

FREEZING IN THE DARK

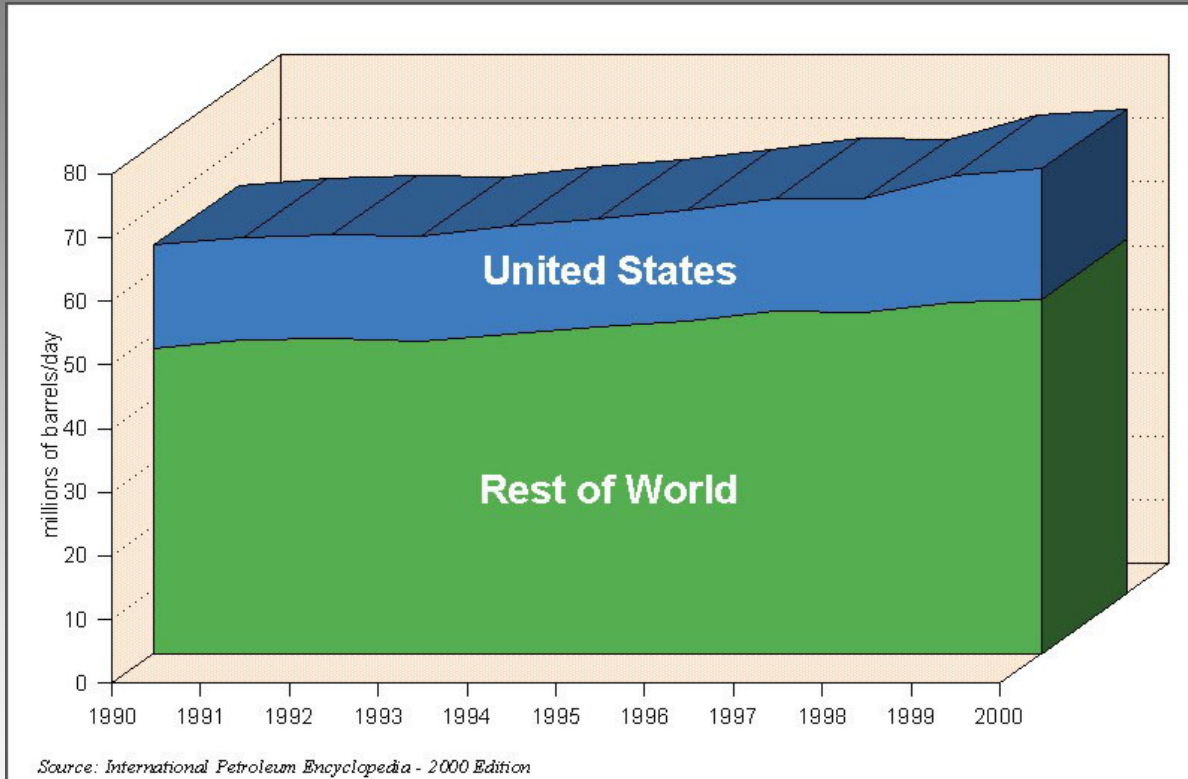
The Global Outlook for Oil Supplies

Adapted from a presentation by E. Hunter Herron before the

**National Capital Section of the
Society of Petroleum Engineers**

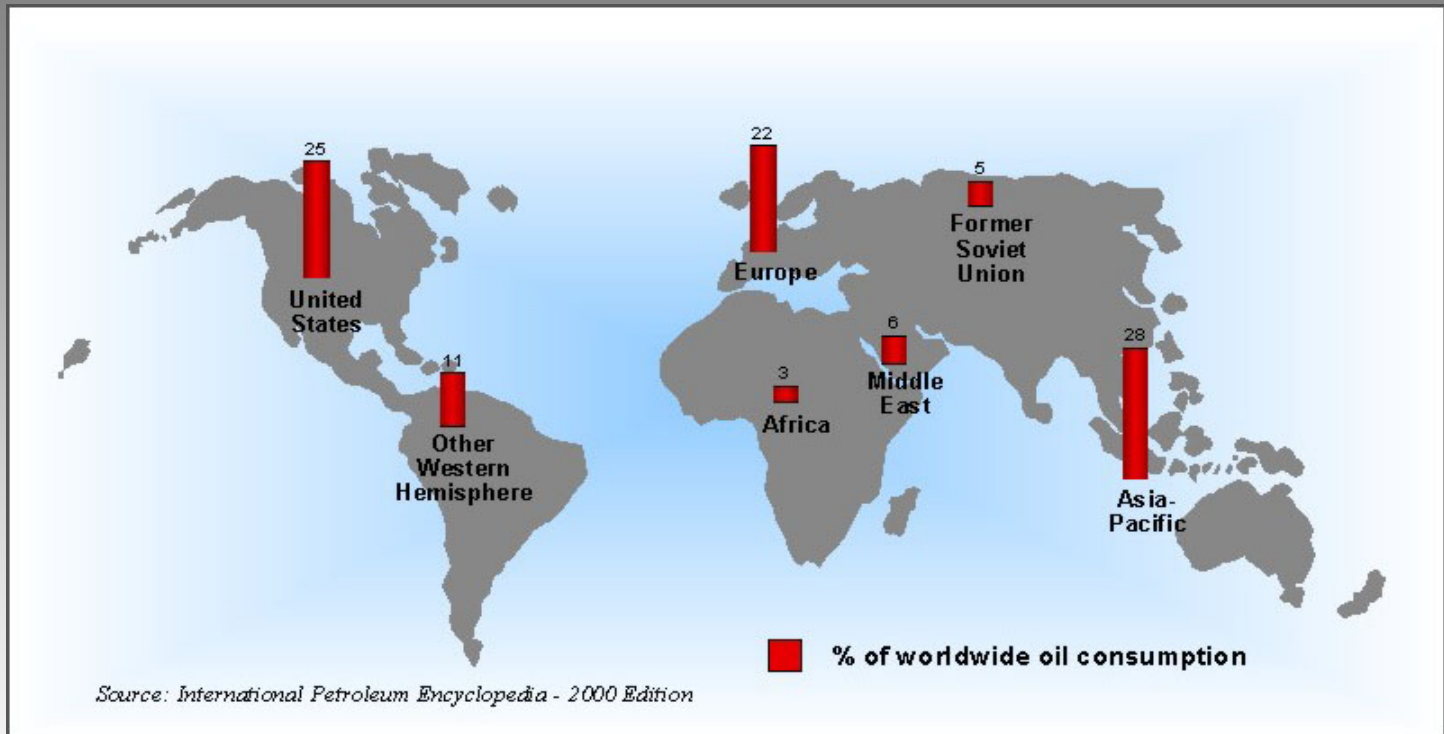
**Arlington, Virginia
April 2002**

Worldwide Oil Consumption



For more than a decade, worldwide consumption of crude oil has grown steadily with the U.S. consistently accounting for one-quarter of all the oil consumed...

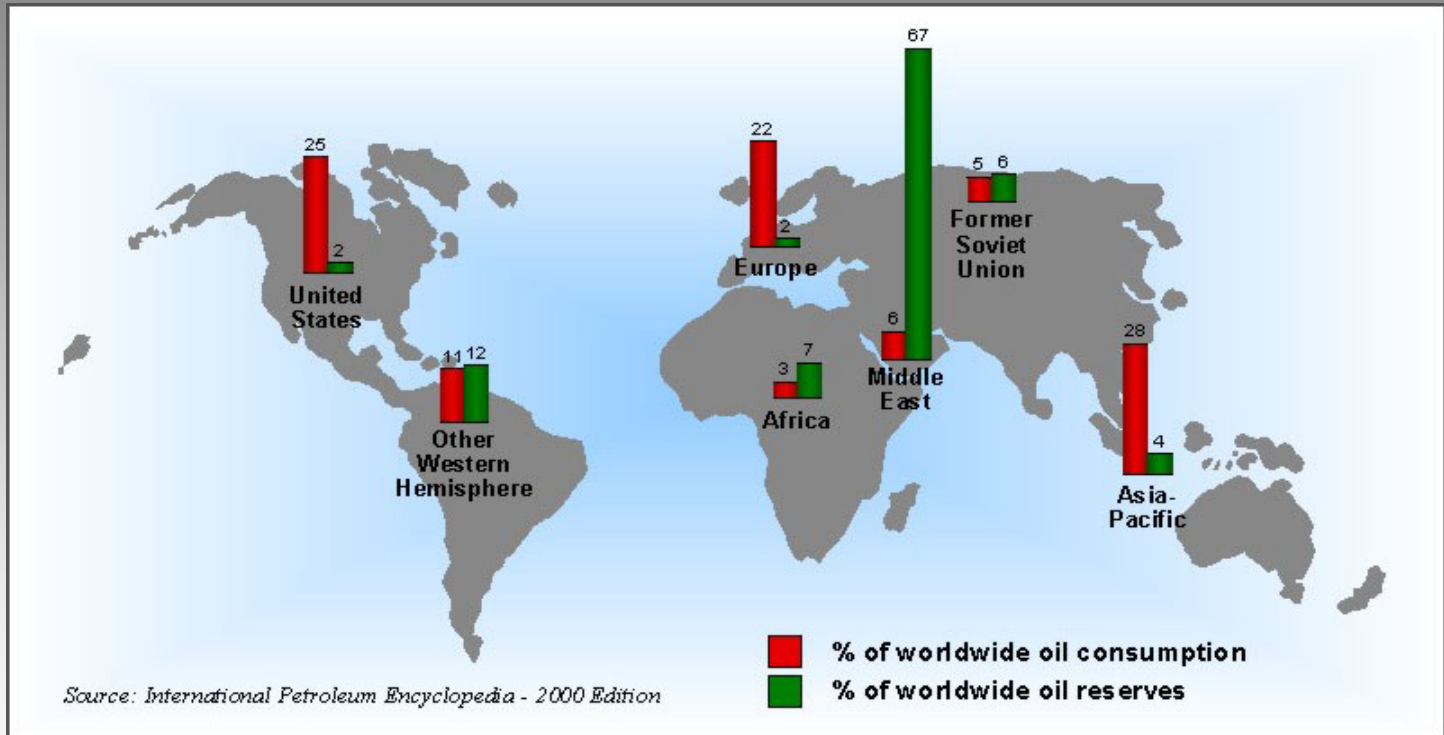
Worldwide Oil Consumption



...but the U.S. is not the only major consumer of crude oil. Europe and the Asia Pacific region each also account for about one-quarter of the world's total consumption.

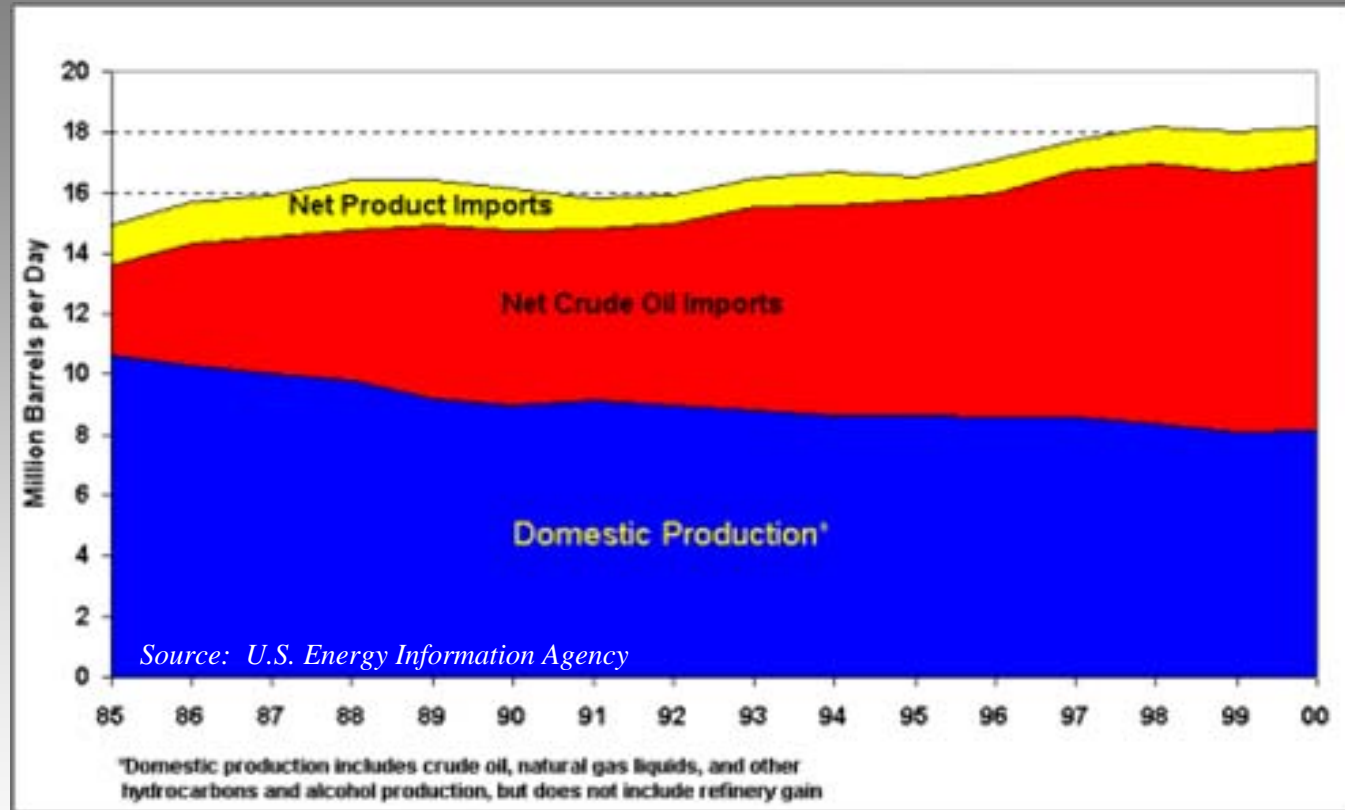
Worldwide Oil Consumption

Worldwide Oil Reserves



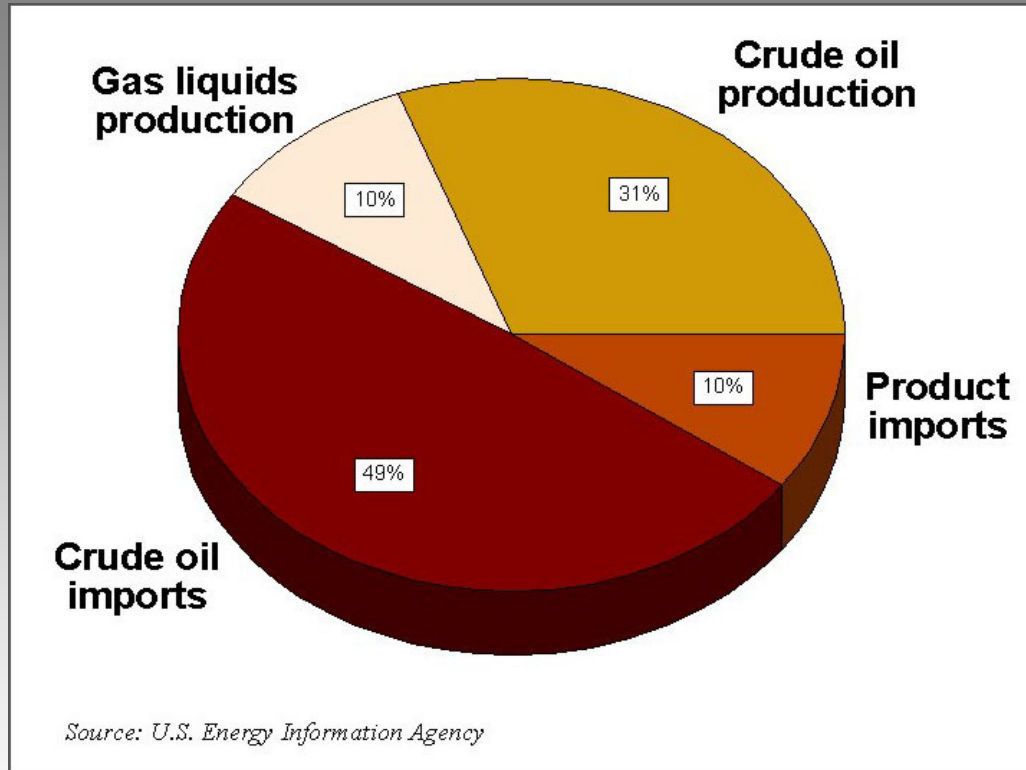
Although the three major oil-consuming regions account for three-quarters of the world's crude oil consumption, they have only eight percent of the world's remaining reserves.

Trend of U.S. Oil Supplies



In the U.S., declining domestic production of crude oil has been steadily replaced with increased oil imports for more than 15 years...

Distribution of U.S. Oil Supplies



...and domestic crude oil production now accounts for barely 30 percent of U.S. oil supplies.

OPEC Member Countries

Middle East

Abu Dhabi

Kuwait

Iran

Qatar

Iraq

Saudi Arabia

Other Eastern Hemisphere

Algeria

Libya

Indonesia

Nigeria

Western Hemisphere

Venezuela

Most of the major exporters of crude oil are members of OPEC.

Worldwide Oil Reserves and Production

<i>billions of barrels</i>	Remaining Reserves	Annual Production	Years of Remaining Production
Non-OPEC	214	16.8	13
OPEC	<u>814</u>	<u>11.3</u>	72
Total World	1,028	28.0	37

Source: *International Petroleum Encyclopedia, 2001 Edition*

If the world's remaining reserves of crude oil could continue to be produced at current rates, non-OPEC countries would run out of oil in 13 years. OPEC countries could produce for 72 years.

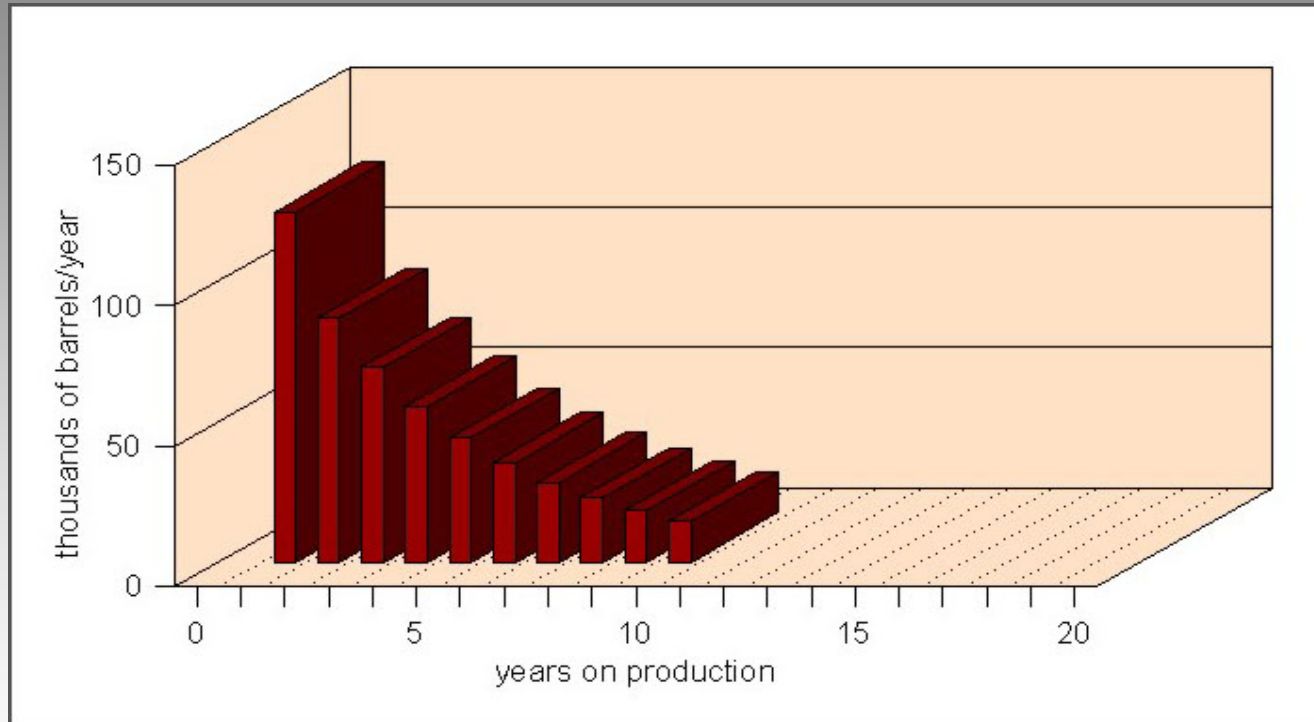
Worldwide Oil Reserves and Production

<i>billions of barrels</i>	<i>Production</i>	Years of Remaining Production
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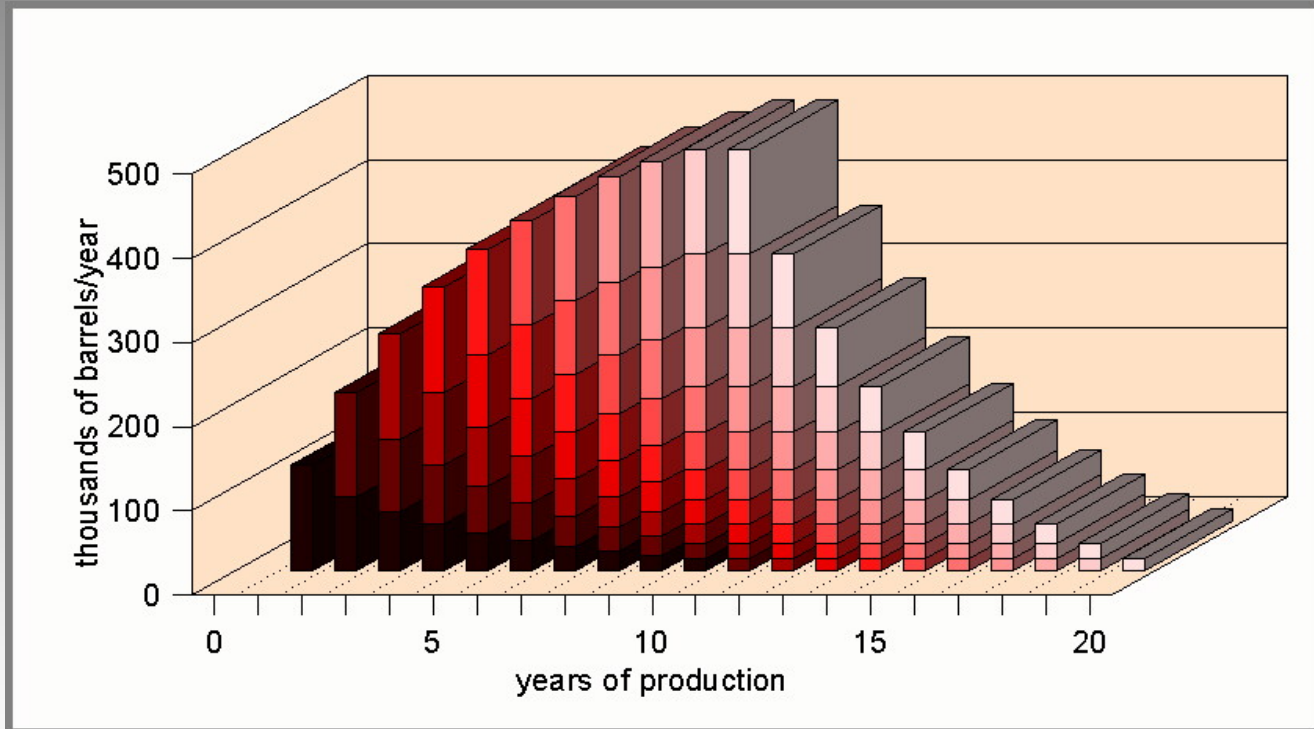
But oil reserves cannot be produced to depletion at constant rates!

Oil Production Profile: Single Well



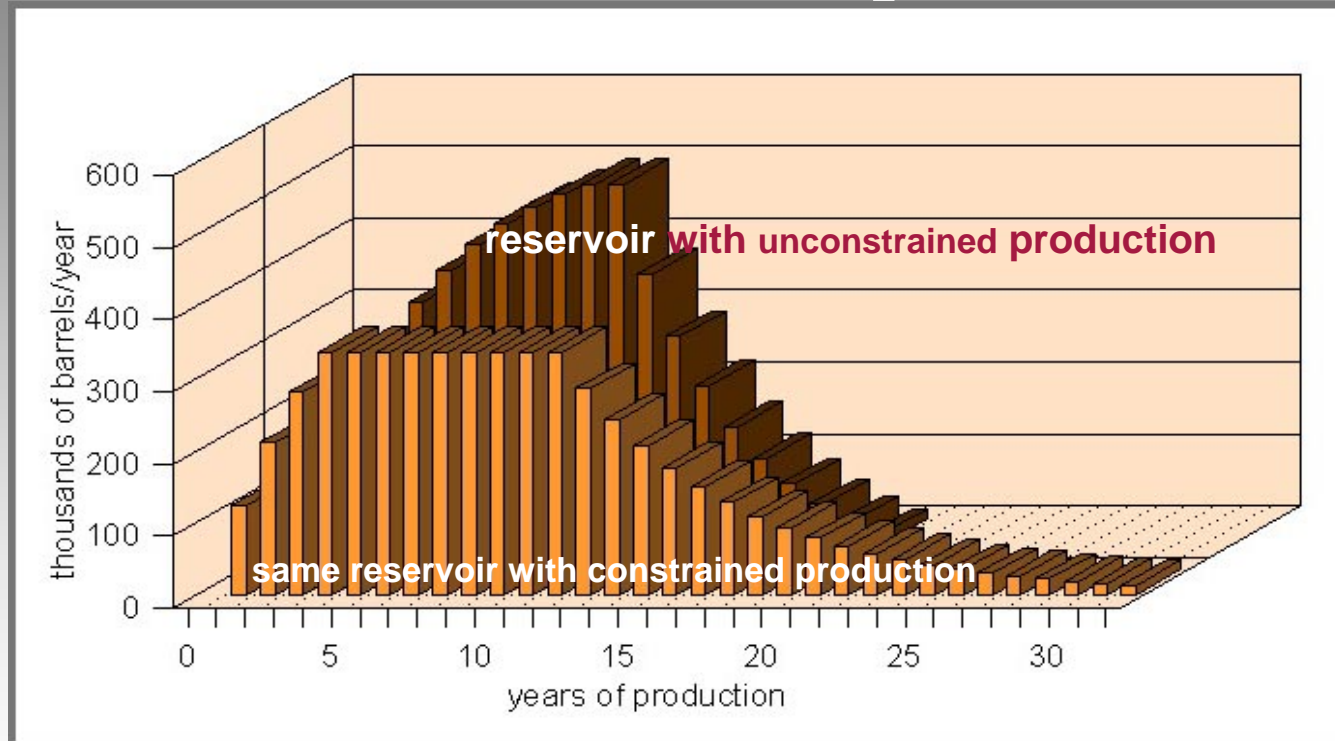
The physics of flow demand that the production rate of a well produced at its full potential will steadily decline as it is produced.

Oil Production Profile: Entire Reservoir



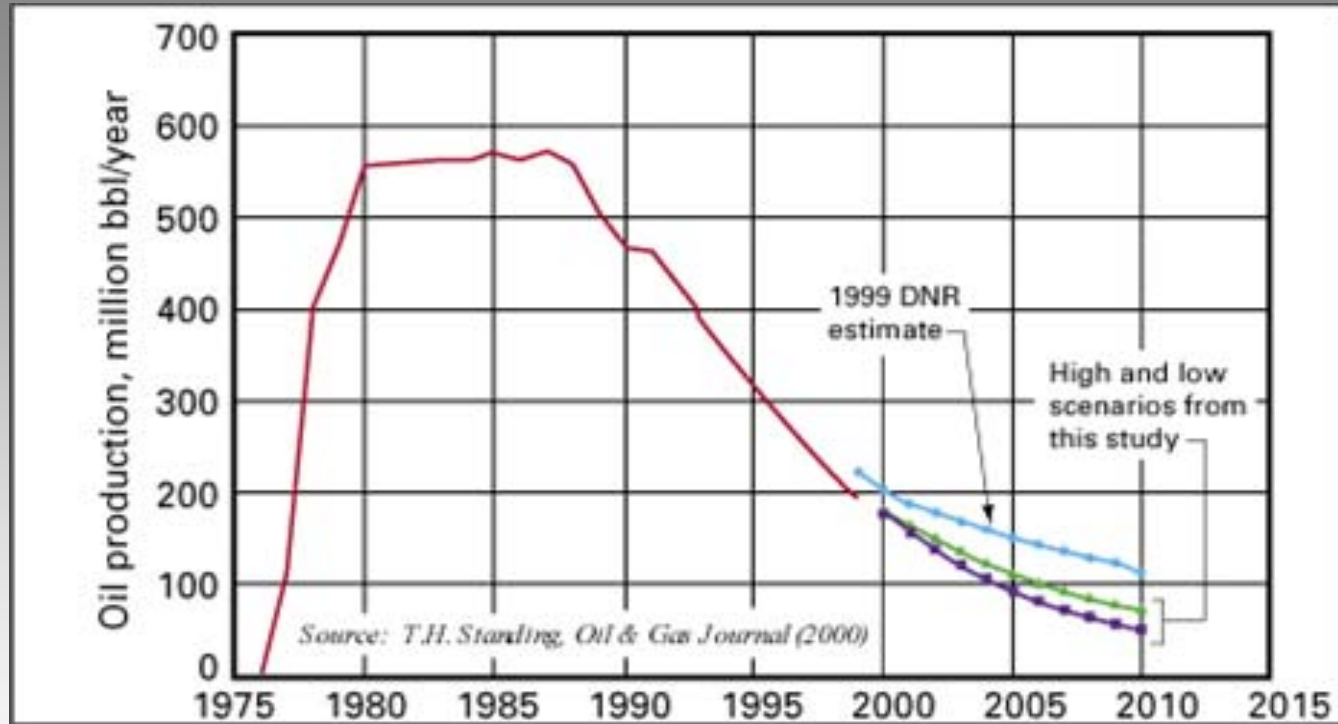
Since the production of every well declines as it is produced, production from an entire reservoir will decline as soon as no more new wells can be brought on production.

Oil Production Profile: Extended Development



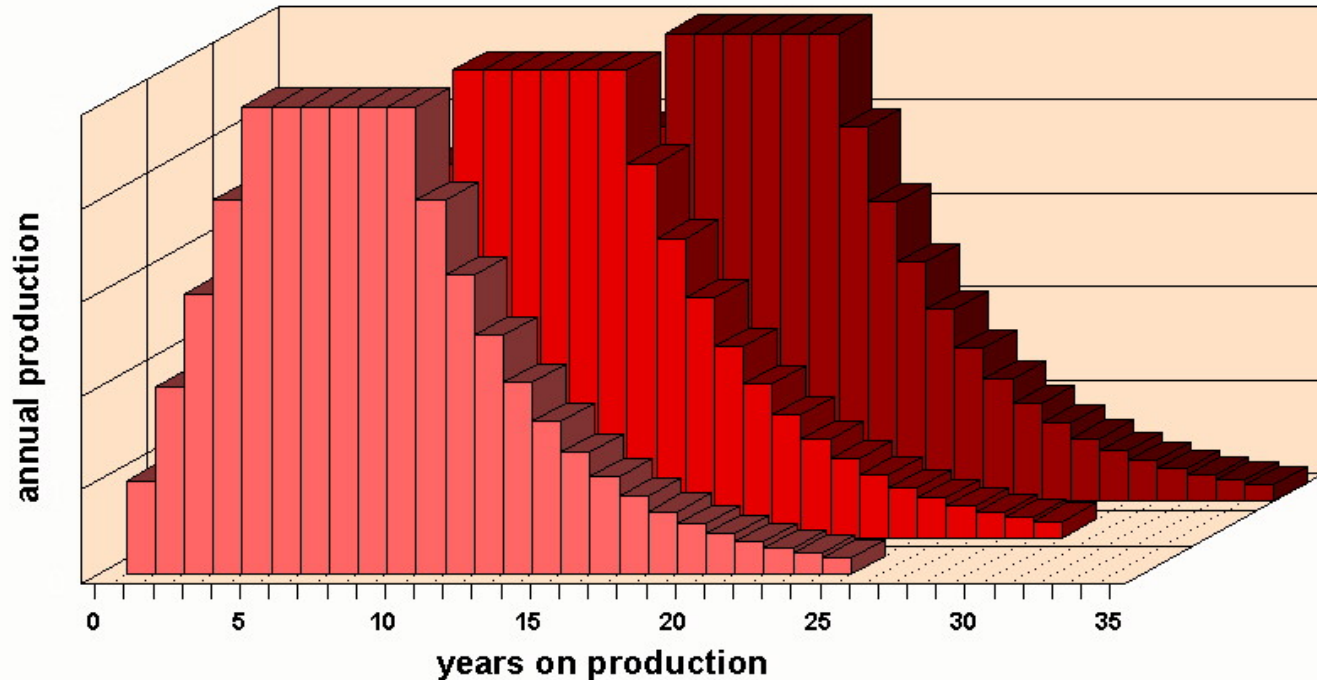
Since reservoir decline is unavoidable, an operator usually constrains production from a reservoir to reduce the facilities required to produce it and prolong the reservoir's life.

Prudhoe Bay Production Profile



Alaska's Prudhoe Bay Field displays the profile of constrained production: buildup, followed by plateau, followed by irreversible decline.

Theoretical Producing Province



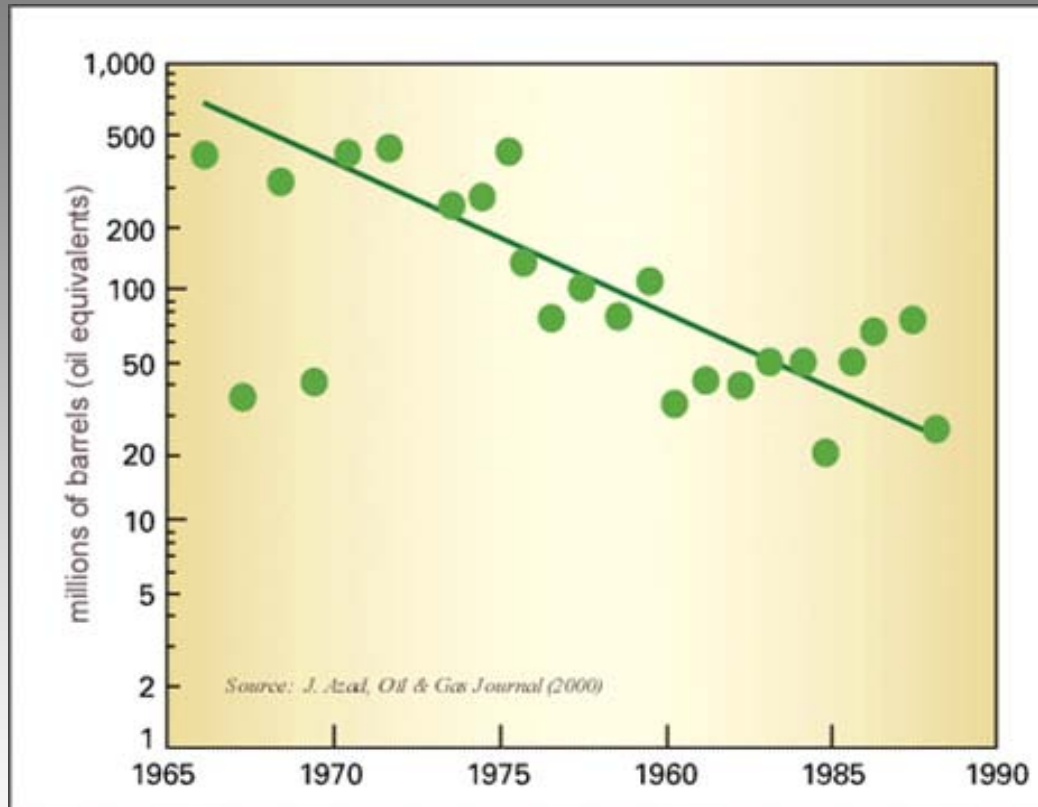
Within a producing province, as reservoirs whose production is constrained are brought on production over time...

Theoretical Producing Province



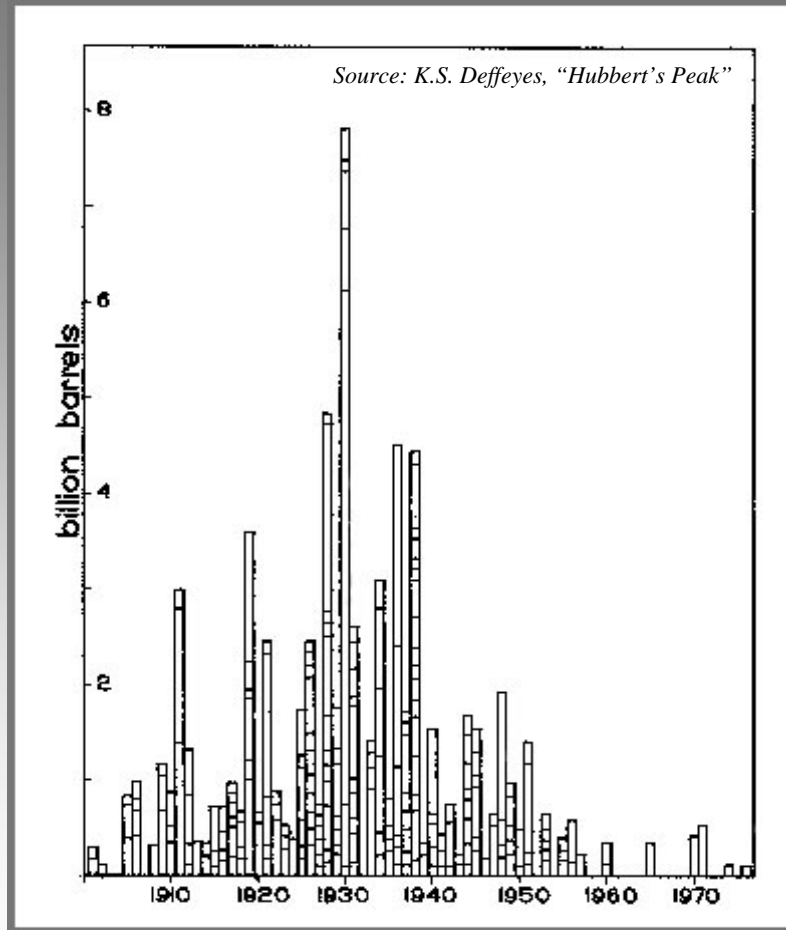
...the aggregate production profile for the province resembles a bell-shaped curve, or *normal distribution*.

Discovery Pattern in the U.K. North Sea



The large fields in of a producing province are generally discovered first, as the discovery pattern in the U.K. North Sea shows.

Discovery Pattern of Onshore U.S. Oil Fields



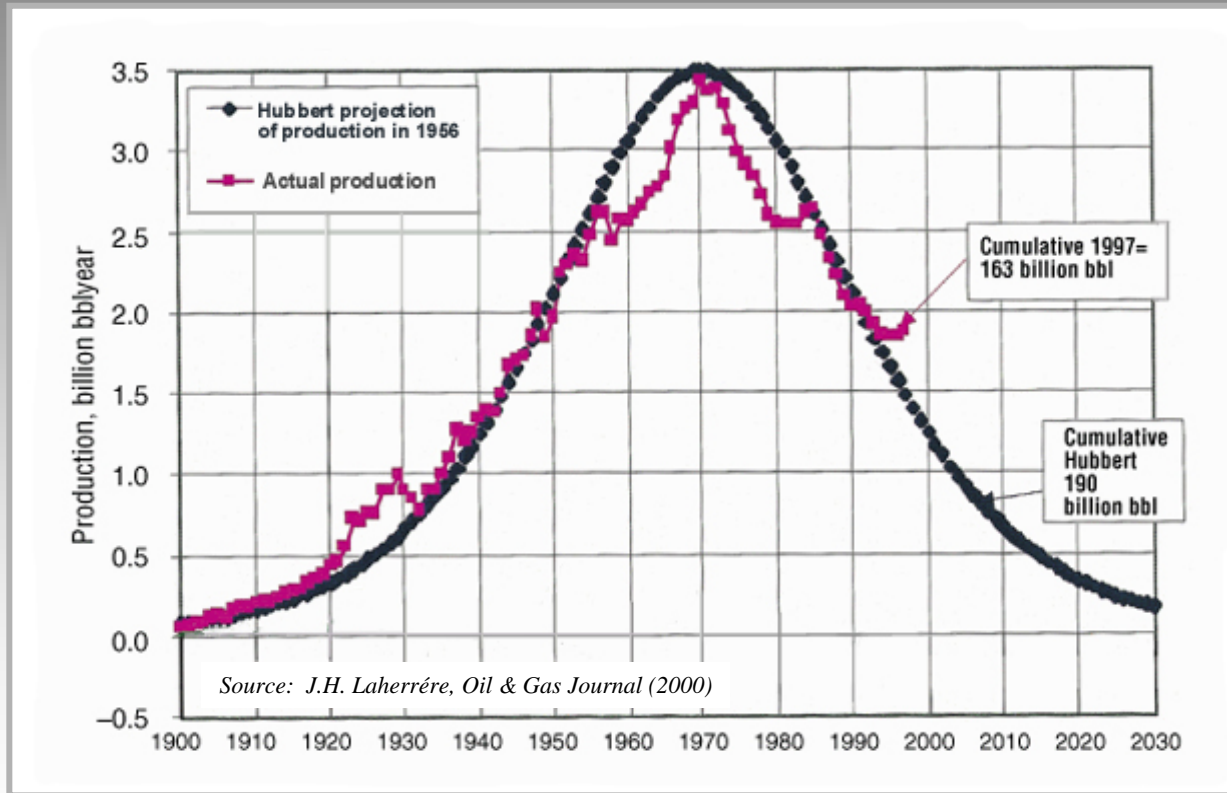
Similarly, U.S. onshore discoveries peaked after the first 20 years of exploration and never recovered.

Principles for Modeling Production Capacity

1. Annual production from a series of discoveries is normally distributed.
2. In general, large fields are discovered first.

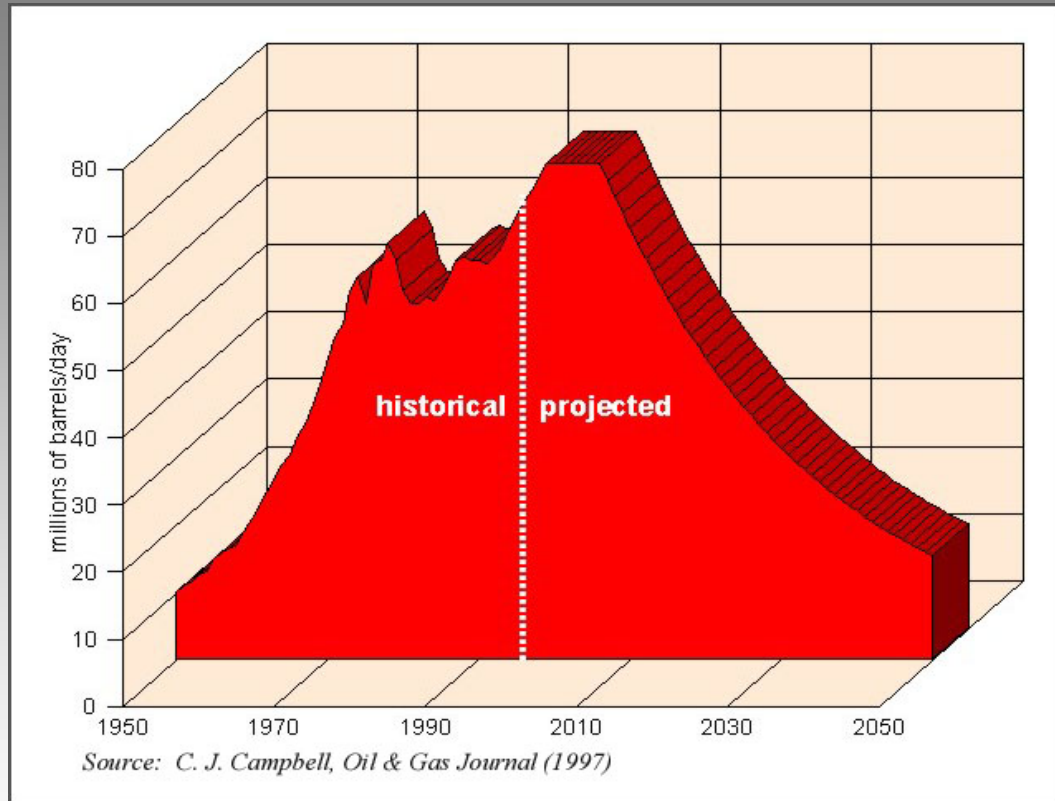
Using these principles for modeling production capacity of a producing province...

Hubbert Production Analysis: Continental U.S. in 1997



...M. King Hubbert accurately predicted in 1955 that oil production in the U.S. would peak in 1970.

Worldwide Oil Production



Applying Hubbert's analysis of production decline to worldwide production, Colin J. Campbell predicted in 1997 that oil production would become constrained by 2000, oil prices would then increase dramatically, and production would irreversibly decline by 2015.



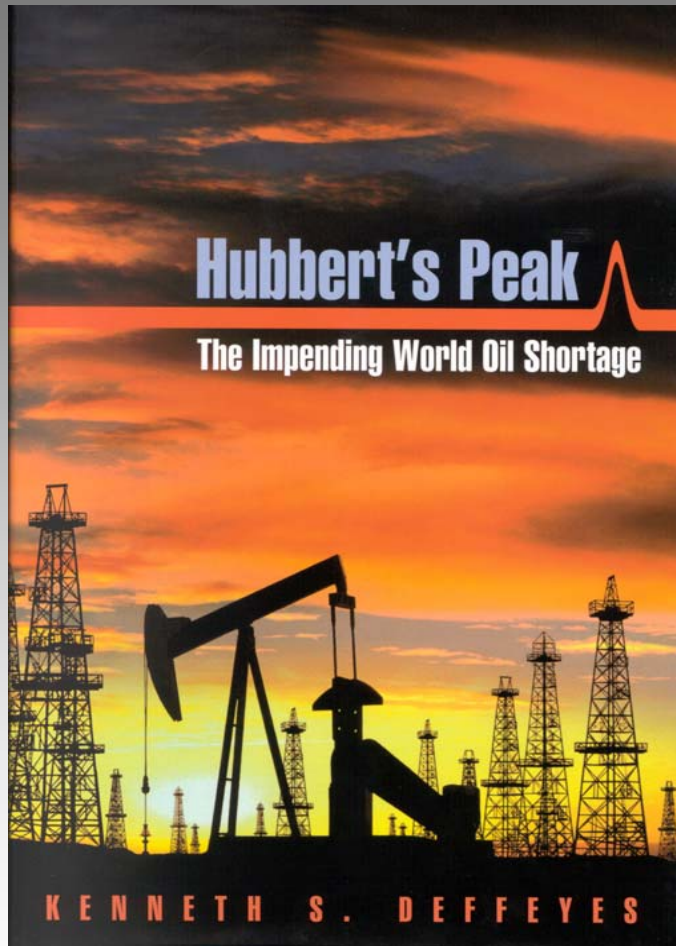
*“It runs on its gasoline engine until it senses guilt,
at which point it switches to battery power.”*

New technology must be harnessed to address the prospect of diminishing oil supplies...



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...before a worldwide oil supply crisis becomes acute.



See *Hubbert's Peak* by Kenneth S. Deffeyes, PhD, for additional information.