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# 23rd IAEE North American Conference

## DRIVERS OF THE ENERGY SCENE

What are they?  
Where do they head us?

*WEC study chaired by Dr. Al-Moneef,  
presented by Jean-Marie Bourdairé*

*Mexico City,  
Oct. 21, 2003*



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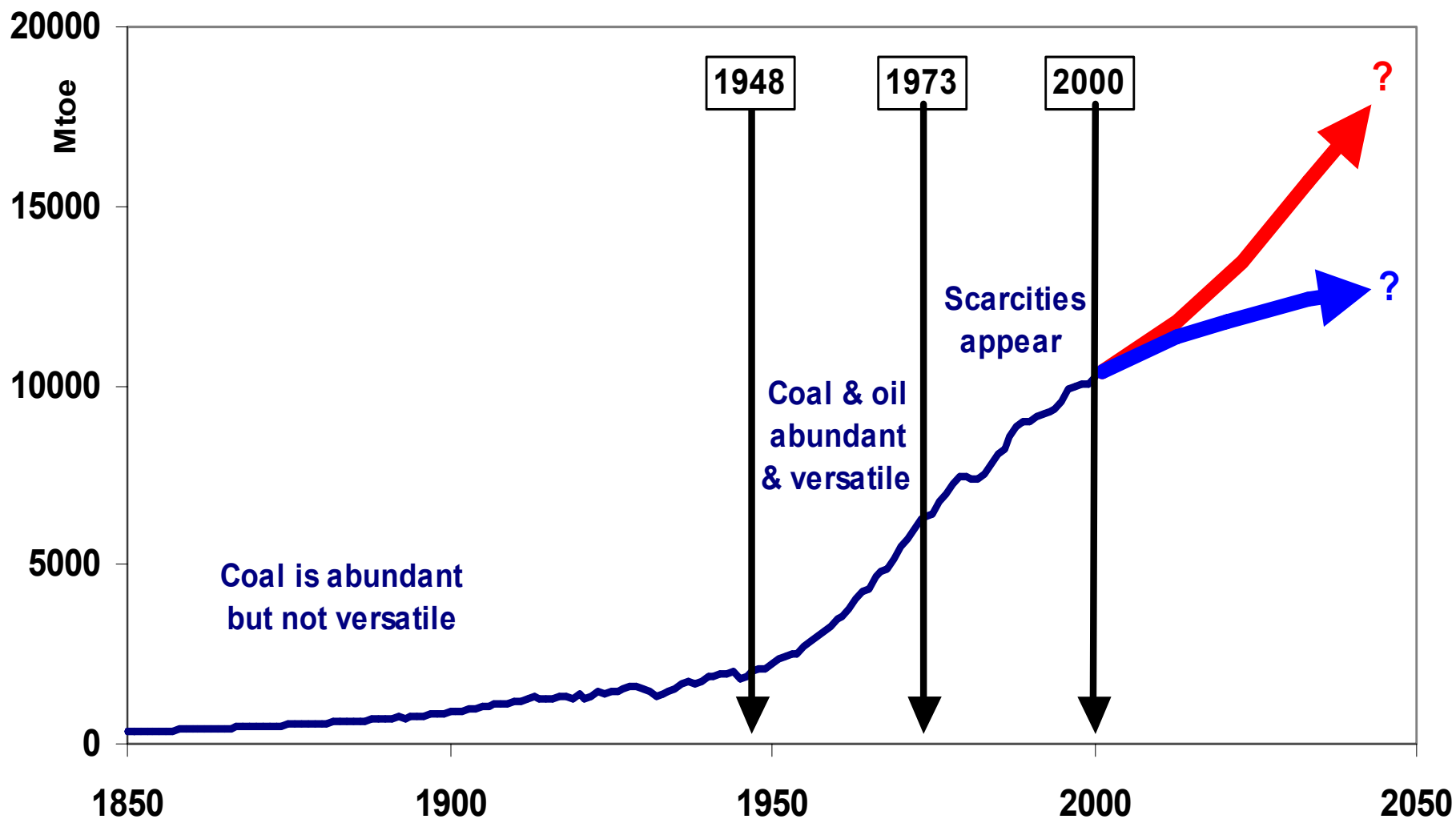
# WHY SUCH A STUDY?

- *Long-term forecasts do not stand the test of time. Become wrong after a few years only*
- *Extrapolations (projections) or interpolations (scenarios) do not seem appropriate methods*
- *By telling an unique message on the future binding constraint, scenarios may be wrong*



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# THAT IS THE QUESTION





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# WHAT FUTURE ENERGY PATH?

- **All published scenarios are of the « red » type with acceptability, i.e. environment, and GHG emissions, the binding constraint**
- **Yet, in « blue » type scenarios, the binding constraints are availability & accessibility, but GHG concentrations may not reach 550 ppm**



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- I. 1850-1948
- II. 1948-1973
- III. 1973-NOW
- IV. NOW- 2050



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# **PART I.**

## **1850-1948**

# GDP ↔ ENERGY

## *GDP drivers:*

- Demographic trends
- Institutional capacity
- Technology

## *Energy drivers:*

- Primary supply
- Final prices
- Quality/versatility



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# GDP DRIVERS

## 1850 to 1948

- Demography *slow but balanced growth*
- Institutions *beginning of democracy*
- Technology *steam-engine, railways, cars*
- Primary supply *cheap & abundant coal*
- Versatility *use of coal is uneasy and dirty*

**1.7% average annual growth**

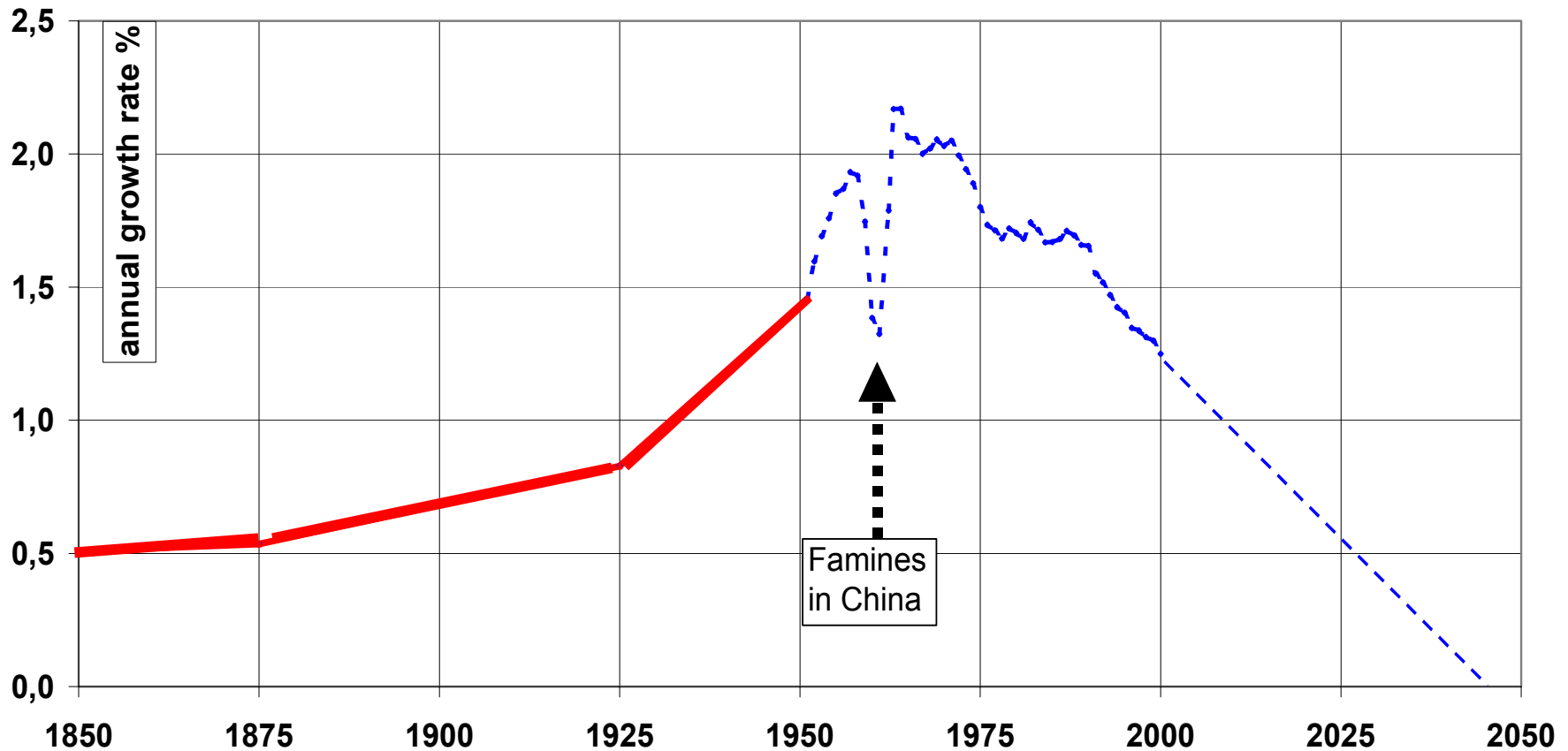




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# FROM 1.0 IN 1850 TO 2.5 BILLIONS IN 1950

## WORLD POPULATION 1850-1950





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# INSTITUTIONAL CAPACITY

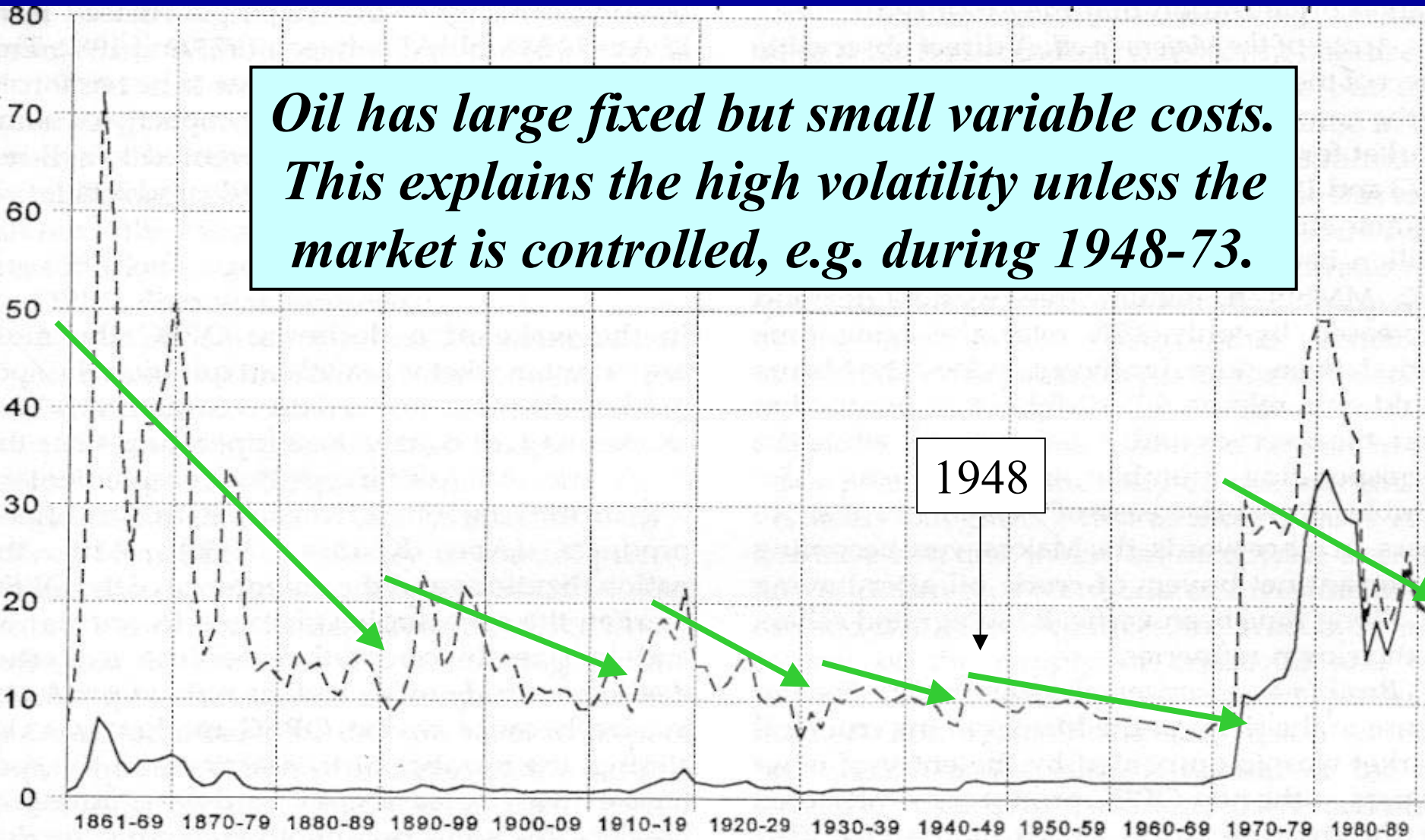
- A **cumulative factor** associated to the stock of knowledge, physical, legal, and ethical «assets»
- It is the (growing or not) capacity of a country to incorporate more sophisticated technology
- It took more than 100 years (1800 to WWII) to build this accumulation in developed countries
- Most developing countries have not catch up yet in terms of institutions, e.g. property rights



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# SAME PATTERNS BUT DIFFERENT IMPACTS

*Oil has large fixed but small variable costs. This explains the high volatility unless the market is controlled, e.g. during 1948-73.*





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# **PART II.**

## **1950-1973**



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# GDP DRIVERS

## 1950 to 1973

- Demography young and rapidly growing
- Institutions secure property rights & savings
- Technology cars, aircrafts, appliances
- Primary supply rapid expansion of oil
- Versatility oil is liquid, electricity grows

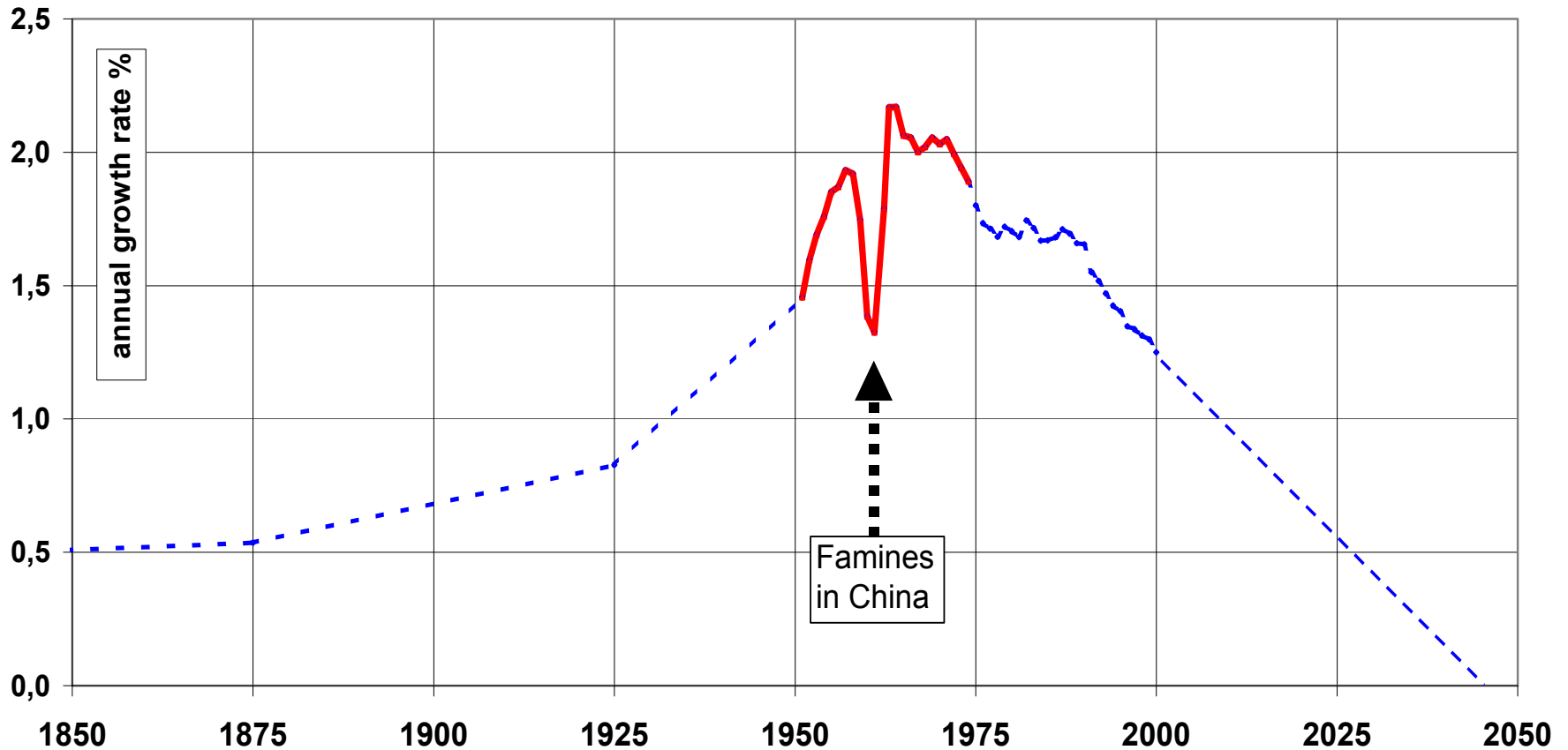
**Exceptional average annual growth of 5%**



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# FROM 2.5 IN 1950 TO 4.0 BILLIONS IN 1974

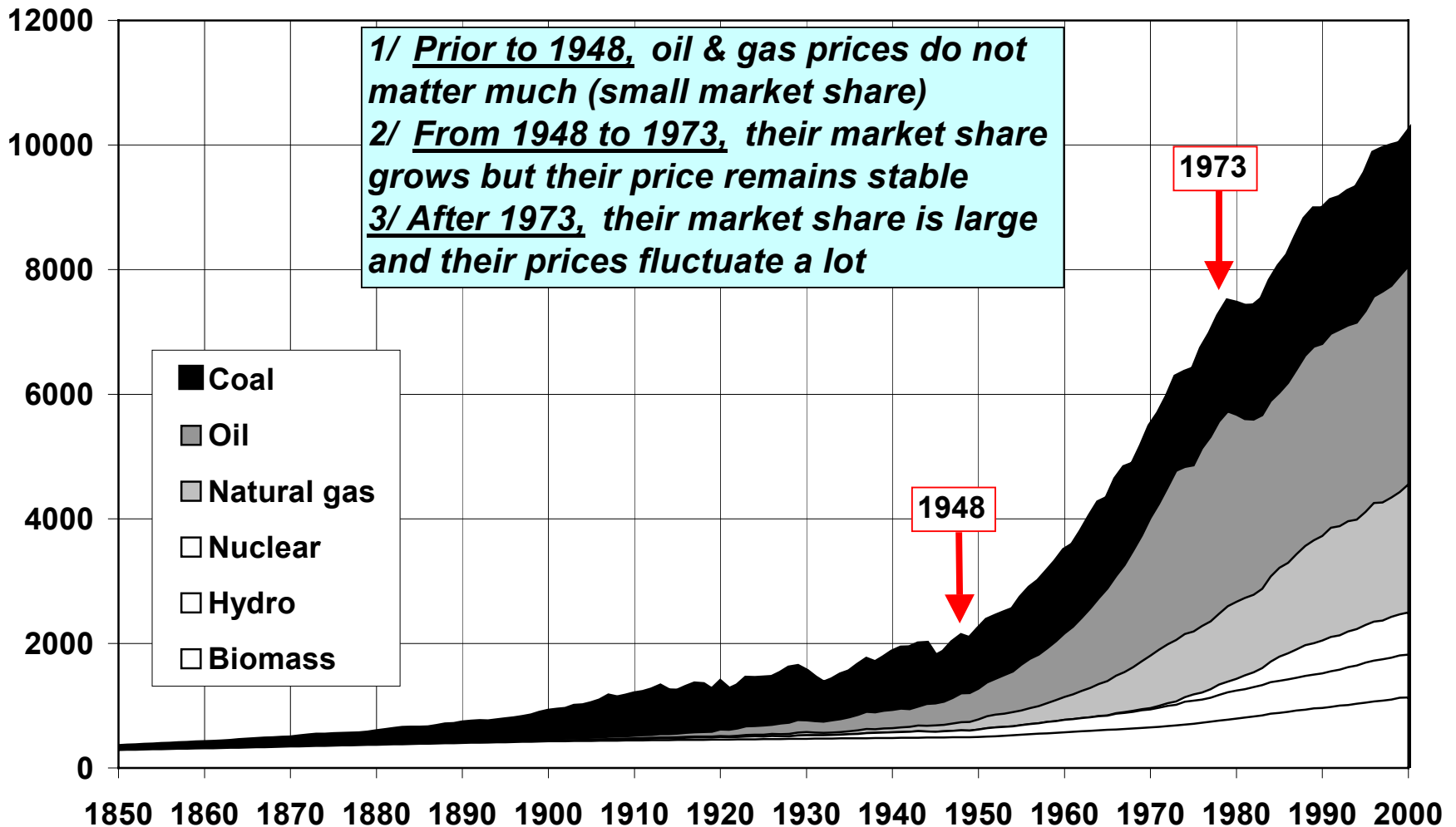
## WORLD POPULATION GROWTH 1950-1974





# OIL & GAS WEIGHT

## WORLD TPER (MTOE) 1850-2000





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# THE OIL MIRACLE OF 1948-1973

- A low price, lower than that of coal, set by Middle-East producers after 1948
- A price first controlled by the TRC up to 1959 (US quota), and by OPEC after 1960
- A dynamic stability thanks to the snowballing growth of the oil market share
- A stability further enhanced by the dominance of the vertically integrated “Seven Sisters”

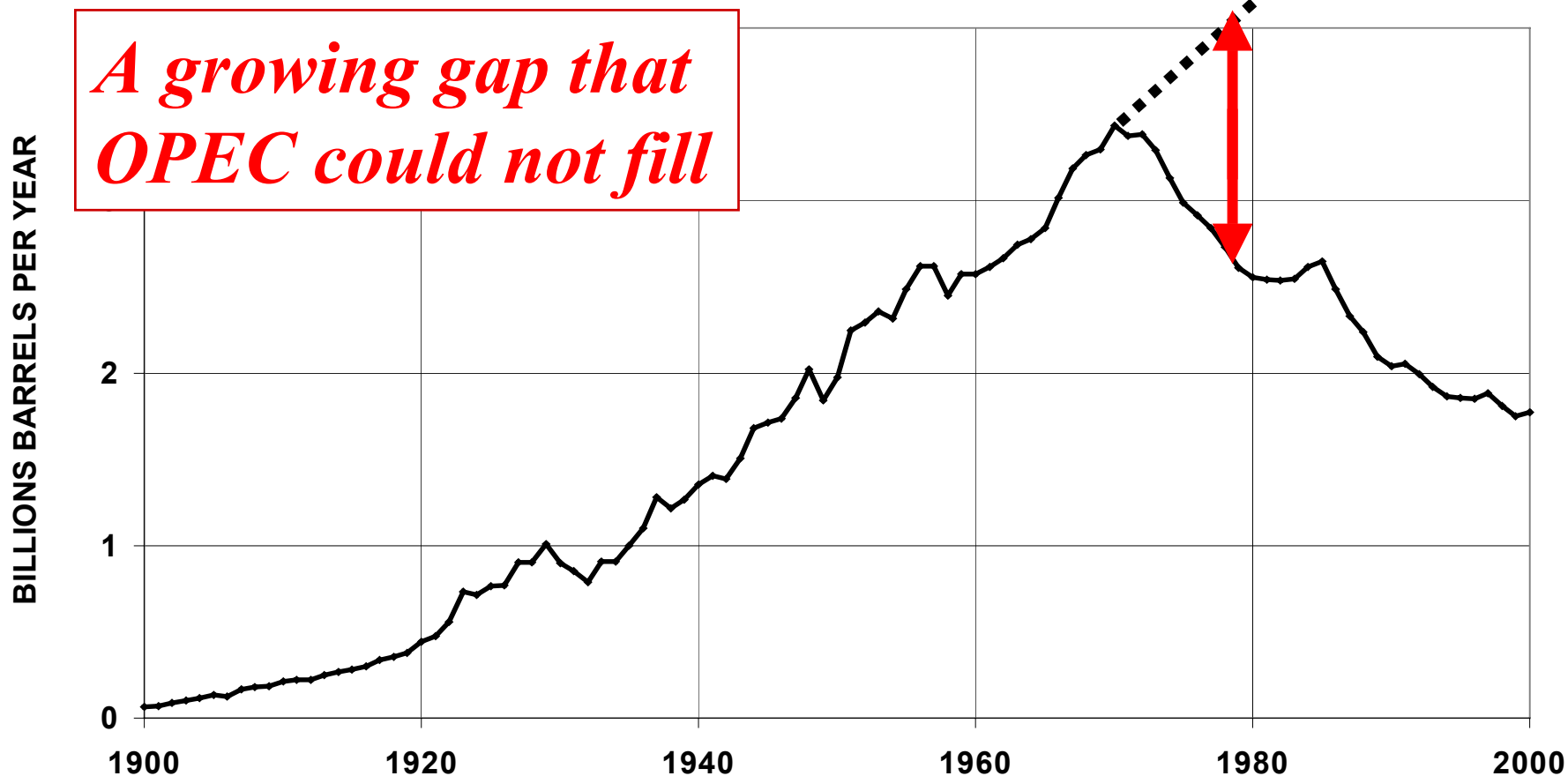




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# DID OIL CAUSED THE 1973 SHOCK?

US OIL PRODUCTION 1900-2000

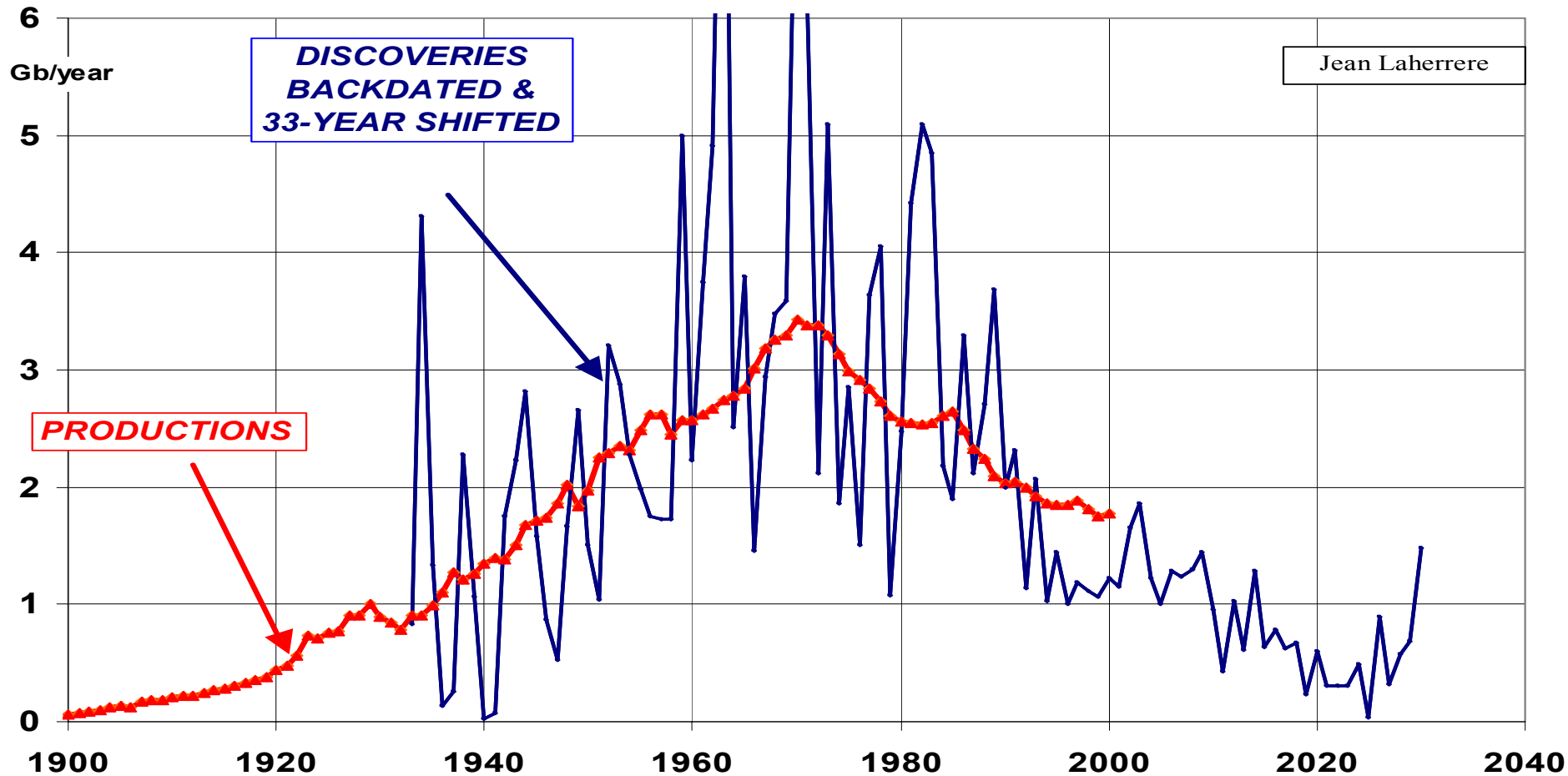




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# US OIL PRODUCTIONS MIMIC DISCOVERIES

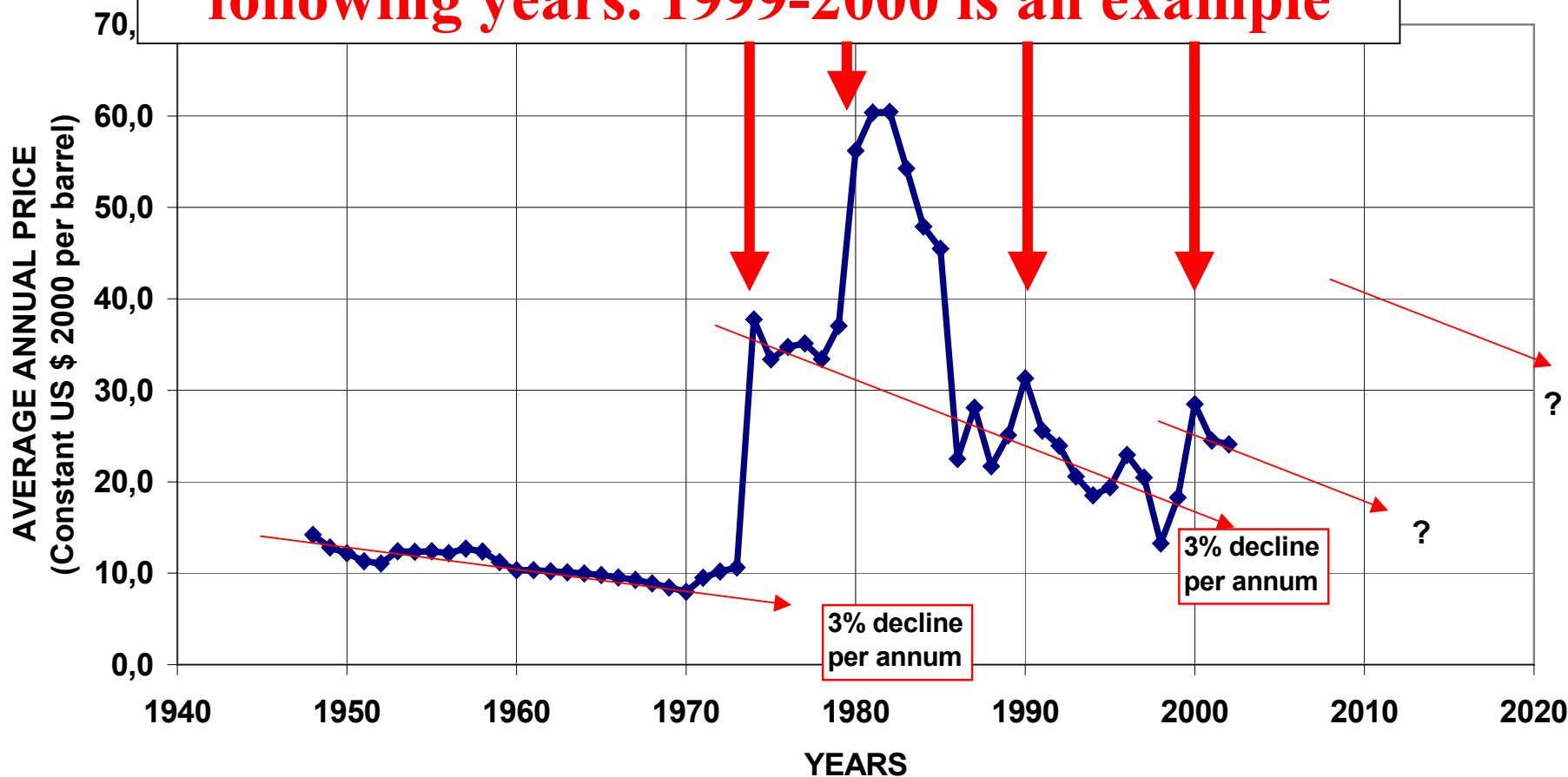
US PRODUCTIONS MIMIC PAST DISCOVERIES





# OIL PRICE

Since 1973, each oil price hike is associated with lower GDP growth during the two following years. 1999-2000 is an example





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# **PART III.**

# **1974-NOW**



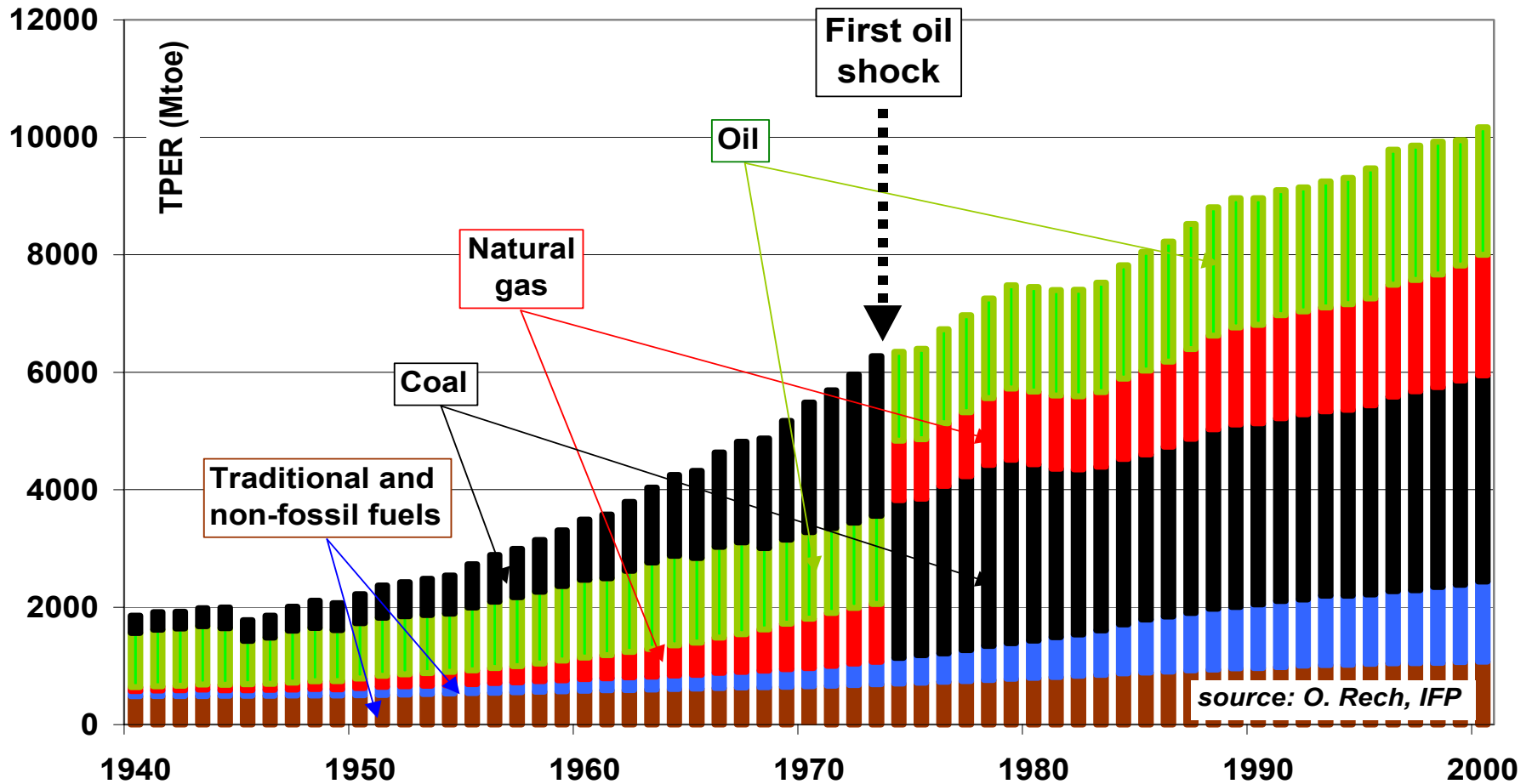
# THE NEW ENERGY SCENE

- *Energy demand started to decelerate* after its acceleration since the industrial revolution (energy curve turns from concave to convex)
- *Oil became the energy “at the margin”*, and the price-setter (direct or indirect) of energy, replacing coal in its former role
- *Energy prices have now an impact on GDP and access* because of the large shares of oil & gas and their high price volatility



# ENERGY PRICE-SETTING

## RANKING OF PRIMARY ENERGIES





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# GDP DRIVERS

## 1974 to NOW

- Demography *beginning of the transition*
- Institutions *too little progress in reforms*
- Technology *CCGT & deepwater, IT*
- Primary supply *oil crises and price hikes*
- Versatility *reliance on new rigid energies*

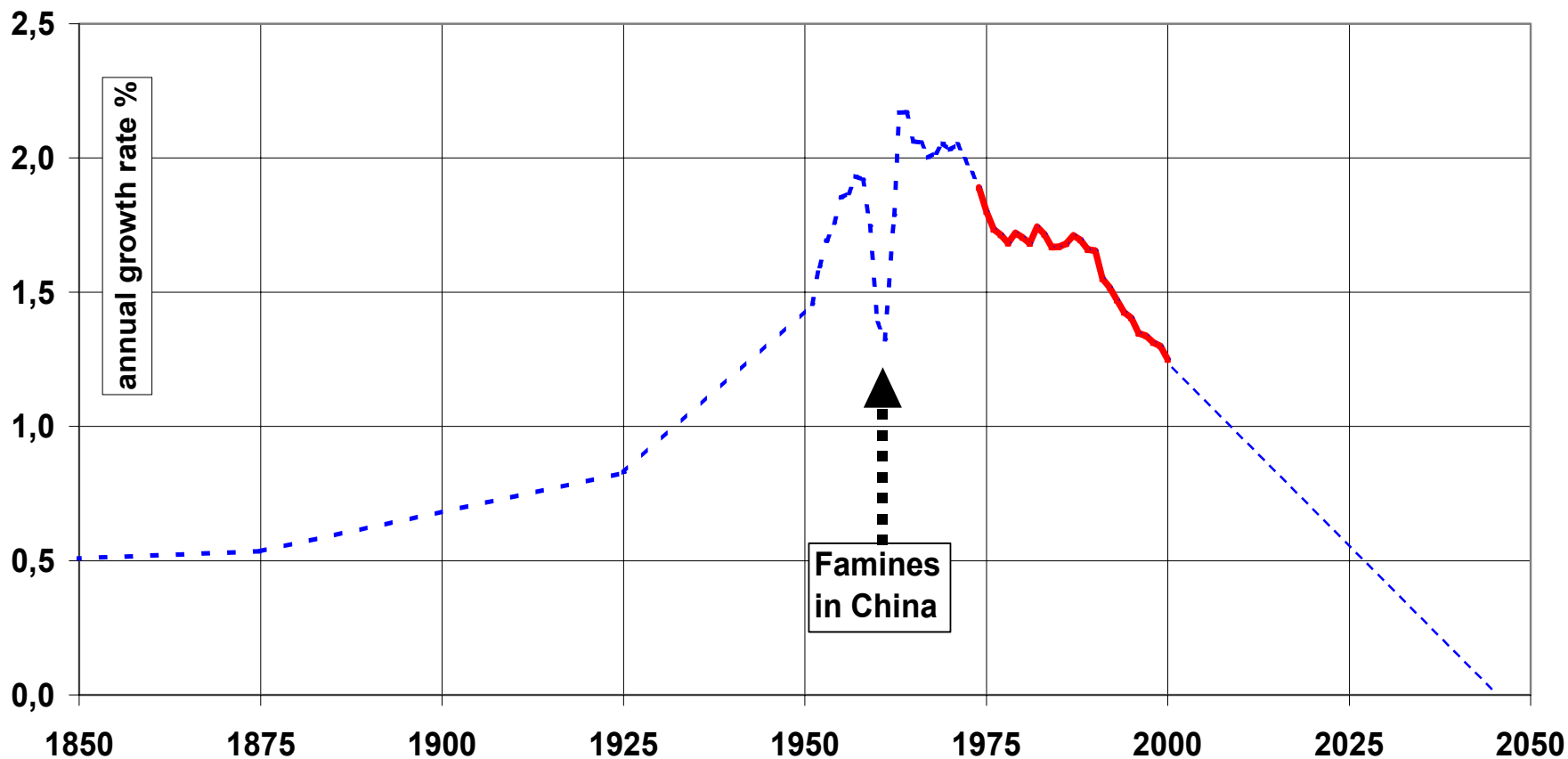
*Average annual growth slows down to 3.0%*



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# FROM 4.0 TO 6.0 BILLIONS IN 2000

## WORLD POPULATION GROWTH 1974-2000

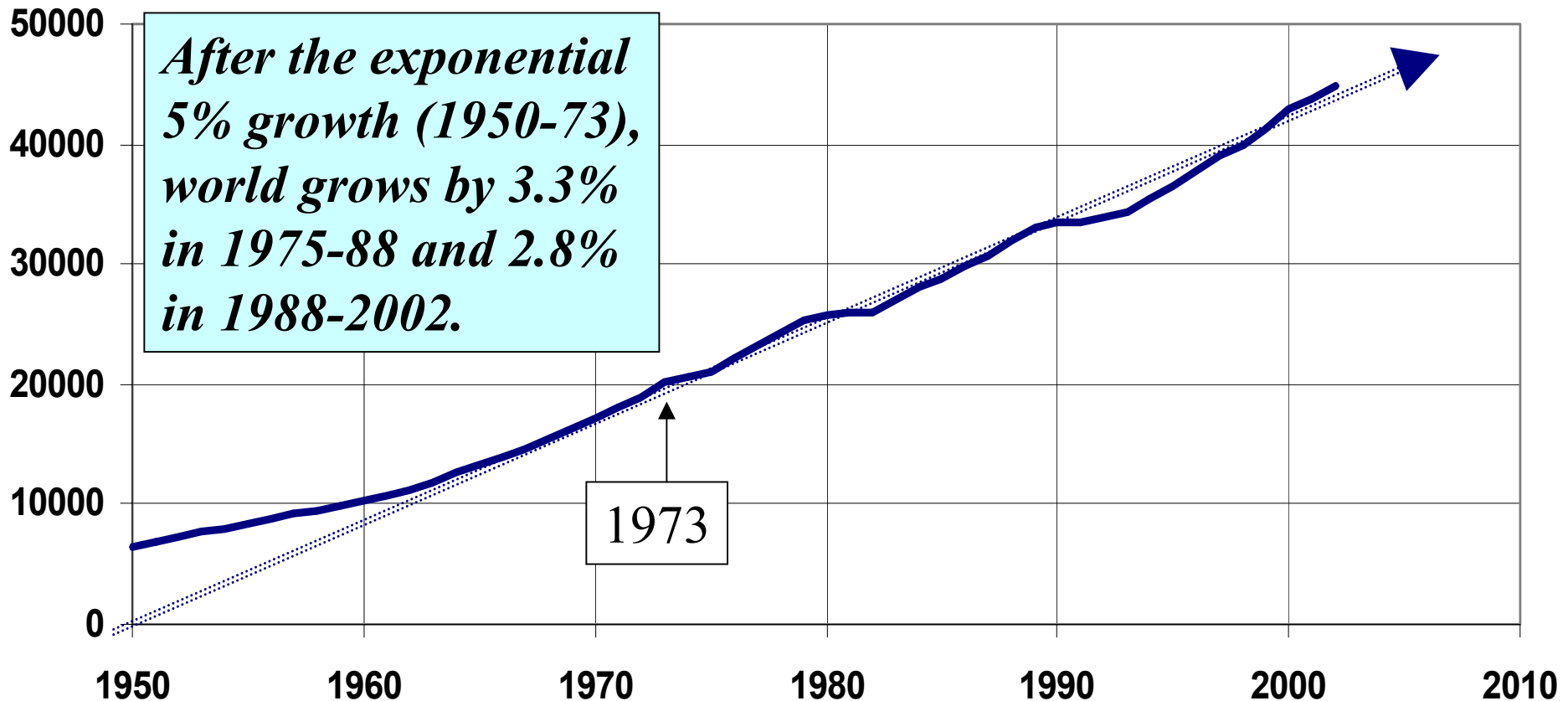






# WORLD GDP GROWTH SLOWS DOWN - 1

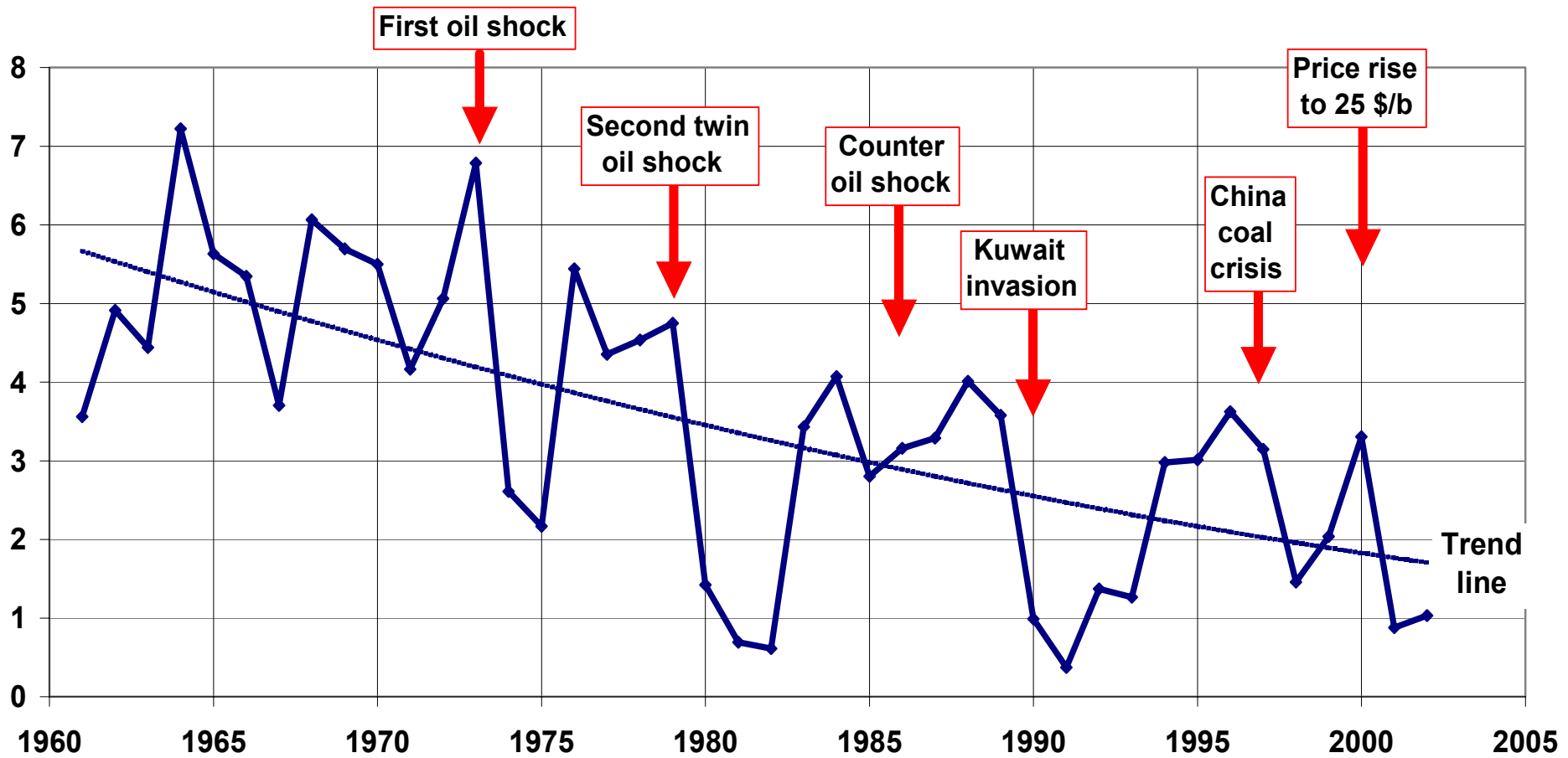
WORLD GDP OVER TIME (G\$ 2000)





# WORLD GDP GROWTH SLOWS DOWN - 2

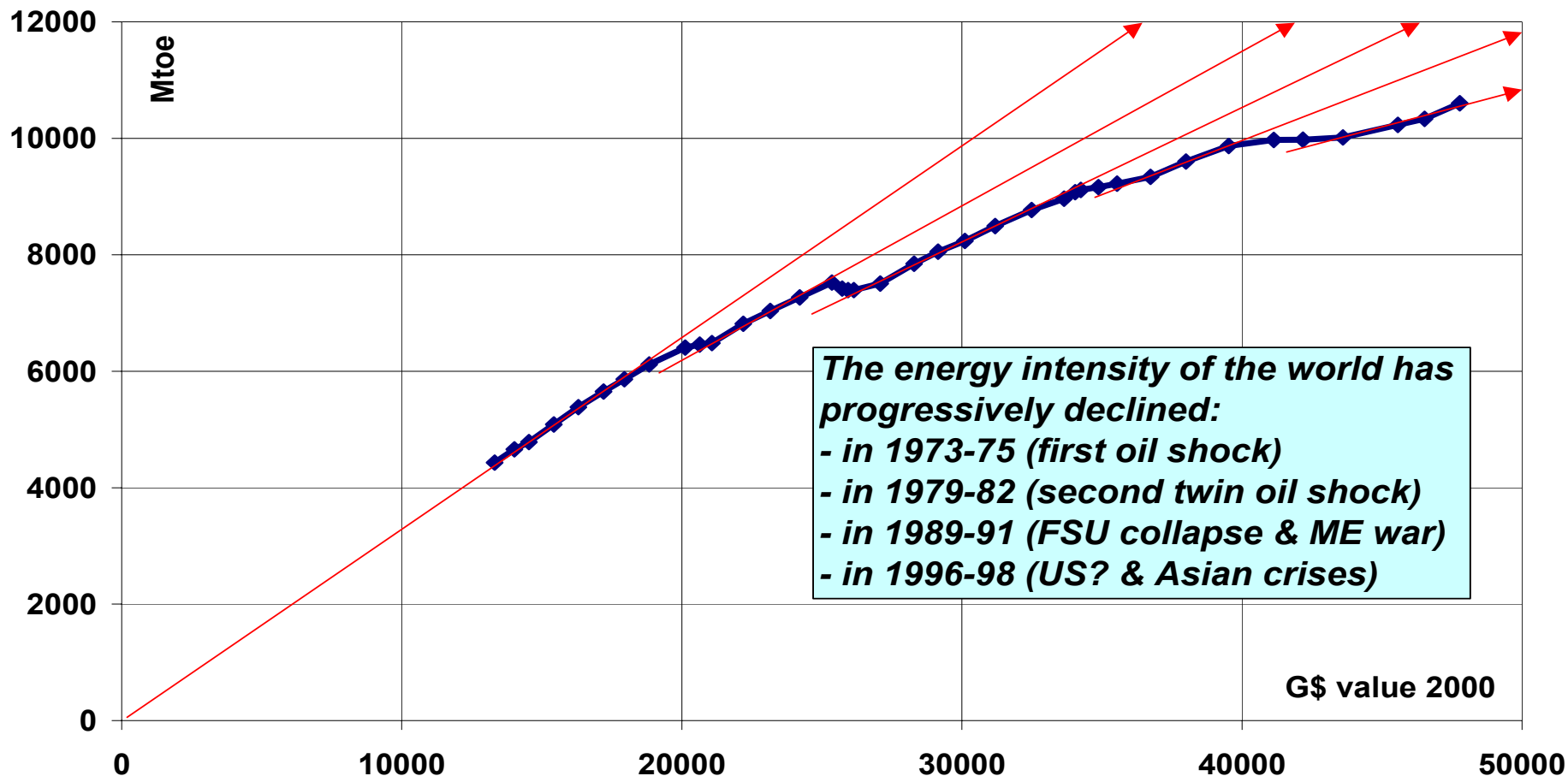
## WORLD OFFICIAL GROWTH RATES





# ENERGY DECOUPLING-1

## WORLD TPER VERSUS GDP 1965-2002

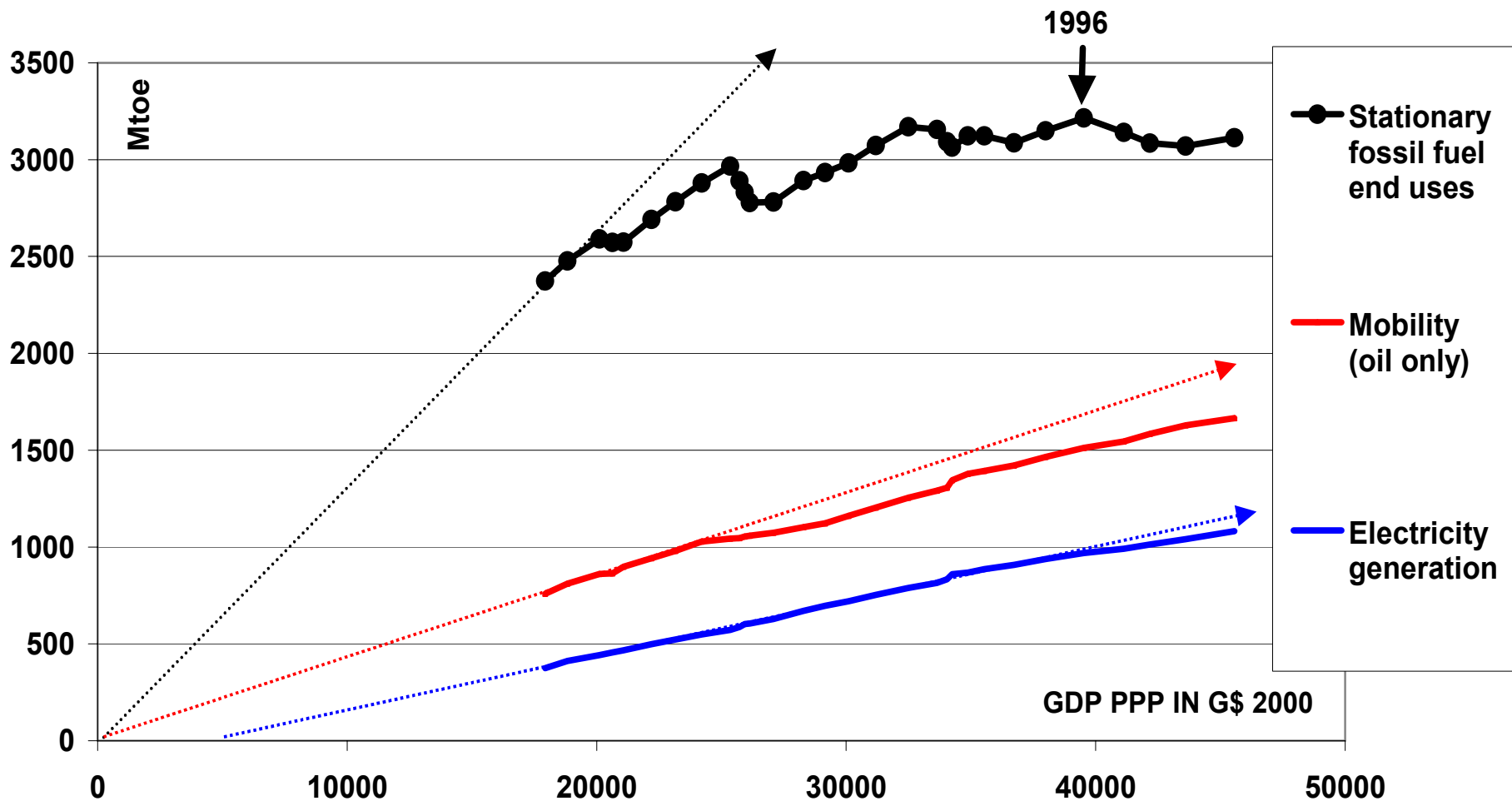




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# ENERGY DECOUPLING-2

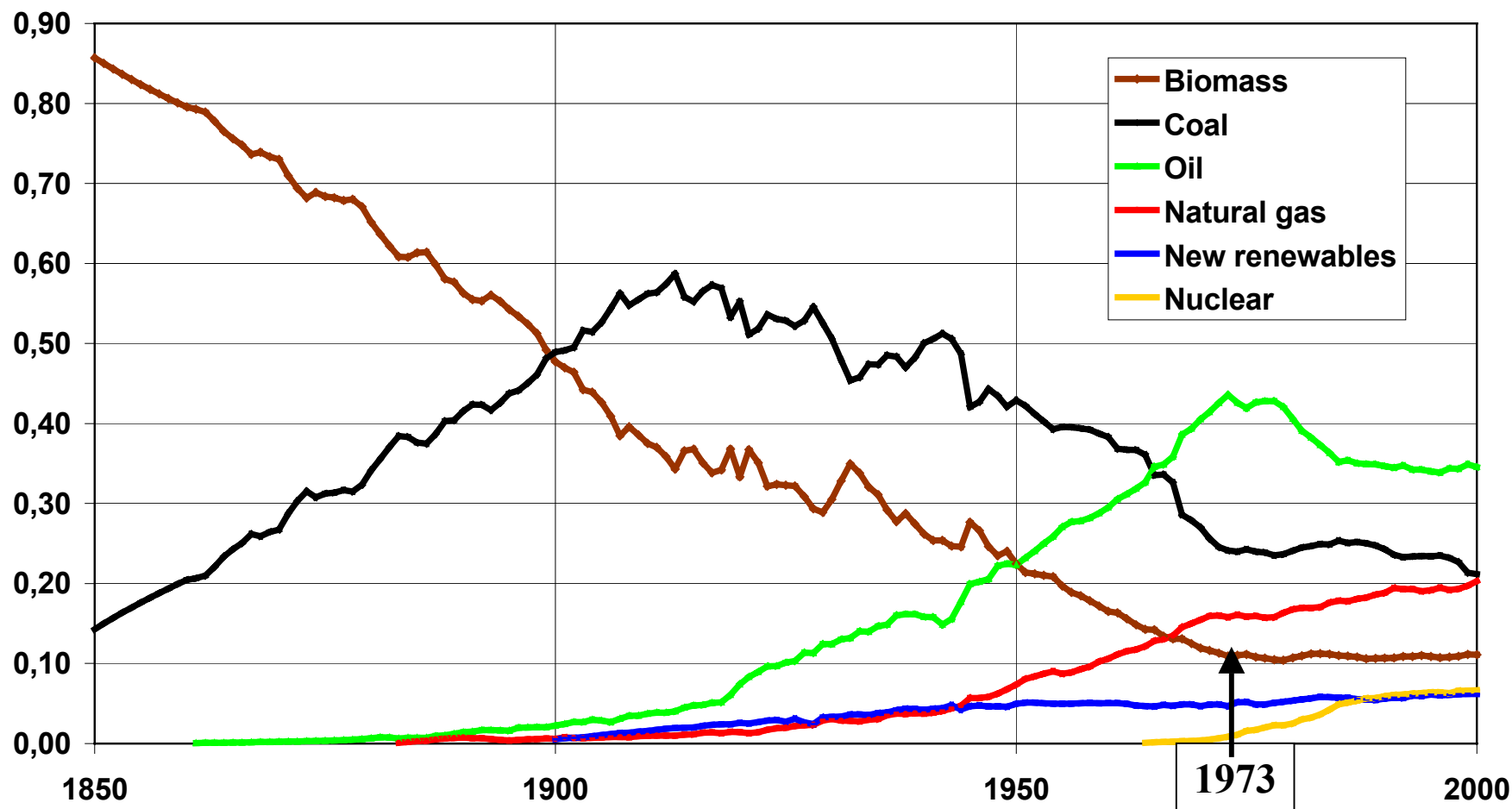
## WORLD ENERGY SERVICES 1971-2000





# ACCESS STOPS TO IMPROVE

## PRIMARY ENERGY MARKET SHARES WORLD 1850-2000





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# **PART IV.**

# **NOW-2050**



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# GDP DRIVERS NOW-2050

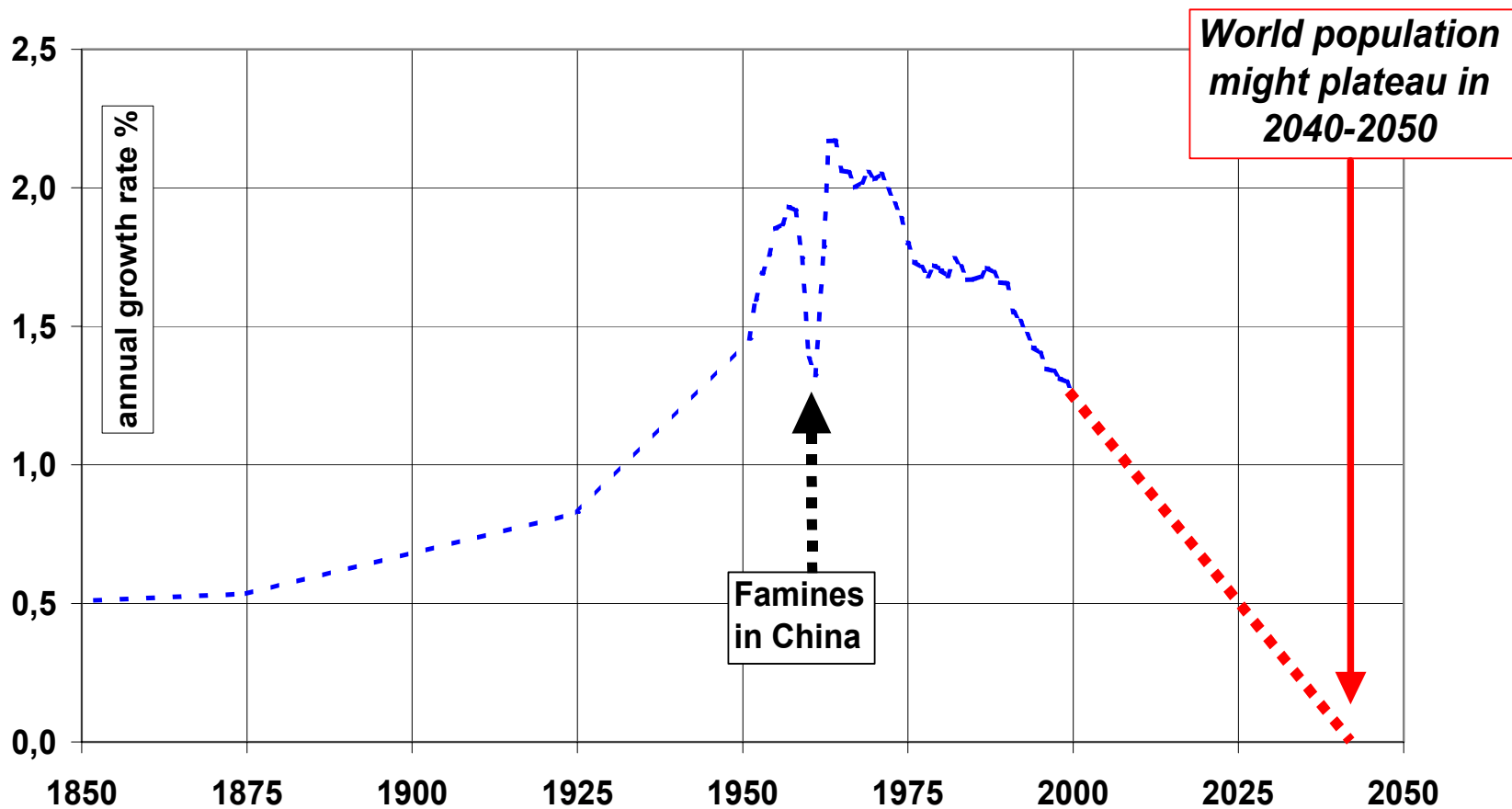
- Demography aging, peaking by 2040-50?
- Institutions will progress be achieved?
- Technology new materials, biotech, IT
- Primary supply supply & environment crises
- Versatility infrastructures to be changed?

*Average annual growth as slow as 1.4%*



# FROM 6.0 TO 8.0? BILLIONS IN 2050

## WORLD POPULATION GROWTH 2000-2050



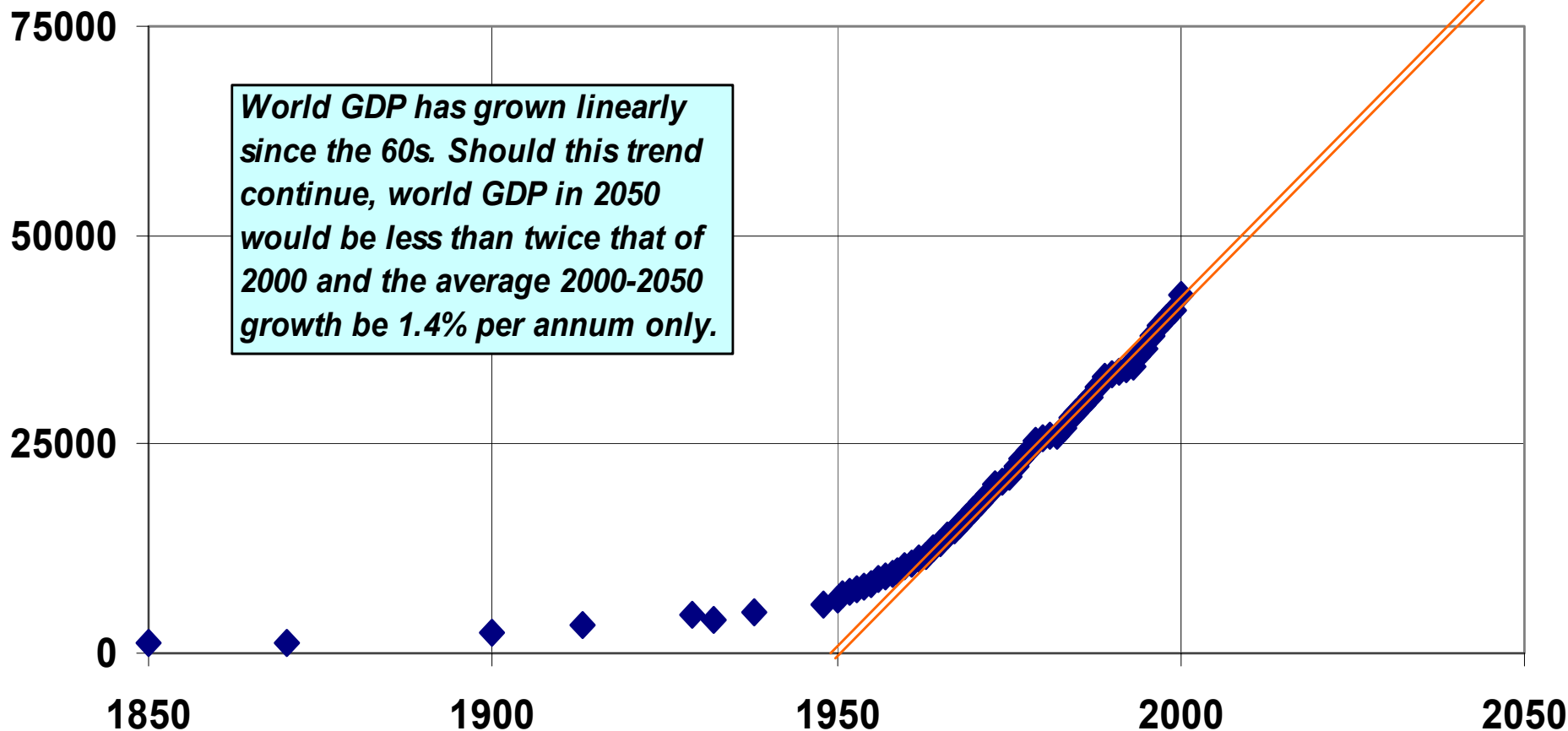




# WORLD GROWTH

## 2000-2050: 1.4%?

WORLD GDP OVER TIME (GDP PPP in G\$ 1990)





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# INSTITUTIONAL CAPACITY

- Education, gender equality, equitable society...
- Property rights, prudential rules, justice...
- Public infrastructures: water, roads, health...
- Market reforms & consumer empowerment
- *What are the future prospects of institutional capacity for the developed, developing and in transition economies?*



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# TECHNOLOGICAL PROGRESS

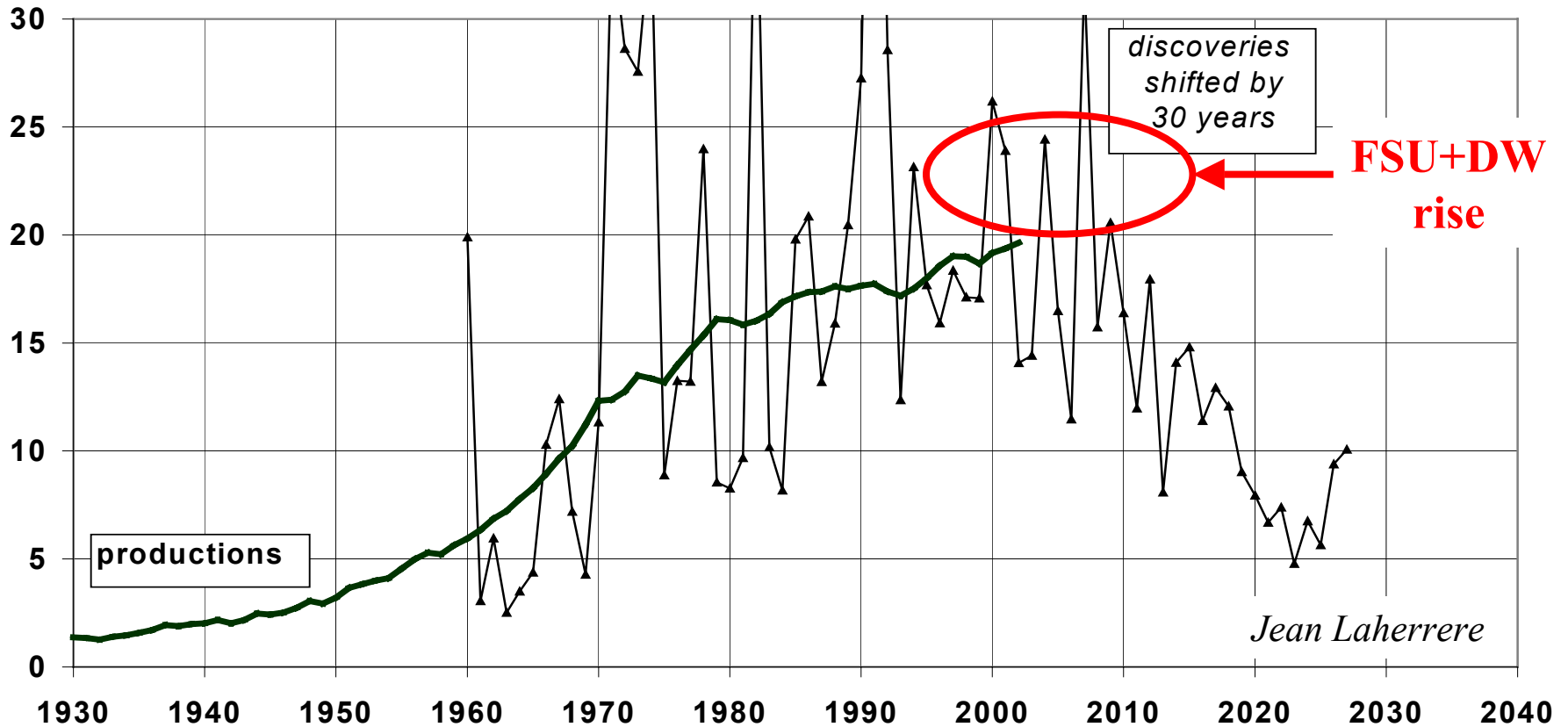
- *If cheap/versatile energy was the main source of past productivity, what future prospects?*
- given the possibility of rising oil production capacity constraints (non-ME & ME),
- given the need to rely on more remote/costly natural gas, in particular LNG from ME,
- given the need to curb down CO<sub>2</sub> emissions that mostly originate from the energy sector.



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# WILL NON-ME OIL MIMIC DISCOVERIES?

WORLD EXCLUDING OPEC MIDDLE-EAST  
annual discoveries shifted by 30 years and productions

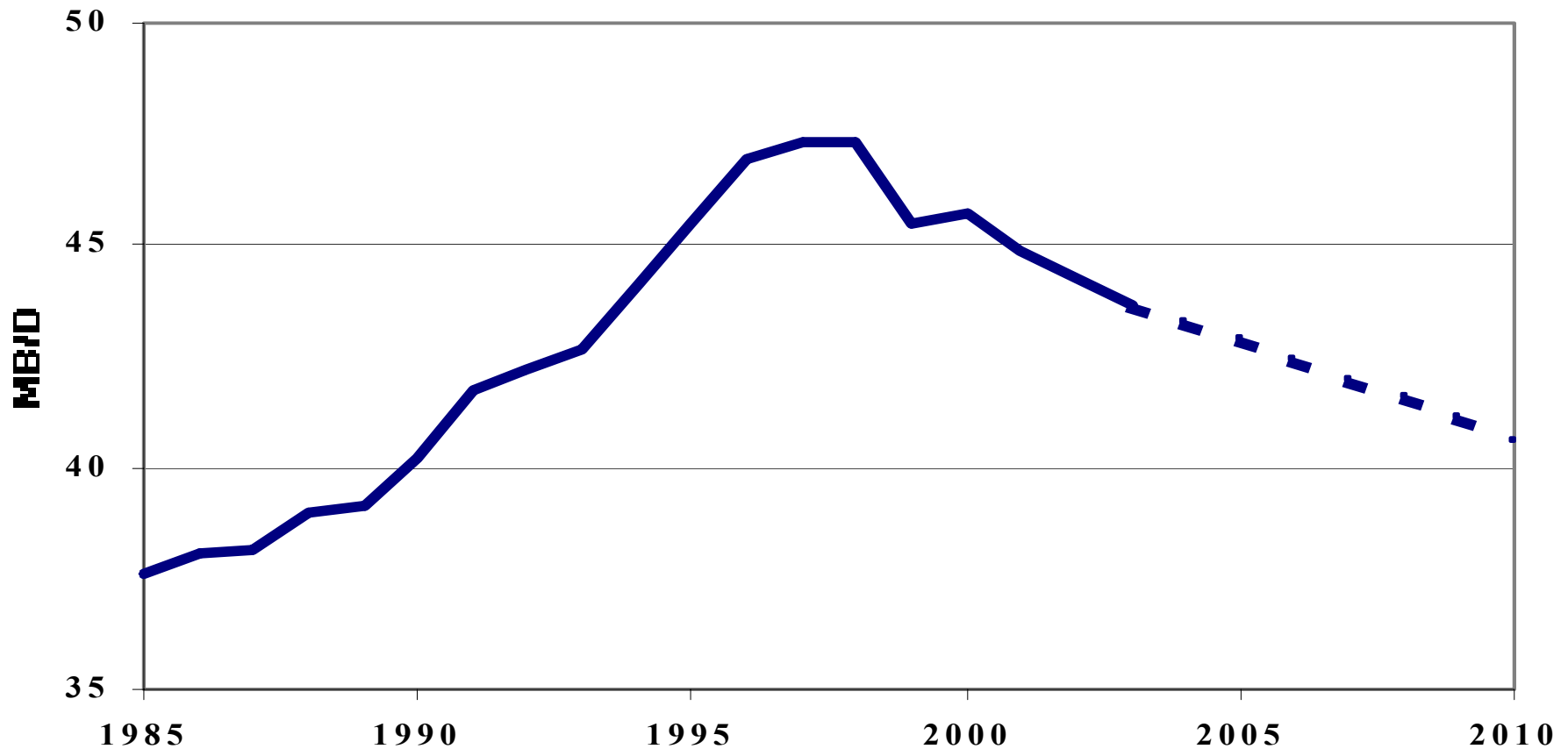




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# NON-ME OIL LESS FSU & DEEPWATER

NON MIDDLE-EAST OPEC OIL LESS FSU & DEEPWATER





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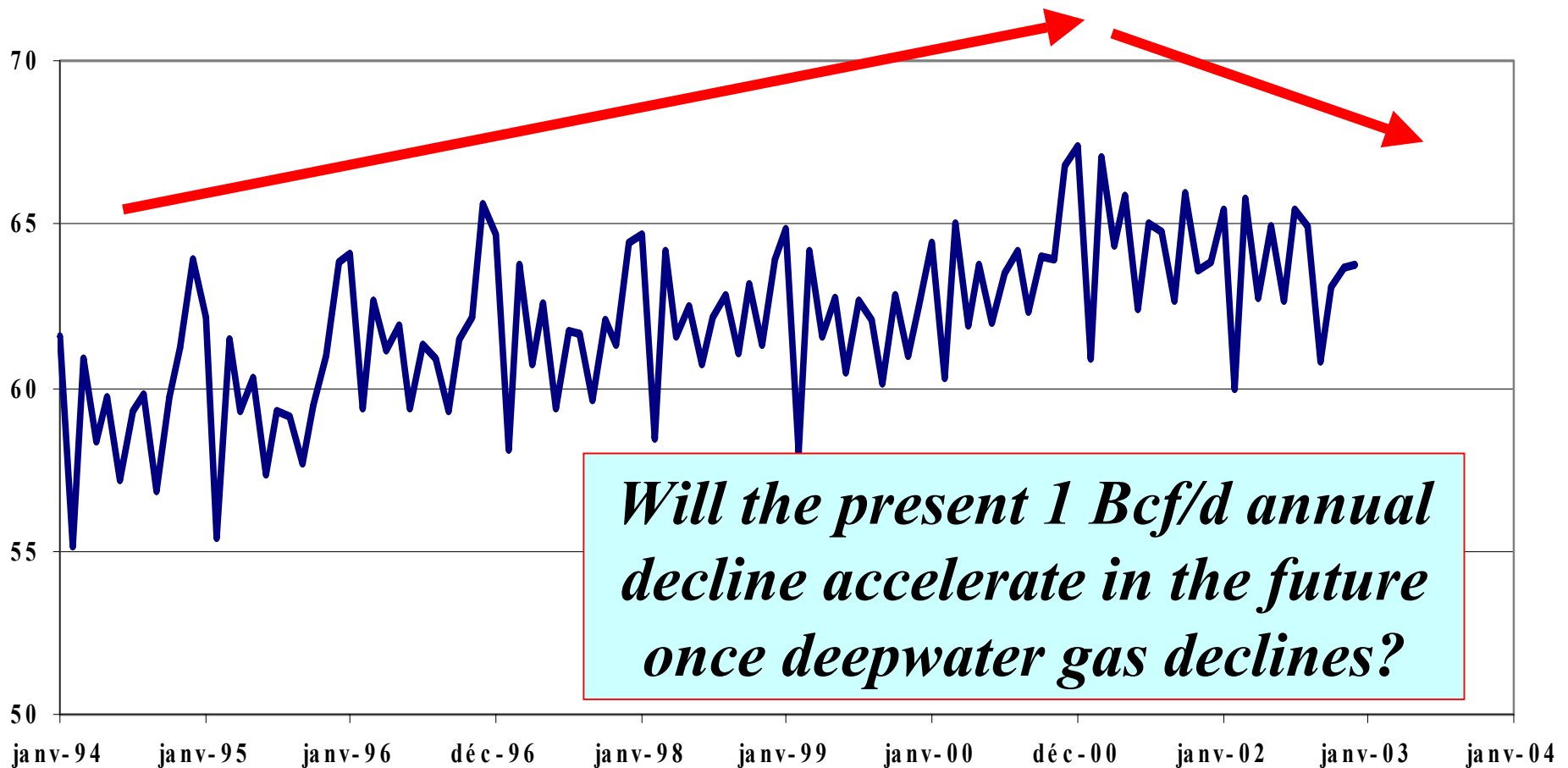
# MIDDLE-EAST OIL PRODUCTION

- On the average, Middle-East oil producing fields are *more than 50-years old*
- On a steady flow basis, they have the capacity to *produce for many future years*
- Yet, like Marathon runners who are not sprinters, they *cannot grow their production quickly*



# NA GAS PRODUCTION

NORTH AMERICAN NATURAL GAS PRODUCTION

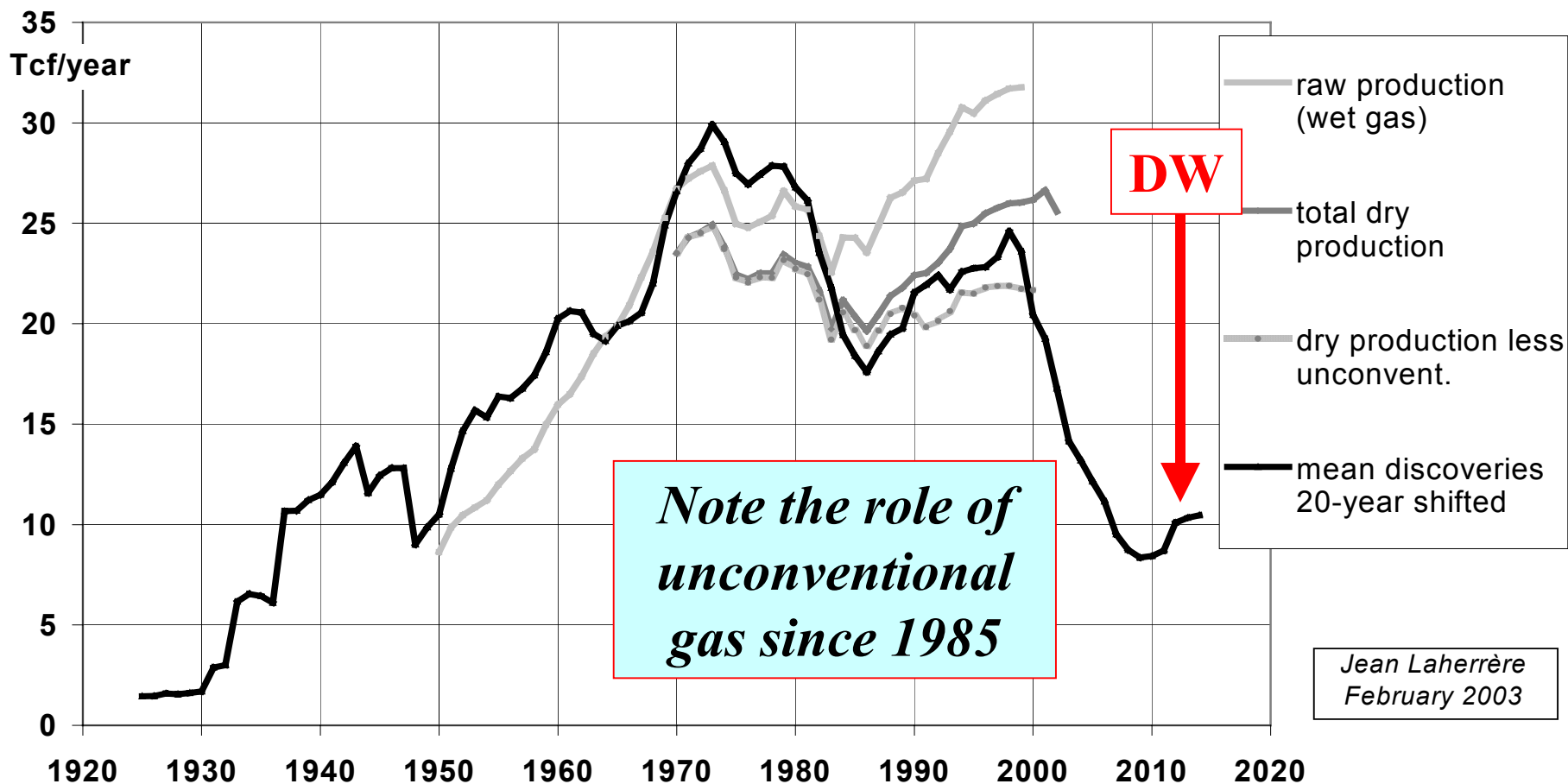


*Will the present 1 Bcf/d annual decline accelerate in the future once deepwater gas declines?*



# N.A. PRODUCTIONS MIMIC DISCOVERIES

*20-year shifted discoveries announced the decline*



*Note the role of  
unconventional  
gas since 1985*





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# NON FOSSIL FUEL SUPPLY

- *Hydro: limited by environmental arguments*
- *Nuclear: stalemate in most OECD countries*
- *Wind & solar: intermittent and diffuse*

*Supply constraints may push energy prices up and limit future GDP growth*



# CONCLUSIONS

## Many questions for existing or future scenarios

- Given institutional barriers and possible negative energy price feedbacks, what GDP hypotheses?
- If energy demand is threatened by high prices, in a context of low growth, what access for the poor?
- If hydrocarbons don't grow much, among nuclear, coal or renewables, what supply for tomorrow?
- In a low growth / low energy scenario, what GHG emissions and what climate change threat?