Welcome to ATMS 111 Global Warming

http://www.atmos.washington.edu/2010Q1/111

Today's Overview

Topic: Economics of global warming

My goal is to cover the issues that you need to know to understand current carbon reduction legislation under discussion

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Pollution and Tragedy of the Commons

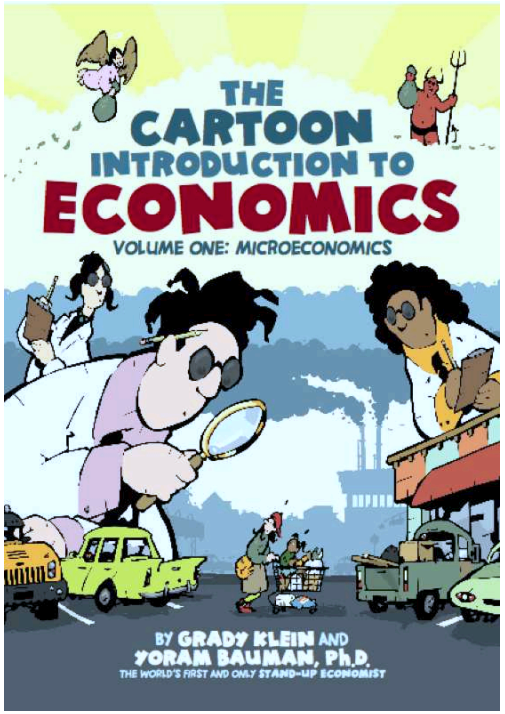
When individual acting in their own self-interest harm a shared resource. Pollution is a classic example where climate is the common good.

"Optimizing behavior of Individuals

Can produce an outcome

That is bad for everybody"

Quote from the Cartoon Introduction to Economics by Grady Klein and Yoram Bauman (UW)



From the Cartoon Introduction to Economics
by Grady Klein and Yoram Bauman (UW)

But to do so most efficiently,

“Everyone, everywhere must face the same price”

William Nordhaus

Managing Climate Change with Adaptation and Mitigation

Adaptation (prevent harm; deal with symptoms):

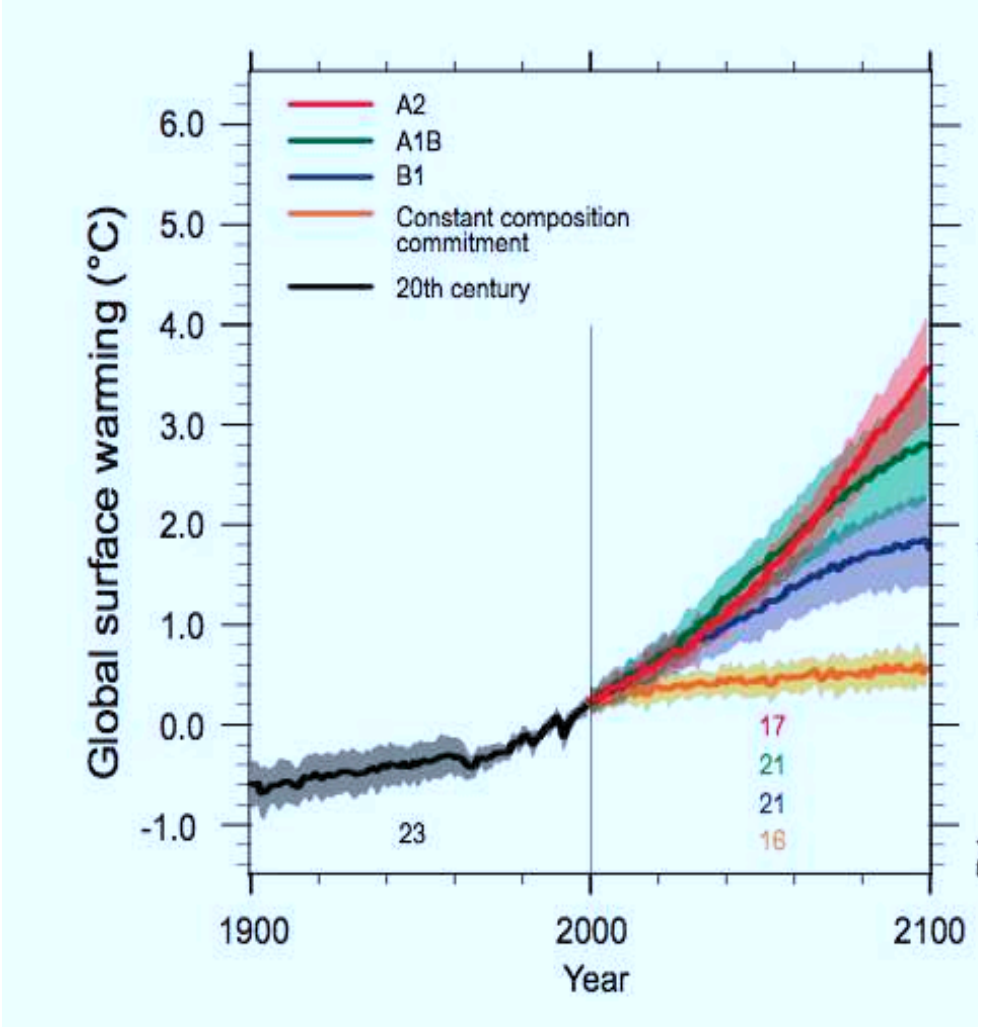
Alter human structures and practices in order to reduce the harmful effects of climate change, e.g.:

- improved health care policies for heat-stress
- switch to heat-resistant crops
- build dikes to deal with sea-level rise

Mitigation (prevent climate change; deal with cause):

Reduce emissions of GHGs in order to reduce the amount of climate change that takes place, e.g.:

- energy conservation
- carbon-free energy (wind, solar, nuclear)
- carbon sequestration



For example:

Mitigation is action to reduce warming from A2 to B1

Adaptation is action to avoid harm for a given warming such as B1

2007 IPCC Figure

Remember: the warming itself is often not a problem. It is the impacts that matter. For example, sea level rise, droughts, floods, food production, species loss, etc.

The harm to the “global commons” is not even!

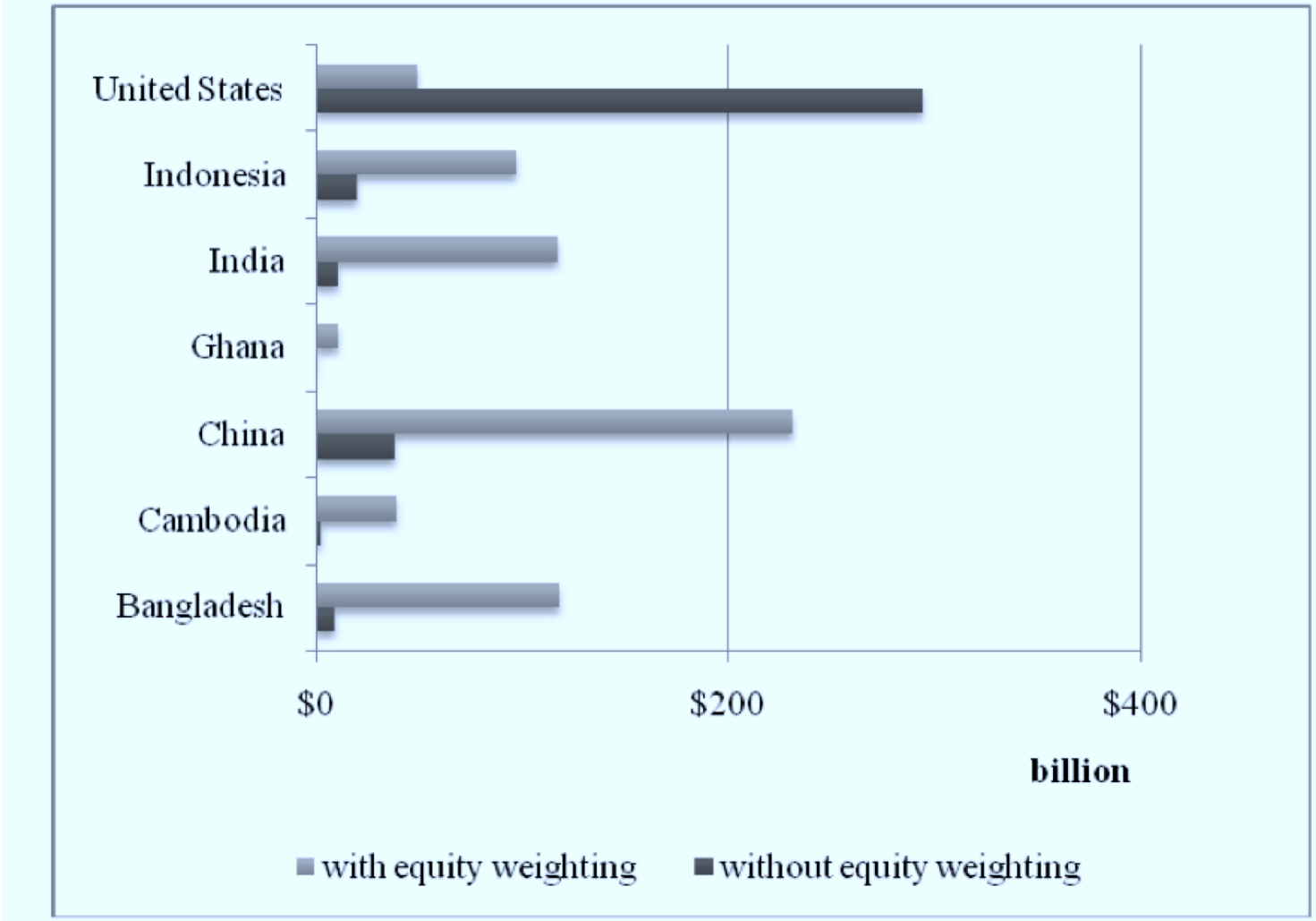
Inequities result in both the

regional variability of the physical response and

wealth of the region affects their ability to adapt

“a dollar to a poor person is not the same as a dollar to a rich person” Anthoff, Nicholls and Tol

Cost of 0.5 m sea level rise by 2100, here equity weighting adjusts for socio-economic standing



Anthoff, Nicholls and Tol

The authors use a conservative B1 scenario of economic growth, which assumes the highest convergence of per capita income

Mitigation: Overview of Approaches

Pacala and Sokolow (2004) "Stabilization Wedges"

- focus on technology
- divide and conquer
- no specific policy recommendations

"Cap and Trade" (e.g. Kyoto, California, Obama proposal)

- sets the maximum emission (the cap)
- let the market figure out optimal technology path

“Carbon Tax"

- puts a price on emitting, rather than a cap on quantity
- revenues can be spent on technology R&D
- or returned to people as a “dividend”

- more on the latter two later

Basics of economic theory of global warm

1. **Benefit is avoiding harm of climate change**
2. **The cost of this benefit is what it takes to reduce or limit GHG emissions**
3. **The price is the current value of damages from adapting to the climate change**

If Cost < Price it makes sense to reduce emissions

Economics of global warming

1) **Climate is an economic externality, transactions impact it although it is third party**

2) **Presently carbon emissions is a market failure because individuals do not pay for the current and future costs of their emissions**

Economics of global warming

Why are there future costs?

1) **Harm is caused by GHG concentrations, not current rates of emission. There is lag between mitigation efforts and decreases in GHG concentrations.**

2) **Lag between decrease in GHG concentrations and reduction in harm to climate.**

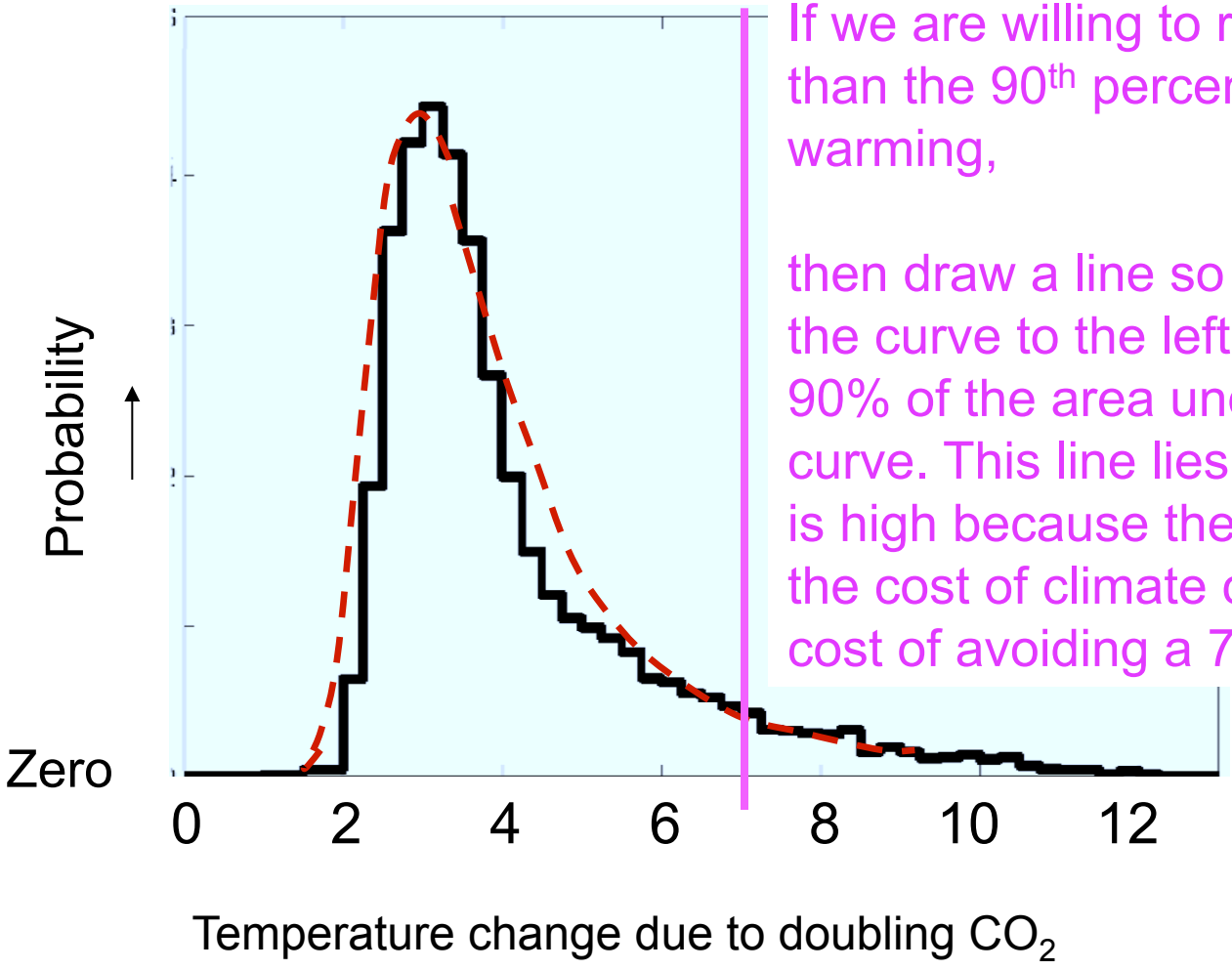
Economics of global warming

Future harm can be considered a risk

Risk is a combination of the likelihood times the severity of impact

For our purposes, we will consider the cost of climate change at the limit of the risk we are not willing to accept.

The Fat (Long) Tail of Climate change



If we are willing to risk no more than the 90th percentile of possible warming,

then draw a line so the area under the curve to the left of the line is 90% of the area under the whole curve. This line lies at about 7°C. It is high because the tail is fat. So the cost of climate change is the cost of avoiding a 7°C warming.

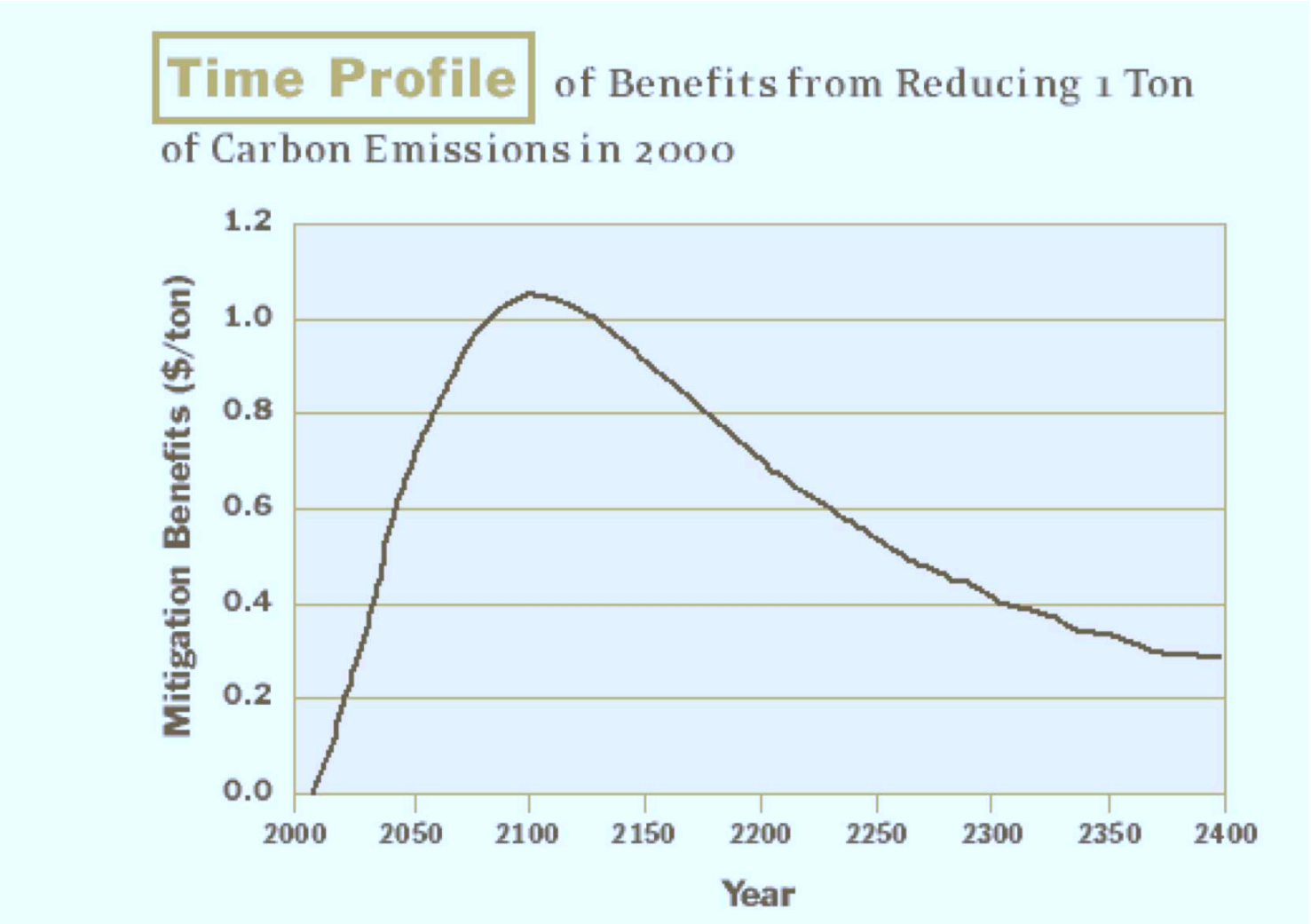
Reality of Reducing Emissions

The benefit of avoiding climate change (which is mostly a future benefit)

IS NOT FREE

Have you ever heard a politician in favor of reducing emissions say this?

Benefit lasts as long as GHG lifetime, which can be centuries, But it starts at _____?



From Pew center report on economic discounting

Discount rate

Discounting is an exercise to estimate current value of future benefit

Example: If the discount rate is 3%
A $100 benefit in 100 years is worth $5.20 today

One can invest ($5.20) today and simply pay for the damages (of $100 in 100 years). However, you would choose to spend the money on mitigation if the price is less (say $4.20) than the cost of the damages

A high discount rate assumes high economic growth, improving standard of living, low risk aversion, low concern for inequity, and/or society holds little value today for a benefit to the welfare of future generations

Discount rate

But no one knows what the discount rate should be!

Some say this uncertainty makes it impossible to use this theory.

Others try to include the uncertainty into the analysis

Still others say the discount rate could be negative because of missed economic growth from developing technology, energy efficiency, energy independence, etc

The Stern Review – see RG p264-5

Sir Nicholas Stern

Used a small discount rate (1.4%) because …

> "If a future generation will be present, we suppose it has the same claim on our ethical attention as the current one."

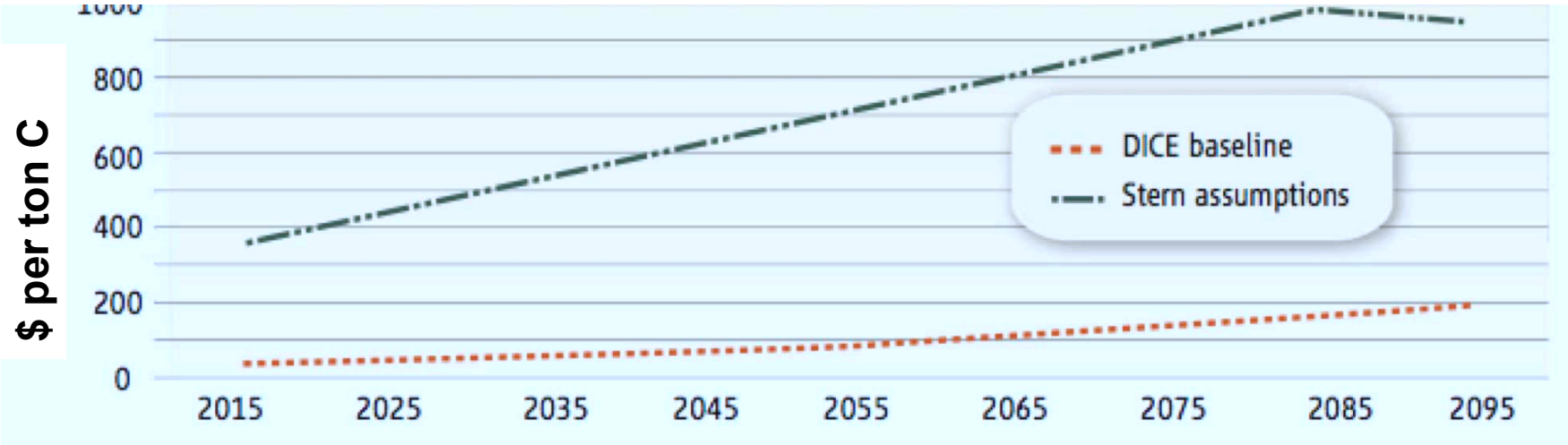
This small rate discounted future damages very little. (e.g., harm from sea level rise in 100 yrs "costs" us quite a lot "today").

The review found, the cost of climate change, which depends on the cost of adaption, could be

> "… equivalent to losing at least 5% of global GDP [gross domestic product] each year."

Cost Equivalent in $ per ton C

Consider the cost of climate change as a cost per ton of carbon that we must avoid emitting. Nobody thinks reducing carbon costs $300/ton C, thus according to the Stern Review **action outweighs the cost**



Another model (DICE by William Nordhaus) puts the price at $30 per ton carbon today – a value at least 10 times the current globally averaged carbon tax (Nordhause, 2007 Science Magazine), but closer to balancing cost of action to cost of climate change.

The Stern Review generated support and criticism

The Stern Review Continued

Sir Nicholas Stern

Recall the cost of climate change

> "… equivalent to losing at least 5% of global GDP each year."

Yet the cost to mitigate (by reducing carbon emissions)

> "Central estimates of the annual costs of achieving stabilisation between 500 and 550ppm CO_2e are around 1% of global GDP, if we start to take strong action now."

Cost to mitigate < Cost of climate change

action outweighs the cost

Let's not worry too much about the actual numbers, but let's assume that the Stern Review is correct when it says action outweighs the costs.

Thus governments decide to mitigate…

How do we go about reducing emissions?

Economists favor using "market-forces"

Cap and Trade

A cap (or limit) is set on the amount of a pollutant

Polluters are given or auctioned a permit that allows a variable number of pollution allowances

The total allowances cannot exceed the cap

Polluters may trade allowances, with the buyer paying to pollute and the seller receiving reward for reducing emissions more than they were expected.

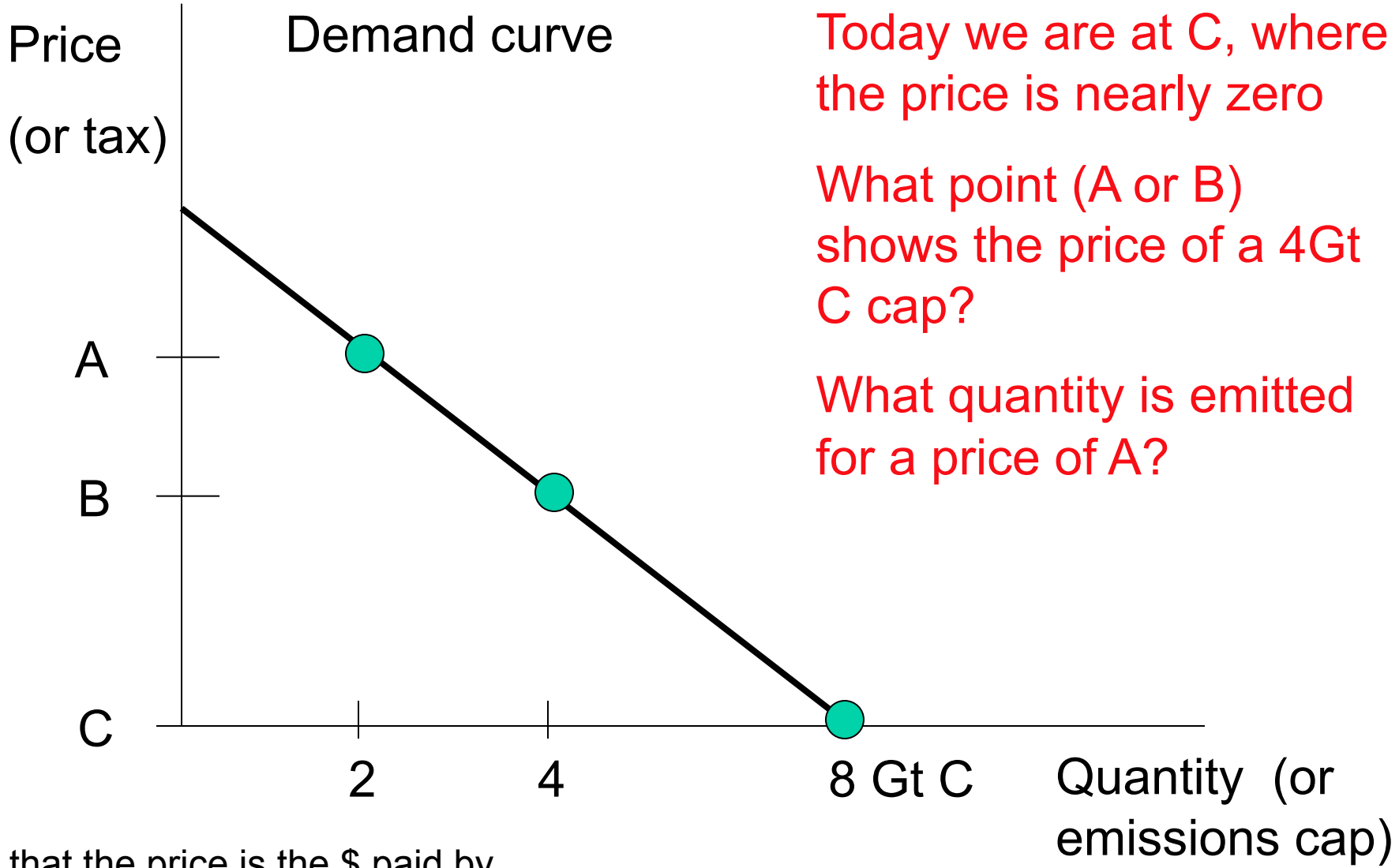
Monitoring, assessment and accountability are key to program success

Carbon Tax

Emitting carbon incurs a **price** charged as a tax

Monitoring, assessment and accountability are key to program success (where have I heard that before?)

Is there really a difference?



Today we are at C, where the price is nearly zero

What point (A or B) shows the price of a 4Gt C cap?

What quantity is emitted for a price of A?

Note that the price is the $ paid by polluters to emit at a certain level

Is there really a difference?

Not much difference between cap and trade and carbon tax *in theory*

One is quantity-based and the other is price-based

The curve maps one to the other, so how can they be different?

- One issue is that the demand curve is not actually known
- Also *many differences in practice*

Is there really a difference continued

Some have argued that cap and trade doesn't generate revenue while taxing doesn't cap…

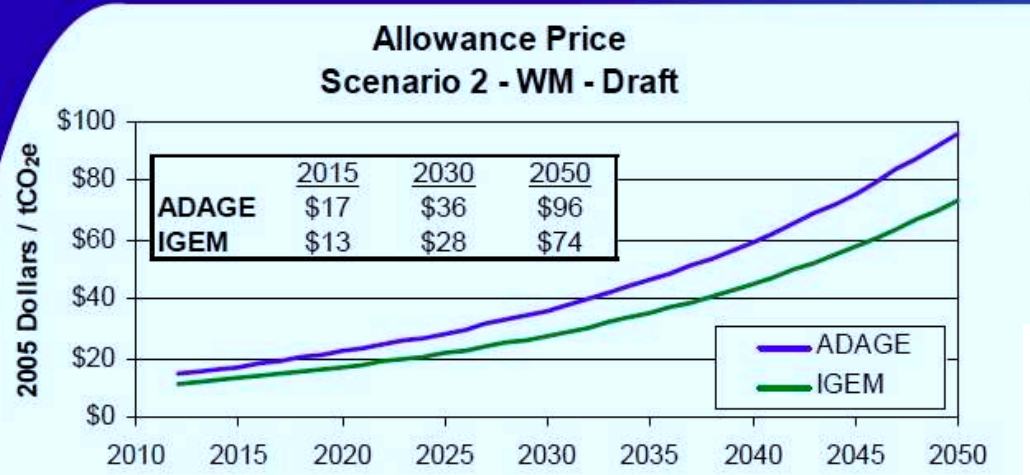
But permits in a cap and trade can be auctioned

And levying a tax will raise prices, which limits demand

Cap and Trade proposals can be converted into a Carbon Price based on the Cap (see previous slide)

GHG Allowance Prices & Sensitivities

WM-Draft Scenario Comparison



- The marginal cost of GHG abatement is equal to the allowance price.
- Range of 2030 allowance price in *"scenario 2 – WM-Draft"* across models is: $28 - $36. This range only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.

Source: EPA preliminary analysis of Waxman-Markey, 4/20/09

Differences in Practice

Cap and trade involves “complex new rules, political wrangling among special interests, and difficulties with enforcement.” (from the Climate Pricing Fact Sheet by Sightline)

The world has no experience with international cap and trade policies.

In contrast, governments are pretty familiar with taxing.

Differences in Practice Continued

Some argue that giving away cap and trade permits based on grandfathering is dangerous because they might be sold for profit without passing along revenue to consumer.

Grandfathering means permits are distributed for free based on past emissions, so past polluters benefit.

"Imagine that carbon permits are World Series tickets. If the government gives all World Series tickets to Exxon for free, will Exxon give them to us for nothing, or sell them for what the market will bear?"

Peter Barnes

James Hansen on his website

"The worst thing about the present inadequate political approach is that it will generate public backlash. Taxes will increase, with no apparent benefit."

"For this reason I strongly favor a "tax and dividend" approach. The entire carbon tax should be given back to the public, an equal amount to each person. "

"Although energy prices will rise, you can bet your bottom dollar that lower and middle income people will figure out how to reduce energy use enough that, overall, they come out ahead. And in so doing, moving to more energy-efficient products, they will spur economic activity and create jobs.

Is Hansen Right?

Is there any reason the revenue from auctioning permits for cap and trade can't be returned to the public too?

U.S. Cap and Trade Legislature on SO2

The Bush I white-house sent congress a plan for cap and trade on SO2 (the source of anthropogenic sulfate aerosols and acid rain).

It received broad bipartisan support

It became an amendment to the Clean Air Act in 1990

Today considered one of the most successful environmental legislation with ~30% reduction in SO2 by 2000 as a result

The permits are allocated for free!

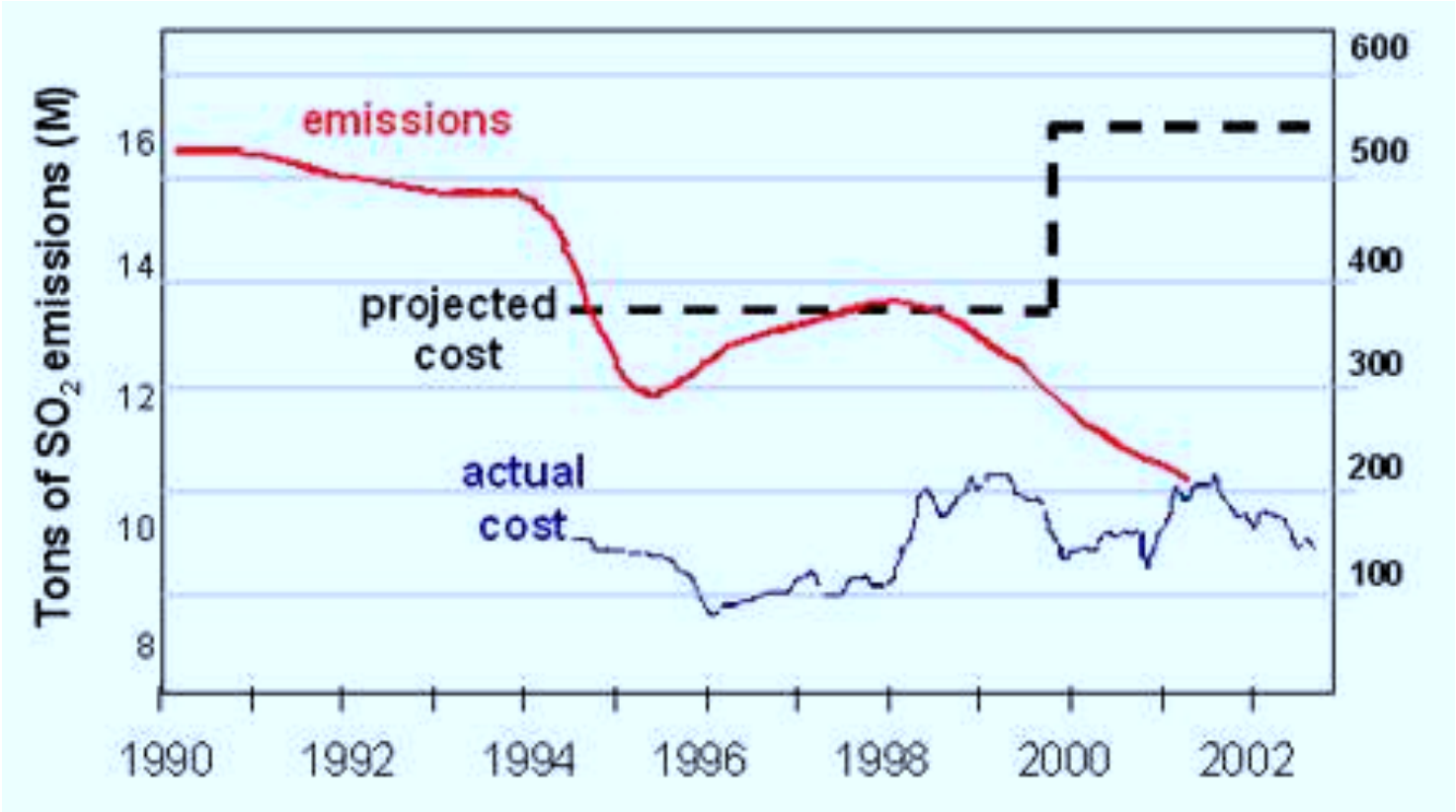


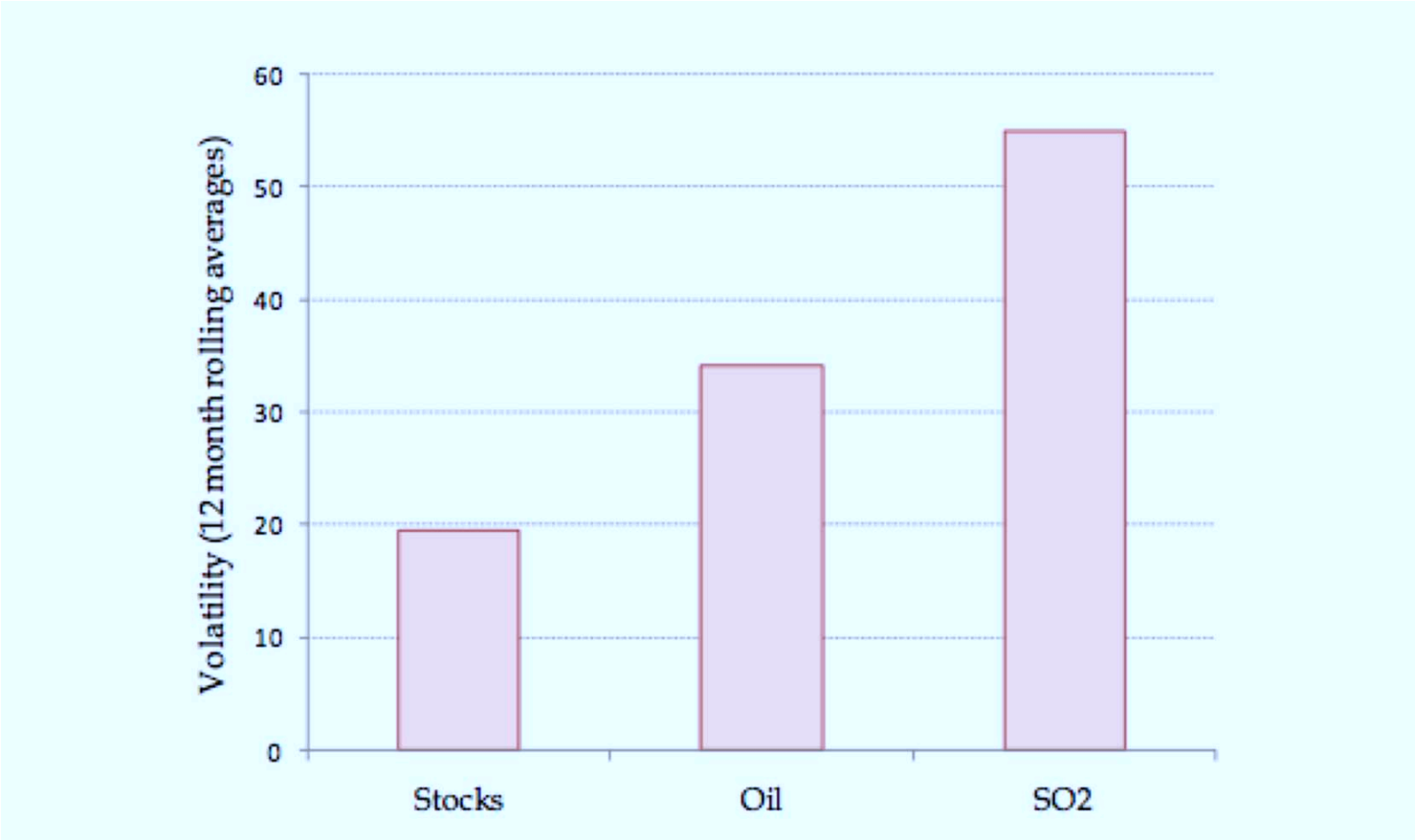
Figure from the Environmental Defense Fund

Figure 7

SO_2 Allowance Prices 1993-2007

Source: Various sources compiled by the authors.

Source: Pew Center on Global Climate Change



Volatility is calculated as the average absolute value of year-to-year changes as percent of average price.
Figure by William Nordhaus.

US Cap and Trade Legislature on CO2

Why not?

The key anthropogenic GHGs are well-mixed and global warming harms the global “common” (or public good, which is the climate and climate impacts in this case). Yet the harm is not uniform.

To stabilize GHGs, everyone must participate in regulating emissions.

According to William Nordhaus, “Everyone, everywhere must face the same price.”

Hence it needs to be international with very high participation

Volatility is a worry

Regional Greenhouse Gas Initiative (RGGI)
A Cap and Trade Example

States sell carbon allowances during quarterly auctions and invest the proceeds in renewable energy, energy efficiency and energy subsidies for the poor.

RGGI has already generated half a billion dollars in its first year of operation

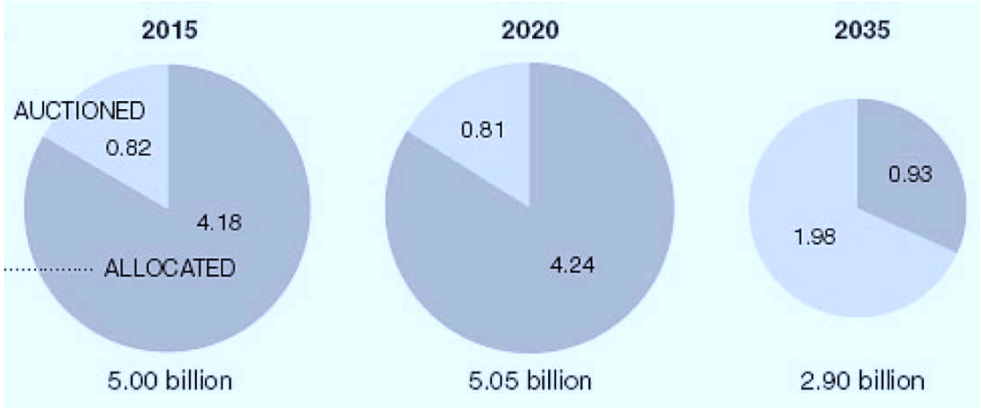
David Littell, commissioner of the Maine Department of Environmental Protection and chair of RGGI's board of directors. **"The investments we are seeing in renewable energy, in energy infrastructure, appear to be the largest wave of capital investment in the state's history."**

US Cap and Trade Legislature on CO2

The Waxman-Markey bill on Energy and Climate Change passed the US house last summer

From the New York Times

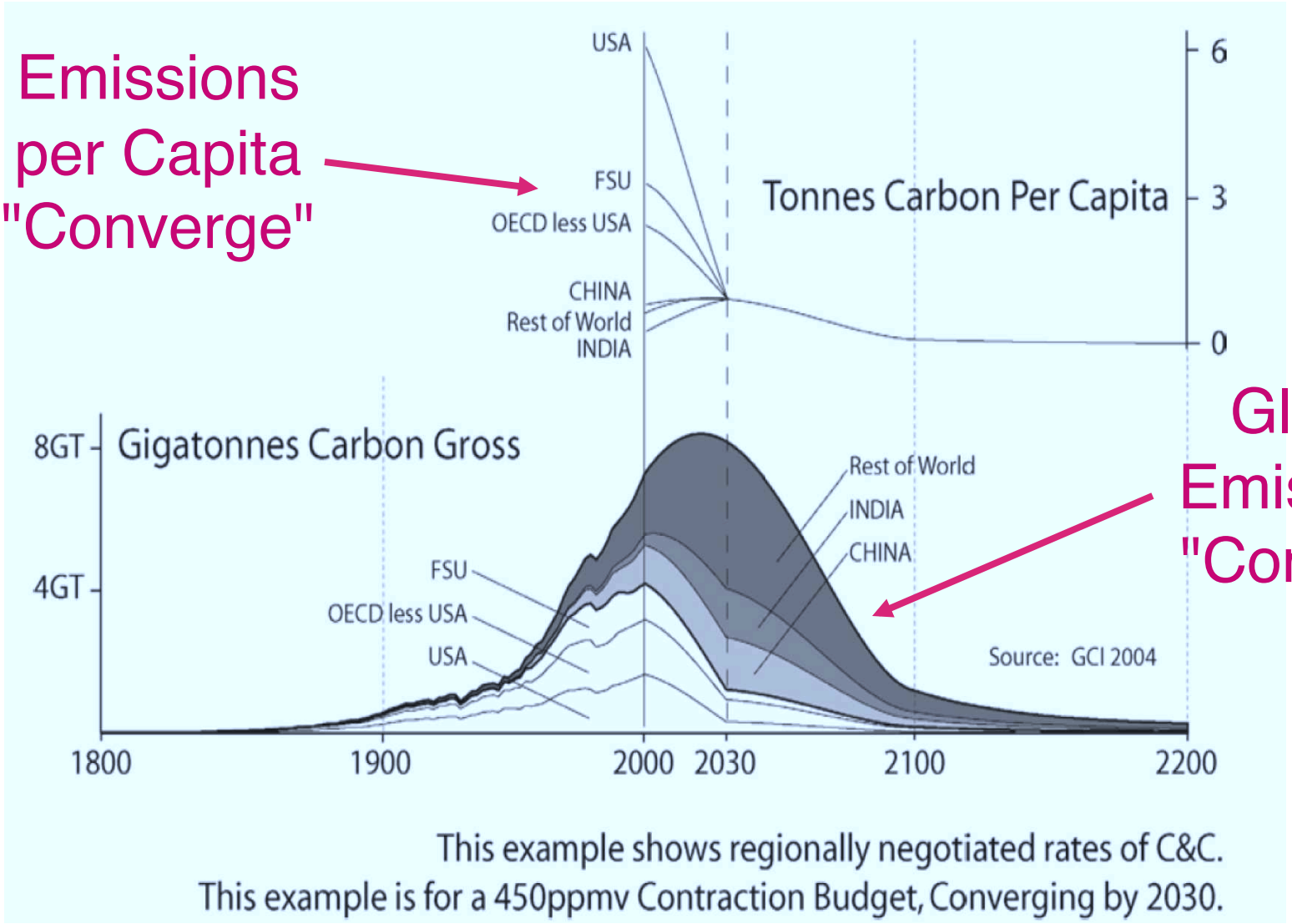
Numbers at right are in billions of allowances. Those “allocated” are free. Those “auctioned” go to the highest bidder, driving up price of emissions.



Some are allocated to recipients who must sell them and use profits to finance renewables

The senate version (the bipartisan Boxer-Kerry proposal) sought to lower CO2 emissions 20% from 2005 levels – by lowering the cap over time. It is stalled

Contraction and Convergence: 450ppm target



Source: http://www.gci.org.uk/briefings/ICE.pdf

[Rough Guide, p. 298]

Carbon Offsetting - see optional reading RG 353-6

Paying an organization to “neutralize” your GHG emissions

For example,

You pay an electrical utility that invests in renewables

Or you pay someone to plant trees.

Does this really work?

Does the quality of the offset vary?

Members include: Ford Motor Co, New Belgium Brewing Co, Puget Sound Energy, King-County, Miami-Dade County, etc (some are offset providers and some are purchasers)

Members trade “offsets” where those who purchase them do so voluntarily, but also to compete in countries that signed the Kyoto Protocol

Summary

Carbon emissions is presently a market failure

Stern Review found “action outweighs cost” of climate change

Making polluters pay with market forces is working in SO2 and there are fledgling efforts with CO2

There is not much difference in theory between cap and trade and carbon taxing - because they are related through the demand curve

The differences lie in implementation

Summary

Auctioning permits to pollute and taxing generate revenue. Some promote returning some of the revenue as a “dividend”. The rest could be spent on technology research and development.

There are inevitably winners and losers, which involves ethics