We're making progress on addressing climate change, and I'm hopeful that we'll continue doing so. Yet it's not clear whether the path we're currently on will make progress fast enough to avoid very serious risks. So what would it take for us to make a quantum leap in this effort? I wouldn't hazard a prediction about whether that will happen or if so what it will be. But I think we can see a roadmap of the possibilities. Here are the ones the categories I can identify, though I can't exclude the possibility of some X-factor that's not on my list.

Tectonic Shift in Attitudes. There are still a lot of climate deniers out there, and far more people who think climate change is a problem but don't view it as that serious or urgent. We don't have a very handle on why public attitudes can sometimes shift suddenly, as they did on environmental issues in the 1960s and 1970s, on the role of women in the 1970s and 1980s, or as they did on gay marriage from 2000 to the present. In developing countries, a massive rebellion against air pollution could also spark radical cuts in coal and gasoline use. We can't rule out the possibility of such shifts in attitudes.

Breakthrough Energy Technologies. It's easy to imagine possibilities here. Super-cheap renewable energy; safe and affordable nuclear or fusion; much cheaper, more efficient energy storage. The price of renewables has come down a lot, which has made them a much more economic alternative. That's already having a major effect on the energy system. But we could imagine a far greater effect if prices went down a lot more or if storage was cheap enough that the intermittency of the sun and wind were no longer a problem. The point about technology is that its progress is hard to predict: to know that cheap fusion is possible, for instance, we'd have to already know how to do it. Technological miracles sound too good to be true, but they're not impossible.

Massive Disruption in Oil Markets. Suppose oil production in the Mideast and Russia collapsed due to political turmoil. Other producers like the U.S. could pick up the slack, but only part it, and prices would spike. All of a sudden, alternatives to oil and natural gas like electric vehicles would be a lot more appealing. This is not an alternative I like to think about, because that degree of political chaos would be terrible for the people involved and destabilizing globally.

Breakthrough in Carbon Removal. I don't see any scenario where geo-engineering is a real substitute for major reductions in carbon emissions. But if we figured out a cheap, scalable method of removing carbon from the atmosphere, that would certainly help reach our carbon goals. I have no reason to think that such

technologies are feasible, especially in the short and medium run, but you never know. (I'm not including solar radiation management as a possibility because of its risks, because it is hard to imagine it as a permanent solution, and because it would do nothing to prevent ocean acidification. But again, I could be wrong.)

The odds that any of those things will happen in the near future are small, but the odds also rise over longer periods. In the meantime, those of us concerned with day-to-day policy have to keep working on more immediate measures to reduce emissions, hoping that these measures will spark a "virtuous" cycle in which they prompt bigger and better solutions.