Global Climate and Global Energy: Is Nuclear Power Required?

James Hansen

3 December 2015

Paris, France

Global Climate Situation

1. Little-Understood Global Crisis

- Climate Inertia → Warming in Pipeline
- Amplifying Feedbacks → Losing Control

2. Rapid Reduction of Forcings Needed

- Fossil Fuel CO_2 Emissions Dominate
- Remain in Climate System for Millennia

3. Solution is Technically Possible

- and is Economically Sensible
- but is Not Being Proposed by Any Nation

Climate Impacts

1. **Species Extermination**
   - Shifting Climate Zones, Multiple Stresses, Species Interdependencies

2. **Ice Sheet Disintegration & Sea Level**
   - Ocean Warming → Ice Shelves Melt → Ice Streams Surge → Disintegration

3. **Climate Extremes**
   - Heat Waves, Drought, Fires
   - Heavier Rain, Floods, Stronger Storms

Threat of Mass Exterminations

Multiple Human-Made Stresses

Overharvesting, Land use changes, Nitrogen fertilization, Introducing exotic species, etc.

in Combination with

Rapid Shifting of Climate Zones

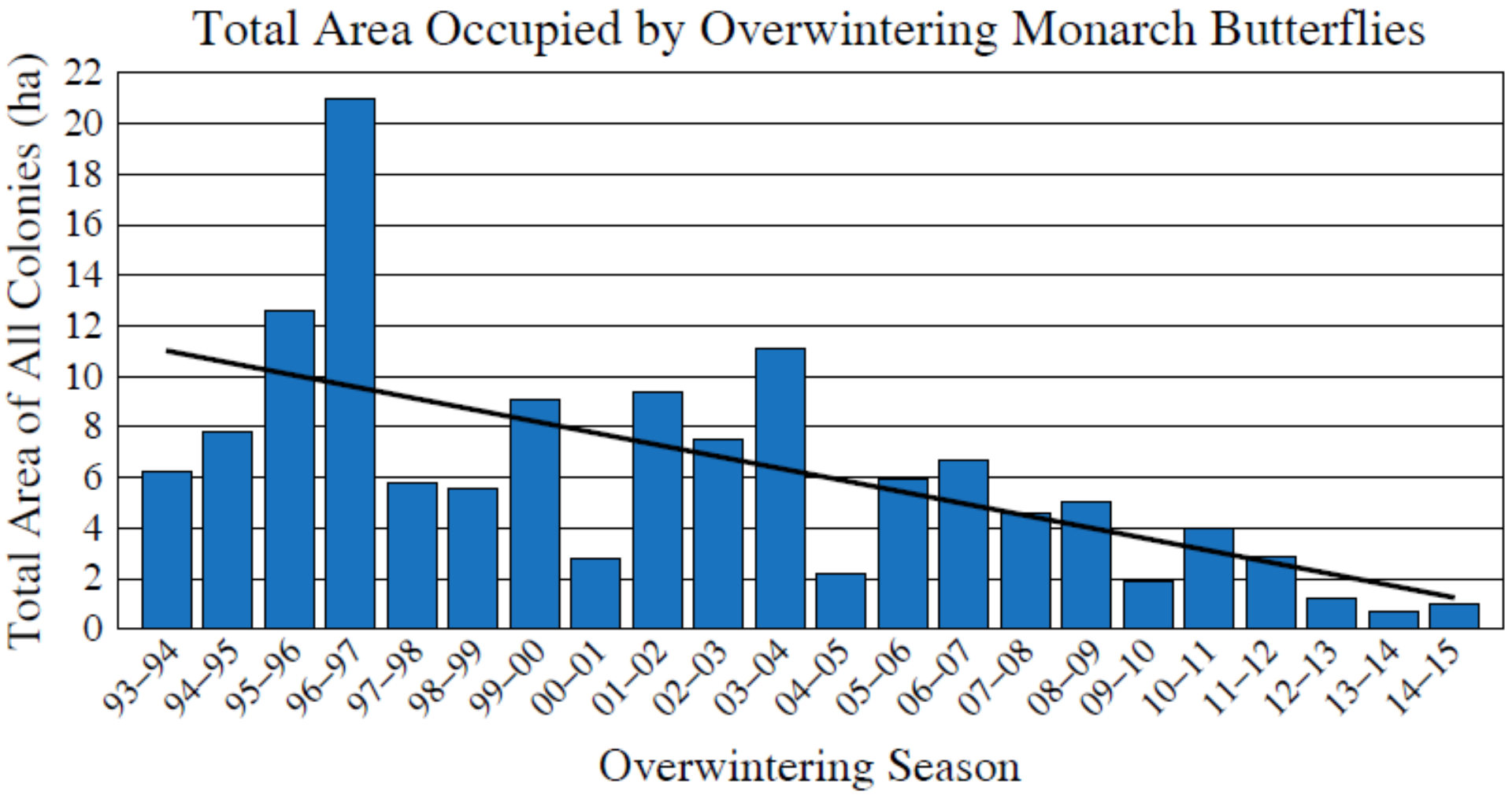
Figure 1. The broken-wing female Monarch on our butterfly bush.

Figure 6. The male Monarch after its first landing, on the butterfly bush.

Figure 7. The female Monarch on the remains of a wildflower.

Current U.S. Drought Monitor

June 2011: Record 7.6% of U.S. in ‘Exceptional’ drought category, simultaneous with record flooding on Mississippi River.



Area occupied by overwintering monarch butterflies

Source: Brower, LP, et al., Insect Conservation and Diversity 5, 95-100, 2012.

Stresses on Coral Reefs

Coral Reef off Fiji (Photo: Kevin Roland)

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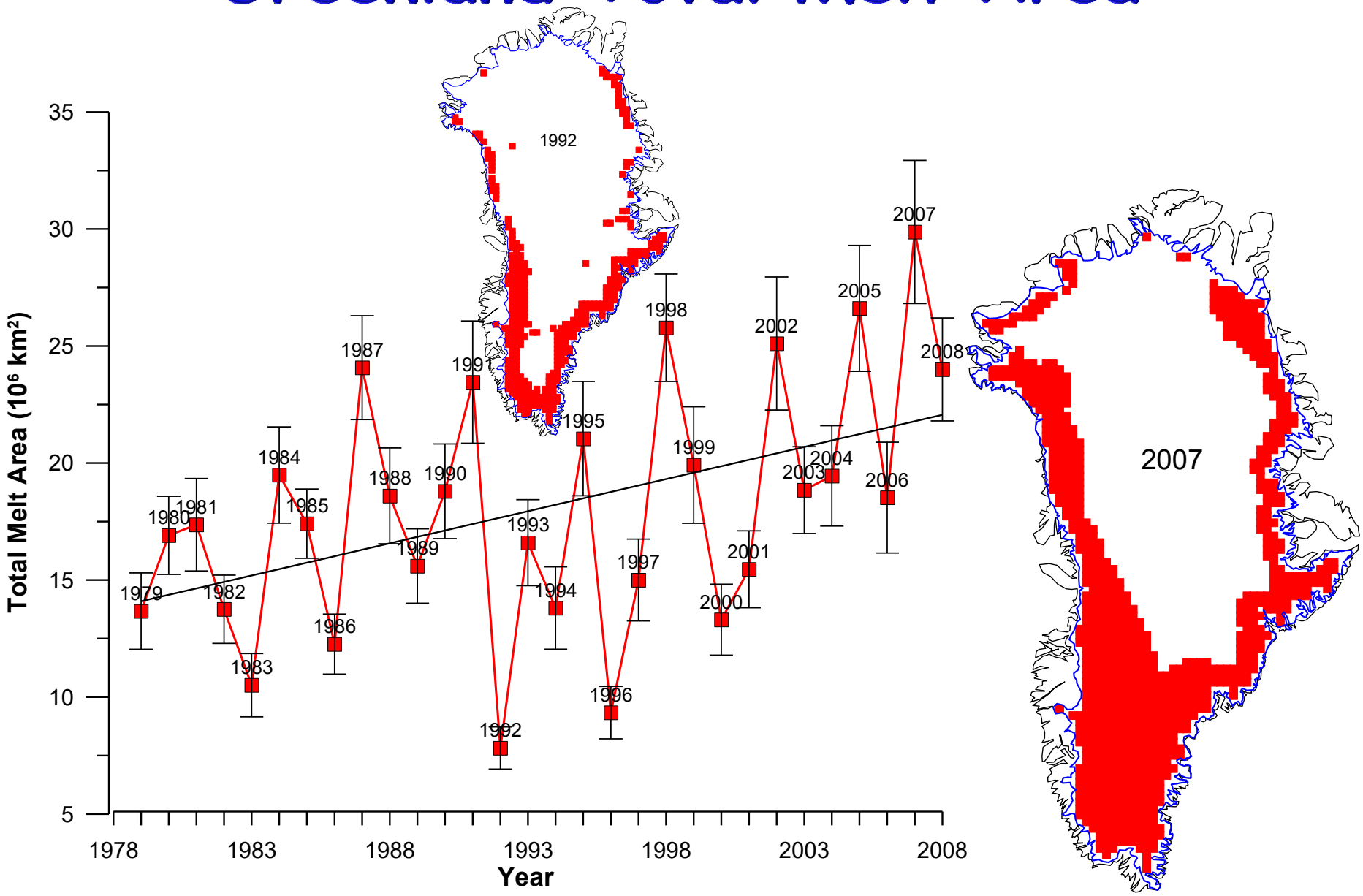
Greenland Total Melt Area



Surface Melt on Greenland

Melt descending into a moulin, a vertical shaft carrying water to ice sheet base.

Source: Roger Braithwaite, University of Manchester (UK)

Jakobshavn Ice Stream in Greenland

Discharge from major Greenland ice streams is accelerating markedly.

Source: Prof. Konrad Steffen, Univ. of Colorado

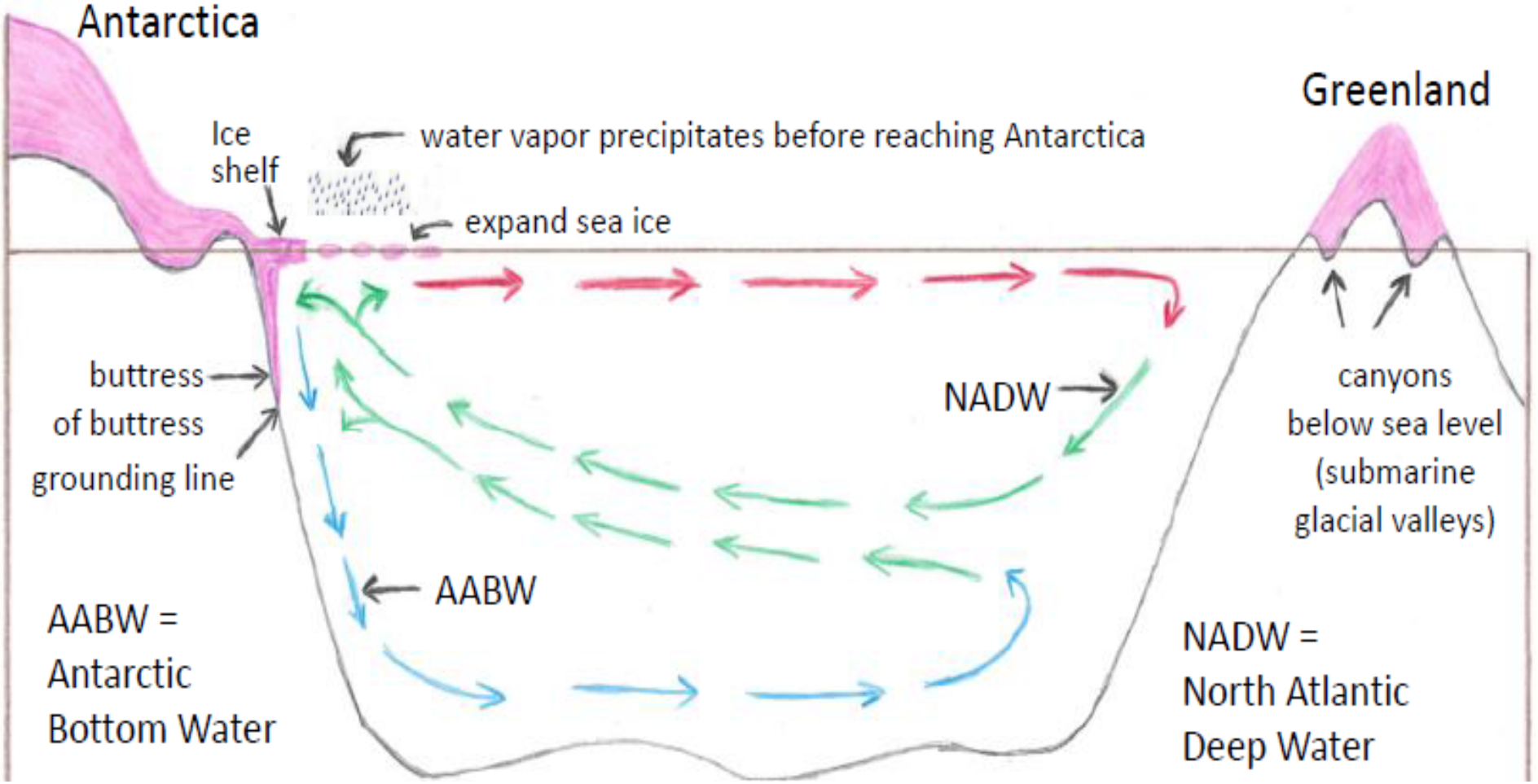
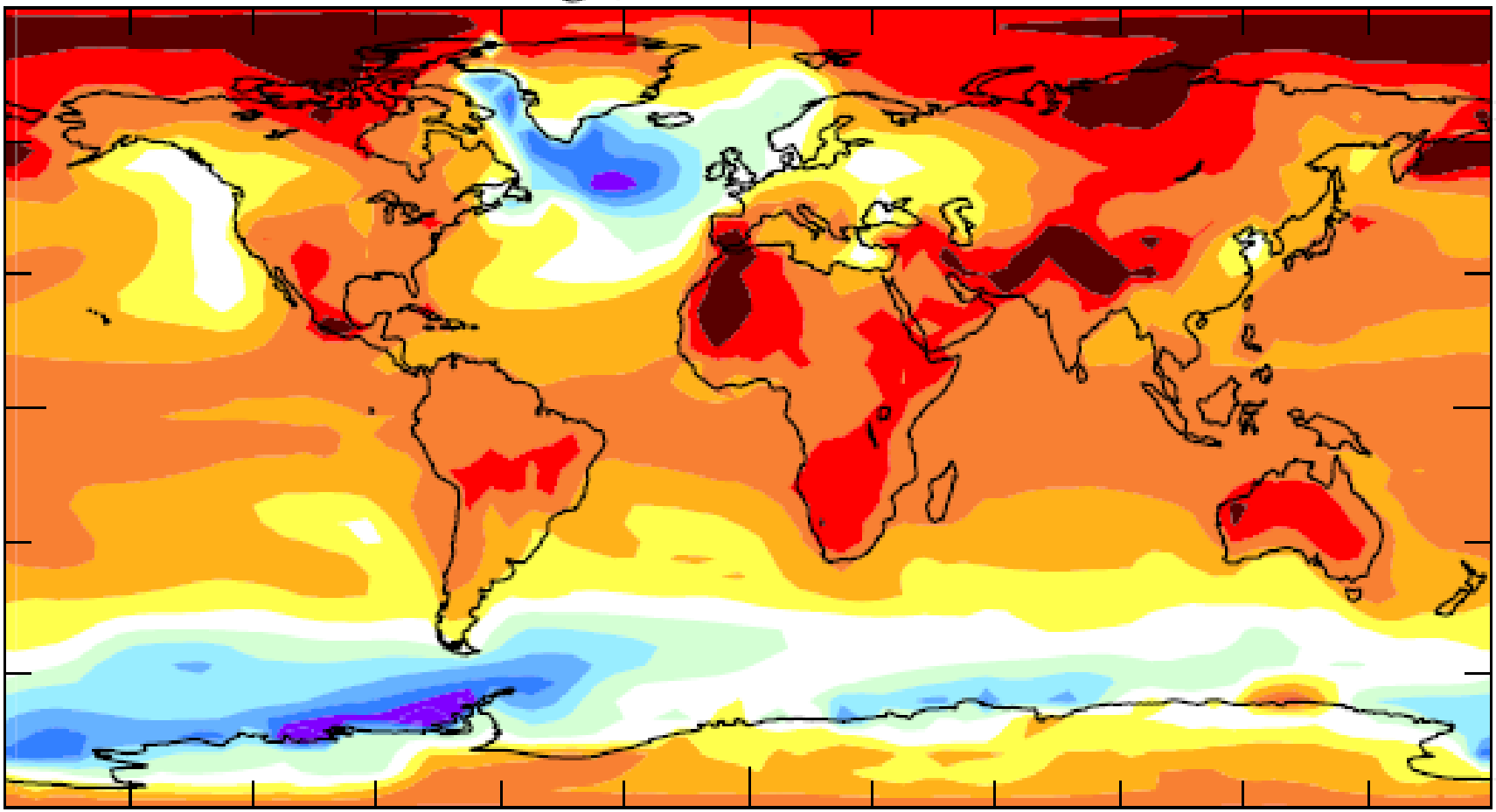


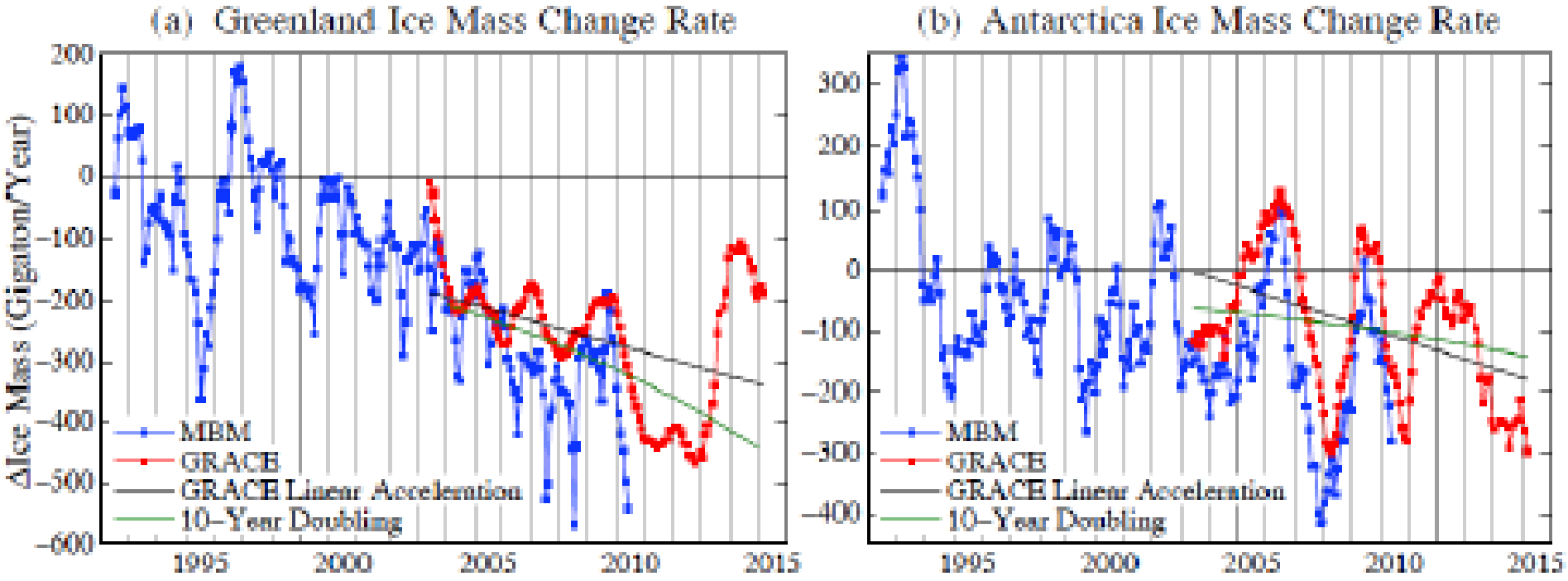
Fig. 22 Schematic of key processes and feedbacks as internal ocean warming drives ice sheet melt

2055-2060 Surface Air Temperature (°C) Relative to 1880-1920

A1B + Modified Forcings, Ice Melt to 1 m 1.19



-4.4 -2.7 -2.1 -1.5 -.9 -.3 .3 .9 1.5 2.1 2.7 4.2



Greenland (a) and Antarctic (b) ice mass change. GRACE data is extension of Velicogna et al. (2014) gravity data. MBM (mass budget method) is update of Rignot et al. (2011).

Paleoclimate Guidance

Eemian sea level +5-9 meters

- **Eemian temperature < +2°C***

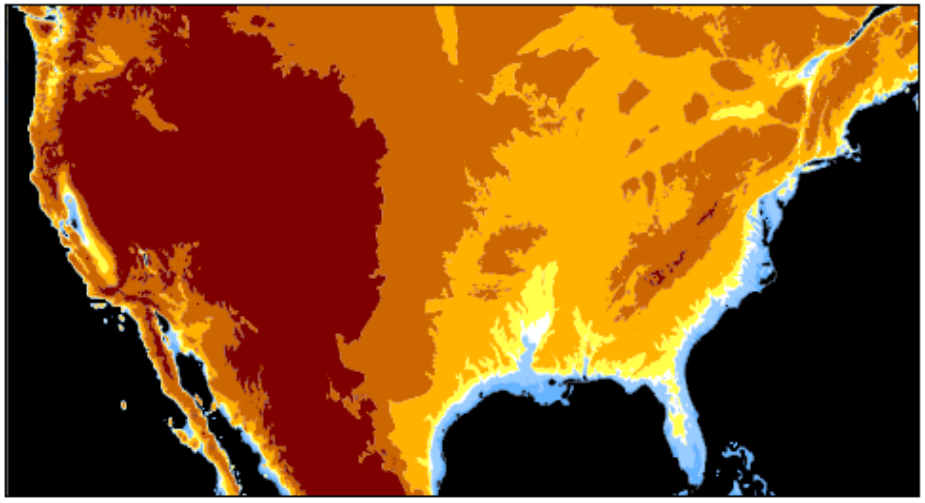
Pliocene sea level up to +15-25 meters

- **Pliocene temperature +3-4°C***

Ice sheet response time uncertain, but it is shorter than the lifetime of fossil fuel carbon and resulting global warming

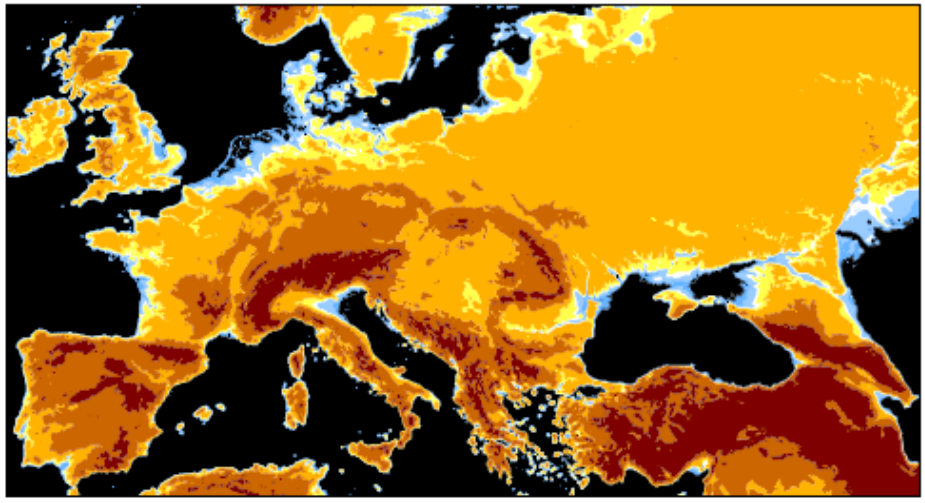
***relative to pre-industrial times**

U.S. Area Under Water



0 6 25 35 75 300 1000 3815

Europe Area Under Water



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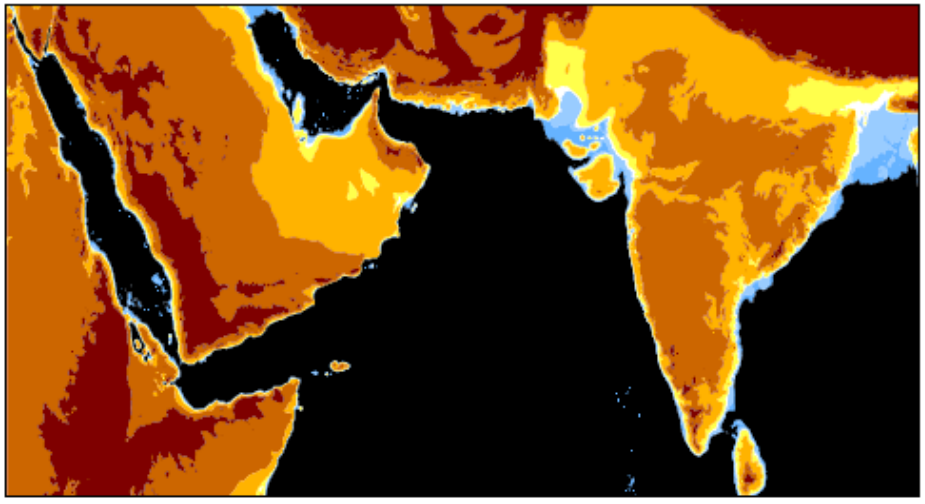
Central Asia: Area under Water



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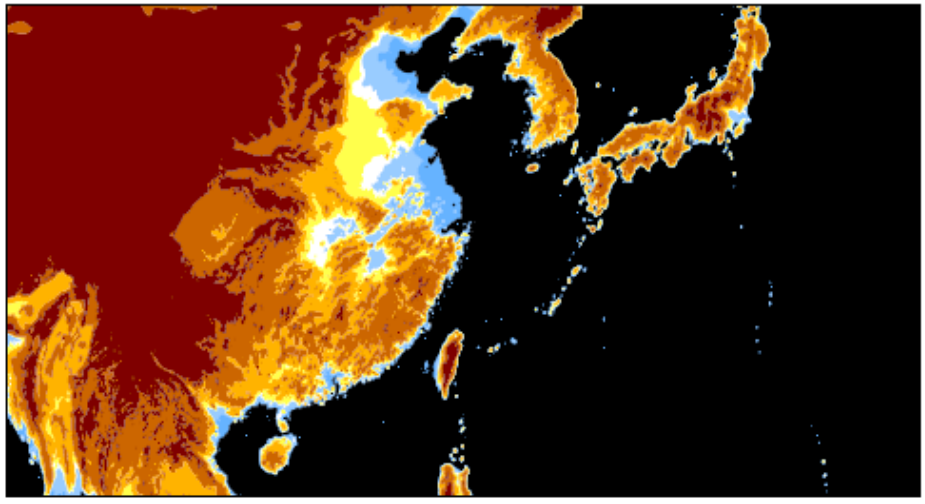
Far East: Area under Water



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Problem & Solution

1. Fossil Fuels are Cheapest Energy
   - Subsidized & Do Not Pay Costs
   - Solution: Rising Price on Carbon
2. Regulations also Required
   - Efficiency of Vehicles, Buildings, e.g.
   - Rising Carbon Price Provides Enforcement
3. Technology Development Needed
   - Driven by Certainty of Carbon Price
   - Government Role Limited

Carbon Fee & Dividend

Fee: Collected at Domestic Mine/Port of Entry

Covers all Oil, Gas, Coal → No Leakage

Dividend: Equal Shares to All Legal Residents

Not One Dime to the Government.

Merits:

Transparent. Market-based. Stimulates Innovation.

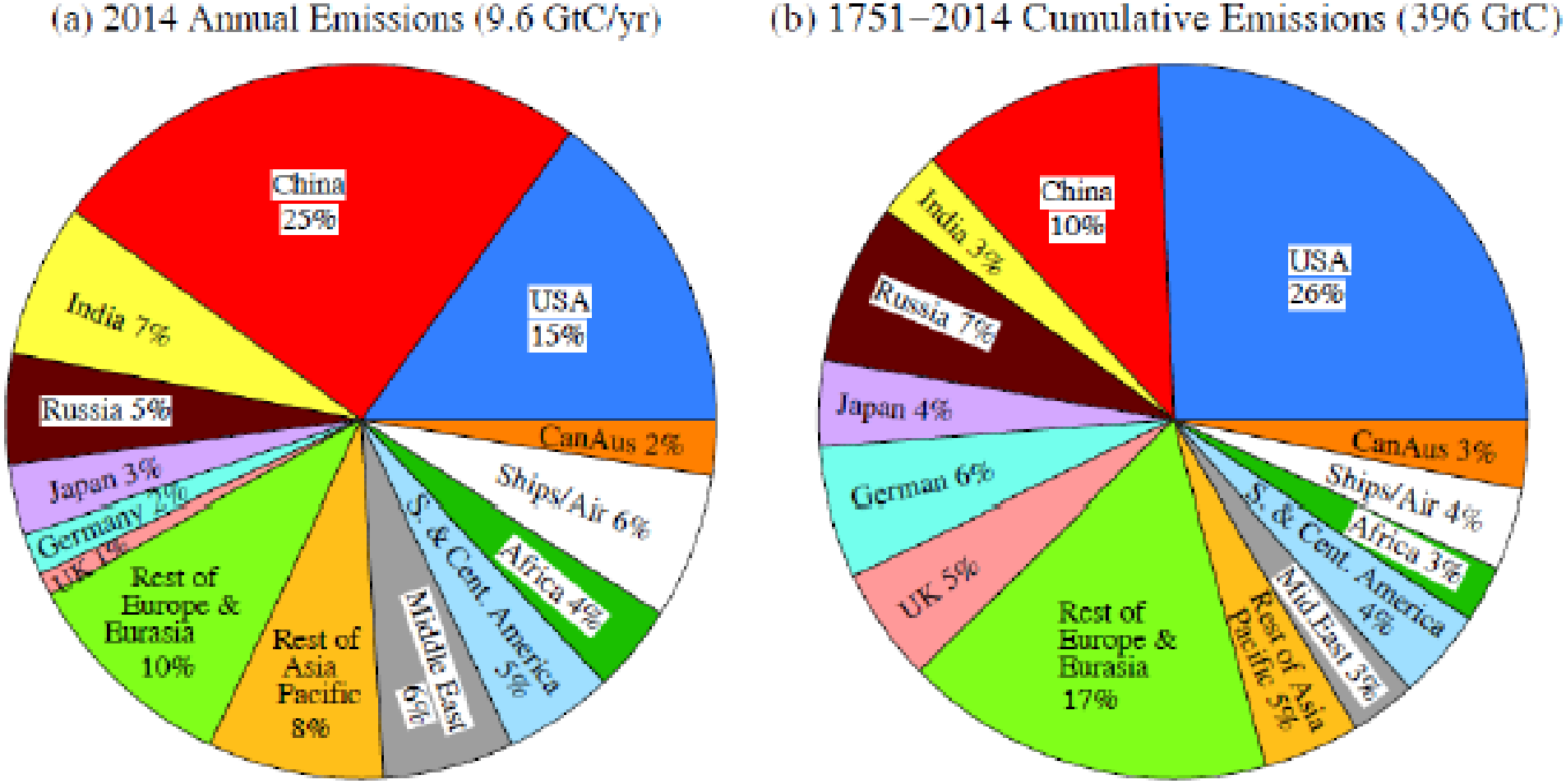
Does Not Enlarge Government.

Leaves Energy Choices to Individuals & Free Competition.

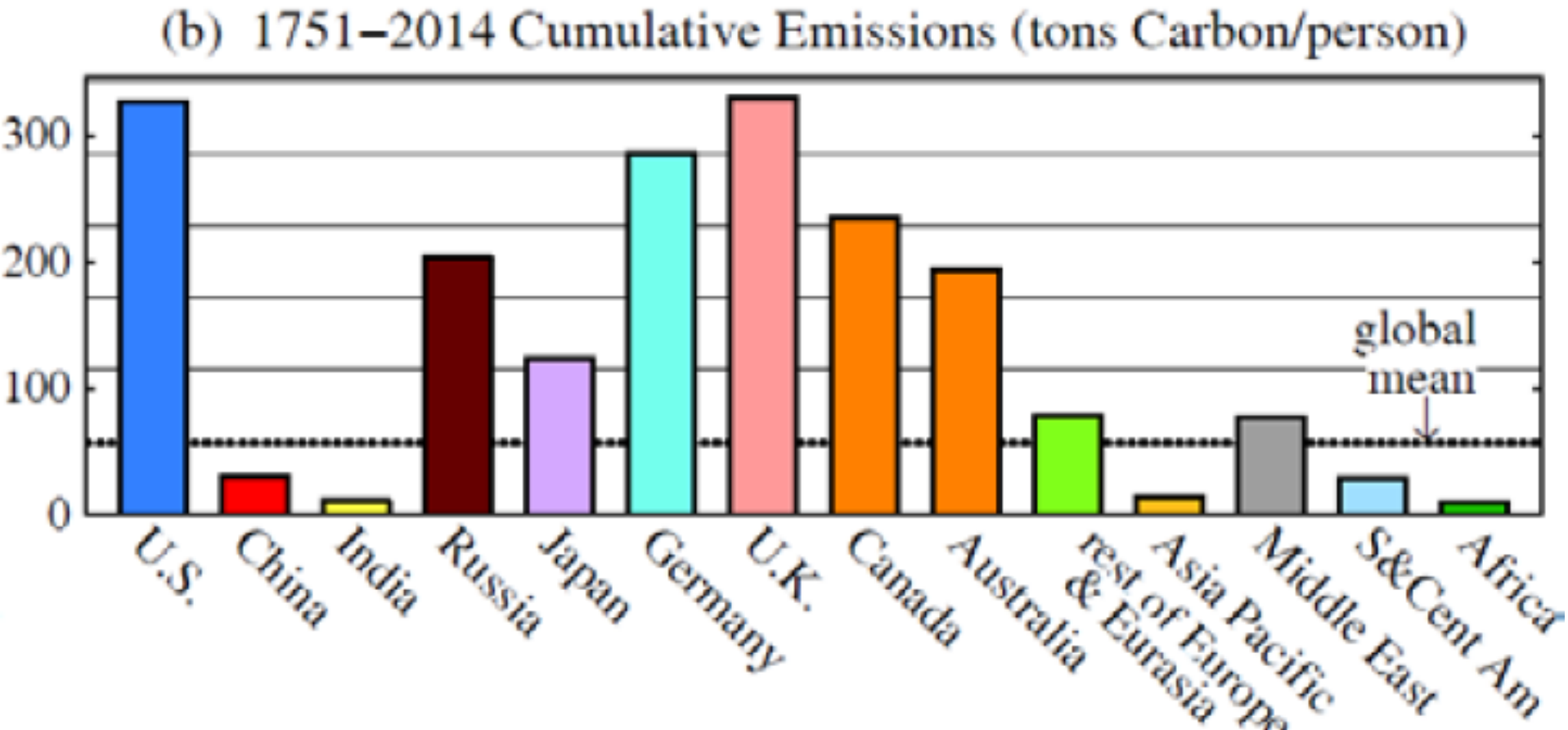
A Conservative Energy & Climate Plan.

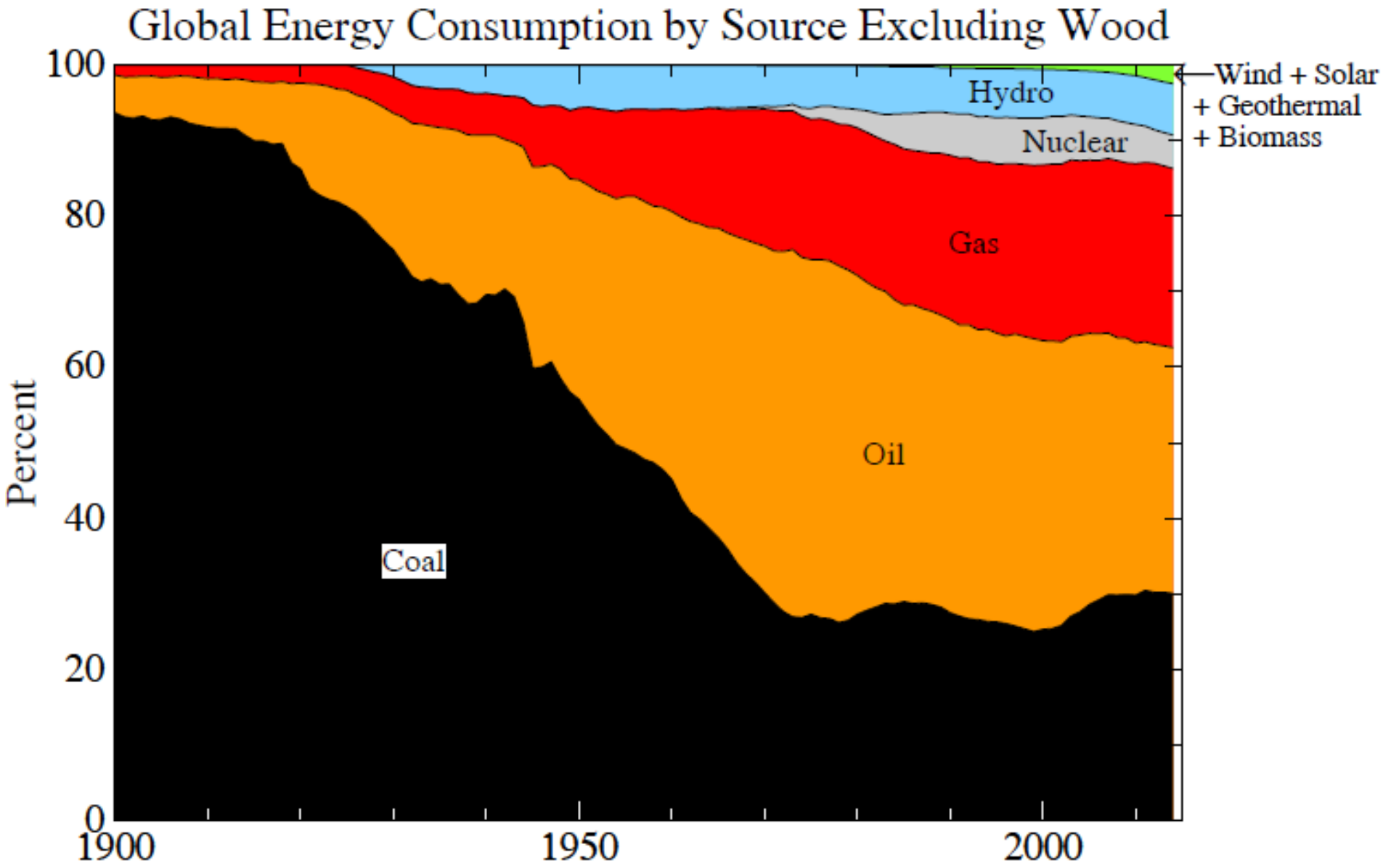
Fee & Dividend Addresses

1. **Economy: Stimulates It**
   - Puts Money in Public's Hands – A Lot
   - Provides Certainty to Businesses and Entrepreneurs
2. **Energy: Solves Fossil Fuel Addiction**
   - Stimulates Innovation – Fastest Route to Clean Energy
   - Complements Efficiency Regulations & Energy RD&D
3. **Climate: Viable International Approach**
   - Border Duties on Products from Nations without Fee
   - Most Coal & Unconventional Fossil Fuel left in Ground

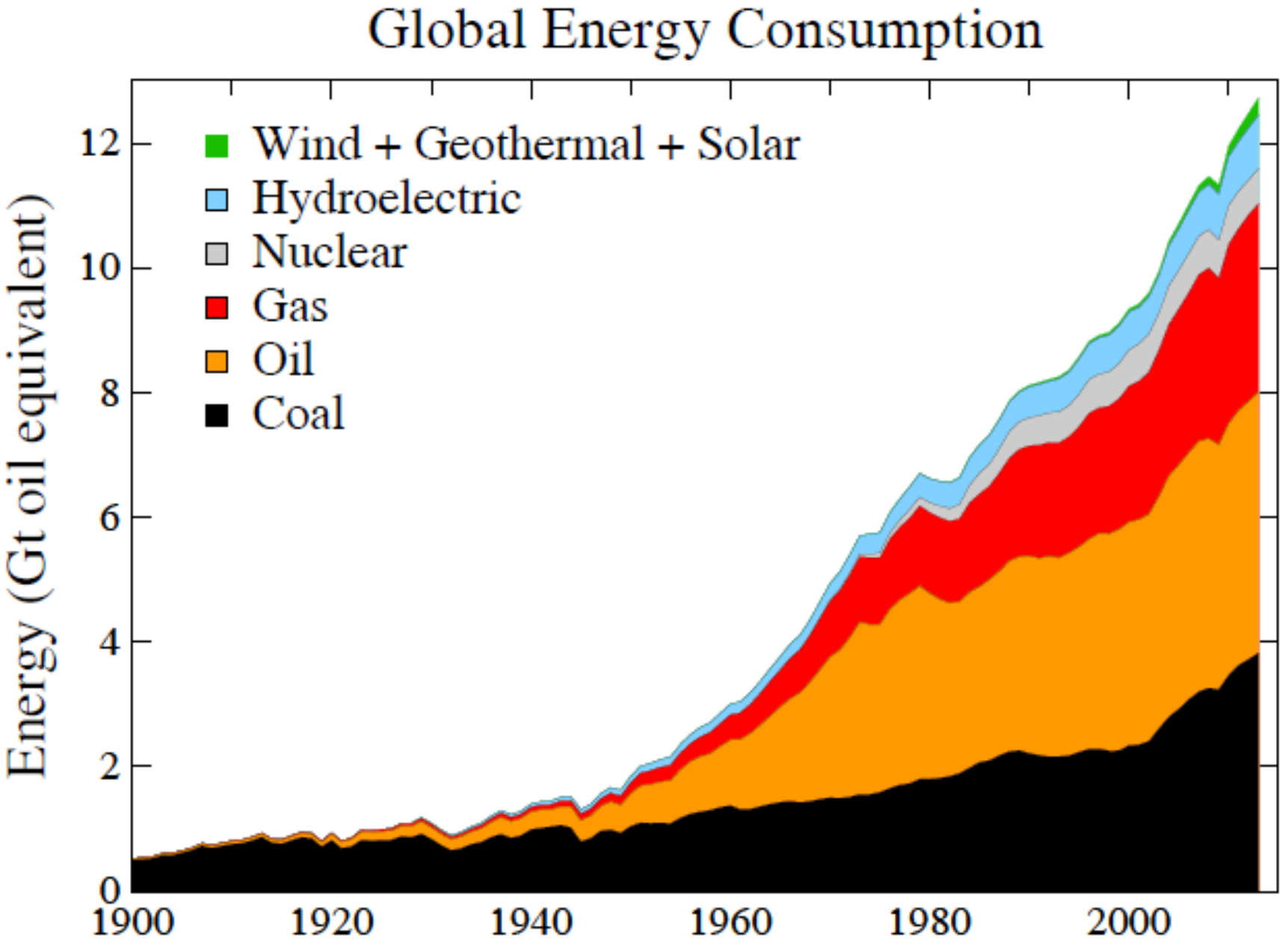


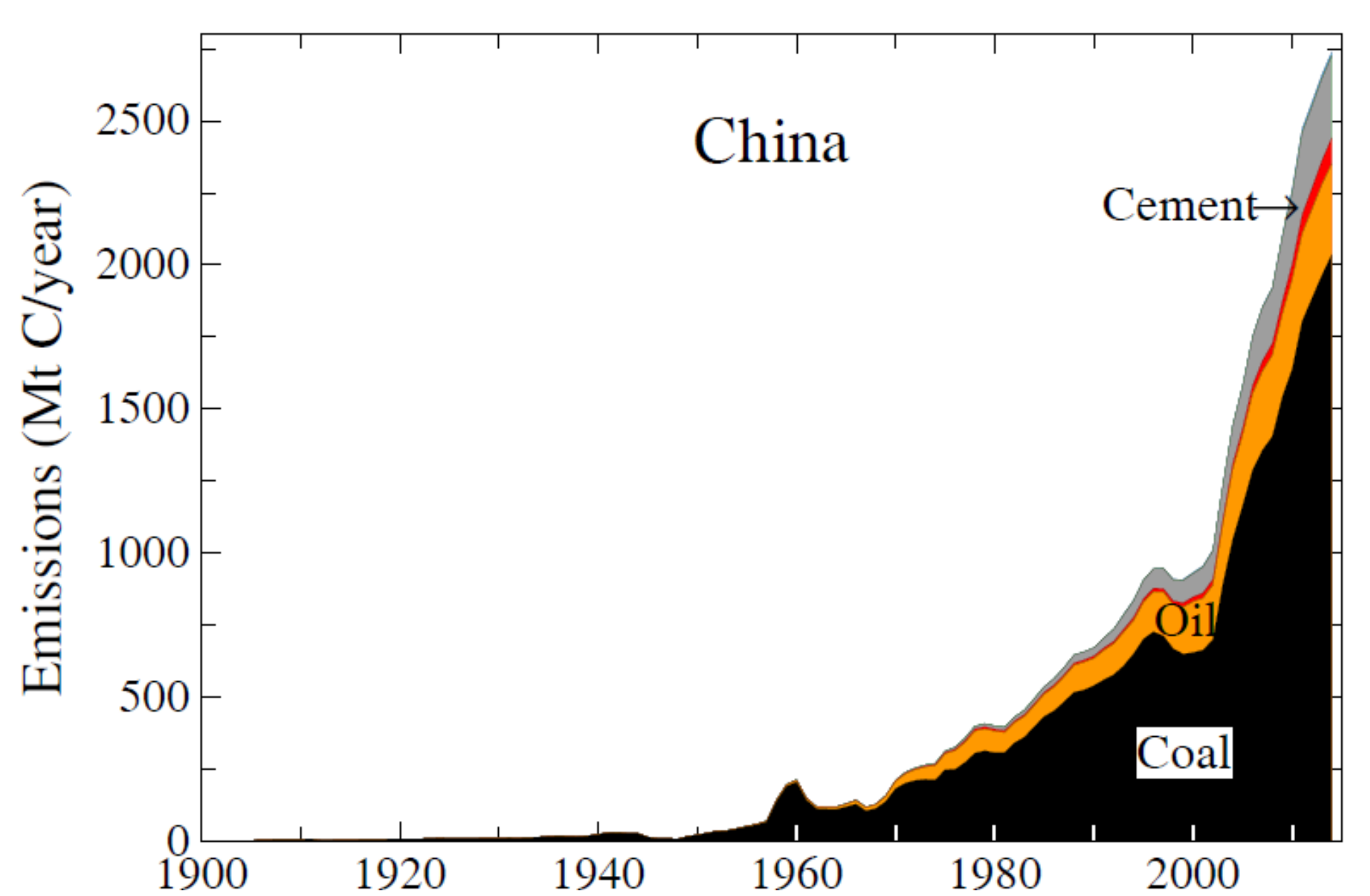
Fossil fuel CO_2 emissions. Update of Hansen et al. (2013) using data of Boden et al. (2015) and BP (2015).

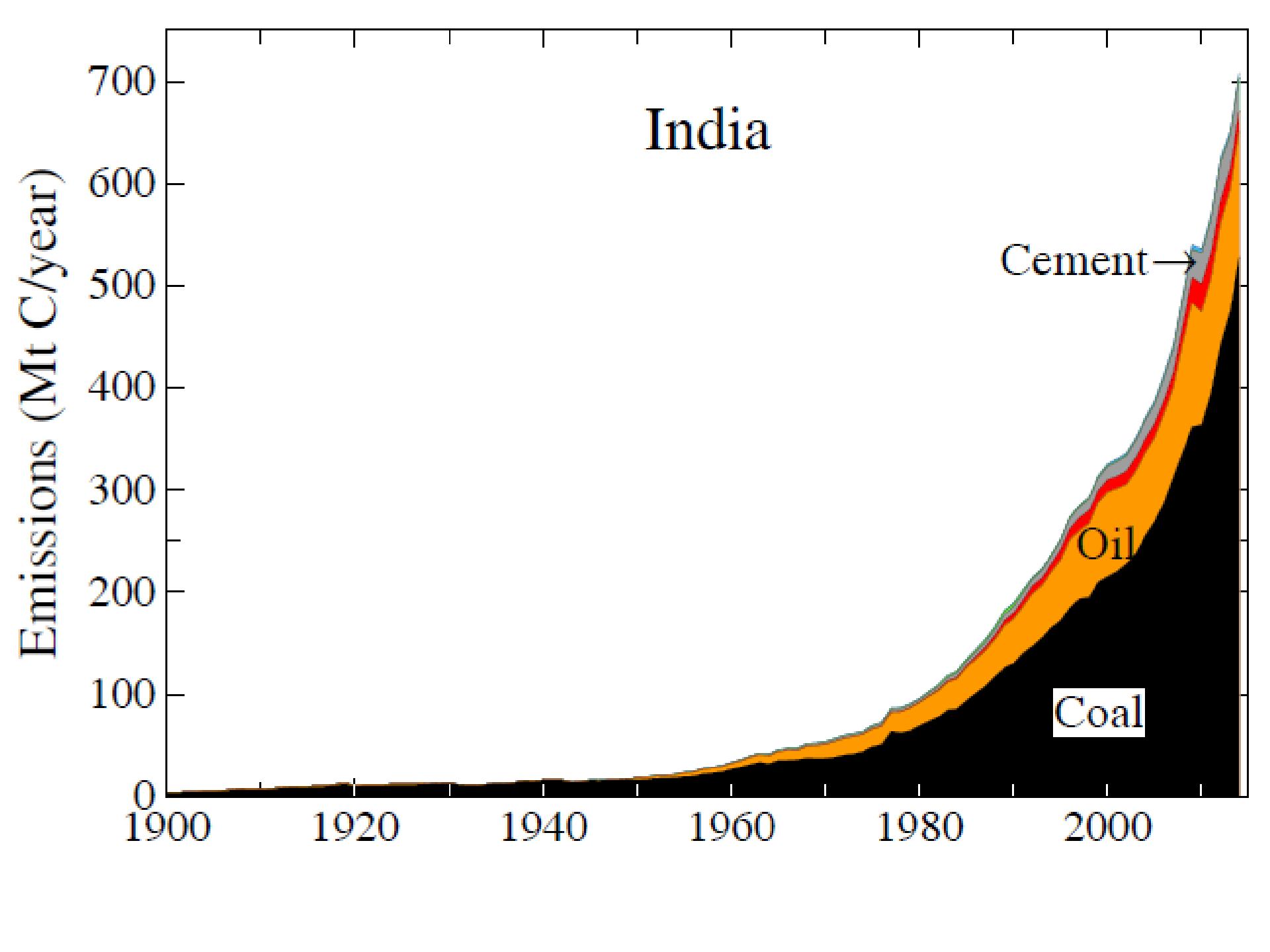

(b) 1751–2014 Cumulative Emissions (tons Carbon/person)
300
200
100
0
global mean
U.S.
China
India
Russia
Japan
Germany
U.K.
Canada
Australia
rest of Europe & Eurasia
Asia Pacific
Middle East
S&Cent Am
Africa



Data through 2014


Global Energy Consumption
Wind + Geothermal + Solar
Hydroelectric
Nuclear
Gas
Oil
Coal
Energy (Gt oil equivalent)
0
2
4
6
8
10
12
1900
1920
1940
1960
1980
2000


China
Emissions (Mt C/year)
2500
2000
1500
1000
500
0
1900
1920
1940
1960
1980
2000
Cement
Oil
Coal


India
Emissions (Mt C/year)
700
600
500
400
300
200
100
0
1900
1920
1940
1960
1980
2000
Cement
Oil
Coal

The Hill

Energy secretary optimistic for climate pact

Anne Wernikoff

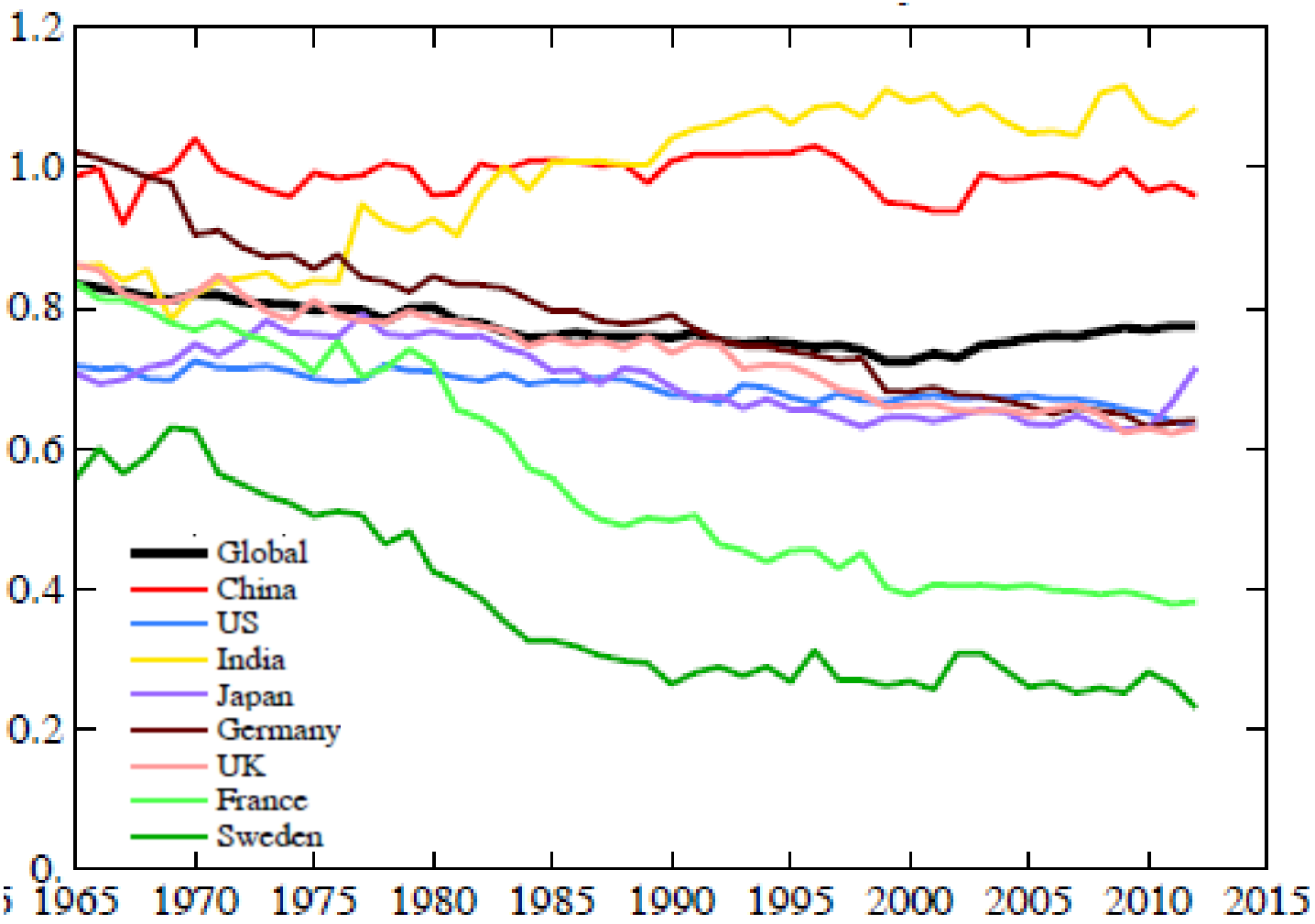
By Timothy Cama - 08/24/15 04:09 PM EDT

Energy Secretary Ernest Moniz said on Monday he is optimistic that world leaders will come to an agreement to fight climate change and that technology will play a key role in the effort.

Moniz and Podesta singled out carbon capture and storage (CCS) — in which carbon dioxide is removed from a fossil fuel-fired power plant and stored — as a promising technology to reduce greenhouse gases.

"CCS certainly, I think remains a very important area for us to develop, because we need all the tools that we can get," Moniz said.

Moniz said the climate deal Obama struck with China last year will enable the countries to collaborate extensively on carbon capture.



<u>Carbon intensity</u>, defined as fossil fuel carbon emissions (GtC) divided by energy consumption (Gt of oil equivalent)

Grandsons Connor and Jake – Connor reading Indiana Jones book.

Connor's Thoughts

If we keep doing what we are doing now then the environment will be ruined when the people who are kids now are grownups.

And unless we can figure out how to make a time machine that actually works, there will be no way to go back in time to fix it.

It's not fair that the grown ups now are ruining the atmosphere for the grownup in the future.

Grown ups now are scared of nuclear power but they should be scared of what will happen if they keep doing what they're doing now because we know the ways to use nuclear power safe and we know that using fossil fuels is not safe. It is very dangerous.

Cap & Trade with Offsets: The Kyoto Approach (&Paris?!)

Certain to be Ineffectual

1. **Not Global**

   Must beg each nation for a cap

2. **No Enforcement Mechanism**

Climate change deal will not include global carbon price: UN climate chief

A climate change deal to be agreed in Paris in December will not be able to come up with a global carbon price, the United Nations' climate chief, Christiana Figueres, said.

Big multinational companies and investors, and most recently oil majors, have called for a global carbon price to help spur investments in low-carbon energy.

A global carbon price would help to create an incentive for operators of power plants and factories to switch to cleaner fuels such as gas or to buy more energy-efficient equipment.

"(Many have said) we need a carbon price and (investment) would be so much easier with a carbon price, but life is much more complex than that," Figueres told a climate investor event in London.

Coherent Discussion Available at:

www.Columbia.edu/~jeh1

Isolation of 1600 Pennsylvania Avenue: Part I
(Communication of 27 November 2015)