

A close-up photograph of a person's face, focusing on their eyes and hands holding binoculars. The binoculars are held up to the eyes, and the lenses show a collage of four images: a blue flame, a glowing lightbulb, an oil pumpjack, and a power plant. The background is a solid dark blue.

Harvard University Energy Lecture

Cambridge, MA  
February 8, 2006

by  
Matthew R. Simmons  
Chairman  
Simmons & Company International

Is Energy's Future Sustainable?

# Energy Matters!

- Creating energy is world's largest industrial activity (\$8 – \$9 trillion).
- Modern energy underpins every cherished aspect of life.
  - Potable water
  - Food production
  - Globalization
  - Health care advances
  - Every aspect of technology
- Despite its importance, “energy” widely misunderstood and ignored.
- Crisis emerging that threatens energy's future.
- How we got mired in this mess is important to understand.

# 20<sup>th</sup> Century Was “Miracle Century”



- The best of times and the worst of times.
  - Explosion in:
    - Technology
    - Population
    - Health Care
    - Wealth
    - Weapons of war
    - Wars
- Could any one ever predict all this?

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# Ladies' Home Journal Predictions For A New Century



THE LADIES' HOME JOURNAL

## WHAT MAY HAPPEN IN THE NEXT HUNDRED YEARS

By JOHN ELFRETH WATKINS, JR.

THESE prophecies will seem strange, almost impossible, to those who have come from the most learned and conservative minds in America. To the young and most energetic men in our greatest institutions of science and learning I have given nothing such in his time to forecast for me what, in his opinion, will have been wrought in his own field of investigation before the dawn of next—a century from now. These opinions I have carefully transcribed.

**Five Hundred Million People.** There will probably be from 500,000,000 to 600,000,000 people in America and its possessions by the lapse of another century. Nicaragua will ask for admission to our Union after the completion of the great canal. Mexico will be next. Europe, seeking more territory to the south of us, will cause many of the South and Central American republics to be voted into the Union by their own people.

The American will be taller by one to two inches. His increase of stature will not, however, lead to vast reforms in medicine, sanitation, food and athletics. He will live fifty years instead of thirty-five as at present—for he will reside in the suburbs. The city house will practically be no more. Building in blocks will be illegal. The trip from suburban home to office will require a few minutes only. A penny will pay the fare.

There will be no G's or O's in our every-day alphabet. They will be abandoned because unnecessary. Spelling by sound will have been adopted, first by the newspapers. English will be a language of condensed words expressing confirmed facts, and will be more extensively spoken than any other. Russian will rank second.

**Hot and Cold Air from Spigots.** Hot or cold air will be turned on from spigots to regulate the temperature of a house as we now turn on hot or cold water from spigots to regulate the temperature of the bath. Central plants will supply this cool air and heat to city houses. In the same way as now our gas or electricity is furnished, using only to build the furnace line will be a task of the old times. Homes will have no chimneys, because no smoke will be created within their walls.

**No Mosquitoes nor Flies.** Insect sprays will be unnecessary. Mosquitoes, house-flies and roaches will have been practically exterminated. Boards of health will have destroyed all mosquito houses and breeding grounds. Drained all stagnant pools, filled in all swamp-lands, and chemically treated all still-water streams. The extermination of the horse and its stable will reduce the house-fly.

**Ready-Cooked Meals** will be bought from establishments similar to our bakeries of today. They will purchase materials in tremendous wholesale quantities and sell the cooked foods at a price much lower than the cost of individual cooking. Food will be served hot or cold to private houses in pneumatic tubes or automobile wagons. The most lasting, or the dishes used will be packed and returned to the cooking establishments where they will be made up in such wholesale quantities that they will be sold in laboratories rather than in kitchens. These laboratories will be supplied with the latest and all sorts of electric devices, such as coffee-grinders, egg-beaters, stirrers, blenders, mincers, dish-washers, dish-driers and the like. All such articles will be used in chemical, fatal to disease microbes. Having one's own cook and purchasing one's own food will be an extravagance.

**No Foods will be Expired.** Stockkeepers who expose food to air, fermented or by purchase in the atmosphere of the busy streets will be arrested with those who sell stale or adulterated produce. Refrigerators will keep great quantities of food fresh for long intervals.

**Coal will Not be Used for Heating or Cooking.** It will be scarce but not entirely exhausted. The earth's hard coal will last until the year 2050 or 2100, its soft-coal mines until 2200 or 2300. Moreover, both kinds of coal will have become more and more expensive. Man will have and electricity generated by waterpower to be much cheaper. Every river or creek with any suitable fall will be equipped with water-motors, turning dynamos, turning electricity. Along the seacoast will be numerous reservoirs continually filled by waves and tides, and will be used to drive the water to be constantly falling over revolving wheels. All of our modern street lights and will thus be harnessed to do the work which Niagara is doing today—making electricity for heat, light and heat.

**There will be No Street Cars in Our Large Cities.** All heavy traffic will be below or above ground when brought within city limits. All of our modern street cars will thus be harnessed to do the work which Niagara is doing today—making electricity for heat, light and heat.

**Photographs will be Telegraphed from any distance.** If there be a battle in China a hundred years hence snapshots of its most striking events will be published in the newspapers an hour later. Even to-day photographs are being telegraphed over short distances. Photographs will reproduce all of Nature's colors.

Trains will be telegraphed to private homes, and will sound as harmoniums or though enjoyed from a stereo box. Automatic instruments reproducing original airs nearly will bring the best music to the families of the untalented. Great musicians gathered in one inclosure in New York, will, by manipulating electric keys, produce at the same time music from instruments arranged in theatres or halls in San Francisco or New Orleans, or Indiana. Thus will great bands and orchestras give long-distance concerts. In great cities there will be police opera-houses whose singers and musicians are paid from fares reproduced by philanthropists and by the government. The piano will be capable of changing its tone from cheerful to sad. Many devices will aid to the emotional effect of music.

**How Children will be Taught.** A university education will be free to every man and woman. Several great national universities will have been established. Children will study a simple English grammar adapted to simplified English, and not copied after the Latin. Time will be saved by grouping like studies. Poor students will be given free board, free clothing and free books if ambitious and actually unable to meet their school and college expenses. Medical inspectors regularly visiting the public schools will furnish poor children free eyeglasses, free dentistry and free medical attention of every kind. The very poor will, when necessary, get free rides to and from school and free lunches between sessions. In vacation time poor children will be taken on trips to various parts of the world. Etiquette and housekeeping will be important studies in the public schools.

**Store Purchases by Tube.** Pneumatic tubes, instead of store wagons, will deliver packages and bundles. These tubes will collect, deliver and transport mail over certain distances, perhaps for hundreds of miles. They will be at first connected with the private houses of the wealthy, then with all homes. Great business establishments will extend them to stations, similar to our branch post-offices of to-day, whence fast automobile vehicles will distribute purchases from houses to homes.

**Vegetables Grown by Electricity.** Winter will be turned into summer and night into day by the farmer. In cold weather he will place best-conducting electric wires under the soil of his garden and thus warm his growing plants. He will also grow large-gardening under glass. At night bareness will be hushed in powerful electric lights, serving, like sunlight, to hasten their growth. Electric currents applied to the soil will make valuable plants grow larger and faster, and will kill troublesome weeds. Rays of colored light will hasten the growth of many plants. Electricity applied to garden seeds will make them sprout and develop unusually early.

**Oranges will Grow in Philadelphia.** Fast-flying refrigerators on land and sea will bring delicious fruits from the tropics and southern temperate zone within a few days. The farmers of South Africa, South Africa, Australia and the South Sea Islands, whose seasons are directly opposite to ours, will thus supply us in winter with fresh summer foods which cannot be grown here. Scientists will have discovered how to raise here many fruits now confined to much hotter or colder climates. Delicious oranges will be grown in the suburbs of Philadelphia. Canadian and other northern fruits will be of such a hardy nature that they can be stored through the winter as potatoes are now.

**Strawberries as Large as Apples** will be eaten by our great-grandchildren for their Christmas dinners a hundred years hence. Strawberries and blackberries will be as large. One will suffice for the fruit course of each Christmas dinner. Strawberries will grow in great quantities in tall bushes. Cranberries, gooseberries and currants will be as large as oranges. One strawberry will supply an entire family. Melons, cherries, grapes, plums, apples, pears, peaches and all berries will be seedless. Figs will be cultivated over the entire United States.

**Peanut as Large as Beans.** Peas and beans will be as large as beans are today. Sugar cane will produce twice as much sugar as the sugar beet now does. Cane will once more be the chief source of our sugar supply. The milkweed will have been developed into a rubber plant. Cheap native rubber will be harvested by machinery all over this country. Flax will be made proof against disease microbes just as readily as man is to-day against smallpox. The soil will be kept enriched by plants whose take their nutrition from the air and give fertility to the earth.

**Black, Blue and Green Roses.** Roses will be as large as cabbage heads. Violets will grow to the size of orchids. The pansy will be as large in diameter as a sunflower. A century ago the pansy measured but had an inch across its face. There will be black, blue and green roses. It will be possible to grow any flower in any color and to transfer the perfume of a scented flower to another which is colorless. Then may the pansy be given the perfume of the violet.

**Fire Drugs will be Swallowed** or taken into the stomach instead of being used for the direct treatment of their organs. Drugs needed by the lungs, for instance, will be applied directly to the inside of the lungs. The skin and flesh of the body will be carried with the electric current applied without need to the outside skin. The skin and flesh of the body will be carried with the electric current applied without need to the outside skin. The skin and flesh of the body will be carried with the electric current applied without need to the outside skin.



# Some “Big 20<sup>th</sup> Century Miracles” That Came True

- Photographs sent around the world.
- Vehicles obsolete the horse.
- 150 mph trains.
- Airship transportation people and war.
- Wireless telephones allow worldwide communication.
- Theaters view real-time coronations and wars.
- Hot and cold air spigots.
- Etc., etc.



How did these forecasters see so clearly  
and what made these miracles happen?

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# 20<sup>th</sup> Century's Secret To Success: Modern Energy

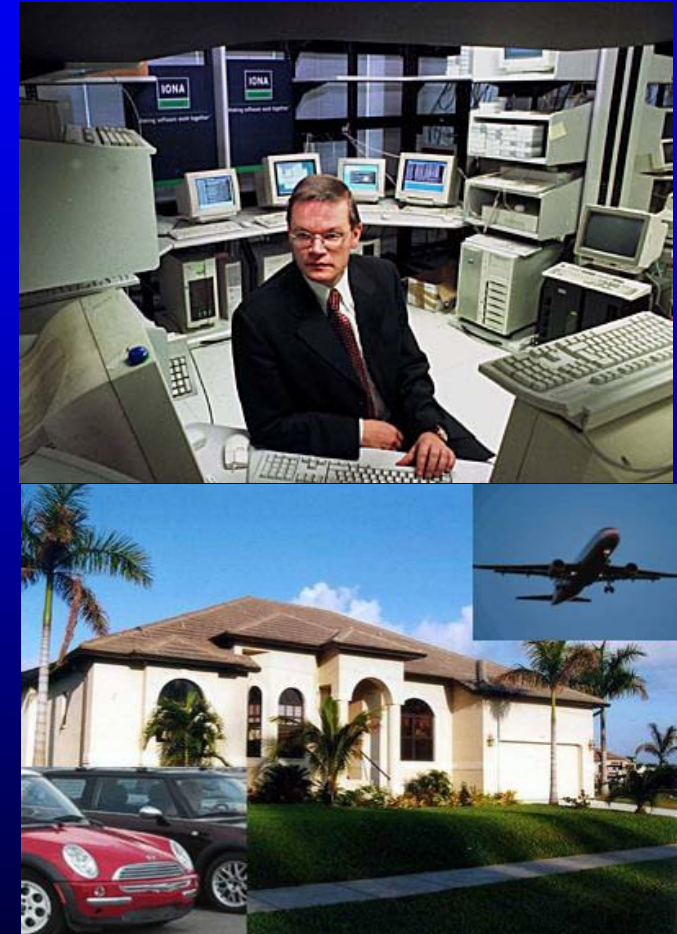
- Every significant advance in the 20<sup>th</sup> century created by “modern energy”:
- Great energy milestones:
  - Big oil era began in 1901
  - Electricity replaced coal, gas and kerosene generated light
  - Internal combustion engine created cars
  - Middle East oil created “cheap oil forever”
  - Atomic energy created “free” electricity
  - Piping natural gas created miracle of energy heat
- Throughout 90% of 20<sup>th</sup> Century, modern energy was virtually “free.”



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# The World Took Full Advantage Of The Energy Miracle

- Explosion in use of vehicles, trains and planes.
- Electrical appliances evolve into Silicon Valley.
- “Suburbia” created cheaper and bigger homes.
- The 20th century “miracle” primarily occurred in North America, Europe and Japan.
- By end of century, the miracle globalized.



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# As “Sixties” Ended, Energy’s Future Was Bright

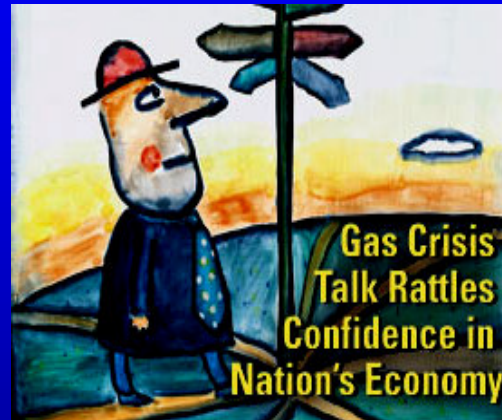
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- \$1.25 oil is 4 – 5 times too high.  
(Morris A. Adelman, Dec. 1969)
- Exploration had discovered new frontiers:
  - Last giant Middle East oil field (1964 – 1968)
  - Western Siberian oil and gas (1963 – 1968)
  - Alaska’s North Slope (1967 – 1968)
  - The North Sea (1969)
- Atomic energy plants starting “everywhere.”
- Cheap energy seemingly was “here to stay.”

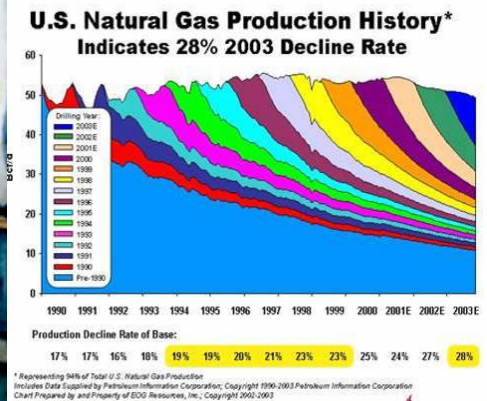
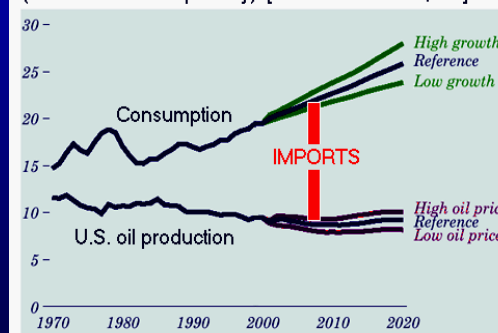


# The 1970s: When Energy's Cheers Started To Fade

- 1970: USA oil supply peaks.
- 1973: U.S. natural gas supply peaks.
- October 1973 oil shock.
- New projects costs soar (nuclear plants, Alaskan pipeline and North Sea).
- Winter of 1977/1978: Natural gas crisis closes down Mid-West.
- 1979 had two crises:
  - Three Mile Island brought atomic energy to a halt
  - Oil Shock II creates gas lines again
- By 1980/1981: \$100 oil seemed “at the front door.”



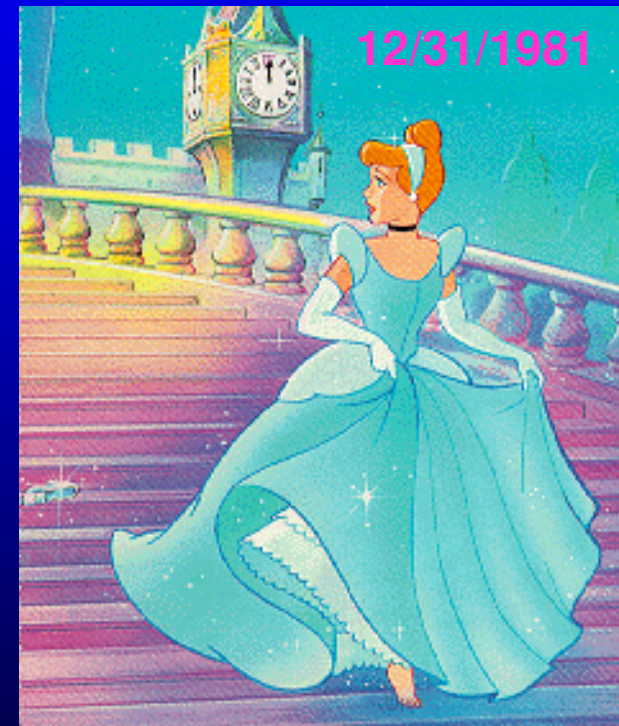
U.S. oil consumption, production & imports (millions of barrels per day) [source: U.S. DOE/EIA]



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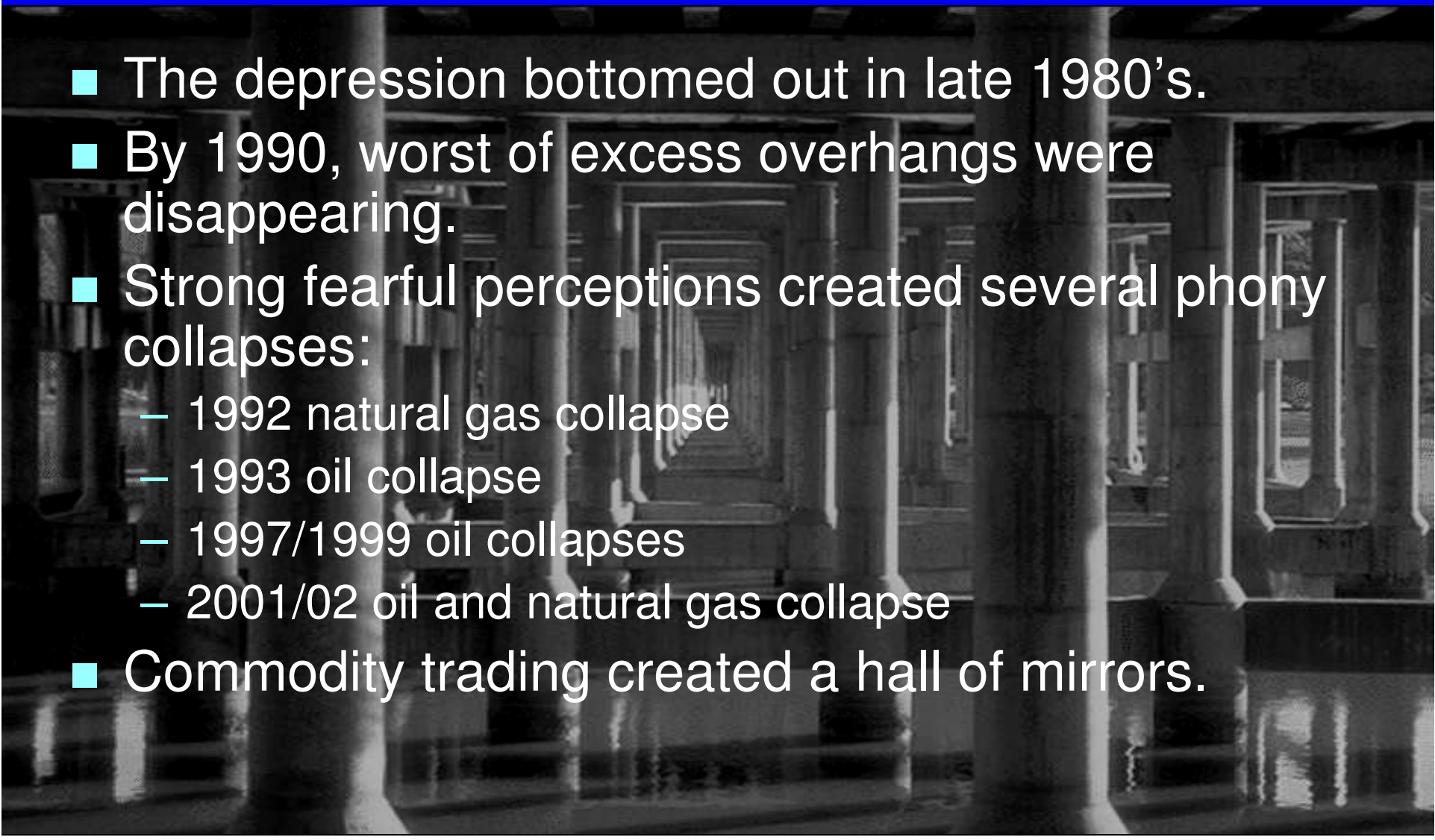
# Cinderella's Ball Ends At Midnight 12/31/1981

- New Years Eve 1981: epic drilling boom peaked.
- New Years Day 1982: Rig collapse began.
- By 1990: Most oil and gas players were broke:
  - US rig count declined by  $\approx 90\%$
  - Millions of oil field jobs lost
  - S&L crisis all “Sunbelt oriented”
  - Survivors cannibalized the industry



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# The Oilfield Depression Lasted Two Decades

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- The depression bottomed out in late 1980's.
  - By 1990, worst of excess overhangs were disappearing.
  - Strong fearful perceptions created several phony collapses:
    - 1992 natural gas collapse
    - 1993 oil collapse
    - 1997/1999 oil collapses
    - 2001/02 oil and natural gas collapse
  - Commodity trading created a hall of mirrors.



# Energy's Conventional Wisdom: 1995 - 2005

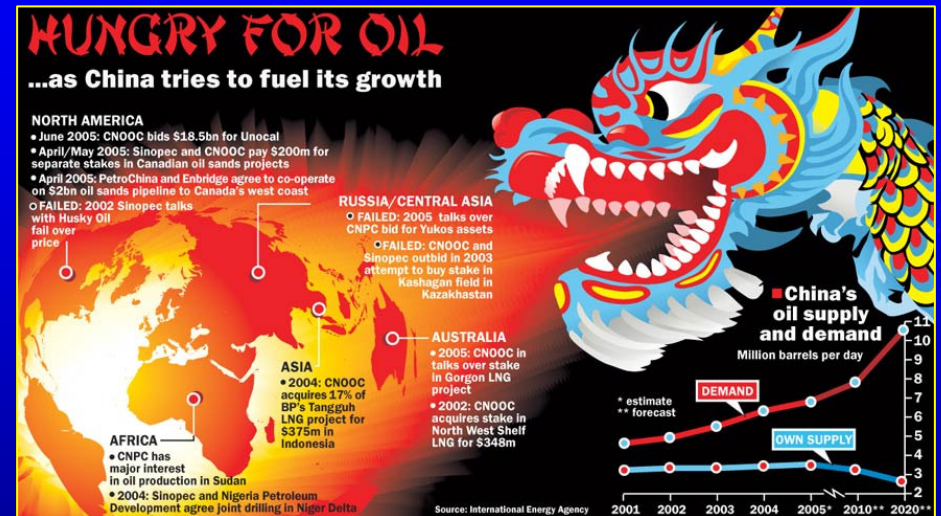
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- Demand growth is fickle (and it might be peaking).
- Technology revolution created a cheap era for oil and gas.
- Technology recovered more existing reserves and found easy to tap new oil and gas.
- Non-conventional energy era also arrived.
- Any return to high prices will kill demand and create new supply glut.

**The believers felt this passionately.**

# Real Facts Disproved “The New Energy Era”

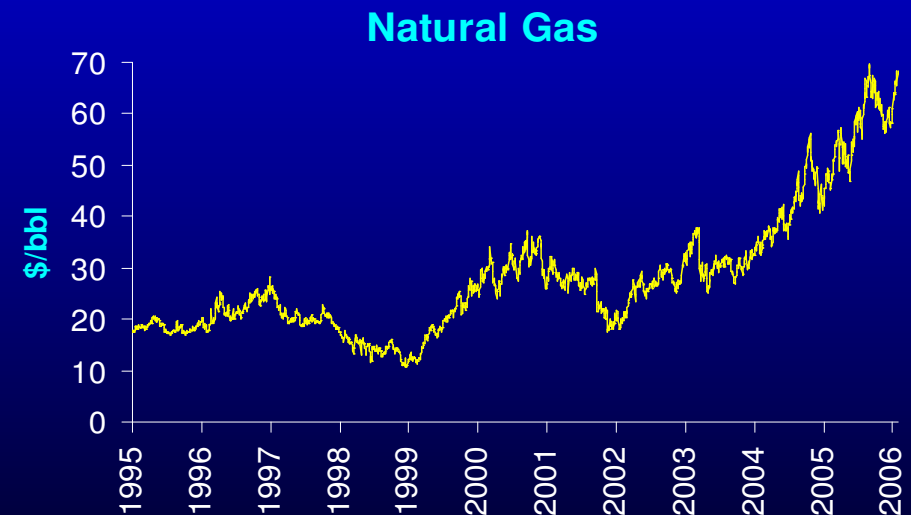
- Demand still soaring, led by “China, Inc.”
- USA’s prosperity sent energy use to record highs.
- Technology “hype” was “hype”:
  - Cost to drill and complete wells rose 2.5 to 3 fold
  - Growing oil and gas production got harder
  - Replacing reserves (post-Shell scandal) got increasingly difficult
  - Reserve appreciation was mostly a concept
- 2000 – 2005 exploration success grew dismal:
  - The few large finds were in awful areas
  - Costs to develop grew 2 to 5 fold



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# High Price Volatility Destroyed Price Signals

- Long-term oil and gas prices were growing.
- Too many pundits thought “high prices” were aberrations.
- Many energy experts bet their reputations that energy prices would “soon fall to normal levels.”



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# Could We Be Entering A New Energy Era?

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- Could end to sustainable energy supply growth be nearing?
- How soon could “peak oil and gas” arrive?
- How long would peak stay at a plateau.
- How fast could supply then decline?
- Is peak oil more likely than peak natural gas?

These are the 21<sup>st</sup> century's most serious questions.

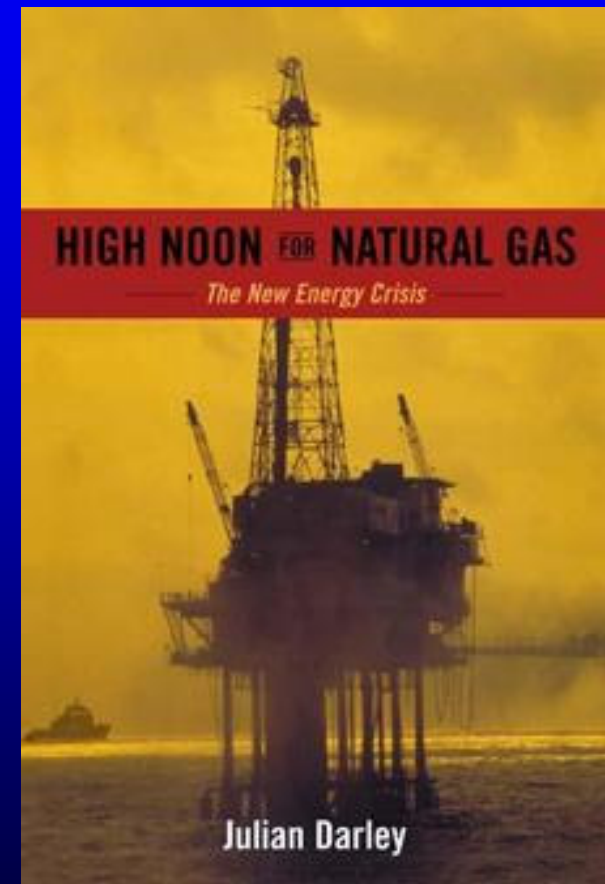
# Everyone Assumes Energy Demand Will Soar

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- EIA, IEA, World Bank and ExxonMobil all forecast:
  - Growth in oil by 2020 – 2030 = 115 to 125 million barrels per day
  - Growth in natural gas and electricity = 30 – 50% higher
- The core assumptions might be too conservative:
  - Slow down in population growth
  - Acceleration of energy efficiencies
  - Emerging economies per capita energy consumption still low

# Theories Abound That Peak Oil Is Distant Issue

- Reserve appreciation “always happens.”
- Technology always advances.
- Impact of high prices kills demand and aids supply.
- Hard work, innovation and ingenuity solves energy problems.
- Proof of these theories is “fuzzy.”
- Peak gas is not on anyone’s radar screen.



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# A Few Hard Facts

Regions In Decline	Proven Oil Reserves Billion B/D		Production Million B/D	
	1984	2004	1984	2004
USA	29.6	29.4	8.4	7.4
UK	4.3	4.5	2.7	2.0
Norway	9.6	9.7	2.7	3.2
Australia	3.9	4.0	0.6	0.5
Egypt	3.9	3.6	0.9	0.7
Oman	5.1	5.6	0.8	0.7
Total	<u>56.4</u>	<u>56.8</u>	<u>16.1</u>	<u>14.5</u>
Some more hard facts	1984	2004	Implied	
OPEC's Paper Barrels*	<u>433</u>	<u>721.7</u>	Addition	
			<u>434</u>	

- UK North Sea:
  - Decline rates coverage
  - 10 – 30% per year
  - 101 oil and gas fields
  - (1995 – 2000) 47 increased
  - 47 decreased
  - 7 unchanged

\*Iran, Iraq, Kuwait, Saudi Arabia, Venezuela and Nigeria

Source: BP Statistic Review Of World Energy 2001

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# Data Disputes Reality Of “Reserve Appreciation”

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- 40 years ago, most new discoveries grew in recovering reserves over time (3 – 8 times).
- Concept is still alive and well.
- Data casts doubts on validity of concept today:
  - The North Sea (Silicon Valley of oil and gas): no proof
  - OPEC’s surge in Paper Barrel Reserves: no proof
  - Countries with irreversible declines and reserve growth: does the reserve data mean anything?

# Non-OPEC Supplies Are Approaching Peak Production

## Five Years Of Tiny Growth

Million Barrels Per Day

	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>4<sup>th</sup> Quarter 2005</u>	<u>Total 2005</u>	<u>Estimated 2006</u>
North America	14.5	14.6	14.1	13.6	14.1	14.3
Europe	6.6	6.3	6.1	5.6	5.7	5.4
Pacific	0.8	0.7	0.6	0.5	0.6	0.6
Asia	5.9	6.0	6.2	6.4	6.3	6.4
Latin America	3.9	4.0	4.1	4.3	4.3	4.5
Middle East	2.1	2.0	1.9	1.9	1.9	1.8
Africa	3.0	3.0	3.4	3.9	3.7	4.3
<b>Total</b>	<b>36.9</b>	<b>37.0</b>	<b>37.1</b>	<b>36.3</b>	<b>36.6</b>	<b>37.4</b>
FSU	9.4	10.3	10.9	11.9	11.6	12.1
<b>Total</b>	<b>46.3</b>	<b>47.3</b>	<b>48.0</b>	<b>48.2</b>	<b>48.2</b>	<b>49.5</b>

Source: IEA Data

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# Why Has Non-OPEC Supply Been Flat?

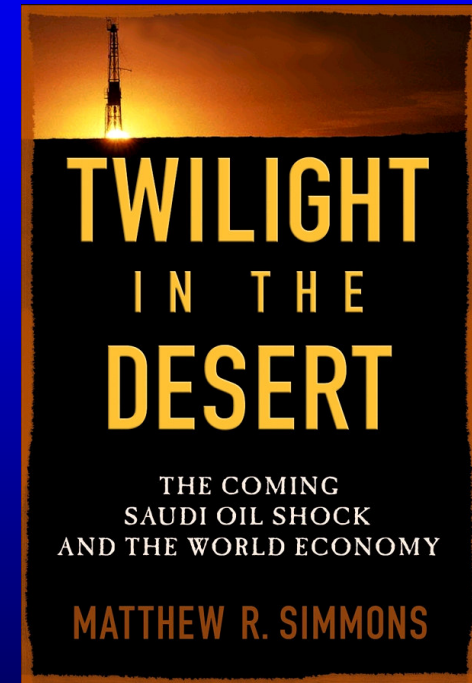
- Giant old fields are scarce and old.
- Most new fields are small.
  - Peak fast
  - Decline fast
- 50% of non-OPEC/non-FSU supply in decline.\*
- Another 22% are set to decline (Mexico, China and India).
- Russia got a “second wind” but might start declining also.
- There is no non-OPEC shut-in supply.

\*USA; Argentina, Columbia, Peru, Norway, UK, Oman, Syria, Yemen, Cameroon, Egypt, Gabon and Australia.

# Twilight Creates Illusions

## The facts about Twilight:

- It creates brilliant last light.
- You can see farther at twilight than mid-day.
- Darkness soon follows.
- Could this be Twilight of the fossil fuel era?
  - Is fossil fuel finite?
  - Do we have warning light when twilight is pending?
  - How solid is the data on fossil fuel resource base?
  - How solid is data on producible fossil fuel?
  - What do we know about energy cost to convert fossil fuel into usable energy?



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# Our Energy “Road Map” Is Broken

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- Current energy data (oil, natural gas and electricity) is inconsistent, misleading and often useless.
- 95% of world’s proven oil and gas reserves are “un-audited.”
- Demand estimates take years to verify.
- Petroleum stocks are mostly computer guesses.
- Field-by-field production reports (excluding North Sea) virtually non-existent.
- No data on “decline rates.”
- Supply data not precise.

# Running Out Of Gas Is Easy With No Gauge

- You run out of gas by ignoring fuel gauge.
- USA has no city-by-city “energy gauge.”
- World has no concept what a “gauge” even means.
- Cars run at 70 mph until they run out of gas.
- Energy shortages happen instantly.
- When shortages happen, people hoard.
- Hoarding intensifies the shortage.



This is Energy 101 in 2006

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# Running Out Of Gas Does Not Mean “World Has No Gas”

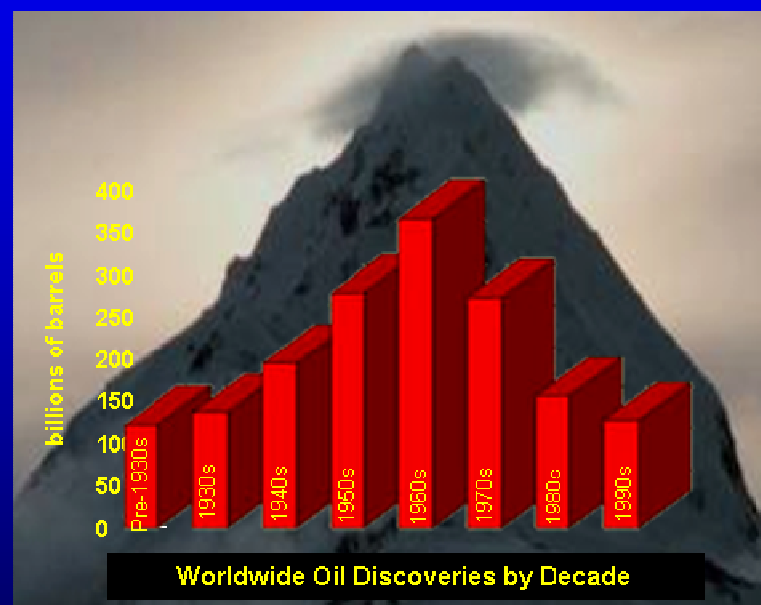
- Two “energy facts”:
  - When a car is out of gas, the issue is how far do I walk?
  - Running out of usable inventory creates a shortage
- Our Current Vulnerability:
  - We have demand growing at an unknown pace
  - Supply is flat or declining in most regions.
  - Many supply areas are in “danger zones”
  - There are no easy supply additions left
  - Money is no object, scarcity in good projects



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# The World Is Entering A Peak For Oil And Gas

- Optimists have no meaningful facts to bolster enthusiasm.
- Peaking of usable oil and gas is either:
  - Approaching front door
  - Knocking at the world's door
  - Now inside the house
- Denial has created an awful global crisis.
- Denying peaking of modern energy creates the ultimate crisis.



# Once Middle East Oil Peaks, World Oil Has Peaked

- Kuwait, Iraq, Iran, Oman, Yemen, Syria and Jordan have already peaked.
- UAE and Qatar are too small to matter.
- Saudi Arabia is all that matters.
- Can Saudi Arabia:
  - Grow to 15 – 25 million barrels per day?
  - Increase sustained supply to 12 million barrels per day?
  - Sustain 8 – 9 million barrels per day?
  - Safely produce 5 million barrels by 2020?

## 'The West is deluded to rely on Saudi oil'

Matthew Simmons doesn't look like a contrarian. He comes across as what he is: an oil-industry magnate. Over the past 30 years, the Texas-based investment bank he founded – Simmons & Co International – has guided countless blue-chip clients through oil deals worth \$60bn (£3.5bn), *series Liam Halligan*. Despite these credentials, Simmons holds controversial views that pit him against almost the entire Western oil establishment. In his London offices last week, he told me he is "deeply concerned" that Saudi Arabia's oil will run out. "For decades, Saudi has been the most important producer on earth," he says. "They have been the only country able to pump extra crude when the West needs it, and everyone just assumes that spare capacity will last."

With oil prices above \$50 a barrel, having risen by 80 per cent this year, the West is indeed relying on yet more Saudi crude. "This is delusion," says Simmons. "Saudi oil output may soon start declining – imminently, in my view, in the next six to 36 months."

Simmons' warning is based on "a very close study of hundreds of technical reports" produced by the Desert Kingdom's own engineers. Saudi's oil capacity is "dangerously concentrated," he says. "Six fields have yielded 95 per cent of all Saudi oil ever produced, with a single field – Ghawar – pumping 60 per cent. But the Saudis have pushed these fields hard. And when you push big fields, reservoir pressures fall."

His analysis, if correct, is scary. It would exert severe

upward pressure on already sky-high oil prices – with devastating implications for financial markets and economic growth worldwide.

"But the conventional wisdom," Simmons says, "that we can rely on Saudi oil indefinitely is driven only by 'group-think' and vested interests."

The Energy Information Administration, part of the US government, forecasts global oil demand of 120m barrels daily by 2025 – up 50 per cent on the current consumption of 80m. Over the same period, the EIA says, Saudi production will rise from 9m bpd to 22m. Put simply, in 20 years' time the world will rely on Saudi for 19 per cent of all oil production – a dramatic increase on the country's current 11 per cent share.

Having served on vice president Dick Cheney's energy task force, Simmons knows these forecasts well. "The EIA numbers are the global economy's energy roadmap," he says. "But while their demand estimates are real, they basically invent the future production numbers as they go along."

So what of US government claims that Saudi will pump 22m bpd in 2025? "If, by some miracle, they find some huge fields that have defied discovery for 50 years," Simmons says, "it might happen. Then again, I could be living on the moon in 2025."

Officially, the Saudis dismiss Simmons' analysis. "Matt is talking rubbish," oil minister Ali Al-Naimi has said. So when I went from Sim-



Al-Husseini: forecast concerns

mons' office to meet Sadad Al-Husseini, I expected him to trot out the same line.

After all, until March, Al-Husseini was head of exploration and production at Aramco, the state-owned oil monolith which accounts for 97 per cent of Saudi's crude output. Yet, astonishingly, Al-Husseini lent some credence to Simmons' views.

"The question isn't 'can we pump 15m or 20m barrels daily?', he says. "The question is, how long it can be sustained? We could only manage 22m bpd for a very short time – maybe 10 years. And that would mean an awful lot of depletion, which isn't in the best interests of the global economy."

What does Al-Husseini make of US estimates of future Saudi production? "These are US numbers, not ours," he says. "The American production outlook is much too high."

When I ask Al-Husseini where the EIA is going wrong, he echoes Simmons: "The EIA focuses only on demand. That

is why they overestimate not only future Middle East supplies but non-Opec and Russian supplies too."

We agree the production outlook for the Middle East as a whole – which the EIA predicts will almost double, from 21m bpd today to 40m in 2025 – depends crucially on Iraq.

"The country does have substantial reserves," says Al-Husseini. "But after years of neglect, it will take a long time for Iraq's oil infrastructure to make a significant contribution to global supplies." How long? "I doubt they can exceed 3m barrels a day by the end of this decade."

Al-Husseini refutes Simmons' claims that the Saudis have partly squandered capacity by pumping too quickly in the past. "The Kingdom's oil is managed in a highly professional manner," he says. "But Simmons' concerns over US output forecasts are legitimate concerns."

Where do these two very different oilmen think prices are going next? Simmons thinks prices are unlikely to ease. "This winter, global demand will considerably exceed supply," he says. "So it is inconceivable prices could fall by much."

Again, Al-Husseini's view is similar. "I suspect prices around \$50 will be with us for a while," he says. And then he issues his own Saudi-related warning. "The excess capacity is no longer there. That will mean more of the volatility and price surges. And the financial markets have yet to wake up to that."

■ *Liam Halligan is Economics Correspondent at Channel 4 News*

Source: The Sunday Telegraph, 'The West Is Deluded To Rely On Saudi Oil', October 31, 2004

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# Some Saudi Arabian Energy Facts

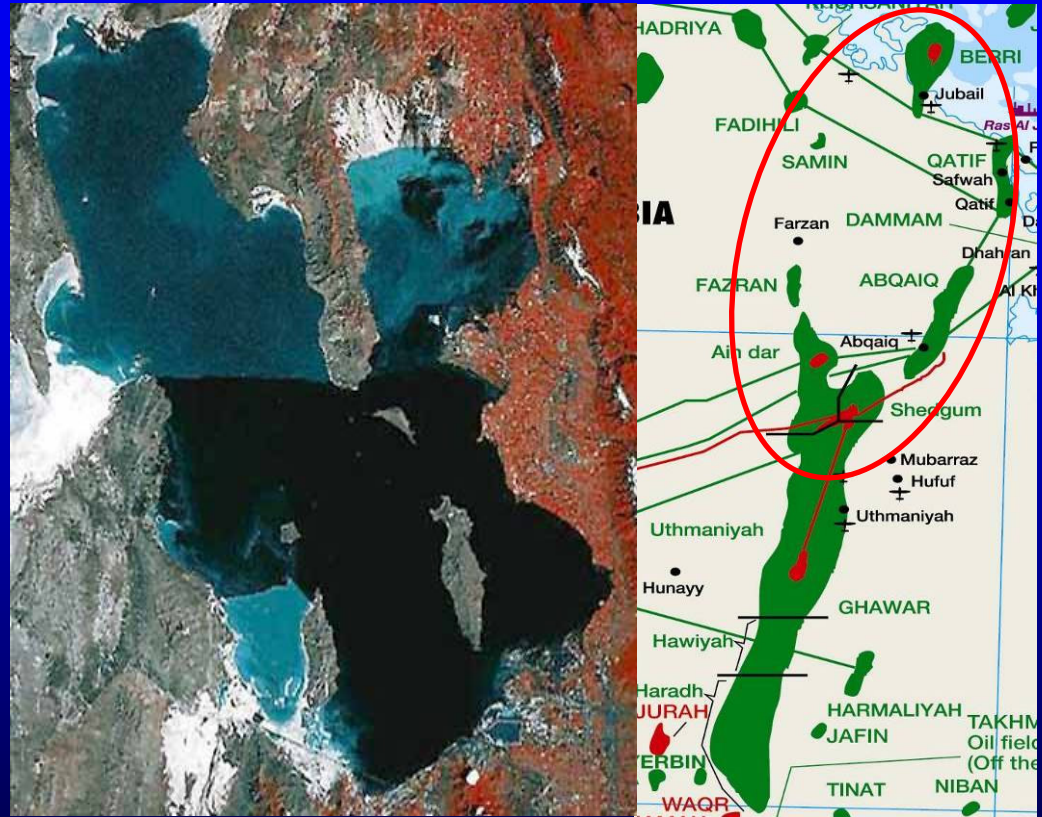
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- 5 old super giant oil fields have produced  $\approx 90\%$  of its oil.
- 3 other giant fields make up most of the balance.
- All their producing fields are mature, have depleted their highest quality oil and face serious water maintenance and corrosion problems.
- All “new projects” are complex oil structures that “never worked” in 1970s era.
- 35 years of intense exploration found little new oil.



# Saudi Arabia's Oil Sweet Spot Was Deep But Geographically Small

- “North Ghawar” (25 x 12 miles) produced ≈80% of Ghawar’s peak oil.
- North Ghawar, Abqaiq and Berri were “best of the world’s best.”
  - Collectively, they produced peak oil of 7 million barrels per day
  - The “ring road” fits into Utah’s Great Salt Lake
- The rest of Saudi’s oil gets more complex to produce or contains less valuable oil.
- Hundreds of small fields undoubtedly exist but will never replace the oil field King, Queens and Lords.



Great Salt Lake

Saudi Arabia's  
Oil Fields

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# “Burgan Is Exhausted”: Is The Canary Now Singing?

- November 2005: “Burgan, the world’s second largest oil field, having produced 2 million barrels per day for 6 decades, is exhausted...by reducing production to 1.7 million barrels per day we hope this sustains production for decades to come.” (Media quote by Chairman of Kuwait Petroleum Company)
- January 2006: PIW reports that Kuwait’s real proven reserves are  $\approx$ 45 billion barrels.

Is this the coal mine canary’s first chirp?

# Peaking Of Natural Gas Is A More Critical Issue

- Natural gas reserve data very sketchy (worse than oil).
- Natural gas, a vapor, declines faster than oil.
- Too many key gas producing regions/key fields in decline.
  - USA
  - Canada
  - Western Siberia
  - United Kingdom
  - Indonesia
- Too many future sources are barely drilled:
  - Saudi Arabia's non-associated gas
  - Qatar and Iran's North Field/South Pars
- Too many exploration basins are undrilled:
  - Arctic gas
  - Most deepwater regions

# Unconventional Oil Resources Are Vast (And Difficult)



- Current IEA estimates assume 6 trillion barrels of heavy oil and bitumen.
- Two trillion “may ultimately be recoverable.”
- Production and processing costs have fallen significantly.
- In Canada it currently takes 30 cubic meters to heat heavy oil and 15 cubic meters to upgrade, using 4 – 7 barrels energy for every usable barrel created.

Source: 2005 IEA Resources to Reserve, Chapter 3: Heavy Oil

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# Non-Conventional Gas Resources Also Hard To Utilize

- Coal bed methane has low permeability.
- Fluids do not easily flow.
- “Tight gas” comes from rocks with extremely low permeability.



- Methane Hydrates are “thought to be most abundant source of hydrocarbon on earth.”
  - Little is known about quantities
  - Limited scientific knowledge on how to explore or produce

Source: IEA's Resources to Reserves 2000

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# If Peaking Of Energy Is Real, “Be Prepared”

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- Mitigating peaking of modern energy will be an unprecedented global challenge.
- Fixing the problem takes “between 7 years” and up to 50 years.
- Starting ahead of the problem has no downside risk.
- Ignoring the crisis until it is in full bloom will make USA’s two worst mistakes seem modest:
  - The Civil War
  - World War II
- It is time to take the crisis seriously before it is too late.

# What Happens Once Fossil Fuel Supply Peaks?

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- When oil or natural gas peaks, fossil fuel use will soon decline.
- Current world “blue print” envisions a 2020 – 2030 world.
  - Using 115 – 130 million barrels per day of oil
  - 30 – 50% more natural gas and electricity
- By 2020, world might be lucky to supply 80% of current oil and gas use.
- The “gap” between demand and use is The Crisis.

# Options On Dealing With “The Gap”

- When demand far exceeds supply, options are:
  - ❑ Bullies get “first in line”
  - ❑ Governments allocate supply
  - ❑ Stakeholders create solutions to crisis before crisis is terminal
- “We” have the choice on which box we vote.



# How We Solve “Peak Oil”

- We reduce transportation intensity of oil:
  - Shipments of goods by truck becomes train to boat
  - Liberation of employees to work close to home
    - End 9 – 5 check in
    - Begin era of “pay by productivity”
  - Grow food locally: End era of ornamental food
  - Reverse globalization: make things at home



## RELATIVE ENERGY EFFICIENCIES



## NUMBER OF MILES ONE TON CAN BE TRANSPORTED PER GALLON OF FUEL



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# Oil Prices Need To Soar

- \$65 oil is \$.10 a cup.
- High prices do not kill economies.
- What should we do with high oil price era?
  - Rebuild the energy infrastructure
  - Create an OPEC middle class
  - Unlock R & D era for new energy source
- High energy prices are salvation.
- Low energy prices are a curse.



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# Creating An OPEC Middle Class Is Vital

- OPEC nations have vast population of poor people.
- Using high energy prices to eradicate poverty creates OECD prosperity.
- It can be a “Marshall Plan<sup>2</sup>.”
- The grim facts:

2005 Data				
Country	Million Population	Fertility Rate	GDP Per Head	Energy Consumption Per Head (TOEM)
Algeria	32	2.5	\$2,090	985
Indonesia	220	2.4	\$950	737
Iran	69	2.3	\$1,990	2,044
Nigeria	124	5.6	\$470	718
Saudi Arabia	24	4.1	\$8,870	5,775
Total	<u>469</u>	<u>3.4 ave</u>	<u>\$2,874 avg</u>	<u>2,052 avg</u>

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Source: Economist Country Profile

# Solving Peak Natural Gas Is Tough

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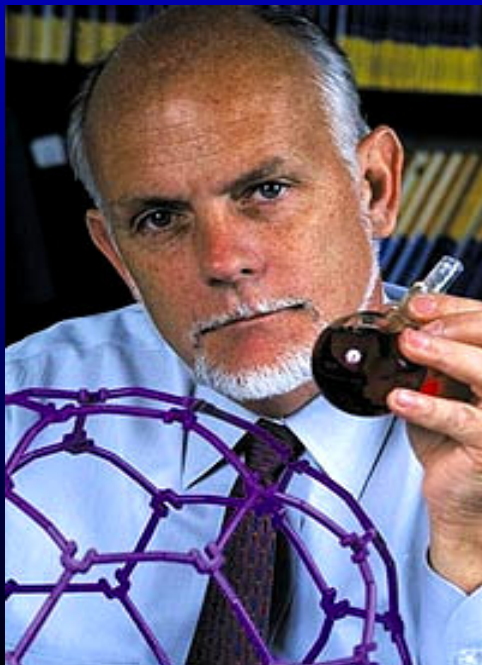
- Natural gas is the only efficient source of instant heat.
- Premium natural gas also has low emissions.
- Natural gas should not be used to create:
  - Usable heavy oil
  - Electricity
- Until new heat source is invented, natural gas will be scarce.
- Natural gas is the world's most precious energy source.

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# Let's "Win One For Rick Smalley"

- Richard Smalley had an energy vision.
- It was rooted in fear about peak oil and natural gas.
- If we win an energy victory, we avoid an energy crisis.
- If we ignore the issue, we will live in a far darker world.

## HUMANITY'S TOP TEN PROBLEMS FOR THE NEXT 50 YEARS



1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism and War
7. Disease
8. Education
9. Democracy
10. Population



# Twilight Can Turn Into A “New Dawn”

- Twilight creates illusion of light getting stronger.
- Twilight then fades into a dark night.
- It is always darkest before dawn.
- If we solve our energy crisis, the 21<sup>st</sup> century will be our greatest dawn.
- If we fail, we will have a dark future.



# Harvard Has Important Role In This Pending Crisis

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- Issues raised by peaking of fossil fuels cuts across every school with the University.
- Harvard's Academic and Moral Authority can change attitudes, create better facts and set agenda for a better world.
- Energy matters.
- Thus, Harvard's role is critically important.

# Harvard's Energy Challenge

- Pending energy crisis creates unforeseen challenges impacting each of Harvard's diverse schools.
- Economic impact could challenge viability of Harvard's financial resources.



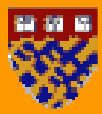
Faculty of Arts  
and Sciences



Faculty of  
Medicine



Faculty of  
Business School



Graduate School  
of Design



Harvard  
Divinity School



Graduate School  
of Education



Radcliffe Institute  
for Advanced Study



John F. Kennedy  
School of Government



Harvard School  
of Public Health

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*to the* **E**nergy  
Industry

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