What would we do if we took climate seriously?

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University of California at Berkeley
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Passing the baton

My target audience this afternoon is the budding analyst in the field of energy and environment.

This talk is not a pep talk. I assume that the analyst is committed and engaged. He or she is hunting right now for a good research problem or has recently found one. Probably, the analyst has been in the field long enough to be a bit baffled that there are so many sacred cows, so many worn paths, so many closed gates.

In this talk, sometimes buried, sometimes lying in the open, are many suggestions for new work. I'm heading your way. Start running, with your right arm hanging back, and let's see if together we can accomplish a passing of the baton.

What would we do if we took climate change seriously?

Let me count the ways: Three sets of four.

Frame the problem honestly

Concede that the news is unwelcome.
Admit that we don't know how large a problem we face.
Acknowledge that "solutions" can be worse than the disease.
Smoke out surrogacy, where another goal is paramount.

Propagate planetary thinking

Accept that the developing world will decide what kind of planet we live on.
Help the developing world invent *authentic* low-carbon industrialization.
Insist on cosmopolitan ethics, where equity is about individuals, not nations.
Undermine the doctrine that the world's neediest must be denied fossil fuels.

Enlarge the system boundary

Value contending norms: freedom, privacy, safety, comfort, variety…
Relegitimate "population."
Protect the scientific method from internal and external abuse.
Imagine humanity's collective future.

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Admit that we don’t know how large a problem we face.

Acknowledge that “solutions” can be worse than the disease.

Smoke out surrogacy, where another goal is paramount.

The news is unwelcome.

Never in history has the work of so few led to so much being asked of so many!

The “few” are today’s climate science researchers.

The “many” are the rest of us.

We are asked to reduce our emissions promptly and substantially.

“Shooting the messenger”? No surprise.

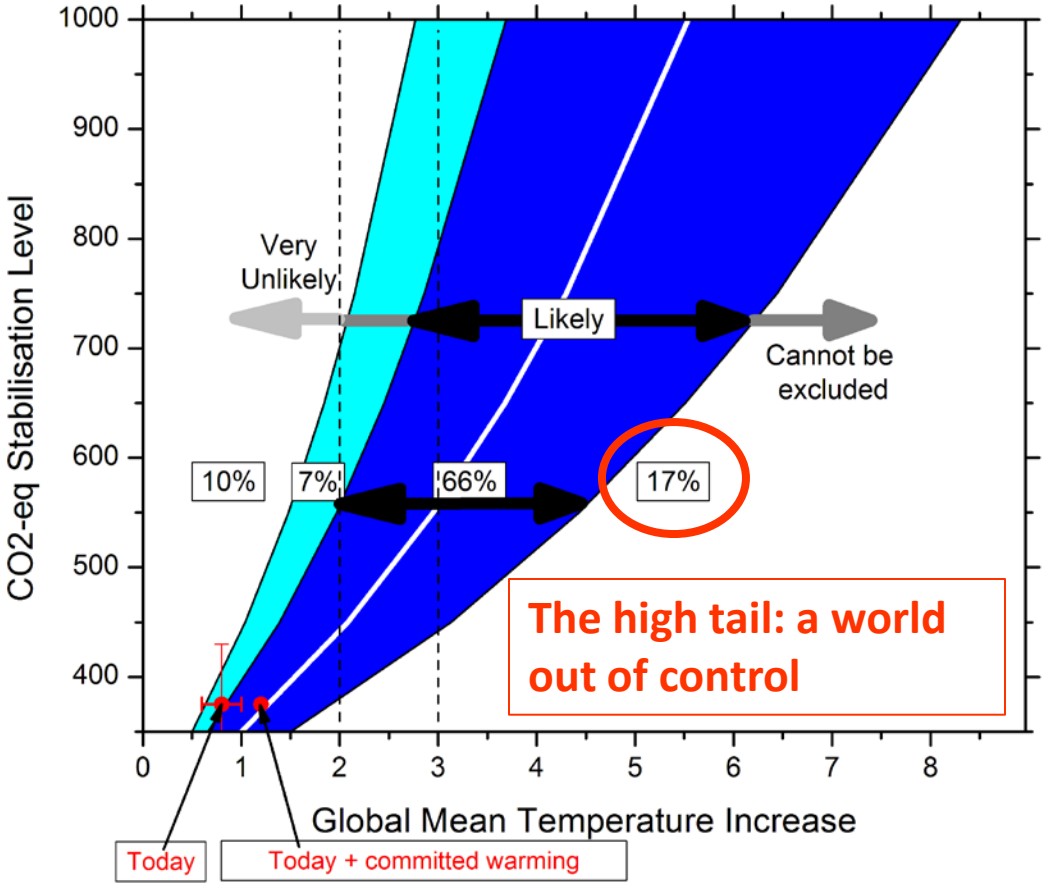
The messenger has been shot before.

> Galileo argued that the earth wasn’t at the center of the universe and was excommunicated.
>
> Darwin argued that human beings were part of the animal kingdom and was cruelly mocked.

The idea that humans can’t change our planet is as out-of-date and wrong as the earth-centered universe and the separate creation of Man.

But all three ideas have such appeal that they will fade away only very slowly.

Don’t fudge our uncertainty



Source: From Martin Manning.

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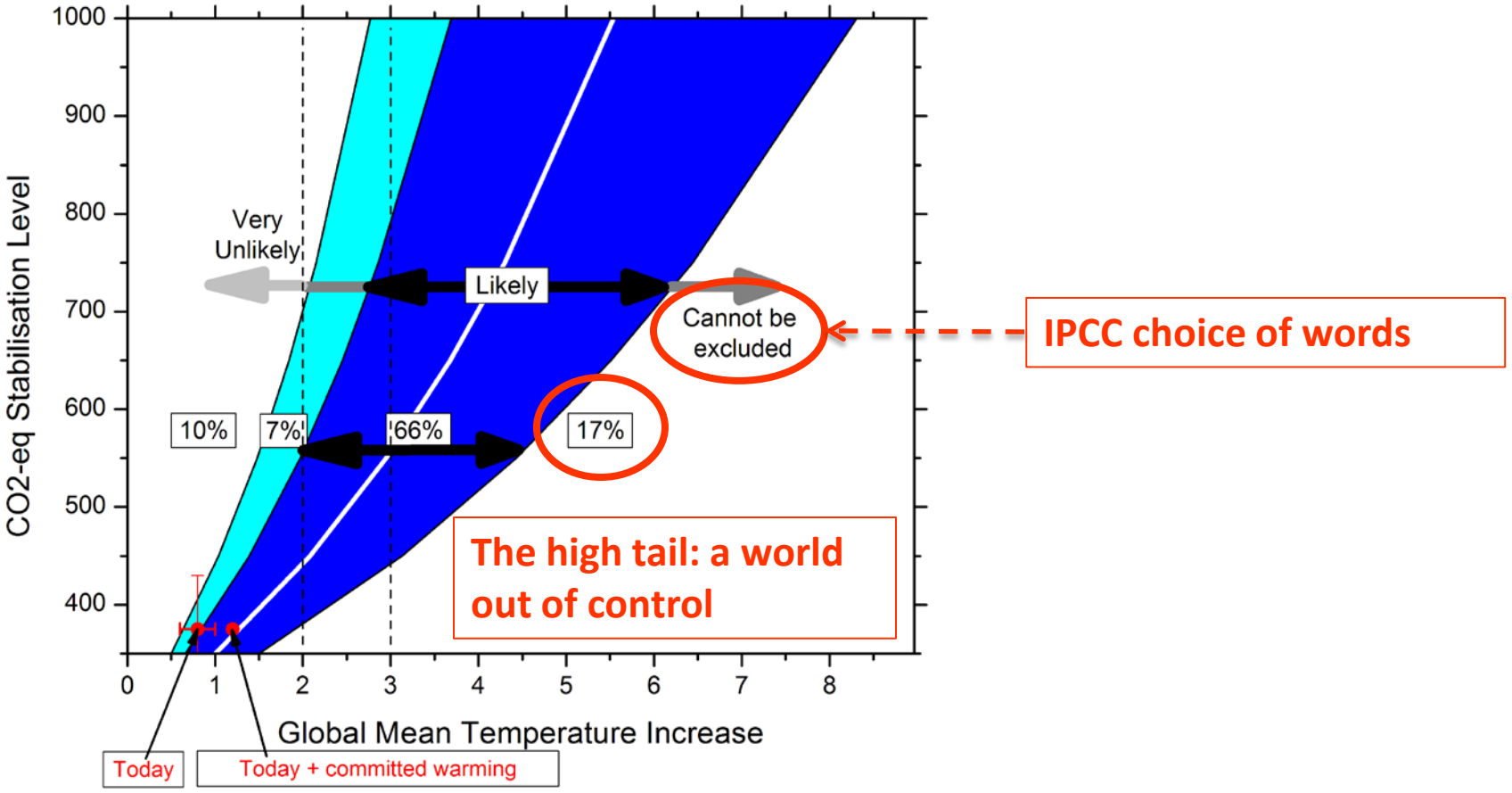
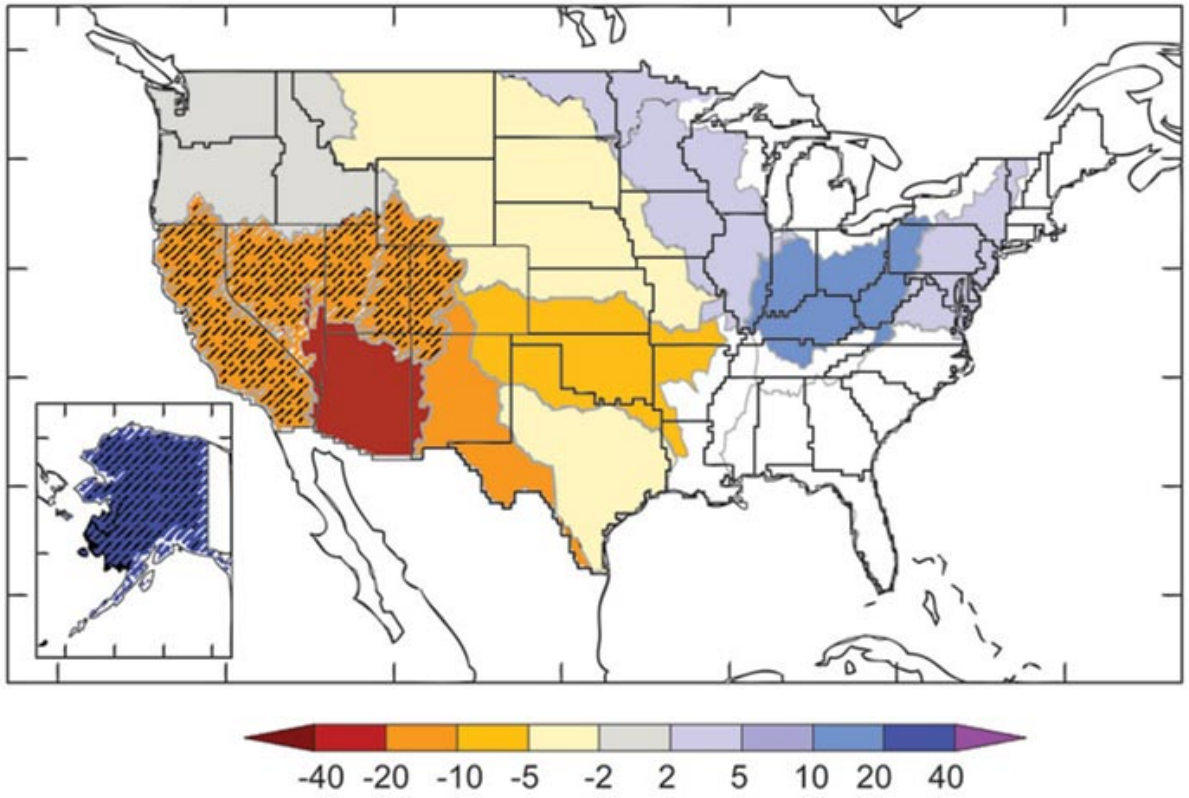


This graph is not found in IPCC AR4 WG1. There was no consensus about the probability shown here as 17%.

Source: From Martin Manning.

Uncertainty across climate models



Projected Percent Changes in Annual Runoff, 2041-60 vs. 1901-70

Source: globalchange.gov/usimpacts

Hatched areas: strong agreement among model projections.
White areas: divergence among model projections.
A middle-of-the-road emissions scenario is assumed.

Uncertain emissions

Thirty year changes for Massachusetts, *controlling for the climate modeling*:

2010-2039:
Done!

2040-2069:
Princeton vs. Washington

2070-2099:
Baltimore vs. Augusta

This graph probably shows how winters could feel too (to be verified).

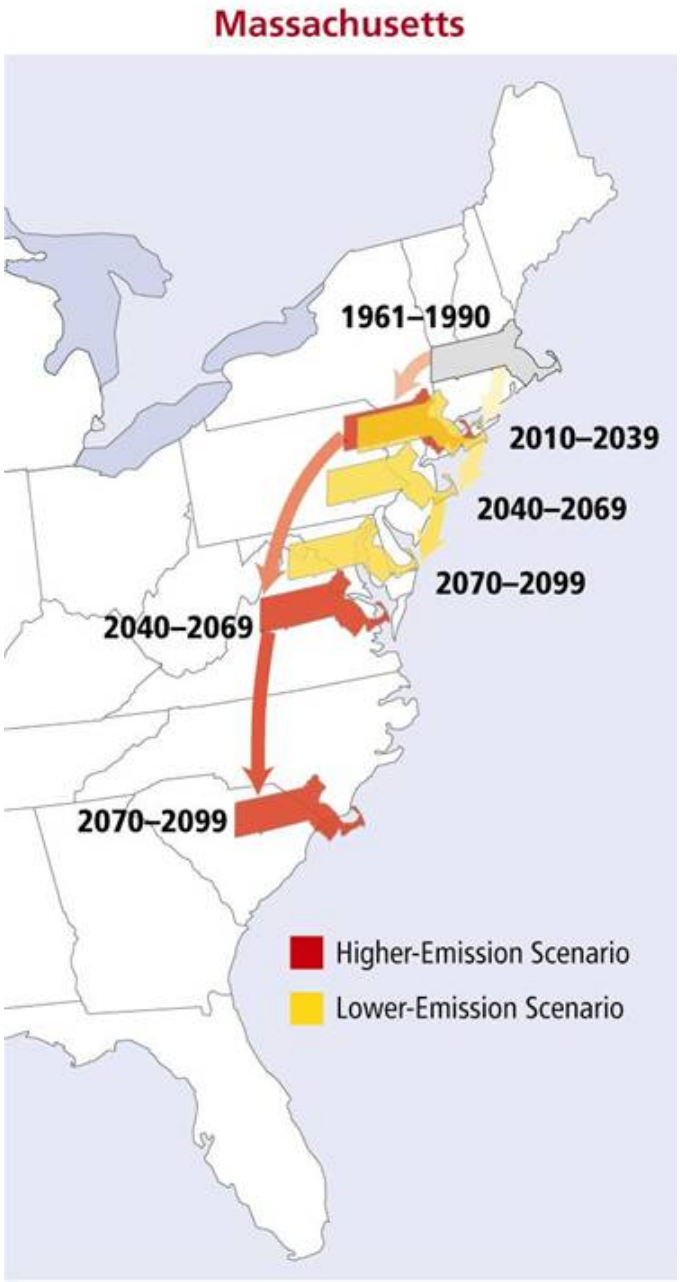
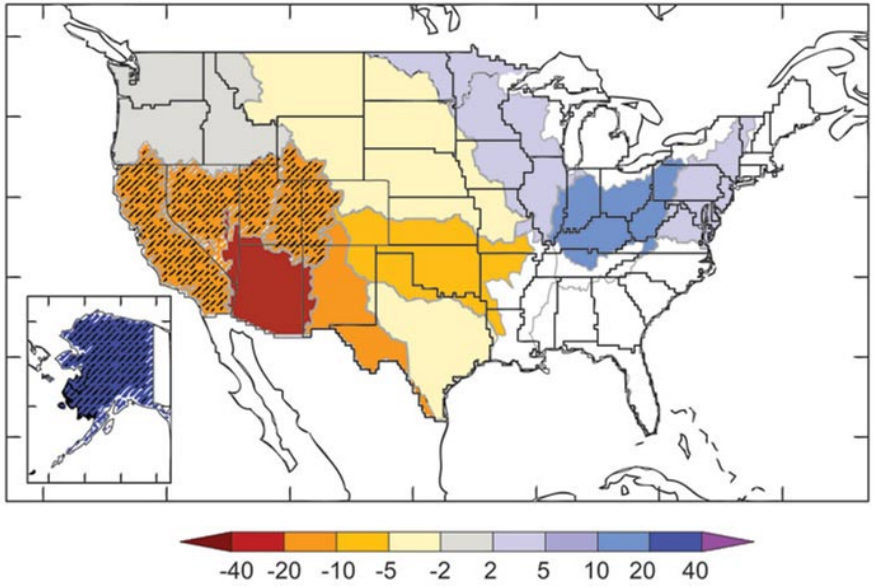


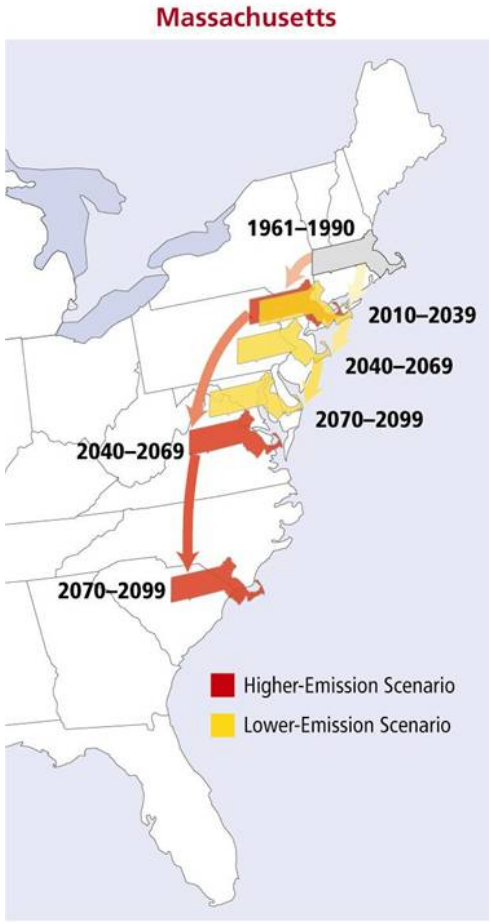
Figure from James McCarthy, Harvard

NECIA, 2007 (see: www.climatechoices.org/ne/)

Which uncertainty is more important?



Source: globalchange.gov/usimpacts



Source: NECIA, 2007 (see: www.climatechoices.org/ne/)

Figure from
James McCarthy, Harvard

The Committee on America's Climate Choices struggled with the relative importance of uncertain climate science and uncertain human behavior.

“Solutions” can bring serious problems of their own.

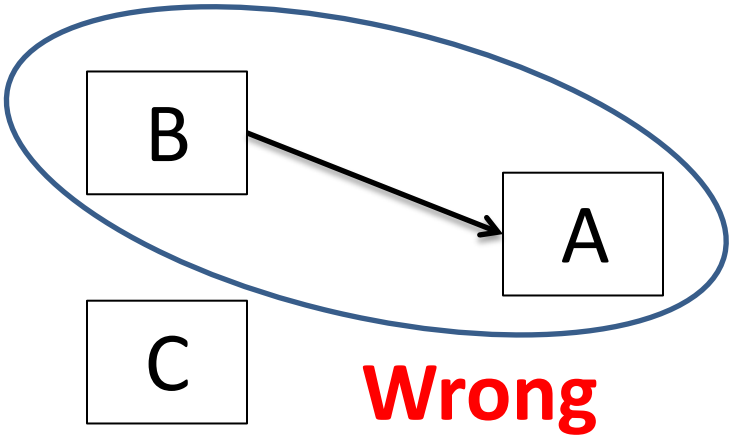
Every “solution” has a dark side.

Conservation	Regimentation
Renewables	Competing uses of land
“Clean coal”	Mining: worker and land impacts
Nuclear power	Nuclear war
Geoengineering	Technological hegemony

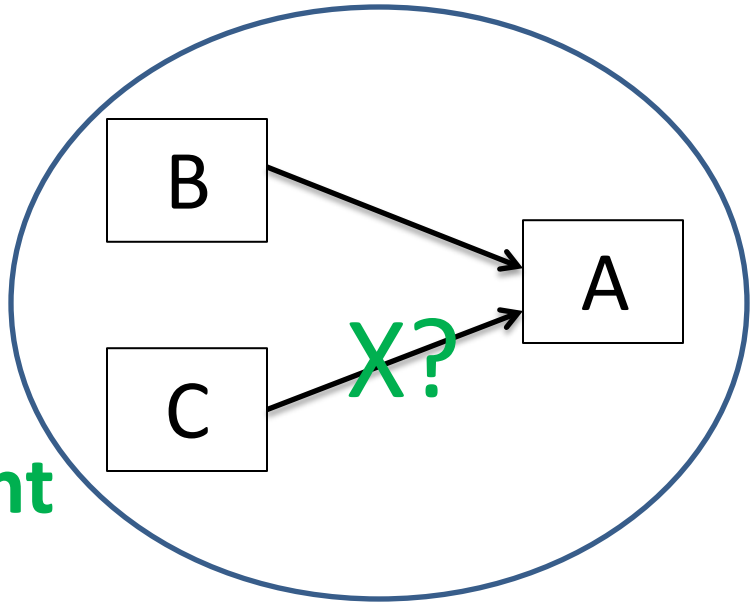
Risk management: In choosing targets, we must take into account both the risks of disruption from climate change and the risks of disruption from mitigation.

Be careful how you wish for what you wish for.

Principle: You want A. You figure out that B will get us to A, and you like B. You foster B. But *there is always a C that someone else likes and you don't like at all*, which also gets us to A. Unless you are alert, your efforts enable C.



Wrong



Right

***Message*: Add conditionality; bargain or walk away.**

Conditionality for biocarbon

What will go wrong if we move headlong to maximize either global biostocks or global biofuels without conditionalities?

Suppose you were a forester or an agronomist in a world where the carbon price was very high. You were told that storing carbon was your only objective. What would you do? Establish a monocrop? Pour on fertilizer? Be inventive....

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Now, change roles. You are the policy maker in the same world. What conditionalities would you place on the carbon market for biostocks in the interest of eliciting actions you would welcome and deterring out comes you would decry?

Conditionality for nuclear power

Make the use of nuclear weapons unthinkable (rather than one of the "options on the table"). Also strengthen the international institutions designed to prevent the diversion into nuclear weapons of the uranium and plutonium associated with nuclear power.

> "We judge the hazard of aggressively pursuing a global expansion of nuclear power today to be worse than the hazard of slowing the attack on climate change by whatever increment such caution entails. "
>
> Robert H. Socolow & Alexander Glaser, "Balancing risks: nuclear energy & climate change," *Dædalus,* Fall 2009, pp. *31-44.*

It would be terrible to exchange climate change for nuclear war anywhere on the planet.

Conditionality for geoengineering

Geoengineering brings a fully engineered world:

Every landscape is simplified.

> Every valley shall be exalted, every mountain and hill shall be made low: and the crooked shall be made straight and the rough places plain.

The well-being of every non-human species is subordinated

Instrumental values completely dominate.

What are the right conditionalities for geoengineering?

Getting to Yes

The more we fear climate change, the less we can allow ourselves to be squeamish about imperfect “solutions.”

We must remember that we want solutions to work. It can’t be enough to identify what’s wrong with a strategy as it is first proposed. We must ask: With what changes, would this strategy become acceptable? How might we get from here to there?

Getting to No

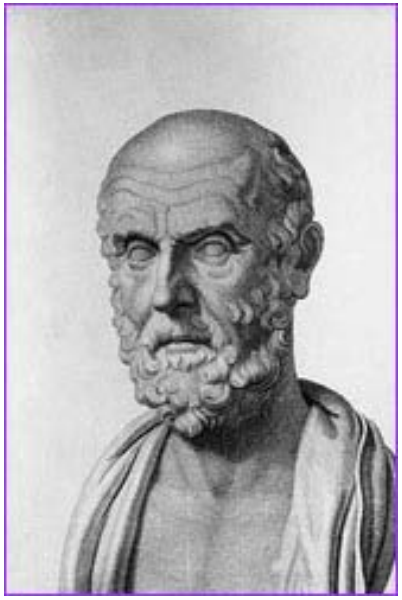
However, we may decide, in some situations, to forego an option.

This may be the result of a moral judgment. We will prefer enduring some amount of climate change to the compromises required to avoid it.

Iterative risk management

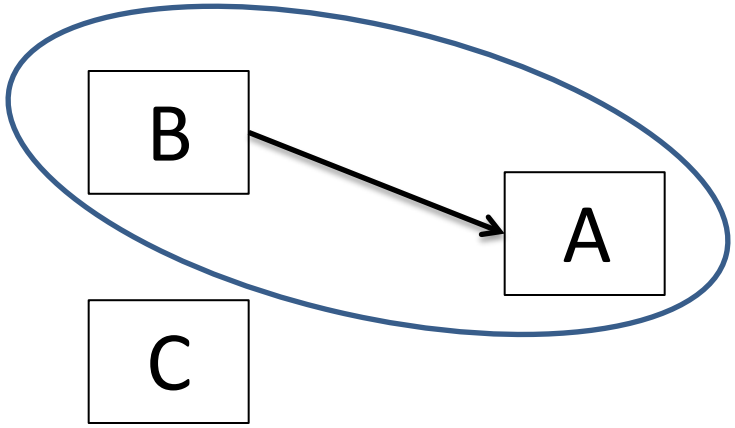
"I will apply, for the benefit of the sick, all measures that are required, avoiding those twin traps of overtreatment and therapeutic nihilism."

Hippocrates



* Modern version of the Hippocratic oath, Louis Lasagna, 1964, http://www.pbs.org/wgbh/nova/doctors/oath_modern.html

Surrogacy



A person holds B strongly and A weakly, but believes that achieving A will help achieve B. A is then a *surrogate* for B.

Support for A vanishes when the prospects for B fade.

Surrogate Goals

Support for climate change can be a surrogate for support for more strongly held goals, such as:

- Augmenting financial transfers to developing countries
- Bringing the fossil fuel era to a close
- Curtailing consumerism and human centeredness
- Promoting self-sufficiency, autonomous communities
- Diminishing the power of technological elites
- Promoting environmental science
- Encouraging entrepreneurship

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Contradictions arise:

- Capturing and storing CO_2 prolongs the fossil fuel era.
- Large and distant solar arrays and windfarms do not promote local self-reliance.

Propagate planetary thinking

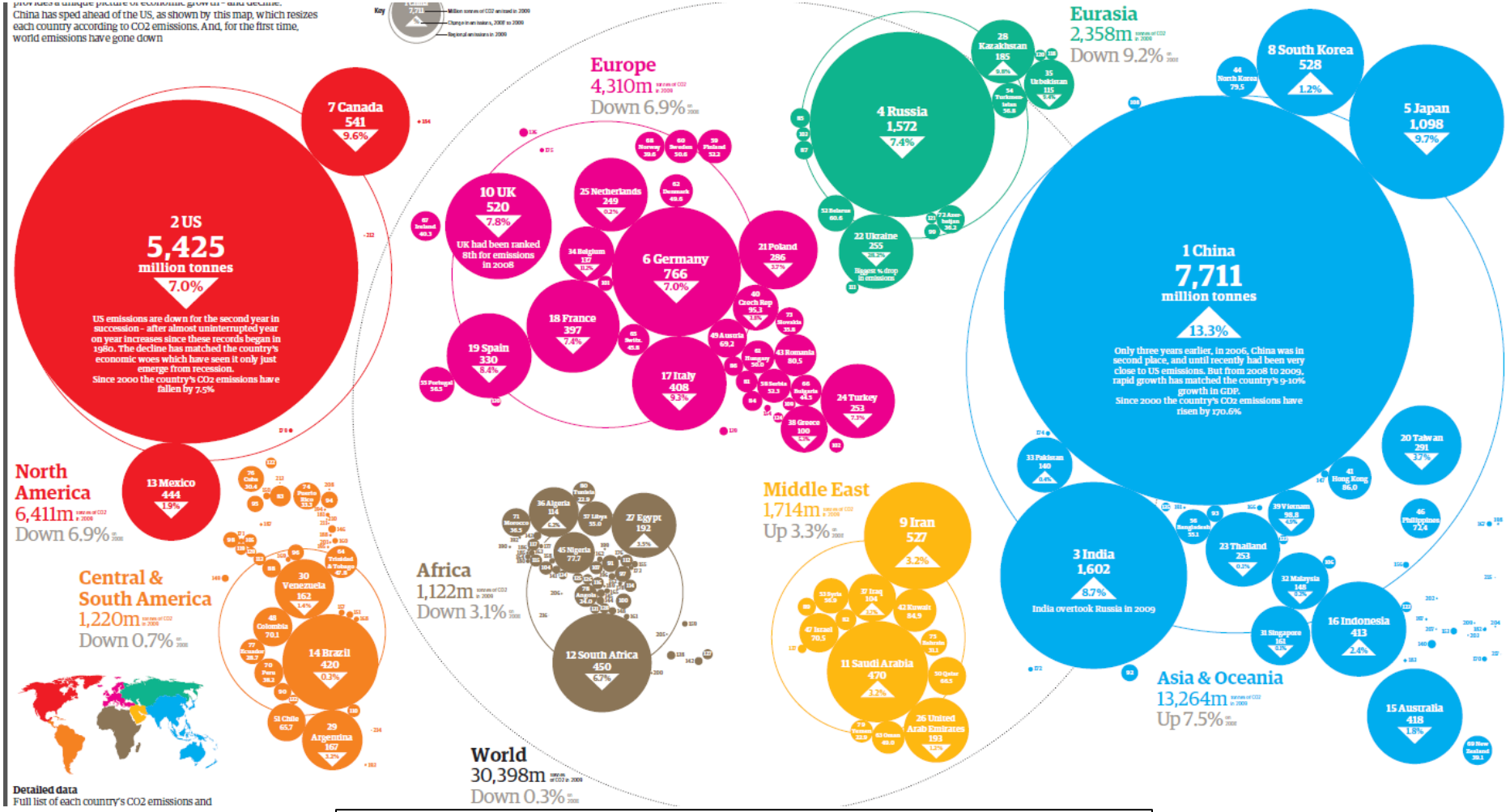
Accept that the developing world will decide what kind of planet we live on.

Help the developing world invent *authentic* low-carbon industrialization.

Insist on cosmopolitan ethics, where equity is about individuals, not nations.

The world's neediest need not be denied fossil fuels.

The developing world will decide what kind of planet we live on



Global CO_2 Emissions, 2009

Source: EIA data; Guardian.co.uk "atlas of pollution"

Safe is not fair, and fair is not safe

Define “fairness” as equal access to the atmosphere for all nations measured by *cumulative per capita emissions* over some time interval.

For a stringent target, fairness in this sense is not achievable.

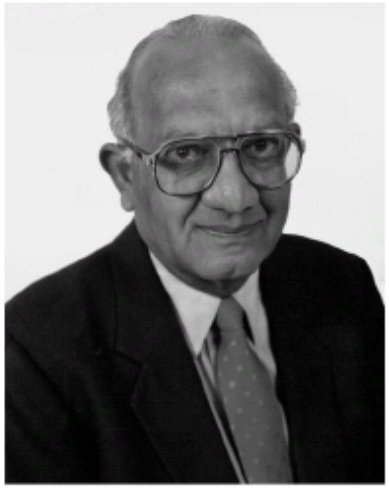
Thus, fairness must be redefined: equal opportunity to develop, while benefiting from options not available in the past.

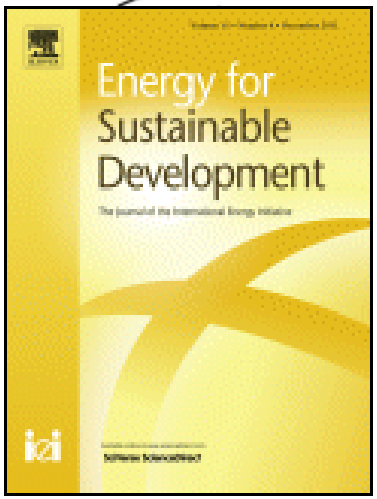
See Tavoni, Chakravarty, and Socolow, “Safe vs. Fair,” *Sustainability*, on-line, February 2012

“Authentic” developing-country energy analysis

Amulya K. N. Reddy (1930-2006) on the founding of *Energy for Sustainable Development*:

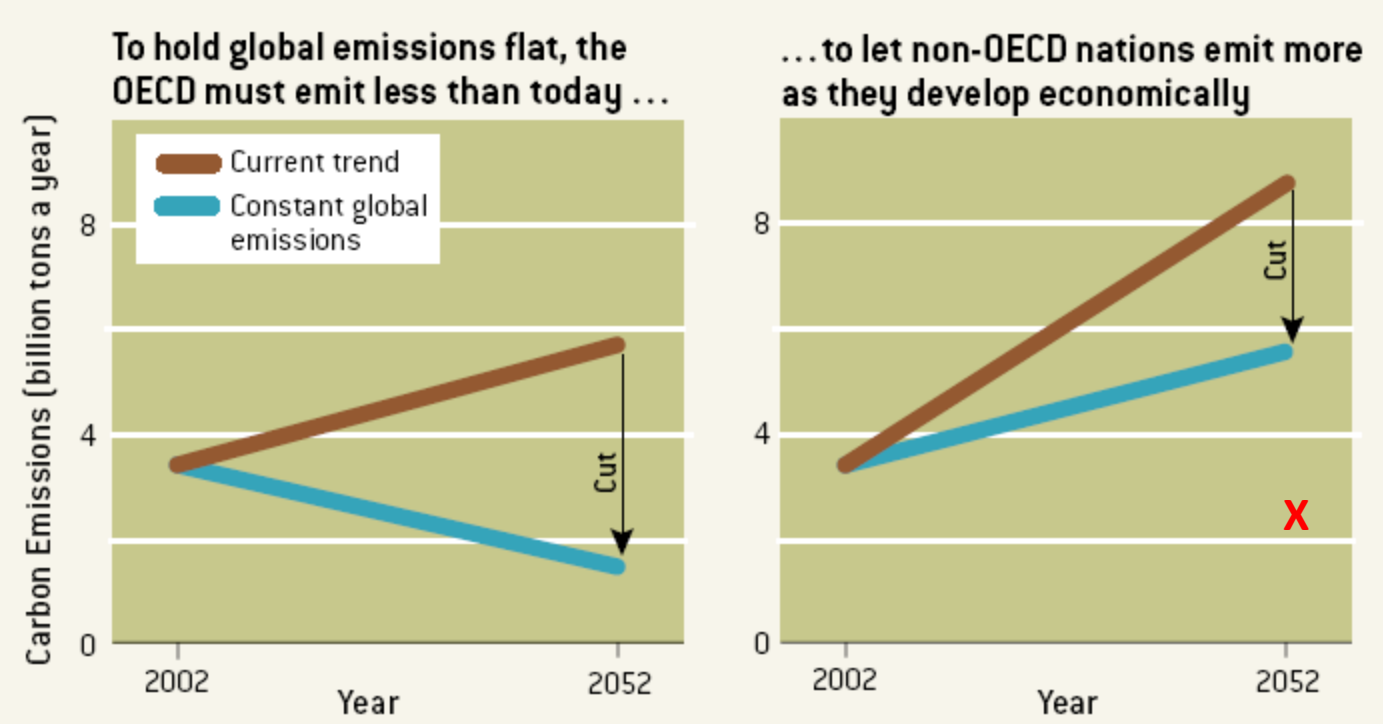
“No international journal then existed… directed toward energy actors concerned with energy in developing countries. Neither was there a journal devoted to exchanging developing-country experiences in the field of energy. Above all, there was no international journal focusing on strengthening the capability of energy actors in developing countries to choose, plan, establish, manage, operate, and efficiently use energy systems.”





Source: *Annual Review of Energy and Environment 2002*. 27:23–56

“Flat” vs. “down 50%” is about the developing world’s emissions



Up 60% or down 60%

Up 140% or up 60%, ***or down 40%***

Analysis of low-carbon industrialization has been far too casual for me to be comfortable endorsing the lower fifty-year target at this time.

Source of Figure: Socolow and Pacala, “A plan to keep carbon in check,” *Scientific American*, Sept 2006.

Post-post-colonialism

The UNFCCC, like many post-colonial international institutions, created two-tier behavior. Annex I expresses guilt and entitlement.

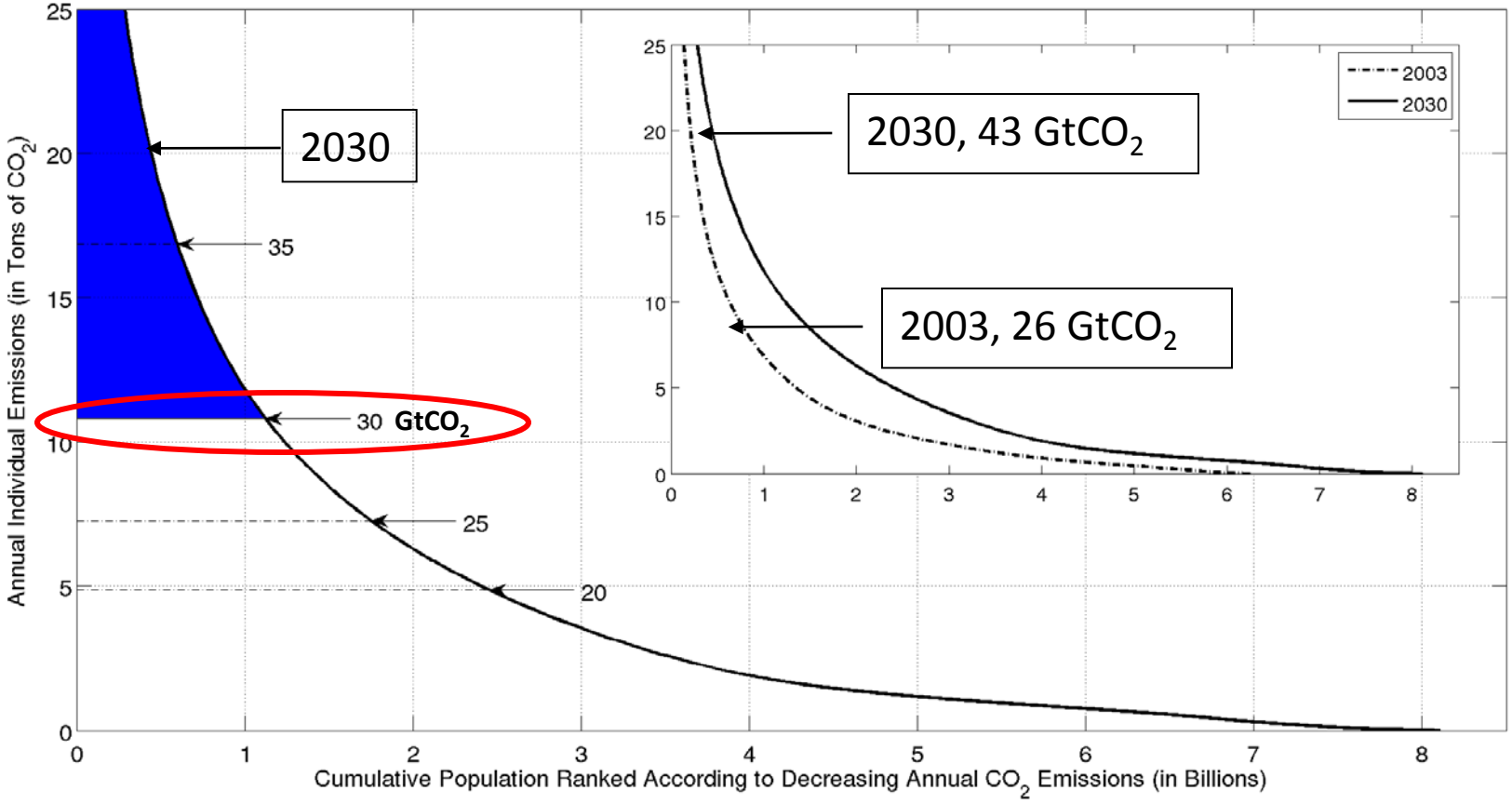
Did Durban chart a path toward *post-post-colonial* institutions, where we are all in the same boat?

Beyond per capita: cosmopolitan ethics

We can't solve the climate problem without moving beyond "per capita" – looking *inside* countries.

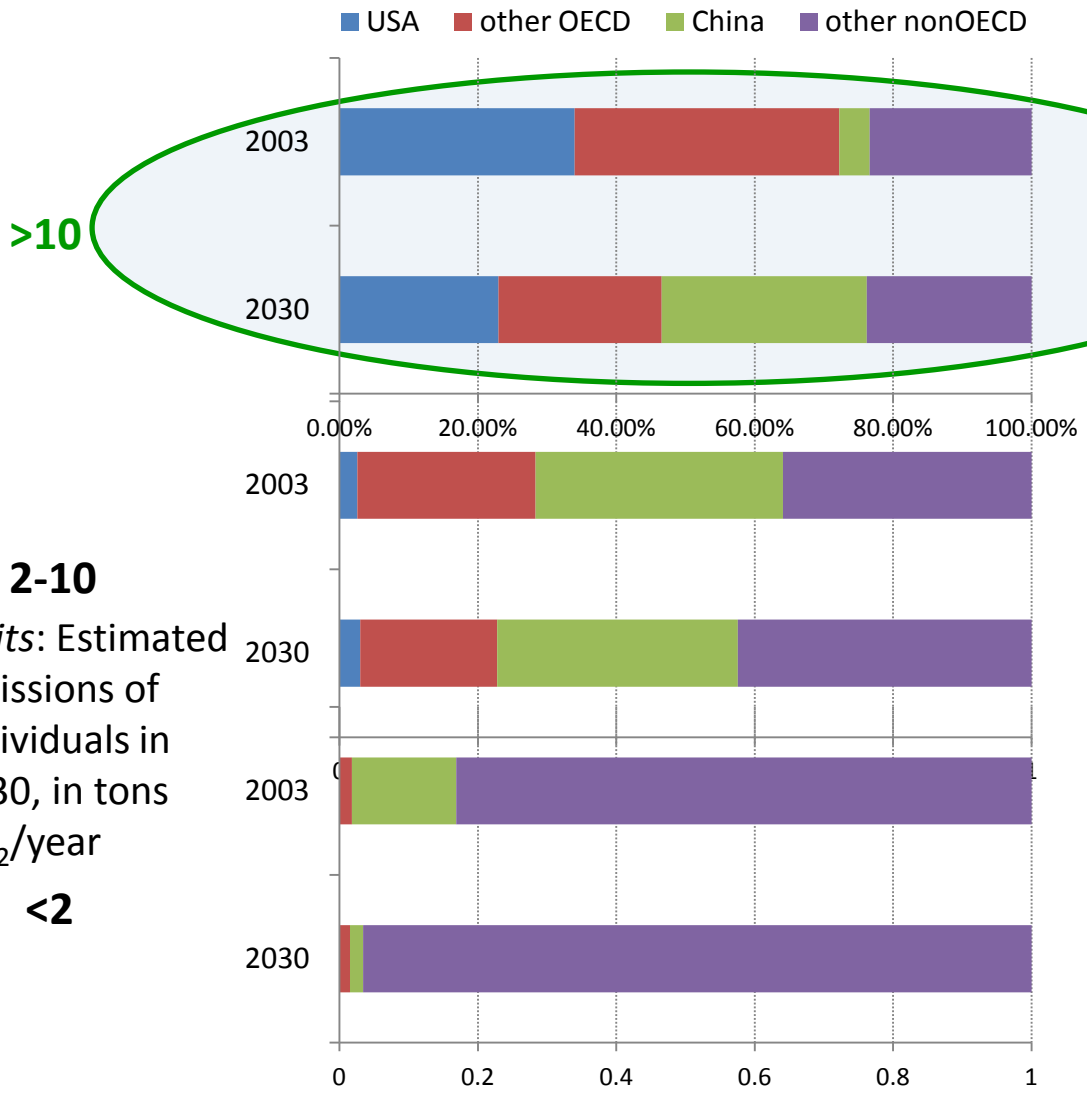
What if "common but differentiated responsibilities" refers to individuals instead of nations?

Count high-emitting individuals



"One-billion high emitters," *PNAS,* 2009. *Co-authors*: Shoibal Chakravarty, Ananth Chikkatur, Heleen de Coninck, Steve Pacala, Massimo Tavoni.

One billion "high-emitters"



2-10

Units: Estimated emissions of individuals in 2030, in tons CO_2/year

<2

In 2030, over half of the "high-emitters" will live outside the OECD.

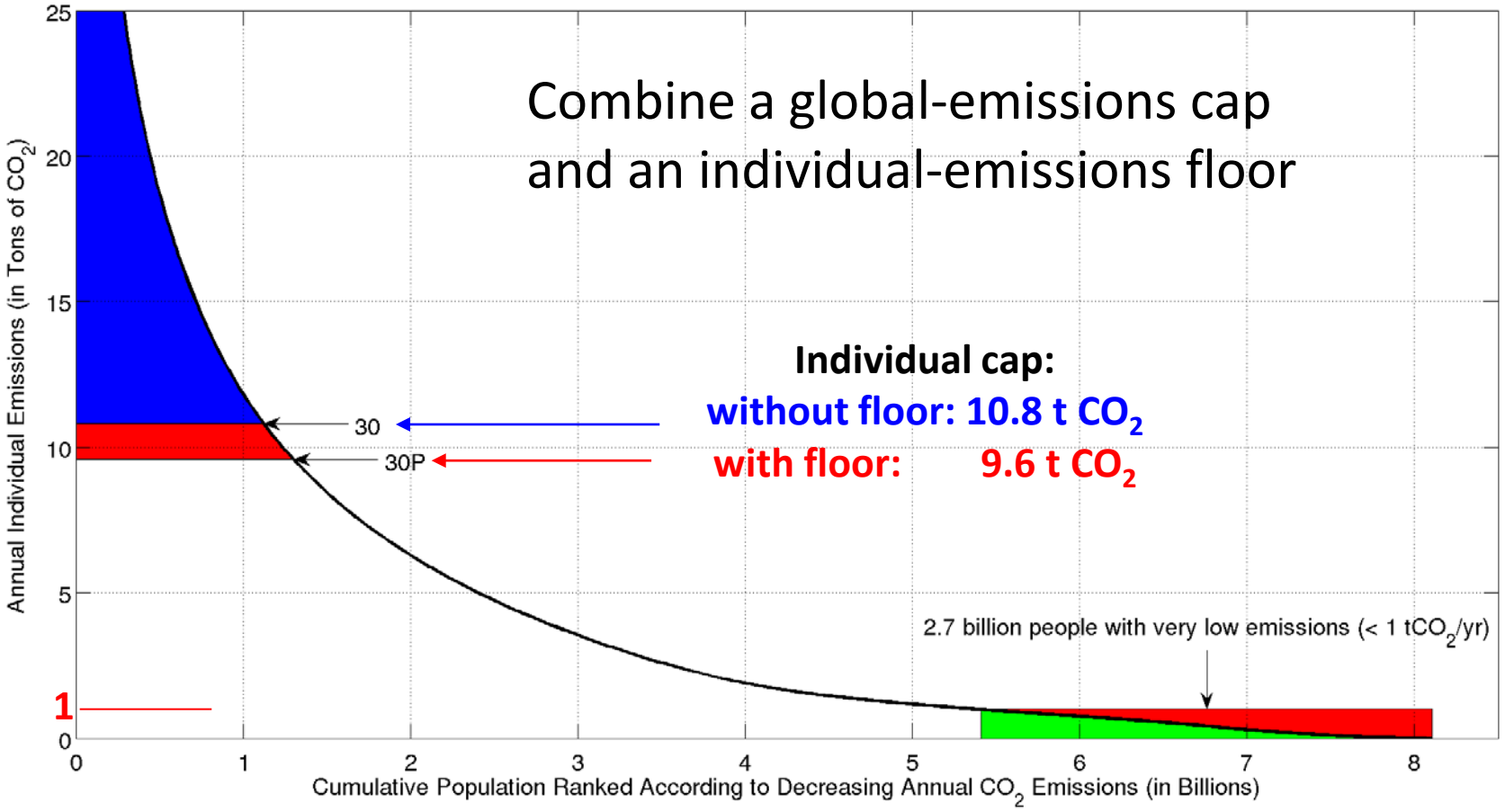
Planetary identity

In the process of taking climate change seriously, we develop a planetary identity.

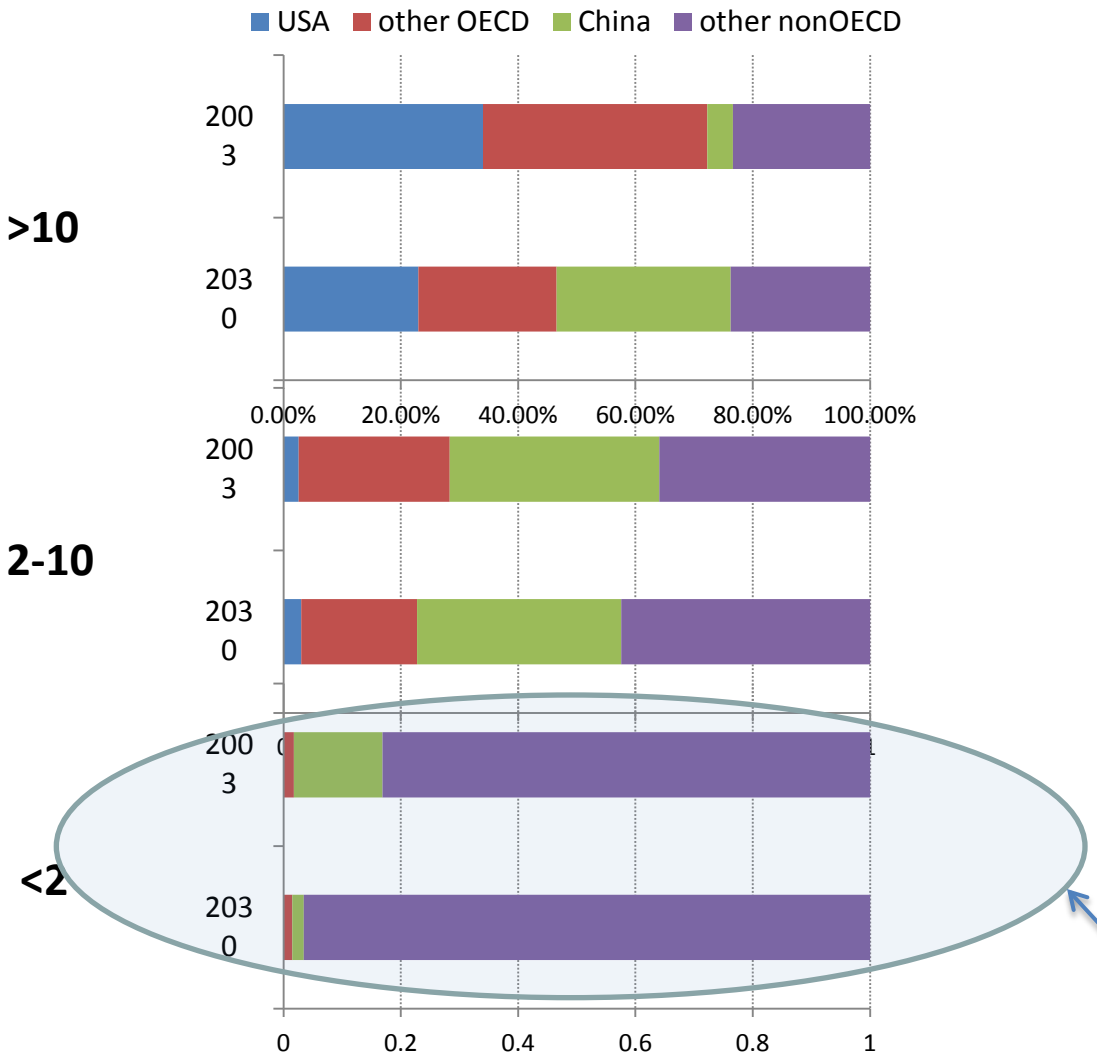
We augment our previous loyalties to family, village, tribe, and nation.

Do *you* have a planetary identity?

The world's poor need not be denied fossil fuels



The number of people in abject poverty does not decline in Business As Usual trajectories



The lower half of the world's emitters

Global distribution of individual emissions. *Units*: $tC0_2$/year

What does 1 tCO_2/person-yr allow today?

Direct Energy Use	*Household rate of use (4.5 people)*	*Individual emissions ($kgCO_2$/yr)*
Cooking	1 LPG canister per month	120
Transport	70 km by bus, car, motorbike per day	220
Electricity	800 kWh per year	160
Total		*500*

1 tCO2/yr: Double the "direct" emissions to account for "indirect" emissions.

Enlarge the system boundary

Value contending norms: freedom, privacy, safety, comfort, variety…

Relegitimate “population.”

Protect the scientific method from internal and external abuse.

Imagine humanity’s collective future.

Acknowledge complementary values

The CO_2 problem is a problem of modernity, a problem of prosperity, a byproduct of choices about what to consume, how to spend time.

Today, it is nearly universally believed, a good life is one lived with exuberance. We seek independence, privacy, safety, comfort, beauty, variety of experience – goals that can thwart low-consumption living.

It will benefit no one if leaders of the second generation of analysts of sustainability (many in this room) again write largely about unrealized potential, because they ignore such complexity.

Will “the good life” be redefined?

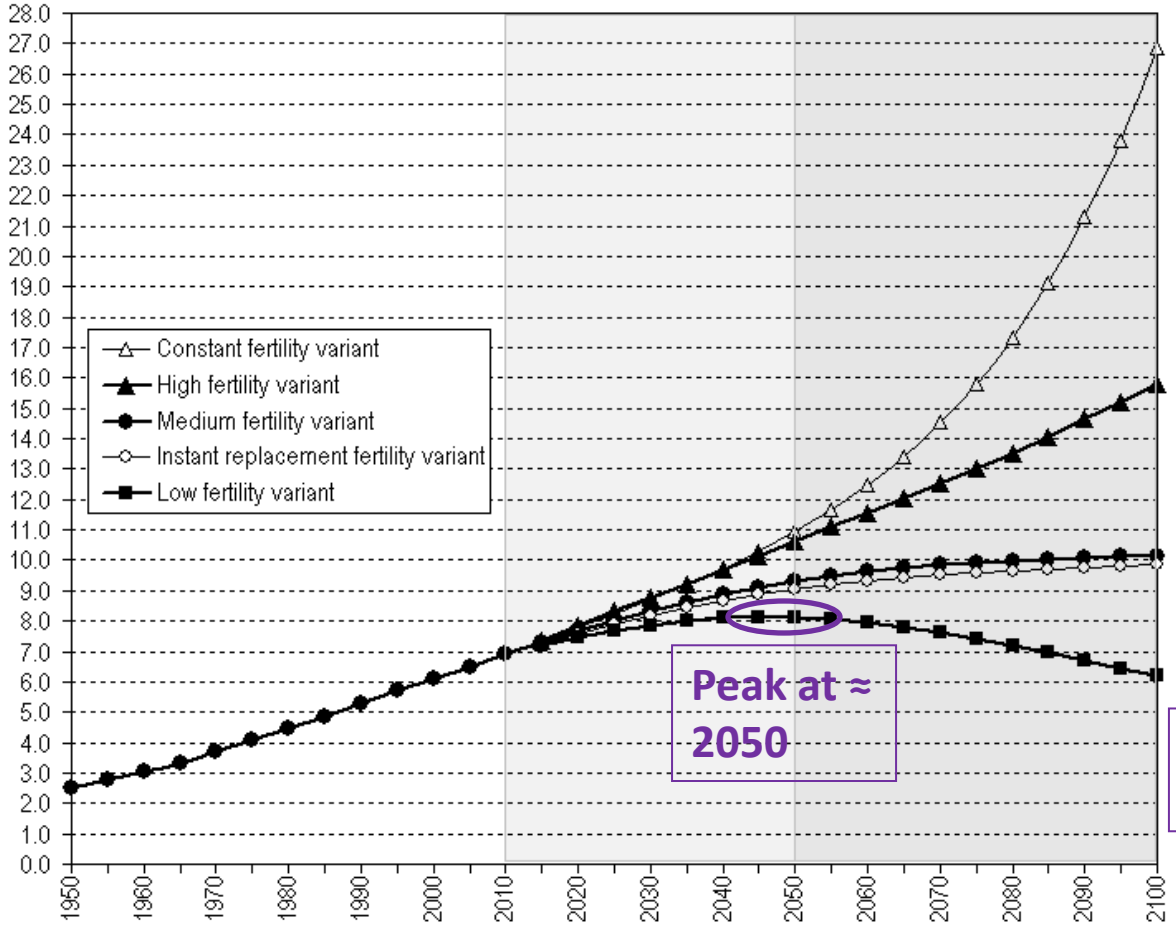
Many cultures in the history of the world have defined the good life differently than prosperous people do today. Are serious challenges to the values of the prosperous in view, anywhere in the world?

How far can technology take us?

Relegitimate "population"

Billion people

The UN's "low"population projection has almost 10 billion fewer people in 2100 than its "high" projection.



High:15.8 B, 2.6 kids/Mom

Medium:10.1 B, 2.1 kids/Mom

Low: 6.2, 1.6 kids/Mom

***dPop/dt* falls to -0.8%/yr in 2100. If sustained, 2.8 B in 2200.**

Source: United Nations. http://esa.un.org/unpd/wpp/unpp/panel_population.htm

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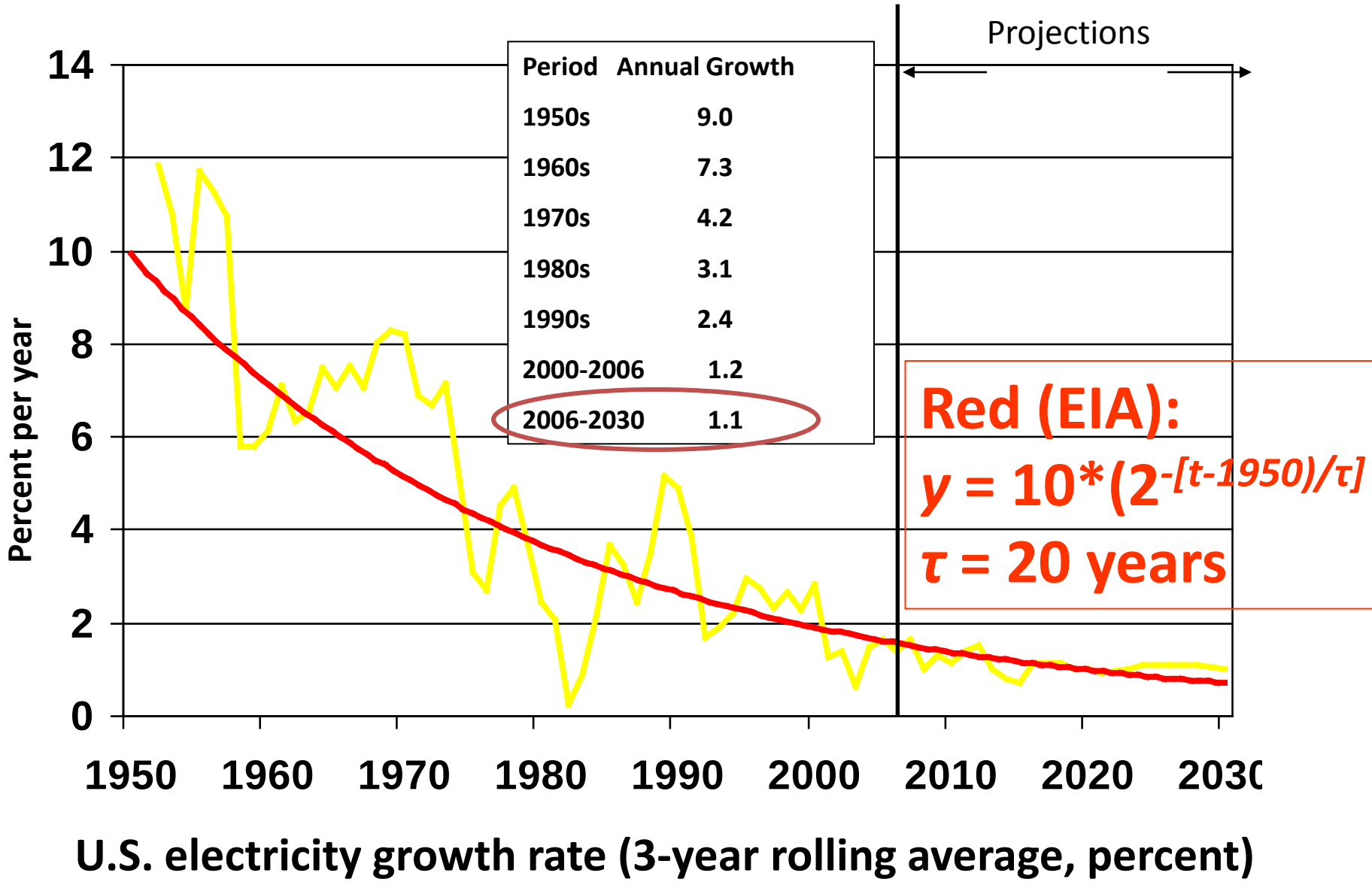
Conceive of the far side of a peak



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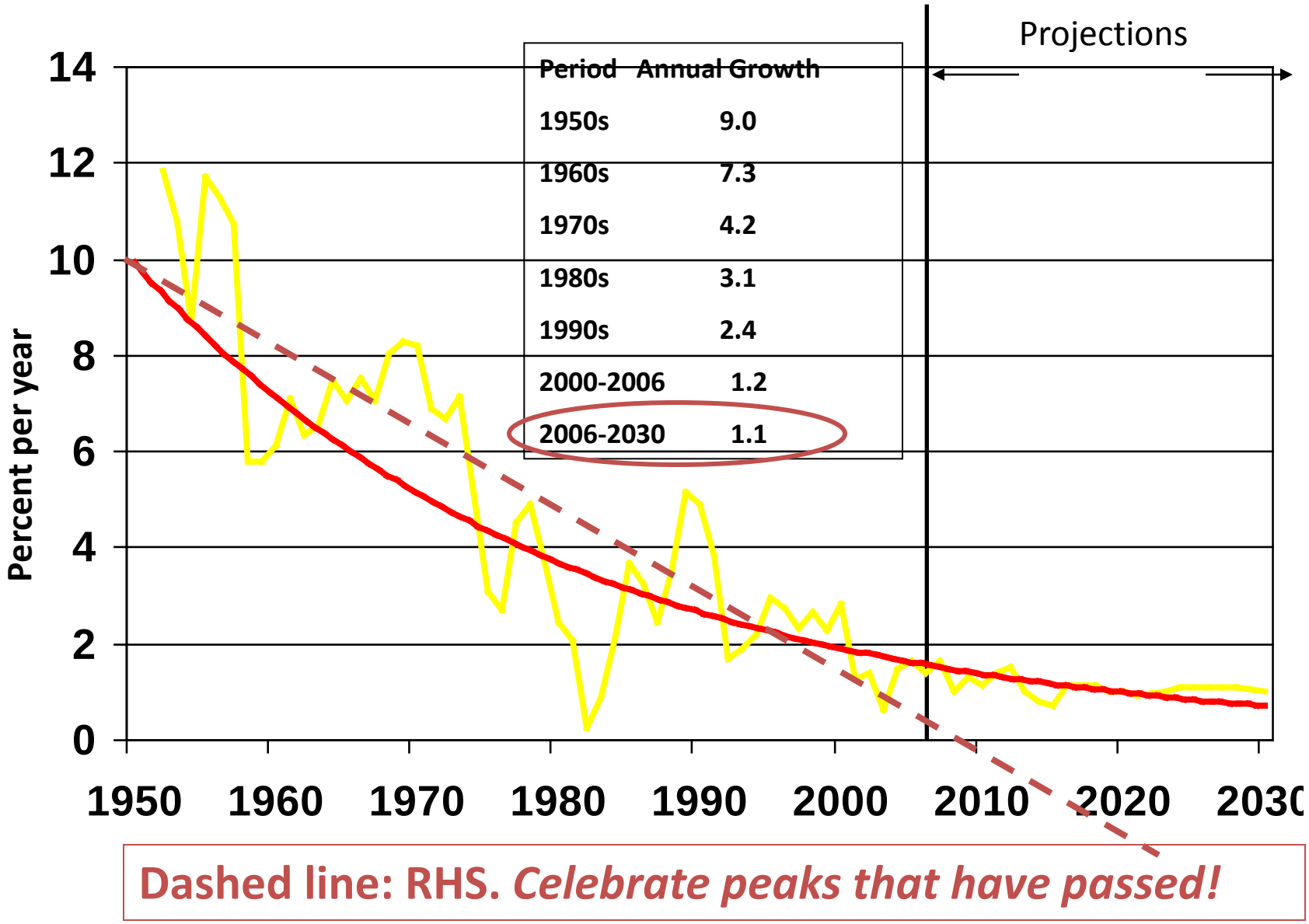

Dashed line: RHS. ***Celebrate peaks that have passed!***

Cherish the scientific method

It's worth at least 0.1C.*

*At 2000 $GtCO_2/^oC$, 200 $GtCO_2$ (seven years of emissions).

Imagine dealing with climate change without it.

In order to know the truth,
it is necessary to imagine
a thousand falsehoods.

Sidney Coleman, ca. 1964, perhaps a quote from H.G. Wells

Imagining our collective future: "Prospicience"

Prospicience: "The art [and science] of looking ahead."

In the past 50 years we have become aware of the history of our Universe, our Earth, and life.

Can we achieve a comparable understanding of human civilization at various future times: 50 years ahead – *vs.* 500 years and *vs.* 5000 years? Prospicience is needed to address planning horizons, infrastructure, waste management….

Imagine spending as much effort on our collective destiny on Earth as we spend on our personal destiny in the afterlife!

We have scarcely begun to ask: What are we on Earth to do?

Berkeley will have a Department of Prospicience by 2025

Grounds for optimism

1. The world today has a terribly inefficient energy system.
2. Carbon emissions have just begun to be priced.
3. Most of the 2062 physical plant is not yet built.
4. Many smart and committed young people now find energy problems exciting.

Fitting on the Earth

Fortunately:

Our science has discovered threats fairly early;

We can identify a myriad of helpful technologies;

We have a moral compass that tells us to care not only about those alive today but also about the collective future of our species.

What has seemed too hard becomes what simply must be done.

Co-authors, some recent papers

Wedges

Steve Pacala
Jeff Greenblatt (LBNL)
Roberta Hotinski
Harvey Lam

Nuclear power

Alex Glaser

One-billion high emitters

Shoibal Chakravarty
Massimo Tavoni (FEEM, Milan)
Ananth Chikkatur (ICF, Washington DC)
Heleen de Coninck (ECN, Netherlands)
Steve Pacala