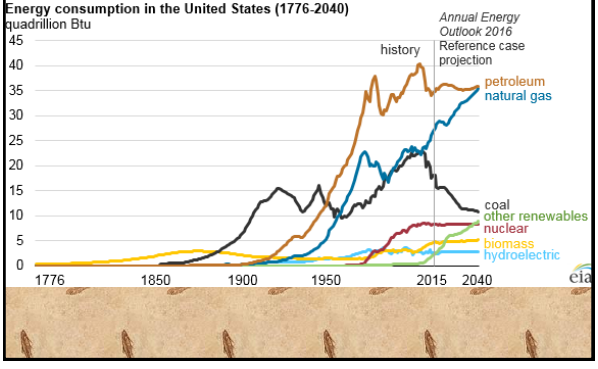
Combustion fuels have ruled…



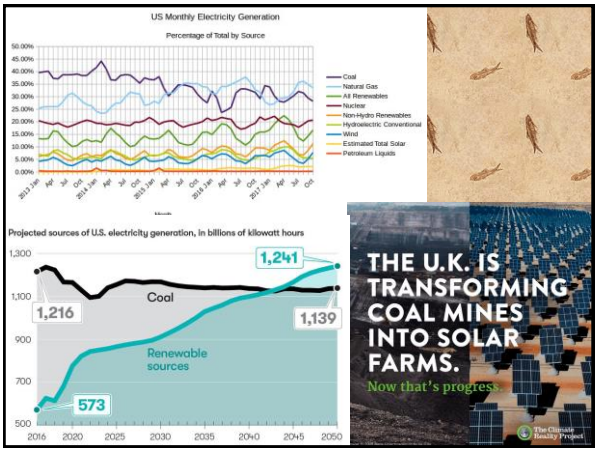
1980 projection:
100 Quads in 2000
2015 generation:
97.5 Quads

11

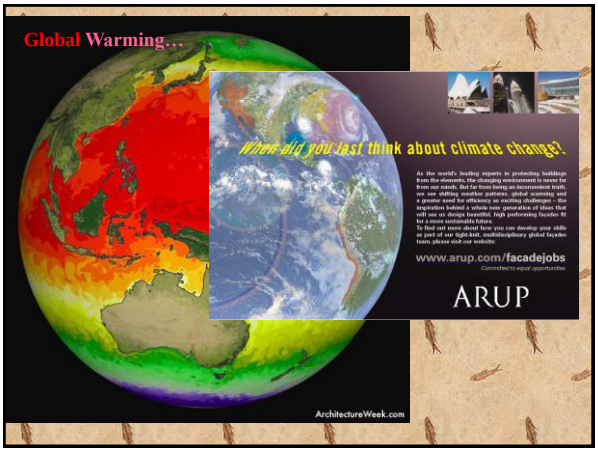
Historic and predicted energy sources 2016:



12


US Monthly Electricity Generation
Percentage of Total by Source
Coal
Natural Gas
All Renewables
Nuclear
Non-Hydro Renewables
Hydroelectric Conventional
Wind
Estimated Total Solar
Petroleum Liquids
Projected sources of U.S. electricity generation, in billions of kilowatt hours
1,241
Coal
1,216
1,139
Renewable sources
573
THE U.K. IS TRANSFORMING COAL MINES INTO SOLAR FARMS.
Now that's progress.
The Climate Reality Project

13


Global Warming…
When did you last think about climate change?
www.arup.com/facadejobs
ARUP
ArchitectureWeek.com

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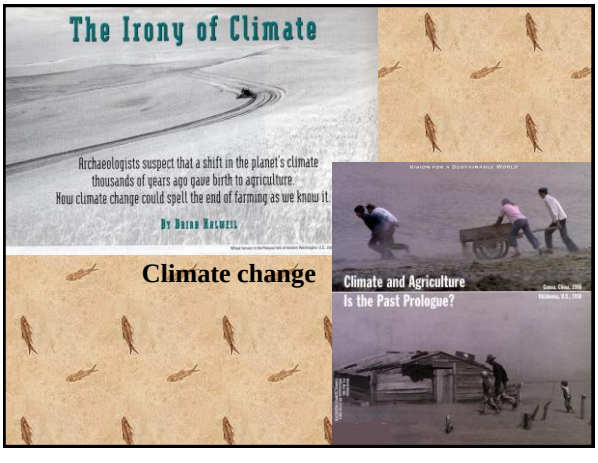
The Irony of Climate
Archaeologists suspect that a shift in the planet's climate thousands of years ago gave birth to agriculture. Now climate change could spell the end of farming as we know it.
By Brian Halweil
Climate change
Climate and Agriculture
Is the Past Prologue?

15

Combustion Fuels

	**Wood & Bio-Mass** **4.72 – 4.83 Quads**
	**Coal** **15.7 – 10.5 Quads**
	**Oil and Gas** **63.7 – 76.9 Quads**

2015 vs. 2021 values

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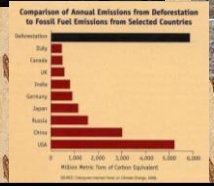
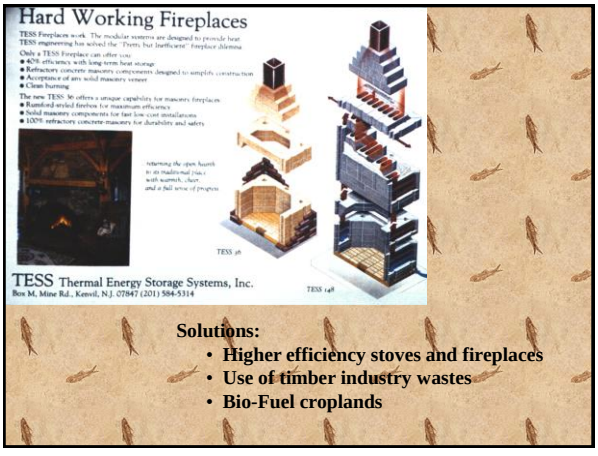
Wood and Bio-Fuels
(4.83 Quads)

17

Air Pollution and Deforestation



18



Solutions:

- **Higher efficiency stoves and fireplaces**
- **Use of timber industry wastes**
- **Bio-Fuel croplands**

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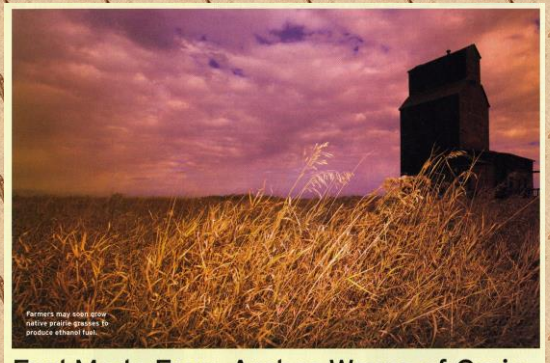
Conflict between food and fuel



Fuel Made From Amber Waves of Grain

Homegrown ethanol can help solve our oil dependence and global warming

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How about algae?

Or elephant grass?

21


greentechmedia:
CONTENTS
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ENTERPRISE
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SIMONA DREVENSE: APRIL 15, 2011
Algae Can Replace 17 Percent of U.S. Fuel Imports, Study Says
Are Genetically Modified Algae a Threat?
by Stephen Lacey, Editor | April 1, 2011 | 5 Comments
A number of companies are working on genetically modifying algae to speed growth, increase lipid content and favorably change the economics of fuel production. But some critics fear that gains in algae productivity could come at t... Full Article
PODCAST
Approximately 17% of the oil imported into the U.S. for cars, trucks and buses could be replaced by algal fuel by 2020, according to a study by the Pacific Northwest National Laboratory.

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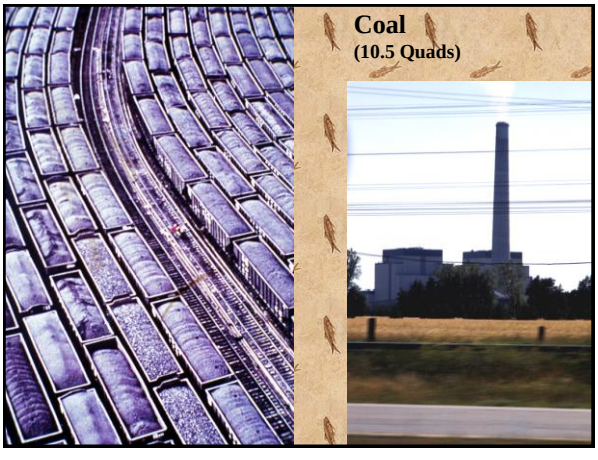
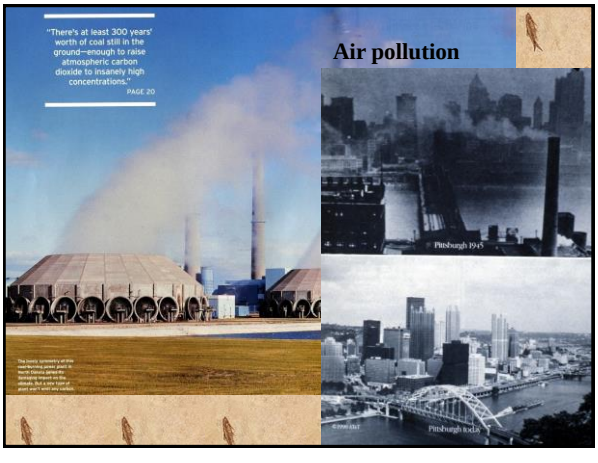

Coal
(10.5 Quads)

23


"There's at least 300 years' worth of coal still in the ground—enough to raise atmospheric carbon dioxide to insanely high concentrations."
PAGE 20
Air pollution
Pittsburgh 1945
Pittsburgh today

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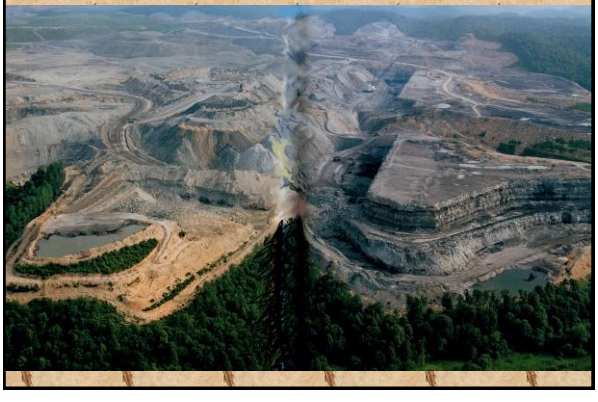
25

Environmental degradation—West Virginia strip mining



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Acid rain

Acid rain healing

A switch to cleaner-burning fuels in Great Britain over the past few decades has allowed some of the nation's most sensitive lakes and streams to recover from the ravages of acid rain. The BBC reports that the conversion to natural gas from coal for power generation since 1970 has resulted in an 84 percent decline in emissions of sulphur and a 37 percent decline in nitrogen oxide. Those gasses are largely to blame for acid rain. Fish such as brown trout have begun to return to rivers and streams, and native algae and insects are also showing signs of recovery.

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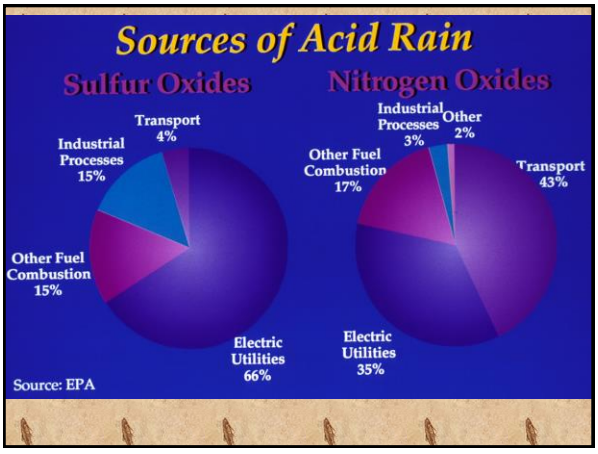
Sources of Acid Rain
Sulfur Oxides
Transport 4%
Industrial Processes 15%
Other Fuel Combustion 15%
Electric Utilities 66%
Nitrogen Oxides
Industrial Processes 3%
Other 2%
Other Fuel Combustion 17%
Transport 43%
Electric Utilities 35%
Source: EPA

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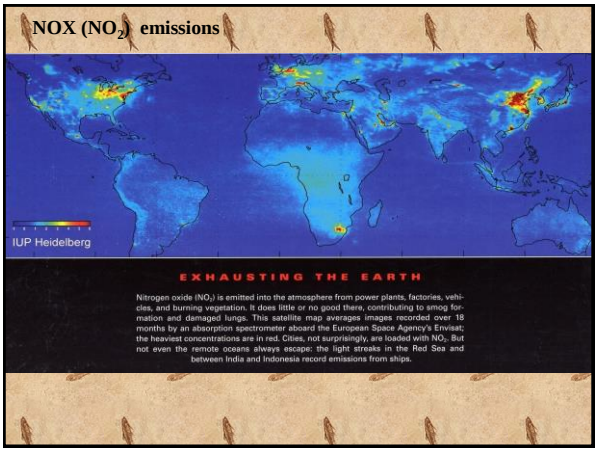
NOX (NO_2) emissions
IUP Heidelberg
EXHAUSTING THE EARTH
Nitrogen oxide (NO_2) is emitted into the atmosphere from power plants, factories, vehicles, and burning vegetation. It does little or no good there, contributing to smog formation and damaged lungs. This satellite map averages images recorded over 18 months by an absorption spectrometer aboard the European Space Agency's Envisat; the heaviest concentrations are in red. Cities, not surprisingly, are loaded with NO_2. But not even the remote oceans always escape: the light streaks in the Red Sea and between India and Indonesia record emissions from ships.

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U.S. ELECTRICITY GENERATION
50% COAL
20% NUCLEAR
18% NATURAL GAS
9% RENEWABLES
3% OIL
U.S. POWER PLANT CO_2 EMISSIONS
83% COAL
13% NATURAL GAS
4% OIL
WHAT'S IN COAL SMOKE?
SULFUR DIOXIDE
The sulfur in coal forms this gas, which gives rise to acid rain when it reacts with water in clouds. Many plants control sulfur emissions by burning low-sulfur coal and passing the exhaust through scrubbers, which capture sulfur dioxide.
NITROGEN OXIDES
The heat of power-plant burners turns nitrogen from the air into nitrogen oxides, which can contribute to acid rain and ground-level ozone. Pollution controls on many plants limit nitrogen oxide emissions.
MERCURY
The traces of mercury in coal escape in power plant exhaust. Falling hundreds of miles away in rain or snow, the mercury builds up in fish, making some species unsafe for children and pregnant women to eat.
CARBON DIOXIDE
Coal produces more CO_2 per energy unit than any other fossil fuel. CO_2 is a greenhouse gas, affecting climate by trapping heat that would otherwise escape to space. Power plants today release all their CO_2 into the atmosphere.
PARTICULATES
Particles from coal-burning plants can harm people who have heart and breathing disorders. Soot and ash are captured before they go up the stacks, but finer particles can form later, from oxides of sulfur and nitrogen.

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Catalyst
The Magazine of the Union of Concerned Scientists
Vol. 5 • No. 1 • Spring 2005
PUTTING COAL ON A CLEANER TRACK
New power plants must address global warming
ALSO
Nutrition benefits of grass-fed beef and milk
Nuclear reprocessing stages a comeback
An energy challenge for your town
Coal's Environmental Impact
From the mines to the power plants, America's dependence on coal comes with a price.
MINING
Altered landscapes. Surface mining in Appalachia often removes entire mountaintops and dumps the wastes into valleys and streams. Between 1985 and 2001, more than seven percent of the region's forests were cut down and more than 1,200 miles of its streams buried or polluted. In addition, waste materials from underground mining are placed in large piles above ground, which can also scar the landscape and alter stream flow.
Water contamination. Acids and toxic metals can contaminate surface and groundwater, harming aquatic life and rendering water supplies undrinkable.
Safety hazards. Underground mining accidents result in many deaths and injuries, and coal dust inhalation causes chronic health problems. Black lung disease still kills about 1,200 former coal miners in the United States each year.
PREPARATION
Water contamination. Impurities such as acids and heavy metals removed from coal and stored in slurry reservoirs can leach into surface and groundwater.
Safety hazards. Slurry reservoir dams can fail, flooding local waterways and putting both wildlife and downstream communities at risk.
TRANSPORTATION & STORAGE
Air pollution. Coal accounts for about half of U.S. freight train traffic. These trains, as well as the trucks and barges that transport coal, run on diesel fuel—a major source of nitrogen oxide and soot. Blowing coal dust adds more soot to the air.
COMBUSTION
Air pollution. Emissions from burning coal contain:
• Sulfur dioxide, which produces acid rain. Coal burning is the leading source of U.S. sulfur dioxide emissions.
• Nitrogen oxides, which contribute to ground-level ozone (smog) and respiratory illnesses.
• Particulate matter (soot), which produces haze and can cause chronic bronchitis, aggravated asthma, and premature death. Both sulfur dioxide and nitrogen oxides transform into particulates in the atmosphere.
• Mercury, a neurotoxin that can contaminate waterways, make fish unsafe to eat, and cause birth defects. Coal burning is the leading source of U.S. mercury emissions.
• Hydrocarbons, carbon monoxide, volatile organic compounds, arsenic, lead, cadmium, and other toxic heavy metals.
WASTE DISPOSAL
Water contamination. Coal ash and sludge is often disposed of in unlined and unmonitored landfills and reservoirs. Arsenic, mercury, chromium, cadmium, and other toxic substances in this waste can contaminate drinking water supplies and harm local ecosystems.

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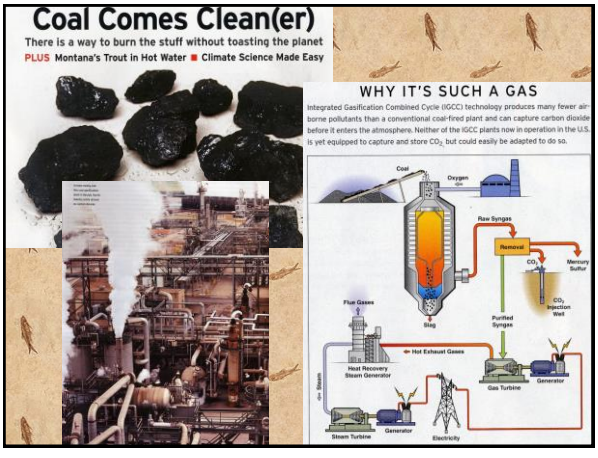
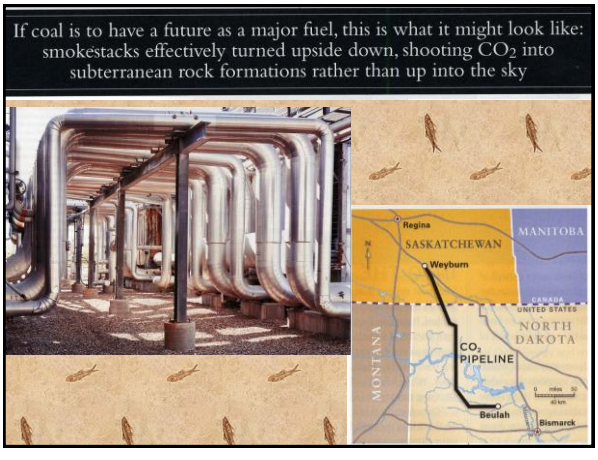

Coal Comes Clean(er)
There is a way to burn the stuff without toasting the planet
PLUS Montana's Trout in Hot Water ■ Climate Science Made Easy
WHY IT'S SUCH A GAS
Integrated Gasification Combined Cycle (IGCC) technology produces many fewer airborne pollutants than a conventional coal-fired plant and can capture carbon dioxide before it enters the atmosphere. Neither of the IGCC plants now in operation in the U.S. is yet equipped to capture and store CO_2, but could easily be adapted to do so.
Coal
Oxygen
Raw Syngas
Removal
CO_2
Mercury Sulfur
CO_2 Injection Well
Flue Gases
Slag
Purified Syngas
Hot Exhaust Gases
Heat Recovery Steam Generator
Gas Turbine
Generator
Steam
Steam Turbine
Generator
Electricity

32


If coal is to have a future as a major fuel, this is what it might look like: smokestacks effectively turned upside down, shooting CO_2 into subterranean rock formations rather than up into the sky
Regina
SASKATCHEWAN
MANITOBA
Weyburn
CANADA
UNITED STATES
NORTH DAKOTA
MONTANA
CO_2 PIPELINE
Beulah
Bismarck

33

Carbon Capture Outlook Grows Bleaker by the Day

The Global CCS Institute says carbon capture and sequestration is falling way behind the pace at which it needs to develop in order to be a meaningful contributor to worldwide CO2 reductions.

EARTHTECHLING, PETE DANKO: OCTOBER 17, 2012

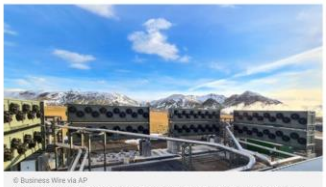
Is it time to stick a fork in carbon capture and sequestration?

34

Business Insider + Follow More from Business Insider

The world's biggest carbon-removal plant just opened. In a year, it'll negate just 3 seconds' worth of global emissions.

awoodward@insider.com (Aylin Woodward) - Yesterday 4:06 AM



© Business Wire via AP
'Orca,' Climeworks' new facility in Iceland, can capture 4,000 tons of carbon dioxide per year. Business Wire via AP

Sep 25. 2021

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Monday, December 17, 2007

Turning Carbon Dioxide into Fuel

Researchers are harnessing solar energy to convert carbon dioxide into carbon monoxide, which can be used to make fuels.

By Duncan Graham-Rowe

Print E-mail Audio » Share »

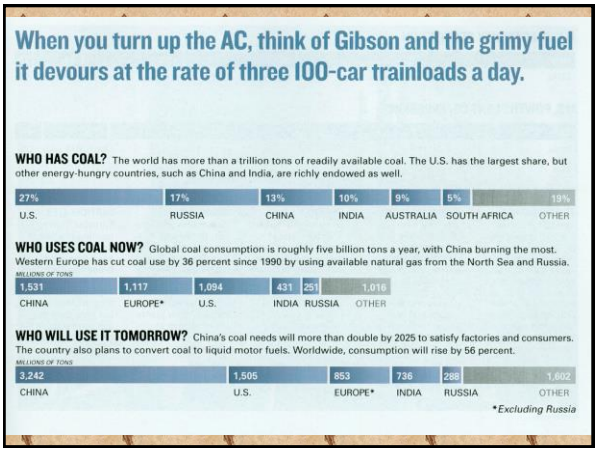
Sun power: Putting the finishing touches on a giant solar collector, which researchers at Sandia National Laboratories will use to power a novel reactor capable of producing carbon monoxide from carbon dioxide. The carbon monoxide can then be used in the manufacture liquid fuels. Credit: Randy Montoya

Could concentrated solar energy be used to reverse combustion and convert carbon dioxide back into gasoline? That's what scientists at Sandia National Laboratories, in Albuquerque, NM, aim to find out by building a novel reactor that can chemically "reenergize" carbon dioxide.

The device uses a two-stage thermochemical reaction to break down carbon dioxide to produce carbon monoxide, says Nathan Siegel, a senior member of technical staffat Sandia's Solar Technologies Department and one of the researchers developing the technology. "Carbon dioxide is a combustion product, so what we're doing is reversing combustion," he says. The carbon monoxide can then readily be employed to produce a range of different fuels, including hydrogen, methanol, and gasoline, using conventional technologies.

Within the Sandia reactor, invented by Sandia researcher Rich Diver, is a ring of a cobalt-ferrite ceramic material, which is essentially made up of iron oxide and cobalt. A parabolic solar concentrator directs sunlight onto the ceramic material, heating it to around 1,500 °C and causing it to give up oxygen.

36


When you turn up the AC, think of Gibson and the grimy fuel it devours at the rate of three 100-car trainloads a day.
WHO HAS COAL? The world has more than a trillion tons of readily available coal. The U.S. has the largest share, but other energy-hungry countries, such as China and India, are richly endowed as well.
27% U.S.
17% RUSSIA
13% CHINA
10% INDIA
9% AUSTRALIA
5% SOUTH AFRICA
19% OTHER
WHO USES COAL NOW? Global coal consumption is roughly five billion tons a year, with China burning the most. Western Europe has cut coal use by 36 percent since 1990 by using available natural gas from the North Sea and Russia.
MILLIONS OF TONS
1,531 CHINA
1,117 EUROPE*
1,094 U.S.
431 INDIA
251 RUSSIA
1,016 OTHER
WHO WILL USE IT TOMORROW? China's coal needs will more than double by 2025 to satisfy factories and consumers. The country also plans to convert coal to liquid motor fuels. Worldwide, consumption will rise by 56 percent.
MILLIONS OF TONS
3,242 CHINA
1,505 U.S.
853 EUROPE*
736 INDIA
288 RUSSIA
1,602 OTHER
*Excluding Russia

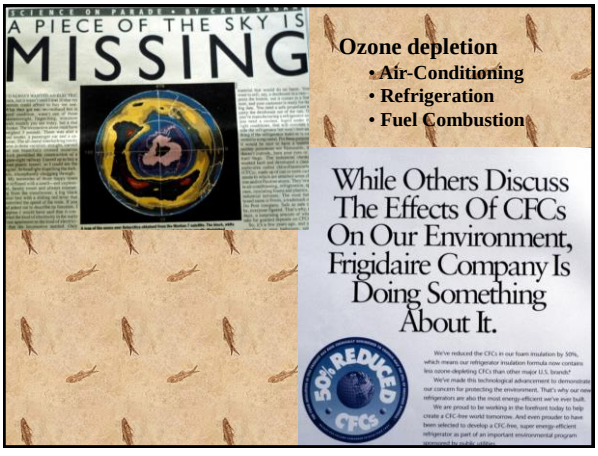
37


EVER WONDER HOW YOUR LUNGS REACT TO TOXIC MATERIALS?
April 23, 1990
THE NEW YORKER
Price $1.75
Health
Lungs

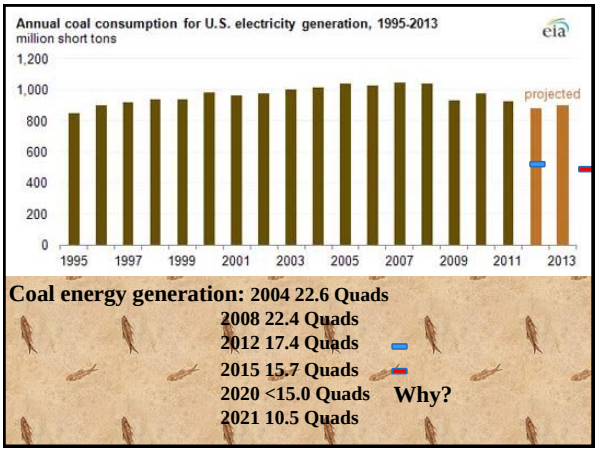
38


Skin and Birth Defects

39


A PIECE OF THE SKY IS
MISSING
Ozone depletion
• Air-Conditioning
• Refrigeration
• Fuel Combustion
While Others Discuss The Effects Of CFCs On Our Environment, Frigidaire Company Is Doing Something About It.
50% REDUCED CFCs

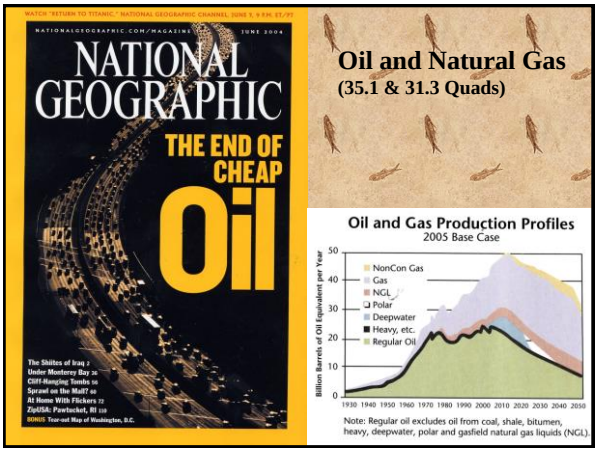
40


Annual coal consumption for U.S. electricity generation, 1995-2013
million short tons
eia
1,200
1,000
800
600
400
200
0
projected
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Coal energy generation: 2004 22.6 Quads
2008 22.4 Quads
2012 17.4 Quads
2015 15.7 Quads
2020 <15.0 Quads
2021 10.5 Quads
Why?

41


A Pile of Retirements: The Next 10 Years for Western Coal Plants
Coal has been used to generate electricity from the beginning of the electric grid. But generating electricity from coal, at least in the West, may become a thing of the past. And utilities' plans indicate the decline of coal generation in the West will be rapid over the next decade. Read more.

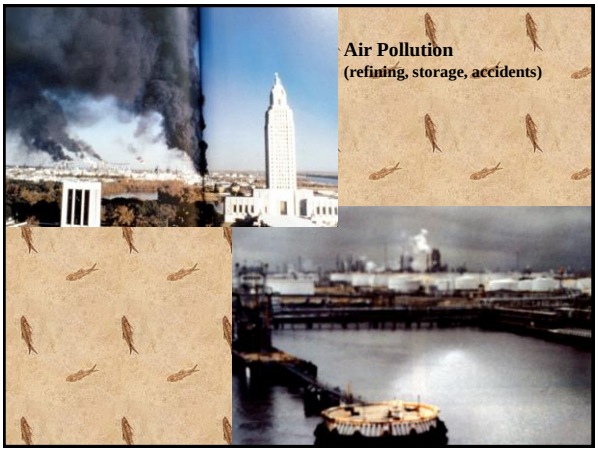
42


NATIONAL GEOGRAPHIC
THE END OF CHEAP
Oil
Oil and Natural Gas
(35.1 & 31.3 Quads)
Oil and Gas Production Profiles
2005 Base Case
NonCon Gas
Gas
NGL
Polar
Deepwater
Heavy, etc.
Regular Oil
Billion Barrels of Oil Equivalent per Year
Note: Regular oil excludes oil from coal, shale, bitumen, heavy, deepwater, polar and gasfield natural gas liquids (NGL).

43


Air Pollution
(from transportation)
China to Tax CO2, Reform Coal and Water Pricing
China leapfrogs the United States in greenhouse gas (GHG) policy
IT'S 1980. AND THE KIDS ARE GOING OUT TO PLA

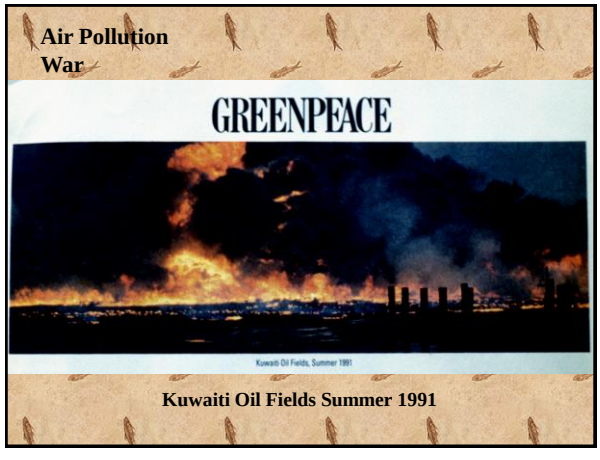
44


Air Pollution
(refining, storage, accidents)

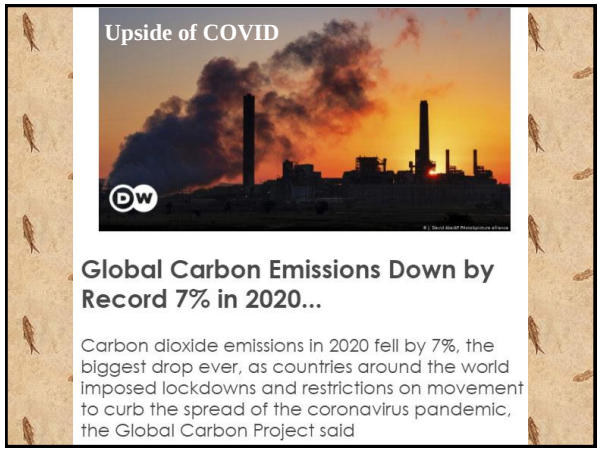
45


GREENPEACE
MAGAZINE
LIVING WITH POLLUTION
POVERTY'S SILENT PARTNER
EXPOSÉ:
LEADED GAS:
Poor People's Campaign
A NATIONAL REVIVAL
THE CLIMATE CRISIS IS A JUSTICE CRISIS
Record topping
Exxon Mobil Corp. posted the largest annual profit by a U.S. company, topping its own 2006 record.
Profits
Annual net income, in billions of dollars
11.5
21.5
25.3
36.1
39.5
40.6
'02 '03 '04 '05 '06 '07
Source: Exxon Mobil Corp.
ExxonMobil posts $40.6 billion profit
FROM WIRE REPORTS
IRVING, Texas – Helped by $90- and $100-a-barrel oil, ExxonMobil announced Friday that
earnings increased to a record $40.6 billion in
2007. That's $4.6 million an hour, roughly the
gross domestic product of Costa Rica and Uru
guay combined.
Unlike recent years, there was no immediate
outcry from consumer groups and critics in
Congress over Big Oil's profits.
One exception was Rep. Ed Markey, D-Mass.,
who said in an e-mail statement quoted by
Bloomberg News: "While the oil companies are
See EXXON, A9

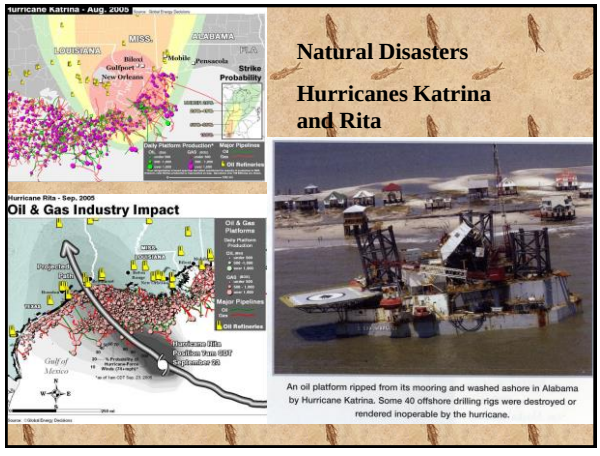
46


Air Pollution War
GREENPEACE
Kuwaiti Oil Fields, Summer 1991
Kuwaiti Oil Fields Summer 1991

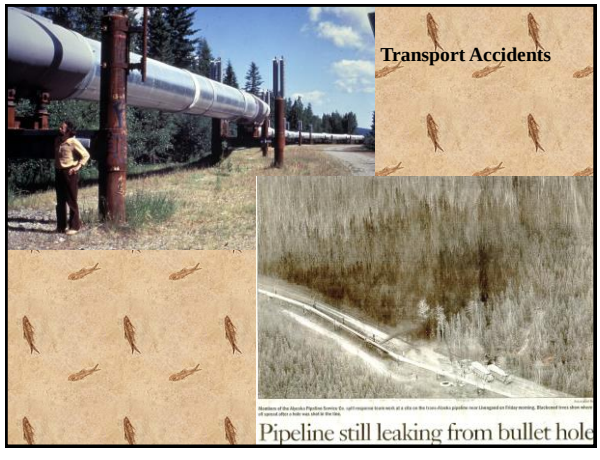
47


Upside of COVID
DW
Global Carbon Emissions Down by Record 7% in 2020...
Carbon dioxide emissions in 2020 fell by 7%, the biggest drop ever, as countries around the world imposed lockdowns and restrictions on movement to curb the spread of the coronavirus pandemic, the Global Carbon Project said

48


Natural Disasters
Hurricanes Katrina and Rita
Oil & Gas Industry Impact
An oil platform ripped from its mooring and washed ashore in Alabama by Hurricane Katrina. Some 40 offshore drilling rigs were destroyed or rendered inoperable by the hurricane.

49


Transport Accidents
Pipeline still leaking from bullet hole

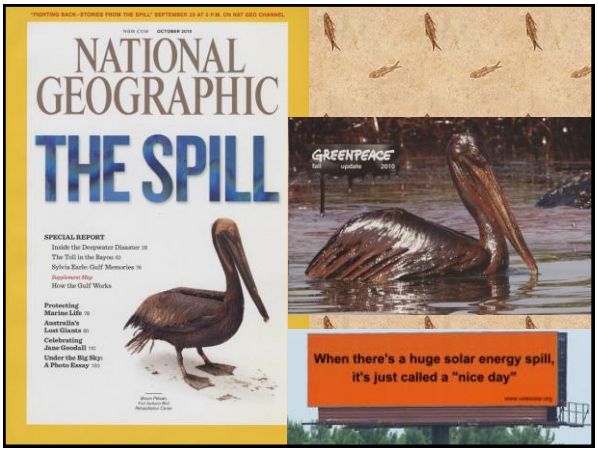
50


A brown bear covered in oil after the Exxon Valdez spilled more than 11 million gallons of crude in 1989.
ANCHORAGE
VALDEZ
PORTAGE
BLIGH ISLAND
Prince William Sound
NAKED ISLAND
KNIGHT ISLAND
CORDOVA
HINCHINBROOK ISLAND
KENAI PENINSULA
KODIAK ISLAND
PRUDHOE BAY
Arctic National Wildlife Refuge
Pipeline
Gulf of Alaska

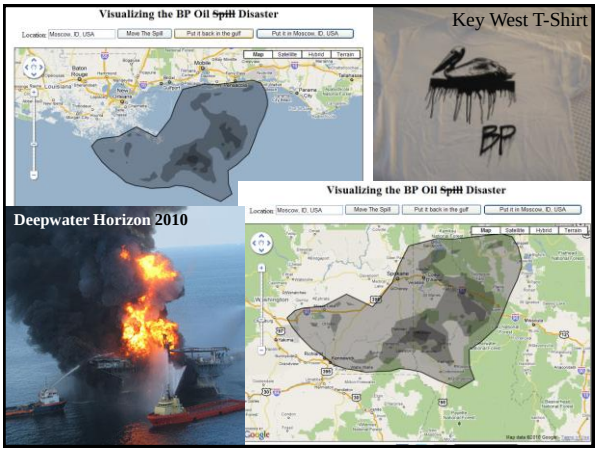
51


Area of Valdez Spill Compared to the California Coast
Area of Valdez Spill Compared to the Eastern Seaboard

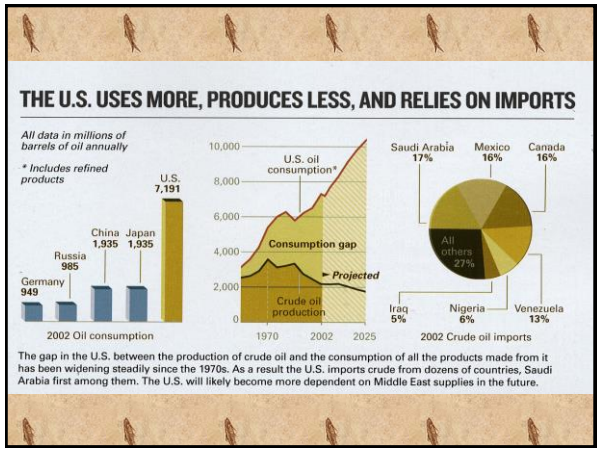
52


NATIONAL GEOGRAPHIC
THE SPILL
SPECIAL REPORT
GREENPEACE
When there's a huge solar energy spill, it's just called a "nice day"

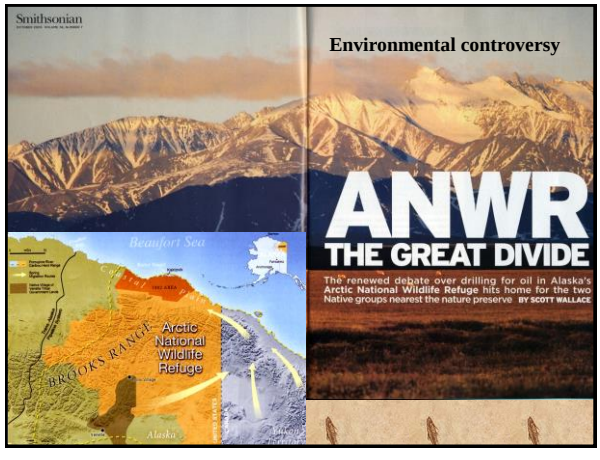
53


Visualizing the BP Oil Spill Disaster
Key West T-Shirt
Deepwater Horizon 2010
Visualizing the BP Oil Spill Disaster

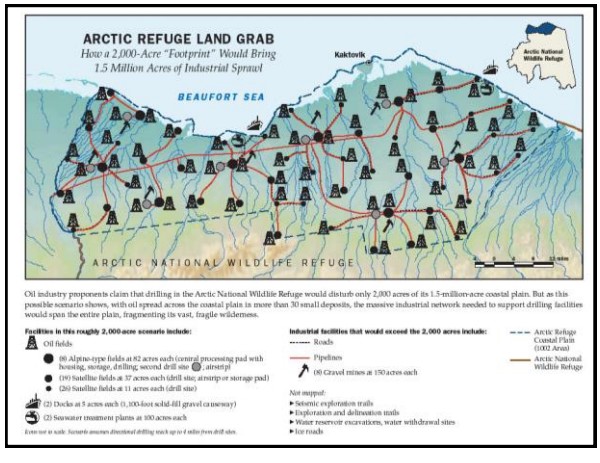
54


THE U.S. USES MORE, PRODUCES LESS, AND RELIES ON IMPORTS
All data in millions of barrels of oil annually
* Includes refined products
U.S. 7,191
China 1,935
Japan 1,935
Russia 985
Germany 949
2002 Oil consumption
10,000
8,000
6,000
4,000
2,000
0
U.S. oil consumption*
Consumption gap
Projected
Crude oil production
1970
2002
2025
Saudi Arabia 17%
Mexico 16%
Canada 16%
All others 27%
Iraq 5%
Nigeria 6%
Venezuela 13%
2002 Crude oil imports
The gap in the U.S. between the production of crude oil and the consumption of all the products made from it has been widening steadily since the 1970s. As a result the U.S. imports crude from dozens of countries, Saudi Arabia first among them. The U.S. will likely become more dependent on Middle East supplies in the future.

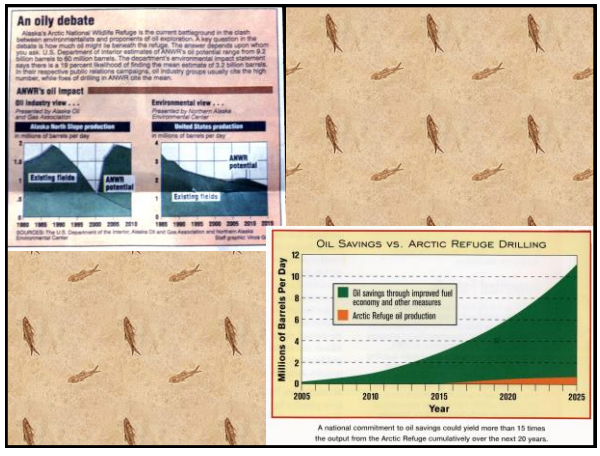
55


Smithsonian
Environmental controversy
ANWR
THE GREAT DIVIDE
The renewed debate over drilling for oil in Alaska's Arctic National Wildlife Refuge hits home for the two Native groups nearest the nature preserve BY SCOTT WALLACE
Beaufort Sea
BROOKS RANGE
Arctic National Wildlife Refuge
Alaska

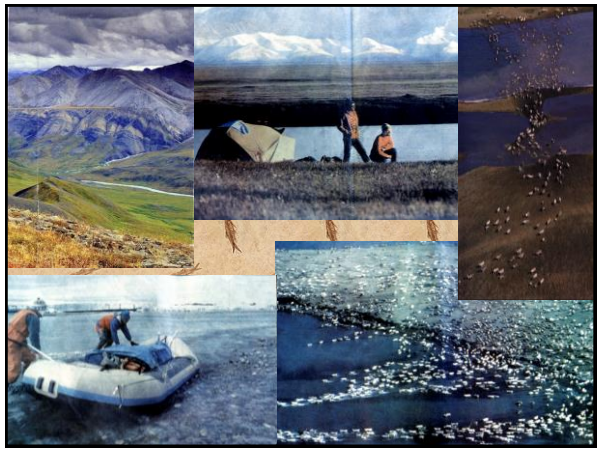
56


ARCTIC REFUGE LAND GRAB
How a 2,000-Acre "Footprint" Would Bring 1.5 Million Acres of Industrial Sprawl
Kaktovik
Arctic National Wildlife Refuge
BEAUFORT SEA
ARCTIC NATIONAL WILDLIFE REFUGE
Oil industry proponents claim that drilling in the Arctic National Wildlife Refuge would disturb only 2,000 acres of its 1.5-million-acre coastal plain. But as this possible scenario shows, with oil spread across the coastal plain in more than 30 small deposits, the massive industrial network needed to support drilling facilities would span the entire plain, fragmenting its vast, fragile wilderness.
Facilities in this roughly 2,000-acre scenario include:
Oil fields
(8) Alpine-type fields at 82 acres each (central processing pad with housing, storage, drilling, second drill site, airstrip)
(19) Satellite fields at 37 acres each (drill site; airstrip or storage pad)
(26) Satellite fields at 11 acres each (drill site)
(2) Docks at 5 acres each (1,100-foot solid-fill gravel causeway)
(2) Seawater treatment plants at 100 acres each
Extent not to scale. Scenario assumes directional drilling reach up to 4 miles from drill sites.
Industrial facilities that would exceed the 2,000 acres include:
Roads
Pipelines
(8) Gravel mines at 150 acres each
Not mapped:
Seismic exploration trails
Exploration and delineation wells
Water reservoir excavations, water withdrawal sites
Ice roads
Arctic Refuge Coastal Plain (1002 Area)
Arctic National Wildlife Refuge

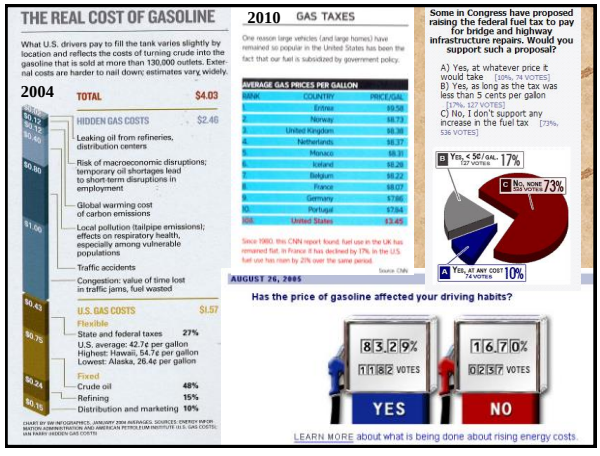
57


An oily debate
ANWR's oil impact
Oil industry view . . .
Environmental view . . .
Existing fields
ANWR potential
Oil Savings vs. Arctic Refuge Drilling
Millions of Barrels Per Day
Oil savings through improved fuel economy and other measures
Arctic Refuge oil production
Year
A national commitment to oil savings could yield more than 15 times the output from the Arctic Refuge cumulatively over the next 20 years.

58

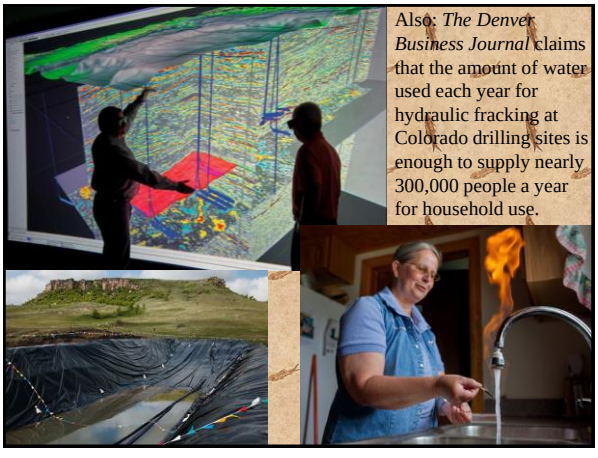


59


THE REAL COST OF GASOLINE
What U.S. drivers pay to fill the tank varies slightly by location and reflects the costs of turning crude into the gasoline that is sold at more than 130,000 outlets. External costs are harder to nail down; estimates vary widely.
2004
TOTAL $4.03
HIDDEN GAS COSTS $2.46
Leaking oil from refineries, distribution centers
Risk of macroeconomic disruptions; temporary oil shortages lead to short-term disruptions in employment
Global warming cost of carbon emissions
Local pollution (tailpipe emissions); effects on respiratory health, especially among vulnerable populations
Traffic accidents
Congestion: value of time lost in traffic jams, fuel wasted
U.S. GAS COSTS $1.57
Flexible
State and federal taxes 27%
U.S. average: 42.7¢ per gallon
Highest: Hawaii, 54.7¢ per gallon
Lowest: Alaska, 26.4¢ per gallon
Fixed
Crude oil 48%
Refining 15%
Distribution and marketing 10%
2010 GAS TAXES
AVERAGE GAS PRICES PER GALLON
RANK COUNTRY PRICE/GAL
1. Eritrea $9.58
2. Norway $8.73
3. United Kingdom $8.38
4. Netherlands $8.37
5. Monaco $8.31
6. Iceland $8.28
7. Belgium $8.22
8. France $8.07
9. Germany $7.86
10. Portugal $7.64
108. United States $3.45
AUGUST 26, 2005
Has the price of gasoline affected your driving habits?
83.2% 1182 VOTES
16.7% 0257 VOTES
YES
NO
LEARN MORE about what is being done about rising energy costs.
Some in Congress have proposed raising the federal fuel tax to pay for bridge and highway infrastructure repairs. Would you support such a proposal?
A) Yes, at whatever price it would take [10%, 74 VOTES]
B) Yes, as long as the tax was less than 5 cents per gallon [17%, 127 VOTES]
C) No, I don't support any increase in the fuel tax [73%, 536 VOTES]
B Yes, < 50¢/GAL. 127 VOTES 17%
C No, NONE 536 VOTES 73%
A Yes, AT ANY COST 74 VOTES 10%

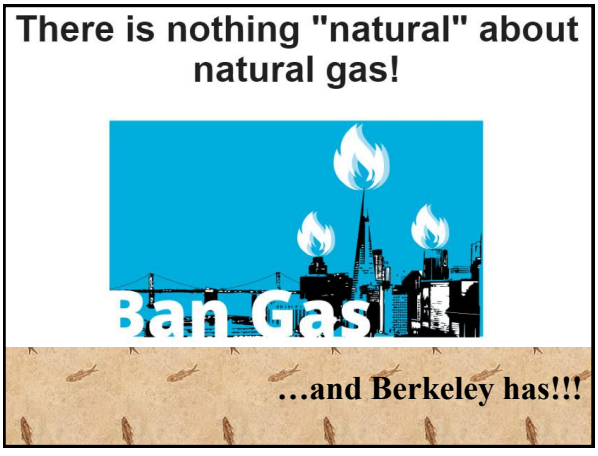
60

61



Also: *The Denver Business Journal* claims that the amount of water used each year for hydraulic fracking at Colorado drilling sites is enough to supply nearly 300,000 people a year for household use.

62



63

Berkeley Says No to New Gas Connections

Although San Francisco has yet to institute a gas ban similar to the one recently enacted across the bay, in Berkeley, several residential projects there anticipate such restrictions, including Mithun's Maceo May Apartments, a 105-unit building for formerly homeless veterans and their families slated for completion in 2021.

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December 15, 2021
6:07 PM PST
Last Updated 20 days ago

U.S. Markets

New York City bans natural gas in new buildings

4 minute read

By Scott Disavino

65

EPA Accused of Fracking Cover-Up

Instrument that measures fracking methane emissions allegedly reports wrong information.

AN ENVIRONMENTAL WATCHDOG ALLEGES THE Environmental Protection Agency (EPA) has engaged in a years-long, systematic cover-up of the true data surrounding climate-warming methane emissions from fracking. That cover-up, the group says, was at the hands of at least one EPA researcher who accepted payments from the oil and gas industry.

The cover-up was discovered by NC WARN when it became aware that the inventor of the Bacharach *Hi Flow* Sampler, an engineer named Touché Howard, had been attempting to blow the whistle for years on the crucial instrument's malfunctioning. The critical failure causes the instrument to under-report methane emissions "up to 100 fold," the organization wrote.

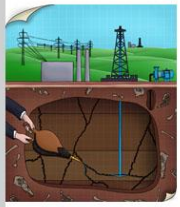
Studies have shown the EPA underestimated methane leaks from fracked gas production for years, and Howard's own research found the agency has been "hugely underestimating" methane emissions specifically as a result of the faulty instrument, according to Common Dreams.

NC WARN filed an incendiary federal complaint with the EPA's Inspector General, the agency's internal watchdog.

Inaccurate reporting. A crucial instrument used in the fracking process allegedly under-reports methane emissions.

66

Following our bad example?!?!?



Energy Conversations
Will Fracking End Fretting?

Wednesday 13 March 2013, 6.30pm
The UK has a potentially huge source of energy on its doorstep. 'Fracking' has transformed the US energy market and now makes shale gas technology an attractive option for the UK energy market. Energy security and consistent lower prices could be significant gain for the UK economy. However, have we overestimated the quantities involved? Can the UK's physical, political and social environment withstand the impact of the technology, and should we be seduced by the attraction of cheap energy?

Speakers:

Professor Kevin Anderson, Professor of Energy and Climate Change, University of Manchester
Professor Richard Selley, Petroleum Exploration, Imperial College
Nick Grealy, No Hot Air
Bill Bordass OBE, William Bordass Associates (Chair)

67

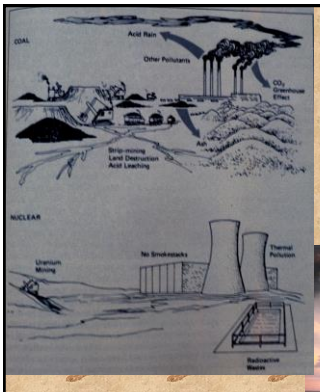
Annals of a Warming Planet

To Counter Climate Change, We Need to Stop Burning Things

Fossil Fuels, even Wood!

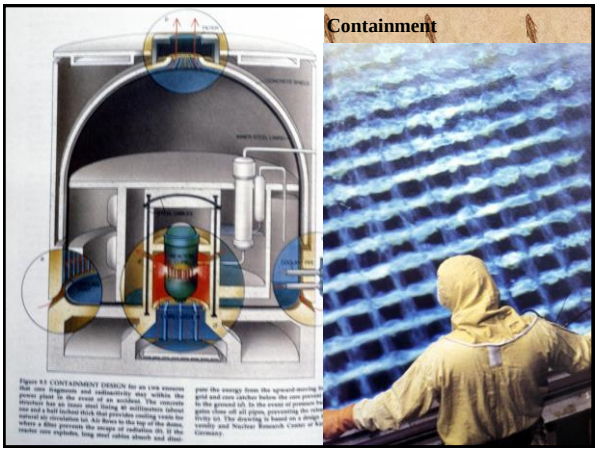
By Bill McKibben

68

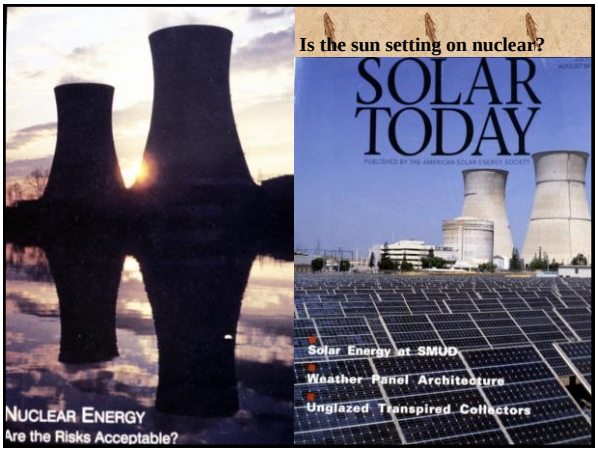


Nuclear Power
(8.13 Quads)
An alternative to combustion?

69


Containment

70


Is the sun setting on nuclear?
SOLAR TODAY
Solar Energy at SMUD
Weather Panel Architecture
Unglazed Transpired Collectors
NUCLEAR ENERGY
Are the Risks Acceptable?

71


ILLINOIS INSTITUTE OF TECHNOLOGY
iitmagazine
Is nuclear the bright light in a green energy future?
…or rising?

72

http://www.rmi.org/images/PDFs/Energy/E05-08_NukePwrEcon.pdf

Lovins, Amory "Nuclear power: economics and climate-protection potential." Rocky Mountain Institute. 11 September 2005.

I have excerpted a couple of sentences from the Abstract below:

"But nuclear power is a still less helpful climate solution because it's about the slowest option to deploy (in capacity or annual output added per year)—as observed market behavior confirms—and the most costly. Its higher cost than competitors, per unit of net CO2 displaced, means that every dollar invested in nuclear expansion will worsen climate change by buying less solution per dollar. Specifically, every $0.10 spent to buy a single new nuclear kilowatt-hour (roughly its delivered cost, including its 2004 subsidies, according to the authoritative 2003 MIT study's findings expressed in 2004 $) could instead have bought 1.2 to 1.7 kWh

of windpower ("firmed" to be available whenever desired), 0.9 to 1.7+ kWh of gas-fired industrial or ~2.2–6.5+ kWh of building-scale cogeneration (adjusted for their CO2 emissions), an infinite number of kWh from waste-heat cogeneration (since its economic cost is typically negative), or at least several, perhaps upwards of ten, kWh of electrical savings from more efficient use. In this sense of "opportunity cost"—any investment foregoes other outcomes that could have been bought with the same money—nuclear power is far more carbon-intensive than a coal plant. For these reasons, expanding nuclear power would both reduce and retard the desired decrease in CO2 emissions."

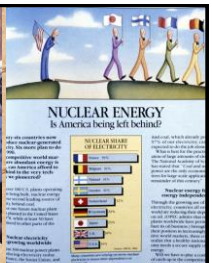
73

From my flight over France

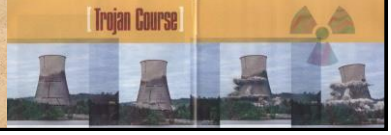
Microclimatic effect…
steam from cooling towers

France has 58 reactors

74



Social Unrest
Social Distress



75

Rising misgivings
Rising costs

Recipe for trouble

CHAIR'S CORNER

Nuclear Power? No, Thanks.

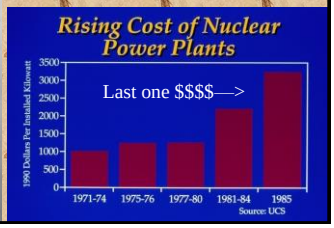
By John Reynolds, FAIA

The United States should phase out nuclear power as soon as possible. Instead of nukes, we need a wholehearted commitment to renewable energy sources. Some of my ASES friends disagree with my nuclear skepticism. I acknowledge their point of view.

The threat of global warming has revived interest in nuclear power, because it apparently produces no gases that con-


John Reynolds, FAIA

nuclear waste sits at each nuclear plant, even those now decommissioned. If we ever build that central waste depository under Nevada's Yucca Mountain, radioactive waste will then be shipped through our cities and farms. Until the



76

US Government Issues Loans for the First Nuclear Reactors in 30 Years


Georgia Power

All eyes are on Georgia to see if nuclear can launch a comeback in the U.S.

Katherine Tweed
February 20, 2014

77

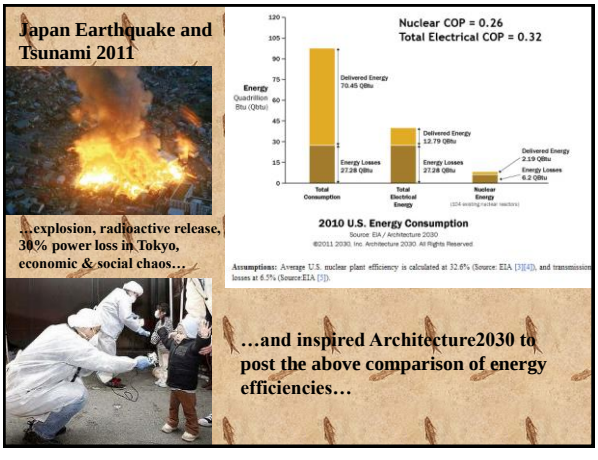
2022 Update


Two nuclear reactors are now under construction in the U.S., at Plant Vogtle in Georgia. They are billions of dollars over budget and years behind schedule.
GEORGIA POWER COMPANY

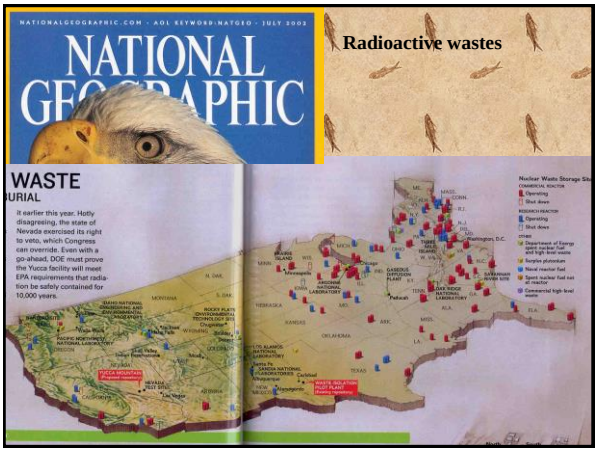
78


Former U.S.S.R.
Accidents @ Chernobyl
1986 disaster,
Still radioactive

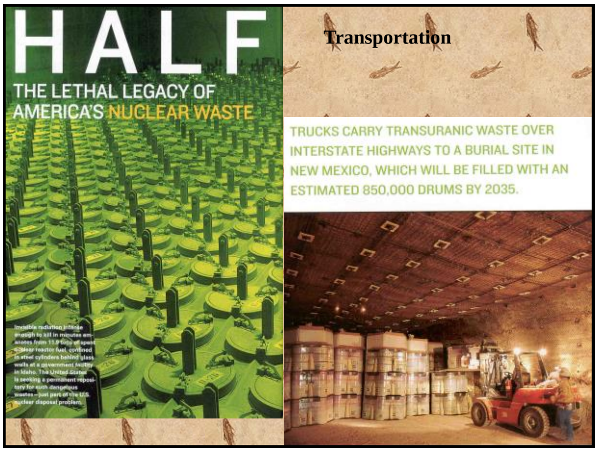
79


Japan Earthquake and Tsunami 2011
…explosion, radioactive release, 30% power loss in Tokyo, economic & social chaos…
Nuclear COP = 0.26
Total Electrical COP = 0.32
Energy Quadrillion Btu (Qbtu)
Delivered Energy 70.45 QBtu
Energy Losses 27.28 QBtu
Delivered Energy 12.79 QBtu
Energy Losses 27.28 QBtu
Delivered Energy 2.19 QBtu
Energy Losses 6.2 QBtu
Total Consumption
Total Electrical Energy
Nuclear Energy
2010 U.S. Energy Consumption
Source: EIA / Architecture 2030
…and inspired Architecture2030 to post the above comparison of energy efficiencies…

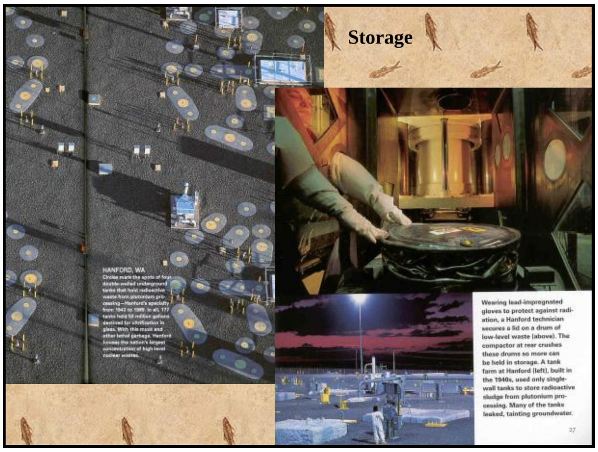
80


NATIONAL GEOGRAPHIC
Radioactive wastes
WASTE
URIAL
it earlier this year. Hotly disagreeing, the state of Nevada exercised its right to veto, which Congress can override. Even with a go-ahead, DOE must prove the Yucca facility will meet EPA requirements that radiation be safely contained for 10,000 years.

81


HALF
THE LETHAL LEGACY OF AMERICA'S NUCLEAR WASTE
Transportation
TRUCKS CARRY TRANSURANIC WASTE OVER INTERSTATE HIGHWAYS TO A BURIAL SITE IN NEW MEXICO, WHICH WILL BE FILLED WITH AN ESTIMATED 850,000 DRUMS BY 2035.
Invisible radiation intense enough to kill in minutes emanates from 11.9 tons of spent nuclear reactor fuel, confined in steel cylinders behind glass walls at a government facility in Idaho. The United States is seeking a permanent repository for such dangerous wastes—just part of the U.S. nuclear disposal problem.

82


Storage
HANFORD, WA
Wearing lead-impregnated gloves to protect against radiation, a Hanford technician secures a lid on a drum of low-level waste (above). The compactor at rear crushes these drums so more can be held in storage. A tank farm at Hanford (left), built in the 1940s, used only single-wall tanks to store radioactive sludge from plutonium processing. Many of the tanks leaked, tainting groundwater.
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Storage casks at the Prairie Island nuclear power plant near Minneapolis (right and below) have nine-inch-thick skins of carbon steel and hold 17.6 tons each of spent fuel assemblies. With the number of aboveground casks limited to 17 by the state of Minnesota, the plant will run out of storage space in 2007.
Rusting drums of waste at Los Alamos National Laboratory in New Mexico recall past haphazard disposal. A lab spokesman questioned whether this photo was taken at Los Alamos, saying, "we do not store drums in a configuration like that." Later he said that this arrangement represents "strict compliance with all radioactive waste disposal regulations."
Shielded by radiation-proof glass at Rocky Flats (facing page), a worker with a torch dismantles steel boxes used in making plutonium triggers for bombs. Buckets and other containers for radioactive materials (above) await disposal at Oak Ridge National Laboratory in Tennessee. Sealed hull sections of 92 submarines containing nuclear propulsion reactors emptied of fuel rest at Hanford (left).

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PADUCAH, KY
Some 36,000 cylinders of depleted uranium, many in poor condition, lie outside the Paducah Gaseous Diffusion Plant, a remap for nuclear-fuel processing. Tainted groundwater has forced the government to provide municipal water for nearby residents.

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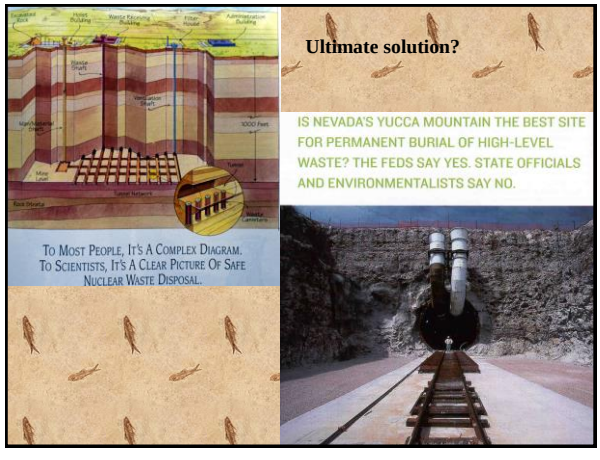
Ultimate solution?
IS NEVADA'S YUCCA MOUNTAIN THE BEST SITE FOR PERMANENT BURIAL OF HIGH-LEVEL WASTE? THE FEDS SAY YES. STATE OFFICIALS AND ENVIRONMENTALISTS SAY NO.
To Most People, It's A Complex Diagram. To Scientists, It's A Clear Picture Of Safe Nuclear Waste Disposal.

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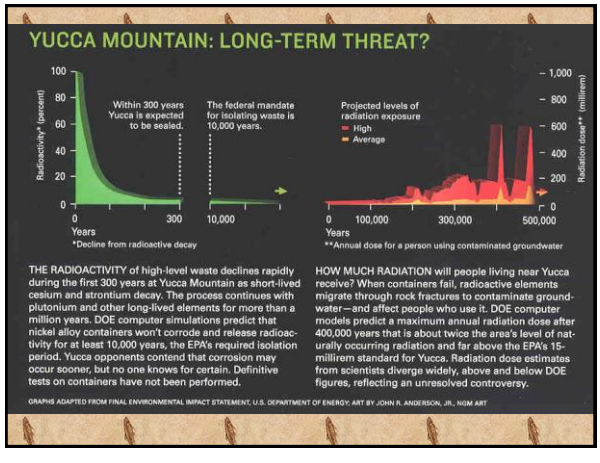
YUCCA MOUNTAIN: LONG-TERM THREAT?
Radioactivity* (percent)
100
80
60
40
20
0
Within 300 years Yucca is expected to be sealed.
The federal mandate for isolating waste is 10,000 years.
0
300
10,000
Years
*Decline from radioactive decay
Projected levels of radiation exposure
High
Average
Radiation dose** (millirem)
1,000
800
600
400
200
0
0
100,000
300,000
500,000
Years
**Annual dose for a person using contaminated groundwater
THE RADIOACTIVITY of high-level waste declines rapidly during the first 300 years at Yucca Mountain as short-lived cesium and strontium decay. The process continues with plutonium and other long-lived elements for more than a million years. DOE computer simulations predict that nickel alloy containers won't corrode and release radioactivity for at least 10,000 years, the EPA's required isolation period. Yucca opponents contend that corrosion may occur sooner, but no one knows for certain. Definitive tests on containers have not been performed.
HOW MUCH RADIATION will people living near Yucca receive? When containers fail, radioactive elements migrate through rock fractures to contaminate groundwater—and affect people who use it. DOE computer models predict a maximum annual radiation dose after 400,000 years that is about twice the area's level of naturally occurring radiation and far above the EPA's 15-millirem standard for Yucca. Radiation dose estimates from scientists diverge widely, above and below DOE figures, reflecting an unresolved controversy.
GRAPHS ADAPTED FROM FINAL ENVIRONMENTAL IMPACT STATEMENT, U.S. DEPARTMENT OF ENERGY; ART BY JOHN R. ANDERSON, JR., NGM ART

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Re-Use or
Oooops

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Proposed Nuclear Fusion Plant
2021 Canada
Amanda Levete Architects

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…stay tuned for what we can do in Idaho…

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