Unlimited Energy

Average intensity of sunlight on the surface of the U.S. = 600 watts/m^2

Total current U.S. energy use ~ 100 QBtu/yr = 10^{17} Btu per yr ~ 10^{20} Joules per year

1 watt = 1 Joule/sec; number of seconds in a year ~ 3×10^7

Energy intensity in watts generated by human activity = 10^{20} Joules / 3×10^7 seconds ~ 3×10^{12} watts

Area of the U.S. = 3.6×10^6 square miles ~ 10^{13} square meters.

No. watts/m^2 due to human activity = 3×10^{12} watts / 10^{13} m^2 = 0.3 watts/m^2

Suppose nuclear fusion energy became abundant and cheap, and that its use increased by 7 % per year (which is about the rate at which oil use increased in the U.S. from 1900 to 1930). How long would it take for the heat intensity at the earth's surface due to human activity to reach 1% of the intensity of sunlight =
6 watts/m^2 (at which point we might expect to see noticeable climate change)?

ANS: 43 years!

A growth rate of 7 % per year corresponds to a doubling time of 70/7 = 10 years.

Years	% of the Intensity of Sunlight
43	1
53	2
63	4
73	8
83	16
93	32
|	|

"In the long run, fusion could bring on the ultimate climatic crisis. The energy released in fusion would not otherwise be available on Earth; it would represent a new input to the global energy flow. Fusion energy would ultimately become heat that Earth would have to radiate into space. As long as humanity kept its energy consumption a tiny fraction of the global energy flow there would be no major problem. But history shows that human energy consumption grows rapidly when it isn't limited by shortages of fuel. Fusion would be unlimited, so our species might expand its energy consumption to the point where the output of our fusion reactors became significant relative to the global input of solar energy. At that point Earth's temperature would inevitably rise. This long-term criticism of fusion holds for any energy source that could add to Earth's energy flow even a few percent of what the Sun provides. Only solar energy itself escapes this criticism."

Nuclear Choices: A Citizens Guide to Nuclear Technology
by Richard Wolfson (The MIT Press, Cambridge, 1993)