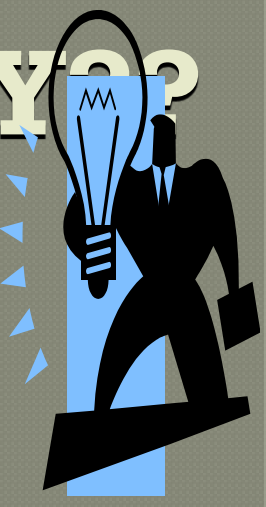
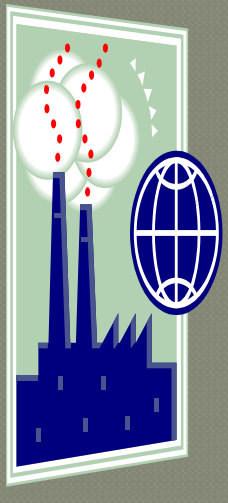
ENERGY??





Where are we going?
How will we get there?
Will our Standard of Living and Quality of Life be Sustainable?

Energy Overview

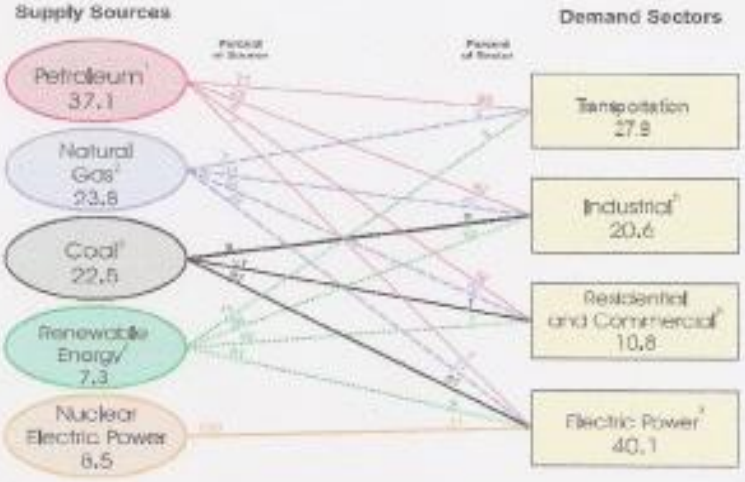
Energy Information Administration
Official Energy Statistics from the U.S. Government

Home > Historical Energy Data > AER > Consumption by Source and Sector

Annual Energy Review (AER) - long-term historical statistics all in one place

U.S. Primary Energy Consumption by Source and Sector, 2008
(Quadrillion Btu)

(0.5 MB)



Legend:
PDF file

Note: Monthly Energy Review (MER) tables show latest data available, including any revisions to annual data.

Related Links

[1]Does not include the fuel ethanol portion of motor gasoline—fuel ethanol is included in "Renewable Energy."
[2]Excludes supplemental gaseous fuels.
[3]Includes less than 0.1 quadrillion Btu of coal coke net imports.
[4]Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.
[5]Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7]Electricity only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.
Source: Energy Information Administration, *Annual Energy Review 2008*, Tables 1.3, 2.1b-2.1f, 10.3, and 10.4.

SUMMARY

ENERGY DISCUSSION SUMMARY

I. Significant Problem Areas
   a. Petroleum, Oil
   b. Coal

II. Problematic
   a. Nuclear

III. Prospects Excellent
   a. Renewables
      solar, wind, geothermal , ++
      hydro, + to (-)
      biofuels, + to (-)
   b. Natural Gas

Nuclear's Fall—and Rise

As some environmentalists begin to offer more support, the future of nuclear power in the U.S. still depends on whether it makes economic sense

By the end of the 1980s, the nuclear-power industry appeared to be heading for a meltdown.

The Three Mile Island accident in 1979 confirmed many people's fears about the danger of nuclear power and led to expensive safety upgrades for planned and existing plants. A recession slashed demand for electricity, inflation made new nuclear plants more expensive and falling energy prices made nuclear power less competitive with other power sources.

Then, in 1986, the Chernobyl accident in Ukraine killed at least 56 people directly and spread radiation throughout much of Europe. Responding to "no nukes" sentiment, many states blocked new plant construction, and some European countries called for shutting down existing plants.

Twenty years later, though, nuclear power may have found its reason for being: global warming. Several leading environmentalists have come out in favor of nuclear power because it is a low-carbon, plentiful source of electricity that could replace dirty coal, especially in rapidly growing countries such as China and India.

No Substitute

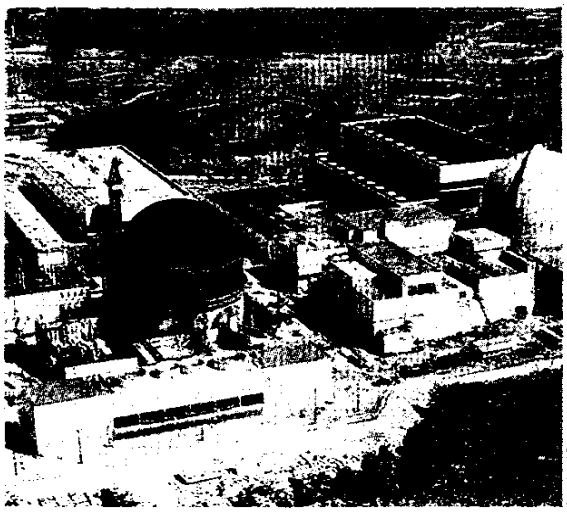
"Coal is the major villain when it comes to greenhouse gases," says Stewart Brand, founder of the Whole Earth Catalog and a former nuclear-power opponent who is now an avid supporter. "Countries are discovering that wind and solar are good to do, and they make a dent. But when it comes to baseload, always-on power, we have nothing that really replaces coal except nuclear."

Meanwhile, public support for nuclear power is growing. A March Gallup survey found 62% of those asked favor nuclear power, the highest level since Gallup began polling on the subject in 1994. In a handful of unscientific surveys on environmental Web sites, a small majority say they are willing to give nuclear power another look as a way to fight climate change. Others, including those who don't believe global warming is a real problem, favor nuclear power as a way to address climate change, including James Lovelock, a British scientist who developed the Gaia hypothesis that sees the Earth as a self-regulating organism; the late Hugh Montefiore, a former Anglican bishop and a trustee of the U.K. Friends of the Earth; and Stephen Tindale, a former executive director of Greenpeace U.K.

Most were driven by what they saw as the potentially catastrophic effects of global warming. In comparison, they viewed the risks of nuclear power as more manageable.

"If you're an environmentalist and you're arguing that catastrophic climate change is a serious problem that we have to deal with, it's increasingly hard to say that we're worried about nuclear power because of what's going to happen to nuclear waste buried inside of a mountain for 10,000 years," says Ted Nordhaus, chairman of the Breakthrough Institute, an Oakland, Calif., think tank.

Zuma Press



Associated Press

Top: Installation of the reactor dome at a next-generation nuclear plant being built in Finland. Above: A May 1979 rally against nuclear power in Washington, soon after the Three Mile Island accident. Below: The Seabrook, N.H., nuclear plant, where Unit 2 (left) has been mothballed since rising costs forced a halt to construction in 1984. Unit 1 (right) has been operating since 1990.

Placing Bets

Still, not all environmentalists are sold on nuclear, and most environmental groups remain opposed. For one thing, they warn that an ambitious nuclear-building program would squeeze out investments in other alternatives. Further, they say, the lengthy process of building and permitting a nuclear plant means the climate-change benefits aren't going to show up anytime soon, while efficiency programs, investments in solar and wind and even new natural-gas plants could meet low-carbon power needs much sooner.

For now, though, nuclear power's future isn't going to depend on how many environmentalists see the nuclear light. Instead, it's going to rise and fall on something more basic: economics. Loan guarantees may help a few new plants get built, but even if a tax or a cap-and-trade system puts a price on carbon emissions, nuclear power is still going to be hard-pressed to compete with coal or natural gas in today's power market without more government support.

This is leading some supporters of nuclear power to place their bets on the next generation of smaller, modular reactors being developed around the world.

crease our supply of nuclear power."

Environmental Mantle

Climate change isn't the first environmental problem that nuclear power promised to solve. Leaders of the Sierra Club favored nuclear power in the 1960s as an alternative to large-scale hydropower dams in the Grand Canyon. The group's board later supported plans for the Diablo Canyon nuclear plant in California, a move that deeply divided the organization; it eventually

Mile Island, utilities had begun canceling orders for new reactors—the last order was placed in 1978—when it became apparent electricity demand wouldn't grow as fast as expected. Construction and capital costs were rising as well, in part because regulators were insisting on better safety features, but mostly because of inflation. While dozens of new reactors already in the pipeline came online during the 1980s, scores of units were canceled or put on hold. Some European countries, notably

Nuclear's Fall—and Rise

4/18/10

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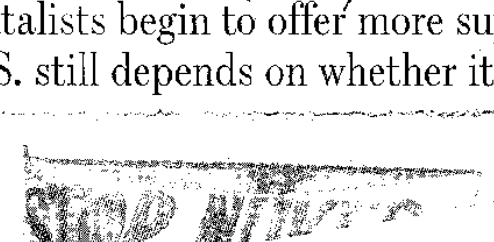


power as a way to addr[ess] mate change, includ[ing] Lovel[ock]

From: Power Gen Worldwide, Brian Wheeler, Associate Editor

August, 4 2010 - While the United States nuclear industry is conti[nues] roadblock for some companies. Cost. The capital cost for nuclea[r] companies cutting back spending and even looking at cancelin[g]

NRG Energy Inc. said it would cut spending on two new re[actors] million a month in July to $1.5 million a month. But NRG late July it would cut spending on the planned Calvert C[liffs] from the Department of Energy for a federal loan guara[ntee] down operations in Maryland by the end of the year i[f]

"This shows you the difficulty in this market and h[ow] getting them off the ground," said Leslie Kass, N[RG] programs.

Since the DOE awarded Southern Co. an $8 Energy, Constellation and Scana Corp. ha[ve] $10 billion remaining of guaranteed mo[ney]

"There is a challenge since they onl[y] they are all so good," said Kass. "I nobody any good."

But Southern Co.'s loan was

The DOE said that before DOE's Loan Program Of reviews each project, e

And those compani[es] commitment is er extremely diffic[ult]

its path to expand, there['s] is not cheap and thi[s] r development

Proj

Japan Set[s] For Nuclea[r]

2/1/2

By Mari Iwata

TOKYO—Japan moved to se[cure] its role in the global nu[clear-power] sector by setting up a government-backed organiza[tion] to promote Japanese tech[nology] and fight off competition for multibillion-dollar contracts from rivals such as South Korea.

Six companies—**Tokyo Electric Power Co.**, **Chubu Electric Power Co.**, **Kansai Electric Power Co.**, **Toshiba** Corp., **Hitachi** Ltd., and **Mitsubishi Heavy Industries** Ltd.—said Tuesday they have set up a preparatory organization to sell nuclear-power-plant construction and operation technologies overseas.

"This is the first, important step toward promoting Japan's nuclear-power technologies in emerging countries by private- and public-sector cooperation," said Masayuki Naoshima, Japan's Minister of Economy, Trade and Industry, following the joint announcement.

The Japanese government hasn't disclosed the value of planned investment in the

Electric nuclear-p[ower] Japanese in the six-c[ountry] won't affec[t] tionships, an[d] to work with [the] necessary, spo[ke] and Mitsubishi "We will quick[ly] policy challenges cluding high-level governments, effo[rts] more nuclear cooper[ation] ments [with other necessary support su[ch] lated education and le[gal] and more risk-taking by mental organizations," Naoshima said.

The effort is a respon[se] Japanese companies losing on bids for nuclear-power c[on]tracts in the United Arab Em[irates] and Vietnam. The losse[s] were a huge disappointment fo[r] Japan, where the govern[ment] hopes to prop up t[he] by selling lo[w]

The Evolutionary Power Reactor, a "generation 3+" design from Areva NP

NEW NUCLEAR REACTORS

THE TECHNOLOGY: Advanced nuclear reactors use simplified, standardized designs that should be cheaper and quicker to build and easier to operate. Passive safety features lower the risk of accidents. These "generation 3+" reactors consume more of the nuclear fuel, lowering operating costs and trimming waste. Looking ahead, some generation IV designs can recycle used nuclear fuel, producing even less waste and relying less on new uranium supplies.

CURRENT STATUS: About a dozen generation 3+ reactors are under construction around the world, and several more are planned, including nearly two dozen in the U.S. awaiting certification and licensing by the Nuclear Regulatory Commission. For generation IV reactors, an international group of scientists and researchers is coordinating research and development, and they've agreed to a list of six technologies to pursue.

WHY IT'S GOING TO TAKE SO LONG: While China and others are moving ahead with construction of the generation 3+ reactors, the first new plants in the U.S. aren't likely to appear until late in the decade; NRC certification of the first of the new designs may not occur before early 2012, and construction, even if accelerated, will take at least four or five years.

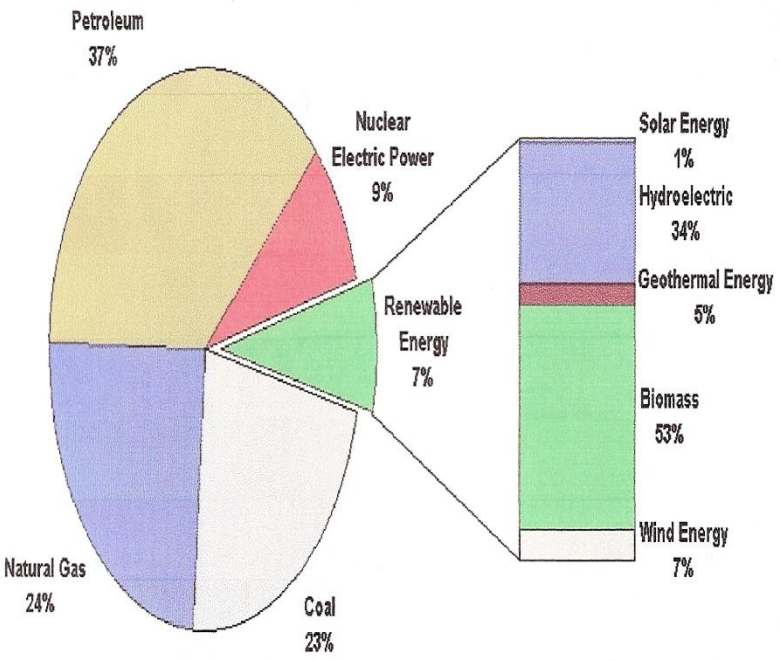
Another hurdle is financing. So far, four companies have been short-listed to receive $18.5 billion in federal loan guarantees designed to reassure investors worried about delays and cost overruns. President Obama is seeking total guarantees of $54 billion, which might spur more companies to proceed with construction plans. The first $8.3 billion in guarantees were approved last week. But at the current pace, only about 10,000 megawatts of new nuclear power is likely to come online by 2020. That's about the amount of wind capacity added last year, and about 10% of current nuclear capacity, or nearly 1% of total U.S. capacity.

Supply-chain problems, such as the limited number of forges capable of making large reactor containment vessels, also could hinder more rapid deployment.

Generation IV reactors, meanwhile, aren't expected to enter commercial development until well after 2020.

RENEWABLES

Figure 1. Renewable Energy Consumption in the Nation's Energy Supply, 2008
Total = 99.305 Quadrillion Btu **Total = 7.301 Quadrillion Btu**



A solar power plant in Nevada

SOLAR

THE TECHNOLOGY: Energy from the sun can be used to make electricity directly with photovoltaic panels or indirectly using concentrated sunlight to heat a liquid, which produces steam to turn electrical turbines. Concentrating solar plants can be built to store heat and deliver power for several hours without sunlight.

CURRENT STATUS: Solar power (both photovoltaic and concentrating) produced an estimated about 3.2 billion kilowatt-hours of electricity in 2009. Total capacity—the amount of power that could be produced if the sun shone constantly—of solar photovoltaic systems has been doubling every two years, and the pace of increase is expected to rise further: An estimated 2,000 megawatts of solar capacity in 2009 was nearly 45% higher than in 2008. That includes about 980 megawatts of concentrating-solar projects; an additional 81 megawatts are under construction.

WHY IT'S GOING TO TAKE SO LONG: Even at that rate of growth, solar power is still minuscule: Solar generation in 2009 accounted for less than 0.1% of total electricity production in the U.S. Solar capacity remains less than 1% of the total. "The biggest obstacle is that we're starting at such a low level," says John Benner, a research manager at the National Renewable Energy Laboratory.

The cost of solar installations has fallen in recent years, but remains high, partly because demand continues to keep pace with supply. The cost for average residential installations was about $5.40 a watt of capacity in 2008 and $4.20 a watt for commercial, after a raft of federal, state and local incentives, according to a study by the Lawrence Berkeley National Laboratory. (Solar installations depend heavily on subsidies, which vary widely; without incentives, costs average $7.50 a watt.) Thanks to capital expenses, electricity from solar is expensive: Estimates of solar costs cover a broad range, from 25 to 46 cents a kilowatt-hour for residential and from 17 to 29 cents from a concentrating solar plant. That compares with about 7 cents a kilowatt-hour for coal and natural gas and 10 cents for wind, according to estimates by the Energy Power Research Institute.

Like wind farms, utility-scale solar photovoltaic and concentrated-solar projects also require additional transmission connections. Since most aim to build in the environmentally sensitive desert Southwest, where much of the land is publicly owned, they also face lengthy and complicated permitting reviews.

Wind turbines along Interstate 10 near Banning, Calif.

Getty Images

WIND

THE TECHNOLOGY: Wind power is one of the fastest-growing alternative energy sources in the world—a low-carbon, renewable source of electricity that can deliver millions of watts of relatively low-cost power.

CURRENT STATUS: In the U.S., wind produced about 73 billion kilowatt-hours of electricity last year, about 2% of total generation and enough to power about 13 million homes. Industry capacity rose nearly 10,000 megawatts, or 39%, last year to a total of about 35,000 megawatts.

WHY IT'S GOING TO TAKE SO LONG: It may not. The U.S. Energy Department laid out a scenario for how wind could meet 20% of total electricity demand by 2030—about 300 gigawatts—displacing half of natural gas-powered and 18% of coal-fired generation. But a recent report by the National Renewable Energy Laboratory, or NREL, found that the Eastern U.S., which isn't blessed with substantial onshore wind resources, could hit the 20% target by 2024.

Still, reaching that goal is going to take significant investments in new transmission lines, especially in a transmission "superhighway" to carry electricity from parts of the country with lots of wind to places where demand is highest. The NREL study estimates the price tag could be as high as $93 billion. Local opposition to transmission lines can also present a challenge, especially when lines have to cross states to carry power to a neighbor.

It also may require significant additions of offshore wind power, which the Energy Department predicts could deliver about 17% of its projected 2030 total. Offshore wind generation promises more reliable power, and because it's closer to East Coast population centers, less transmission is needed. But offshore generation is about twice as expensive as onshore wind power and faces opposition from coastal property owners. Power from the first of a handful of proposed offshore wind projects is expected by 2012.

RENEWABLES B

s Ethanol Enthusiasts With a Hangover

ethanol's economics. A Congressional Budget Office report issued last month calculated ethanol production, with subsidies, is only profitable when a gallon of gasoline costs 70% or more of the price of a bushel of corn. This has only happened during oil price spikes this decade and in the early 1980s.

While other fuels also enjoy various subsidies, corn-based ethanol suffers by comparison because it only provides, at best, 1.8 times the amount of energy used to make it. Gasoline's "energy balance" is a multiple of this—hence its stranglehold over the fuel market.

The paradox is that ethanol, designed to displace gasoline demand, looks uneconomical when gasoline prices are high.

Advanced types of ethanol made from other crops look much better in terms of efficiency and environmental impact. But commercial-scale production, at reasonable prices, looks years off. It is possible to argue that these new fuels require a corn-based ethanol industry on which to build. But it isn't clear that we need one bigger than what exists already.

Similarly, as pointed out by Geoffrey Styles, head of consultancy GSW Strategy, arguments for greater production of ethanol in terms of creating "green" jobs miss a key point. Energy is an economic input: The fewer resources, including labor, going into its production, the better. With other technologies now competing for taxpayer dollars, the logic for plowing more money into corn looks ever less compelling.

—*Liam Denning*

Everyone Hates Ethanol 3/16/0

These days, it's routine for businesses to fail, get rescued by the government, and then continue to fail. But ethanol, which survives only because of its iron lung of subsidies and mandates, is a special case. Naturally, the industry is demanding even more government life support.

> But the subsidies keep growing, and growing, and . . .

Corn ethanol producers—led by Wesley Clark, the retired general turned chairman of a new biofuels lobbying outfit called Growth Energy—want the Obama Administration to make their guaranteed market even larger. Recall that the 2007 energy bill requires refiners to mix 36 billion gallons into the gasoline supply by 2022. The quotas, which ratchet up each year, are arbitrary, but evidently no one in Congress wontrary, but evidently no one in the economy

cerned Scientists are opposed too, since will increase auto emissions. The Natural R sources Defense Council and the Sierra Cl agree, on top of growing scientific eviden that corn ethanol provides little or no net duction in CO_2 over the gasoline it d places.

The biggest losers in this scheme are U oil refiners. Liabi[illegible]y for any problems a ing from ethe[illegible]

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The Ethanol Bubble Pops in Iowa

4/18/09

Dyersville, Iowa

In September, ethanol giant VeraSun Energy opened a refinery on the outskirts of this eastern Iowa community. Among the largest biofuels facilities in the country, the Dyersville plant could process 39 million bushels of corn and produce 110 million gallons of ethanol annually. VeraSun boasted the plant could run 24 hours a day, seven days a week to meet the demand for home-grown energy.

CROSS COUNTRY
By Max Schulz

But the only thing happening 24-7 at the Dyersville plant these days is nothing at all. Its doors are shut and corn deliveries are turned away. Touring the facility recently, I saw dozens of rail cars sitting idle. They've been there through the long, ruptcy, closing many of its 14 plants and laying off hundreds of employees. VeraSun lost $476 million in the third quarter last year.

A town of 4,000, Dyersville is best known as the location of the 1989 film "Field of Dreams." In the film, a voice urges Kevin Costner to create a baseball diamond in a cornfield and the ghosts of baseball past emerge from the other to play ball. Audiences suspended disbelief as they were charmed by a story that blurred the lines between fantasy and reality.

That's pretty much the story of ethanol. Consumers were asked to suspend disbelief as policy makers blurred the lines between economic reality and a business model built on fantasies of a better environment and energy independence through ethanol. Notwithstanding federal subsidies and mandates that force-feed the biofuel to the driving public, ethanol is proving to be about

tine Renewable Energy, a large ethanol producer, lost $37 million despite selling a company record 278 million gallons of the biofuel. Last week it filed for bankruptcy. California's Pacific Ethanol lost $146 million last year

> More evidence the fuel makes little economic sense.

and has defaulted on $250 million in loans. It recently told regulators that it will likely run out of cash by April 30.

How could this be? The federal government gives ethanol producers a generous 51-cent-a-gallon tax credit and mandates that a massive amount of their fuel be blended into the nation's gasoline supplies. And those mandates increase every year. This year the mandate is 11 billion gallons and is on its

To meet this political demand, VeraSun, Pacific Ethanol, Aventine Renewable Energy and others rushed to build ethanol mills. The industry produced just four billion gallons of ethanol in 2005, so it had to add a lot of capacity in a short period of time.

Three years ago, ethanol producers made $2.30 per gallon. But with the global economic slowdown, along with a glut of ethanol on the market, by the end of 2008 ethanol producers were making a mere 25 cents per gallon. That drop forced Dyersville and other facilities to be shuttered. The industry cut more than 20% of its capacity in a few months last year.

What's more, as ethanol producers sucked in a vast amount of corn, prices of milk, eggs and other foods soared. The price of corn shot up, as did the price of products from animals—chickens and cows—that eat feed corn.

Texas Gov. Rick Perry reacted by standing with the cattlemen in his

tion Agency last year to suspend [illegible] of the ethanol mandates (which it the power to do under the 2007 ene bill). The EPA turned him down The Consumer Price Index later ve[illegible]d that retail food prices in 2 we[illegible] up 10% over 2006. In Mexico, ing prices led to riots over the cos ter[illegible]illas in 2007. The United Nat Food and Agricultural Organiza and other international organizat is[illegible]sued reports last year criticizing fuels for a spike in food prices.

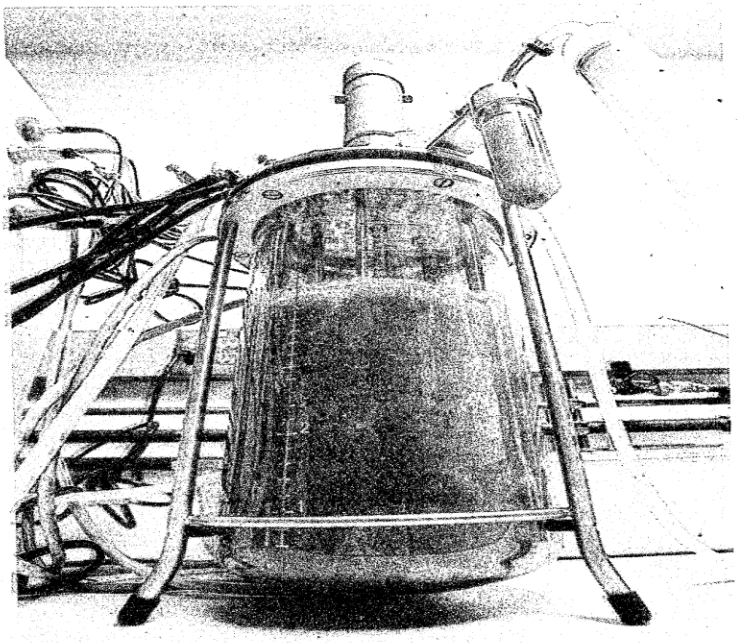
Ethanol is also bad for the envi ment. Science magazine publishe article last year by Timothy Sea linger of Princeton University, an others, that concluded that biof cause deforestation, which speed mate change. The National Oce graphic and Atmospheric Admini tion noted in July 2007 that the noi boom rapidly increased amount of fertilizer polluting the sissippi River. And this week, Un

Algal biofuel

ALGAL BIOFUELS

THE TECHNOLOGY: Algae are fast-growing, consume carbon dioxide and have the potential to produce more oil per acre than other biofuels. The oils they produce can be used to make substitutes for diesel fuel, aviation fuel and gasoline. Backers say the U.S. could meet its entire liquid-fuel needs with algal biofuels.

CURRENT STATUS: About 150 companies world-wide are working to commercialize algal biofuels, and U.S. government support has soared over the past few years; the Energy Department recently granted $44 million for research into commercializing algal biofuels and $97 million for algae pilot and demonstration projects.



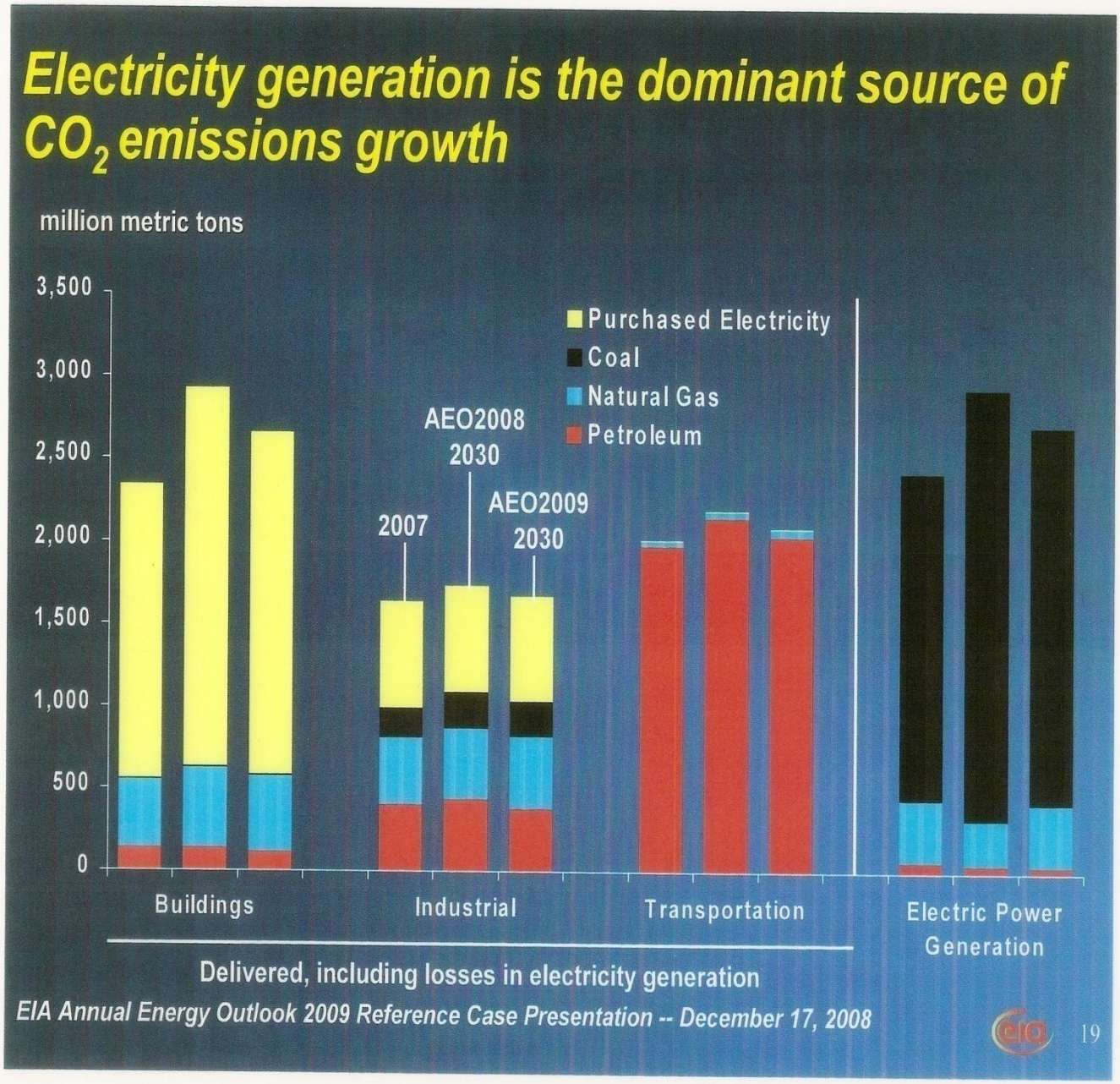
Solazyme

A fermentor used by Solazyme to improve growth of microalgae

In the biggest, Sapphire Energy of San Diego, Calif., plans to break ground on a 300-acre biorefinery in New Mexico later this year. Another recipient, Solazyme Inc., uses a fermentation method to produce algae-based fuels and has contracts to provide the U.S. Navy with 1,500 gallons of jet fuel and 20,000 gallons of diesel to power navy ships; the company is converting an existing plant in Pennsylvania into a demonstration biorefinery. Big oil companies, including ExxonMobil and BP, also have invested in algae-biofuel projects or companies.

WHY IT'S GOING TO TAKE SO LONG: As promising as the technology is, it hasn't proved that it can produce fuels in sufficient quantities or at a low enough cost to make a dent in U.S. liquid-fuel consumption. Solazyme's fermentation method, which grows algae in dark, enclosed tanks, is considered by some experts to be closest to maturity; the company expects to reach commercial-scale production by 2013, producing "hundreds of thousands" of gallons of oil or fuel substitutes. But it's a long way from being cost-competitive with oil.

Sapphire's open-pond method could deliver lower-cost (but still expensive relative to oil) agriculture-scale production. The company aims to produce one million gallons of "green crude" by the end of 2012, and hopes to begin commercial production within three years, with a goal of 10,000 barrels a day by 2018. But the technique hasn't yet demonstrated that such productivity levels are possible. It also has to deal with such issues as adequate water supplies, lower productivity caused by wild algae strains and supplies of easily accessible carbon dioxide.


Electricity generation is the dominant source of CO_2 emissions growth
million metric tons
3,500
3,000
2,500
2,000
1,500
1,000
500
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Purchased Electricity
Coal
Natural Gas
Petroleum
AEO2008
2030
AEO2009
2030
2007
Buildings
Industrial
Transportation
Electric Power Generation
Delivered, including losses in electricity generation
EIA Annual Energy Outlook 2009 Reference Case Presentation -- December 17, 2008
eia

'Clean' coal power plants a far-off goal

8/13/09

A carbon capture project in West Virginia illustrates the obstacles to meeting new emission limits.

STEVEN MUFSON

WASHINGTON — At a bend in ... River, a bulky new de- ... to a 30-

Once-Hot Coal Piles Up as Demand Cools

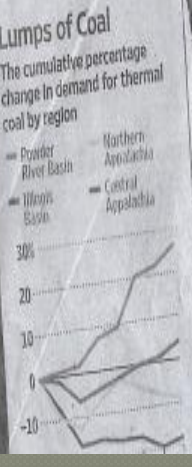
7/29/08

BY REBECCA SMITH AND KRIS MAHER

Mountains of coal are piling up along the winding roads of Central Appalachia, a boon to buyers and a bane to miners.

Coal companies centered in this region, which includes parts of Kentucky, Tennessee, Virginia and West Virginia, are seeing far fewer shipments to utility companies and steelmakers, result- ... or

A mountain of coal at a Central Pennsylvania power plant.



... intended to be a ... ... 15% of the ... ... Morris' pred- ... smart enough to ... extra land at the ... plant, but other ... could have trouble ... capture device, built ... Alston, would take ... pt. of the plant ... burned and "bui ... a solution of chi ... The CO2 ...

AEP's Mountaineer facility, the first operating power plant to capture and store carbon dioxide

Agence France-Presse/Getty Images

CARBON CAPTURE AND STORAGE

THE TECHNOLOGY: Carbon-capture technology pulls carbon dioxide from the smokestacks of coal and other fossil-fuel plants, pressurizes the gas and pumps it underground for permanent storage.

CURRENT STATUS: A handful of small-scale carbon-capture and storage pilot and demonstration projects are under way in the U.S. and elsewhere. In a test to capture CO_2 from an operating power plant, American Electric Power Co. is running a pilot at its Mountaineer plant in West Virginia, collecting about 1.5% of the plant's CO_2 emissions and storing them under the site. Other sites in Europe, Africa and Australia are investigating underground storage, but the Mountaineer project is the first to integrate capture and storage.

WHY IT'S GOING TO TAKE SO LONG: Technically, carbon capture has been shown effective in small, less expensive pilot projects. In capturing larger emissions streams, operators have to fine-tune the equipment and see how it works in different weather conditions and using different grades of coal. In the most-advanced test, at AEP's Mountaineer plant, this stage is expected to take at least a year.

Once that is done, the next stage is building and operating a commercial-scale demonstration plant. AEP recently received $334 million in federal stimulus funds for its planned 235-megawatt demonstration plant. Designing the facility can overlap with the current pilot, but construction of the plant is expected to take several years; the goal is to have it online by fall of 2015. It would then have to be operated for several years to test its reliability and efficiency. AEP expects that power-plant builders could begin offering commercial versions of the technology by 2020.

Ultimately, commercial adoption also will depend on whether Congress decides to impose a price on carbon and what that price is. Carbon capture is expensive—it could double the price of electricity from some existing coal plants, and cuts plant efficiency by about 30%. Most experts agree that it is going to take a carbon price of at least $50 a ton to make carbon capture economically feasible.

Natural Gas

The Natural Gas Revolution

7/16/10

n Deutch

ven energy experts tend to forget the enormous impact unanticipated events can have on markets and public policy. Today there are two ments that have the potential dramatic change: the exis- enormous reserves of natu- nd the BP spill.

cently as two years ago, we dea that there were vast as resources in unconven- servoirs like coal seams, d and shales in the United d elsewhere. That's the surprise. On the negative severity of the oil spill in of Mexico could well turn l public against oil and nat- exploration.

past is any guide, accidents ergy sector profoundly af- country's energy outlook. incidents at the nuclear ations at Three Mile Island burg, Pa., in 1979 and in yl, Ukraine, in 1986 inter- uclear power plant con- in the U.S. and Europe for des. The 1973 oil embargo and the 1978-79 oil crisis

and the long-term price trend.

The BP spill will certainly lead to a major review of the risks involved in offshore drilling. Re-examining operating practices and regulations will likely take more than a year, during which time new deepwater operations will be curtailed. The

> Experts are so focused on analyzing the BP spill that they're overlooking the next big thing.

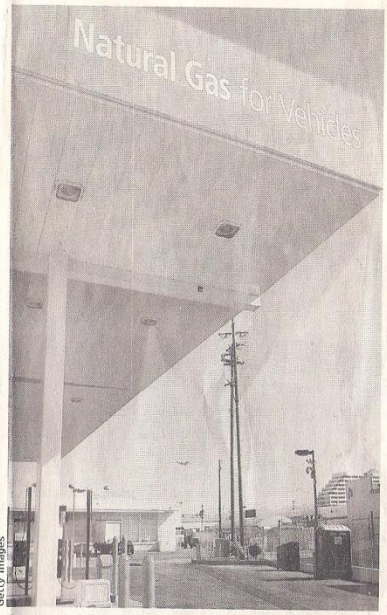
danger is that public attitudes and government policy will lead to an extended period of reduced investment and licensing.

Some observers will characterize the blowout as an exceptional case due to chance or negligence. Others will see it as evidence of general inattention. Few will recall the facilities in the Gulf survived Hurricane Katrina in 2006, an unusually stressing event, without appreciable problems.

Yet even as we endlessly debate U.S. energy and climate policy in the wake of the BP gusher, we aren't

natural gas's transition from a dwindling to an abundant resource. According to the Energy Information Agency (EIA), natural gas could become a much more important fuel for the U.S. in the coming decades.

In its 2010 International Energy Outlook, the EIA predicts growth in natural gas production principally from shale in Latin America, China, Australia, North Africa and the former Soviet Union. Global unconventional gas production is projected to increase to 7.9 trillion cubic feet in 2035 (1/3 of total natural gas production) from its 2008 level of 3.5 trillion cubic feet (about 1/6 of total production). The 2010 EIA projection of world-wide production of unconventional gas increases at 5.2% per year between 2008 and 2035, compared to 1.4% for total gas production.



Getty Images

Gas pump of the future?

What will this mean? In the short run, natural gas will displace coal in the electricity sector. This will significantly lower carbon emissions. In terms of renewable energy, low-cost natural gas will make hybrid solar plants that use both sunlight and natural gas to make electricity more economically attractive.

As oil gets more expensive and natural gas cheaper, there will also be an enormous incentive to use far more natural gas in the transporta- compressed natural gas motor gasoline and ethanol from corn).

Natural gas can also be transformed into liquid fuels, such as methanol, for transportation or industrial use at a production cost that I estimate to be approximately $45-$60 per barrel of product. This is expensive, but lower than the likely price of crude oil and the anticipated cost of synthetic liquids from coal or shale (plus it has less carbon emissions).

The continued expansion of gas pipelines around the world, as well as the expanding trade of liquefied natural gas, indicate a movement toward a global market for natural gas similar to oil, and ultimately with a single world price. A global price implies major changes in patterns of gas trade between the North American market, where gas is priced to coal, and the Asian market, where gas is priced to oil. Because coal is cheaper than oil on an energy efficient basis, this means that current natural gas prices in North America are $4 per thousand cubic feet compared to $10 per thousand cubic feet in Asia.

That's where things seem to be

Natural-Gas Firms Increase Drilling Despite Price Drop

2/28/10

N CASSELMAN

ural-gas producers are g hit hard by sliding gas but that isn't keeping rom drilling more wells. ral gas this week fell be- per million British ther- s for the first time since r and is down 14% since of the year. That is hit- its at big gas producers **Chesapeake Energy** G Resources Inc. and tern Energy Co. ern this week reported llion net loss for 2009, s fourth-quarter prof- to $158 million

in late 2008, big gas producers slashed budgets and reduced drilling. But the number of rigs drilling for gas has bounced back 36% since July, as energy companies plowed into new fields in Pennsylvania, Louisiana and elsewhere that remained profitable even at low prices.

The drilling rebound is keeping U.S. gas production high, bucking predictions it would fall along with prices. Gas production in the lower 48 states has declined just 1.2% since its peak in February 2009 and actually rose slightly in December from a year earlier, according to

"There's renewed enthusiasm over U.S. unconventional gas. You can really see that in the spending," said Aliza Fan Dutt, an analyst with the firm.

Still, energy executives say that if prices remain below $5 per million BTUs, drilling will slow again, crimping production.

"I think $5 gas is not a sustainable gas price even for the best shale plays," Chesapeake Chief Executive Aubrey McClendon told investors this month.

Increased demand for drilling rigs has led service providers to raise

HOW Shale Gas IS GOING TO Rock the World

Huge discoveries of natural gas promise to shake up the energy markets and geopolitics. And that's just for starters.

5/10/10

BY AMY MYERS JAFFE

There's an energy revolution brewing right under our feet.

Over the past decade, a wave of drilling around the world has uncovered giant supplies of natural gas in shale rock. By some estimates, there's 1,000 trillion cubic feet recoverable in North America alone—enough to supply the nation's natural-gas needs for the next 45 years. Europe may have nearly 200 trillion cubic feet of its own.

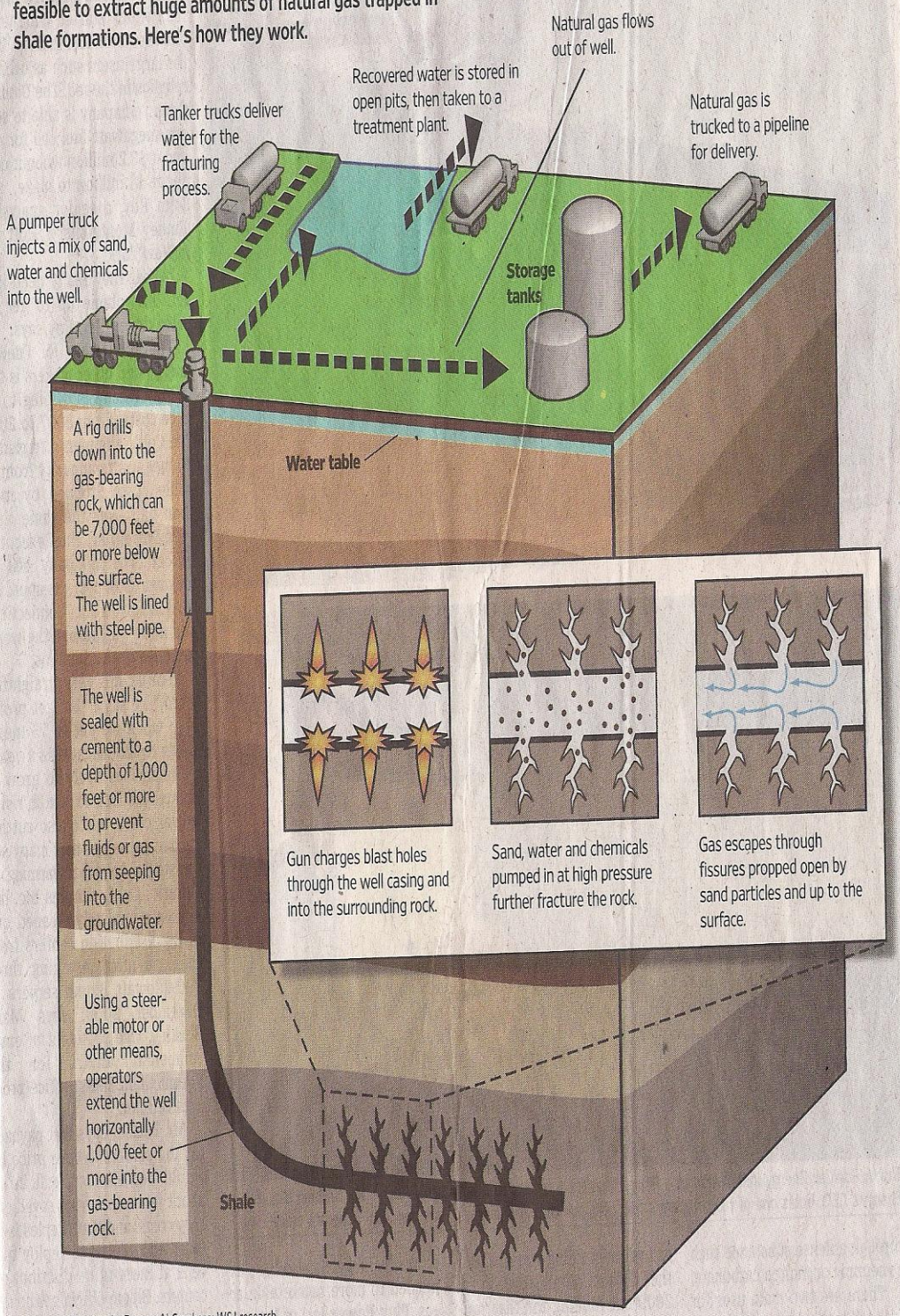
We've always known the potential of shale; we just didn't have the technology to get to it at a low enough cost. Now new techniques have driven down the price tag—and set the stage for shale gas to become what will be the game-changing resource of the decade.

I have been studying the energy markets for 30 years, and I am convinced that shale gas will revolutionize the industry—and change the world—in the coming decades. It will prevent the rise of any new cartels. It will alter geopolitics. And it will slow the transition to renewable energy.

To understand why, you have to consider that even before the shale discoveries, natural gas was destined to play a big role in our future. As environmental concerns have

Tapping the Gas

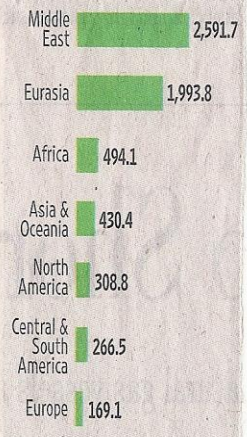
Horizontal drilling and hydraulic fracturing have made it feasible to extract huge amounts of natural gas trapped in shale formations. Here's how they work.



Sources: Chesapeake Energy; Al Granberg; WSJ research

How Much Is There?

Latest estimates of proven natural-gas reserves* around the world, in trillion cubic feet. Most shale gas isn't yet in this category.



*Proven reserves are, roughly speaking, what companies know is in the ground and can be extracted—or to be exact, estimated quantities that analysis of geologic and engineering data demonstrates with reasonable certainty are recoverable under existing economic and operating conditions.

Source: Oil & Gas Journal, Energy Information Agency

Shale gas in North America, in trillions of cubic feet. So far only about 25 trillion cubic feet has been produced or placed into proven reserves.

	Resource Endowment[1]	Remaining Recoverable Resource[2]
U.S.	3,760	470
Canada	1,380	240

[1] An estimate of the total volume of natural gas originally contained in shale formations.

[2] An estimate of how much of the resource endowment is potentially producible with today's, or reasonably foreseeable future, technology.

Source: Advanced Resources International Inc.

Oil, A Major Problem Area – WHY?

Basic data:

import oil – 11Mb/d (millions of barrels/day) 2008 data

Consumption – 18Mb/d

Cost, imported oil – approaching $1B(Billion)/day, $360B/annum

Sustainable? No, but no choice to support our way if life.

Some Key Questions:

How do we replace US fleet, 240M personal cars/light trucks (total fleet 250M)?

How are winner/losers selected from multiple choices of alternate vehicles (AV)?

How will manufacturing proceed on which AV? Financing, how?

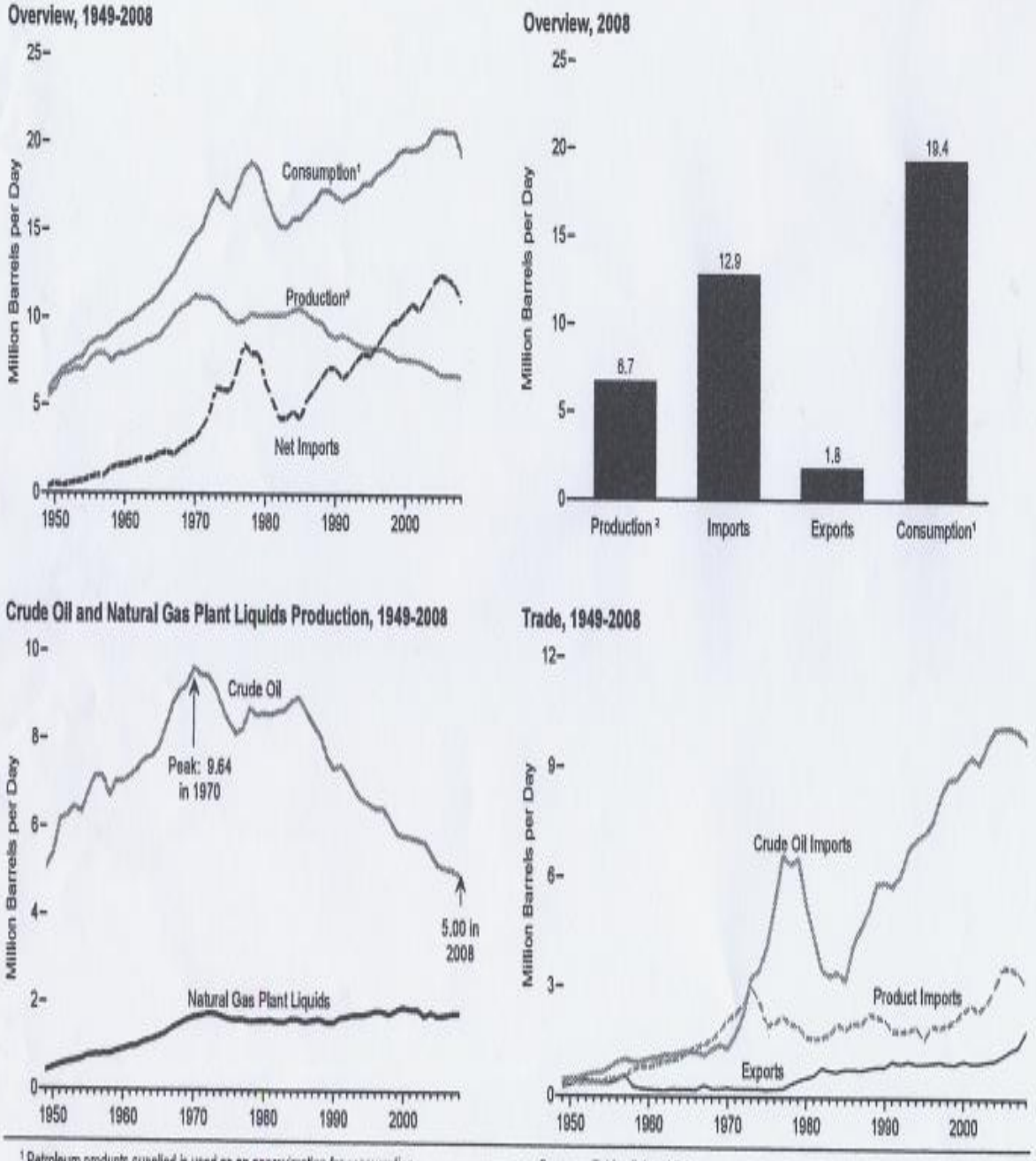
With choice of alternate fuels, how will infrastructure be built, financed and operated for which fuels?

Conclusion:

No obvious solution to dilemma of oil

- will remain a problem area for next several decades

Figure 5.1 Petroleum Overview



[1] Petroleum products supplied is used as an approximation for consumption.
[2] Crude oil and natural gas plant liquids production.

Sources: Tables 5.1 and 5.3.

Alternative Vehicles

The Road Ahead

Gasoline has powered the vast majority of the world's automobiles for the past century. But now amid rising oil prices and increasing concern about tailpipe emissions and global warming, new types of propulsion technologies are starting to emerge. Here's an overview of what's here now, and what's ahead. - *Kelly McDaniel-Timon*

	Pros	Cons	Vehicles	Availability/Starting Prices
Hybrids Have a battery and electric motor to power the car at low speeds and a gas engine for accelerating and highway driving.	Increases fuel-economy significantly, especially in heavy stop-and-go driving.	Price premium over standard models can be $2,500 or more for a Toyota Prius, $8,000 and up for large hybrid SUVs. Mileage improvements modest in some larger vehicles.	Toyota Prius, Ford Escape Hybrid, GMC Yukon Hybrid, Lexus LS600h, Lexus RX400h, Chrysler Aspen Hybrid, Dodge Durango Hybrid.	On the market now. Prius $23,375, Yukon $50,920, Lexus RX400h $43,480.
Mild Hybrids Electric motor only assists the gasoline engine; it can't drive wheels on its own.	Cost. Generally less expensive than full hybrids.	Only modest improvement in fuel economy.	Honda Civic Hybrid, Chevrolet Malibu Hybrid, Saturn Aura Hybrid.	On the market now. Honda Civic $22,600, Chevy Malibu $24,695, Saturn Aura $24,930.
Plug-In Hybrids A full hybrid with a large battery that drivers can recharge by plugging the car into an AC outlet.	Dramatic boost in fuel economy- can go up to perhaps 120 miles on the battery alone.	The advanced batteries required are not yet available. They are also expensive and can overheat.	None on the market today. Some "hackers" can convert Priuses to plug-ins.	Many auto makers working to offer them in 2-4 years.
Flex Fuel Vehicles Have standard internal combustion engines that can run on gasoline or a mix of gasoline and ethanol.	No price premium, can be used in vehicles of all sizes. Reduces greenhouse gas emissions.	Ethanol not widely available. A gallon of ethanol has less energy than a gallon of gas, so mile per gallon is lower.	Almost all GM, Ford and Chrysler models.	On the market now.
Fuel Cell Vehicles Use hydrogen gas and a chemical process to generate electricity that powers an electric motor.	Uses no fossil fuel, hydrogen is widely available and the only tailpipe emission is water vapor.	Still in experimental stage, hydrogen not widely available as fuel, technology still far too expensive for commercial use.	Models now in tests include Honda FCX Clarity and Chevrolet Equinox among others.	Small number of Clarity and Equinox available for lease through test programs.
Electric Car Powered by a long-lasting battery and electric motor. Can have a small gas engine on board to charge the battery.	Practically no emissions or engine noise. Can be recharged from AC outlet.	Technology still unproven. Batteries not available.	GM working on Chevy Volt. Also start-up electric car makers Tesla, Fisker and others.	Volt due by 2011. Tesla, Fisker and others possibly sooner.
Clean Diesel New, advanced diesel engines that burn fuel more cleanly and use low-sulfur fuel.	20% to 40% more miles per gallon and more torque than gas engines, reduced greenhouse gas emissions.	More expensive than models with gas engines. Diesel fuel more expensive than gasoline. Unclear if Americans will embrace diesel.	Jeep Grand Cherokee and Volkswagen Jetta are two examples. BMW and Mercedes-Benz also offering clean diesel models.	VW Jetta diesel $21,999, Grand Cherokee $31,390.

Source: WSJ Reporting

which just half are open to the marily in periods when other

A Chevrolet Volt getting charged at last month's Consumer Electronics Show in Las Vegas

ELECTRIC VEHICLES

THE TECHNOLOGY: In theory, electric vehicles could replace most gasoline-powered cars and light trucks. They can run entirely on battery power, or in the case of plug-in hybrids, on batteries that can be charged by a separate gasoline engine when needed as a backup.

CURRENT STATUS: About 56,000 electric vehicles are in use, but the numbers are deceiving—most are limited to low-speed driving and have limited range. So far, Tesla Motors Inc.'s Roadster is the only open-road electric vehicle, but a handful of other all-electric cars, including Nissan Motor Co.'s Leaf, are expected to come to market in 2010. The first commercial plug-in hybrids, led by General Motors Co.'s Chevy Volt, also are slated to be available later this year.

WHY IT'S GOING TO TAKE SO LONG: The biggest obstacle is cost. The advanced lithium-ion battery pack that powers the Volt, which can travel 40 miles on a charge, can cost as much as $10,000, though prices are expected to fall as production ramps up. The U.S. Energy Information Administration predicts that in 2030, the added cost of a plug-in hybrid will be higher than fuel savings unless gasoline costs around $6 a gallon.

Another challenge is the need for public recharging stations. Though most drivers travel fewer than 40 miles a day, well within the range of first-generation electric vehicles, consumers will balk if they worry about running out of juice.

Public charging spots are less important for plug-in hybrids, which are more likely to be recharged at home. Still, owners may need to upgrade their existing outlets to recharge more quickly; a 120-volt outlet will take about four to six hours to charge a plug-in vehicle and about 12 to 24 hours for an all-electric vehicle. A 240-volt outlet, which can charge an electric vehicle in about three to six hours, generally requires adding a circuit to the home's electric system to handle the additional load.

Electric cars

California's Costly Electric-Car Push

6/17/10 also other side contd.

By Rebecca Smith

California's early lead in preparing for electric cars has made it the place experts are watching to see if buyers embrace a greener form of transportation.

The state has created numerous incentives to encourage consumers to buy electric vehicles, including generous rebates. Now it is backing an ambitious and costly network of charging stations intended to ease one of the biggest concerns of potential buyers—will you run out of juice before you reach a place to recharge the batteries?

California is funneling $200 million a year through 2015 into low-emission vehicles. As part of the plan it is subsidizing more than 5,000 charging stations that should be in operation by 2012, which is expected to be more than in any other state.

California's goal is to have 7,500 all-electric and 25,000 plug-in hybrid cars on its roads by 2014, rising to 60,000 electrics and 85,000 plug-in hybrids by 2017. The first of the models will begin arriving this fall.

"California is leading the way," said Sue Cischke, global vice president of sustainability, environment and safety engineering at **Ford Motor** Co., which is preparing electric versions of a delivery van and Focus compact car, among other models.

Several companies are benefitting from the push to install charging stations. **Coulomb Technologies** Inc. of Campbell, Calif., says it will build 1,600 stations in San Francisco, Sacramento and Los Angeles. Arizona-based eTec, a unit of **ECOtality** Inc., is installing 2,550 charging points in Southern California, mostly in the San Diego area.

Meantime, **ClipperCreek** Inc. of Auburn, Calif., is upgrad more than 600 existing chargi stations in California, most o which it installed in the late 1990s in an electric-car push that stumbled early this decade.

New business models are being proposed to support "Level

Reuters

The federal government is subsidizing a network of more than 5,0

President Obama with local officials, including Gov. Jennifer Granholm, next to a Volt this month in Michigan.

Getty Images

Chevy Volt to Start at $41,000

7/28/10

By Sharon Terlep And Rebecca Smith

DETROIT—**General Motors** Co. said Tuesday that the starting price for the battery-powered Chevrolet Volt will be $41,000, answering the biggest question surrounding the much-hyped Chevy launch.

The Volt's closest rival, **Nissan Motor** Co.'s all-electric Leaf, starts at $33,000. Both cars could also provide buyers a $7,500 tax rebate.

The Volt is scheduled to go on sale late this year. GM said dealers in targeted launch markets, including California, New York and Michigan, could begin placing orders for the car.

GM marketing chief Joel Ewanick, who unveiled the pricing details at the Plug-In 2010 conference in San Jose, Calif., said the Volt is "starting the world on a different path."

The company is counting on the Volt to help it cultivate a image and to position GM if—as it ex- prices spike in

connected to a generator will power the electric motor. The Volt can also be plugged in via a special adapter to recharge the battery.

The Volt will initially launch as a low-volume specialty car. GM expects to sell a small number this year and around 10,000 in 2011, but it has vowed to eventually make the Chevy a high-tech car for the masses.

Striking the right balance on the price is central to that goal. Price the Volt too low, and GM could easily lose thousands of dollars on a vehicle with a costly battery system and sky-high development costs. Charge too much, though, and the Volt could come to be seen as a luxury vehicle, out of reach of the average buyer.

Toyota Motor Corp. lost money on the best-selling Prius for years, and those losses have more than paid off. But GM Chairman and Chief Executive Edward E. Whitacre Jr. has vowed that any car made by GM, including the Volt, will be a moneymaker for the company.

Meantime, spending at GM, which is majority-owned by the U.S. government, receives close tiny from politicians and

Internal debate over the Volt's price continued until recent weeks. Pricing the car even higher to help make it more profitable was considered, according to people familiar with the situation.

GM also said it would offer a lease for $350 a month. The company announced earlier this month that the Volt will come with an eight-year, 100,000-mile warranty on the battery pack.

Lots of companies are paying close attention to electric-car pricing for a clue to how rapidly the new technology could shak up the transportation indust creating a need for other p ucts and services.

Utilities, for example beefing up transform neighborhoods where th there could be a s adoption of plug-in c Volt. That's because ing of batteries can stress on circuits homes. Utilities caught unprepa sidered the wo Charging for pure el Nissan's Le a somewh because tion en

Oil Industry Booms

NORTH DAKOTA 2/25/10

State Is Riding High as Firms Develop Better Ways to Tap H

By Ben Casselman

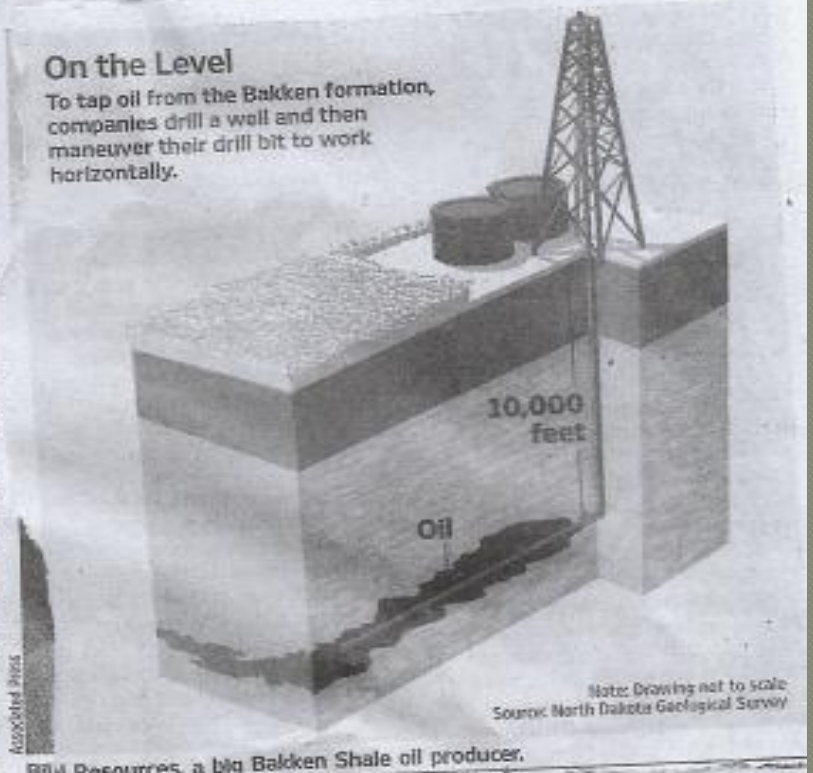
KILLDEER, N.D.—A massive oil reserve buried two miles underground has put North Dakota at the center of a revolution in the U.S. oil industry, a shift that has radically altered the fortunes of this remote area.

The Bakken Shale deposit has been known and even tapped on occasion for decades. But technological improvements in the past two years have taken what was once a small, marginally profitable field and turned it into one of the fastest-growing oil-producing areas in the U.S.

The Bakken Shale had helped North Dakota oil production double in the past three years, surging to 80 million barrels in 2009—tiny relative to the more than seven billion barrels consumed by the U.S. every year, but enough to vault the state past Oklahoma and Louisiana to become the country's fourth-biggest oil producer, after Texas, Alaska and California.

"Most people felt like they could kind of write off the oil industry in the U.S., and that's just a long way from the truth," said Harold Hamm, chairman and chief executive of Continental Resources Inc., one of the biggest Bakken producers. "The fact of the matter is that a lot of people quit looking for oil." Continental reported Thursday that its North Dakota oil production doubled in 2009 and would continue to grow rapidly this year.

The Bakken Shale could contain up to 4.3 billion barrels of recoverable oil, according to the U.S. Geological Survey. That would make it the biggest oil field discovered in the contiguous U.S. in more than 40 years—and many in the industry believe the amount of recoverable oil could be even greater as



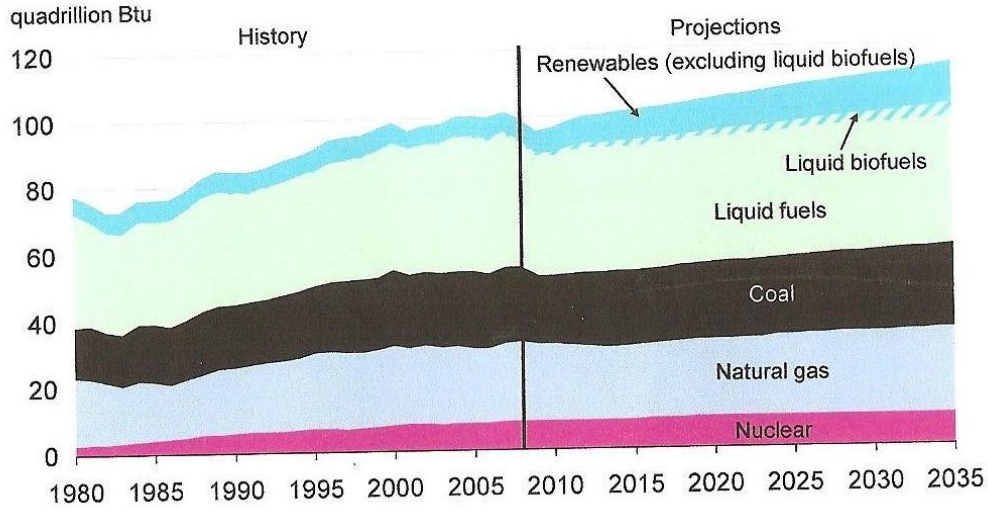
Bill Resources, a big Bakken Shale oil producer.

other big oil discoveries in California and the Gulf of Mexico, helped U.S. oil production rise last year for the first time since 1991, according to U.S. government figures.

Production has grown so rapidly here, 100 miles south of the Canadian border, that companies had to build a rail line to transport their oil to market, since there wasn't a big enough pipeline in the state to handle the oil. Companies have scrambled to find labor in a state with fewer than a million people, and to keep drilling rigs running when the wind chill pushes temperatures to 50 degrees below zero. Booming Bakken oil production has helped North Dakota escape the worst of the eco-

western city of Williston, leaving it with a chronic shortage of ho-

Non-fossil energy use grows rapidly, but fossil fuels still provide 78 percent of total energy use in 2035



Source: *Annual Energy Outlook 2010*