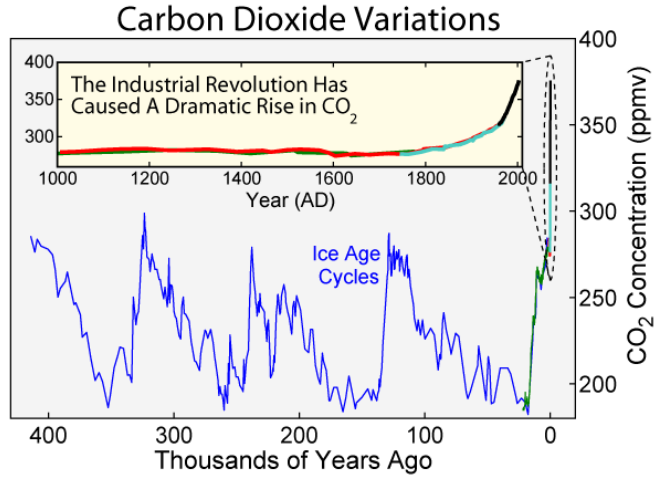
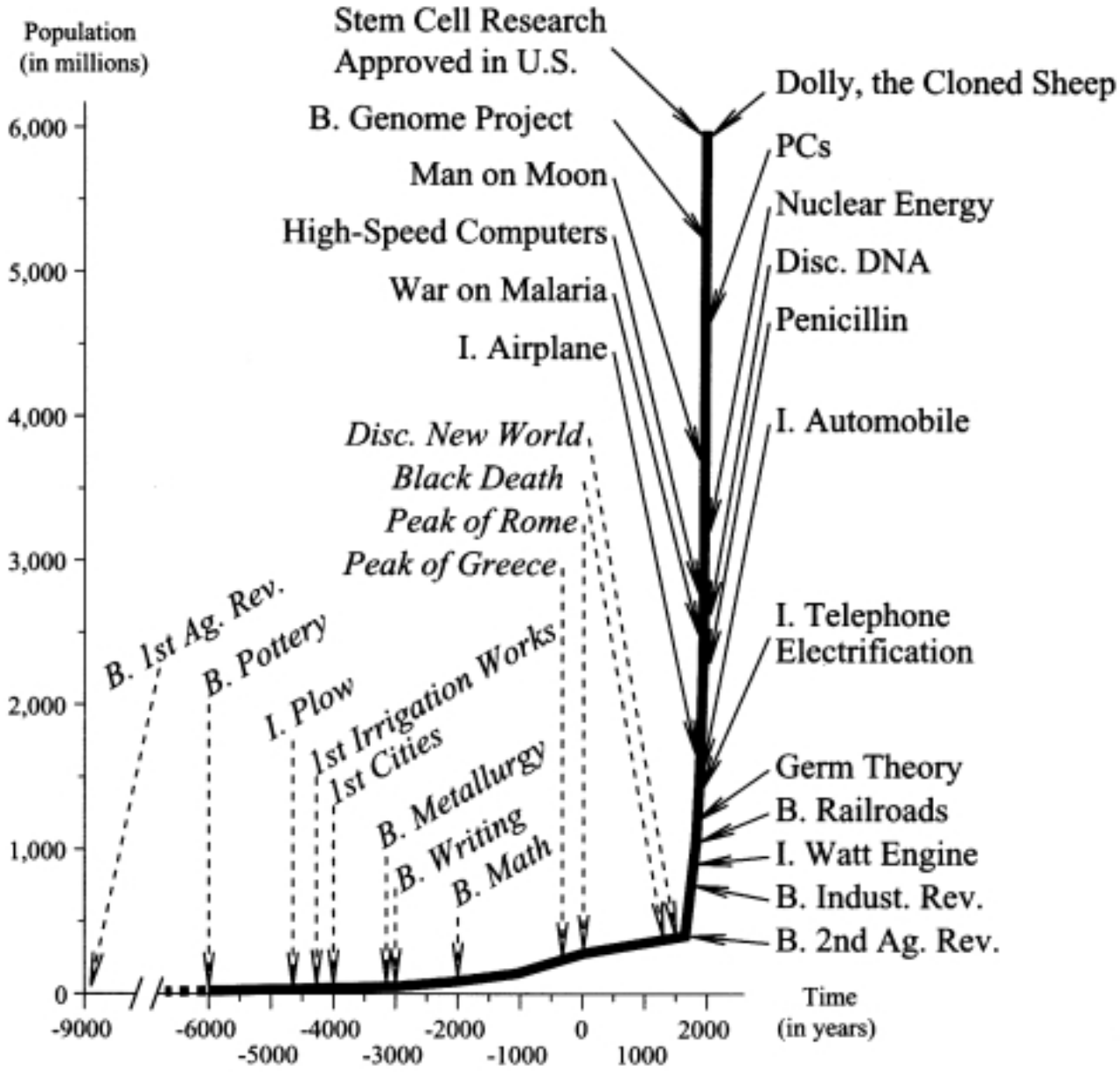
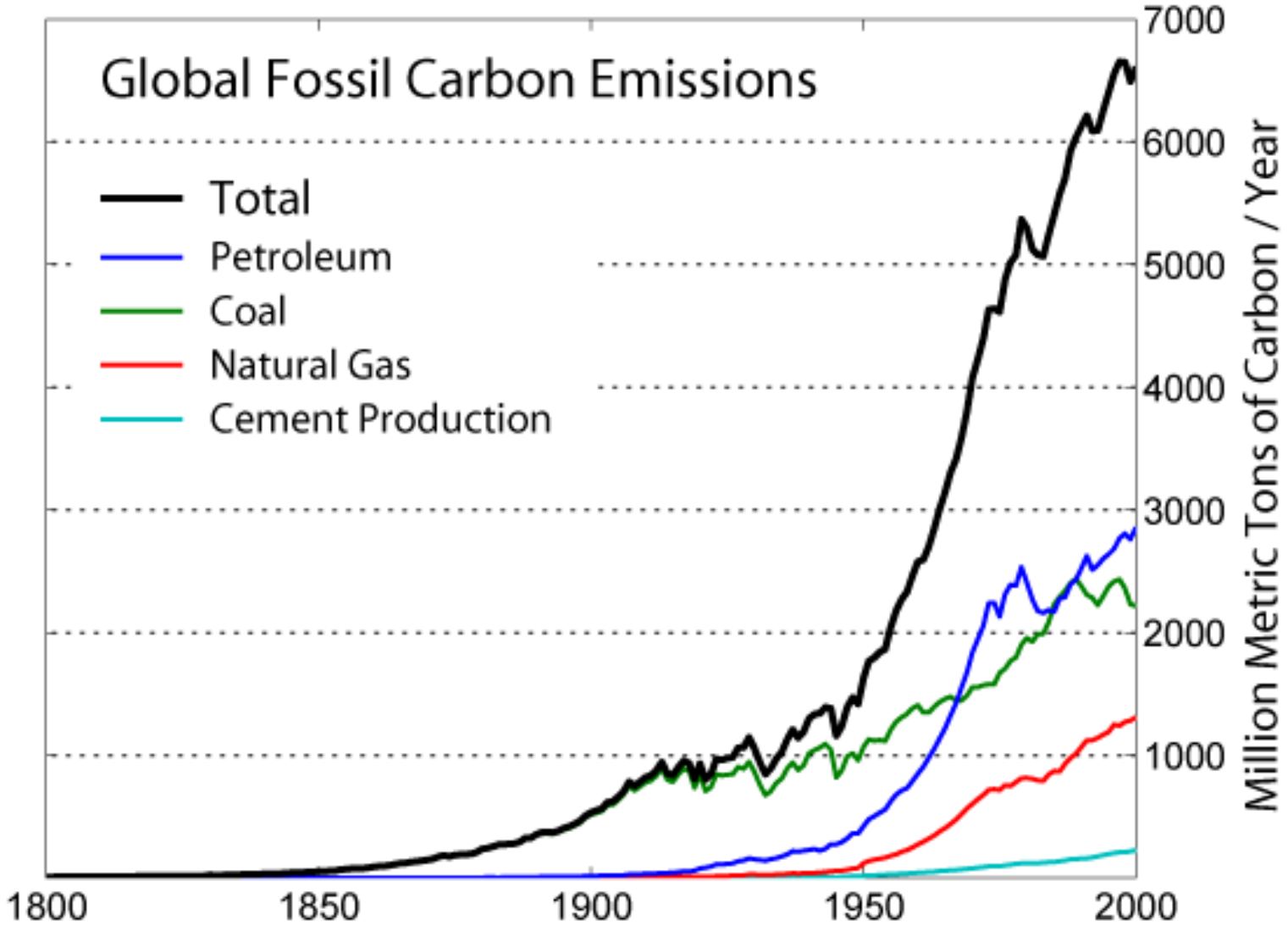
# ENERGY AND THE ENVIRONMENT — WHAT PHYSICISTS CAN DO




**John Baez**
**Perimeter Institute**
**17 April 2013**




Robert Fogel - *The Escape from Hunger and Premature Death, 1700-2100*


Global Fossil Carbon Emissions
Total
Petroleum
Coal
Natural Gas
Cement Production
7000
6000
5000
4000
3000
2000
1000
Million Metric Tons of Carbon / Year
1800
1850
1900
1950
2000

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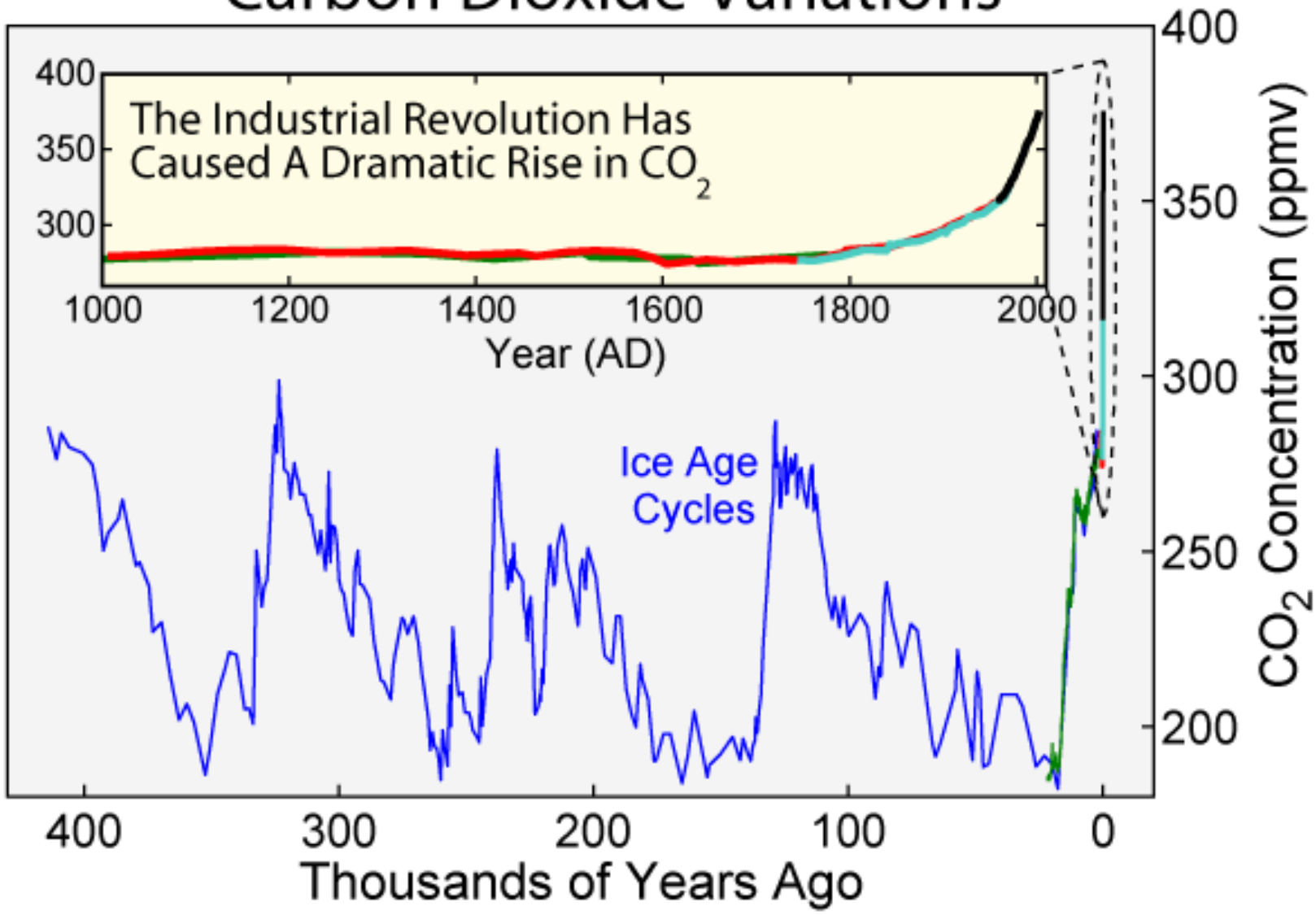
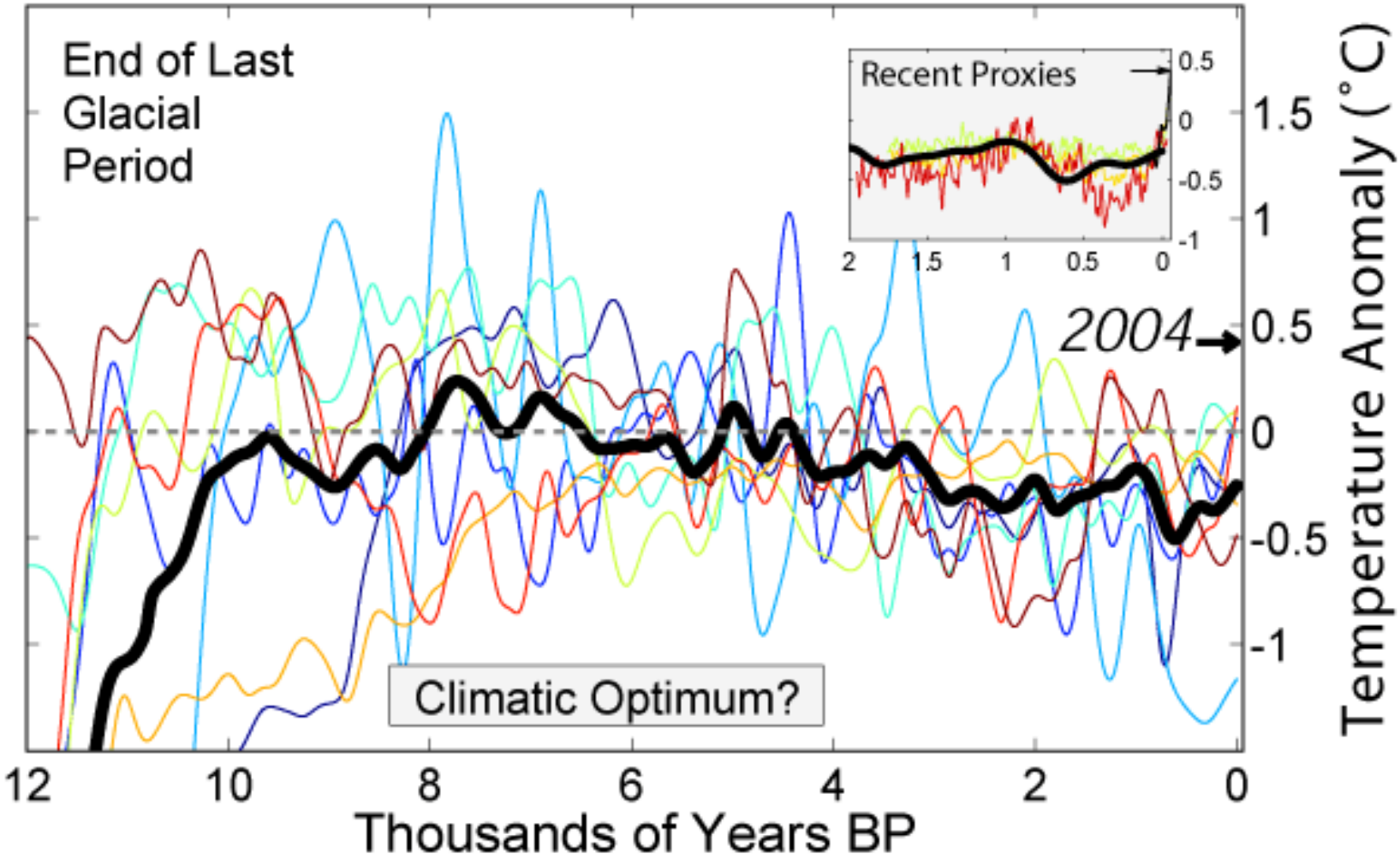
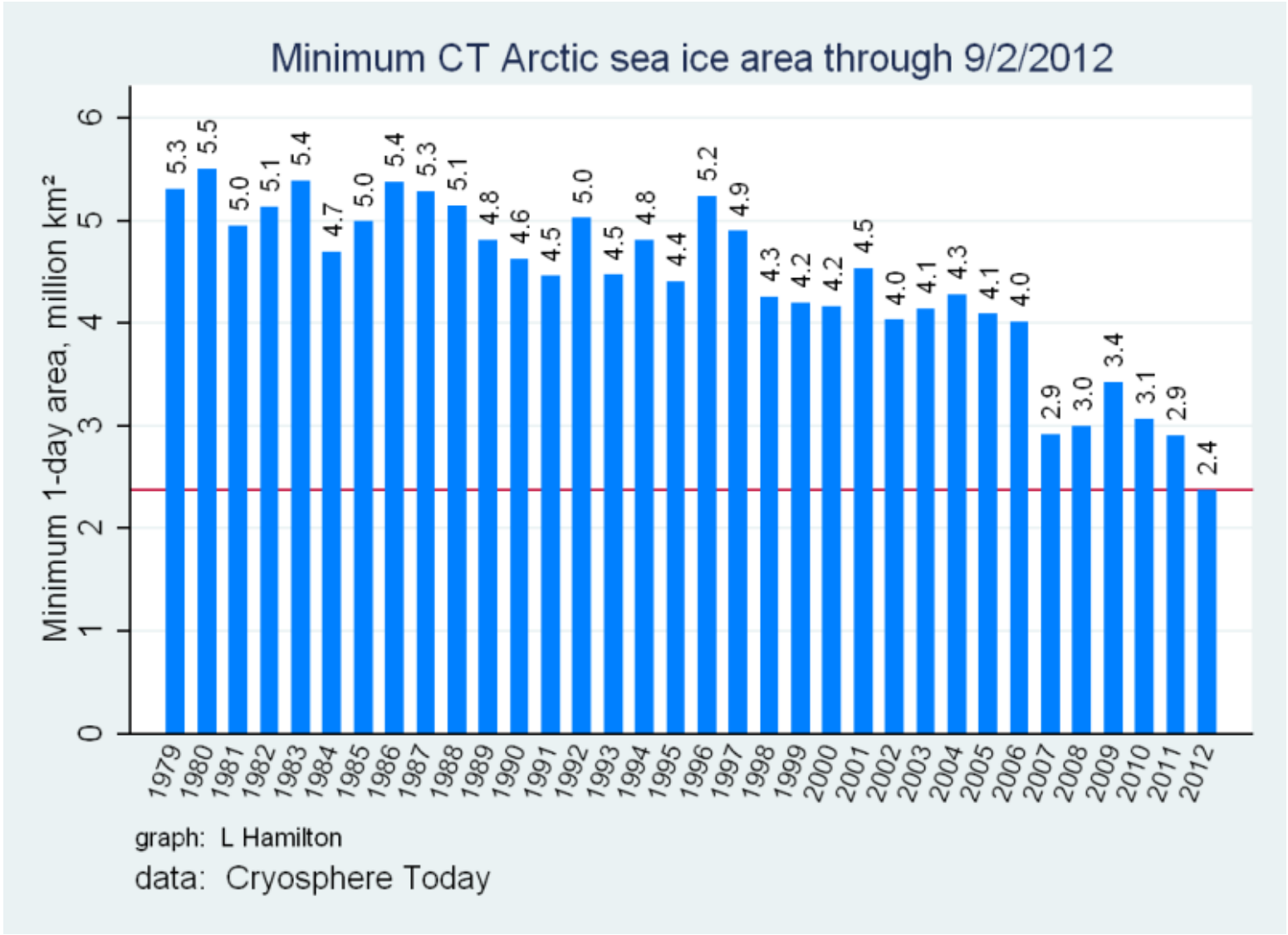
The total amount of carbon in the atmosphere is just 3000 gigatonnes. So, we're dramatically affecting the biosphere.

# Carbon Dioxide Variations



# Holocene Temperature Variations




Minimum CT Arctic sea ice area through 9/2/2012
Minimum 1-day area, million km²
0
1
2
3
4
5
6
5.3
5.5
5.0
5.1
5.4
4.7
5.0
5.4
5.3
5.1
4.8
4.6
4.5
5.0
4.5
4.8
4.4
5.2
4.9
4.3
4.2
4.2
4.5
4.0
4.1
4.3
4.1
4.0
2.9
3.0
3.4
3.1
2.9
2.4
1979
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1994
1995
1996
1997
1998
1999
2000
2001
2002
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2007
2008
2009
2010
2011
2012
graph: L Hamilton
data: Cryosphere Today

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Acting as if these are true inevitably brings us to a point where they stop being true.

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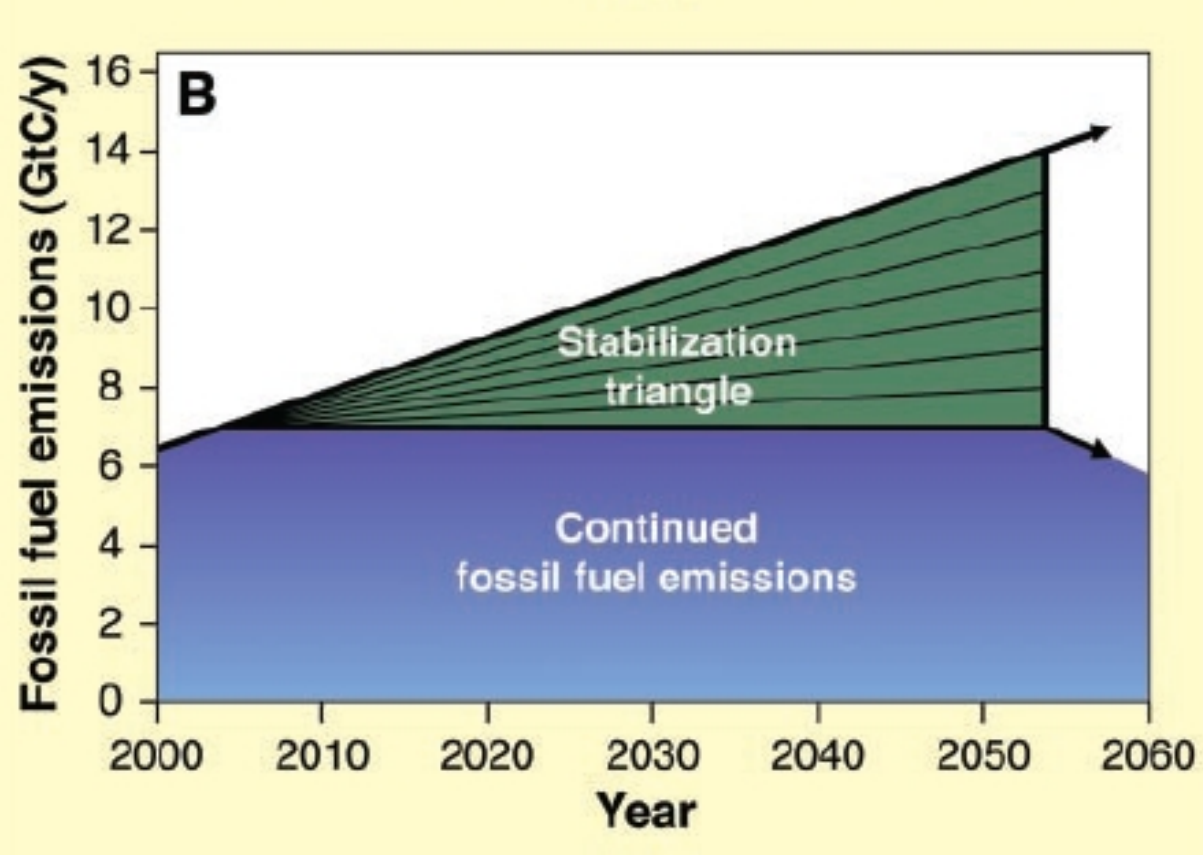
For better or worse, we *will* adapt to life on a finite-sized planet. The challenge is to do it gracefully.

In 2004, Pacala and Socolow looked for ways to hold carbon emissions constant until 2054 — *not a solution, just a start!*




They said it would require 7 'wedges'. Each wedge was a way to reduce carbon emissions by 1 gigatonne/year by 2054.

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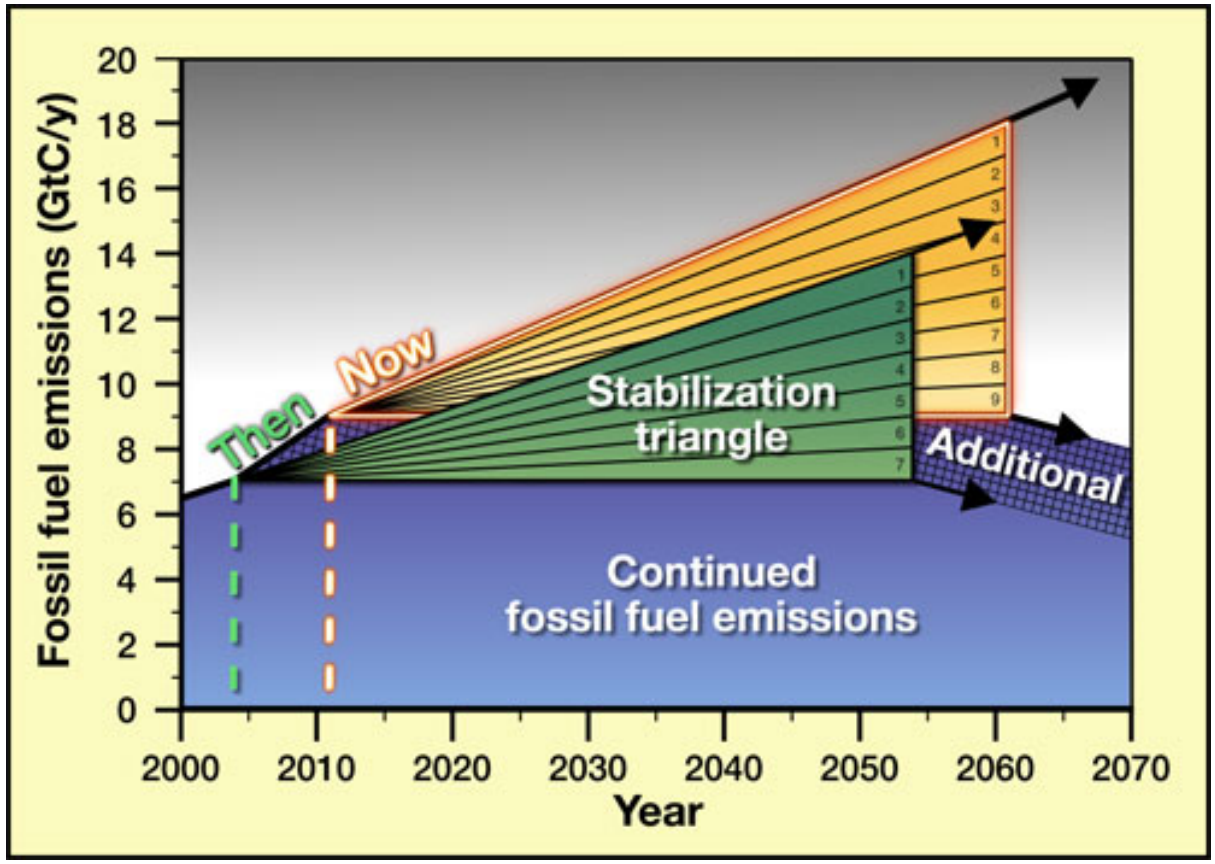
**Conservation/efficiency:** Cut carbon emissions by 25% in buildings and appliances.

It's a race against time. In 2004 we needed 7 wedges to hold carbon emissions constant for 50 years. In 2011 we needed 9:




And this is just a stopgap. We really need to *stop burning carbon* or *actively remove it from the air*.

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We should get smart about conferences: *transfer more bits, fewer bodies*.

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For help, get Eric Mazur's Peer Instruction materials.

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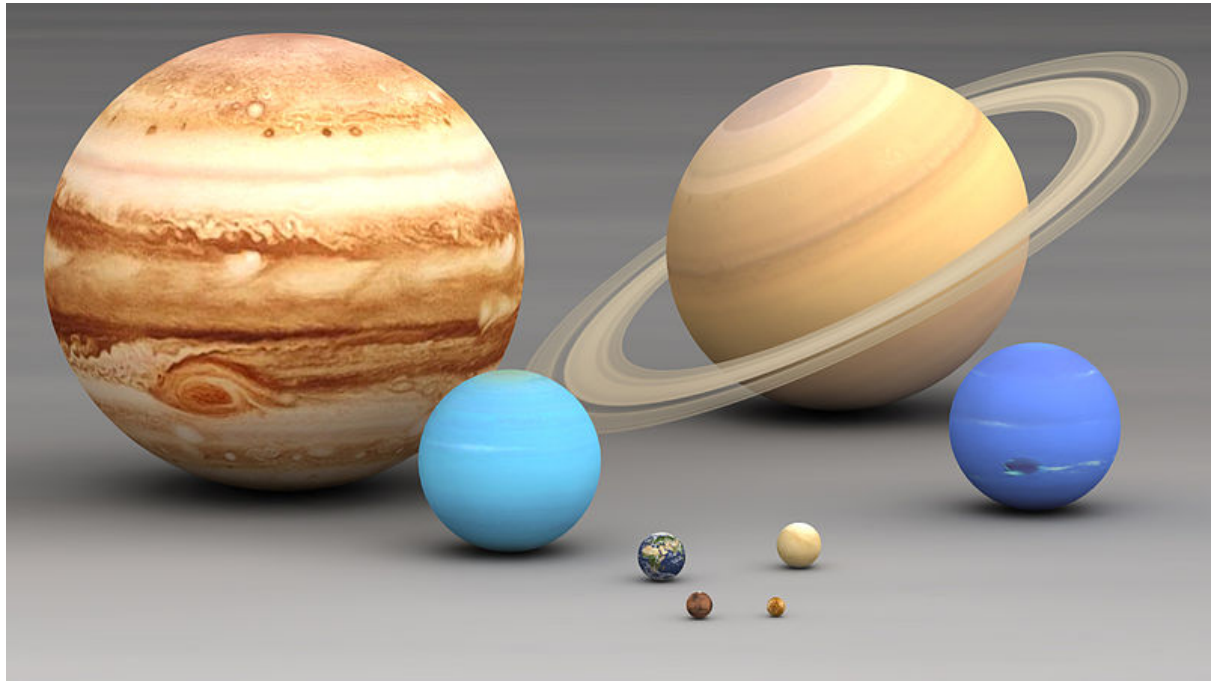
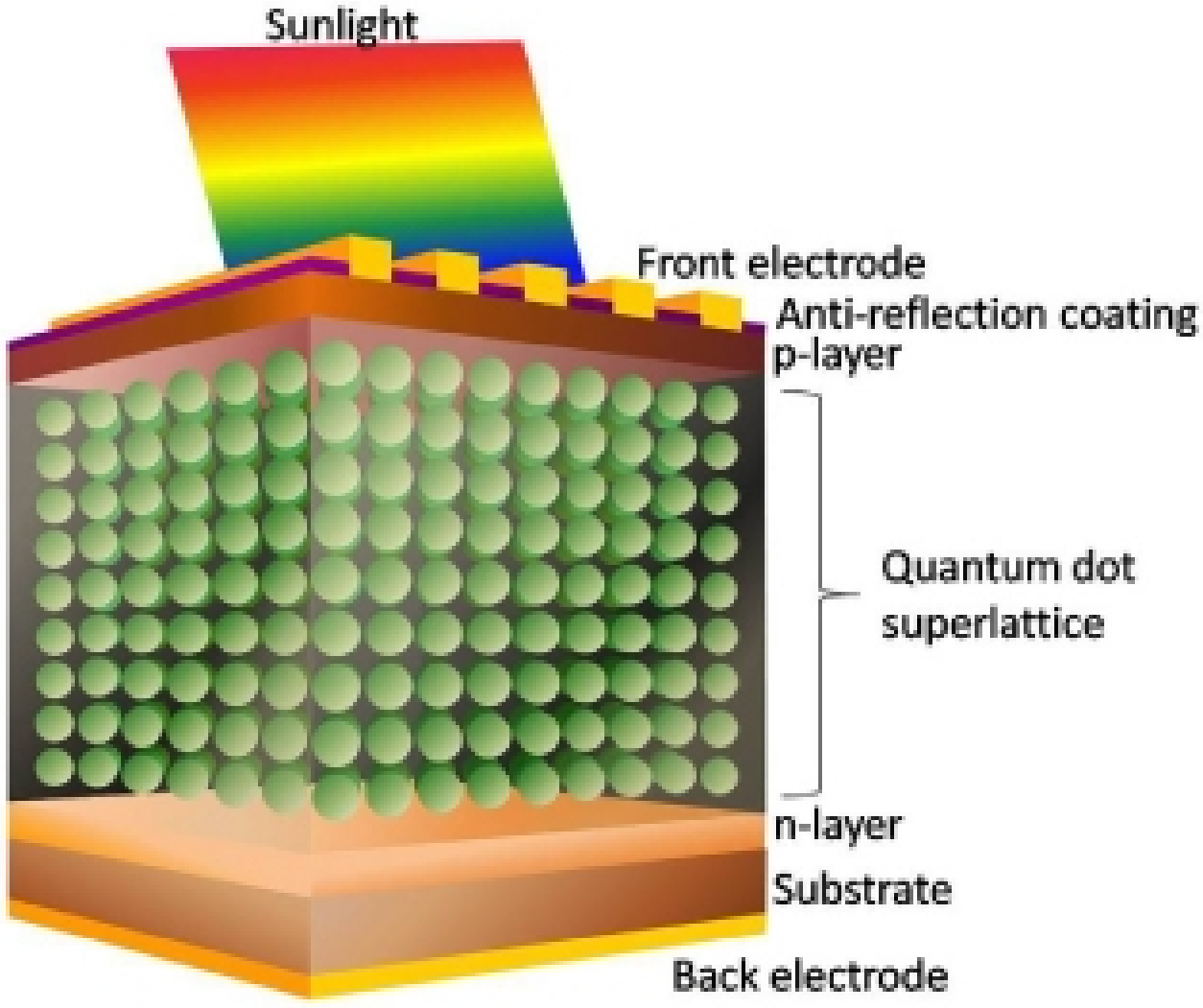
In 2007, most MIT grad students didn't know this. Better physics teaching could help.

3. Create the physics we need for life on a finite-sized planet.



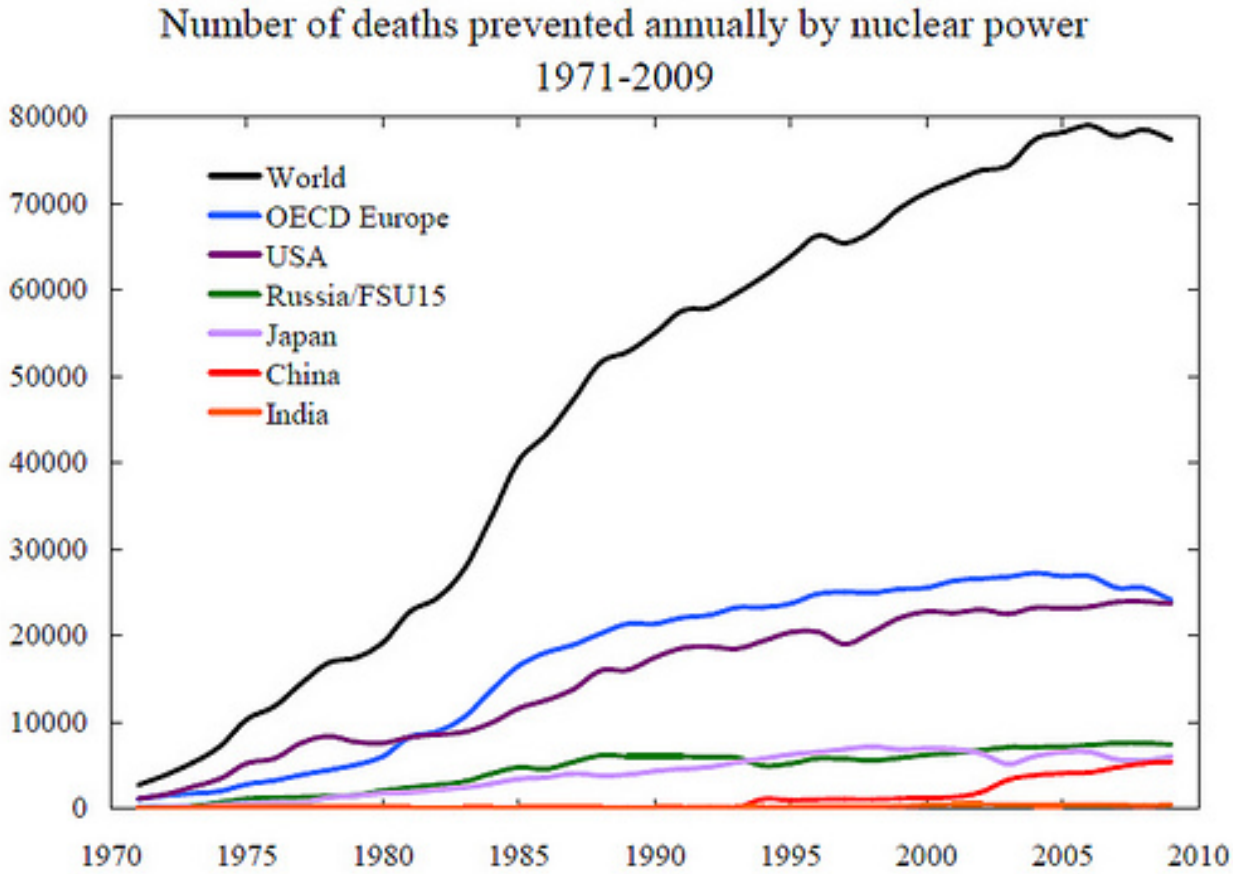
There are many *fun* things to do here! I'll mention just a few.

- Make solar power cheaper than fossil fuels. For example: quantum dot solar cells have efficiency 65% instead of just 31% for ordinary silicon cells.



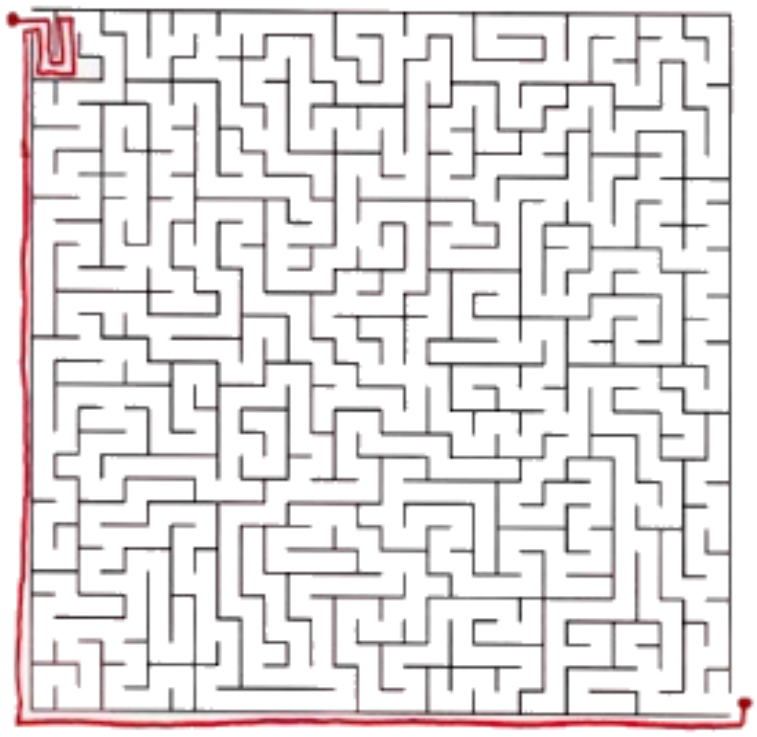
- Make wind power cheaper than fossil fuels. For example: understanding multi-scale turbulence is important. In the US, if a wind farm's predicted power generation is off by 1%, it can cost them millions of dollars!

- Make nuclear power cheaper and safer. According to James Hansen it's already saved 1.8 million lives: coal is what kills!




But there's a lot to be done on passive safety, thorium reactors and more. And for the ambitious, don't forget fusion!

- Think outside the box.



Physicists are famous for doing this.

There's lots of room for everyone.

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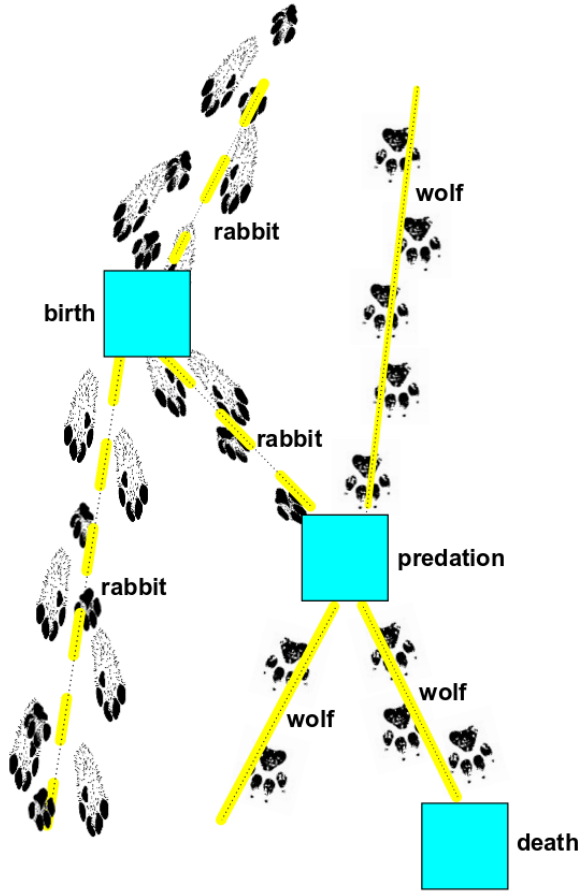
Since I'm very mathematical, I've been working on *networks*.




**To understand ecosystems, ultimately will be to understand networks.** — B. C. Patten and M. Witkamp

If you want to join me, check out the Azimuth Project!