The Global Scramble for Energy and Mineral Resources–

Will the Move Towards Alternative Energy Sources Alleviate Our Import Problems?

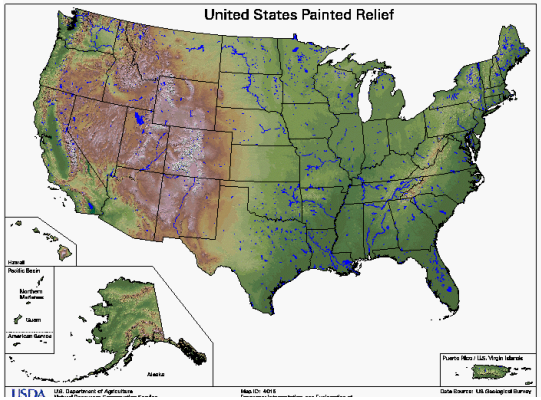
Vincent Matthews Ph.D., Director
Colorado Geological Survey

TMS2010

February 14-18, 2010 – Seattle, Washington

China

India



U.S.

Overall Impacts

Americans will suffer from natural-resource-driven inflation

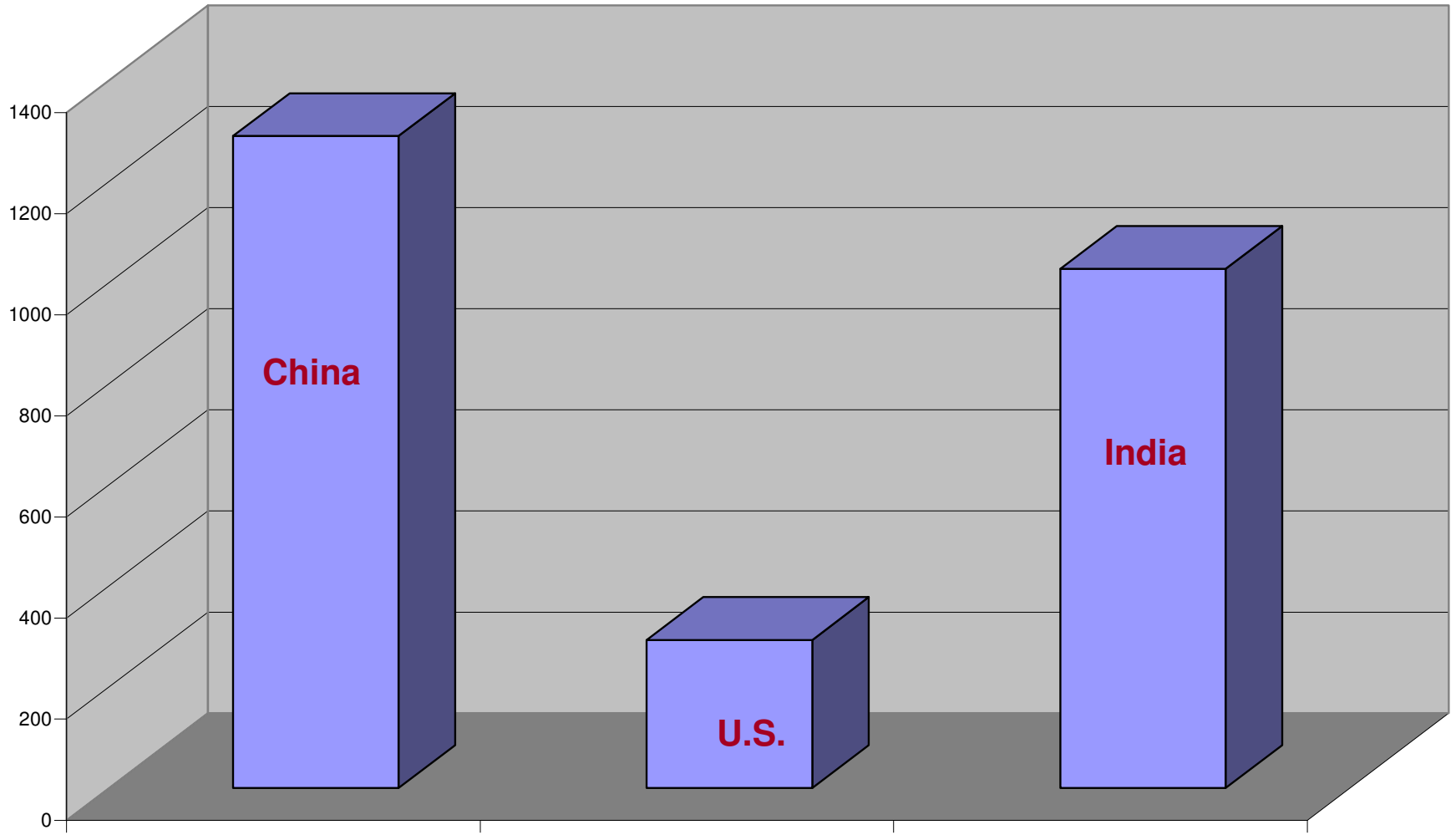
Americans may see increasing shortages of critical raw materials

Pressures will mount to develop more of America ’s natural resources

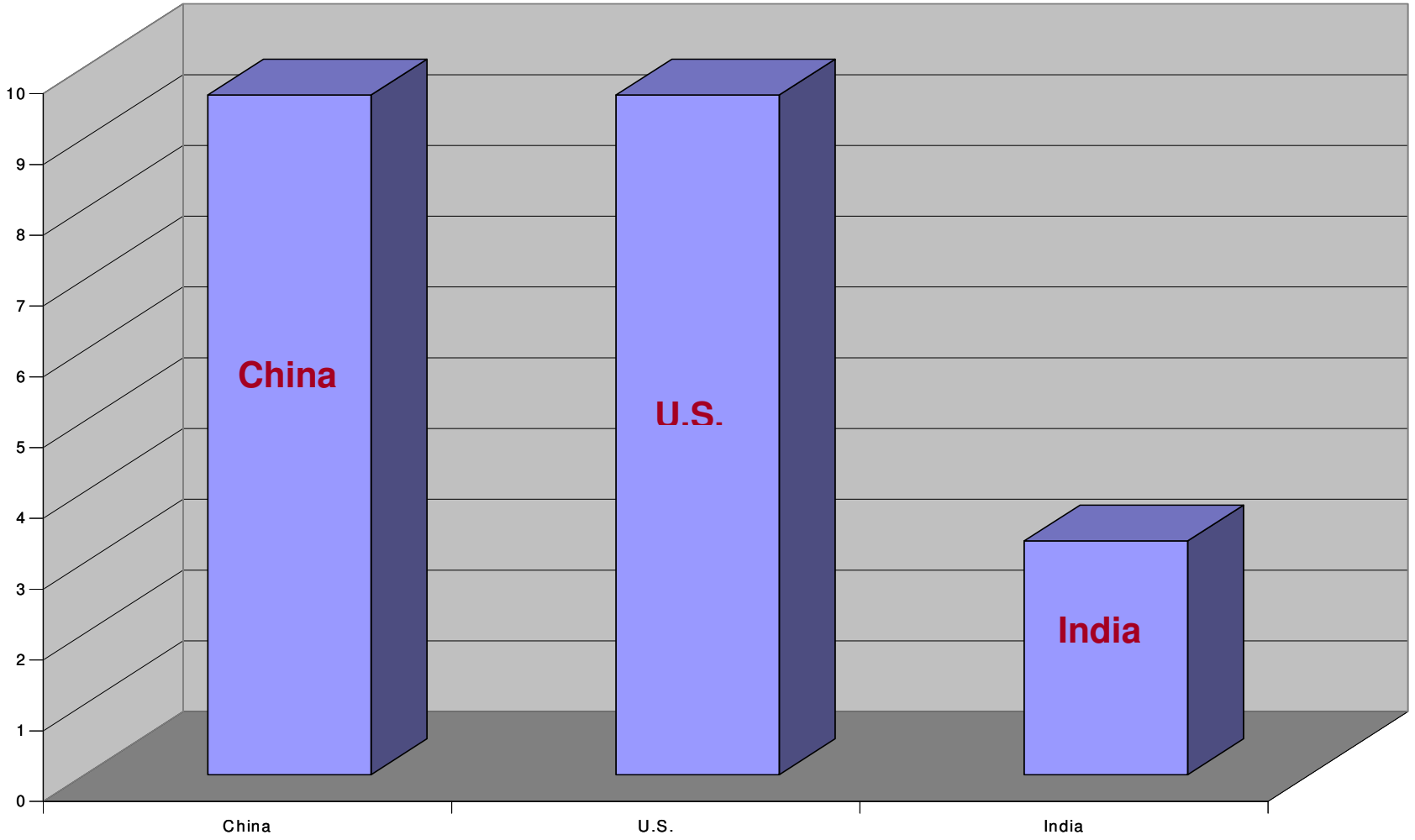
Conflicts may arise with multi-national corporations operating in America

How do we turn lemons into lemonade?

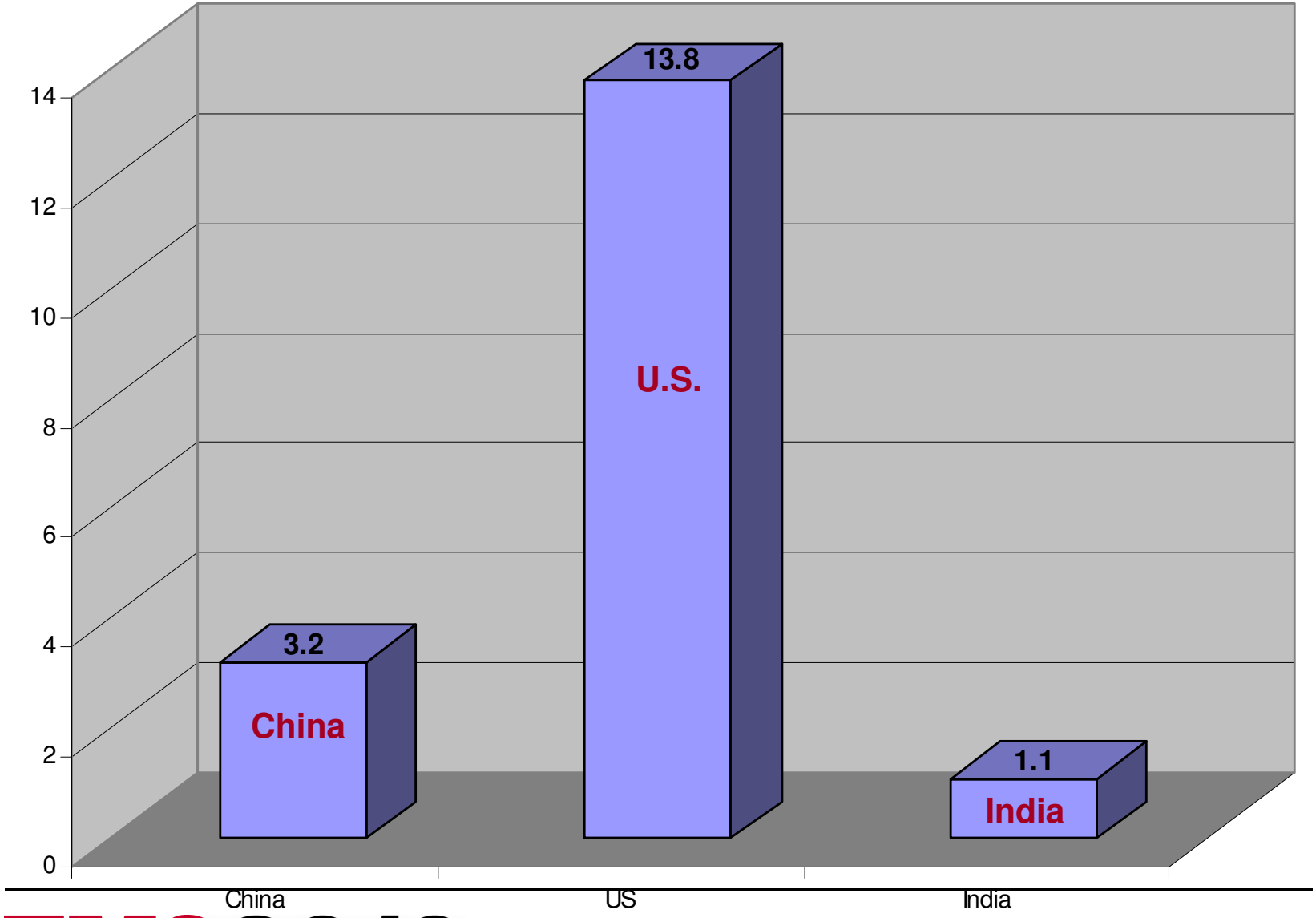
Population Comparison



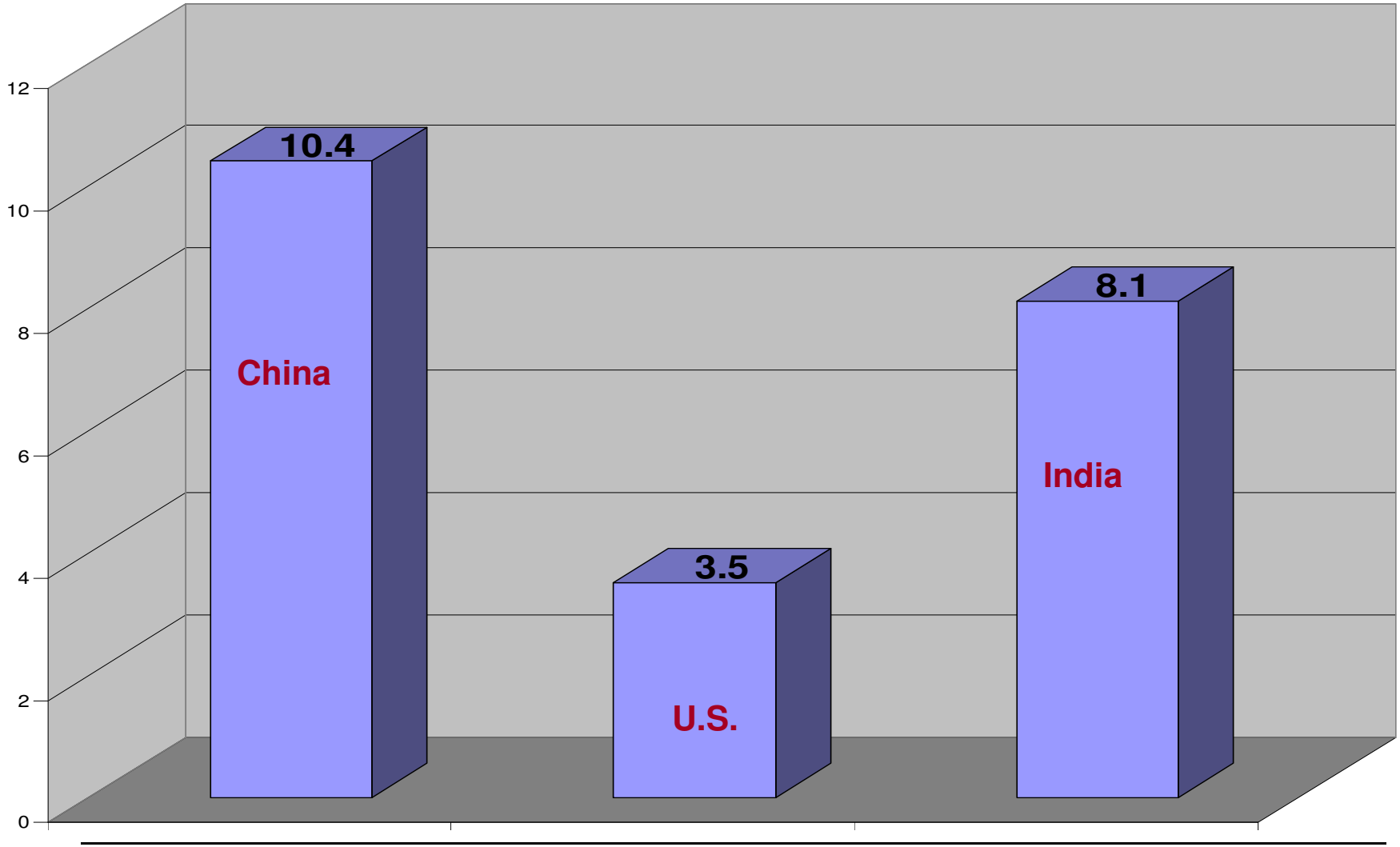
Land Area Comparison



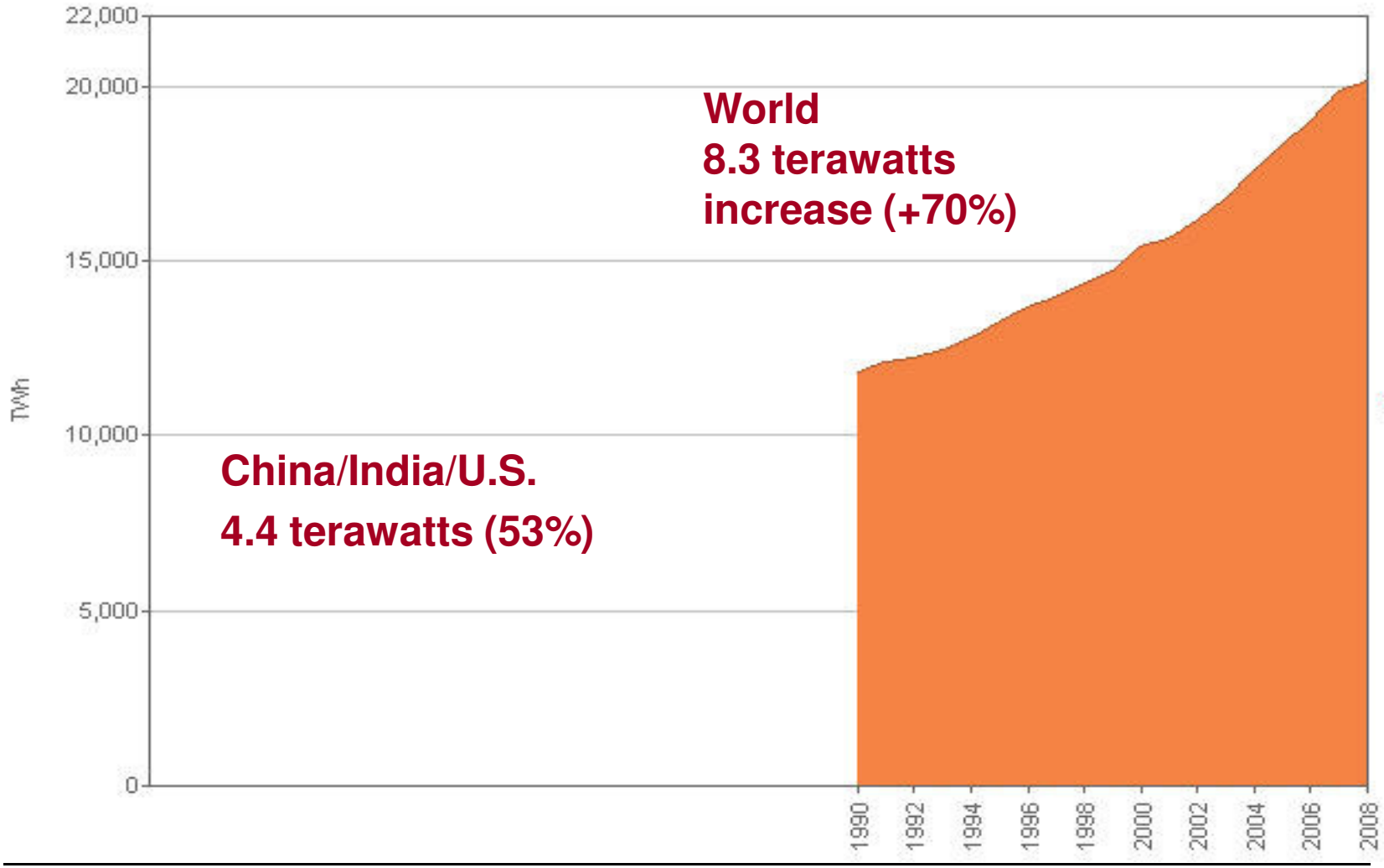
GDP Comparison - 2007



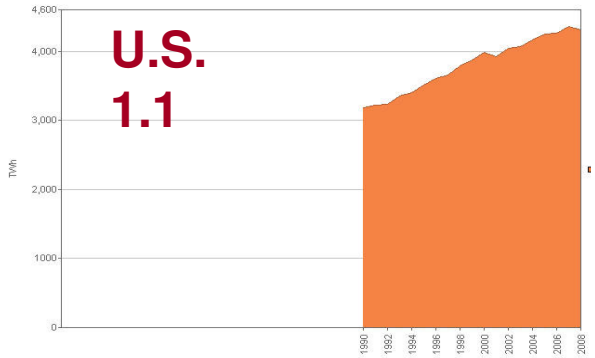
GDP Growth Comparison 2004-06

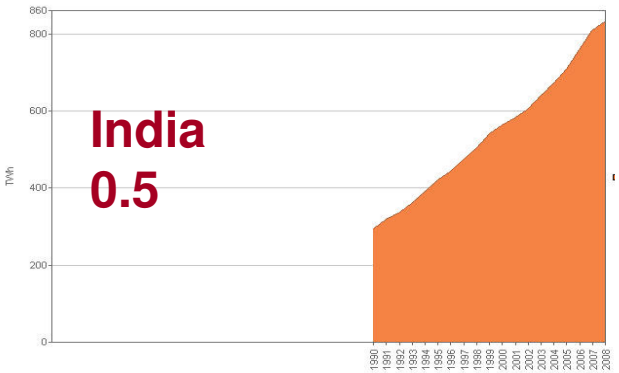


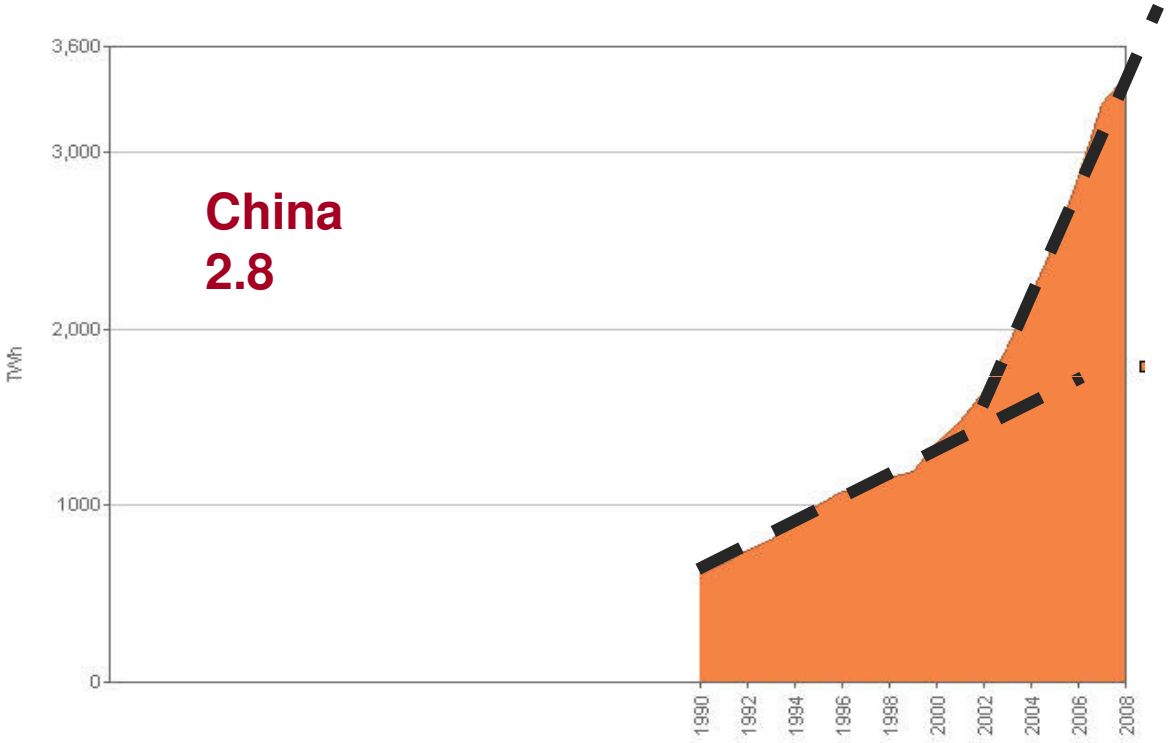
World Electrical Growth



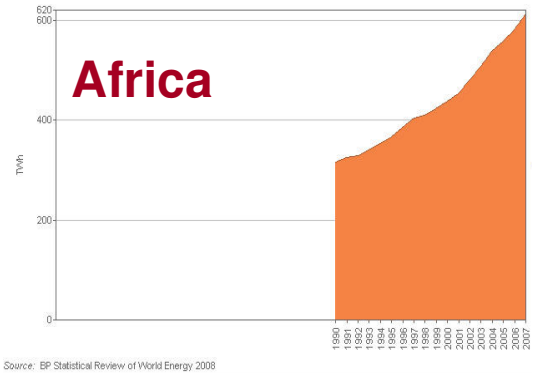
China/India/U.S. Electrical Growth

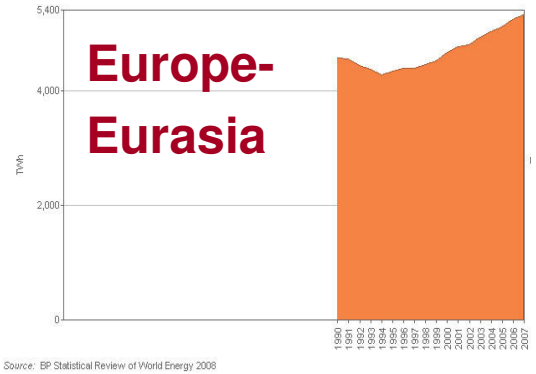


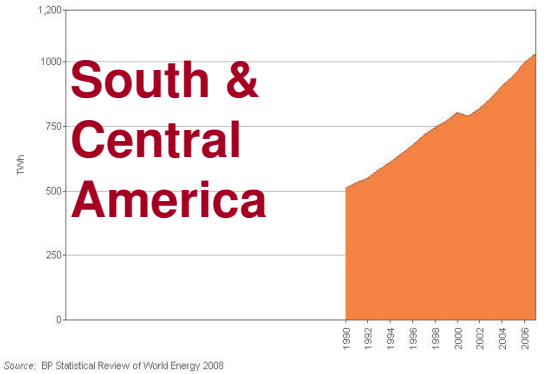


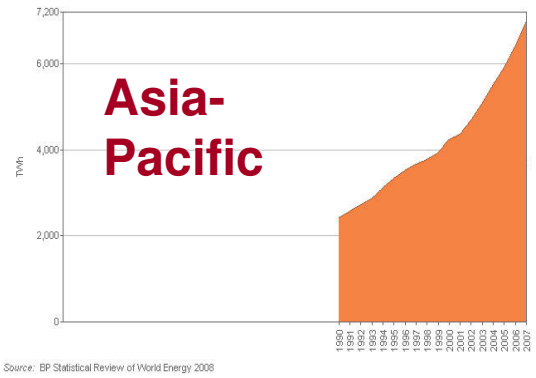


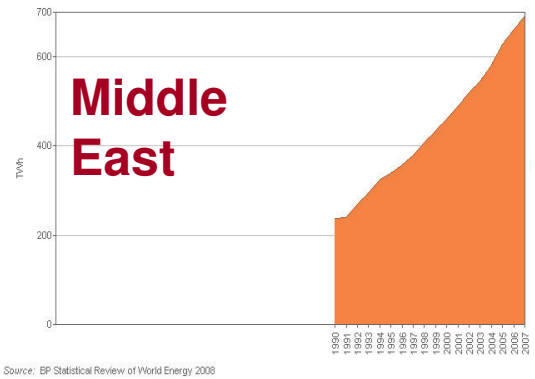
World Electrical Growth

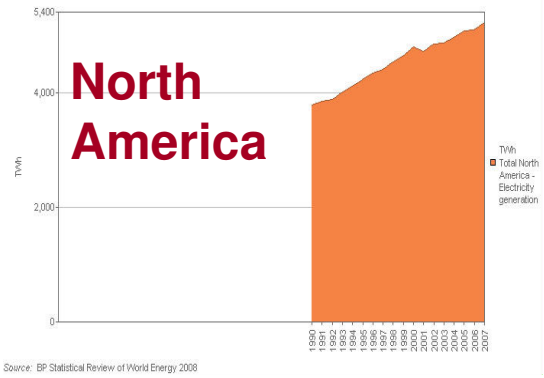










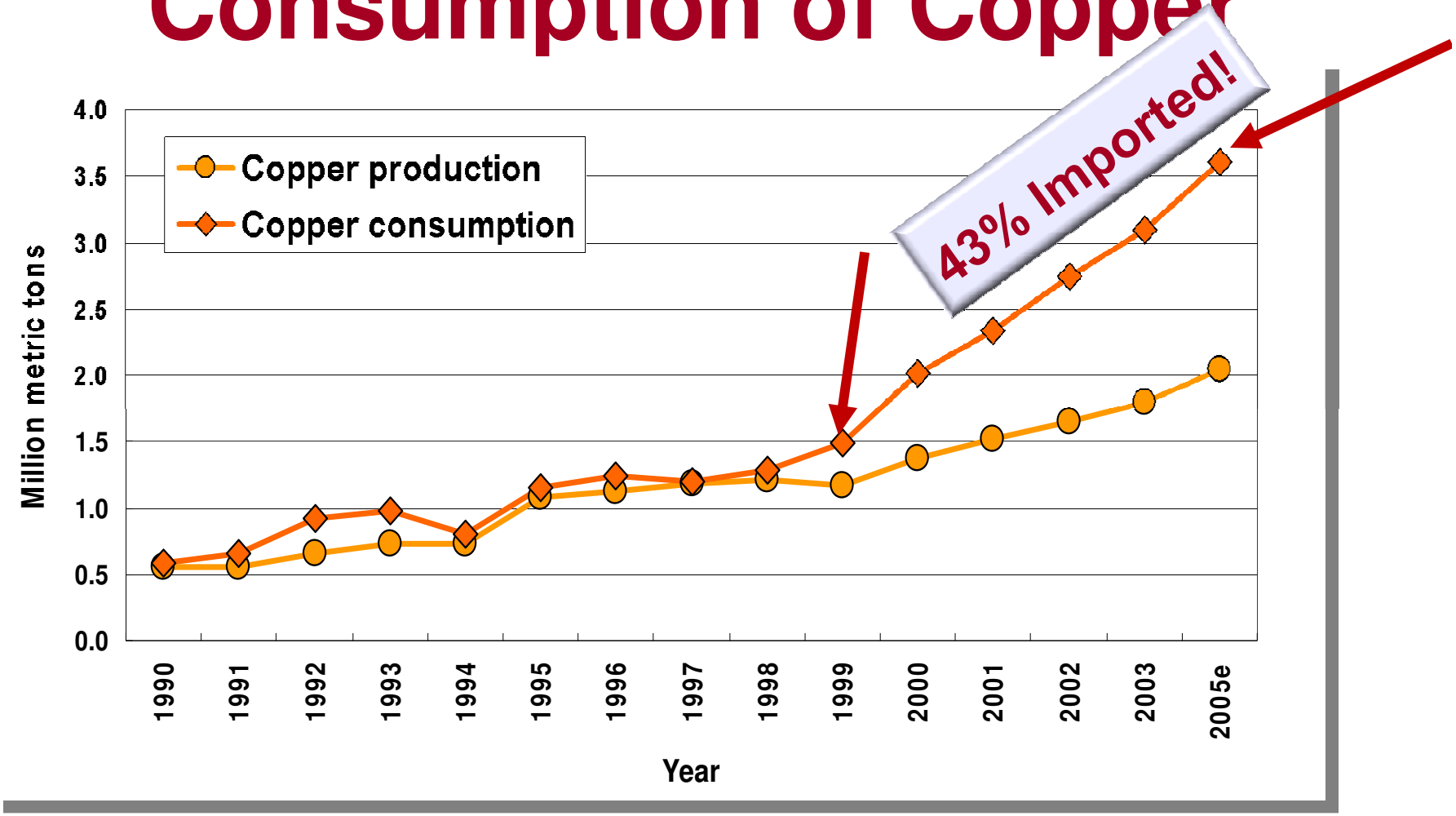


China's Share of World Mineral Production in 2005

Industrial minerals:	%	Rank
Cement	45	1
Fluorspar	51	1
Rare earths	96	1
Metals:		
Aluminum	24	1
Antimony	86	1
Copper	16	2
Gold	9	4
Lead	32	1
Magnesium	75	1
Molybdenum	22	3
Silver	12	3
Steel, crude	31	1
Tin	35	1
Tungsten	87	1
Zinc	26	1

Source: USGS, Menzie and Tse

China's Production and Consumption of Copper



Global Impact

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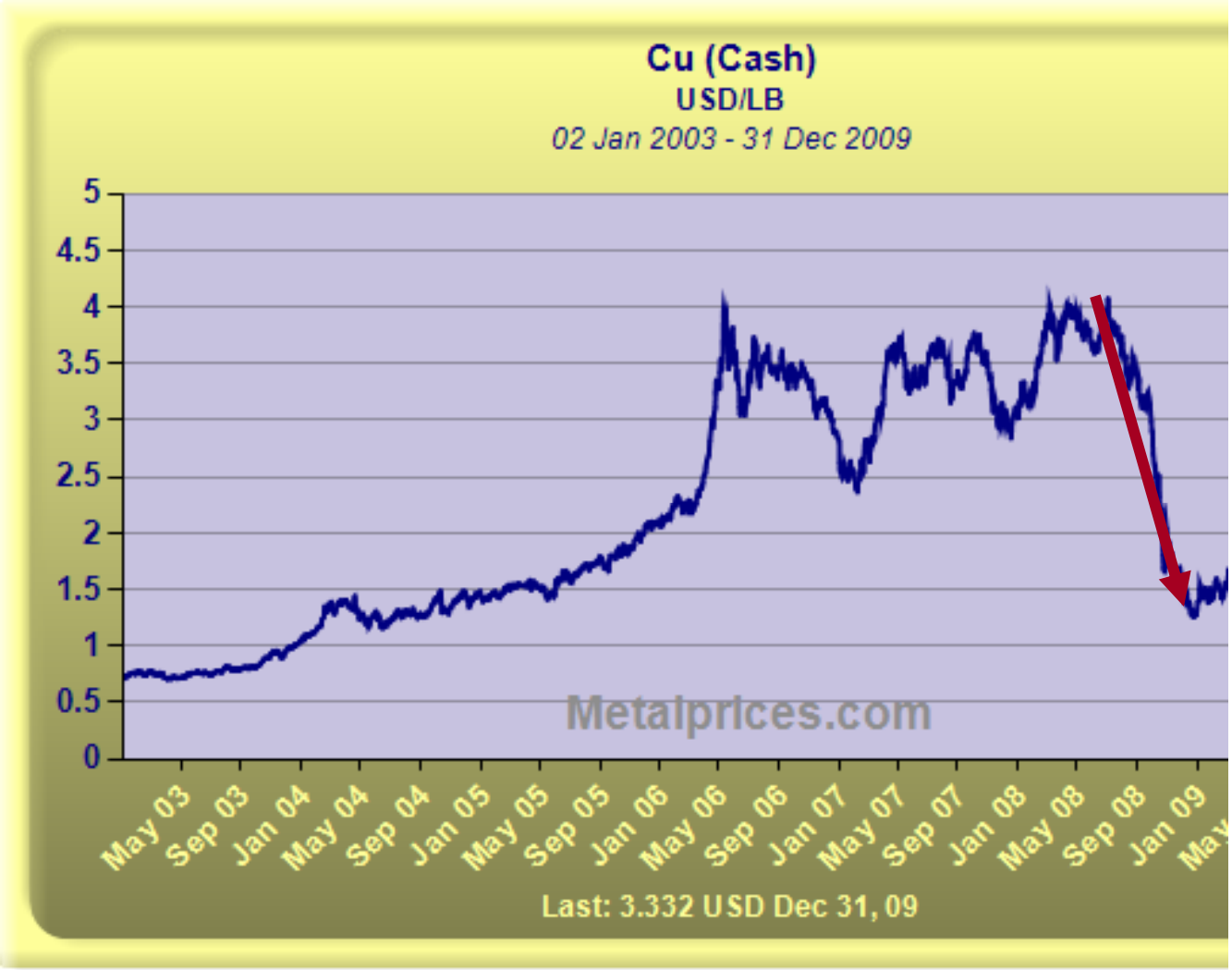


Metal prices fall further than during Great Depression

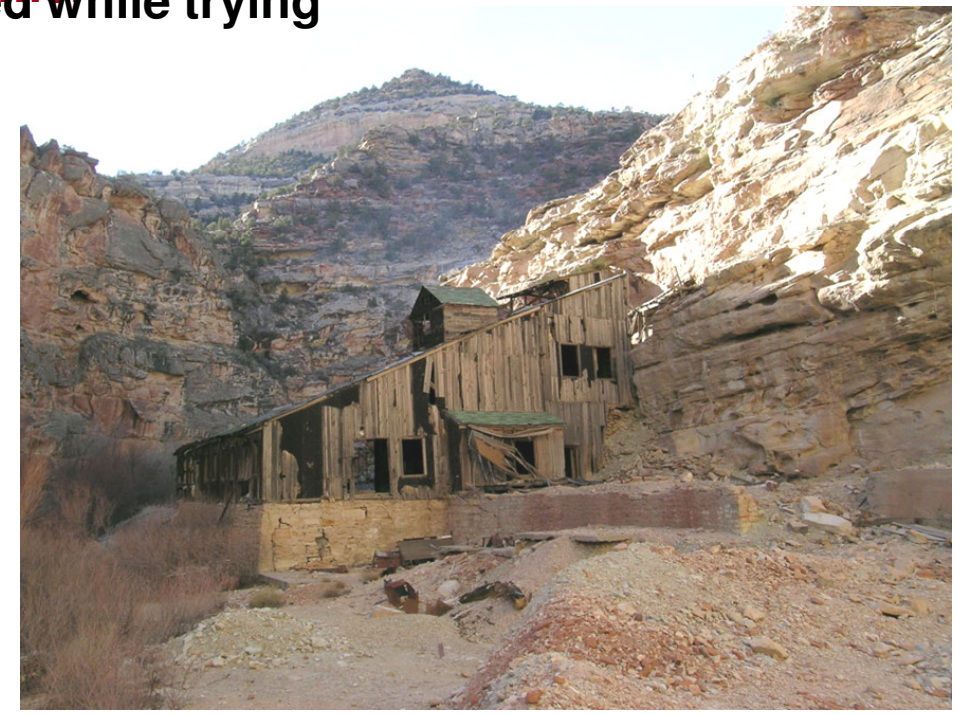
The price of key industrial metals has fallen further over the last four months than occurred during the worst years of Great Depression between 1929 and 1933, according to research by Barclays Capital.

By Ambrose Evans-Pritchard
Last Updated: 7:29AM GMT 03 Dec 2008

Global Impact

U. S. Impact

- Difficulty in manufacturing of copper products
- Increased copper thefts
- Increased costs to the consumer
  - Pueblo man electrocuted while trying to steal wiring 10/27/09
- Copper mine reopening



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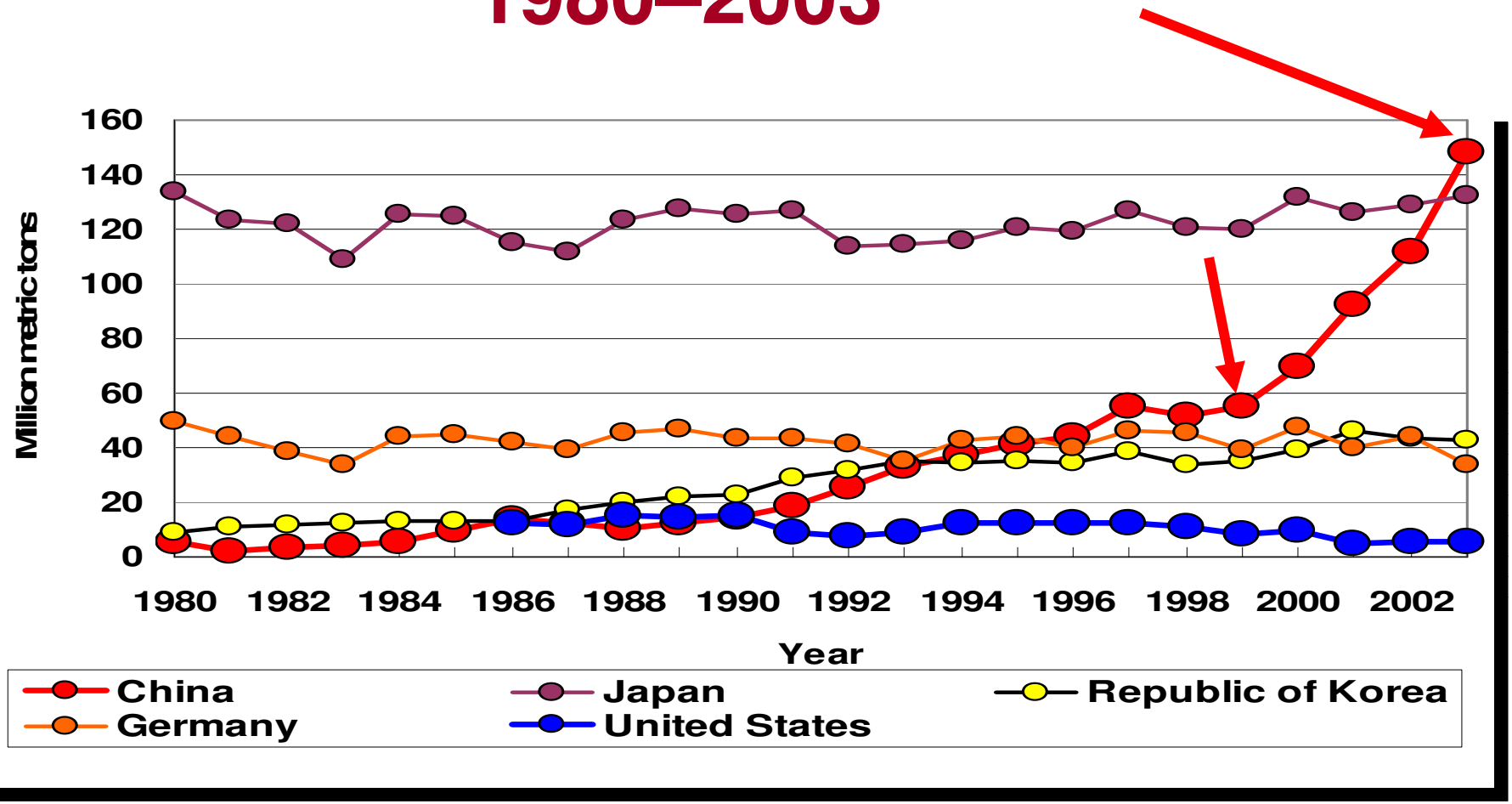
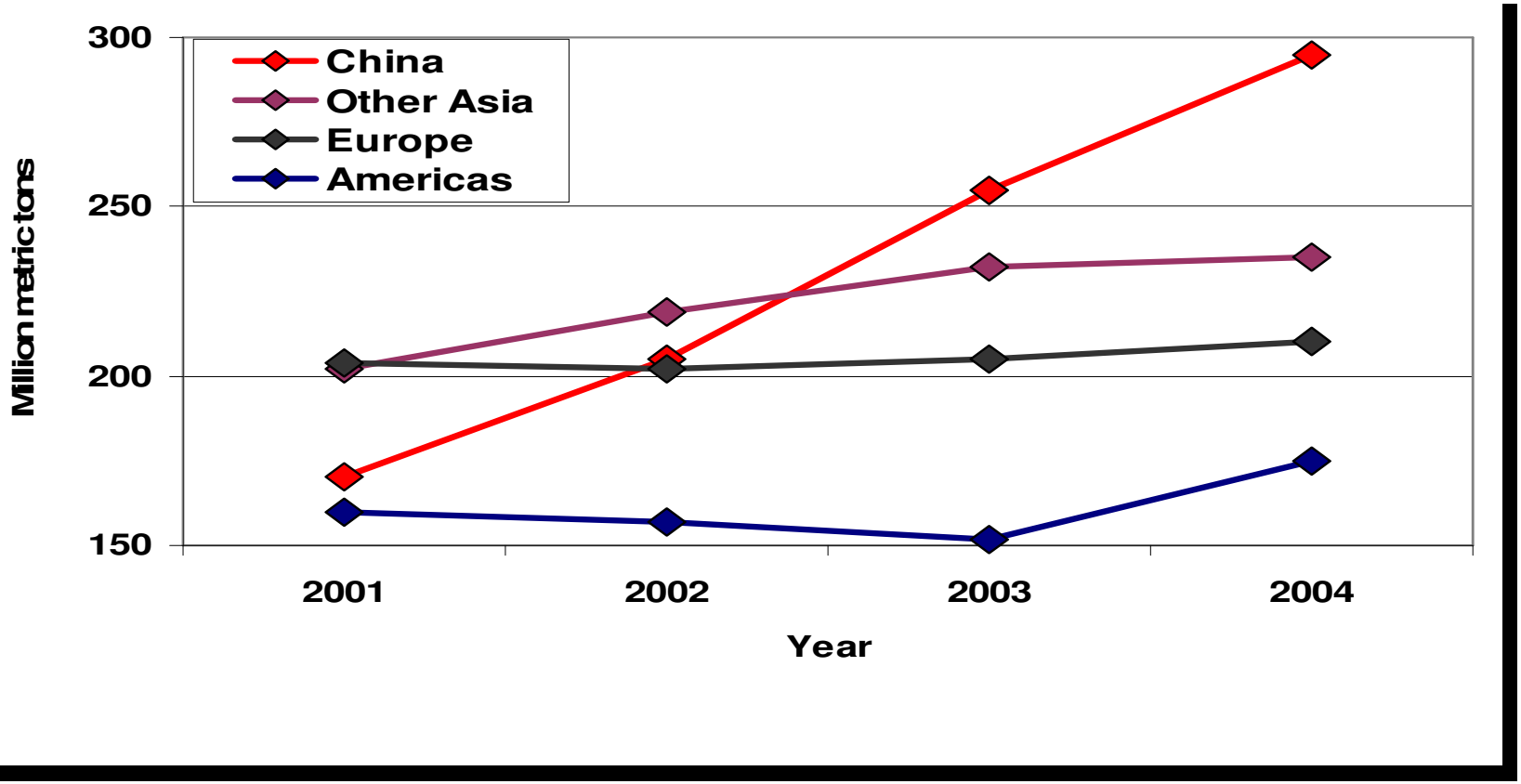
Source: USGS, Menzie and Tse

Leading Importers of Iron Ore—1980–2003

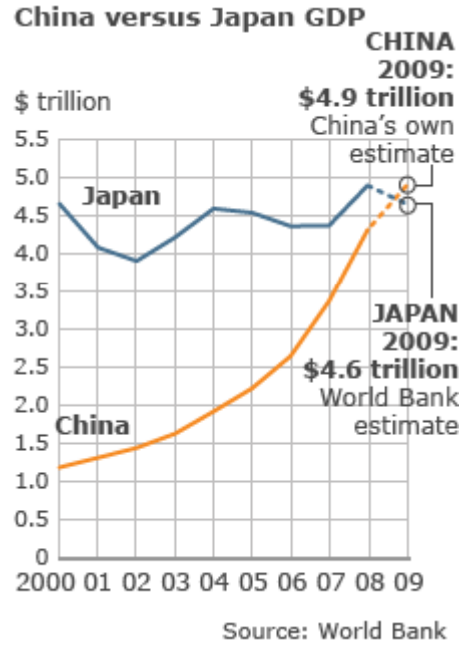


Trends in Demand for Steel

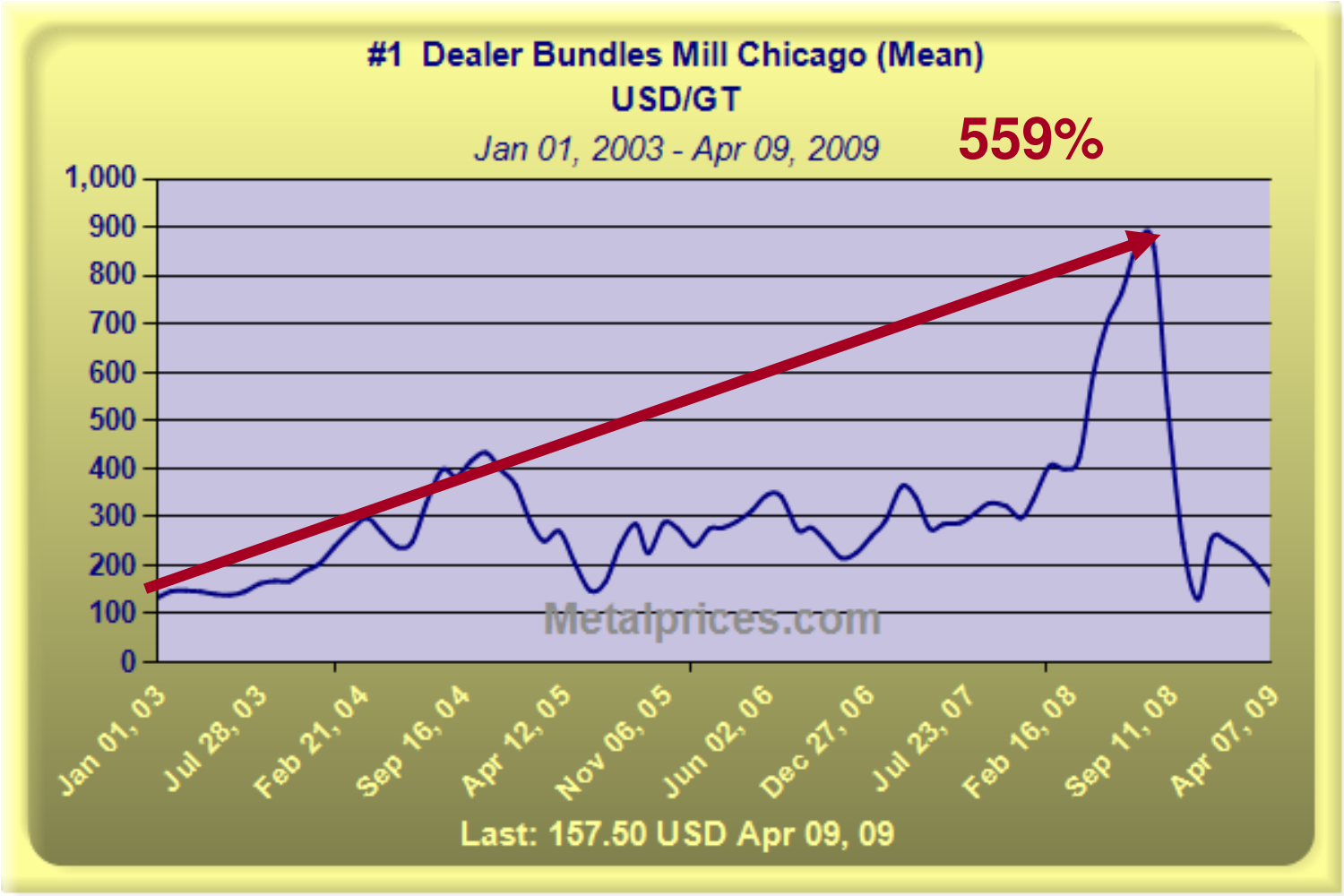


China

- 2005 – Opened 70,000 new supermarkets
- 2006 – Became #3 car manufacturer
- 2008 – Became #2 car market
- 2009 – Became #1 car market
- 2009 – Became #1 car manufacturer
- 2009 – Became #2 economy

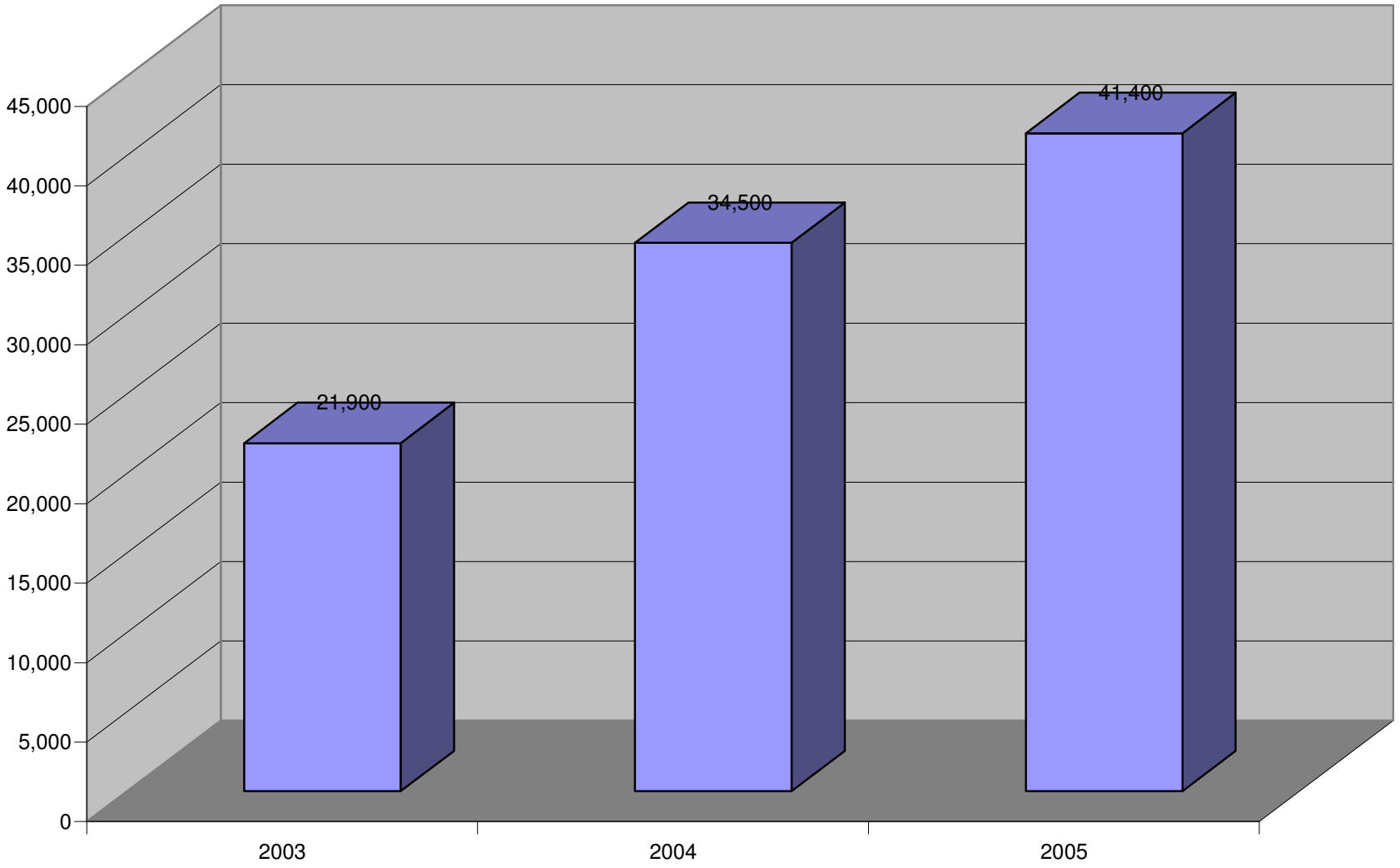


Price of Scrap Iron

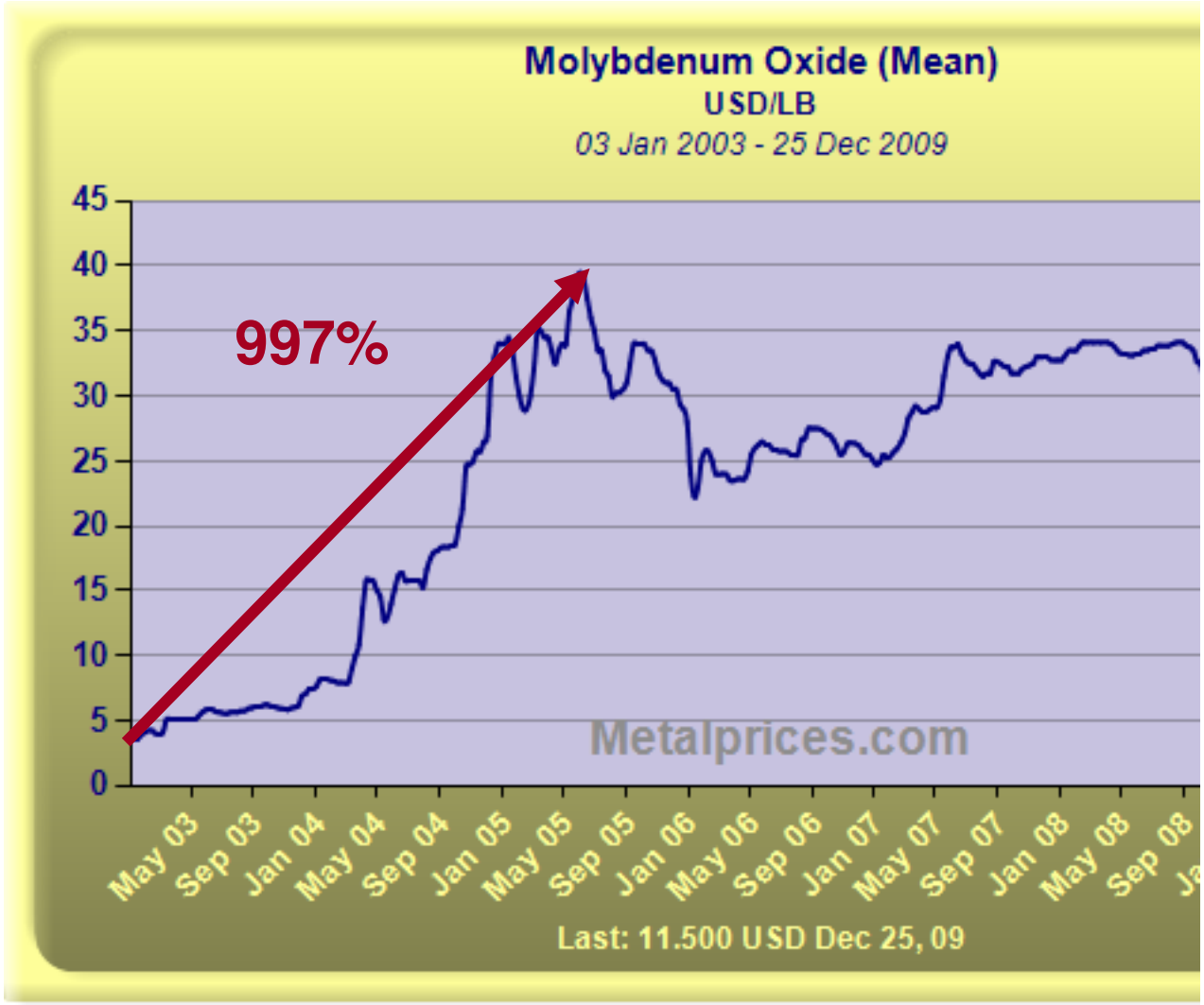


Leadville Herald Democrat

U.S. molybdenum exports

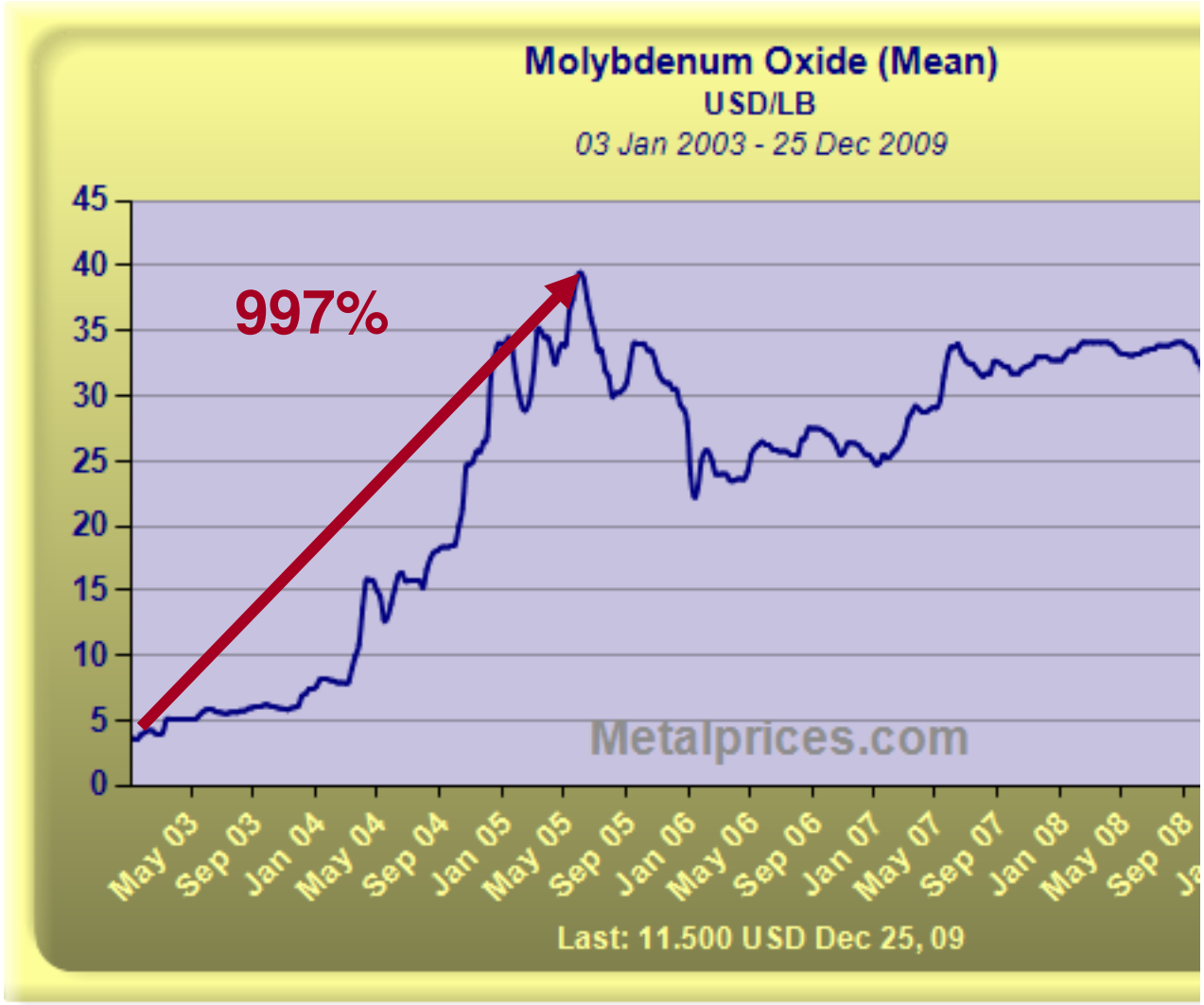


MOLYBDENUM Price

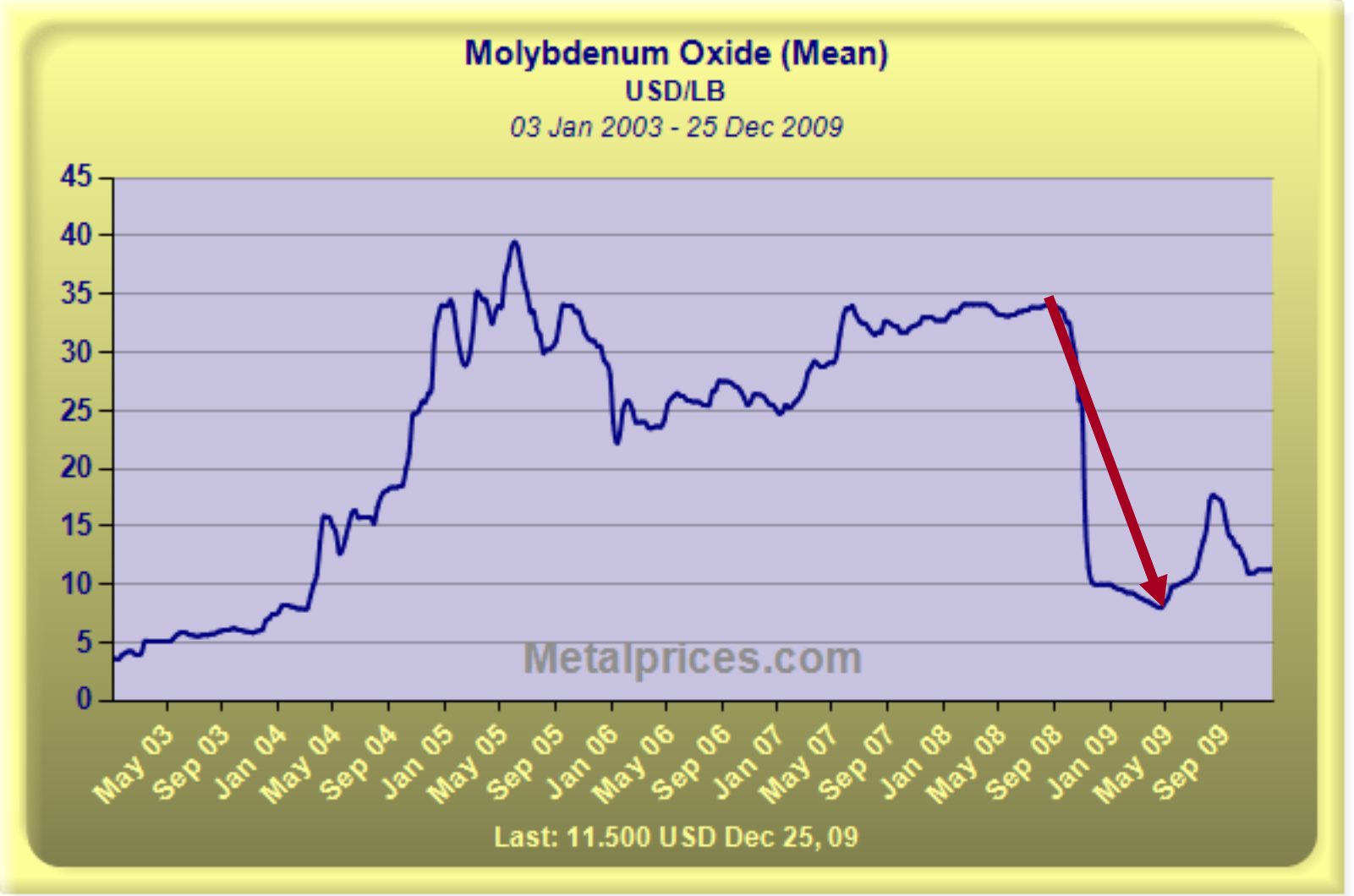


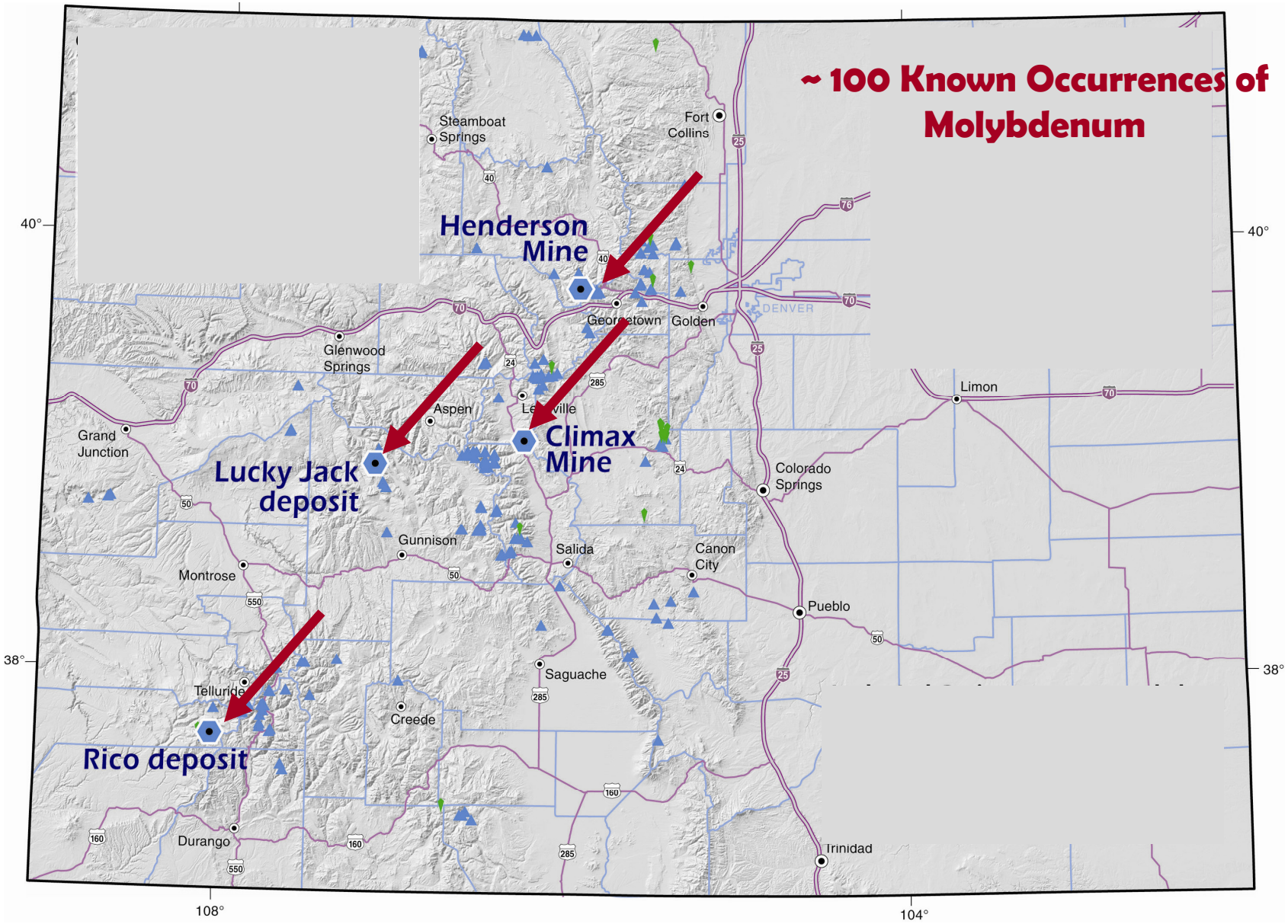
Ball mill gets real Leadville welcome

MOLYBDENUM Price



MOLYBDENUM Price




~ 100 Known Occurrences of Molybdenum
Henderson Mine
Climax Mine
Lucky Jack deposit
Rico deposit
Steamboat Springs
Fort Collins
Georgetown
Golden
DENVER
Glenwood Springs
Aspen
Leadville
Grand Junction
Limon
Colorado Springs
Gunnison
Salida
Canon City
Montrose
Pueblo
Saguache
Telluride
Creede
Durango
Trinidad
40°
38°
108°
104°

TMS2010

Precious & Base Metal Increases 01/03 - 01/10

Gold
274%

Silver
367%

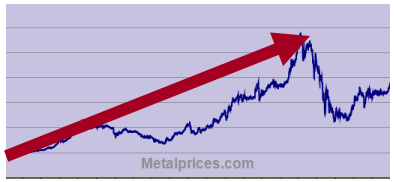
Average Price Increase

379%

Nickel
630%

Aluminum
144%

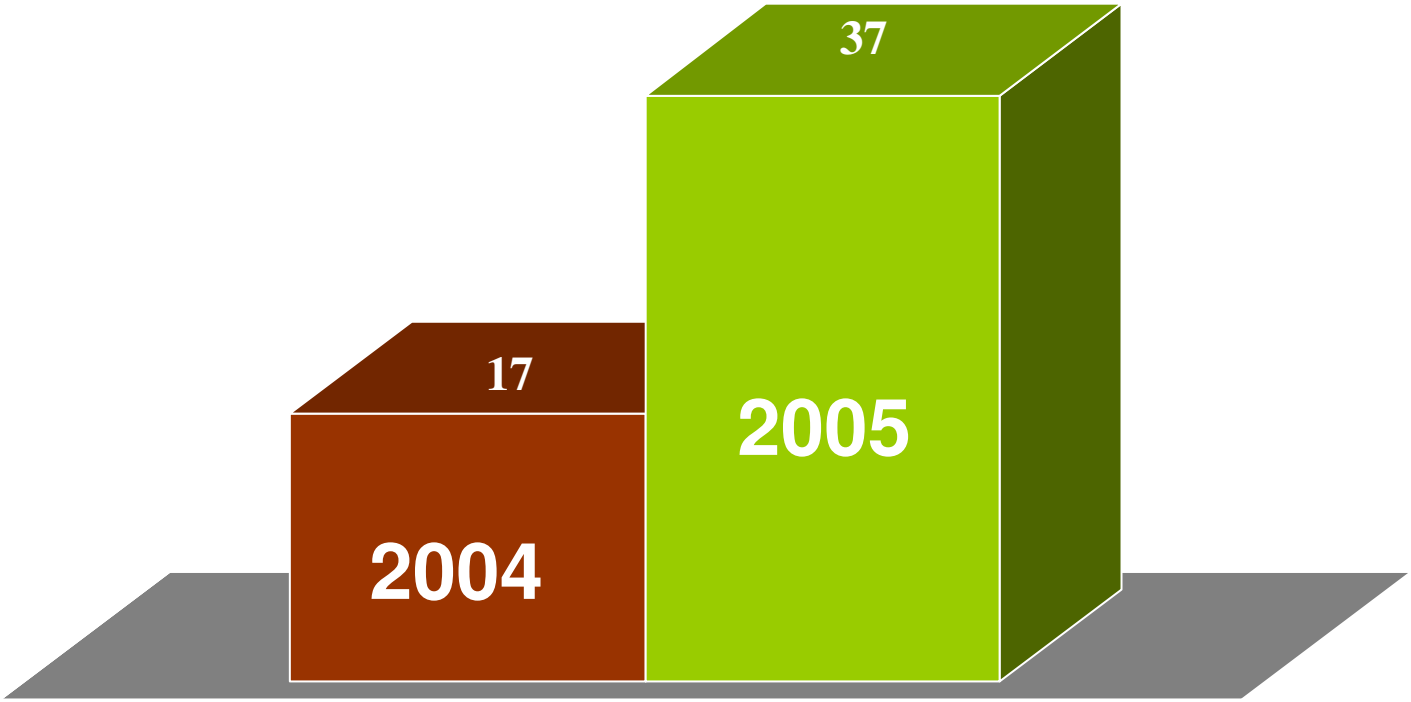
Tin
229%



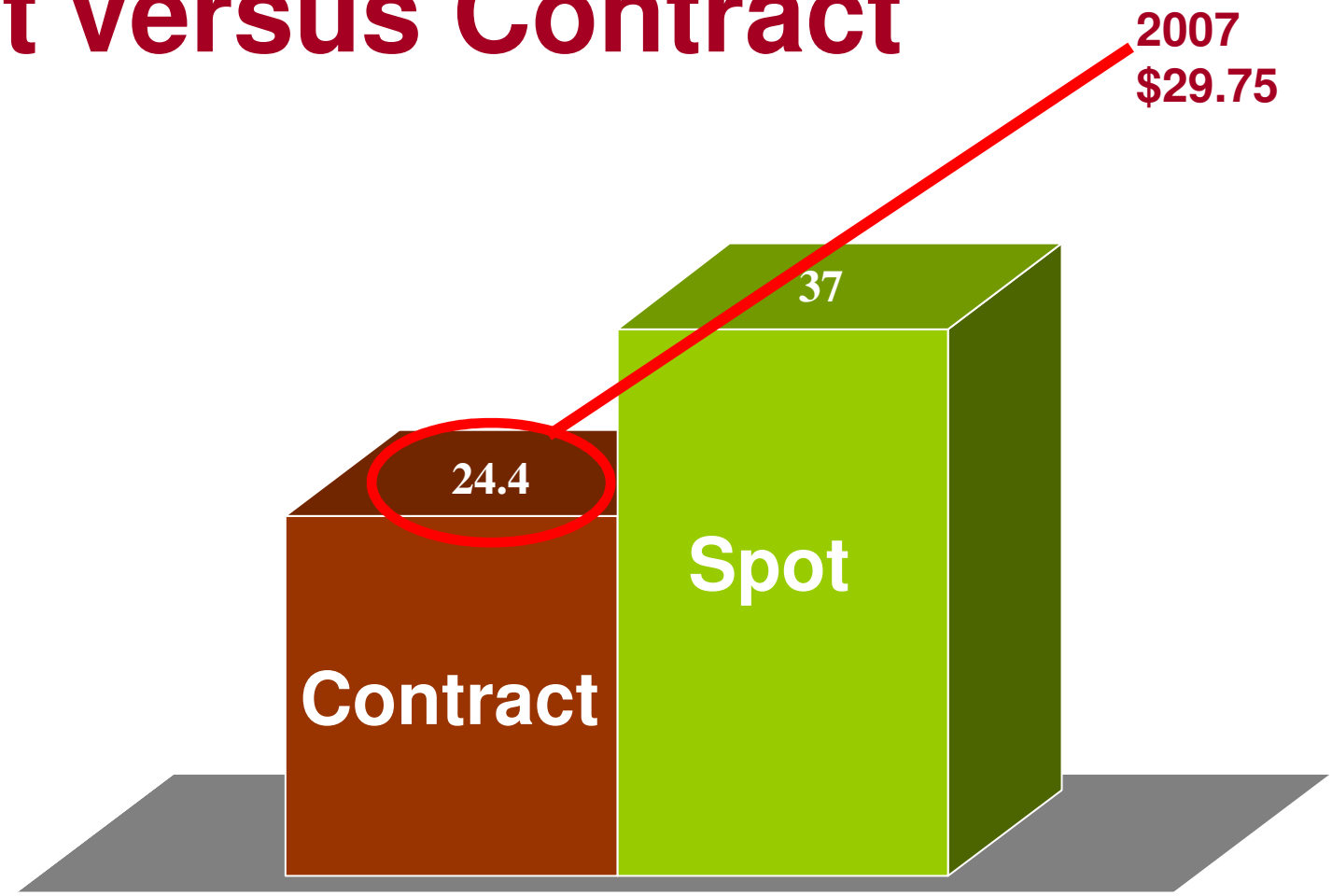
Zinc
497%


Antimony
159%
Bismuth
671%
Cadmium
908%
Chromium
719%
Cobalt
581%
Average Price Increase
746%
Germanium
193%
Rhenium
685%
Selenium
1620%
Titanium
600%
Tungsten
531%
Vanadium
2060%
Metalprices.com

Increase in Coal Spot Price



2005 Coal Price
Spot versus Contract



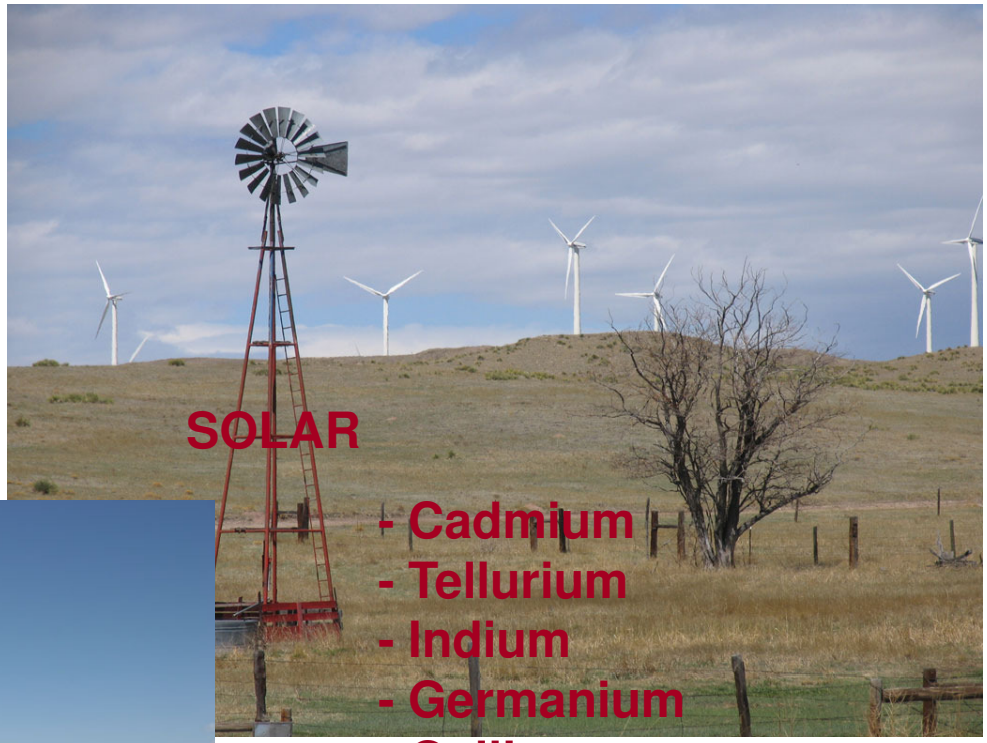
"Chinese companies and their rivals are scouring the globe from Australia to Africa for access to the raw materials needed to sustain the Asian nation's growth as commodity prices surge."

--June 23, 2006 (*Bloomberg*)

Renewable Energy

WIND

- Neodymium
- Molybdenum
- Iron Ore



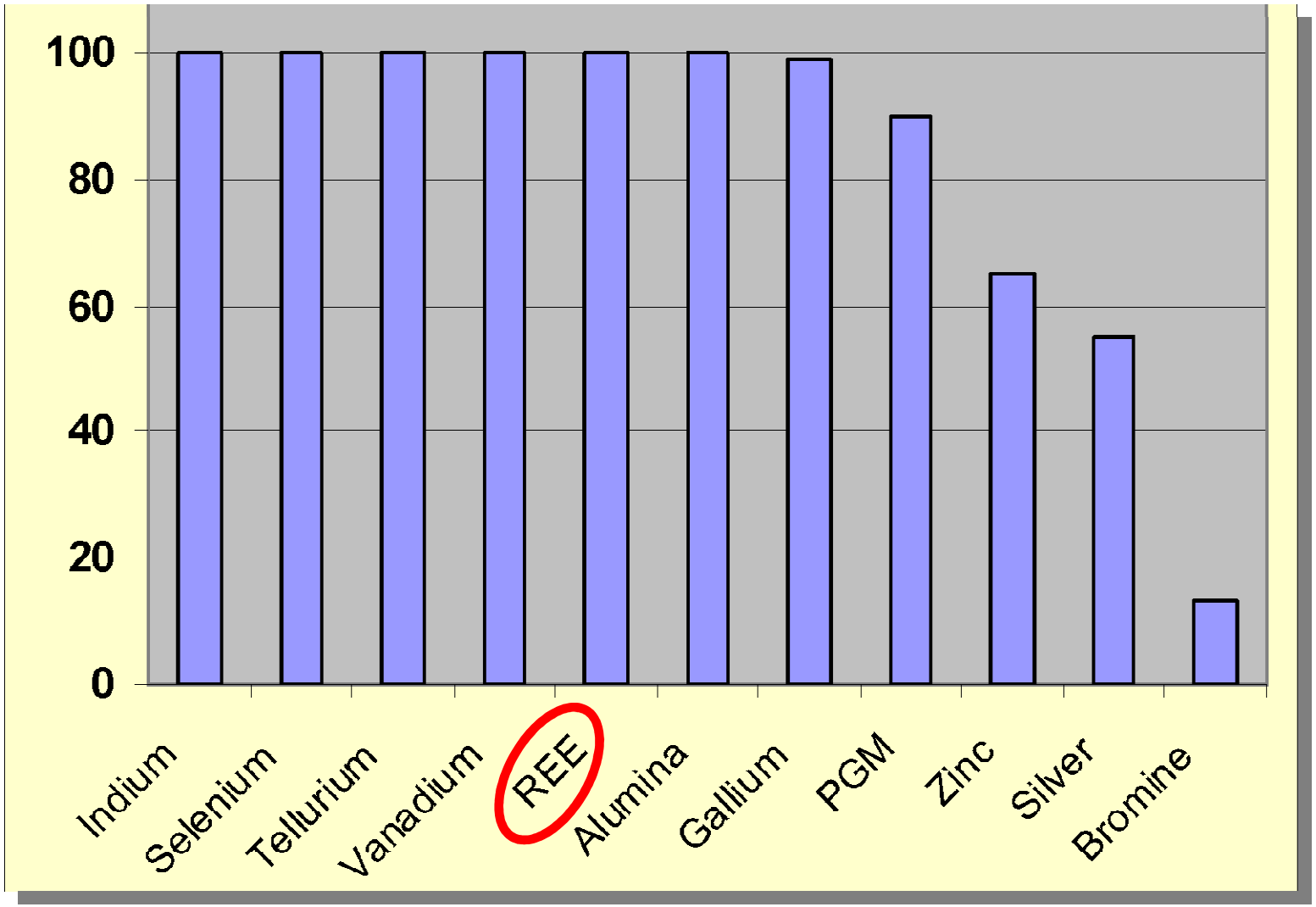
SOLAR

- Cadmium
- Tellurium
- Indium
- Germanium
- Gallium
- Selenium
- Silicon
- Copper

Strategic and Critical Materials with uses in Alternative Energy applications for which the U.S. is dependent on imports for 50% or more of consumption

Commodity	Primary Sources	*Applications in Alternative Energy*
Antimony	China	Thermoelectric/paraelectric materials
Barium	China	Thermoelectric/paraelectric materials
Bismuth	China, Mexico	Thermoelectric/paraelectric materials
Cobalt	Kinshasa,Australia	Photovoltaics (solar cells)
Gallium	China	Photovoltaics, paraelectric materials
Germanium	Belgium,Canada	Photovoltaics (solar cells)
Indium	China, Canada	Solar cells, thermo/paraelectric materials
Manganese	Gabon, S. Africa	Photovoltaics
Nickel	Canada	Fuel cells
Platinum group	South Africa	Fuel cells, para/thermoelectric mtrls
Rare Earths	China	Fuel cells, para/thermoelectric mtrls
Scandium	China, Russia	Thermoelectric/paraelectric materials
Selenium	Canada	Solar cells, thermoelectric materials
Strontium	Mexico	Thermoelectric/paraelectric materials
Tantalum	Brazil	Thermoelectric/paraelectric materials
Tellurium	Belgium, Germany	Solar cells, thermoelectric metrls, semiconductors
Tin	Peru	Thermoelectric materials
Titanium	Australia, S. Africa	Solar cells
Vanadium	Czech Rep., S. Africa	Fuel cells
Zinc	Canada, Mexico	Photovoltaics, fuel cells, thermoelectric mtrls

Percent imported



REE = Rare Earth Elements = 15 + 2

neodymium,
lanthanum,
terbium,
dysprosium

Toyota Prius

Molycorp Minerals
THE RARE EARTHS COMPANY

UV CUT GLASS
- Cerium

GLASS AND MIRRORS POLISHING POWDER
- Cerium

DIESEL FUEL ADDITIVE
- Cerium
- Lanthanum

LCD SCREEN
- Europium
- Yttrium
- Cerium

COMPONENT SENSORS
- Yttrium

HYBRID NiMH BATTERY
- Lanthanum
- Cerium

HYBRID ELECTRIC MOTOR AND GENERATOR
- Neodymium
- Praseodymium
- Dysprosium
- Terbium

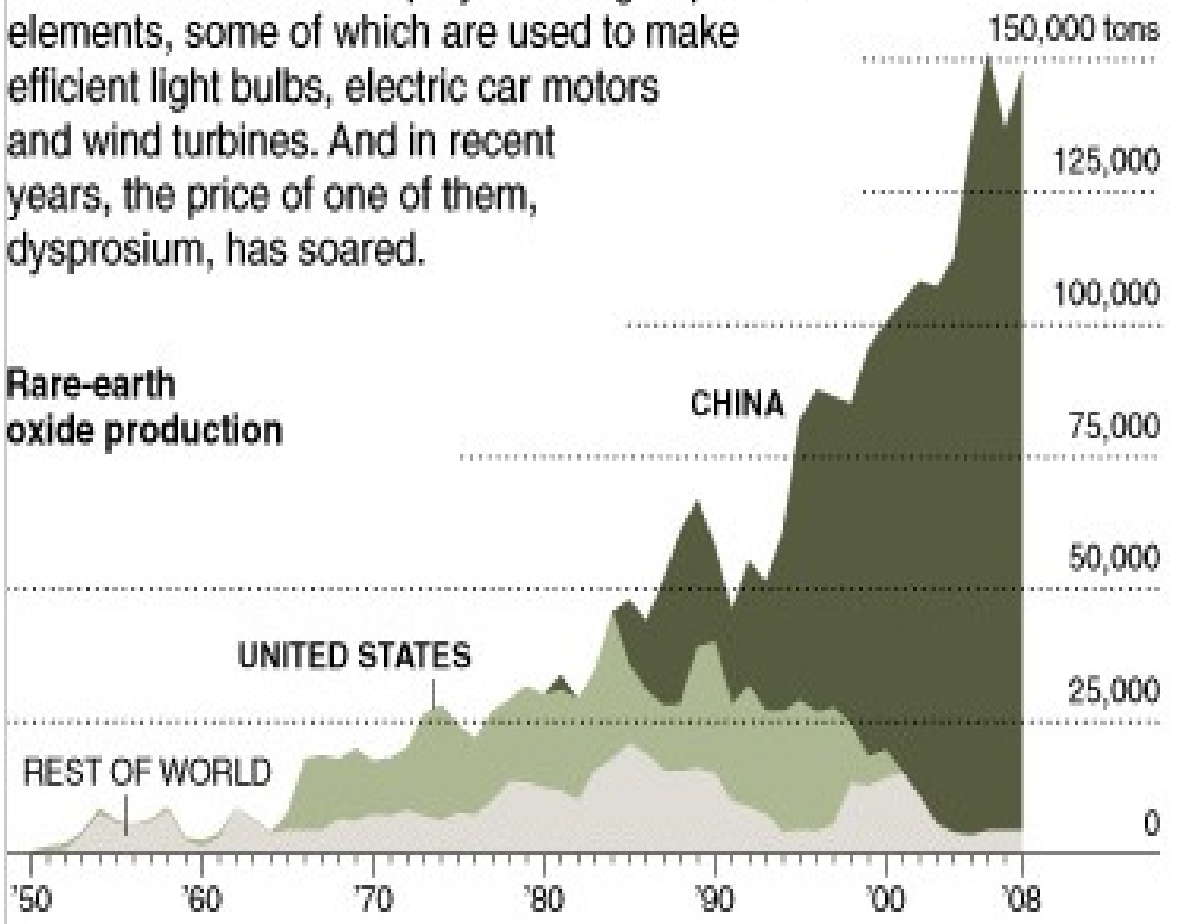
CATALYTIC CONVERTER
- Cerium / Zirconium
- Lanthanum

25+ ELECTRIC MOTORS THROUGHOUT VEHICLE
- Nd Magnets

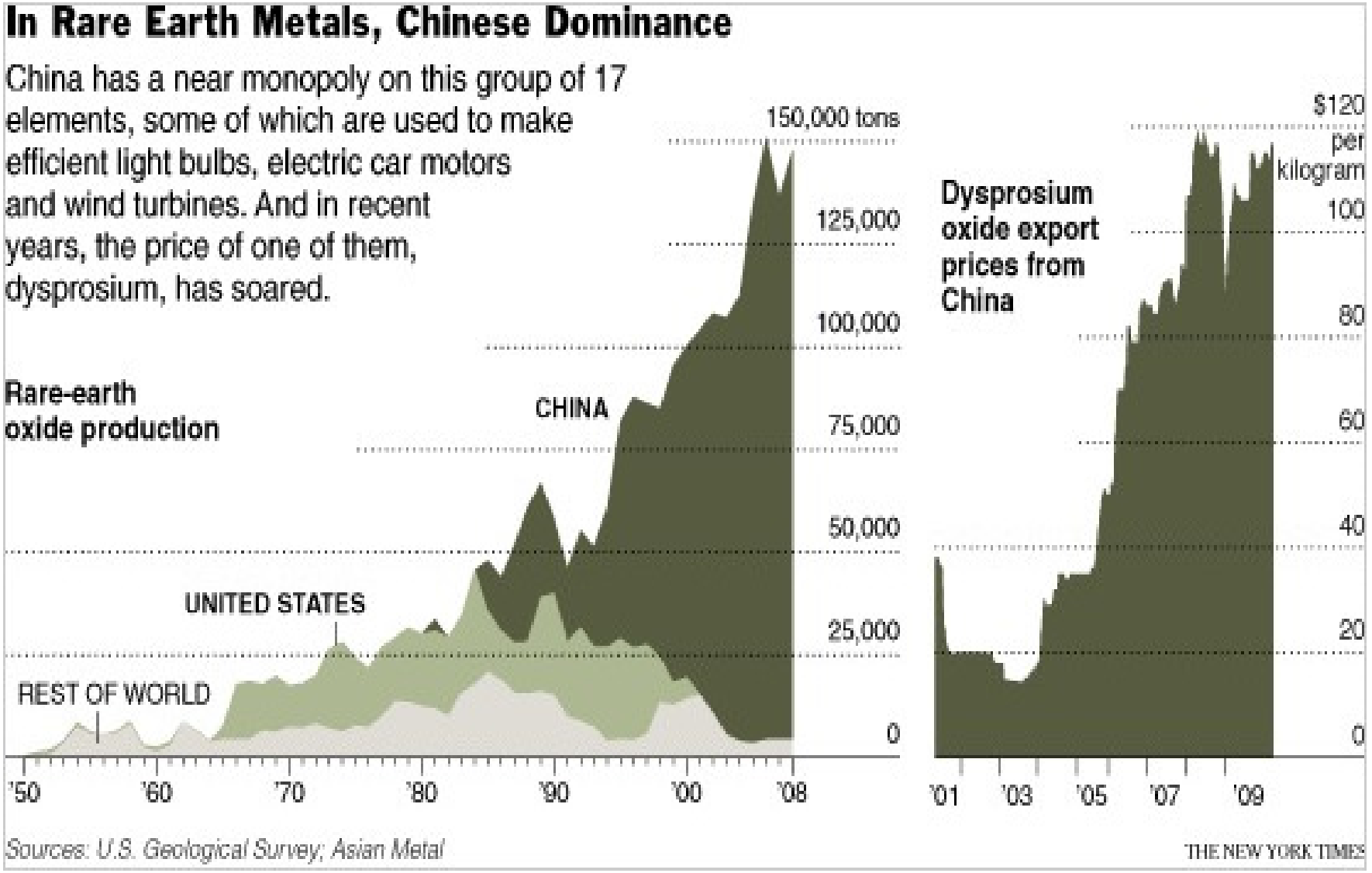
HEADLIGHT GLASS
- Neodymium

In Rare Earth Metals, Chinese Dominance

China has a near monopoly on this group of 17 elements, some of which are used to make efficient light bulbs, electric car motors and wind turbines. And in recent years, the price of one of them, dysprosium, has soared.



Sources: U.S. Geological Survey; Asian Metal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Rare-earth oxide production
150,000 tons
125,000
100,000
75,000
50,000
25,000
0
CHINA
UNITED STATES
REST OF WORLD
'50
'60
'70
'80
'90
'00
'08
Dysprosium oxide export prices from China
$120 per kilogram
100
80
60
40
20
0
'01
'03
'05
'07
'09
Sources: U.S. Geological Survey; Asian Metal
THE NEW YORK TIMES

TMS2010

HONG KONG — China is set to tighten its hammerlock on the market for some of the world's most obscure but valuable minerals.

--August 31, 2009 (The New York Times)

World faces hi-tech crunch as China eyes ban on rare metal exports

–August 24, 2009 (*London Telegraph*)

As hybrid cars gobble rare metals, shortage looms

–August 31, 2009 (*Reuters*)

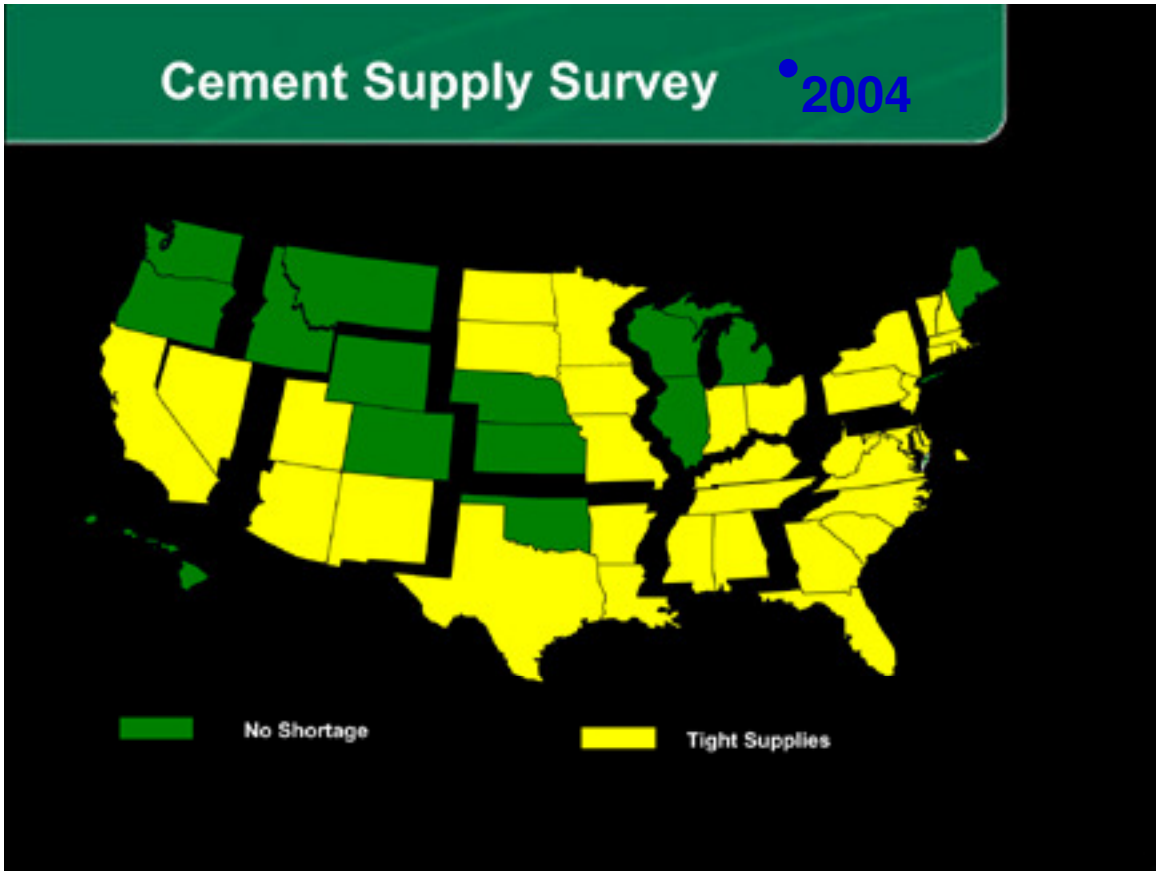
China Considers Rare-Earth Reserve in Inner Mongolia

–September 2, 2009 (*Bloomberg News*)

Cement producers

1. China
2. India
3. U.S.

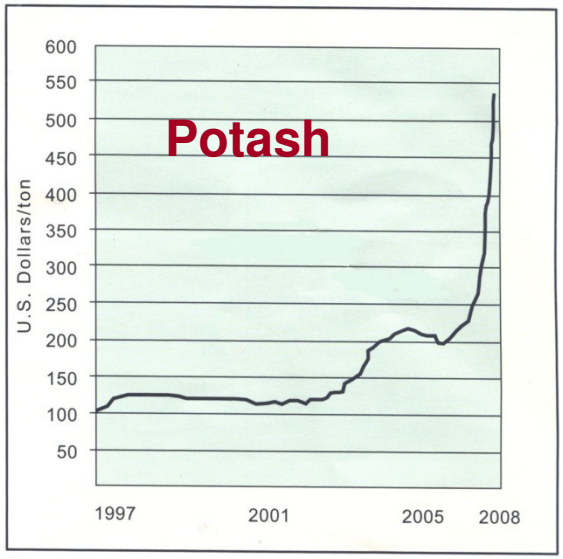
22% Imported

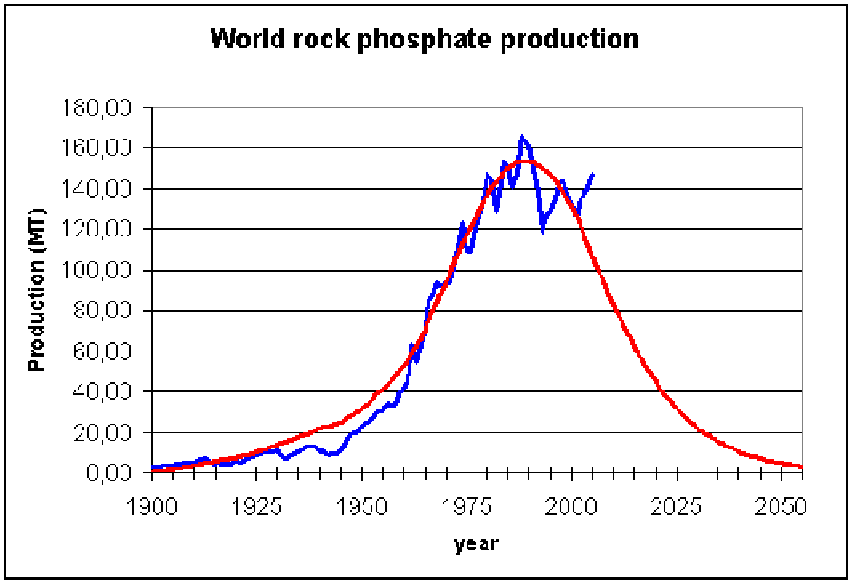


China Consumes ½ of all the concrete in the world

U.S. cement manufacturing is 81% foreign owned

Fertilizers

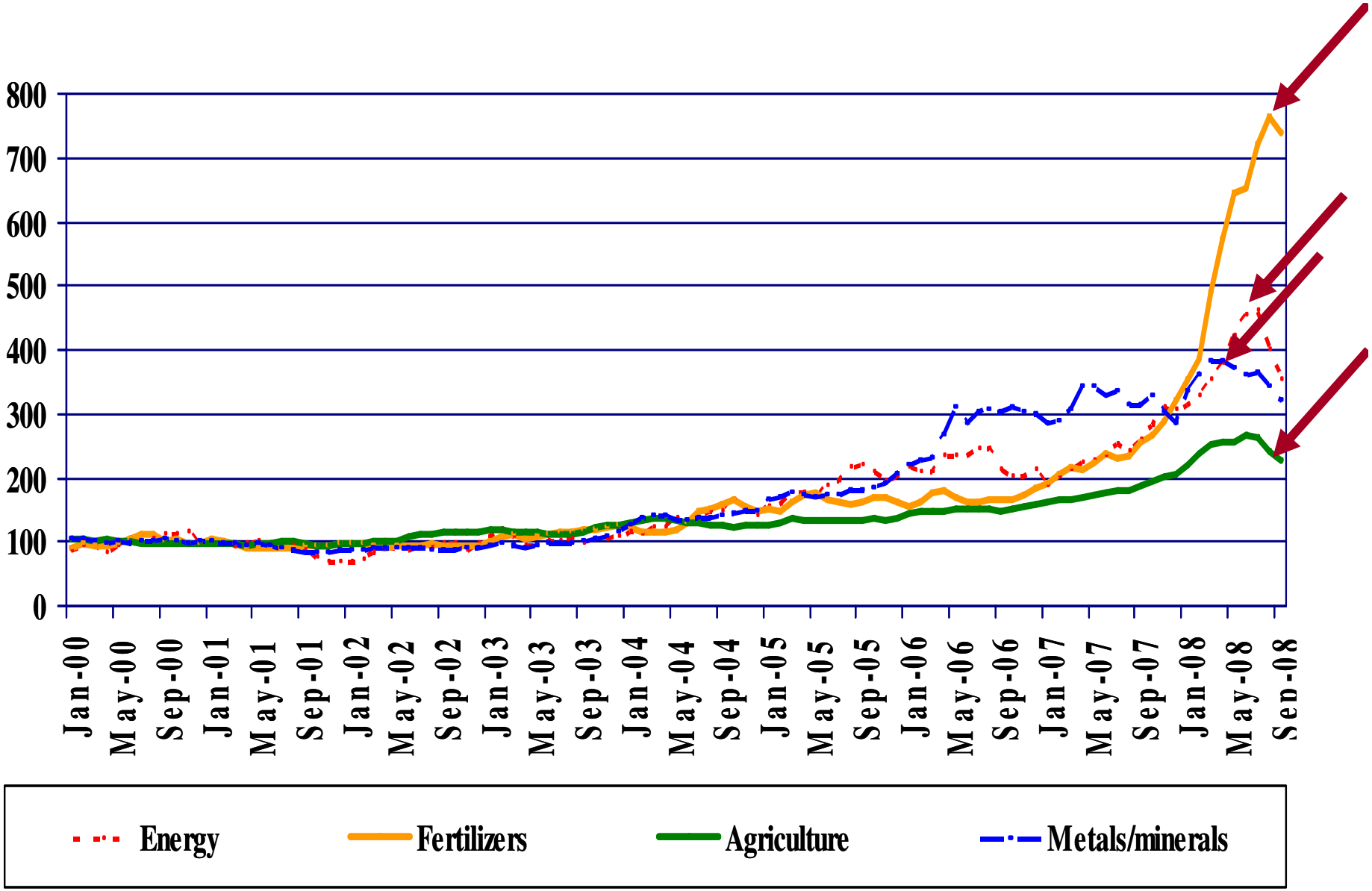




$50/ ton > $200/ ton in 2008

Nitrogen urea $1000/ ton.

$50/ ton > $500/ ton in one year


800
700
600
500
400
300
200
100
0
Jan-00
May-00
Sep-00
Jan-01
May-01
Sep-01
Jan-02
May-02
Sep-02
Jan-03
May-03
Sep-03
Jan-04
May-04
Sep-04
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May-05
Sep-05
Jan-06
May-06
Sep-06
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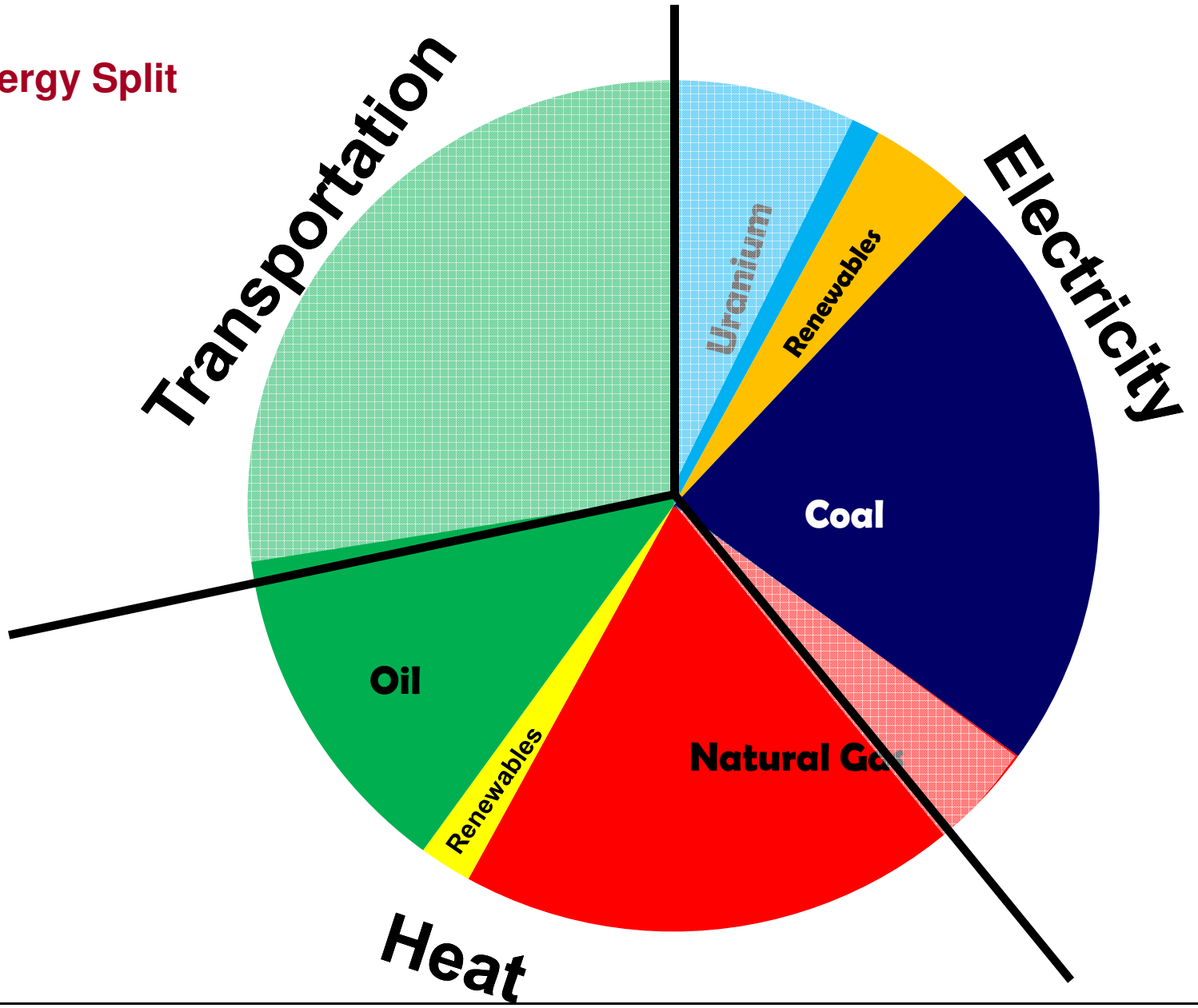
Energy
Fertilizers
Agriculture
Metals/minerals

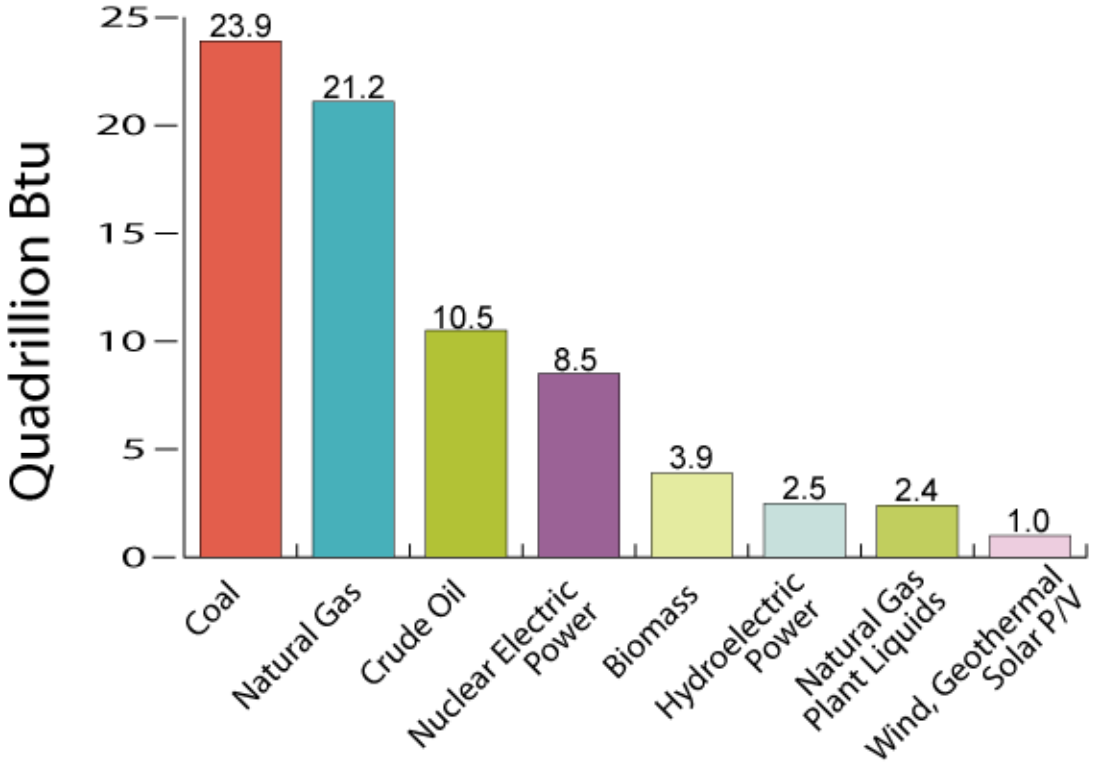
U.S. Energy Split



U.S. Energy Split

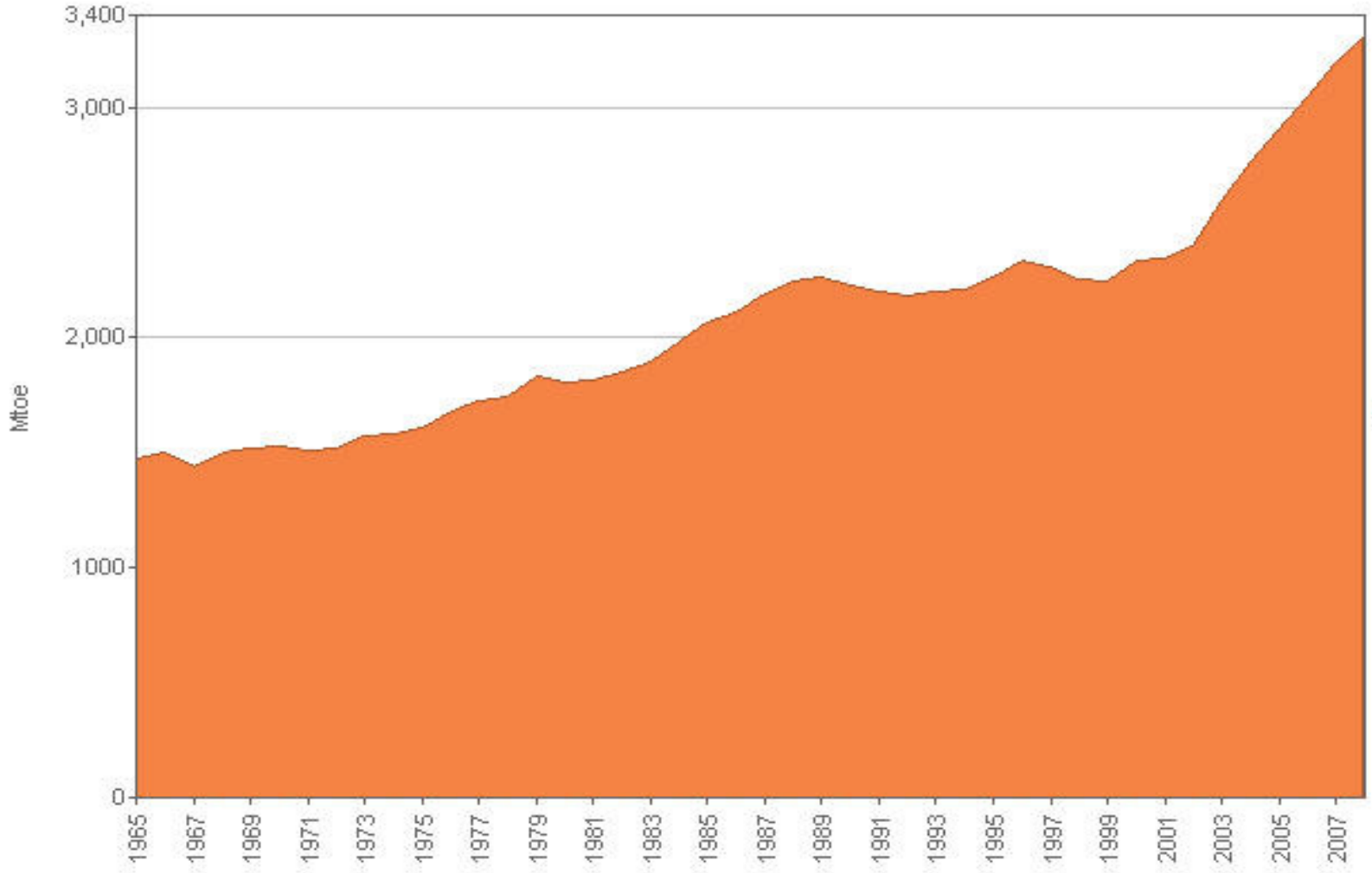
	Commodity	Percent of U.S. energy supply	Percentage Price Increase 2003-07	Percent Imported (2007 Net)
93%	Coal	24	381	0
	Oil	37	306	67
	Uranium	9	481	89
	Natural Gas	24	206	16
7%	Hydroelectric	2.5	-	-
	Biomass	3.6	-	-
	Solar	.1	-	-
	Wind	.5	-	-
	Geothermal	.3	-	-

U.S. Primary Energy Production by Major Source (2008)

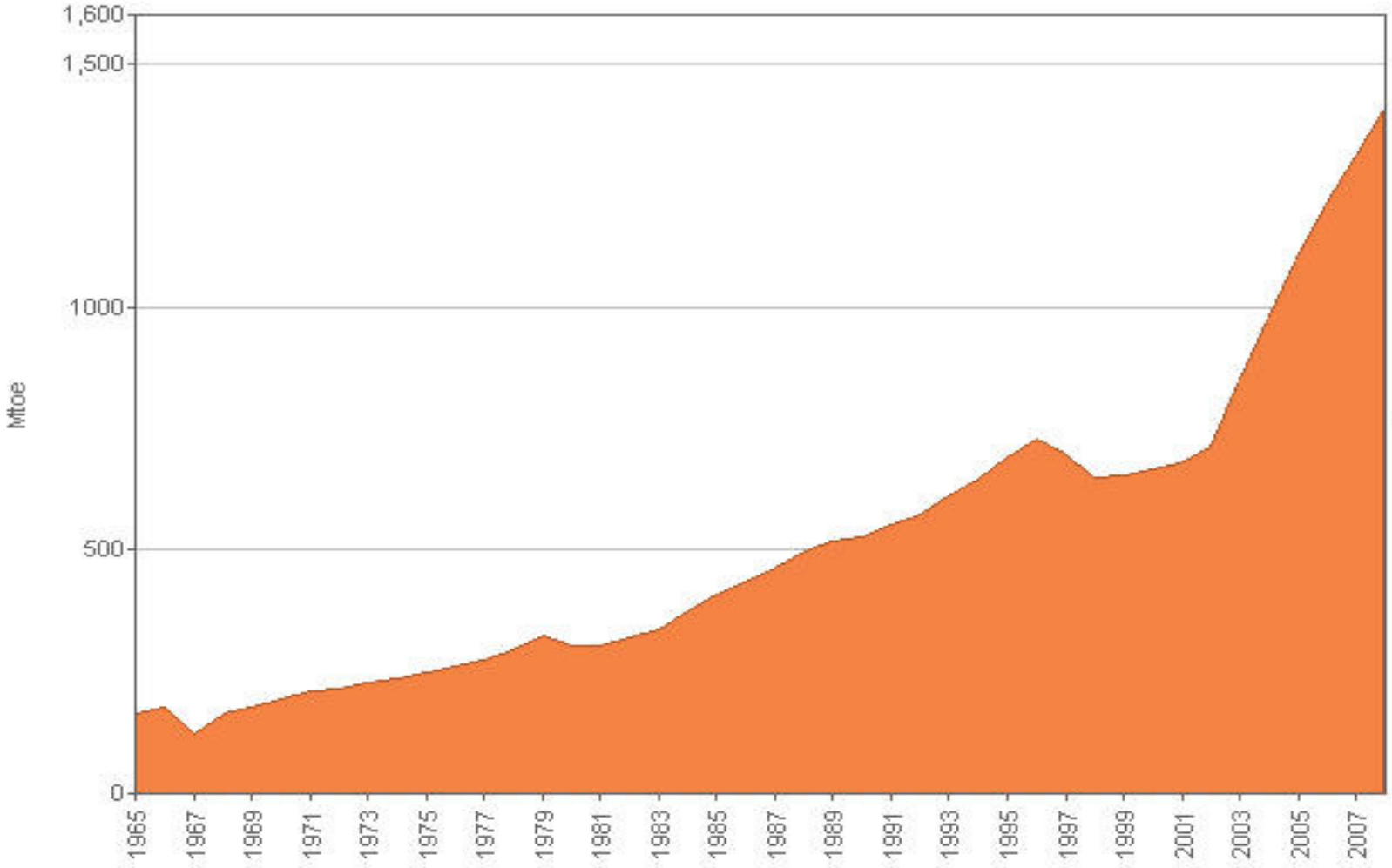


Source: Energy Information Administration, *Annual Energy Review 2008*, Table 1.2. (June 2009)

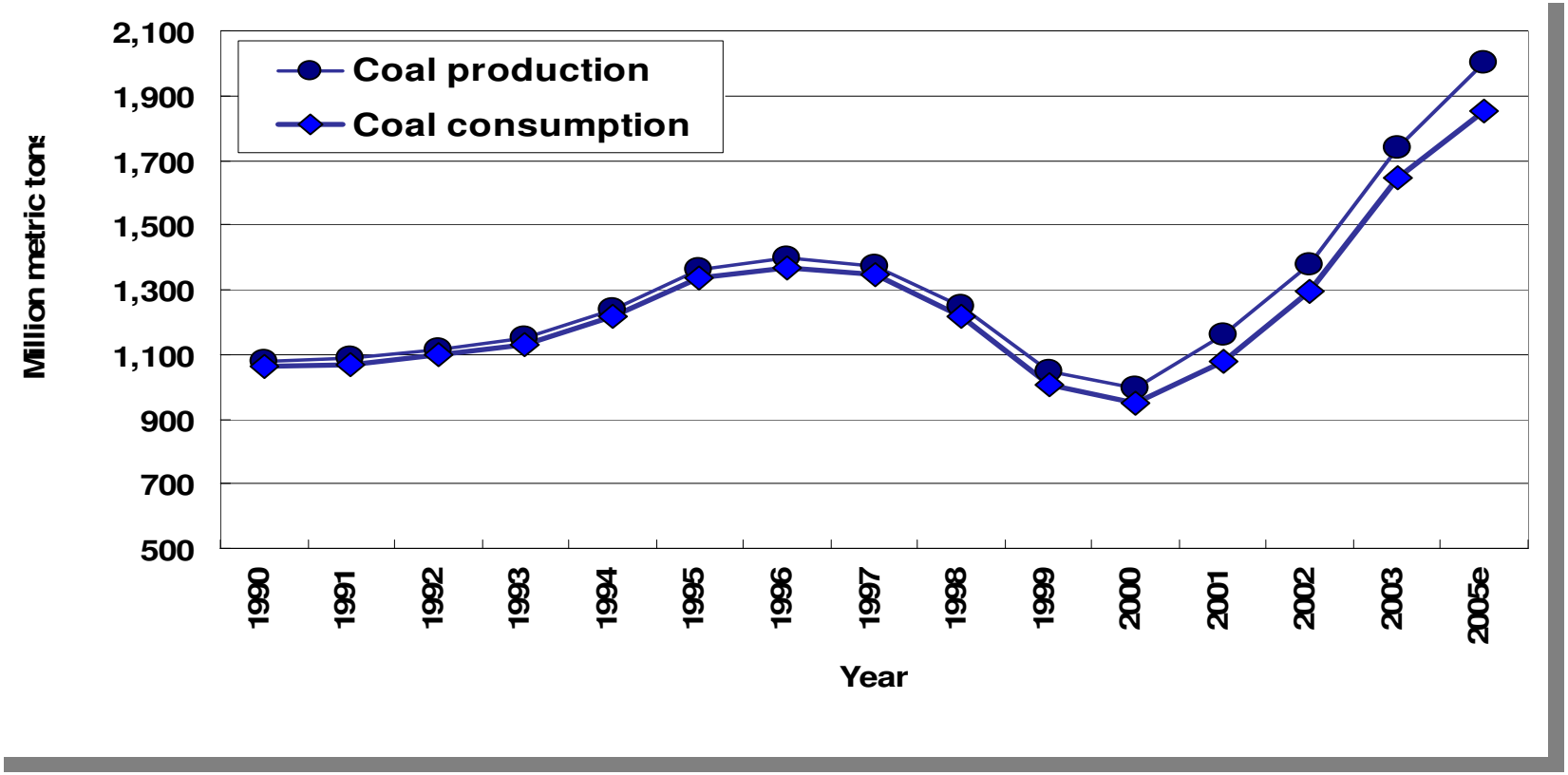
World Coal Consumption



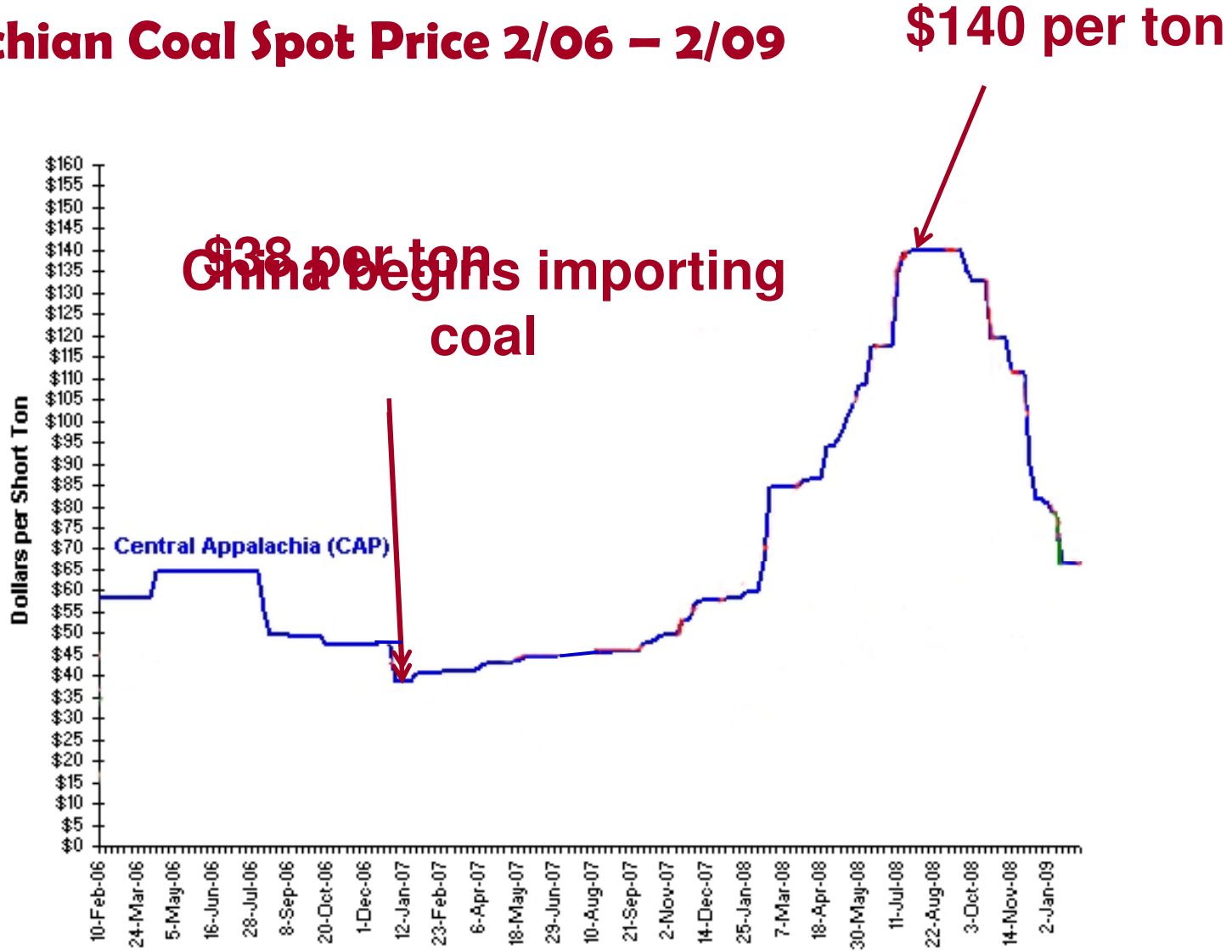
COAL Consumption- China



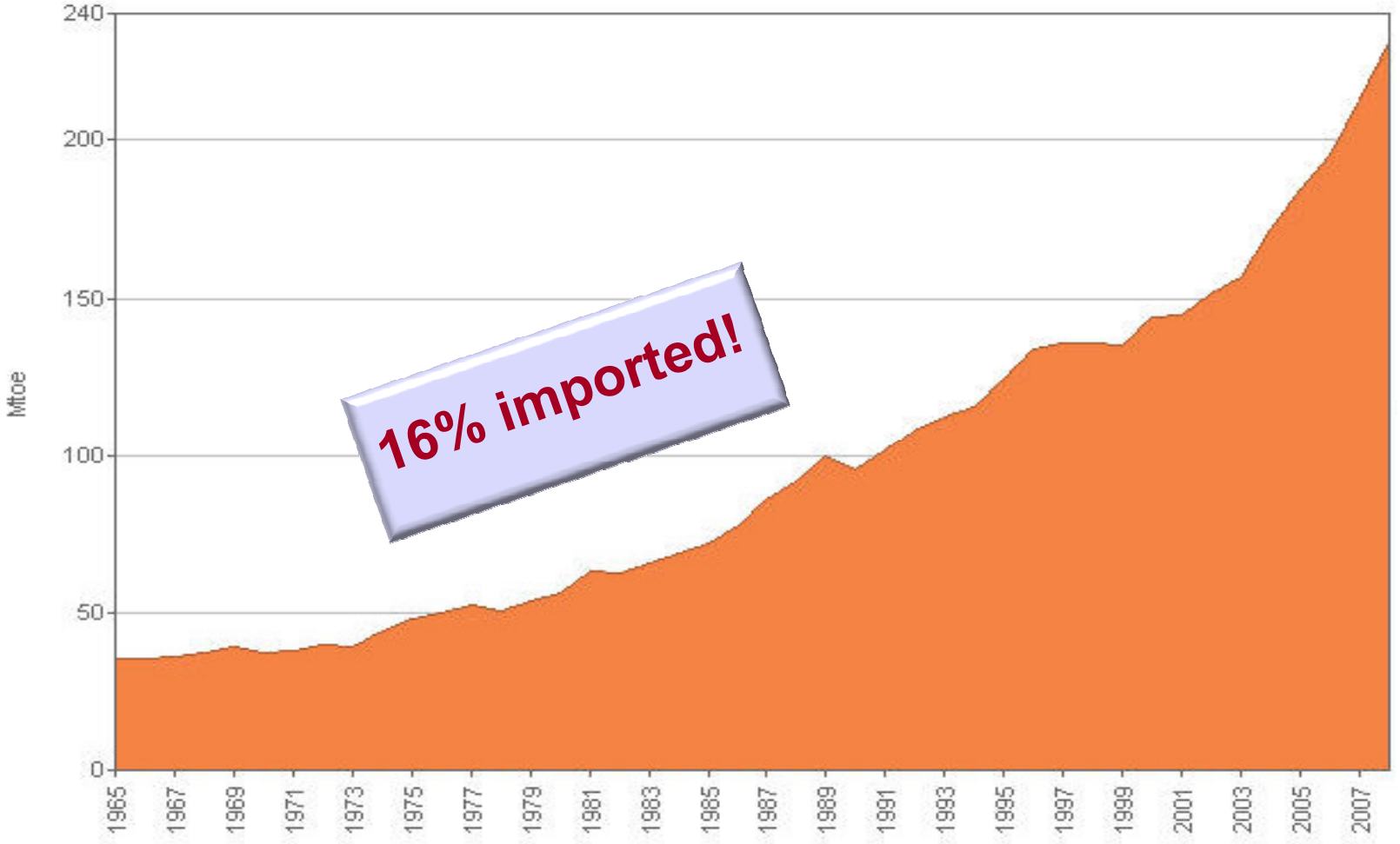
China's Production and Consumption of Coal



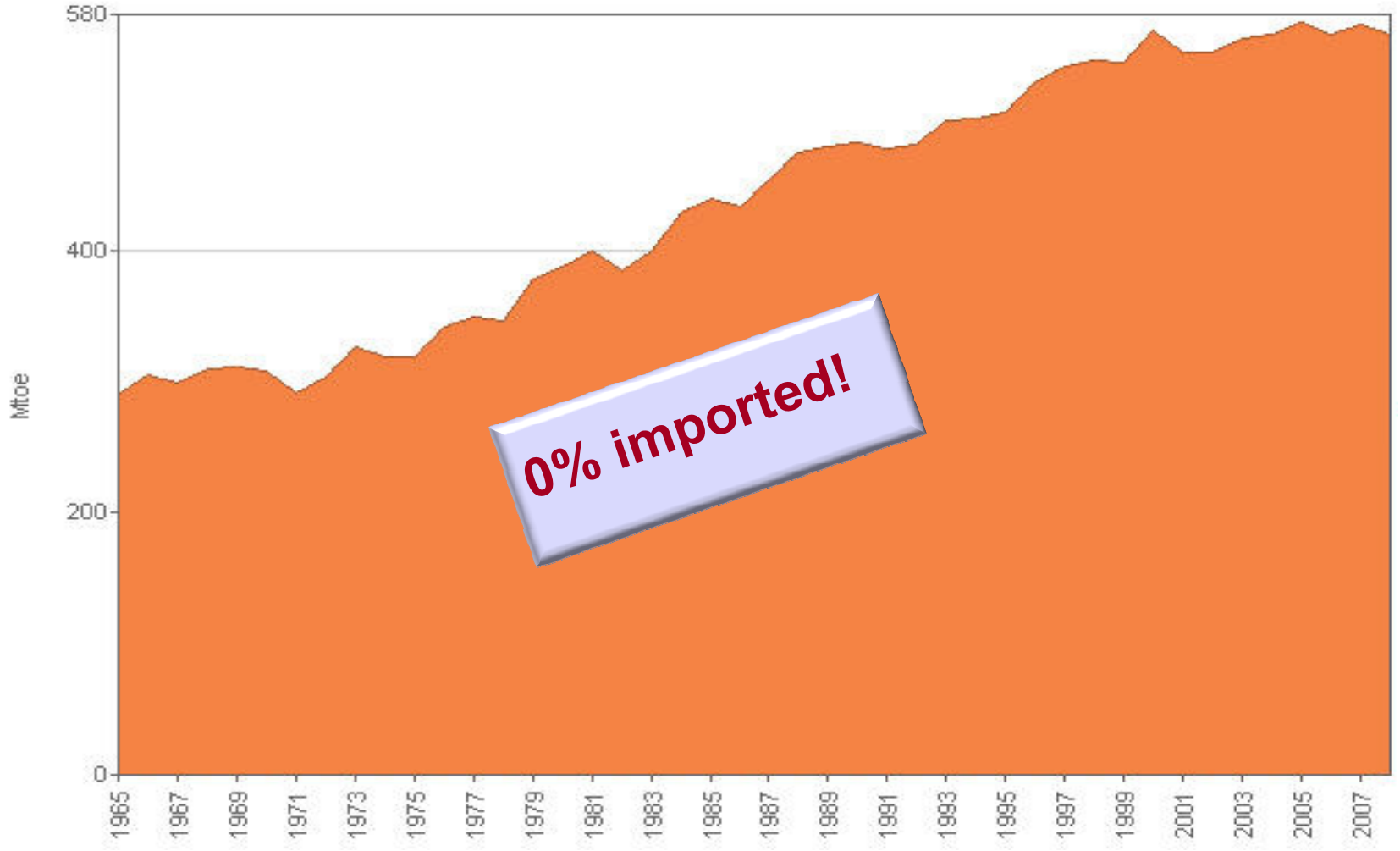
Appalachian Coal Spot Price 2/06 – 2/09



COAL Consumption- India



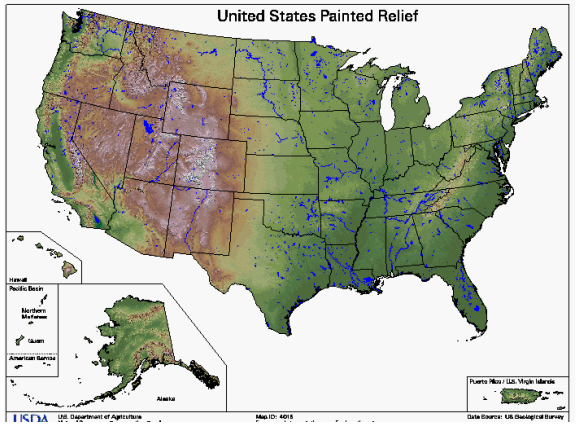
COAL U.S.


580
400
200
0
Mtoe
0% imported!
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007

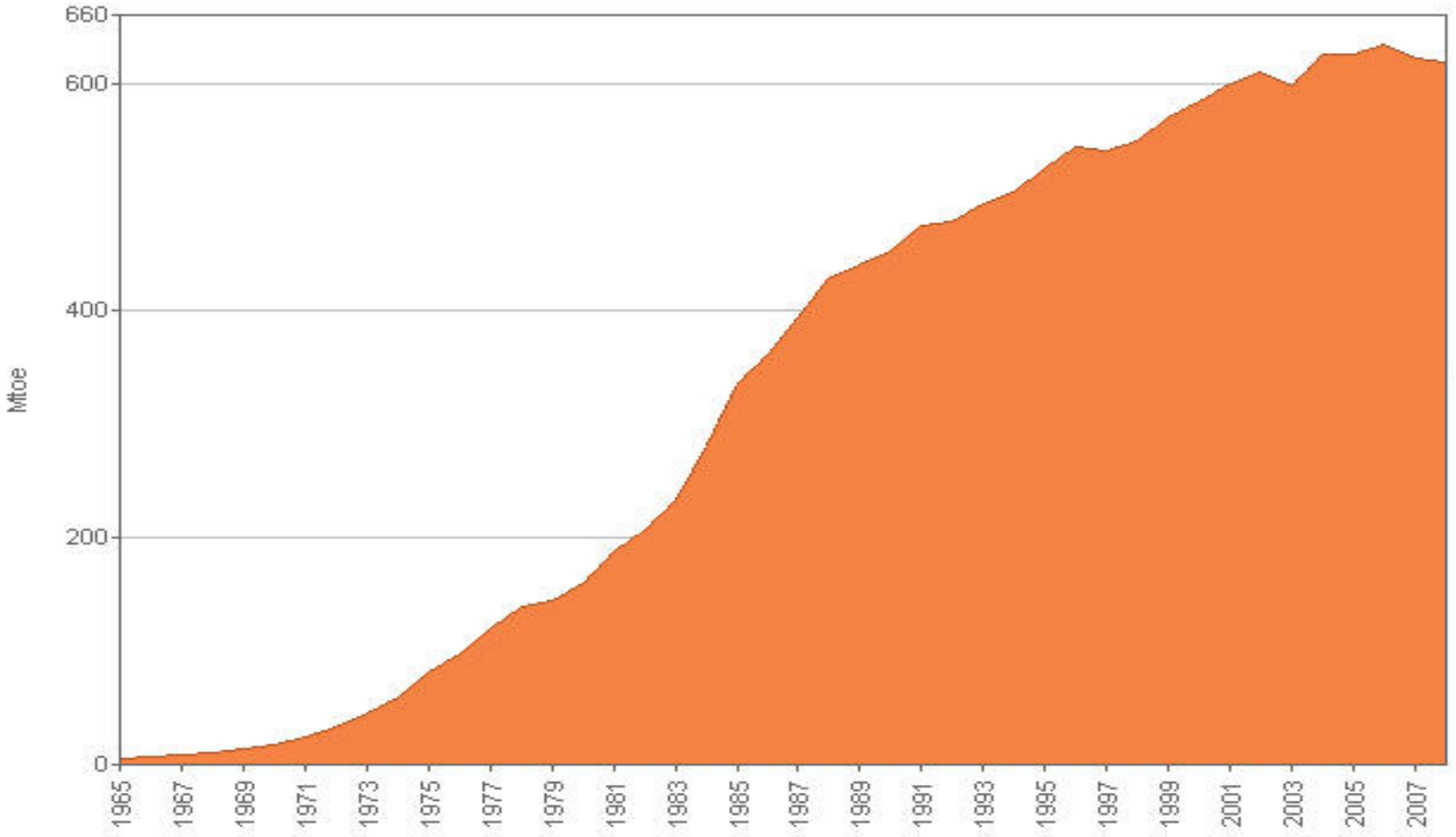
China/U.S. Coal

54% of world production.

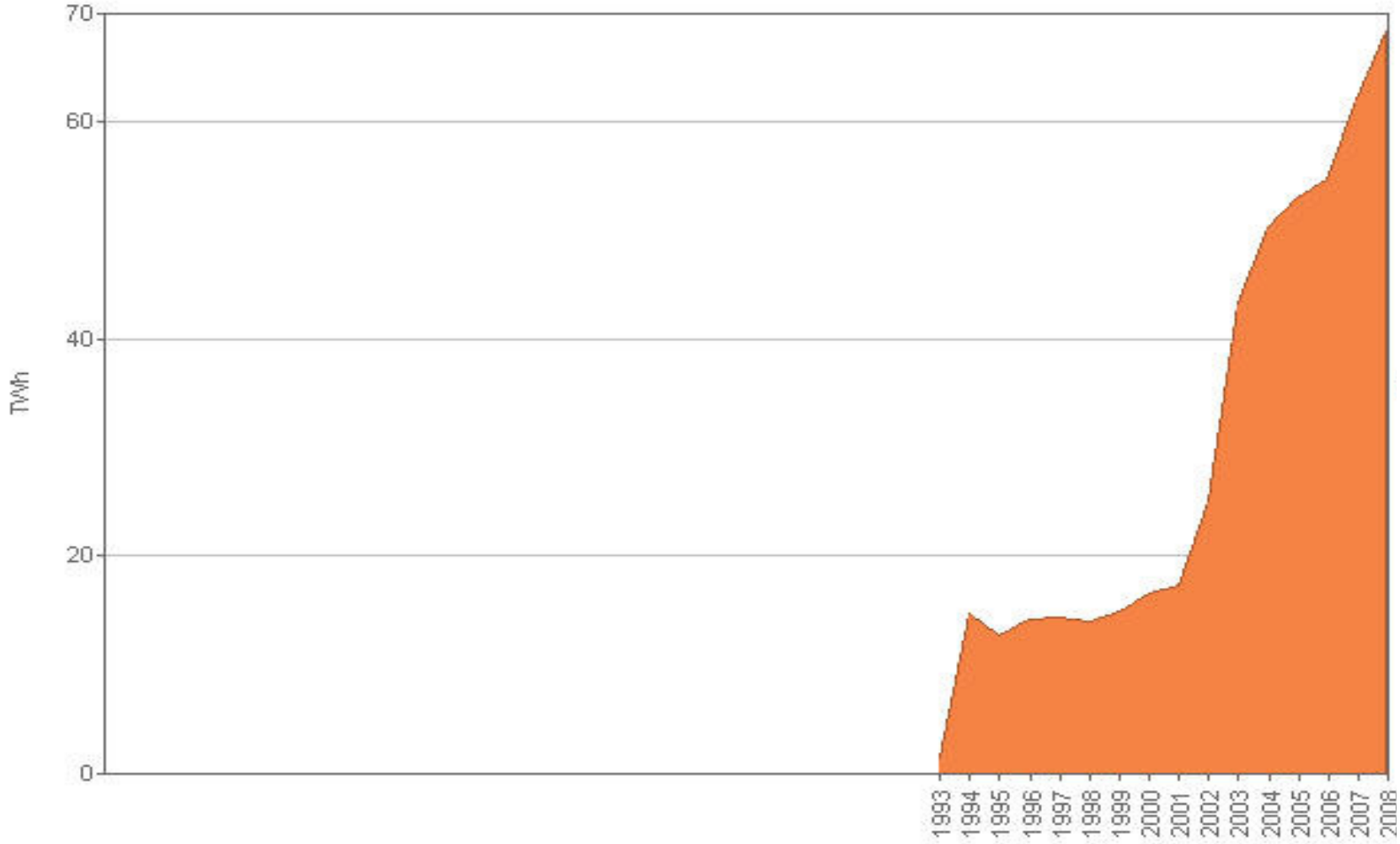
51% of world consumption.



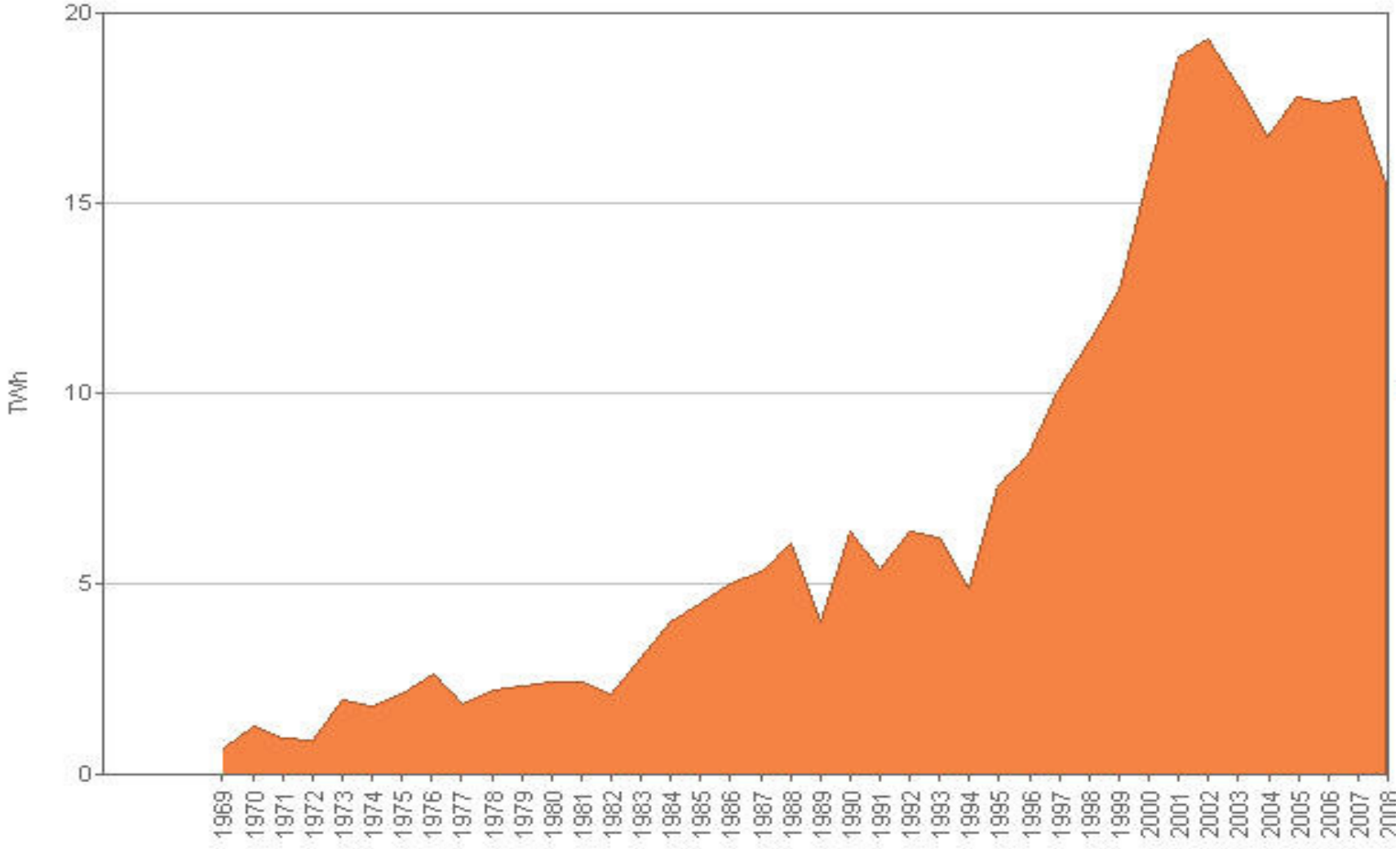
World Nuclear Consumption



NUCLEAR- China



NUCLEAR- India



China : 32 new plants by 2020

4 per year through 2015
9 GW to 60 GW

India: 17 new reactors by 2012

NUCLEAR- U.S.

The last nuclear power plant came on line in 1996

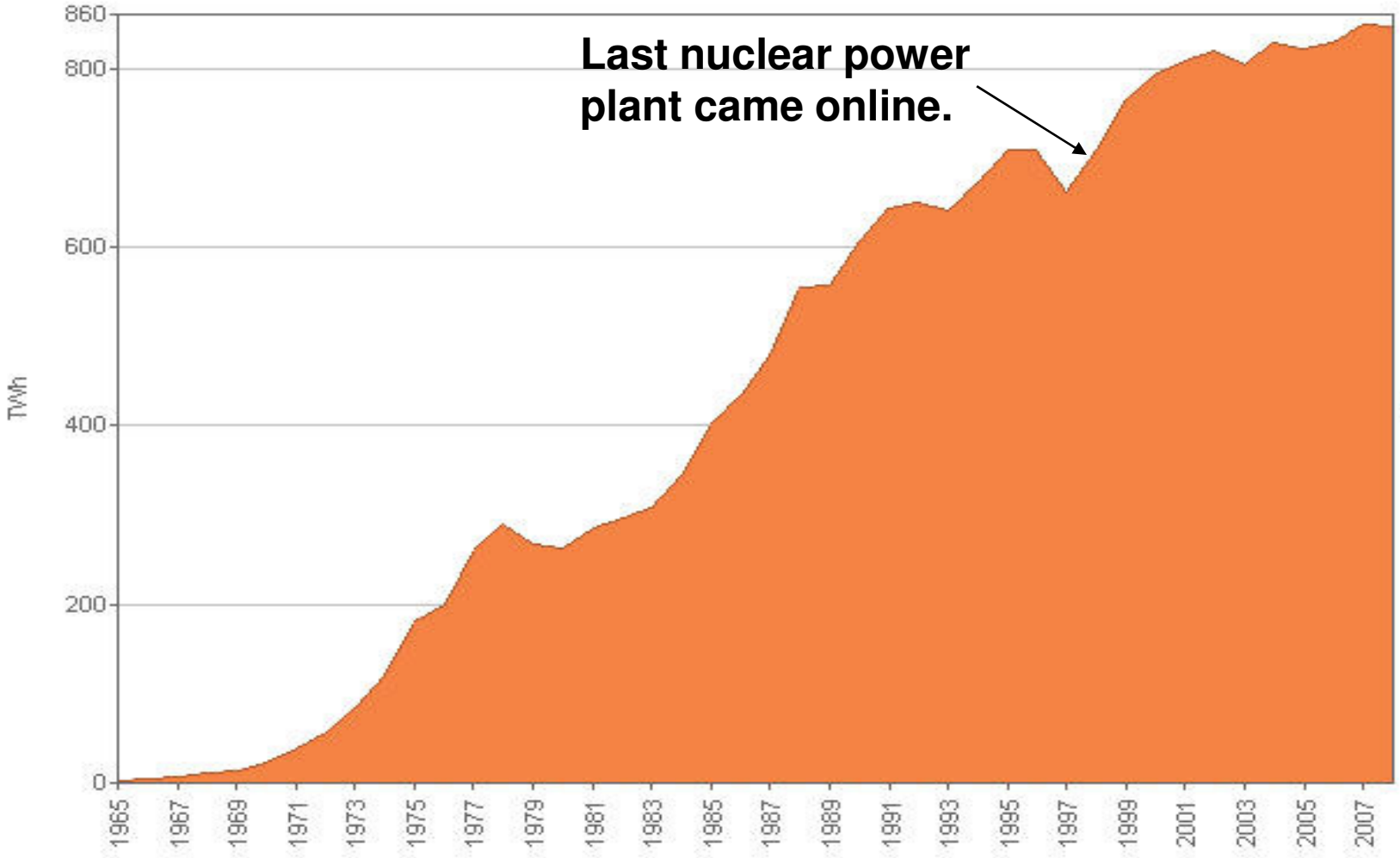
Since then has U.S. nuclear generation --

Increased?

Decreased?

Remained flat?

NUCLEAR- U.S.


Last nuclear power plant came online.
TWh
860
800
600
400
200
0
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007

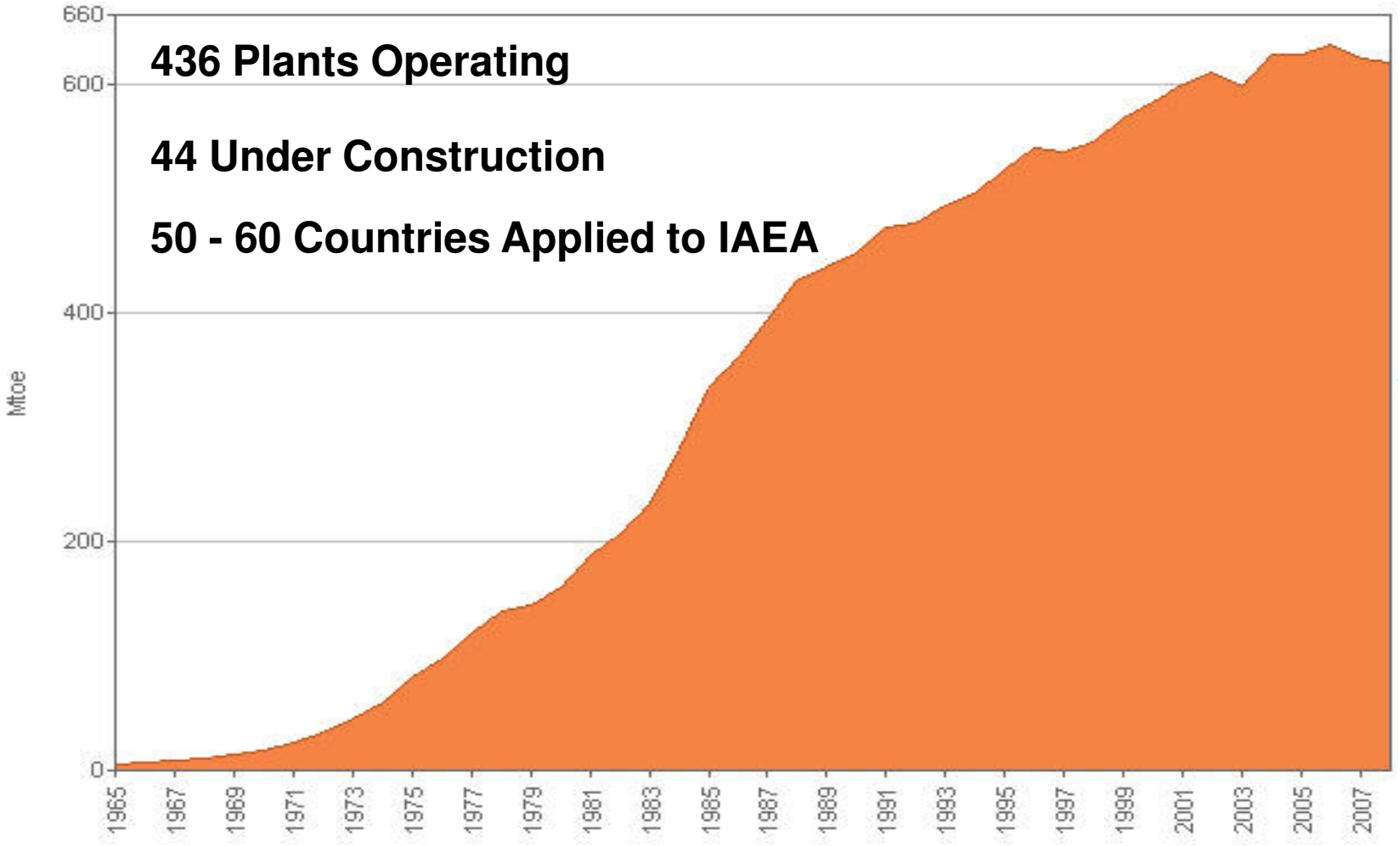
And, the largest nuclear power generator in the world?

The United States generates as much nuclear energy as—

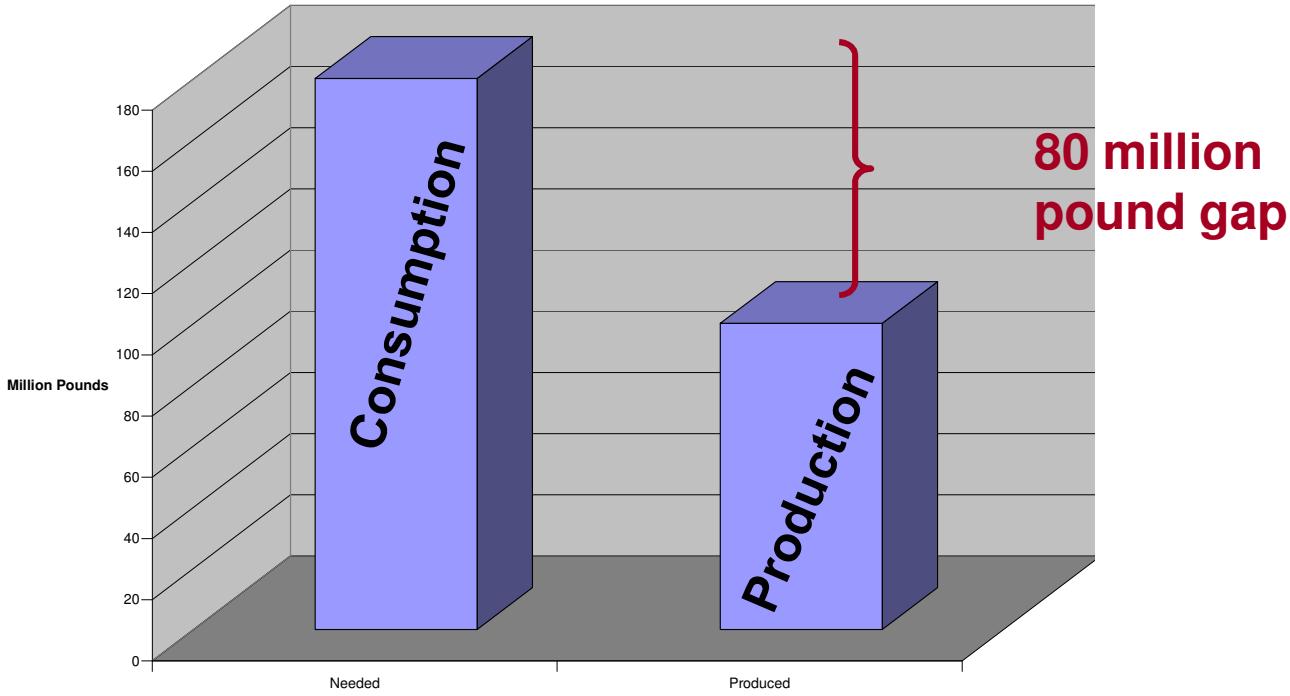
France,
Germany,
Spain,
Sweden,
United Kingdom

***combined*!**

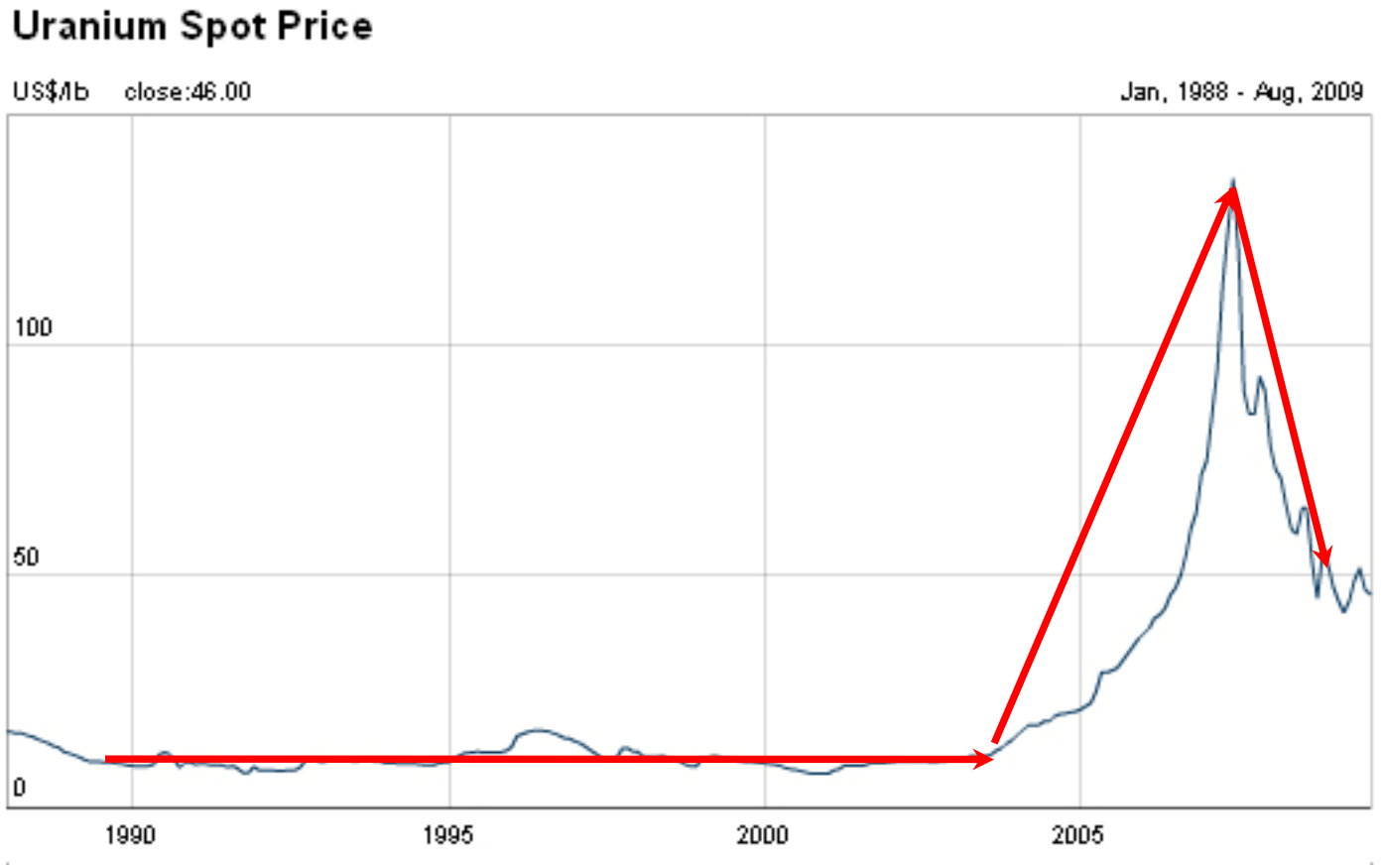
World Nuclear Power Consumption



The world's existing 436 nuclear reactors currently need 180 million pounds of uranium each year.



Uranium prices



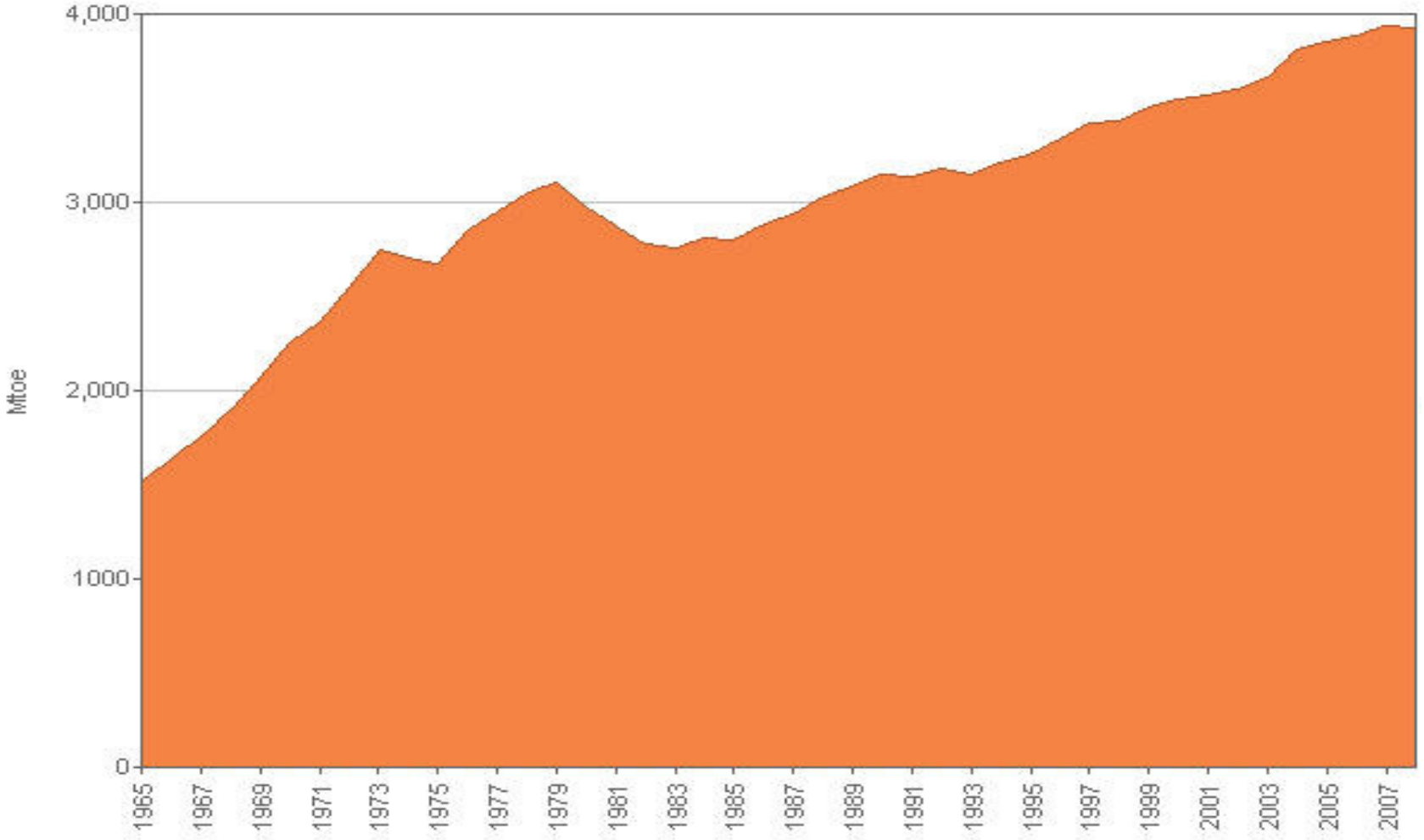
Colorado Impact

Three new mines opened in Colorado in 2008

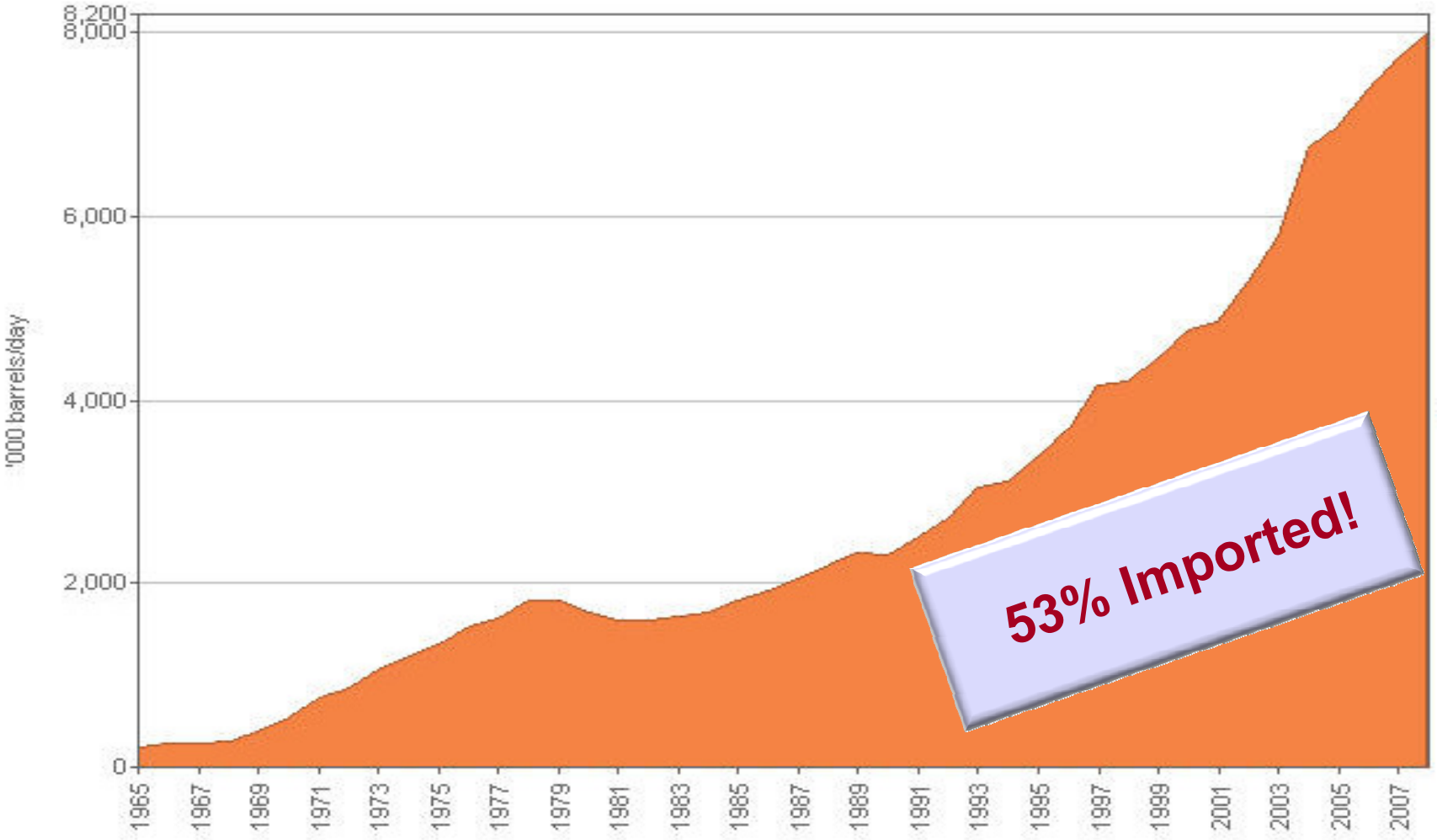
10,000+ claims filed on federal lands in Colorado in 2005-6.

10,000+ claims filed on federal lands in Colorado in 2007.

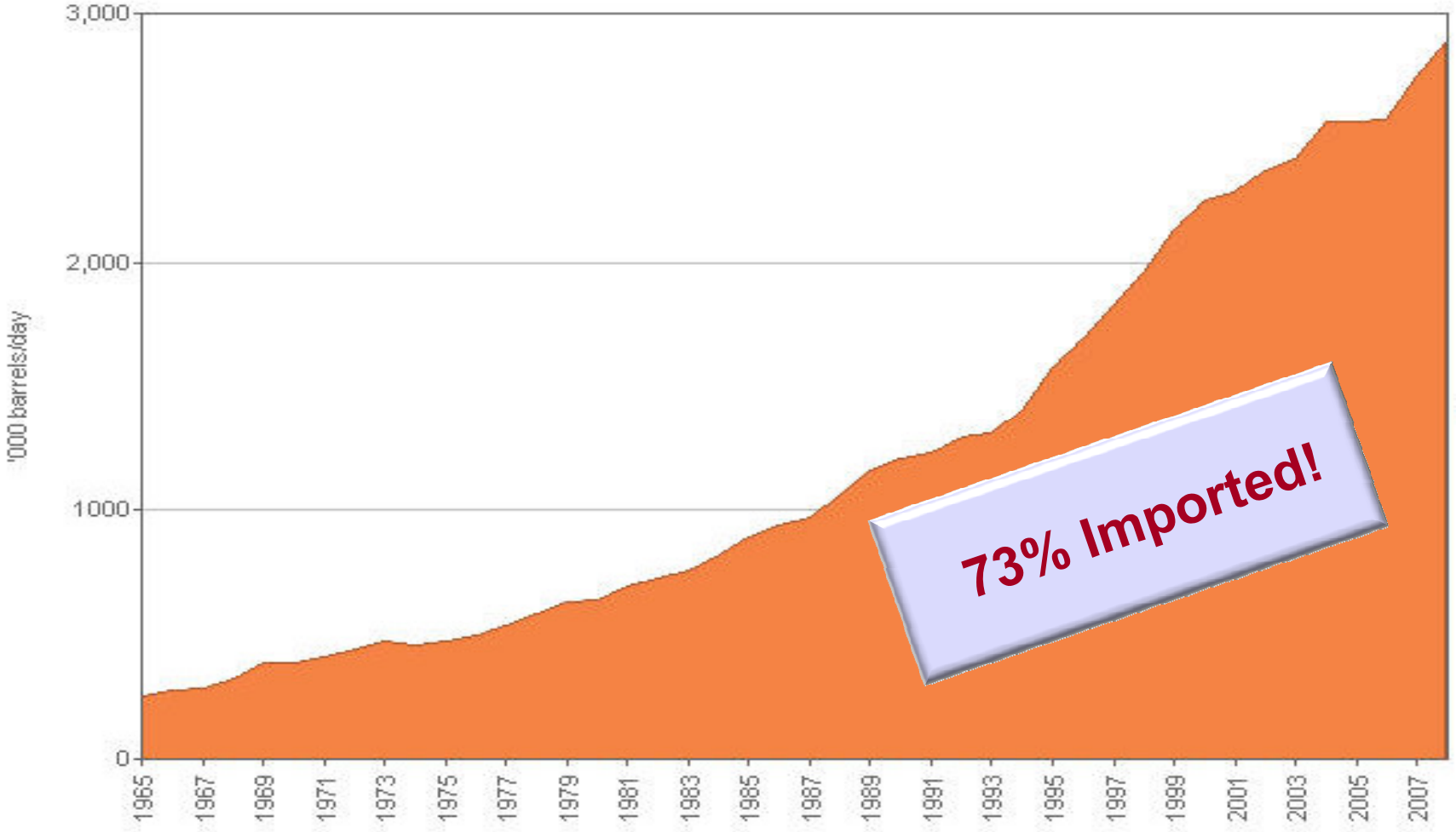
World Oil Consumption



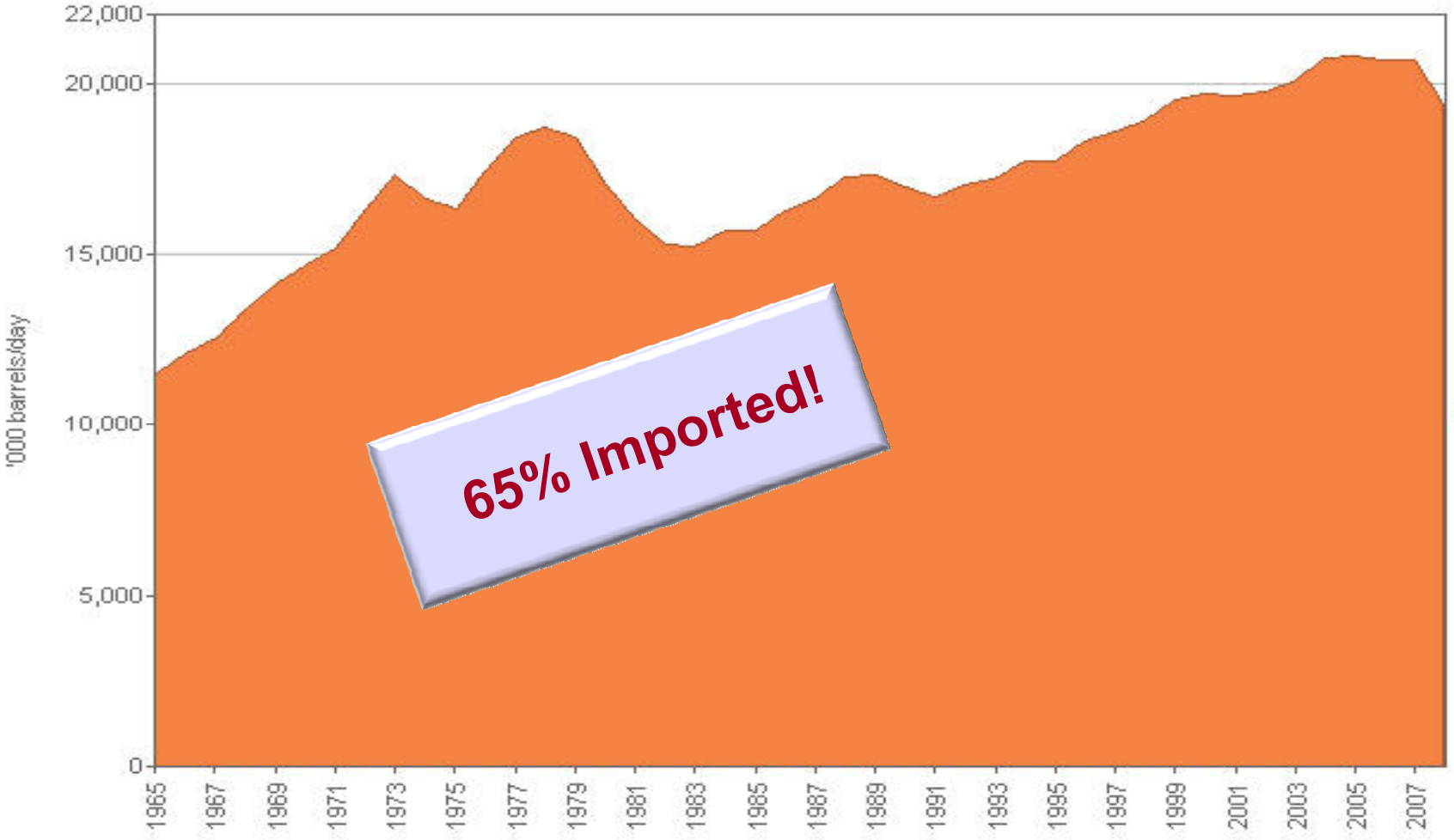
OIL CONSUMPTION- China



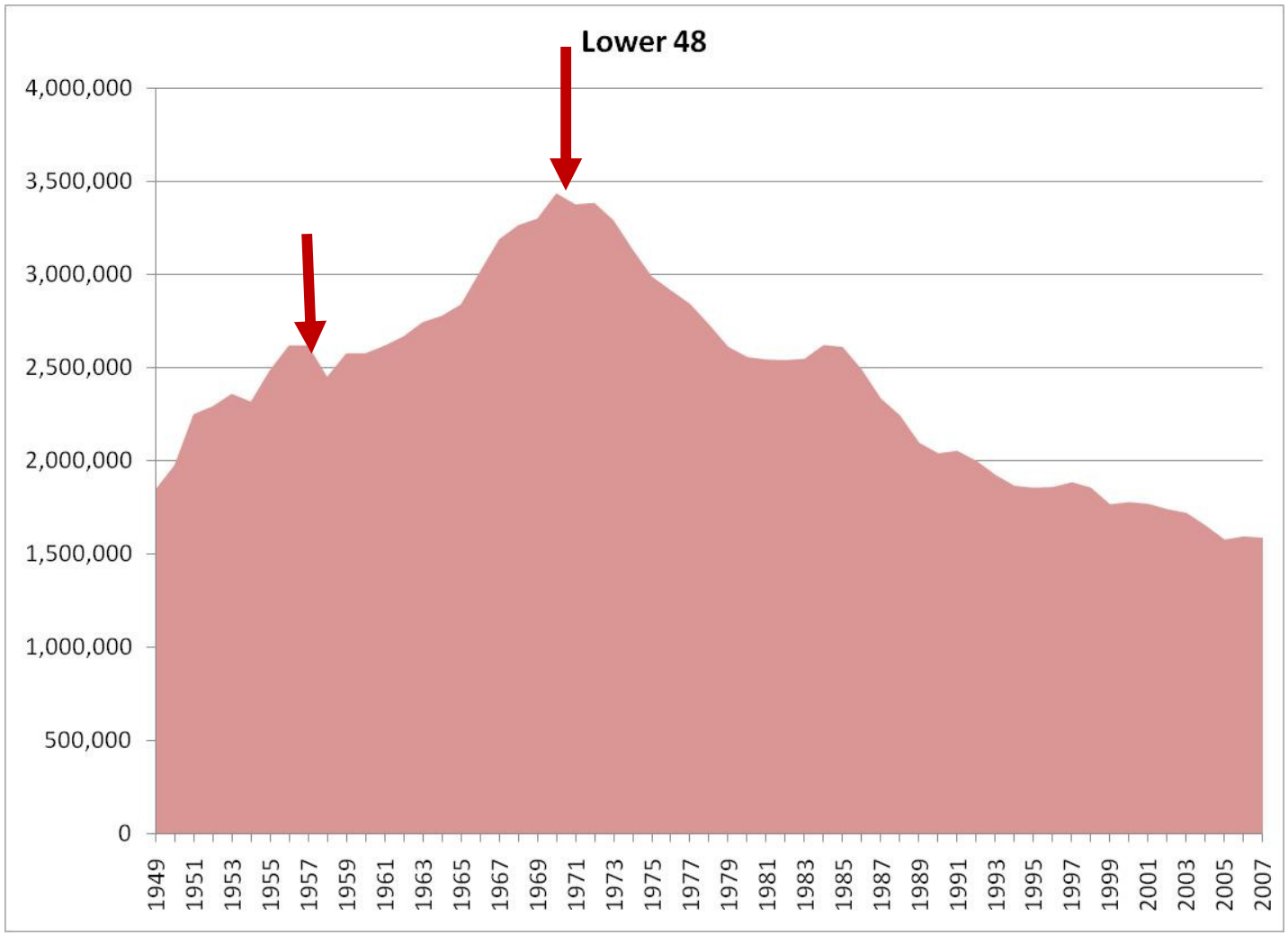
OIL- CONSUMPTION India

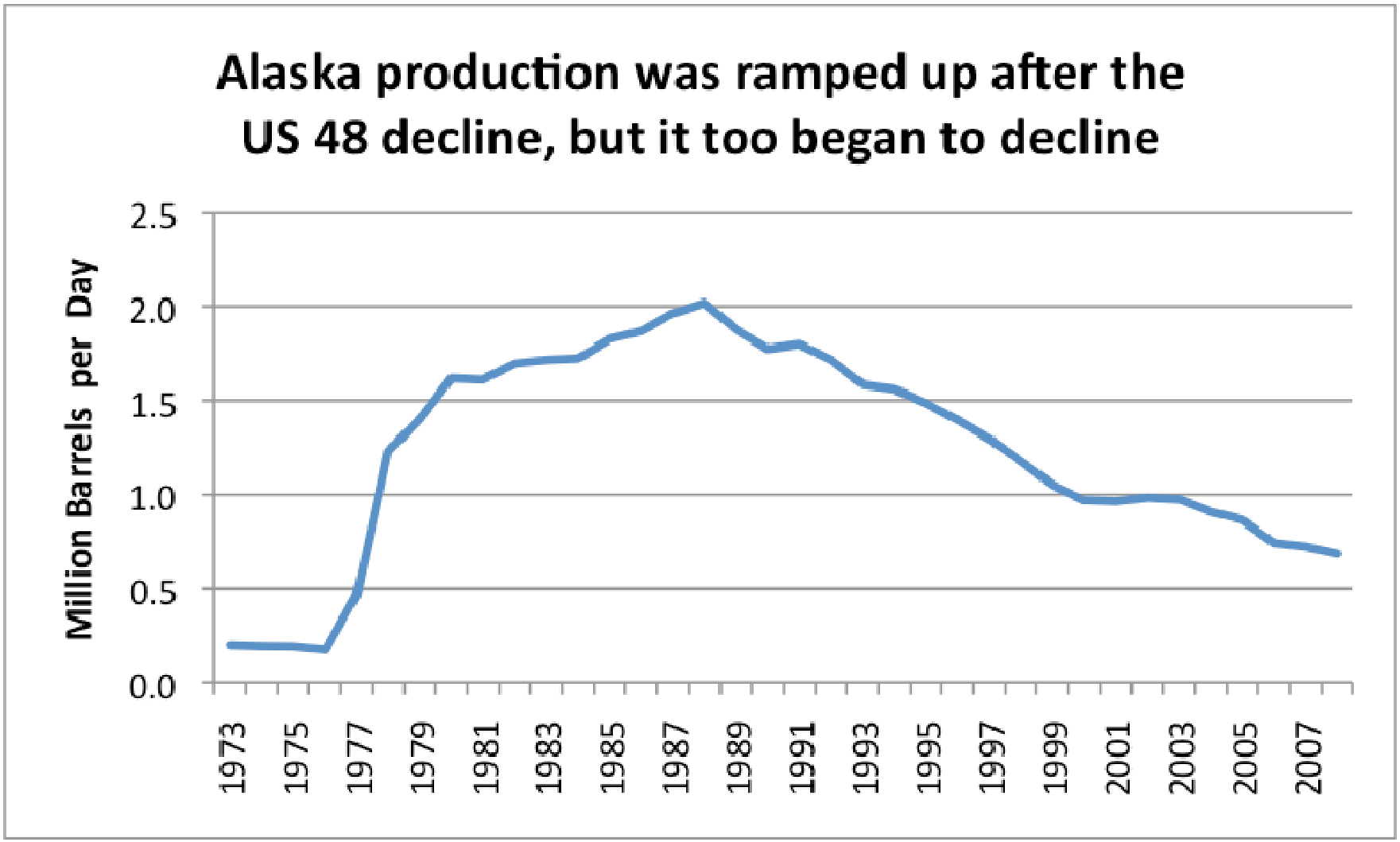


OIL- U.S. Consumption

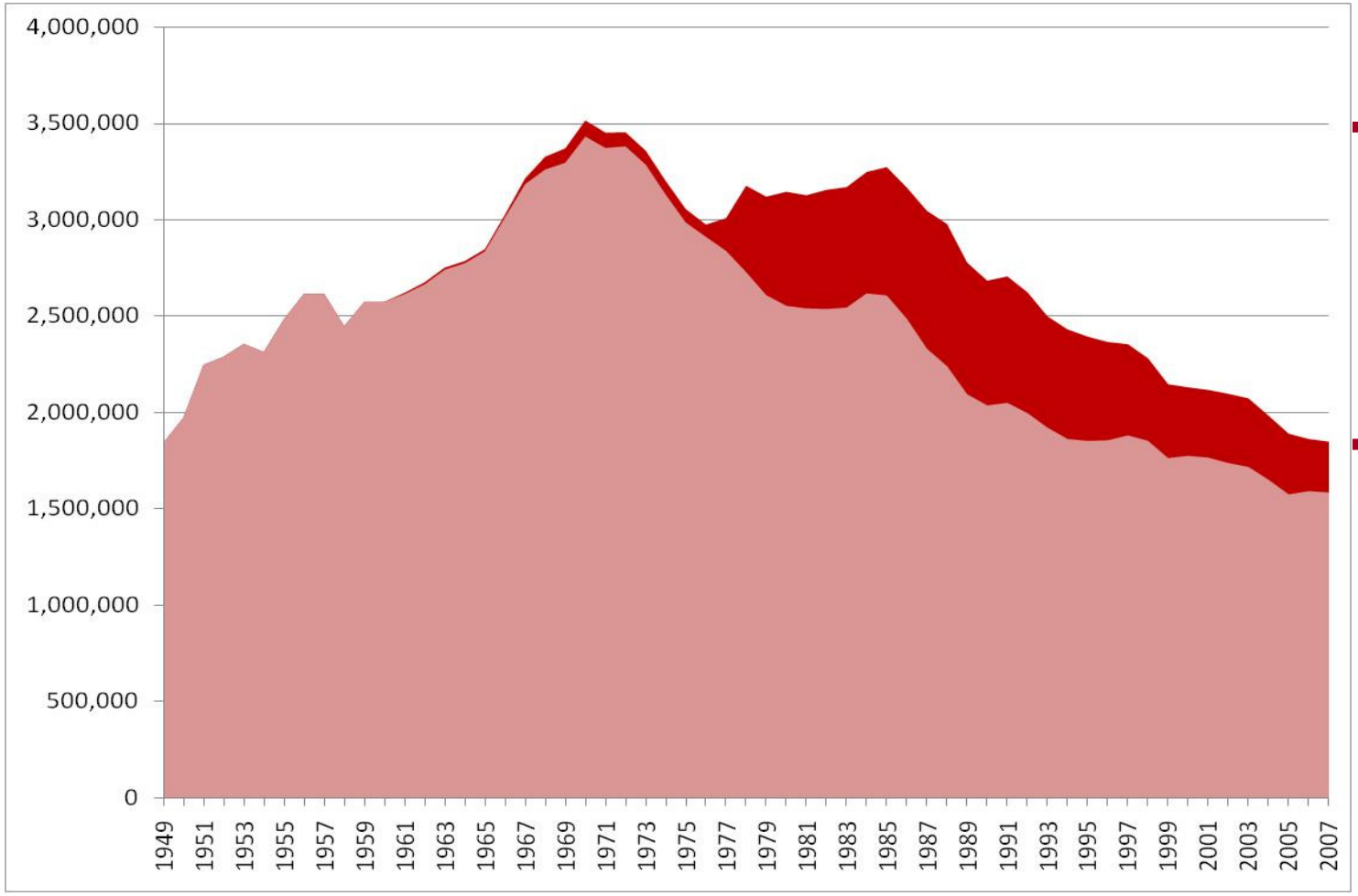


OIL- U.S. Production

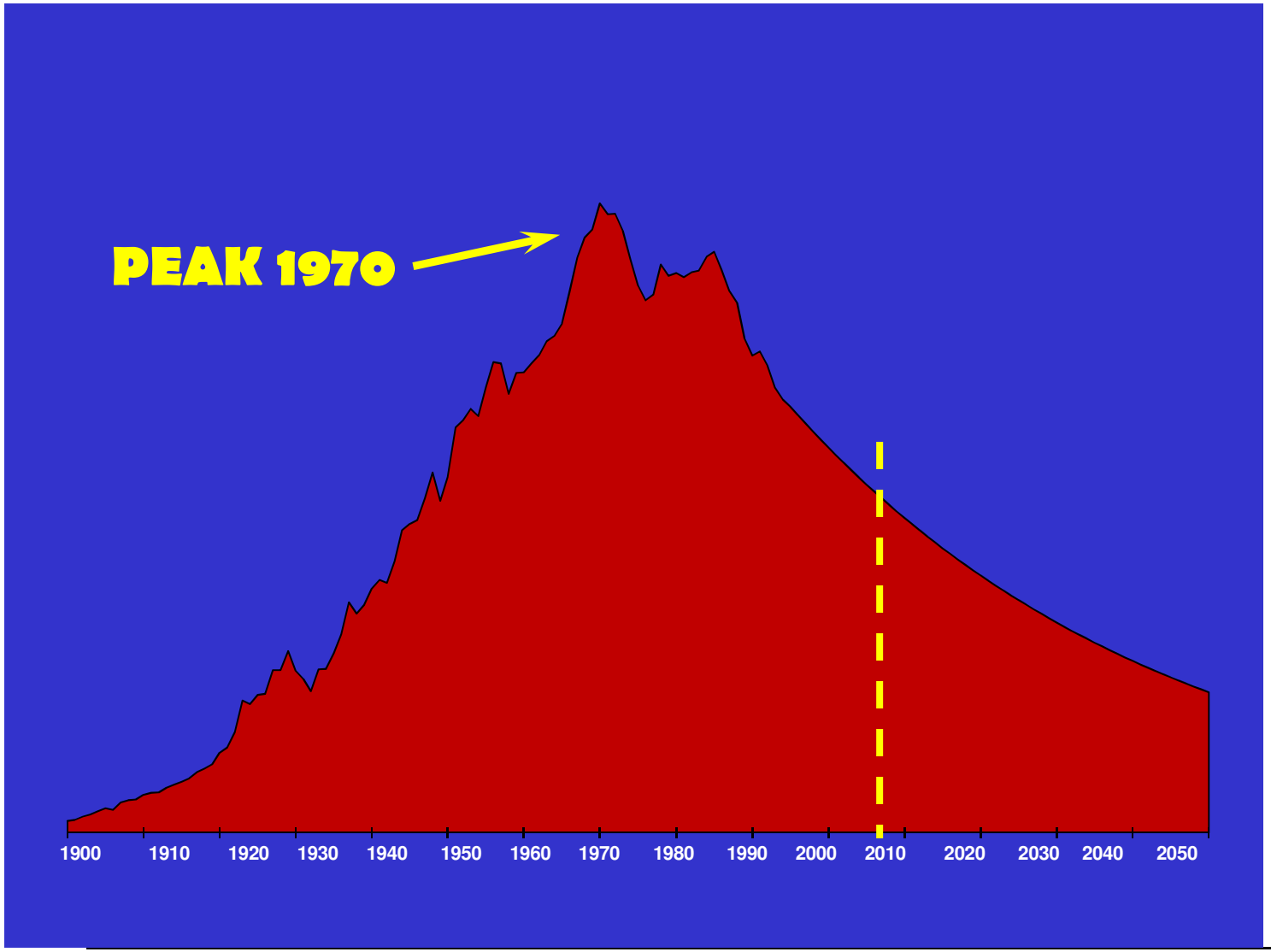



Alaska production was ramped up after the US 48 decline, but it too began to decline
Million Barrels per Day
2.5
2.0
1.5
1.0
0.5
0.0
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007

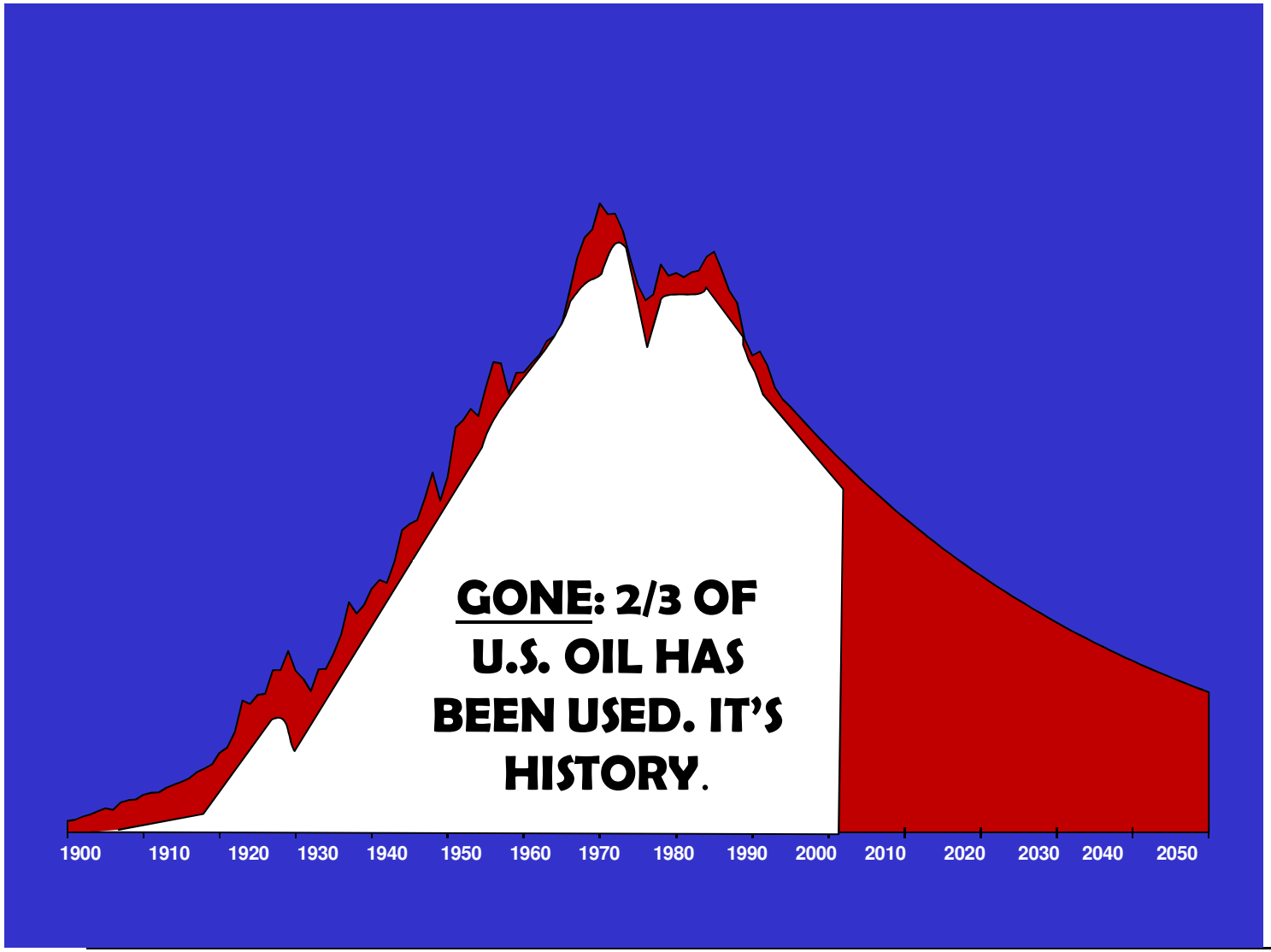
OIL- U.S. Production



U.S. OIL PRODUCTION - 1900 to 2050

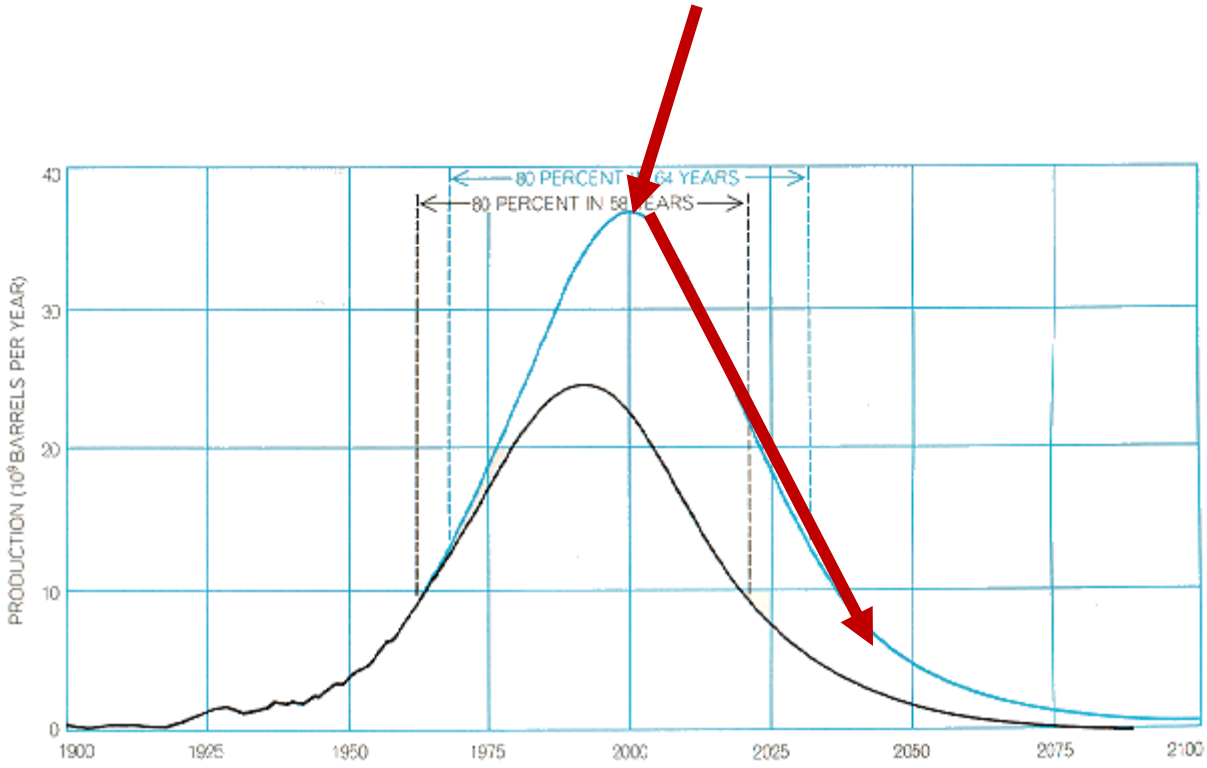


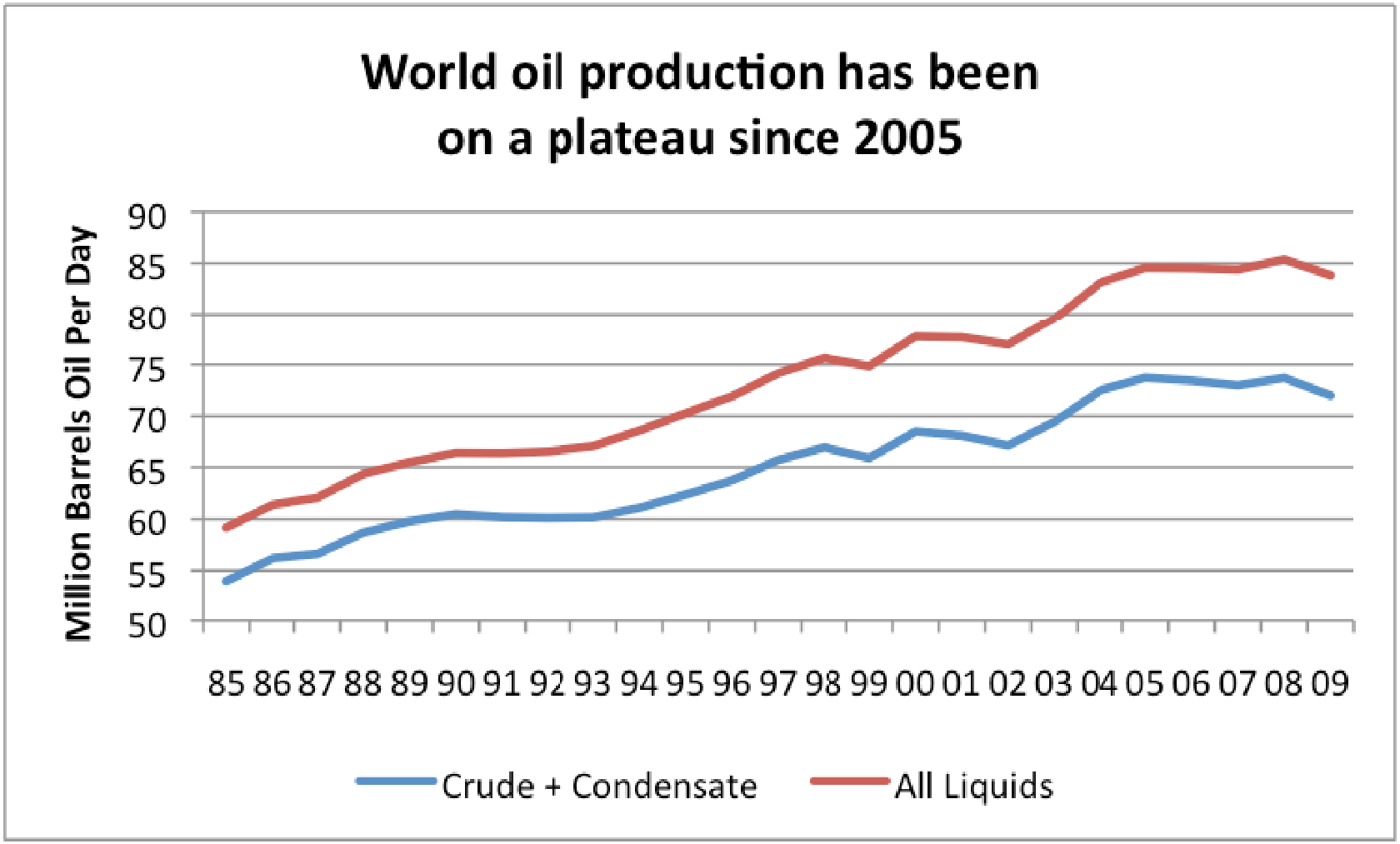
U.S. OIL PRODUCTION - 1900 to 2050



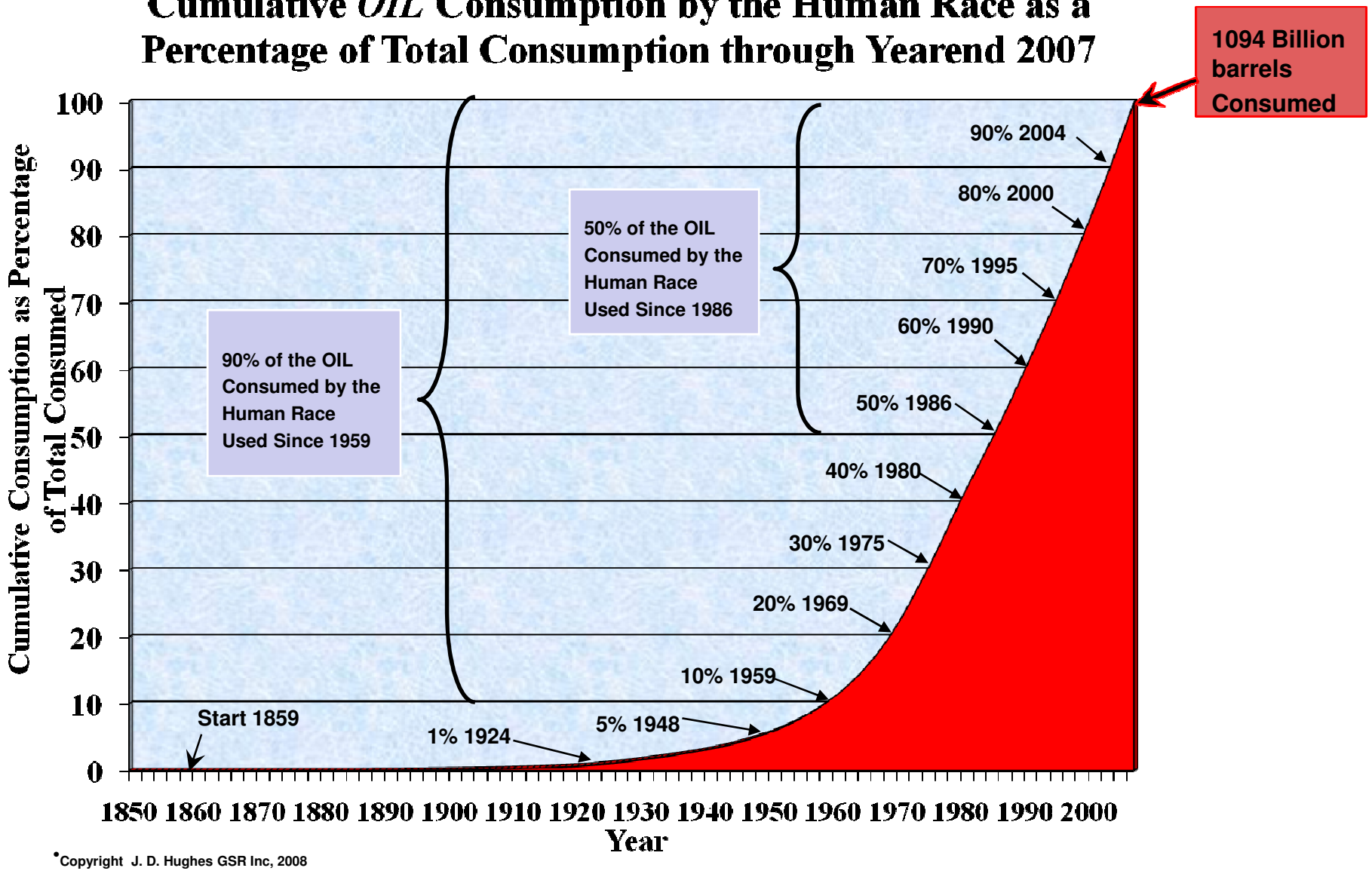
How do you communicate what "2/3 of something gone" means?

In 1969, M. King Hubbert Predicted that World Production would Begin Declining in 2000.

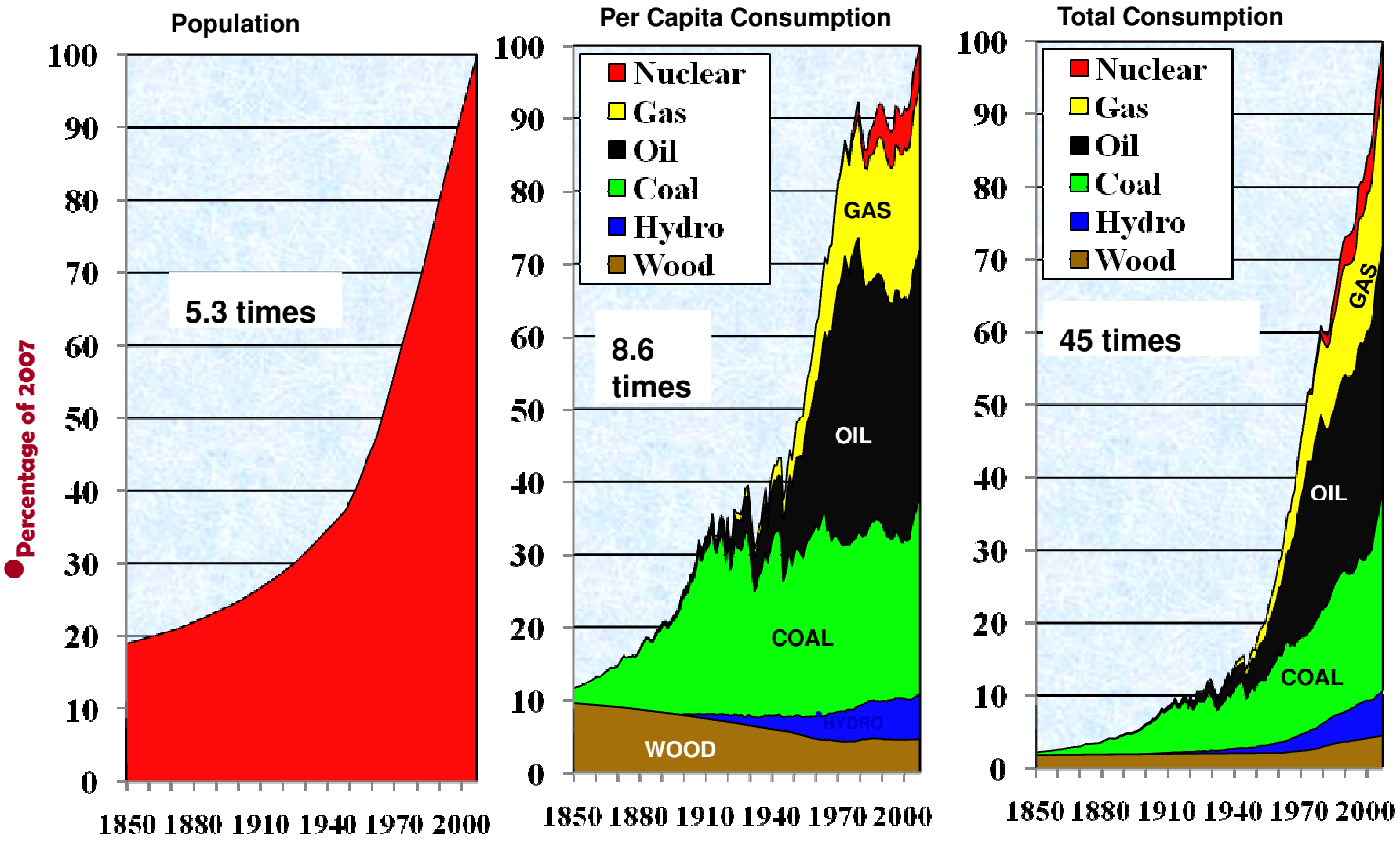



World oil production has been on a plateau since 2005
Million Barrels Oil Per Day
90
85
80
75
70
65
60
55
50
85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09
Crude + Condensate
All Liquids

Cumulative *OIL* Consumption by the Human Race as a Percentage of Total Consumption through Yearend 2007



•(data from Arnulf Grubler, 1998; BP Statistical Review of World Energy, 2008)



85% of the world's oil comes from just 20 of the 65 producing countries

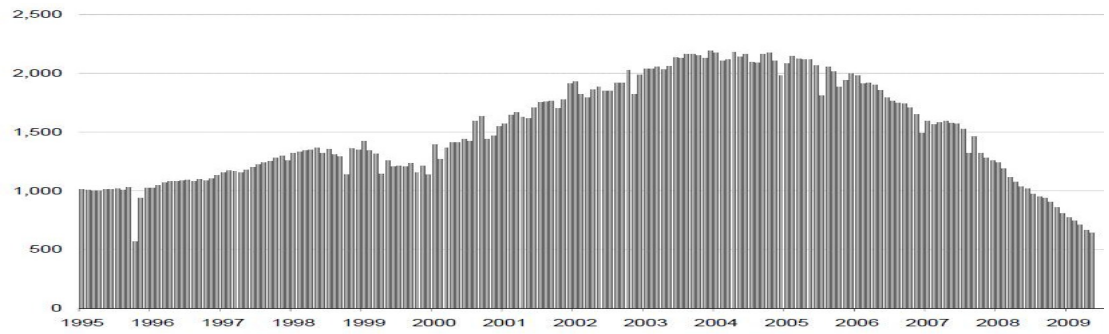
54 of the 65 producing countries are in decline

Mexico's declining production at Cantarell field accelerating

Mexican state oil company Pemex said Wednesday that production at its Cantarell oil field, the world's second-largest, will drop faster than expected.
08/03/06

2005-- producing 2.2 million barrels per day

2009-- producing 0.550



IEA says existing fields have 3.7% decline in 2007

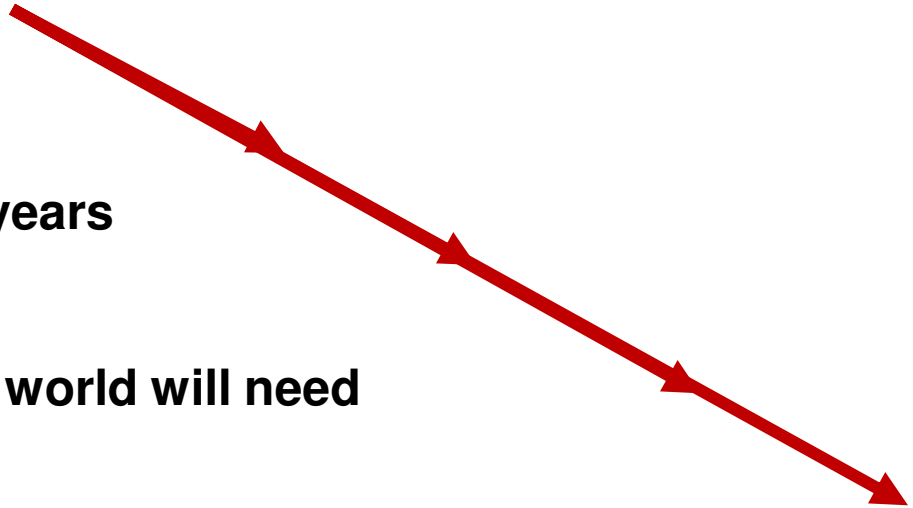
IEA says existing fields have 6.7% decline in 2008

At 5% decline rate

In only five years

The world will need

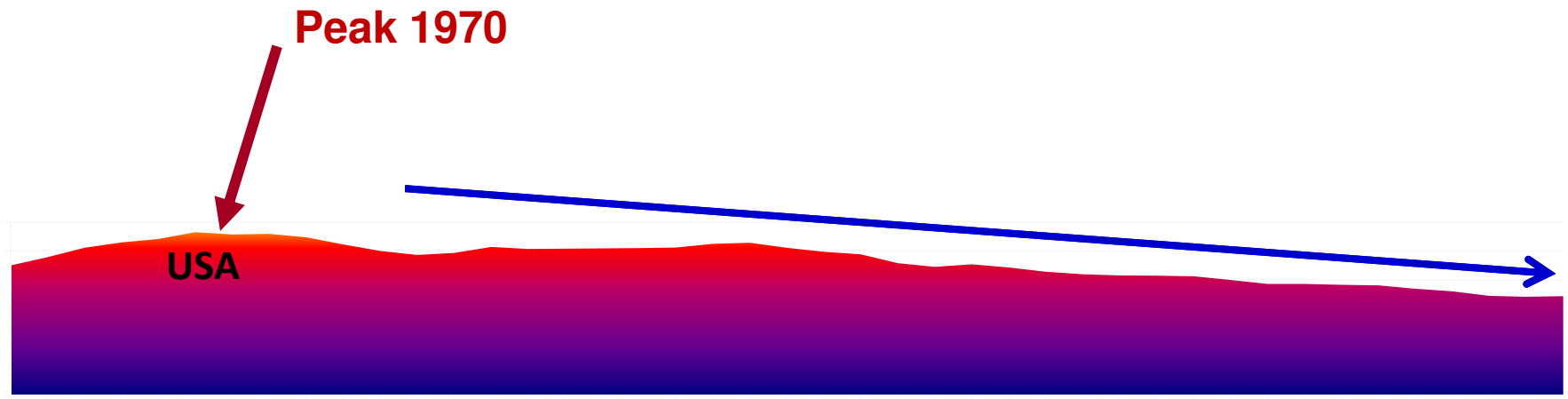
19 million barrels!



Declines never sleep!

1 of 65 producing countries

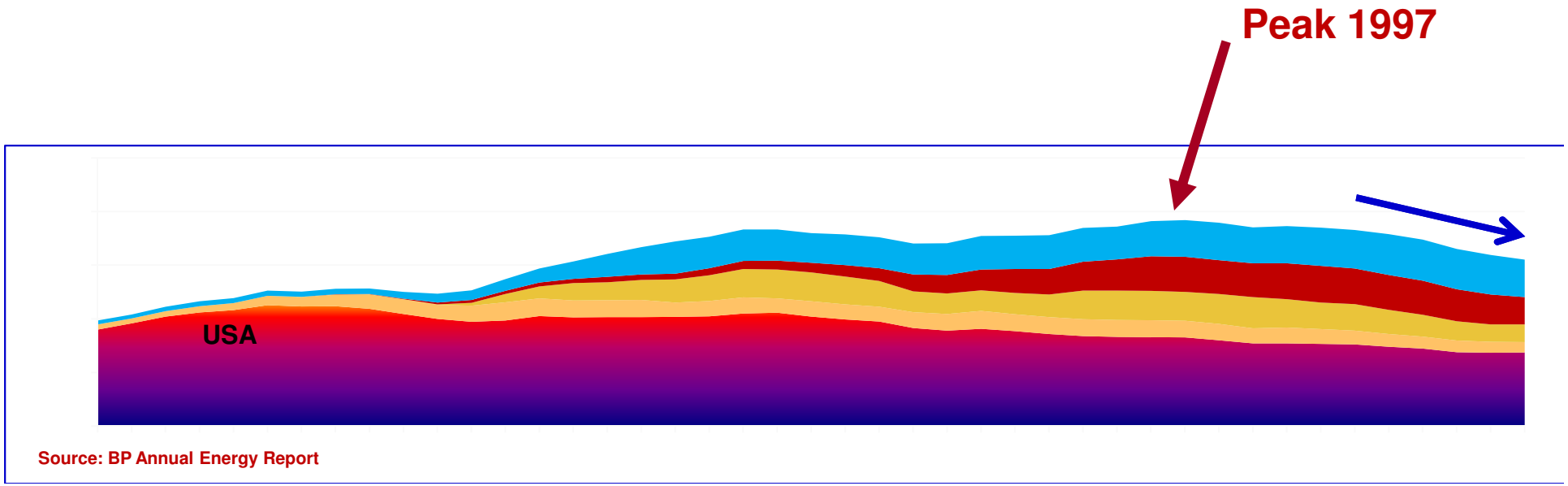
United States of America



Source: BP Annual Energy Report

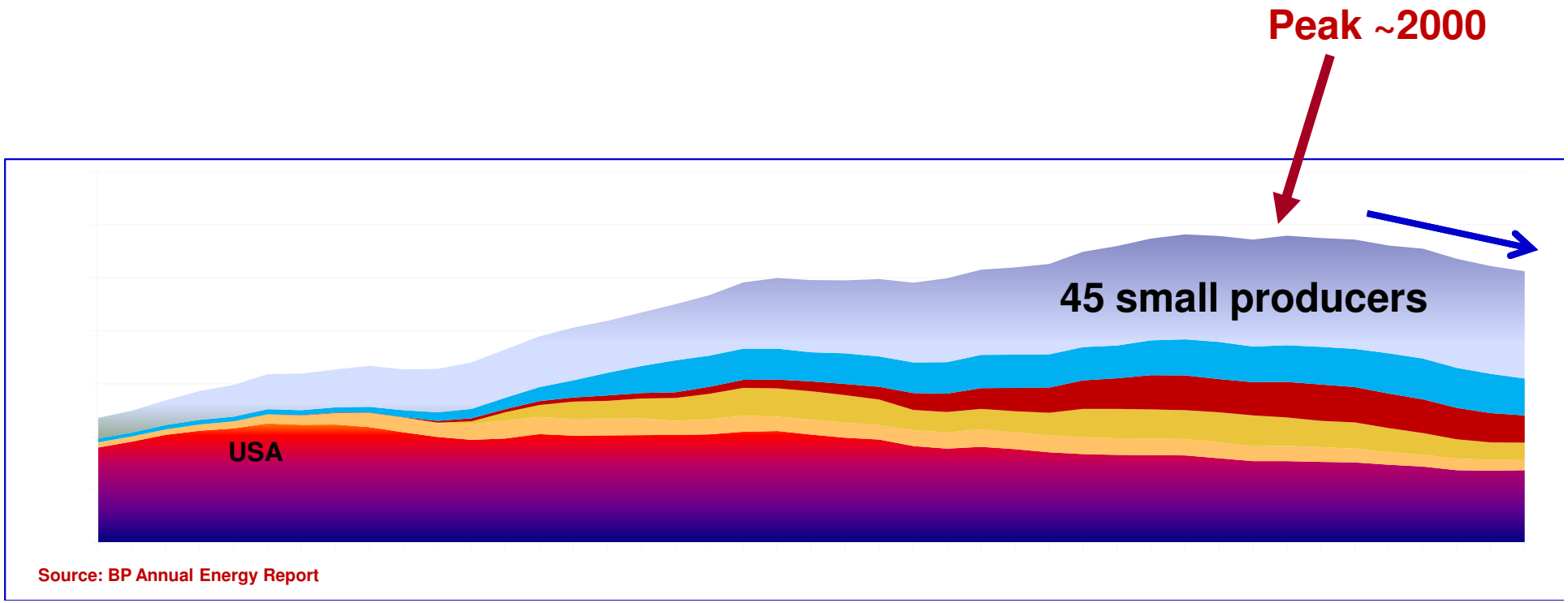
5 of 65 producing countries

Mexico
Norway
UK
Indonesia



Source: BP Annual Energy Report

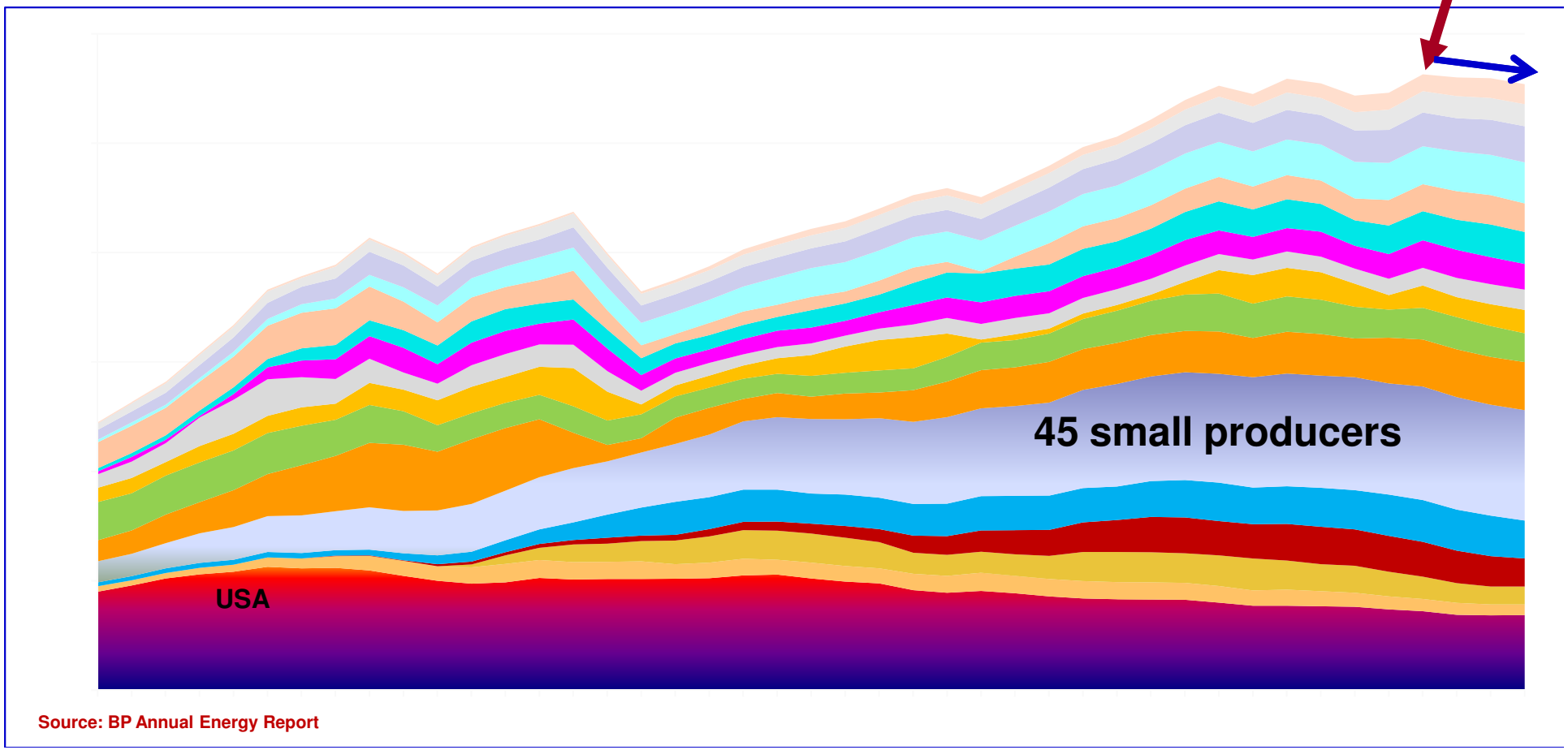
50 of 65 producing countries



Source: BP Annual Energy Report

61 of 65 producing countries

Brazil	Kuwait	Iraq
Algeria	UAE	Venezuela
Canada	Nigeria	Iran
China	Libya	

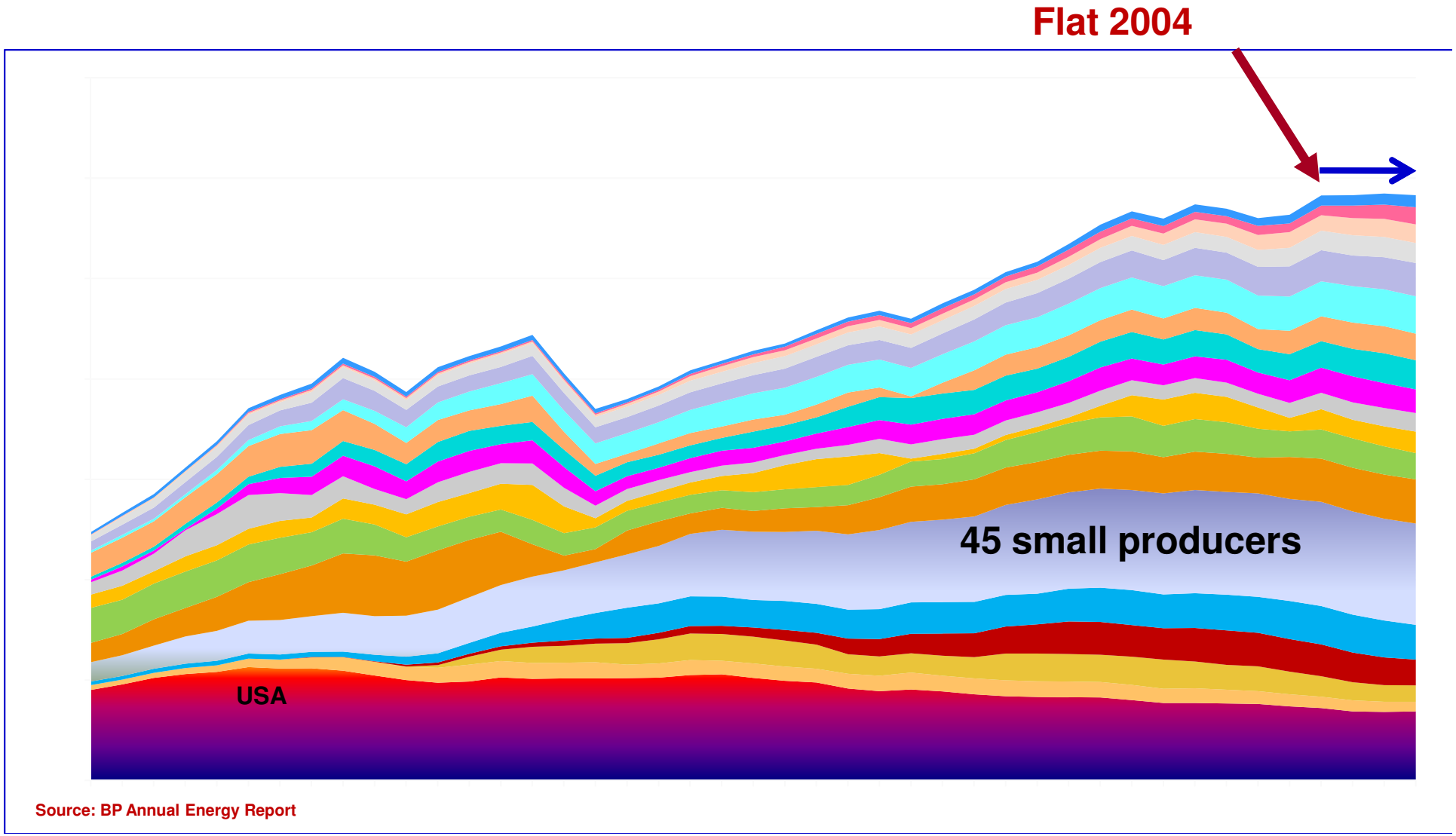


Source: BP Annual Energy Report

63 of 65 producing countries

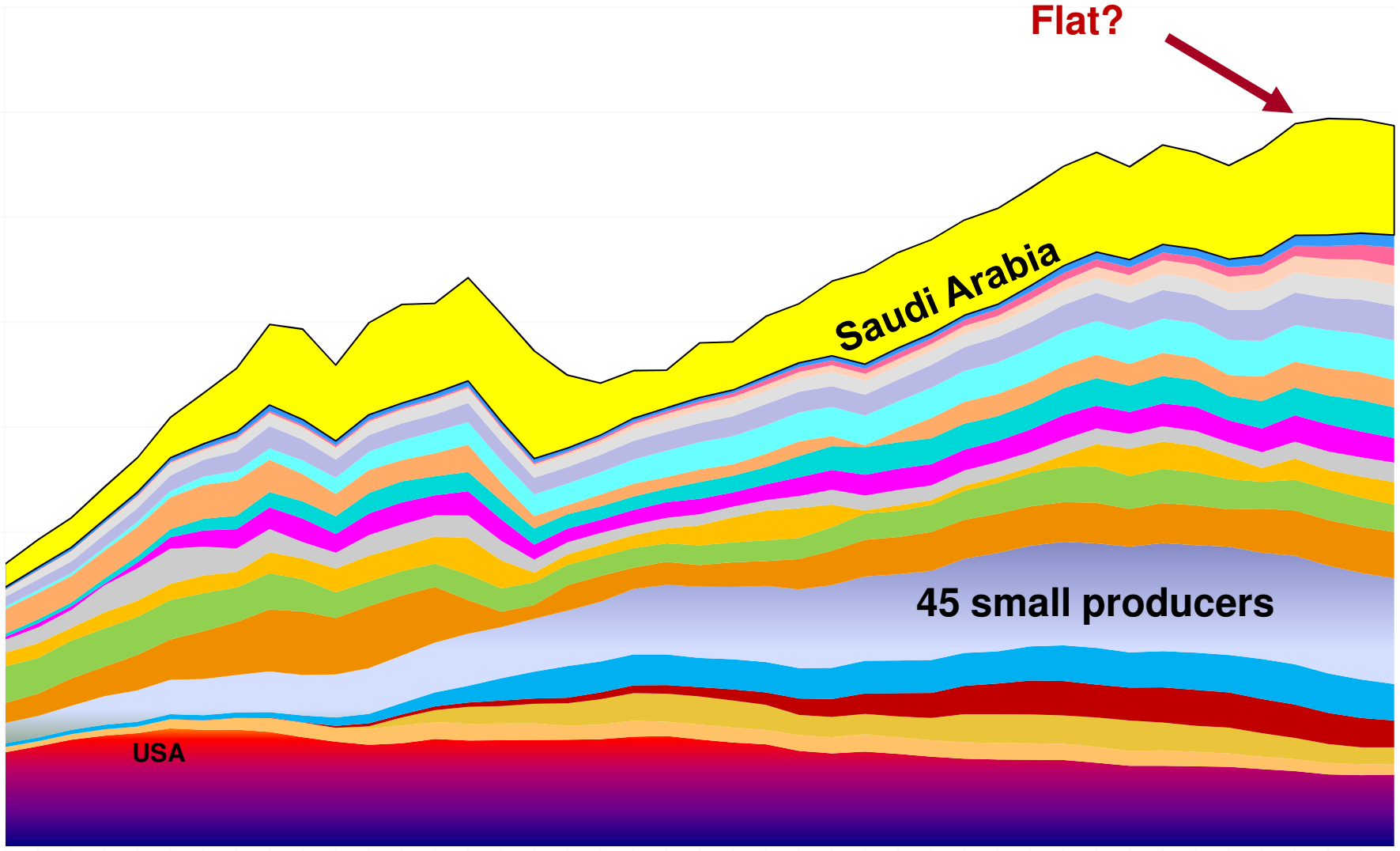
Qatar

Angola



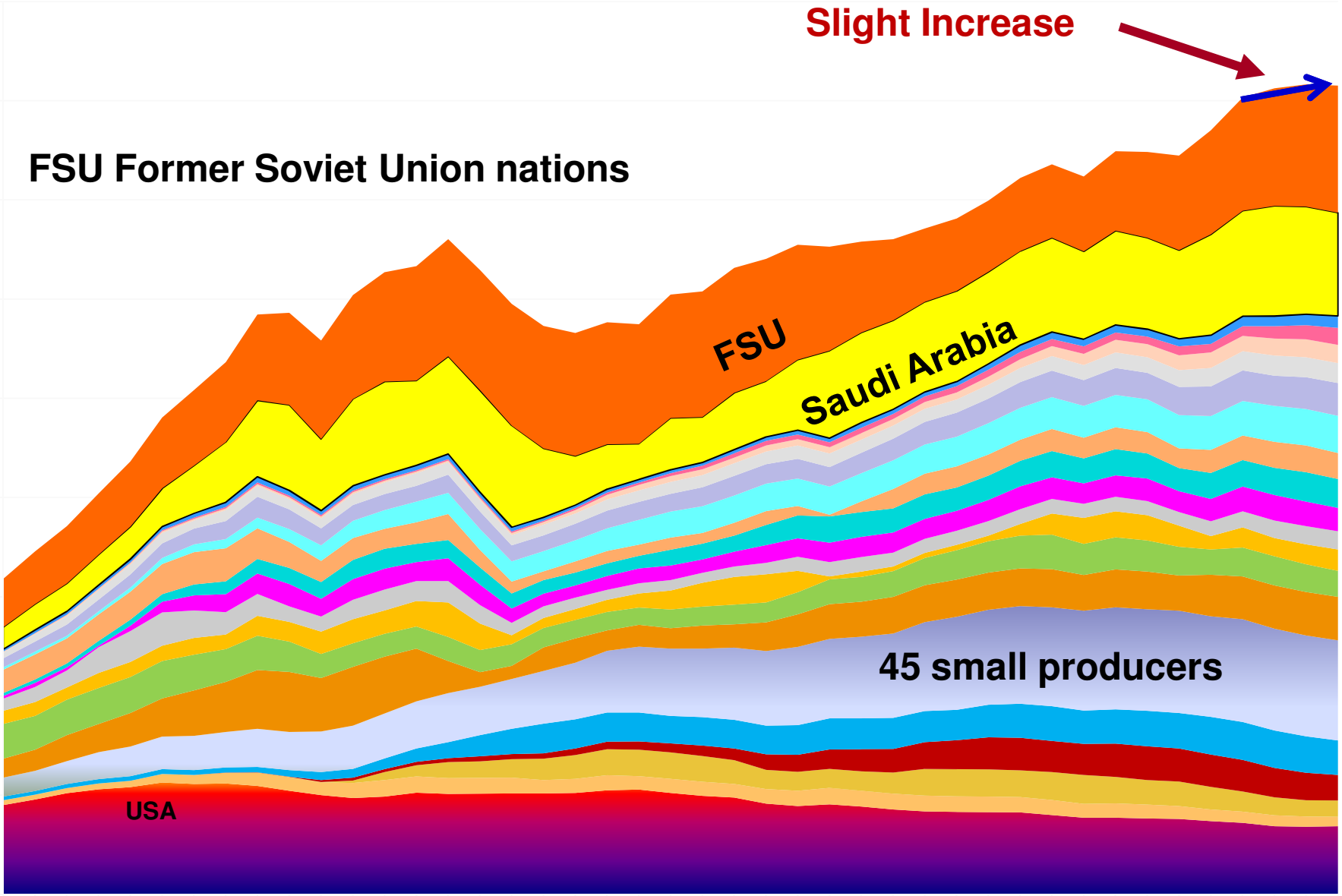
Source: BP Annual Energy Report

64 of 65 producing countries

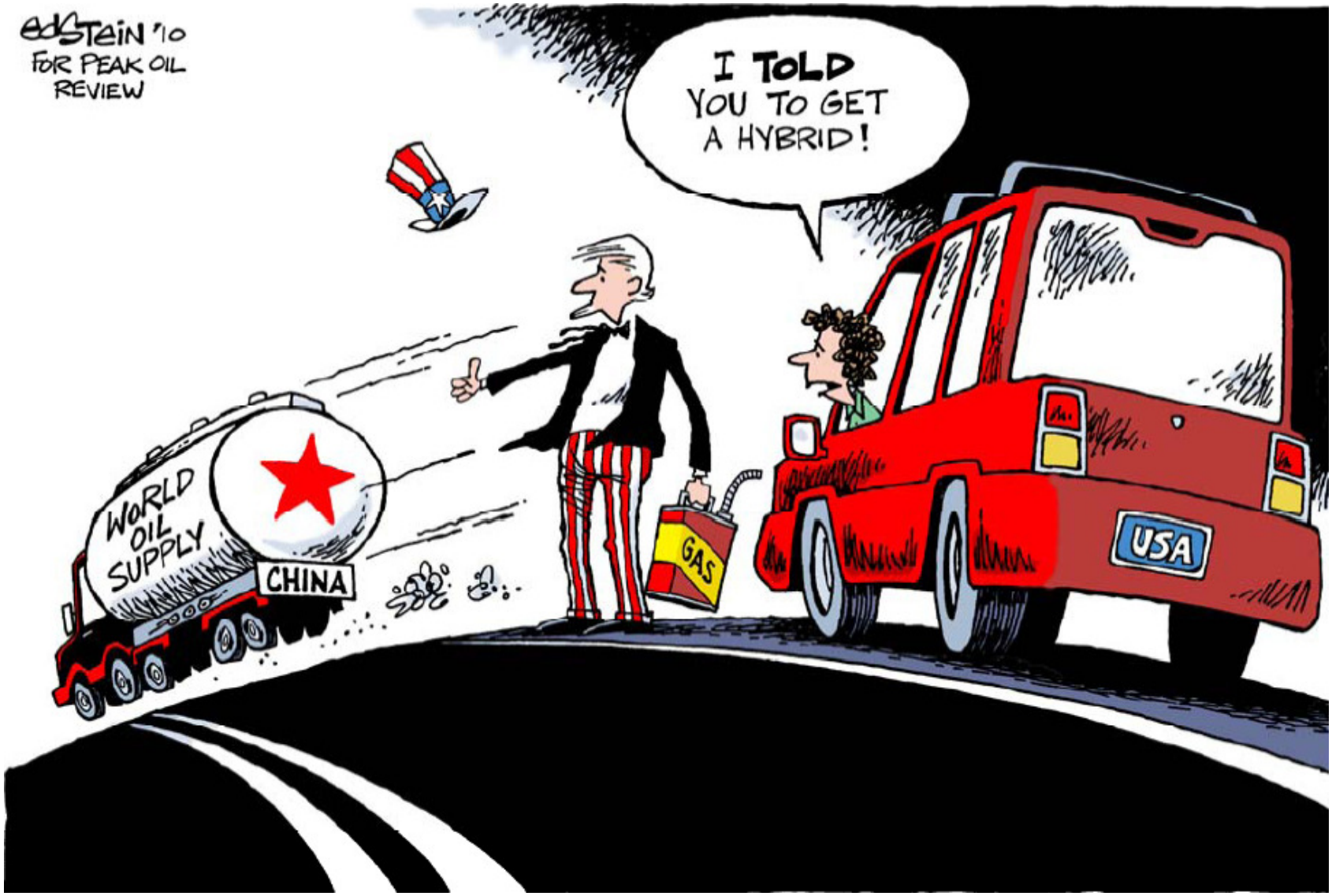


Source: BP Annual Energy Report

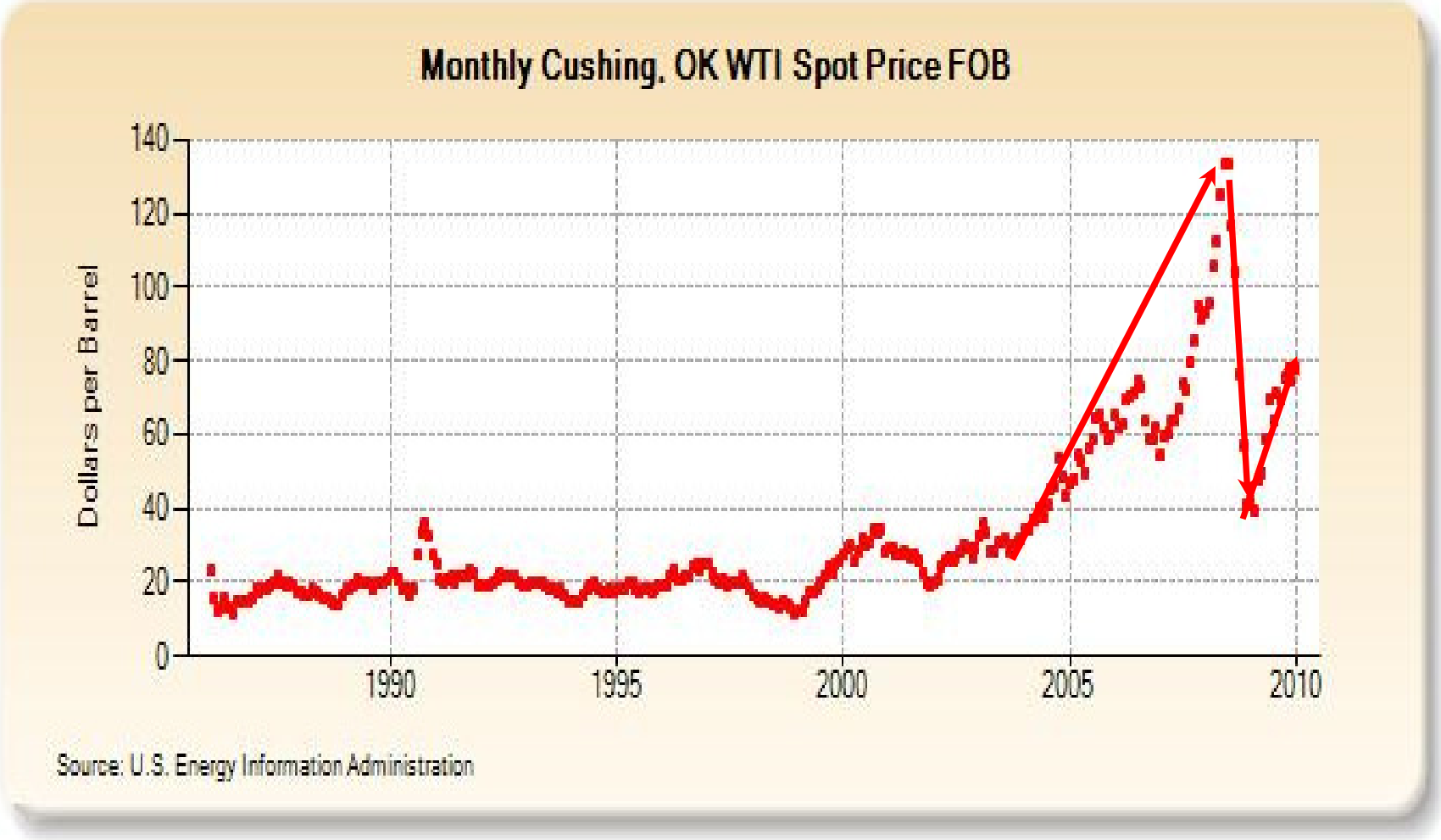
65 of 65 producing countries



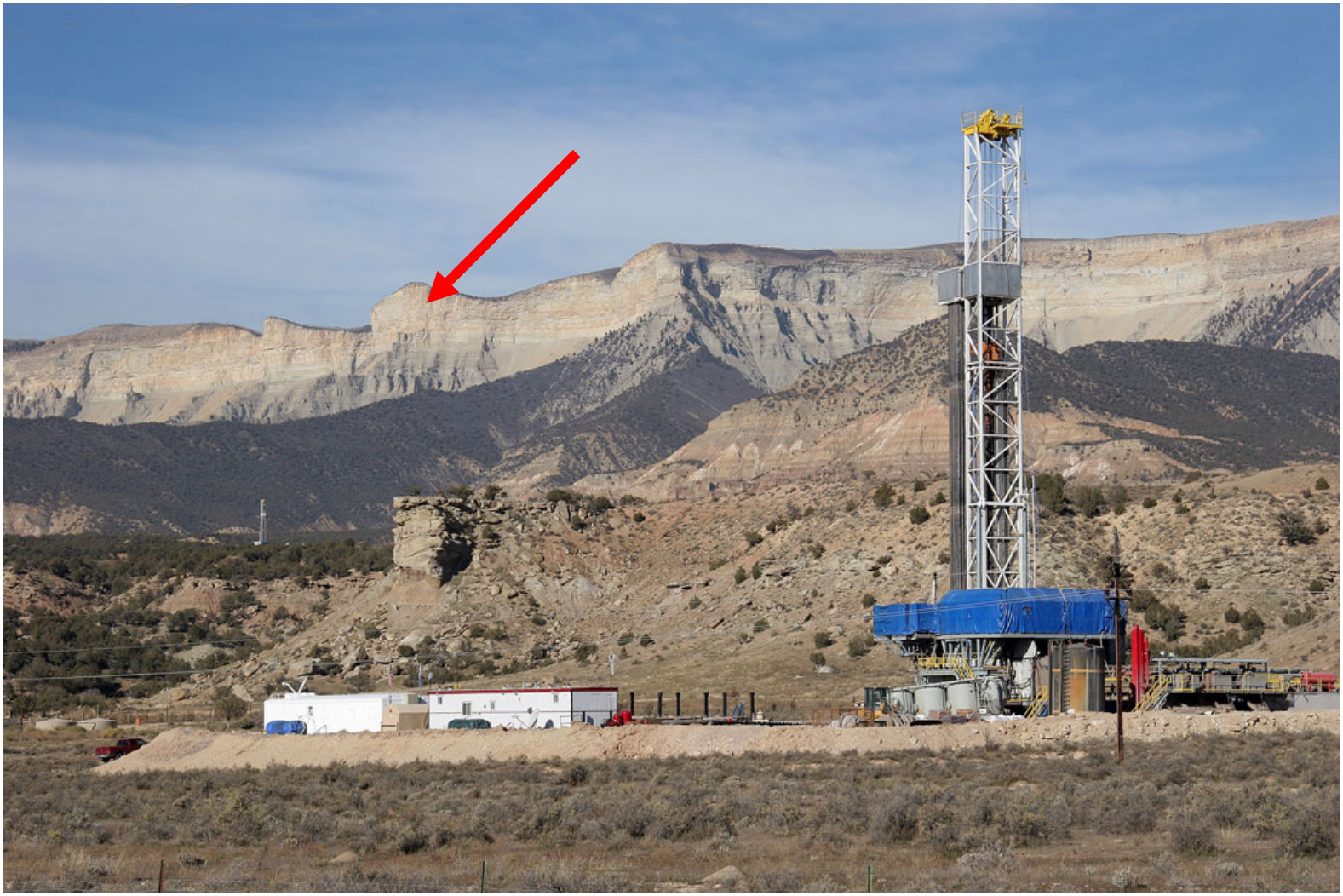
Source: BP Annual Energy Report

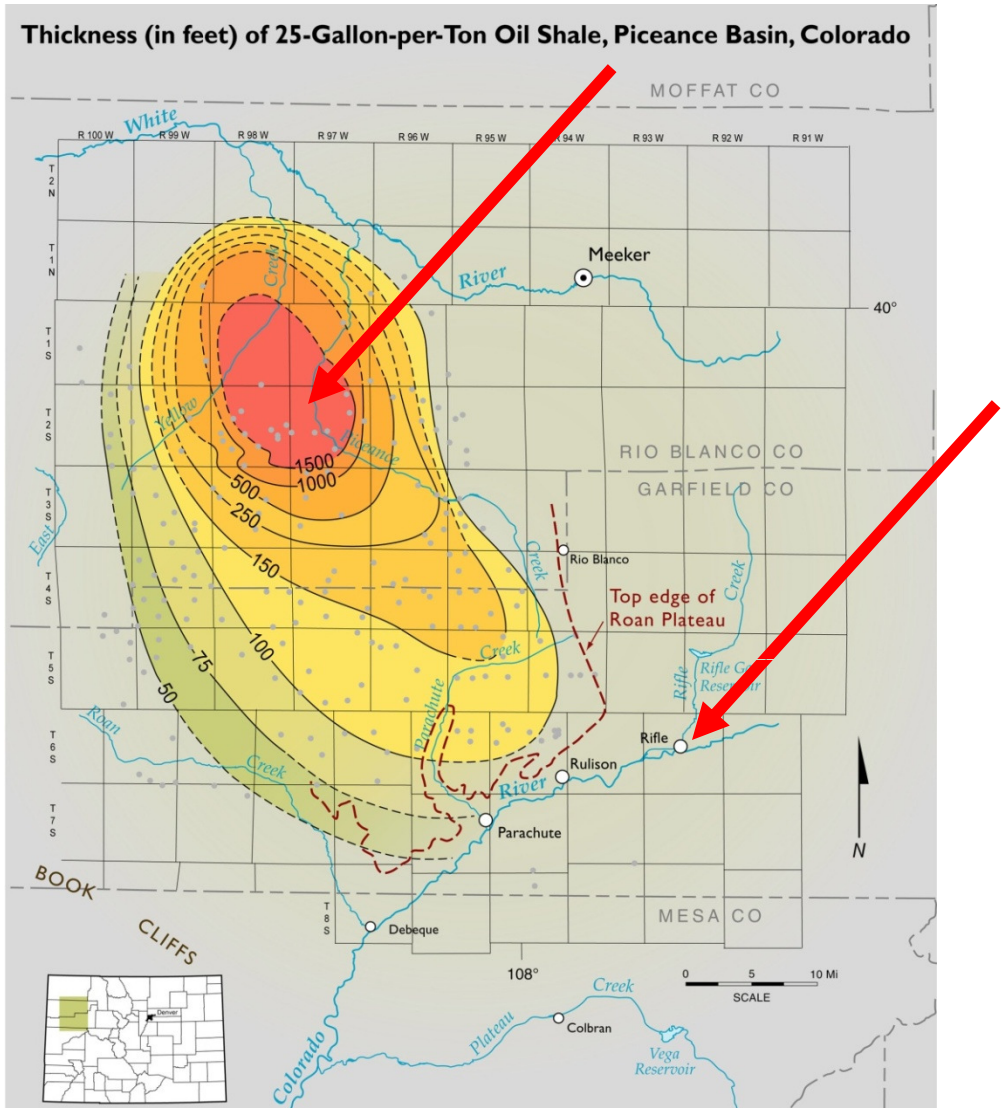

edSTEIN '10
FOR PEAK OIL
REVIEW
I TOLD YOU TO GET A HYBRID!
WORLD OIL SUPPLY
CHINA
GAS
USA

Crude Oil Prices

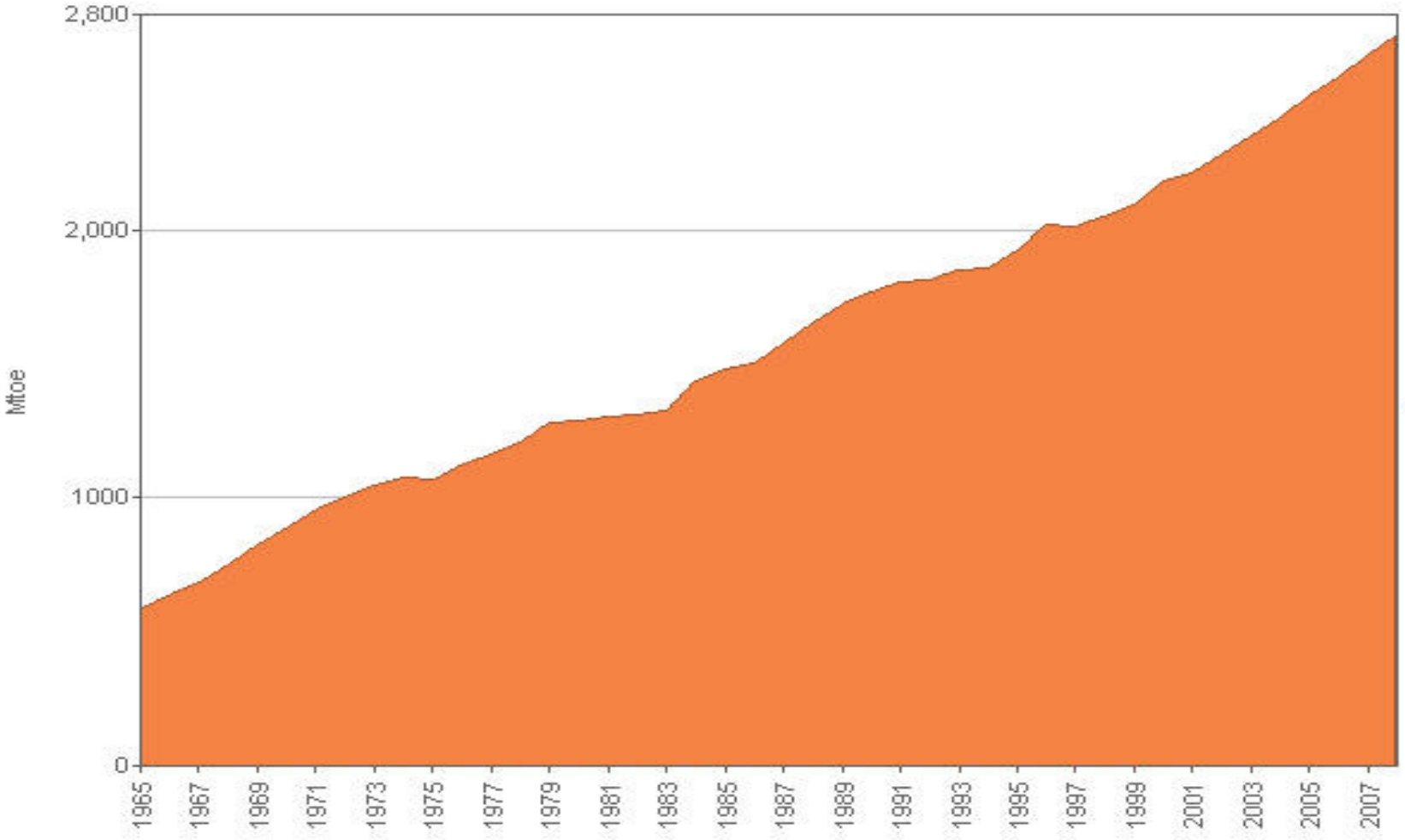


Oil shale is being seriously re-appraised.

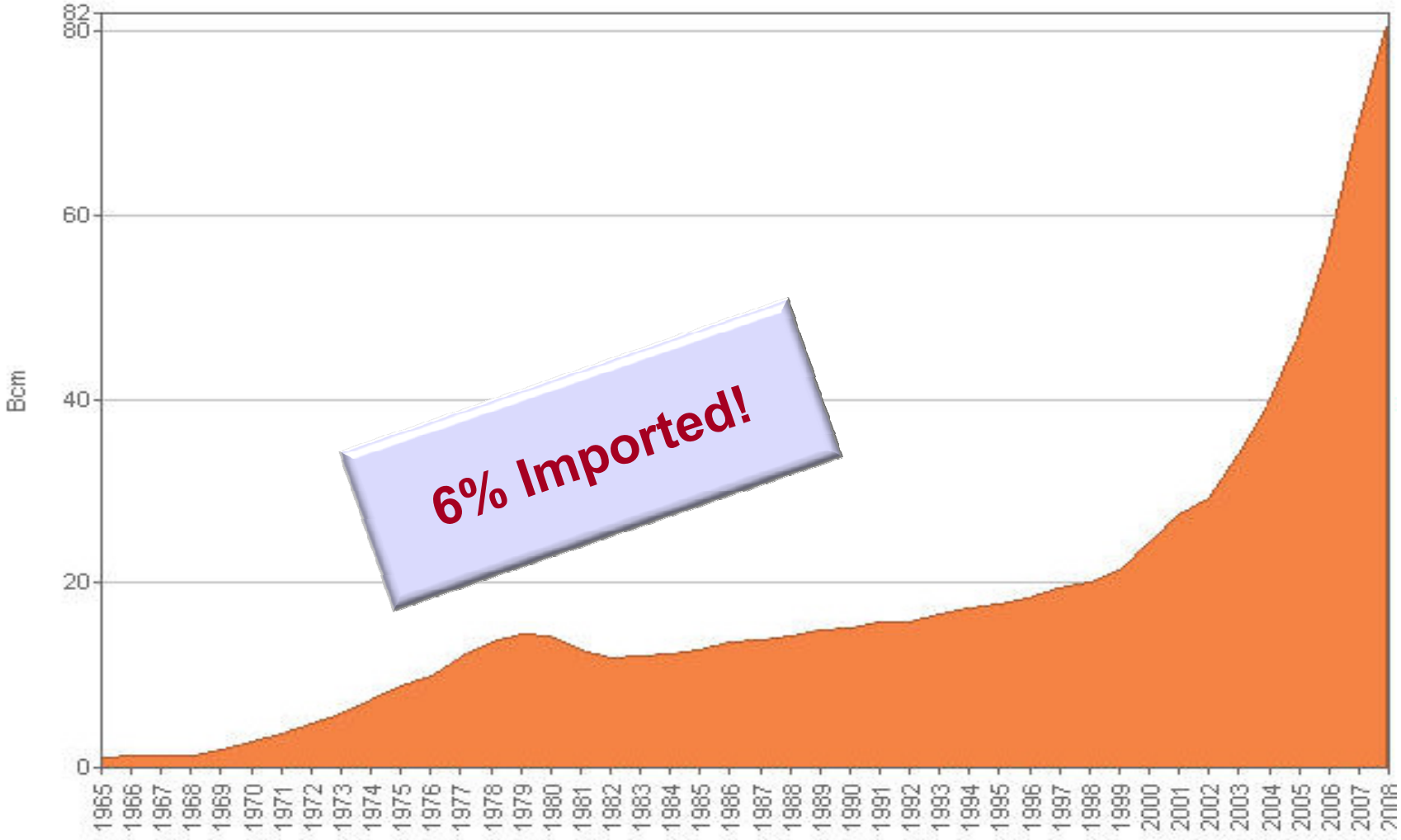



Thickness (in feet) of 25-Gallon-per-Ton Oil Shale, Piceance Basin, Colorado
MOFFAT CO
RIO BLANCO CO
GARFIELD CO
MESA CO
BOOK CLIFFS
Meeker
Rio Blanco
Rifle
Rulison
Parachute
Debeque
Colbran
Top edge of Roan Plateau
1500
1000
500
250
150
100
75
50
40°
108°
N
0 5 10 Mi
SCALE
White River
Yellow Jacket Creek
East Creek
Roan Creek
Parachute Creek
Rifle Creek
Plateau Creek
Colorado River
Vega Reservoir

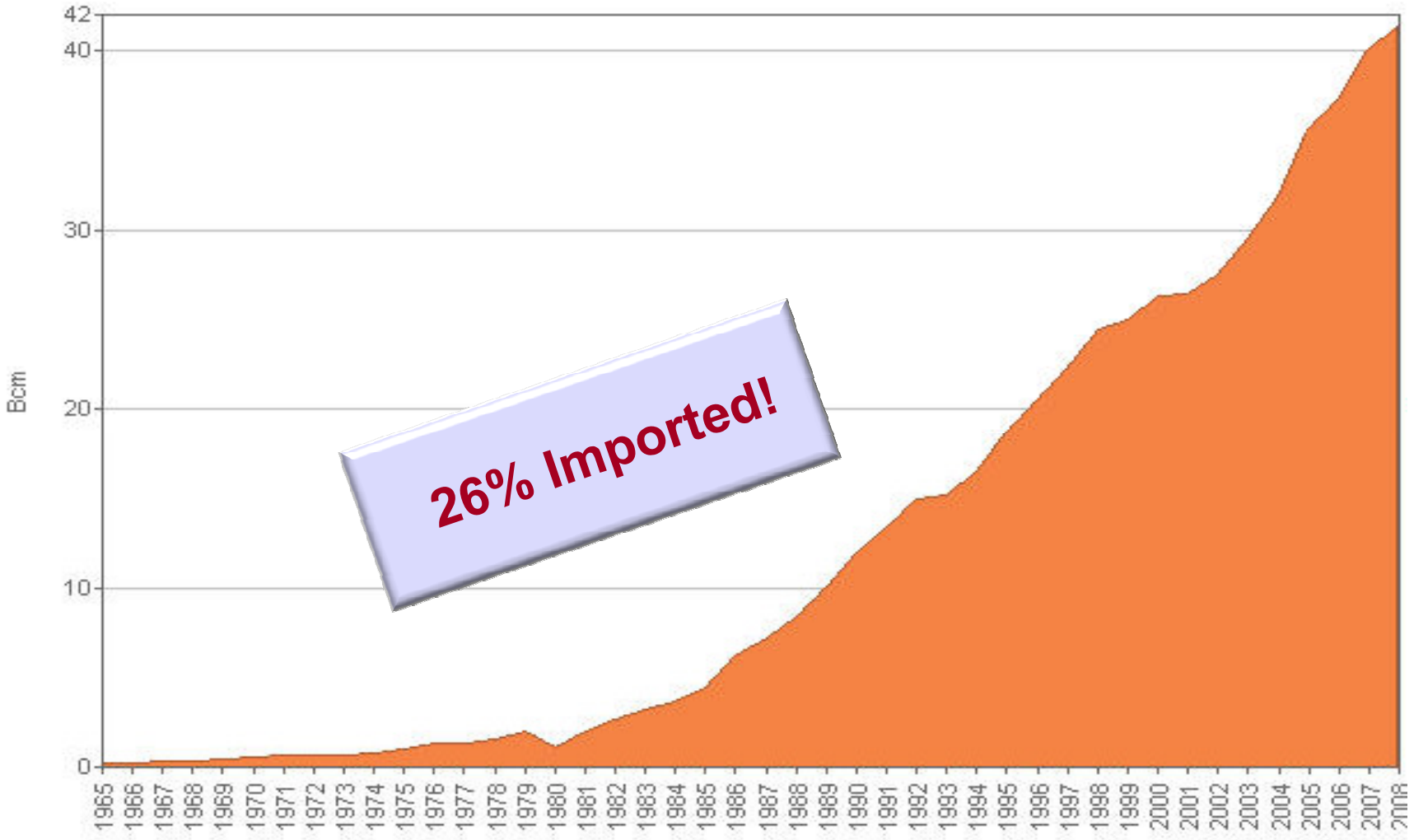
World Natural Gas Consumption



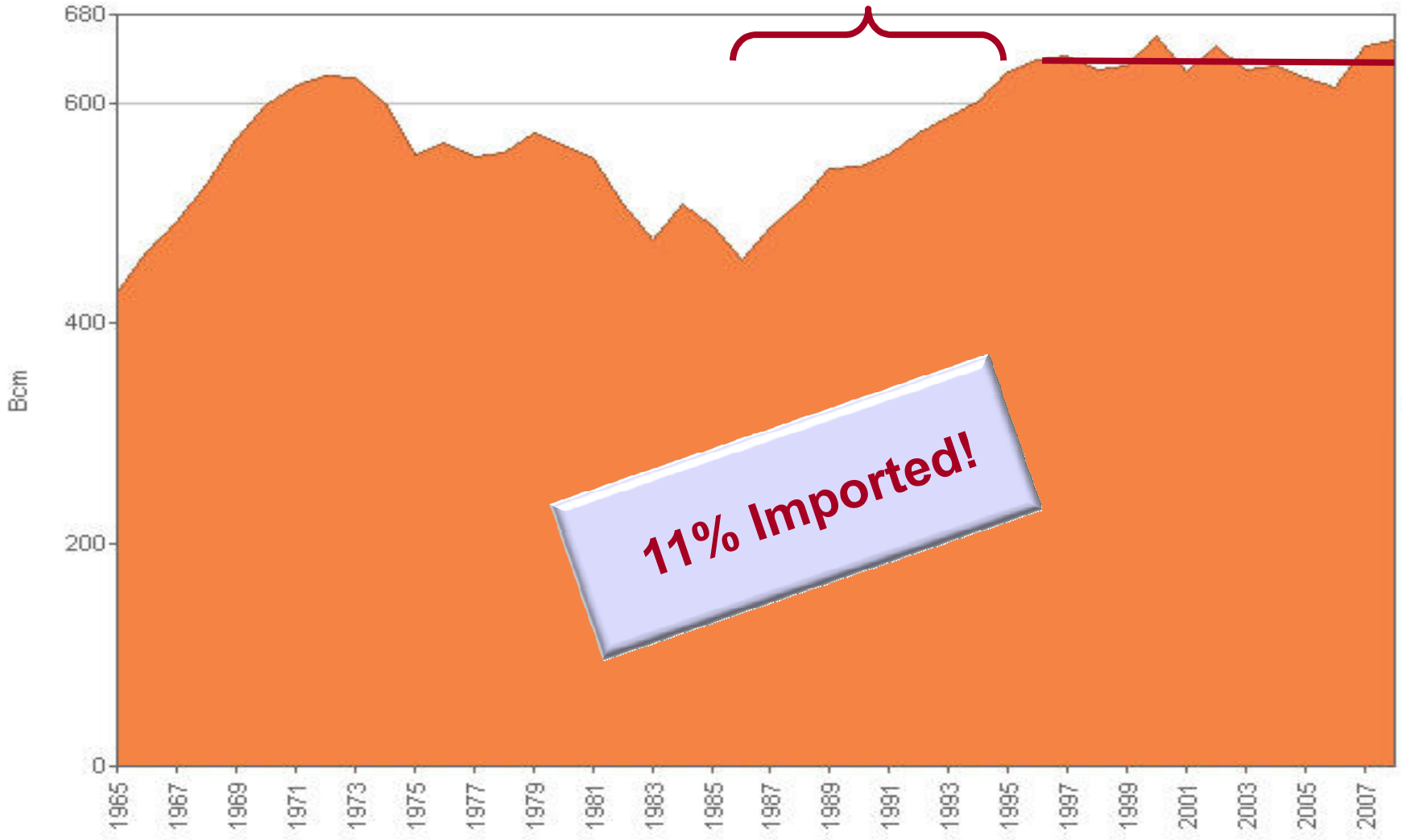
NATURAL GAS CONSUMPTION - China



NATURAL GAS CONSUMPTION- India



NATURAL GAS CONSUMPTION - U.S.



Natural Gas – America's Silver Bullet?

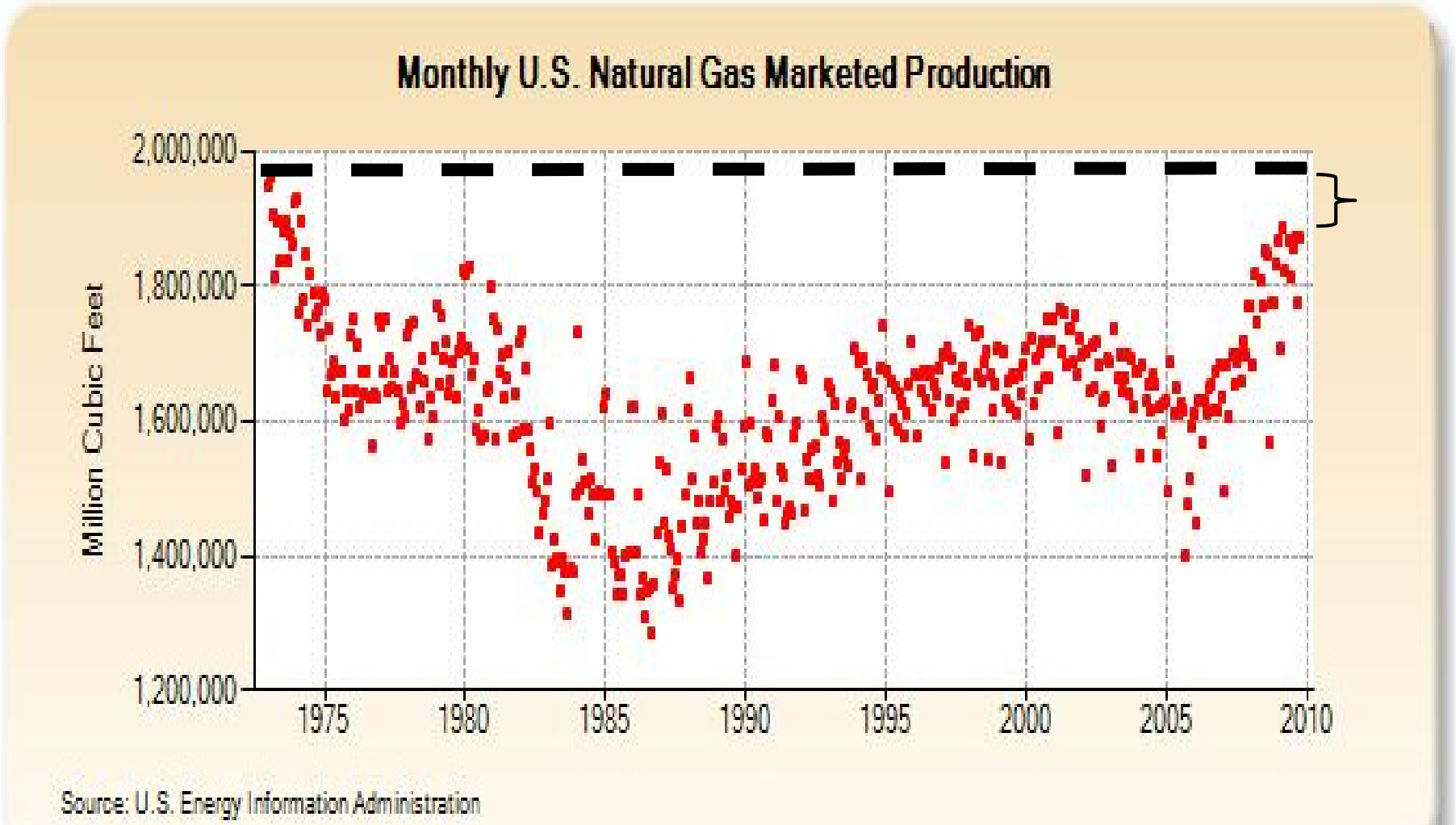
Natural Gas

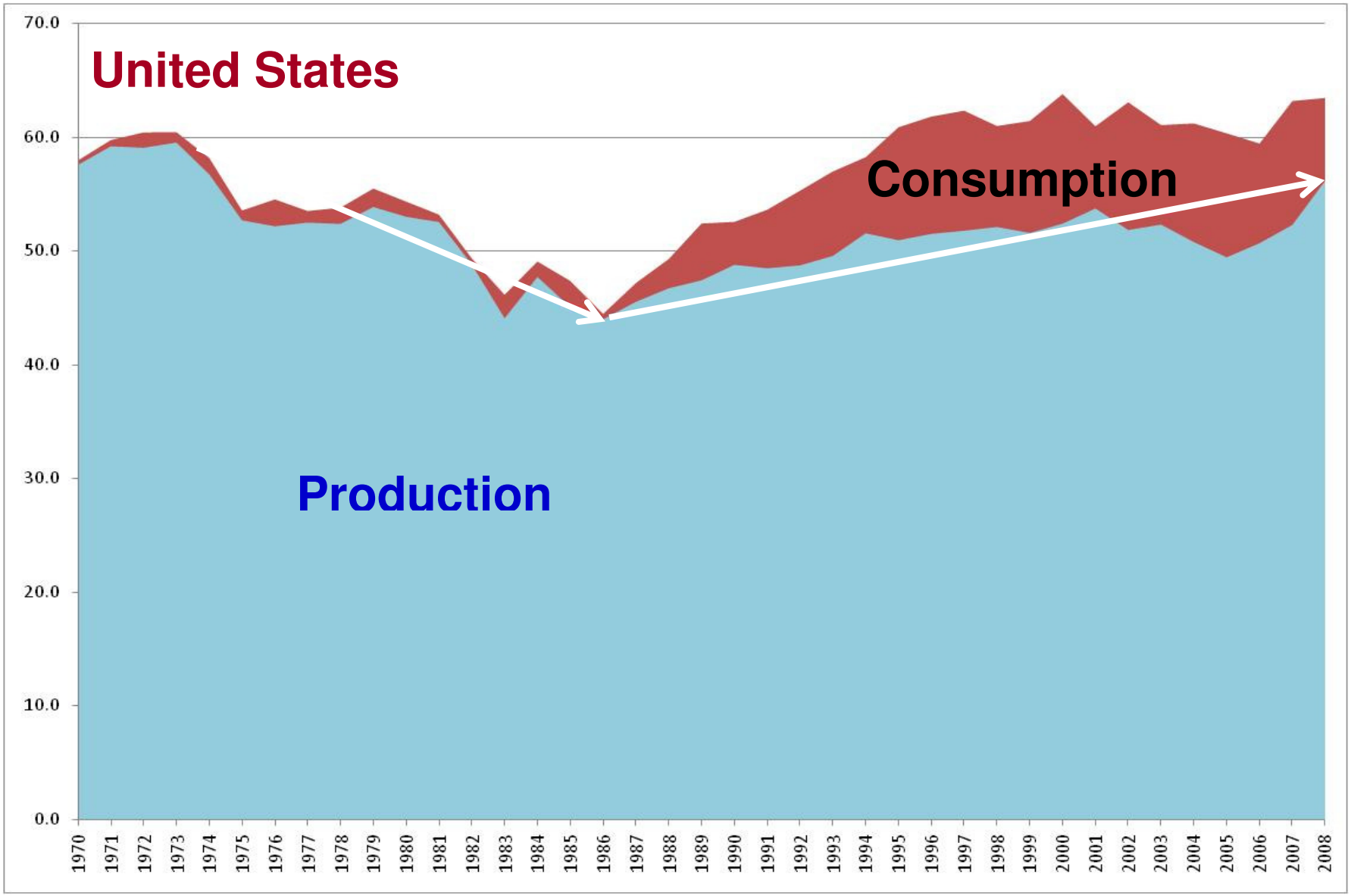
Clean Burning!

Unlimited Supply!

Cheap!

Low Carbon Footprint!


Monthly U.S. Natural Gas Marketed Production
Million Cubic Feet
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1975
1980
1985
1990
1995
2000
2005
2010
Source: U.S. Energy Information Administration


United States
Consumption
Production
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
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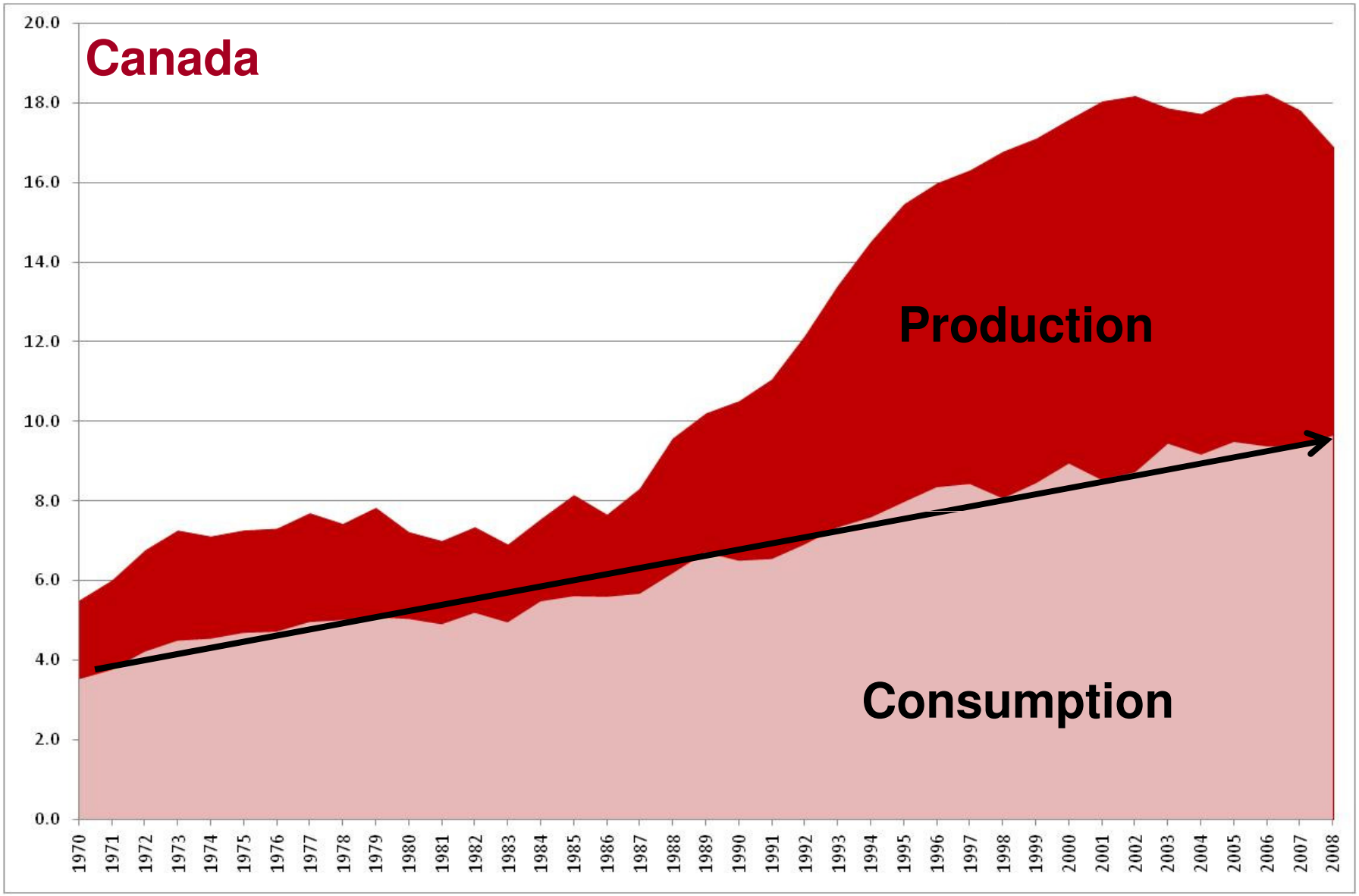
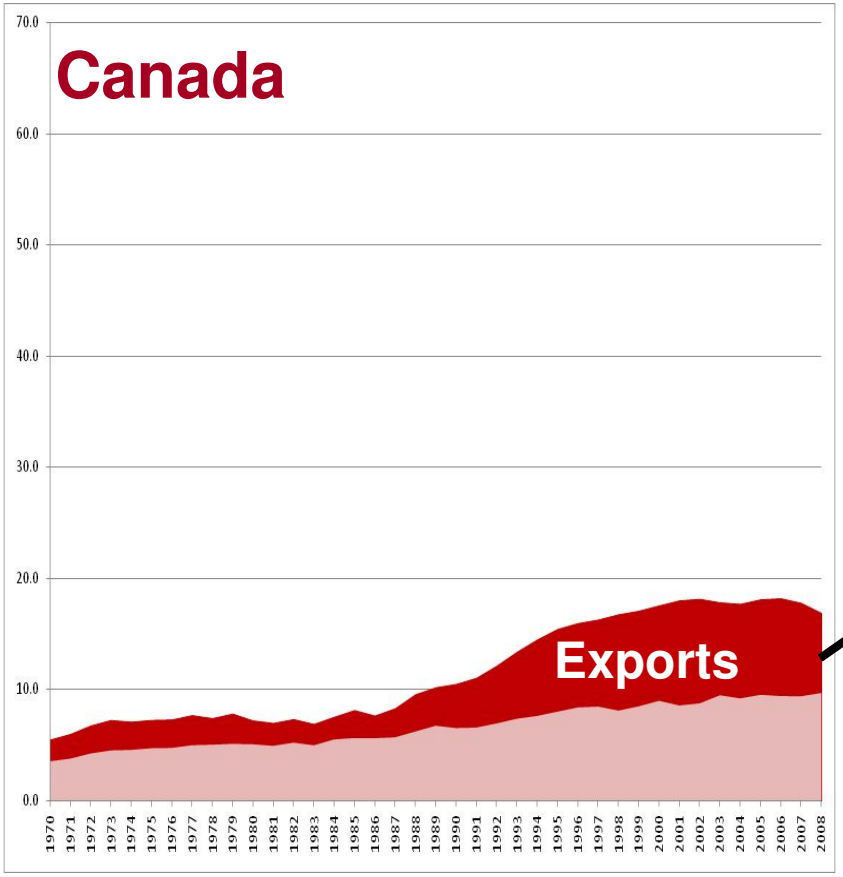
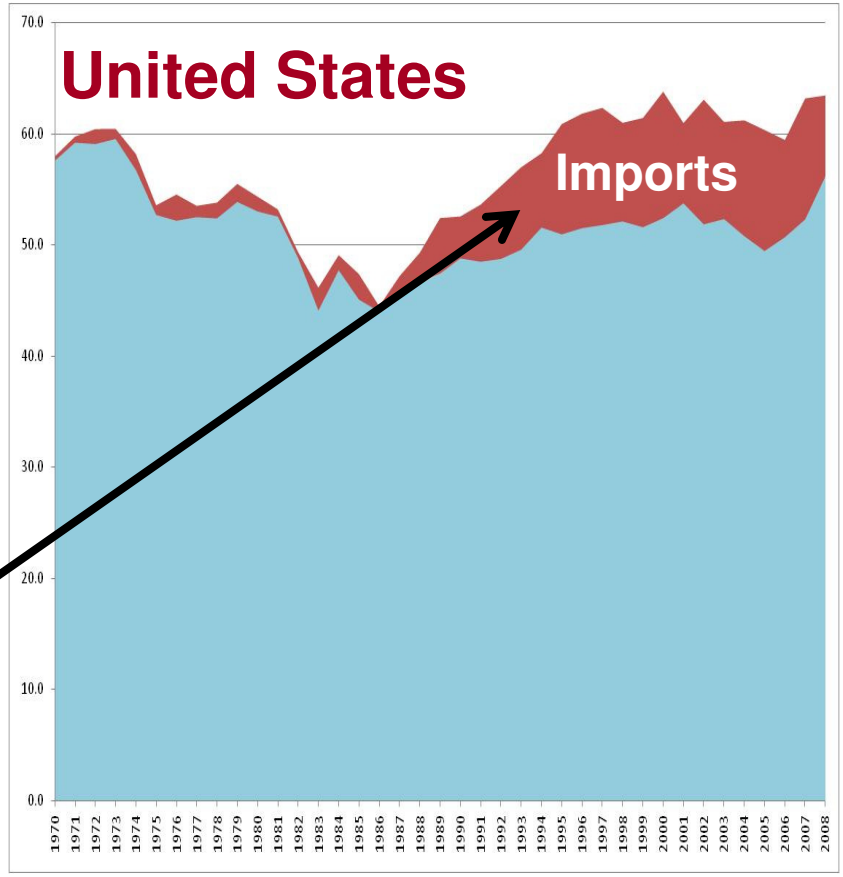
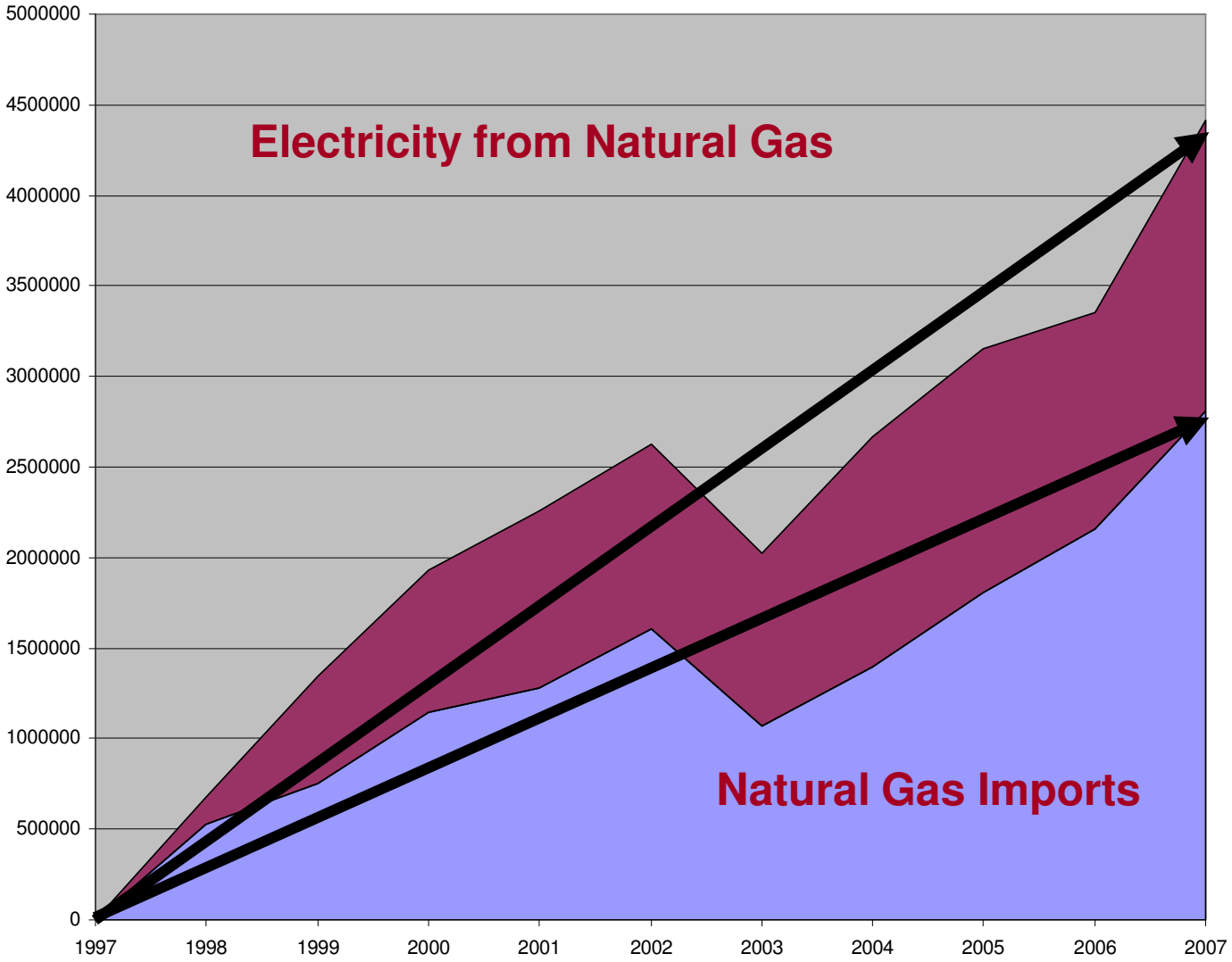
2004
2005
2006
2007
2008


Canada
Production
Consumption
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

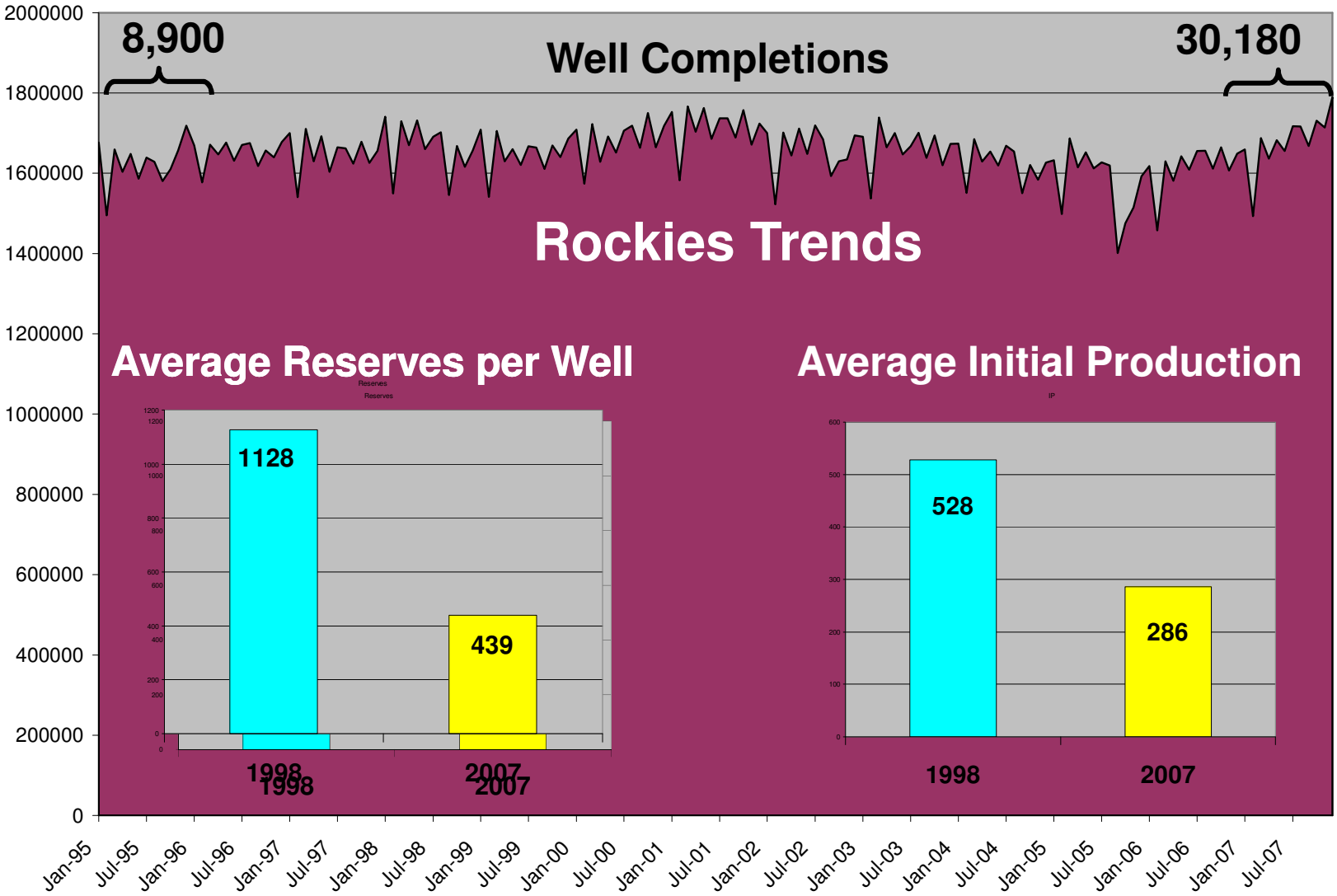

Canada
Exports
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008


United States
Imports
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

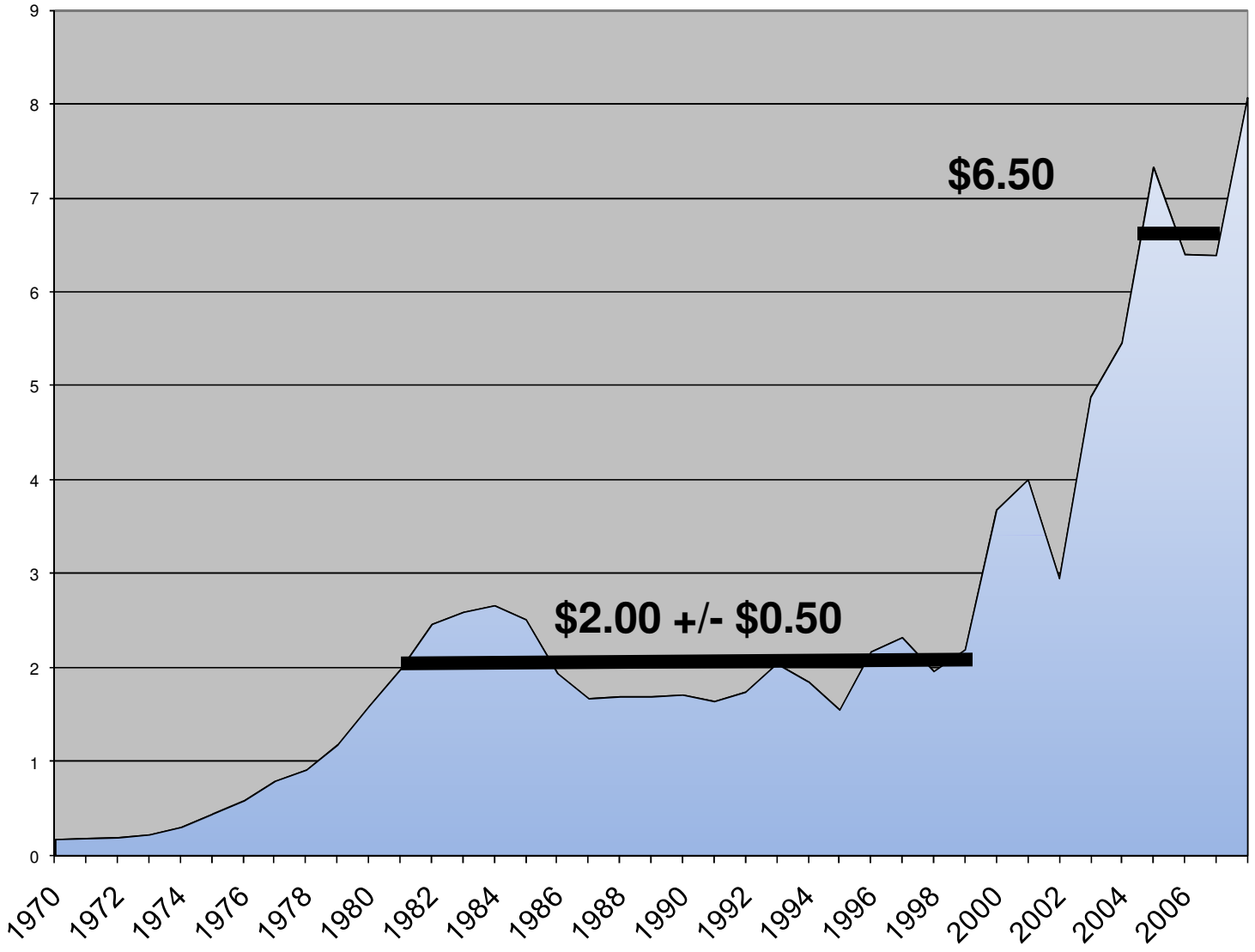
Natural Gas Electrical Generation vs Natural Gas Imports



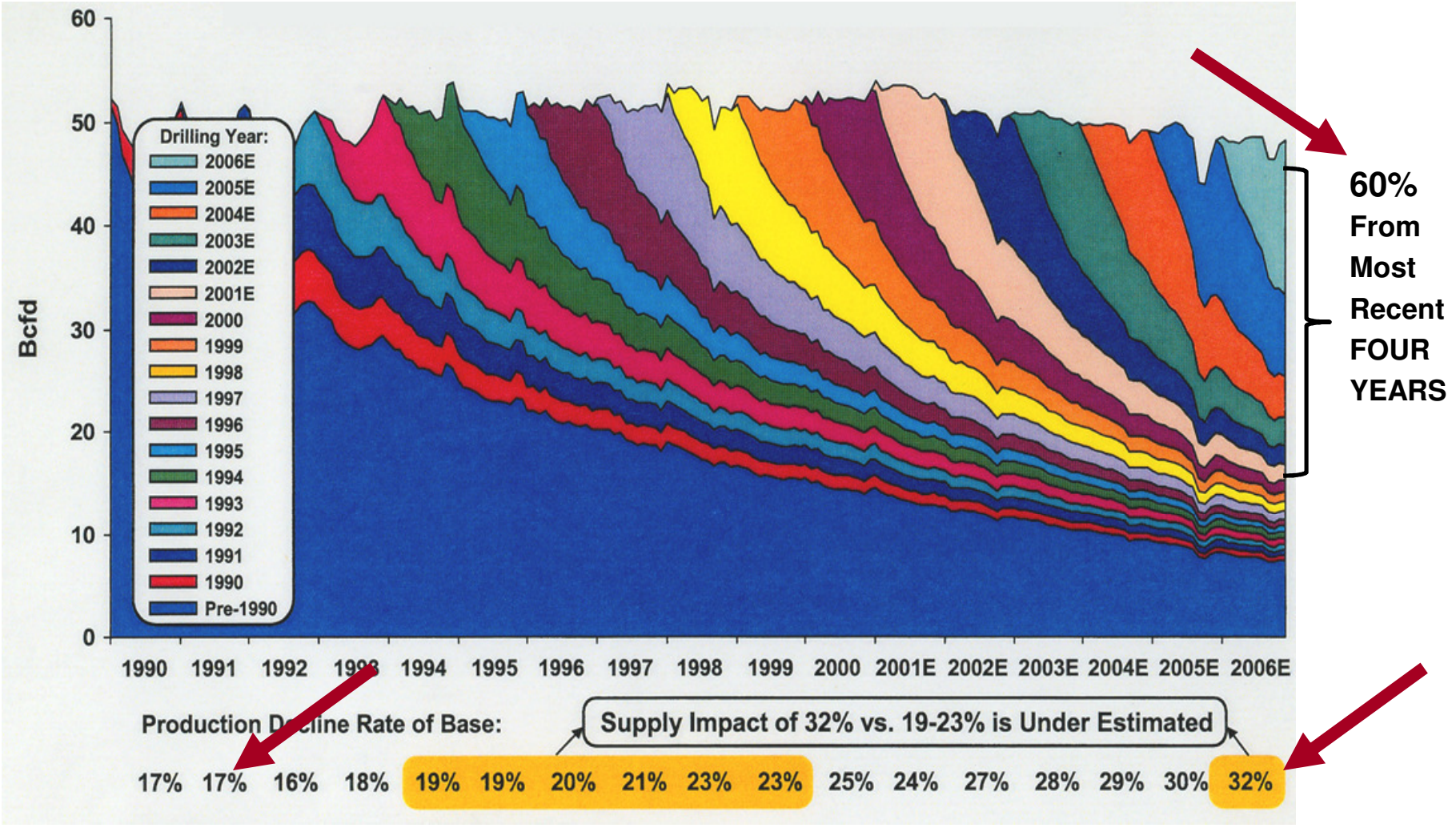
U.S. Monthly Natural Gas Production



Natural Gas Prices



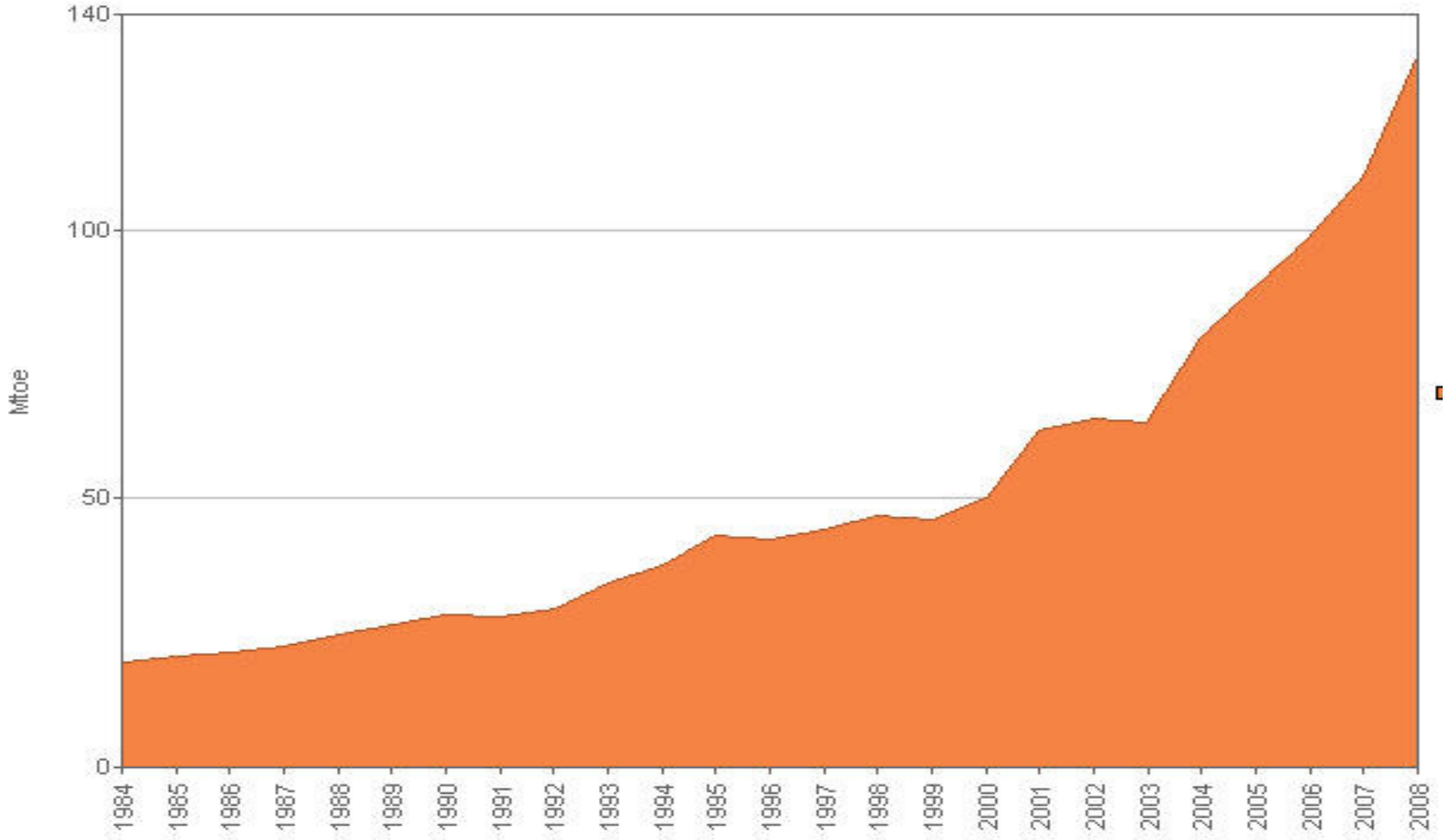
Natural Gas – America's Silver Bullet?


Bcfd
60
50
40
30
20
10
0
Drilling Year:
2006E
2005E
2004E
2003E
2002E
2001E
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
Pre-1990
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001E 2002E 2003E 2004E 2005E 2006E
60% From Most Recent FOUR YEARS
Production Decline Rate of Base:
Supply Impact of 32% vs. 19-23% is Under Estimated
17% 17% 16% 18% 19% 19% 20% 21% 23% 23% 25% 24% 27% 28% 29% 30% 32%

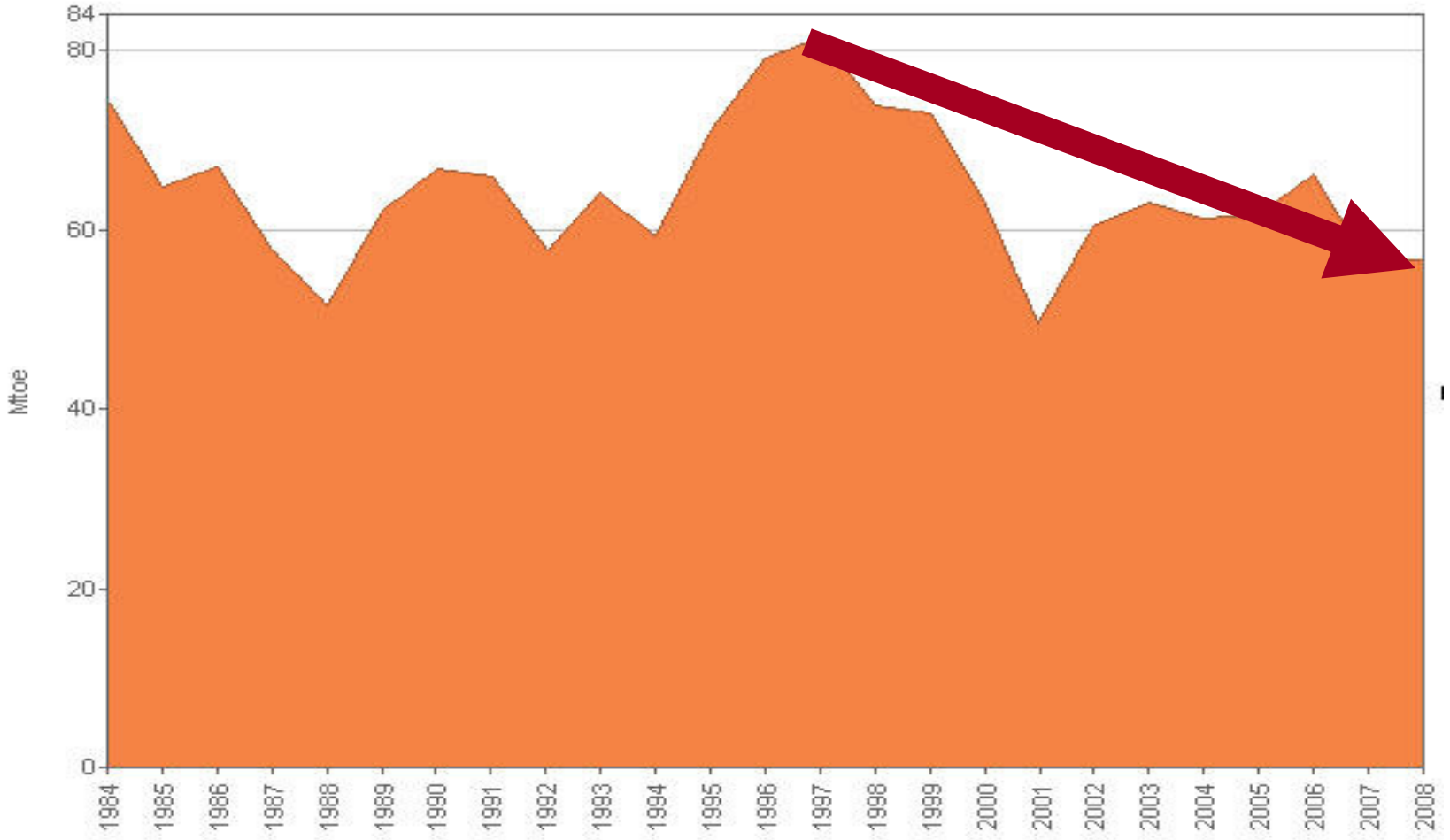
Natural Gas – America's Silver Bullet?


Oil
Conservation
Natural Gas
Wind
Solar
Geothermal
Biomass
Efficiency
Coal
Hydro
Nuclear

Hydro Generation - China



Hydro Generation – U.S.



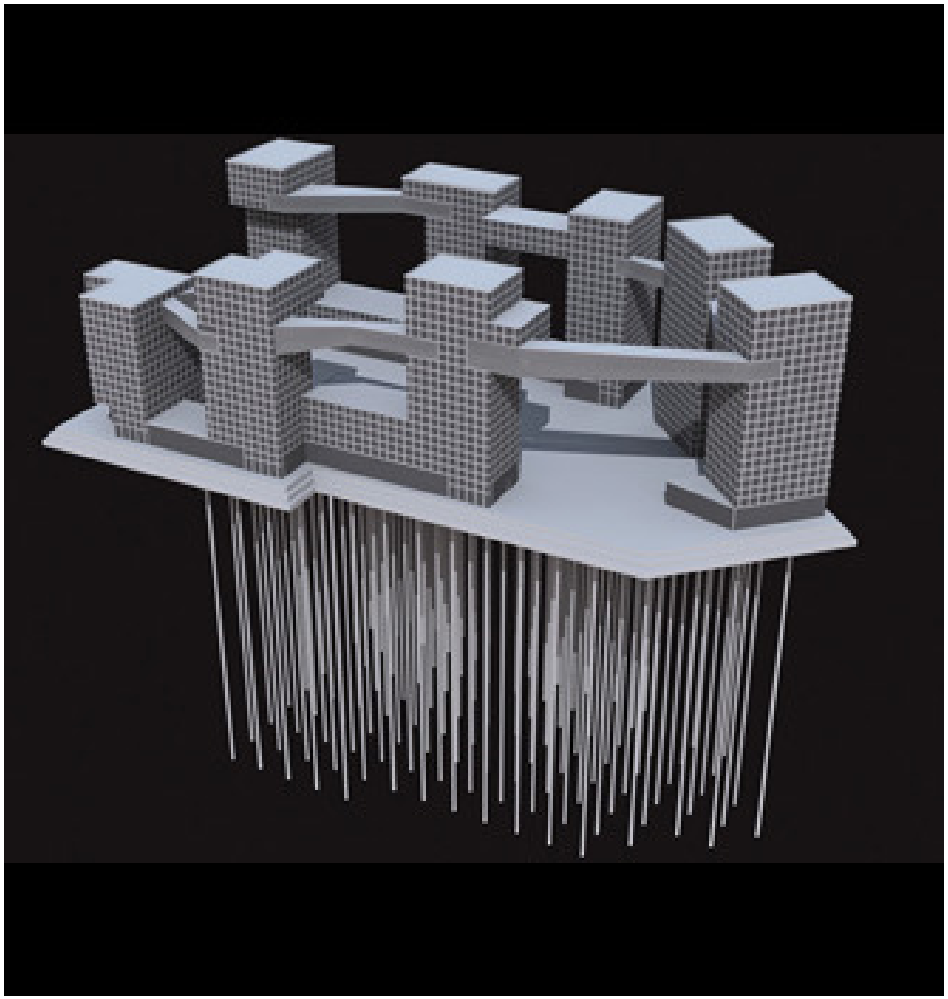
Geothermal Energy

Direct Use

Geoexchange Heat Pumps

STEVEN HOLL ARCHITECTS LINKED HYBRID PROJECT

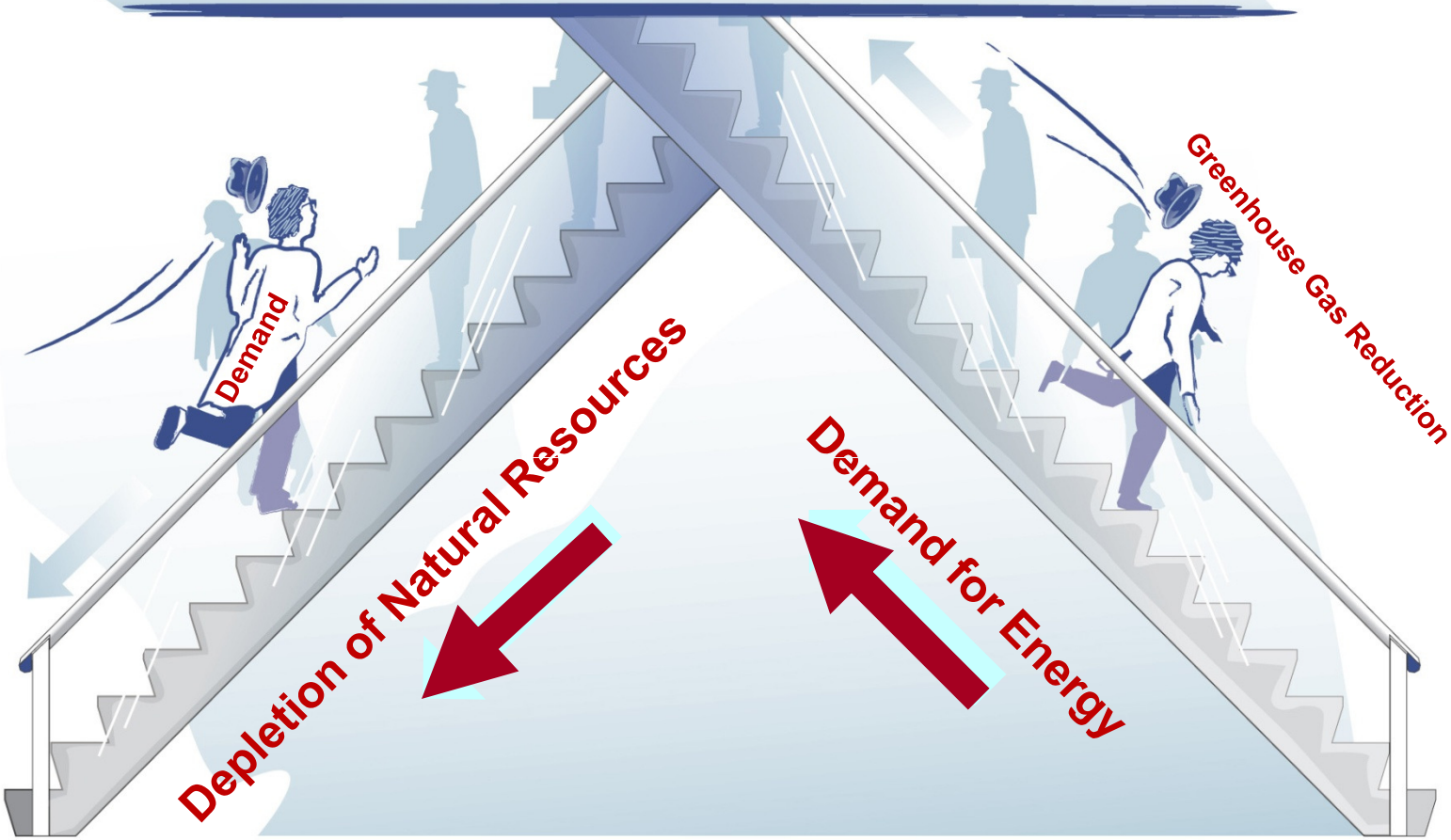
THE LARGEST GEOTHERMAL HOUSING COMPLEX



Below the 690 apartments—not to mention the gyms, bars, dry cleaners and movie theater—that make up the 15-acre Linked Hybrid residential complex in Beijing, China, are 660 geothermal wells that eliminate the need for air conditioners and boilers. Each well funnels water 325 feet beneath the ground into bedrock, where the constant 55ºF temperature either heats or cools it before it's pumped back to the surface and piped through the building's concrete floors. The system will reduce energy costs by up to 30 percent in the summer and up to 40 percent in the winter.

The Escalator Dilemma

Natural Forces are Working Against Our Goals



The future is here!

Are we ready?

“The world is a football field now and you’ve got to be sharp to be on the team which plays on that field.

If you’re not good enough, you’re going to be sitting and watching the game. That’s all.”

--Rajesh Rao, founder and CEO of Dhurva Interactive

The End!

Of the talk, that is.