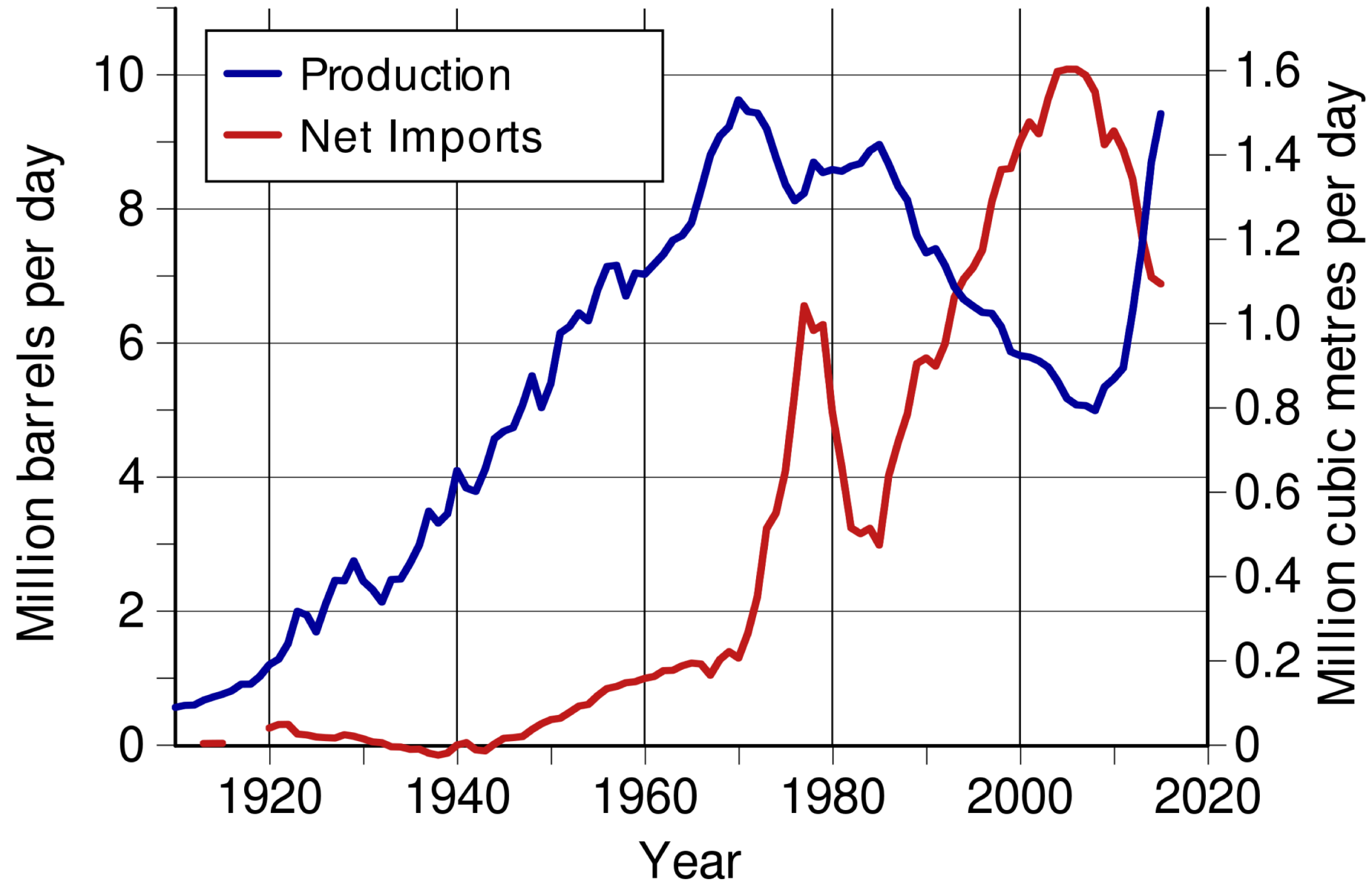
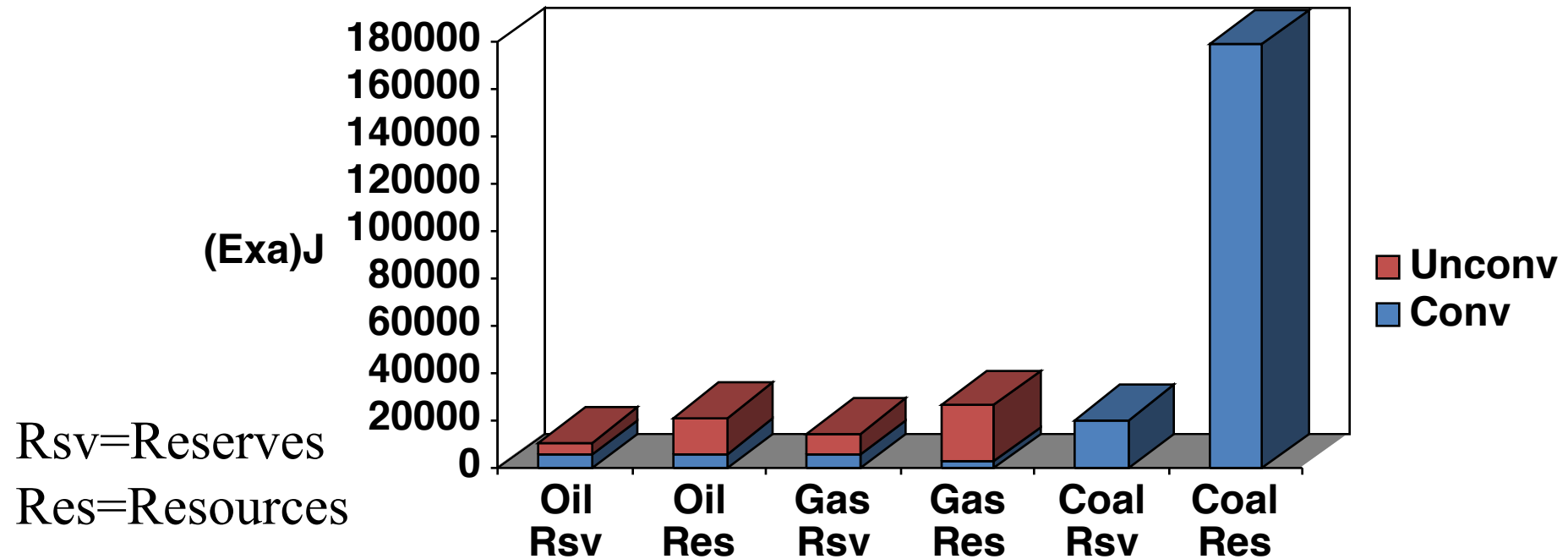


U.S. Crude Oil Production and Imports



Energy Reserves and Resources



Rsv=Reserves
Res=Resources

Reserves/(1998 Consumption/yr)

Resource Base/(1998 Consumption/yr)

Oil 40-78

51-151

Gas 68-176

207-590

Coal 224

2160

- Climate Change
- Future World Power Demand and CO₂ limits
- The options and their limits:
 - Nuclear Power
 - Carbon Capture and Sequestration
 - Renewables:
 - Hydropower
 - Geothermal Power
 - Ocean Power
 - Wind Power
 - Biomass
 - Solar Electricity
 - PV Growth Needed

- Abundant, Inexpensive Resource Base on Fossil Fuels
- Renewables will not play a large role in primary power generation unless/until:
 - technological/cost breakthroughs are achieved, or
 - unpriced externalities are introduced
(e.g., environmentally-driven carbon taxes)

- **Climate Change**
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 - **Solar Electricity**
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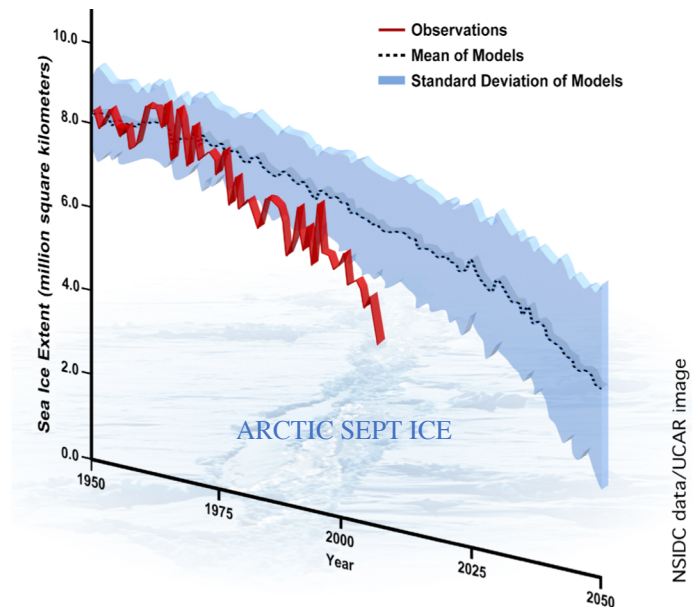
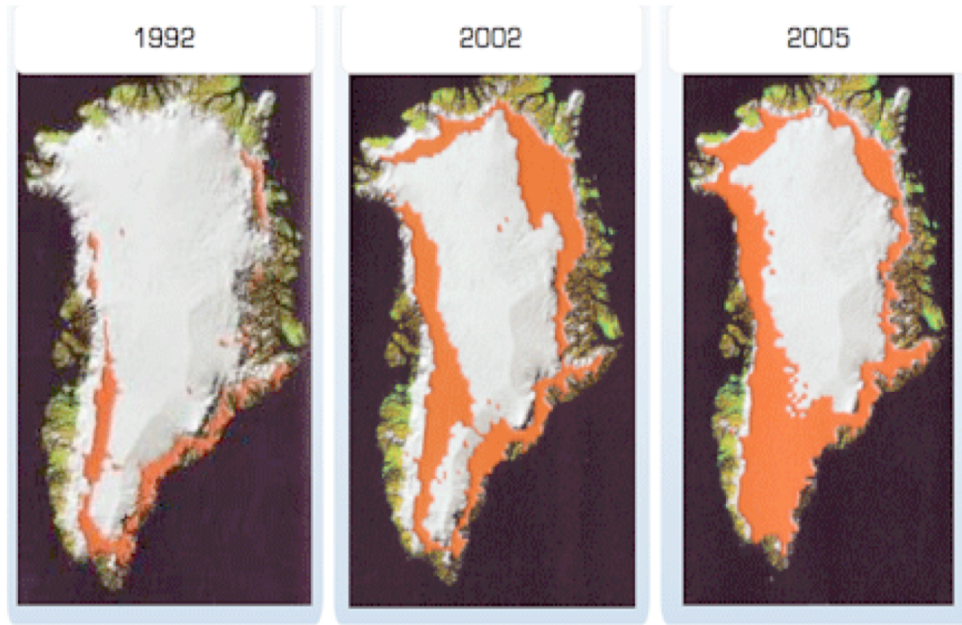
Summary



Climate Change



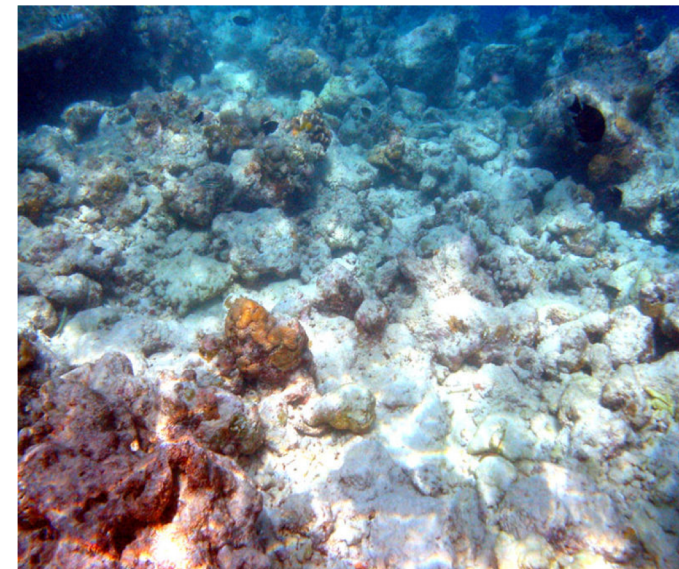
Greenland Ice Sheet



Permafrost



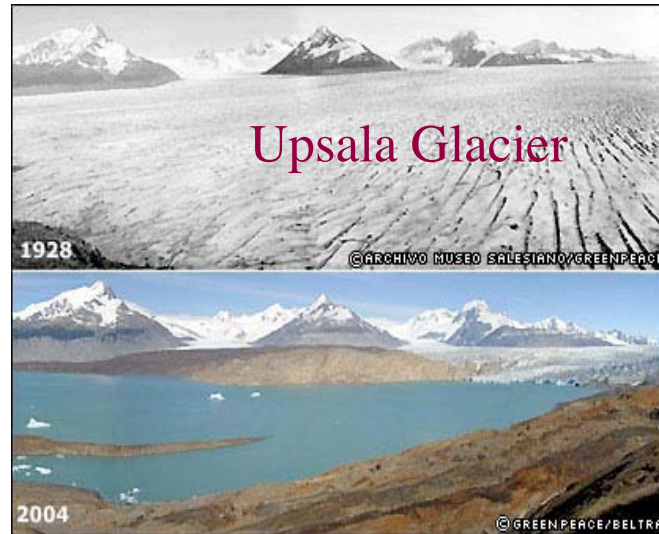
Coral Bleaching



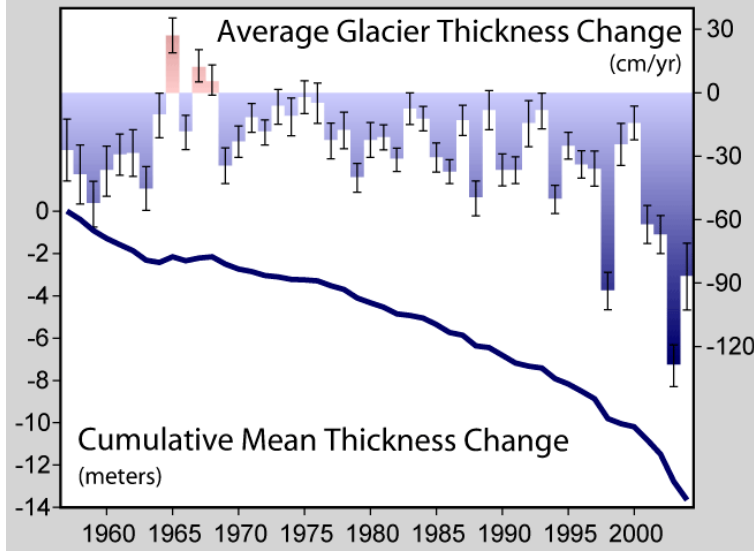
Observations of Climate Change

- Glaciers

Argentina

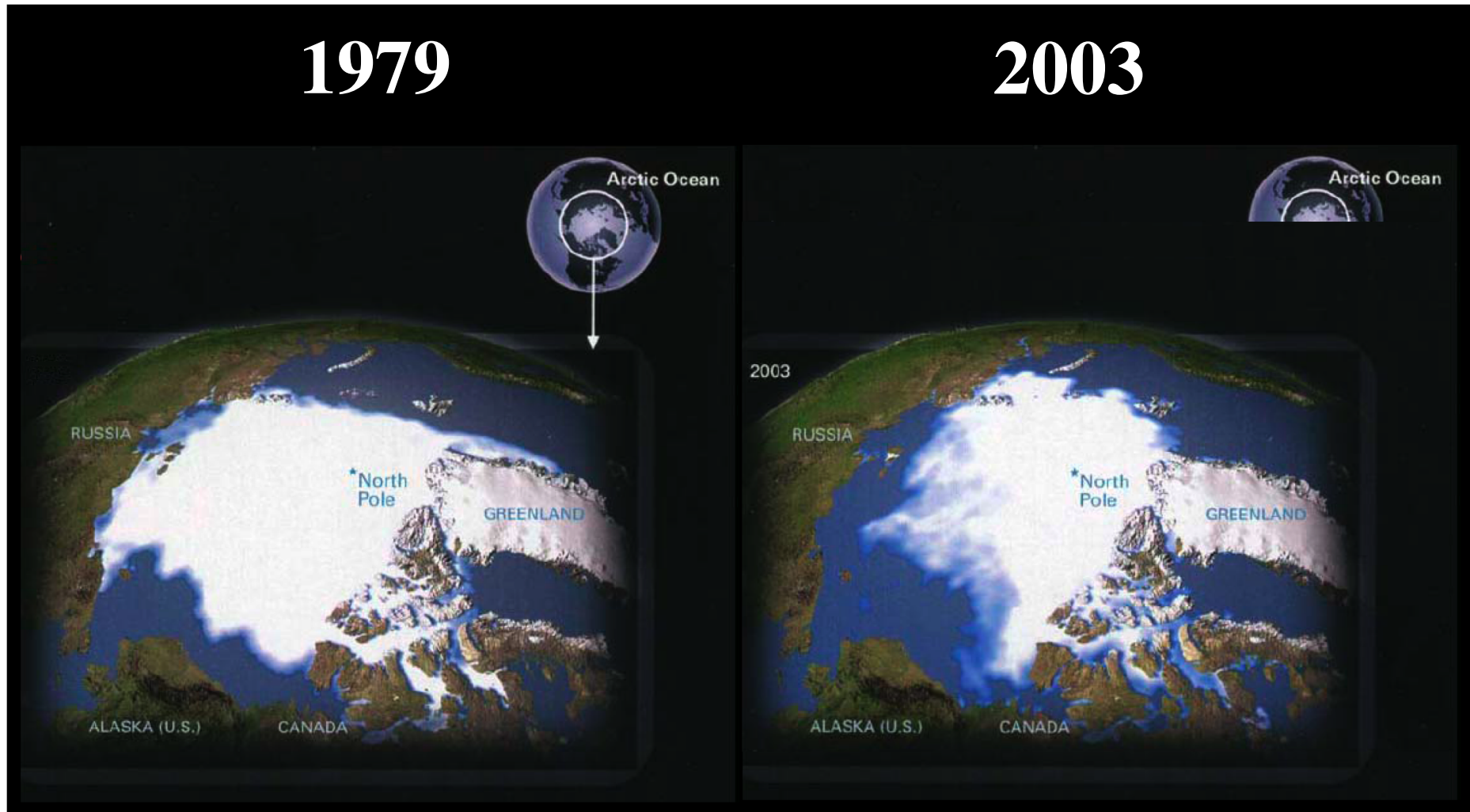


World*

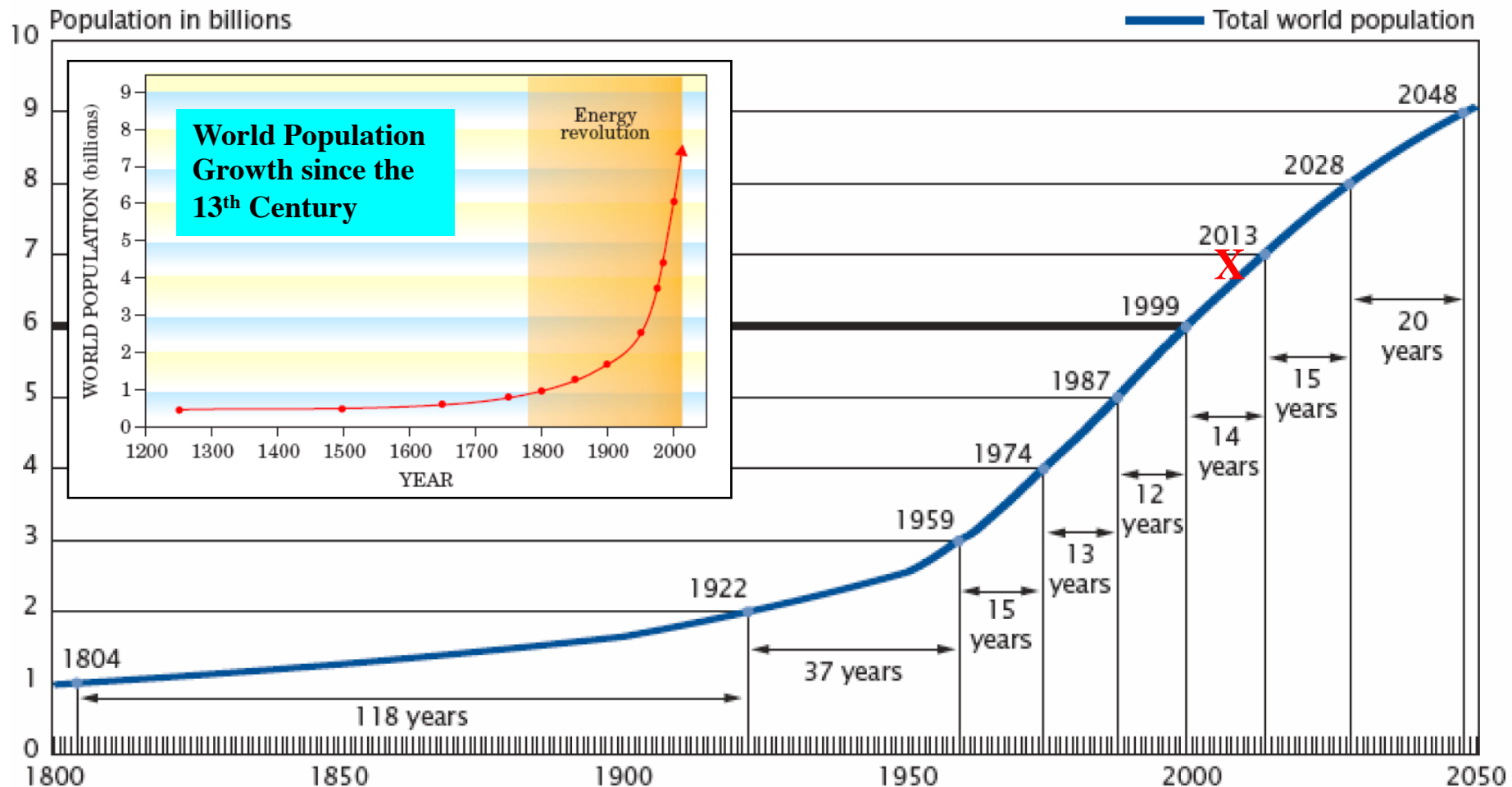


* Ref: http://en.wikipedia.org/wiki/Retreat_of_glaciers_since_1850

Arctic Ice Caps Melting



Population Growth



The Good News: Rate is declining (!?)

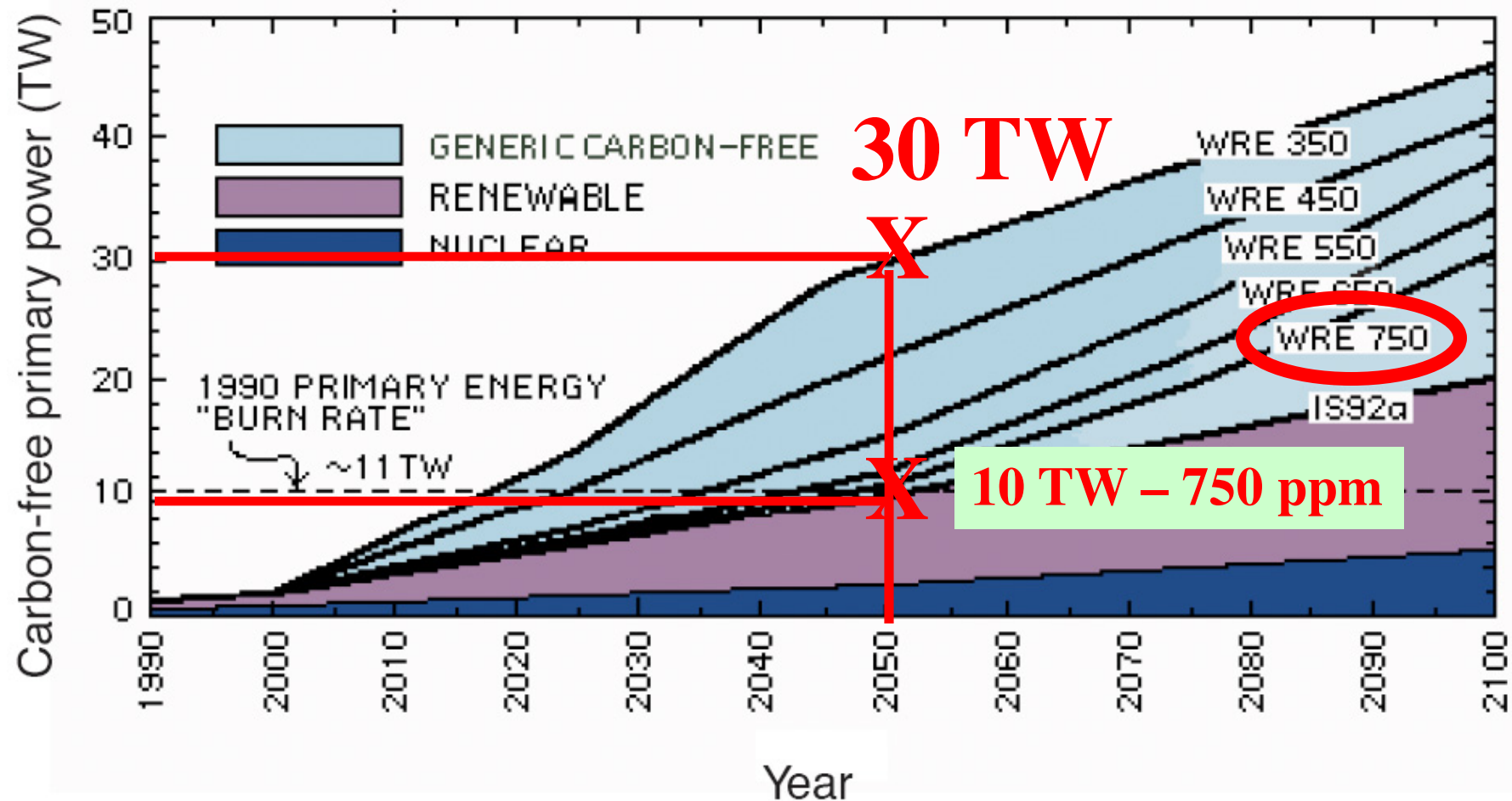
Source: United Nations, US Census Bureau, International Programs Center, International Data Base and unpublished tables, cited from: A. Krothapalli, SESEC, FSU, lecture at COBEM 2005, published in: <http://www.sesec.fsu.edu/documents/COBEM2005.pdf>

Insert: P. B. Weisz: "Basic Choices and Constraints on Long-Term Energy Supply", Physics Today July 2004, 47-53

Current population (May 2008) from: Dt. Stiftung Weltbevölkerung: DSW-Bevölkerungsuhr in: <http://www.weltbevoelkerung.de>

Need for Carbon-free Power

Amounts of CO₂-free power needed to provide mankind with sufficient power while keeping CO₂-levels below certain limits.



In **2050** the world needs

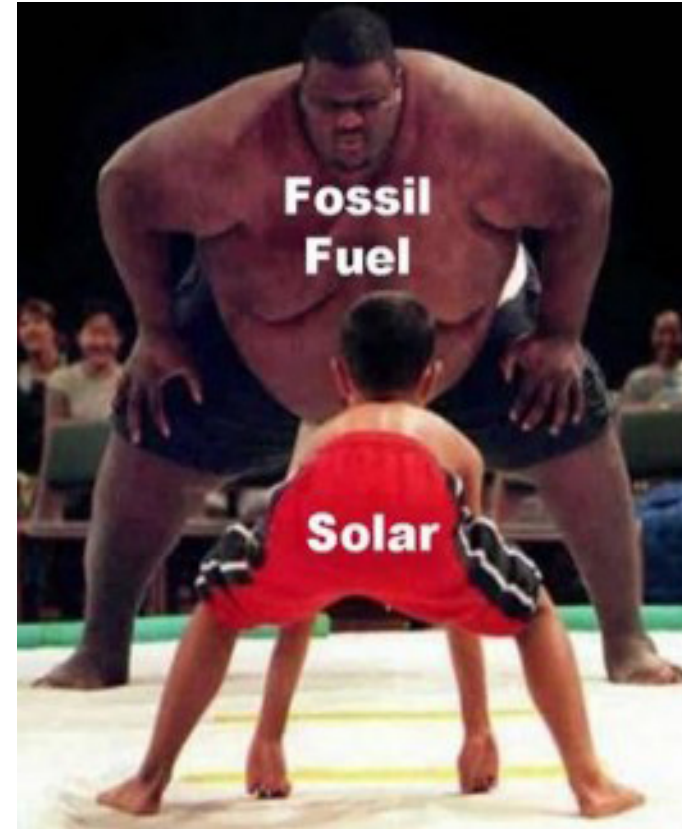
at least

10 to 30 TW

of CO₂-free power

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Summary



Possible sources of CO₂-free Power

- **Nuclear (fission and fusion)**
- **Carbon Capture and Sequestration**
- **Renewables**