

# **Class 2 Presentation**

Ch En 310  
Fall, 2008

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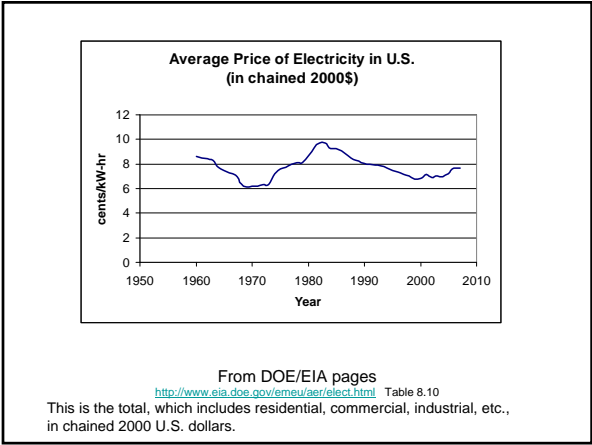
# Cost of electricity

Year	Average price of US electricity \$ per kWh (at 1990 prices)
1900	2.4
1910	1.1
1920	0.4
1930	0.5
1940	0.5
1950	0.2
1960	0.2
1970	0.15
1980	0.1
1990	0.1
2000	0.1

**Figure 1.41** Average household rates for US electricity, 1900–2000, expressed in real terms, i.e. taking into account the effects of inflation (source: Smil, 2000)



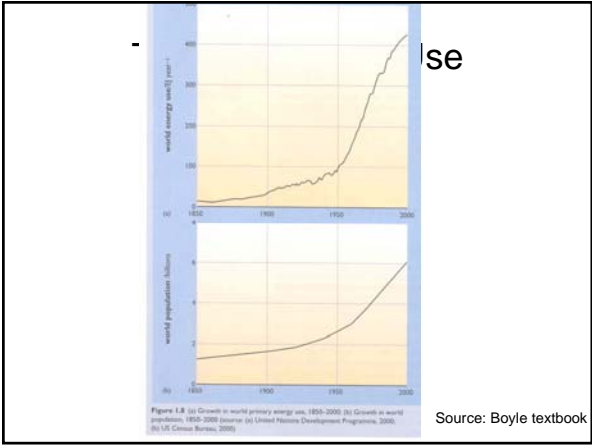
**Figure 1.41** Average household rates for US electricity, 1900–2000, expressed in real terms, i.e. taking into account the effects of inflation (source: Smil, 2000)



From DOE/EIA pages

<http://www.eia.doe.gov/emeu/aer/elect.html> Table 8.10

This is the total, which includes residential, commercial, industrial, etc., in chained 2000 U.S. dollars.



**Figure 1.8** (a) Growth in world primary energy use, 1850–2000; (b) Growth in world population, 1850–2000 (source: (a) United Nations Development Programme, 2000)

Source: Boyle textbook

# Population Trends

Figure 11 is a line graph showing world population in billions from 1750 to 2020. The x-axis represents years from 1750 to 2020 in 50-year increments. The y-axis represents population in billions from 0 to 12 in increments of 2. The population remains below 1 billion until approximately 1850, then rises sharply to about 7.8 billion by 2020. A shaded gray area represents the UN's medium variant forecast from 2000, showing a continued upward trend.

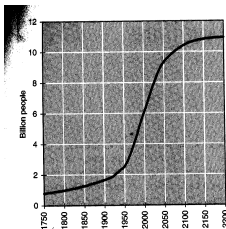
**Figure 11** World population 1750–2200, the UN's medium variant forecast from 2000. Source: UNPD 2001b:27; 1998b:37, 1998c:<sup>11</sup>

Figure 12 is a line graph showing the demographic transition in Sweden from 1750 to 2000. The x-axis represents years from 1750 to 2000 in 50-year increments. The y-axis represents the percentage of the population from 0 to 40 in increments of 5. Two lines are plotted: a solid line for the birth rate and a dashed line for the death rate. Both rates show a general downward trend. The birth rate starts at approximately 35% in 1750 and declines to about 10% by 2000. The death rate starts at approximately 30% in 1750 and declines more sharply to about 5% by 2000. A shaded gray area represents the forecast for 1990–2000.

**Figure 12** The demographic transition (showing birth and death rates in Sweden (1750–2000) and SA Lunda (1910–2000), forecast for 1990–2000). Indeed, how far the death rate declines, and then the birth rate, as the population begins to age, the death rate runs higher. Source: MCHD 1975, 1995, World Bank 2000a, 2000c, 2001a.

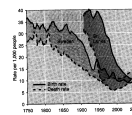
Figure 13 is a line graph showing the increase in Earth's population from 1950 to 2005. The x-axis represents years from 1950 to 2005 in 10-year increments. The left y-axis represents population in billions from 0 to 80 in increments of 10. The right y-axis represents percentage from 0.0% to 2.0% in increments of 0.5%. Two lines are plotted: a solid line for absolute population and a dashed line for percentage. Both lines show a significant upward trend. The absolute population starts at approximately 2.5 billion in 1950 and reaches about 6.5 billion by 2005. The percentage starts at approximately 0.5% in 1950 and reaches about 1.8% by 2005. A shaded gray area represents the forecast for 1990–2005.

**Figure 13** Increase in the Earth's population in absolute figures and as a percentage, 1950–2005. The forecast for 1990–2005 was due to the United Nations Population Division, which held that anthropogenic climate change would slow down the population growth rate (UNFCCC, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 24

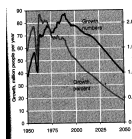


**Figure 11** World population 1750–2200, the UN's medium variant forecast from 2000. Source: UNPD 2001b:27; 1998b:37, 1998c.<sup>311</sup>

Source: Skeptical Environmentalist



**Figure 12** The demographic transition showing birth and death rates in Sweden (1750–2050) and Sri Lanka (1910–2050), forecast for 1999–2050. Notice how first the death rate declines, and then the birth rate. As the population begins to age, the death rate rises slightly. Source: Mitchell 1975, 1995, World Bank 2000c, USCB 2001a.



**Figure 13** Increase in the Earth's population in absolute figures and as a percentage, 1950–2000. A dramatic fall in 1959–62 was due to China's Great Leap Forward, which led to catastrophic starvation and cost almost 30 million people their lives (WFS 1996c:3.15). Forecast from 2001. Source: USCB 2001a.

# World Energy Use (by fuel)

Energy Source	Percentage Contribution
oil	34.6%
natural gas	21.4%
coal	21.6%
'new' renewables	2.1%
nuclear	6.6%
large hydro	2.3%
traditional biomass	11.3%

**Figure 1.9** Percentage contributions of various energy sources to world primary energy consumption, 2000.

Region	Per capita primary energy consumption (tonnes of oil equivalent per year)
North America	~9.5
Europe	~6.5
Former Soviet Union	~5.5
East of World	~1.5
World	~1.5

**Figure 1.11** Per capita primary energy consumption, in tonnes of oil equivalent per year, for different regions of the world and for the world average in 1998. (Data: 1998 World consumption per person the highest almost on all growth rates in the year 2000. Note: World consumption per capita is more than twice that of Europe and the former Soviet Union, and almost 10 times the level in the East of the World. Hence that these figures actually only moderately ranked fairly, i.e., they provide a reduced National Income (© 2002).

Source: Boyle textbook

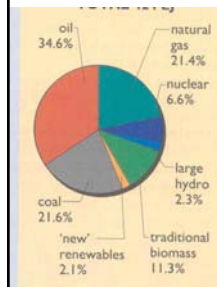


Figure 1.9 Percentage contributions of various energy sources to world primary energy consumption, 2000.

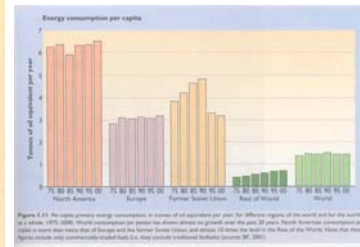
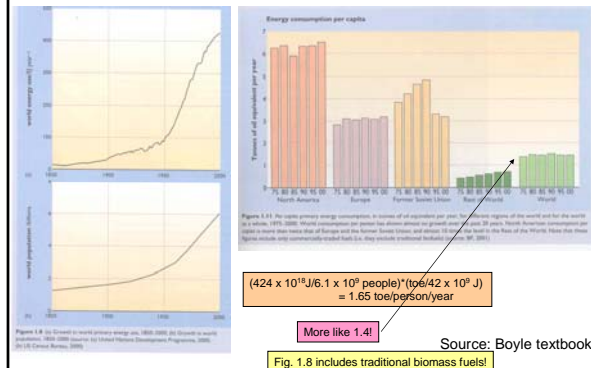


Figure 3.11: The rapid primary energy consumption, in tonnes of oil equivalent per year, for different regions of the world and for the world as a whole, 1975–2000. World consumption per person has almost doubled in the past 20 years. North American consumption per capita is more than twice that of Europe and the Soviet Union, and almost 10 times the rate in the Rest of the World. Note that the figure includes only commercially traded fuels, i.e. it excludes traditional biomass (source: BP, 2001).

Source: Boyle textbook

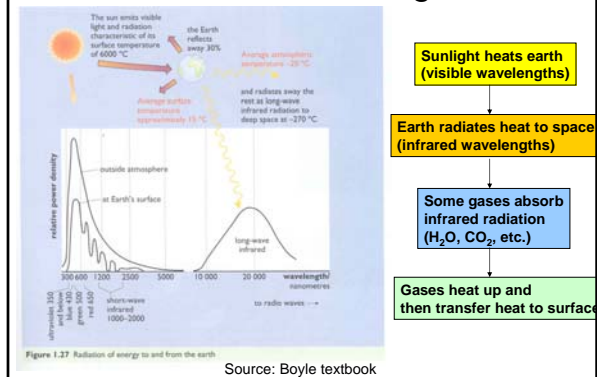
## Compare Figs. 1.8 & 1.11



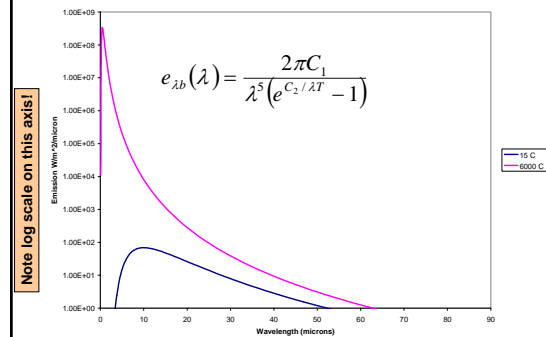
## Thoughts on Global Warming



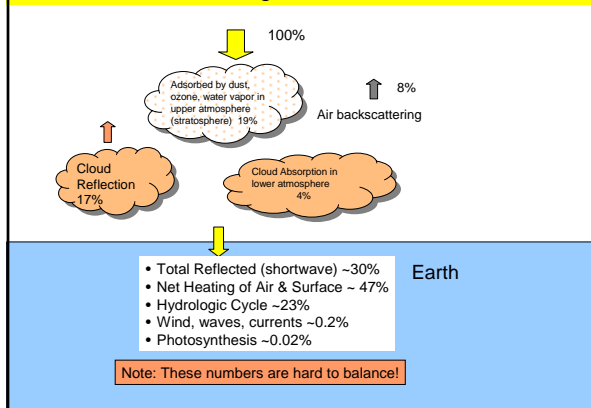
## Global Warming



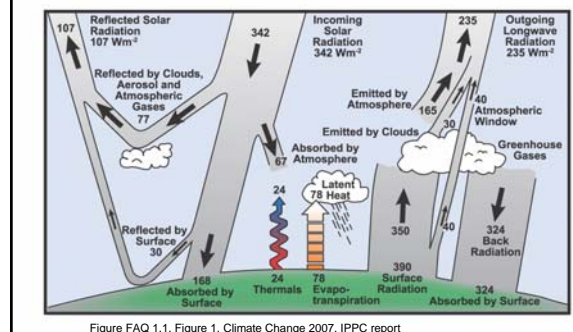
## Planck's Law



## Sunlight



## Energy Balance for Earth



## Temperature and CO<sub>2</sub> Data

Source: Skeptical Environmentalist

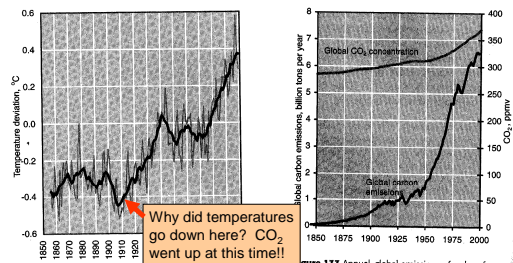
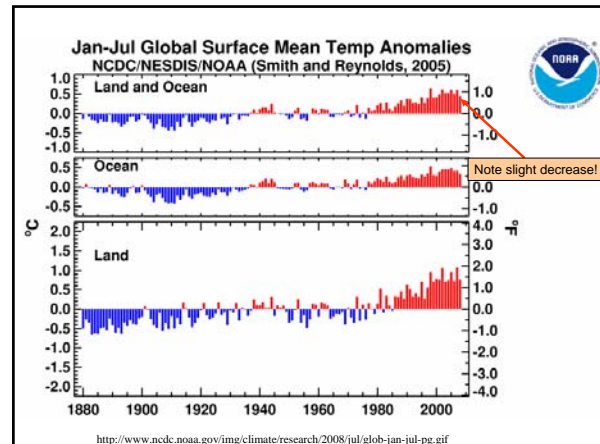
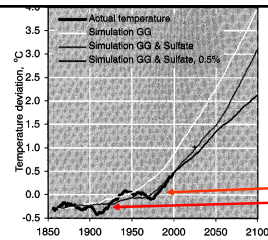


Figure 135 Global temperature, 1856–2000, expressed as deviations (anomalies) from the average of the period 1961–90. Temperature is a weighted average of land air and sea surface temperatures. Light lines, actual yearly measurements; black heavy line, moving 9-year average. To obtain absolute global temperature add 14.0°C (57.2°F). Source: Jones et al.

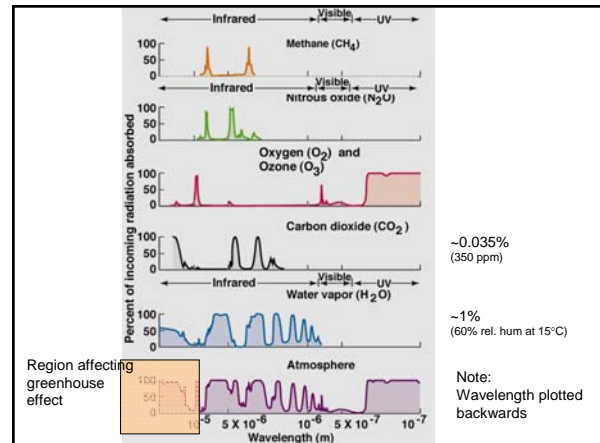


## Global Warming Models



None of the models show an increase in temperature in these time periods, even though CO<sub>2</sub> increases substantially!!

Source: Skeptical Environmentalist

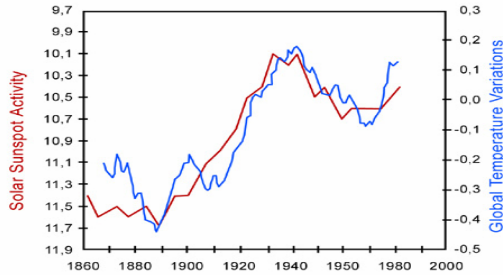


## Science Problem

- If CO<sub>2</sub> (or any other infrared absorber) causes extensive warming, then the atmosphere should show increased temperature change before the earth
  - All theories operate on this scientific principle
- No major changes have been observed in the atmospheric temperature at the correct altitudes!

Are There Any Other Possible Explanations for Rise in T<sub>earth</sub>?

## Correlation with Sunspot Activity



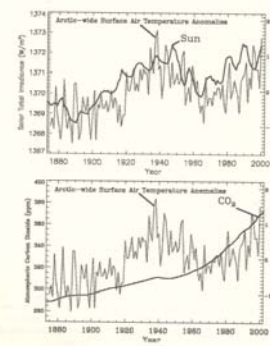
There is also some evidence that the temperature increase precedes the CO<sub>2</sub> increase

## Solar Activity

- CO<sub>2</sub> should have most effect on temperature in polar regions
  - No apparent correlation with CO<sub>2</sub>
- Good correlation with solar activity
  - Not enough change in solar flux to account for temperature change
  - Thought to be the solar wind deflection of cosmic rays, which affects cloud formation

Singer & Avery, *Unstoppable Global Warming* (2007)

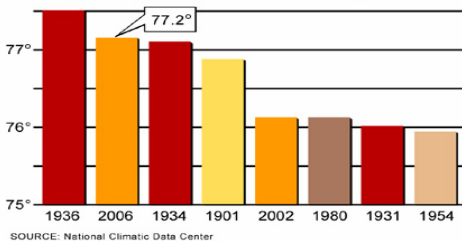
Figure 2.1 Arctic Temperatures Correlate with Solar Activity, Not CO<sub>2</sub>



Source: W. Soon, "Variable solar irradiance as a plausible agent for multidecadal variations in the Arctic-wide surface air temperature record of the past 130 years," *Geophysical Research Letters* 32, 2005.

## Hot U.S. Temperatures Do Not Correspond to CO<sub>2</sub>

Average July temperature: contiguous USA



SOURCE: National Climatic Data Center

## Misinformation

Figure 6.1: The Last 1,000 Years of Earth Temperatures from Tree Rings, Ice Cores, and Thermometers

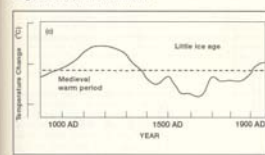


Figure 2.2: Climate Change 1995, Intergovernmental Panel on Climate Change

1995 Report

The natural temperature variations were erased to make it look more serious!

(taken from Singer and Avery, *Unstoppable Global Warming* (2007))

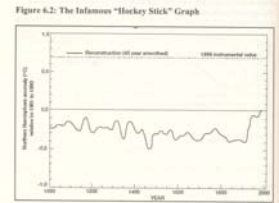


Figure 2.20: Climate Change 2007, Intergovernmental Panel on Climate Change

2001 Report

1765 - 2100

1765 - 2100

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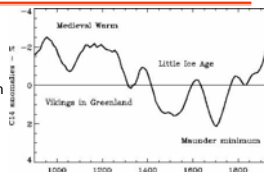
1765 - 2100

1765 - 2100

1765 - 2100

## Bottom Line

- The global temperature is increasing
  - We have been in a "Little Ice Age"
  - There seems to be a 1500 year cycle
- There have been periods when the earth was warmer
  - Greenland was actually farmable
  - No CO<sub>2</sub> mechanism was responsible
- The evidence that CO<sub>2</sub> is causing the temperature increase leaves lots of room for doubt (in my mind)
- The media and many politicians have decided that CO<sub>2</sub> is a problem
  - Many scientists doubt this, but do not get heard
  - No viable sequestration or replacement is available
  - No replacement is available on a large scale



Predictions of C14 during the last 1000 years. The variation in the C14 production is caused by changes in solar activity. When solar activity is high the production of C14 is low, due to the shielding effect of the solar wind against cosmic rays. Note that the rise in the C14 production has been reversed. The Maunder minimum refers to the period 1645 - 1715 when very few sunspots were observed on the sun. In this period the production of C14 was very high in agreement with a low solar activity.

## In This Class

- We will recognize that CO<sub>2</sub> emission regulations are coming
- We will discuss options to reduce CO<sub>2</sub> emissions
- You do not have to agree with my opinion on this matter

