HONR 229L: Climate Change: Science, Economics, and Governance

Discussion #20: Paris INDCs

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Class Web Site: http://www.atmos.umd.edu/~rjs/class/honr229L

ELMS Page: https://myelms.umd.edu/courses/1269254

COP21 leaders – from left to right, Laurence Tubiana, Christiana Figueres, Ban Ki Moon, Laurent Fabius, and François Hollande – celebrate after the agreement is announced. Credit: UN Climate Change

https://archinect.com/news/article/143667350/what-the-paris-agreement-means-for-architecture

7 November 2019

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HONR 229L: Climate Change: Science, Economics, and Governance

AT 19, Q1. According to the reading:

a) what two countries rank third and fourth, behind China and the US, in greenhouse gas emissions and why do these countries rank so high?

Indonesia and Brazil rank behind China and the US in greenhouse gas emissions, and this is particularly due to the deforestation issue that is going on in both of these countries.

⇒ **Hello Jared Diamond**

b) what type of carbon credit trading has been proposed to address the reason GHG emission is so high, from the countries that rank third and fourth in GHG emission?

The type of carbon credit trading that has been proposed to address the issue of deforestation is a "forest protection credit" system. In this system, participating countries would use prehistoric data as a baseline for comparison and then the countries would have to reduce the rate of deforestation below that baseline. After this, countries could sell each ton of carbon that is not emitted on the global carbon market to companies that need the extra resources.

c) would the cost of emitting a ton of carbon under the RGGI program for the most recent auction, which is $5.20 per ton of CO_2, have an impact on the resource that is the subject of this question?

The reading states that pricing a ton of carbon at under $2 would prevent 6 billion tons of carbon. By pricing carbon at the latest RGGI price, we could see significantly more emissions prevented. Over 12 billion could be prevented, if we assume that since the price would over double, then the prevented carbon emissions would also over double.

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It seems that the book is referring to the cost in units of tons per carbon, whereas the RGGI price is in terms of tons of CO_2. I checked the Nepstad et al. (2007) paper, and it really seems like they are referring to the cost of emitting a ton of carbon, rather than CO_2.

If this is true, then the RGGI price of $5.20 per ton of CO_2 equates to (44/12)x$5.20 = $19 per ton of carbon, which would go a long way to helping alleviate deforestation in Brazil, provided we could figure out:

1) a transfer mechanism for the money

2) monitoring and compliance (i.e., assuring the forest is truly preserved)

3) single counting of the payment for each forest tract over several decades period of time (framework considers one-time payments to preserve a tract of forest for several decades).

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HONR 229L: Climate Change: Science, Economics, and Governance

AT 19, Q2. The reading discusses numerous companies, as is the style of the book written by Krupp and Horn. For better or worse, the book was written in a manner highly focused on events that occurred around 2007. Interesting to see a few words about Elon Musk and Tesla, which incorporated in 2003.

Here is a list of companies (or division) that, as far as I can tell, are still intact and functioning quite well: IBM Big Green Innovations, Interface, Nextek Power Systems, and PAX.

> **IBM's mission is in developing more sustainable technologies that are cost-effective, affordable, and efficient. This company works towards developing clean, efficient energy sources that have a low carbon footprint for businesses. One of the main focuses of IBM is *sustainable building operation development*. From electricity usage, space management, to operating costs, IBM strategizes to plan and operate more sustainable buildings called cognitive buildings. Within developing sustainable energy usage, IBM works in implementing *more efficient, sustainable IT centers, in companies that store data*. Overall, IBM aids businesses with the transition towards more sustainable practices, involving building, electricity, resource management, data storage, and more. This company is making large strides to help reduce business levels of carbon dioxide emissions into the atmosphere.**

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Interface has a current plan called "Climate Take Back". It involves aiming for zero carbon emissions in production. The company uses a lot of recycled material and runs its plants on renewable energy. The company also "loves carbon", as it uses materials that take in or use waste carbon in their flooring, such as their first prototype of carbon-capturing title that leverages photosynthesis by using plant-derived carbon its material. It claims that all their floors are carbon neutral.

This [business strategy] is incredibly important for the future of the world, as the first step to reducing global emissions is finding substitutes for normal components of our lives which have smaller footprints. This having absolutely zero carbon footprint marks a turning point for manufacturing processes everywhere. The precedent has been set.

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Nextek Power Systems produces "Direct Coupling" power distribution systems. These systems are designed to centralize the energy sources of buildings, which directly reduces energy costs and simplifies the installation of electrical systems through reduced wiring and fewer conduits. The Direct Coupling name comes in part from how it uses direct current (DC) unlike other systems which partly use alternating current (AC); sticking to DC can be more efficient in actions such as battery backup power generation (which originally uses DC, so with Nextek's product the current doesn't have to be converted into AC and then back to DC again for distribution). In addition, it can determine when to pull from the grid or from solar power, helping to reduce energy costs, and it can introduce some automation like dimming the lights when necessary.

Nextek's efforts contribute toward averting climate catastrophe by reducing inefficiencies in power distribution systems. By doing this, not only will energy bills for homes and businesses that use its product decline, but the amount of energy they consume will also decline. This alleviates some of the pressure on the grid (along with introducing solar integration where applicable), reducing the carbon emissions from fossil fuel-based power plants.

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> **PAX Scientific is a company that creates more efficient fans for appliances, refrigerators, computers, and transportation. *Their website claims that fans use 22% of global electrical energy*. PAX's fans use less energy, are quieter, have a more controllable flow, and cost less to produce. *Their new product, a portable fan called Flair, uses 85% less electricity than conventional portable fans*. Replacing old fans with PAX's efficient technologies can cause a significant reduction in greenhouse gas emissions.**

Hard to believe the PAX estimate that 22% of the world's electricity is consumed by fans, even though this is what is stated on their website. At https://www.iea.org/futureofcooling, the International Energy Agency states:

> **the use of air conditioners and electric fans already accounts for about a fifth of the total electricity in buildings around the world – or 10% of all global electricity consumption.**

Nonetheless, 10% is a lot … and the improvement in fan efficiency that PAX has innovated is an important step in the right direction.

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AT 19, Q3a. Krupp & Horn are advocates of cap and trade, due to the successful implementation of cap and trade to solve what had been vexing air quality issues in the US. They also highlight two “more localized market failures” that need to be addressed, regardless (my words) of whether the driving market force is a carbon tax or cap and trade.

Name and briefly describe these two local market forces?

The first "localized market failure" is the consumer's lack of access to accurate product information. Without correct energy use data, it is impossible for consumers to make environmentally conscious decisions.

⇒ Amazing that so many consumers are apparently not influenced by energy star ratings on appliances.

The second market failure is "principal-agent problems". This occurs when the person spending money is not the same person as the person making energy efficiency standards. For example, my apartment rental agency will not install more efficient appliances because my roommates and I have to pay the utility bill anyway.

⇒ The principal-agent problem is endemic to tenant / landlord relatons, likely experienced in at least one form or fashion by all who rent.

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AT 19, Q3b. Write a few sentences summarizing why Krupp and Horn favor electric vehicles as well as the Vehicle-To-Grid (V2G) system.

Electric vehicles are becoming far more feasible due to big steps forward in the way of battery capacity. Additionally, the emissions produced by driving an electric car (indirect emissions from the power plant) are significantly less than those produced when driving a normal combustion engine car, even when the power comes from a non-renewable energy source.

Remarkably, the better efficiency of e-vehicles is true even if the electricity is generated at a coal power plant. A power plant is simply able to capture much more of the heat of combustion, and turn this into energy, than can be done using a conventional automobile engine.

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Ford reveals electric Mustang with 'stunning' acceleration

By Peter Valdes-Dapena, CNN Business

Updated 1:30 PM ET, Wed November 6, 2019

(CNN) – Ford unveiled a fully electric Mustang with over 900 horsepower at a car show in Las Vegas Wednesday. It's not for sale, but the customized Mustang is intended to gauge interest in a high-performance electric car, Ford said.

Later this month Ford (F) will unveil a "Mustang inspired" electric SUV that customers will be able to buy. The SUV, however, will likely be far less powerful than this show car, which Ford is calling the Mustang Lithium.

Ford didn't provide any exact performance figures for the Mustang Lithium, but described the car's acceleration as "stunning."

The Ford Mustang Lithium has two clear panels in the hood to allow a view of the parts underneath.

https://www.cnn.com/2019/11/06/success/ford-electric-mustang-trnd/index.html

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Plan to convert state's largest ferries to electric moves forward

WSF announced funding was secured to convert its three largest ferries, the Jumbo Mark IIs, to use hybrid-electric propulsion instead of diesel fuel.

Author: Hannah Everman
Published: 8:43 PM PDT October 22, 2019

Washington State Ferries is making waves with plans to convert its largest ferries to run on hybrid-electric battery power instead of diesel fuel.

Washington state was allocated $112.7 million as part of a federal Volkswagen settlement, in which Volkswagen violated policies of the Clean Air Act by installing illegal software to cheat emission tests on many of its diesel vehicles.

Under the settlement, the money can be used in projects to replace or repower eligible vehicles, vessels, and equipment with greener forms of power.

The Department of Ecology, which oversees investing the settlement funds, approved $35 million of that settlement to WSF to help convert the first of its three largest ferries into hybrid-electric propulsion operating vessels.

"Air pollution from diesel emissions is one of the most pressing public health threats facing Washington," said Ecology Director Maia Bellon. "Converting these ferries to hybrid propulsion will slash pollution in our state."

https://www.king5.com/article/news/local/washington-state-ferries-converting-to-electric-power/281-191657ee-4b04-4ffa-9b79-dd864cd1a82d

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AT 19, Q3b. Write a few sentences summarizing why Krupp and Horn favor electric vehicles as well as the Vehicle-To-Grid (V2G) system.

The V2G system ~~is also~~ [might in the future become] a huge breakthrough. With this system, car batteries would be hooked up to the grid when not being used and this would allow for filling in the gaps when renewable energy sources aren't producing as much energy (wind, solar, etc).

It would also allow for storage of excess energy ie solar on a sunny day. If implemented properly this system has the potential to solve nearly every problem associated with renewable energy sources.

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Modes News Trucking

EVs to the rescue: Lessons from a California blackout

"Electric cars are part of the solution, not the problem."

Linda Baker, Staff Writer • 3 weeks ago

When the lights went out in California last week, one resident used the power stored in his electric vehicle (EV) to keep his oxygen machine up and running. Reports of similar incidents around the state called attention to a vision of the future where people use their electric cars and trucks to power homes and businesses.

"If we cannot get power from the original source, we can use local generation," said Gil Tal, director of the Plug-in Hybrid & Electric Vehicle (PH&EV) Research Center at UC Davis. "The electric vehicle is one way to make the grid more reliable."

Opportunities to wrest energy from EVs will only increase as more electric cars and trucks come online. And as electricity stored in the vehicle batteries is fed back into the grid, EVs "could really be used as one of the main sources of power," Tal said.

https://www.freightwaves.com/news/lessons-from-a-california-blackout-in-the-near-future-well-be-using-evs-to-power-homes-and-businesses

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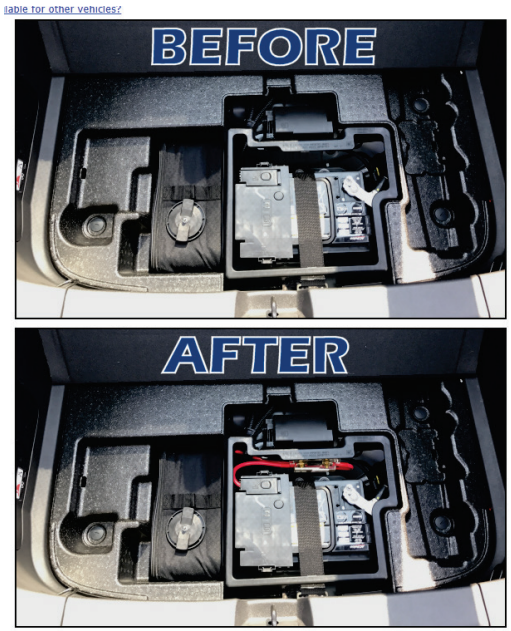
Emergency Power Wiring Kit (for 2016-2019 Chevrolet Volt)

EVEX-1000V/EVEX-1001V

Frequently Asked Questions | Brochure (PDF)

Item Number	Item Description	Purchase
EVEX-1000V	2016-2019 Chevrolet Volt 1000W Emergency Back-up Power Wiring Kit	$189.00 Sold Out
EVEX-1001V	2016-2019 Chevrolet Volt 1000W Emergency Back-up Power Wiring Kit, bundled with a 1000W pure sinewave inverter with 2000W surge.	$444.00 Sold Out
EVEX-1002V	2016-2019 Chevrolet Volt 1000W Emergency Back-up Power Wiring Kit, bundled with a 1500W pure sinewave inverter with 3000W surge.	$444.00 Sold Out
EVEX-1003V	2016-2019 Chevrolet Volt 1000W Emergency Back-up Power Wiring Kit, bundled with a 1500W pure sinewave inverter with 3000W surge and a remote switch.	$474.00 Sold Out



https://www.evextend.com/Gen2-Chevrolet-Volt-Kit.php

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AT 19, Q4. Provide a few words of some type of entrepreneurial enterprise that you believe can be important to reducing society's reliance on fossil fuels. In other words, if Krupp & Horn were to write an update to their book, what new efforts should they include in a 2019 update to Chapter 9.

1. Farm to Table movement aims to keep food local to reduce transportation emissions. This movement has seen increased popularity in recent years and is active in 30 states. In the average US household, food transportation emissions reach nearly 1 metric ton per year. This could be significantly reduced if a greater focus is put on local options.

2. Actualization of solar cells that:

- **a) are made out of complex materials that allow absorption of more wavelengths than silicon**
- **b) track the sun**
- **c) concentrate sunlight**

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3. LED lights, like those created by a company called Environmental Lights, use at least 75% less energy than conventional incandescent light bulbs. Lighting buildings takes a significant amount of electricity, so using more efficient lighting technology would help reduce greenhouse gas emissions.

According to energy.gov, "widespread use of LEDs could save about 348 TWh (compared to no LED use) of electricity by 2027" and "a total savings of more than $30 billion at today's electricity prices".

https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/led-lighting

4. Enterprises like GE Renewable Energy have power generating solutions from products use wind, hydroelectric, and solar power instead of fossil fuels, specifically GE Renewable Energy is one of the largest wind turbine suppliers around the world.

5. I believe that an important entrepreneurial enterprise to pursue in regards to reducing society's reliance on fossil fuels is the pursuit of *alternatives to traditional agriculture*, as it, combined with deforestation, makes up about 24% of the world's GHG emissions as of 2014 according to the IPCC.

6. Algae in biofuels and as a super-efficient converter and absorbant of CO2. T. Companies like Exxon and other such companies are looking into the use of algae in energy production, and as a biofuel it is particularly interesting.

7. The new development of bioplastics. These are materials made from plant materials that can be recycled by natural processes and thus don't require as much fossil fuel use in processing, Due to the worlds dependence of plastic, this innovation could serve to significant reduce both plastic pollution and fossil fuel usage.

8. Zero plastic grocery stores.

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9. Ideas in this field can range from as tame to reducing the air conditioning energy costs in a car (which consumes 5-10% of a car's energy source when left running), to ideas as radical as having traffic generate power through the wheels of cars pushing pistons in the road up and down to generate electricity. Although some of these aren't as viable as others.

10. Much more about Tesla. While the company was invented by the time the book was written and is mentioned in the book, Tesla has come a long way from where it was around 2007. It is mentioned as not yet released and only purchased by celebrities. By 2019, Tesla has released a few models of cars and is becoming more accessible to upper-middle class people. So there would need to be a mention of ~~that~~ [this company's success].

11. Alternatives to cars and shortening the distance people need to go for goods and services by making cities and areas more compact would reduce the need for people to drive everywhere.

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12. Air travel is a major source of carbon emissions and a huge factor in society's reliance on fossil fuels. Finding alternatives to flying could greatly reduce our oil usage. One example of this is the hyperloop, an underground train idea introduced by Elon Musk that would be faster and more efficient than flying. Further research and investment into this project could be an important step in reducing plane travel

13. Lab grown meat: if successful and scaled up properly then the majority of farmland can be reforested. This not only causes far fewer emissions since there will not be any methane emissions from cows but it also allows for the recreation of massive carbon sinks, including rainforests.

14. Animal feed from maggots:
https://www.vice.com/en_us/article/9agjx5/animal-feed-made-from-maggots-might-save-the-world
We all know that meat consumption uses up a lot of resources - you've got to feed the cows, clean the cows, ship the cows, slaughter the cows, all the works. Feeding the cows in and of itself burns up valuable farmland that could be used to feed, you know, actual people instead.

⇒ **Yuck !**

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15. Uber pool system for electric vehicles

16. Gamification (i.e., point or rewards) via social media for energy innovation

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Paris INDCs

Ryan Lau

7 November 2019

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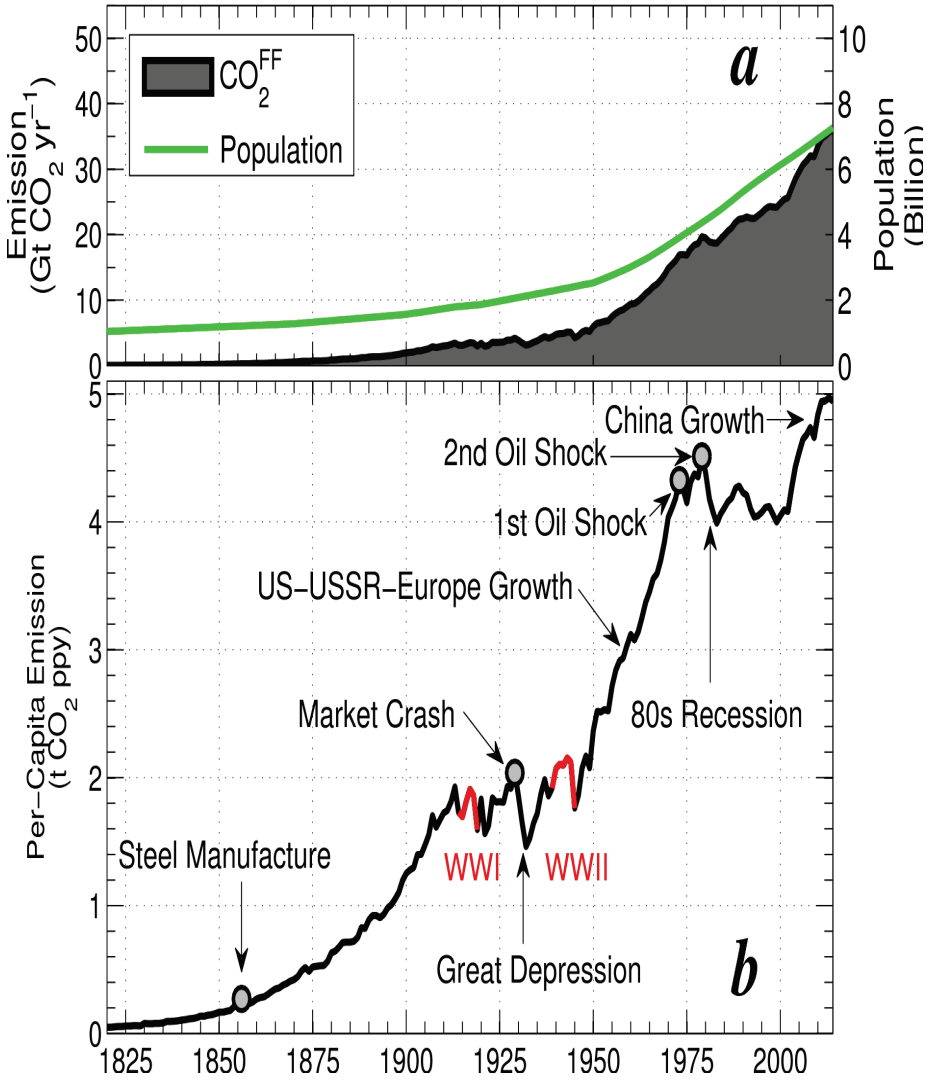

Figure 3.1 Total global emission of atmospheric CO_2

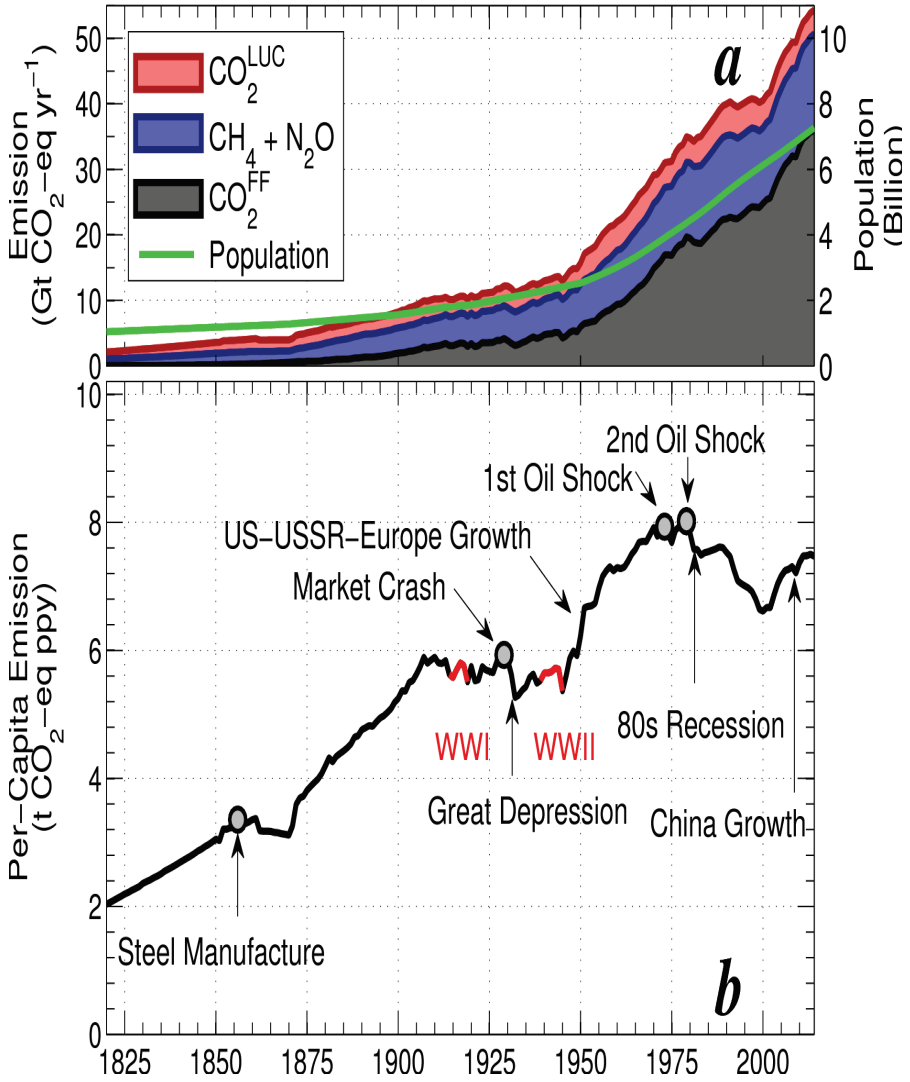

Figure 3.2 Total global emission of atmospheric CO_2, CH_4, and N_2O

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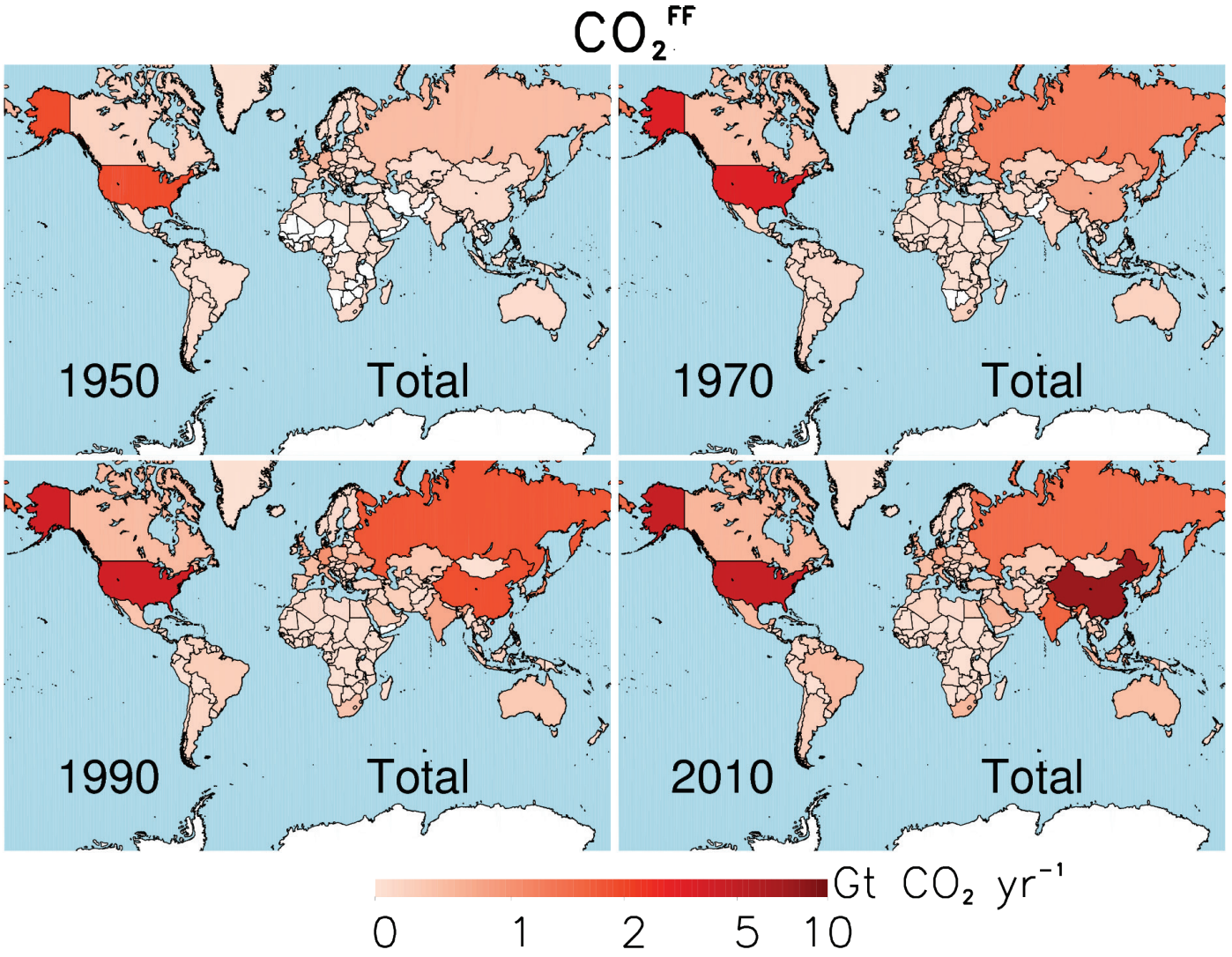

Figure 3.4 Atmospheric fossil fuel CO_2 emission maps, 1950–2010

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Kyoto Protocol

- Predecessor of Paris Climate Agreement
- Focused on reducing carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. All of these were known as Kyoto basket of GHGs
- World split into two categories: Annex I nations (basically the developed world in 1997), and everyone else
- Each nation in Annex I negotiated their own emission reduction target, 15 European countries agreed on one target (8%)
- Kyoto Protocol put no restrictions on Non-Annex I nations

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Australia	Greece	Norway
Austria	Hungary	Poland
Belarus	Iceland	Portugal
Belgium	Ireland	Romania
Bulgaria	Italy	Russia
Canada	Japan	Slovakia
Croatia	Latvia	Slovenia
Cyprus	Liechtenstein	Spain
Czech Republic	Lithuania	Sweden
Denmark	Luxembourg	Switzerland
Estonia	Malta	Turkey
Finland	Monaco	Ukraine
France	Netherlands	United Kingdom
Germany	New Zealand	United States

Table 3.1 Annex I nations of the Kyoto Protocol

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What is the Paris Climate Agreement

- Global agreement and commitment to fight the global climate crisis
- Goal: Looking to reduce cumulative emission of greenhouse gases so that the increase in global mean surface temperature is below °C and to pursue efforts to limit the temperature increase to °C above pre-industrial

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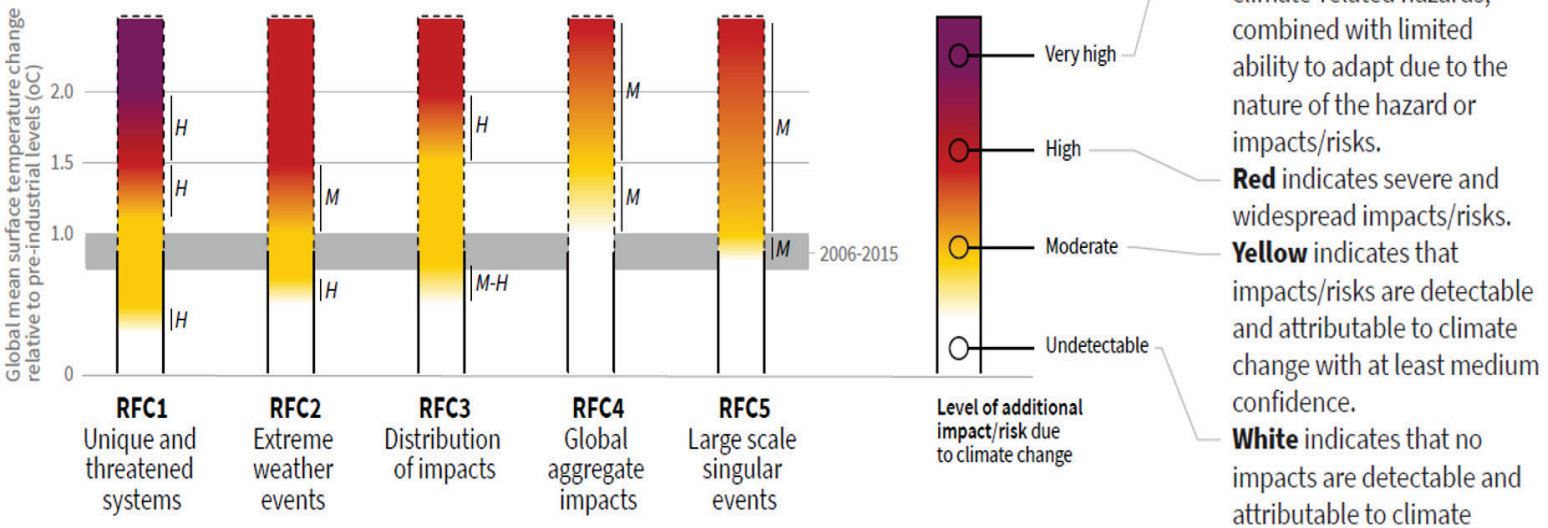
How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

Red indicates severe and widespread impacts/risks.

Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

White indicates that no impacts are detectable and attributable to climate change.

http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

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Paris Climate continued

- Consists of INDCs
- CO_2-equivalent emissions: Converting the amount of a particular gas to the equivalent amount of carbon dioxide. You can get it by multiplying the annual emissions of each compound by the global warming potential of that specific compound

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Table 1.1: Global warming potentials (GWPs)

GHG	IPCC (1995)	IPCC (2001)	IPCC (2007)	IPCC (2013)
100 Year Time Horizon				
CH_4	21	23	25	28, 34*
N_2O	310	296	298	265, 298*
20 Year Time Horizon				
CH_4	56	62	72	84, 86*
N_2O	280	275	289	264, 268*
*Allowing for carbon cycle feedback				

CO_2–equivalent emissions = $CO_2^{\text{Fossil Fuel}}$ emissions + $CO_2^{\text{Land Use Change}}$ emissions +
$28\times(CH_4$ emissions$)+ 265\times(N_2O$ emissions$)$

where 28 & 265 are the global warming potentials
of CH_4 & N_2O on a 100 year time horizon, respectively

and all of the book-keeping is ***conducted per unit mass***,
rather than per unit molecule.

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INDCs

- Intended Nationally Determined Contributions
- Non- binding

https://www.marketing91.com/bottom-up-marketing/

Conditional	Unconditional
Contingent on financial assistance and/or technology transfer. Mainly made by developing nations	Firm commitments. Mainly made by nations who are developed.

When it comes down to it, developed nations will face moral dilemmas when deciding whether to help developing nations reduce their GHG emissions.

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AT #1

Q1. What aspect of the difference between the Kyoto Protocol and the Paris Climate Agreement do you think will turn out to be most important moving forward in time, either for better (i.e., *helping the world avert climate catastrophe*) or worse (i.e., *preventing the world from averting climate catastrophe*)?

In your reply, please identify the difference and clearly state whether you think it will be for better or worse, with a brief explanation to support this view.

There is of course no right answer here ... *just looking for a thoughtful reply*

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2010			1990		
Nation	$CO_2^{EQ\text{-}IN}$	$pC^{EQ\text{-}IN}$	Nation	$CO_2^{EQ\text{-}IN}$	$pC^{EQ\text{-}IN}$
	10.65	7.9		5.75	22.8
	6.15	19.8		5.38	18.7
	2.87	2.3		3.83	3.30
	2.39	16.7		1.65	11.0
	2.11	8.7		1.48	1.7
	1.72	8.7		1.42	7.8
	1.13	8.9		1.20	15.2
	0.88	10.9		1.17	9.6
	0.85	24.8		0.78	13.6
	0.75	10.2		0.65	22.3
	0.66	5.6		0.53	9.37
	0.64	22.6		0.53	13.7
Sum, Top 12	30.79	7.82	Sum, Top 12	24.36	7.41
Global	49.19	7.37	Global	37.32	7.53

Table 3.2 Top Emitters, $CO_2^{FF} + CO_2^{LUC} + CH_4 + N_2O$

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AT #2

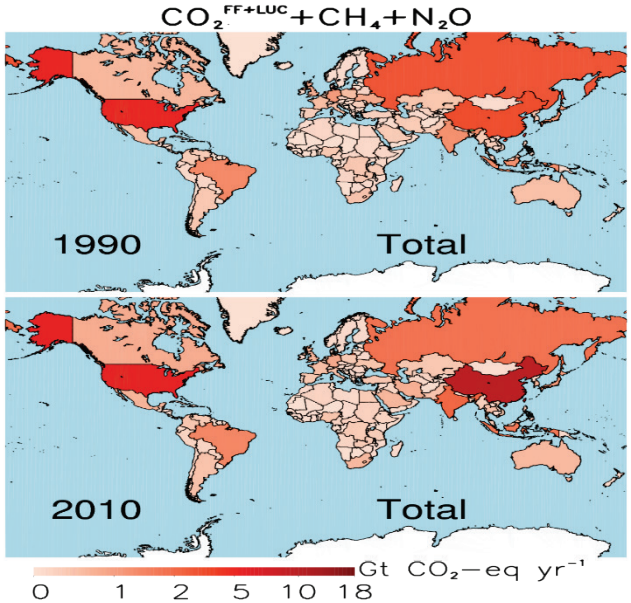
Q2. Fig. 3.6 shows maps of emissions of the 3 most important anthropogenic GHGs, CO_2, CH_4, and N_2O, expressed as CO_2-equivalent, which uses the global warming potentials of CH_4 and N_2O to relate emission of these gases to CO_2.

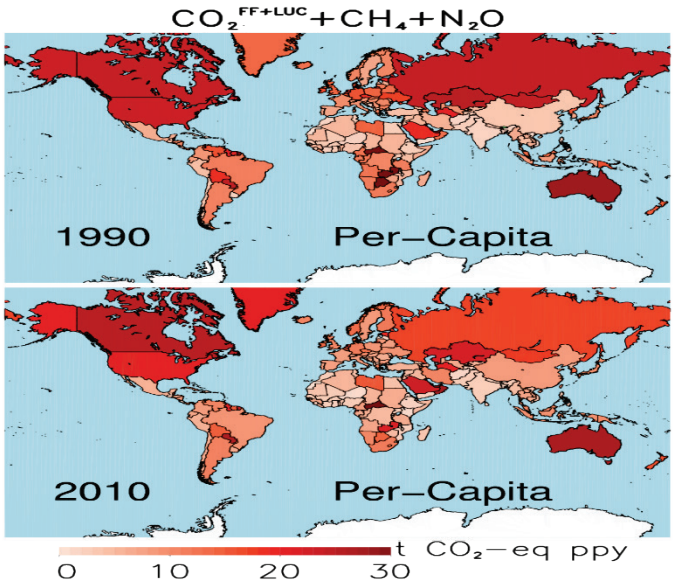
Figure 3.7 shows maps of the per-capita emission of CO_2, CH_4, and N_2O.

Both figures show data for 1990 (earliest possible date) and 2010.

a) State one aspect of these two figures you think will be vitally important to address, in order for the goal of the Paris Climate Agreement to be achieved

b) State one aspect of these two figures you find to be surprising, given your knowledge prior to reading this chapter.





Side Note from the reading: CO_2 Emissions consider two terms; Fossil Fuels (CO_2^{FF})and LUC (Land Use Change, CO_2^{LUC}), which is other words for deforestation

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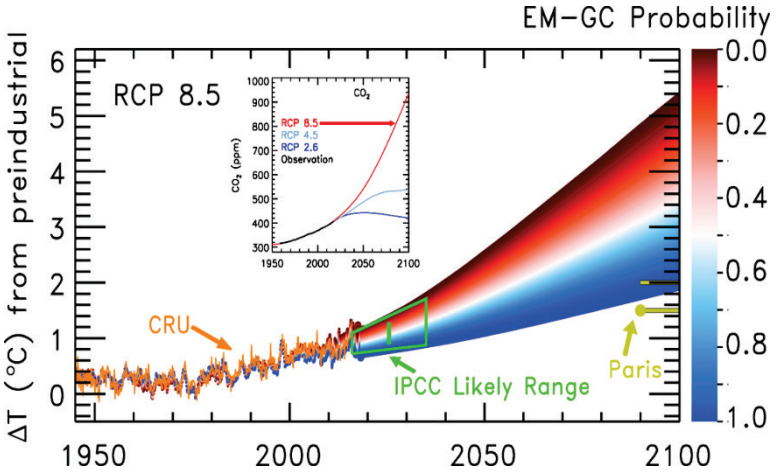
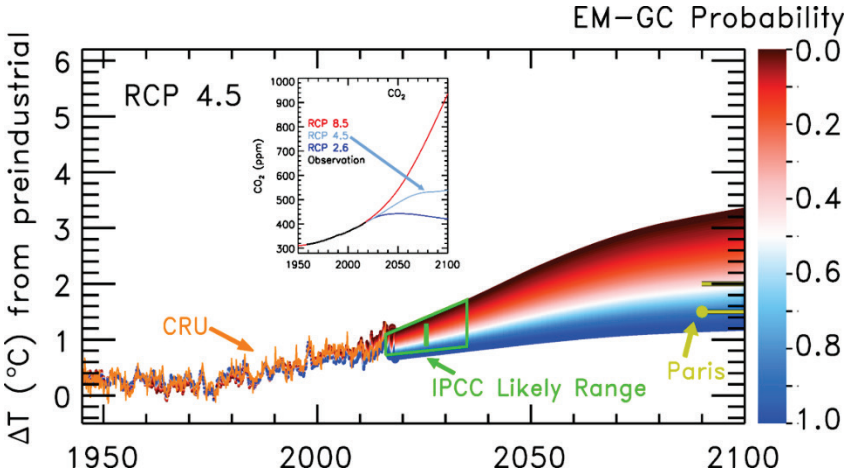
RCP 8.5



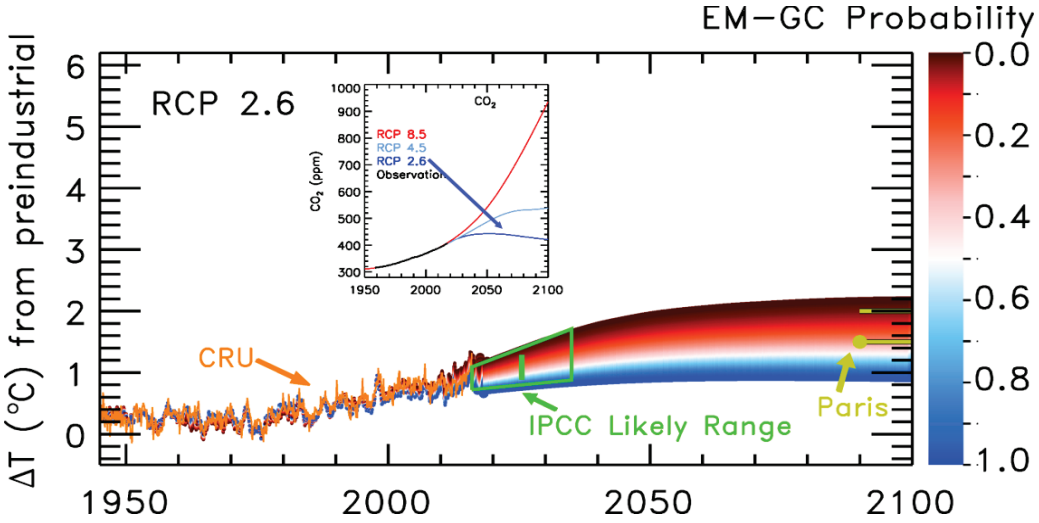
If GHGs follow RCP 8.5, **0%** chance rise GMST stays below **1.5°C** and **0.1%** chance stays below **2.0°C**

RCP 4.5



If GHGs follow RCP 4.5, **9%** chance rise GMST stays below **1.5°C** and **51%** chance stays below **2.0°C**

RCP 2.6



If GHGs follow RCP 2.6, **68%** chance rise GMST stays below **1.5°C** and **96%** chance stays below **2.0°C**

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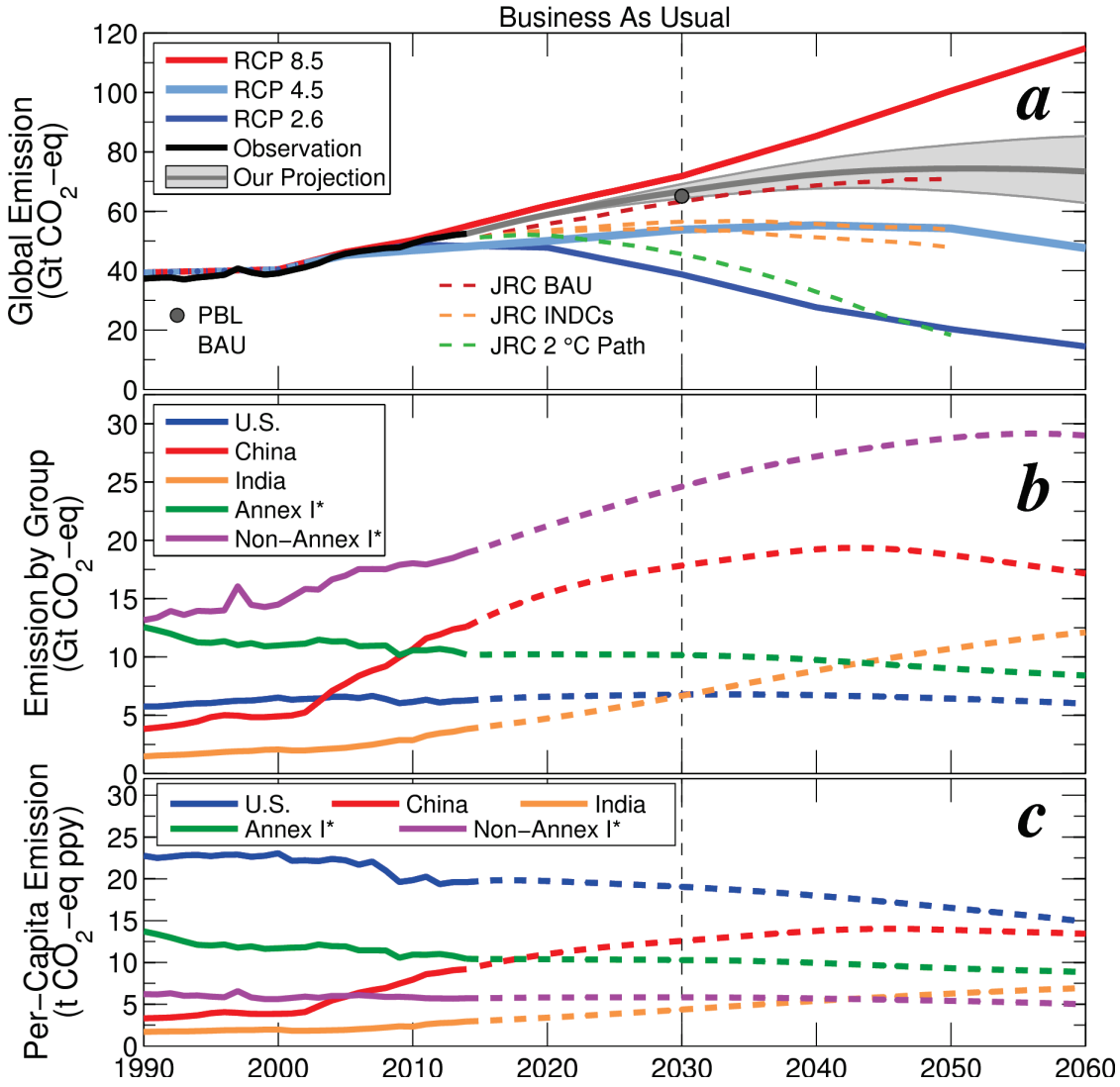

Figure 3.8 Future GHG projections, Business as Usual (BAU)

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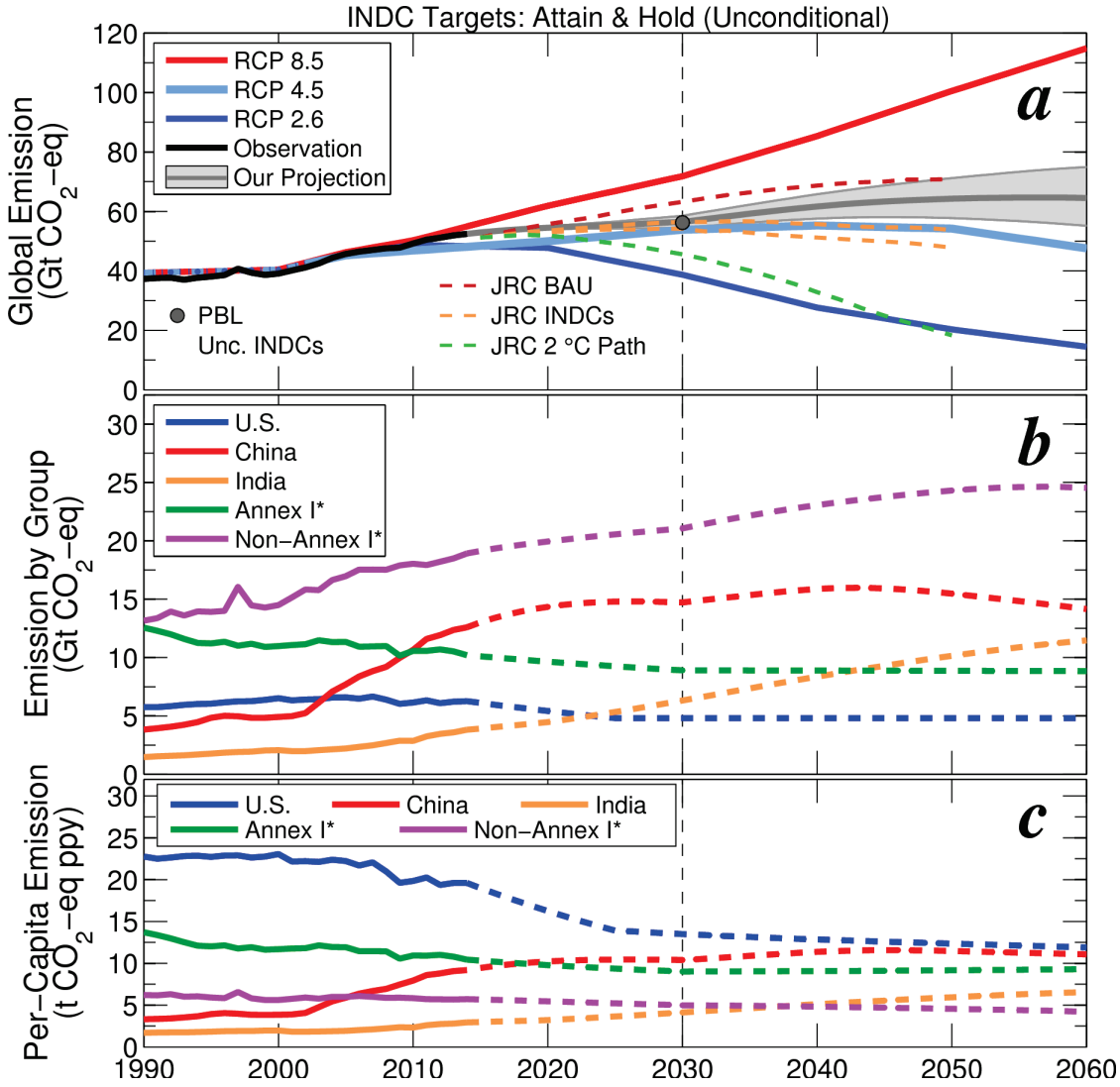

Figure 3.9 Future GHG projections, Paris Unconditional INDCs, Attain & Hold

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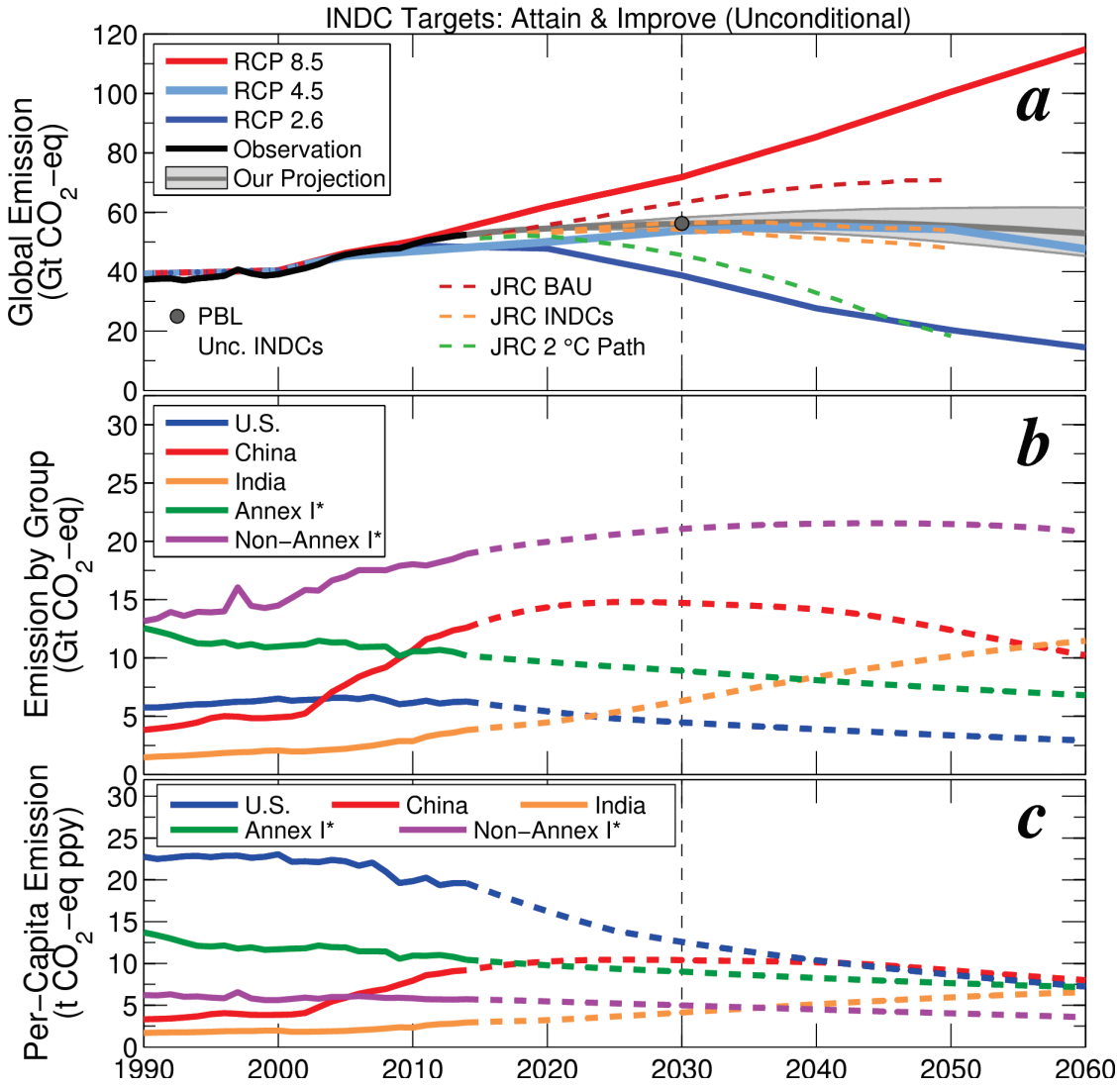

Figure 3.10 Future GHG projections, Paris Unconditional INDCs, Attain & Improve

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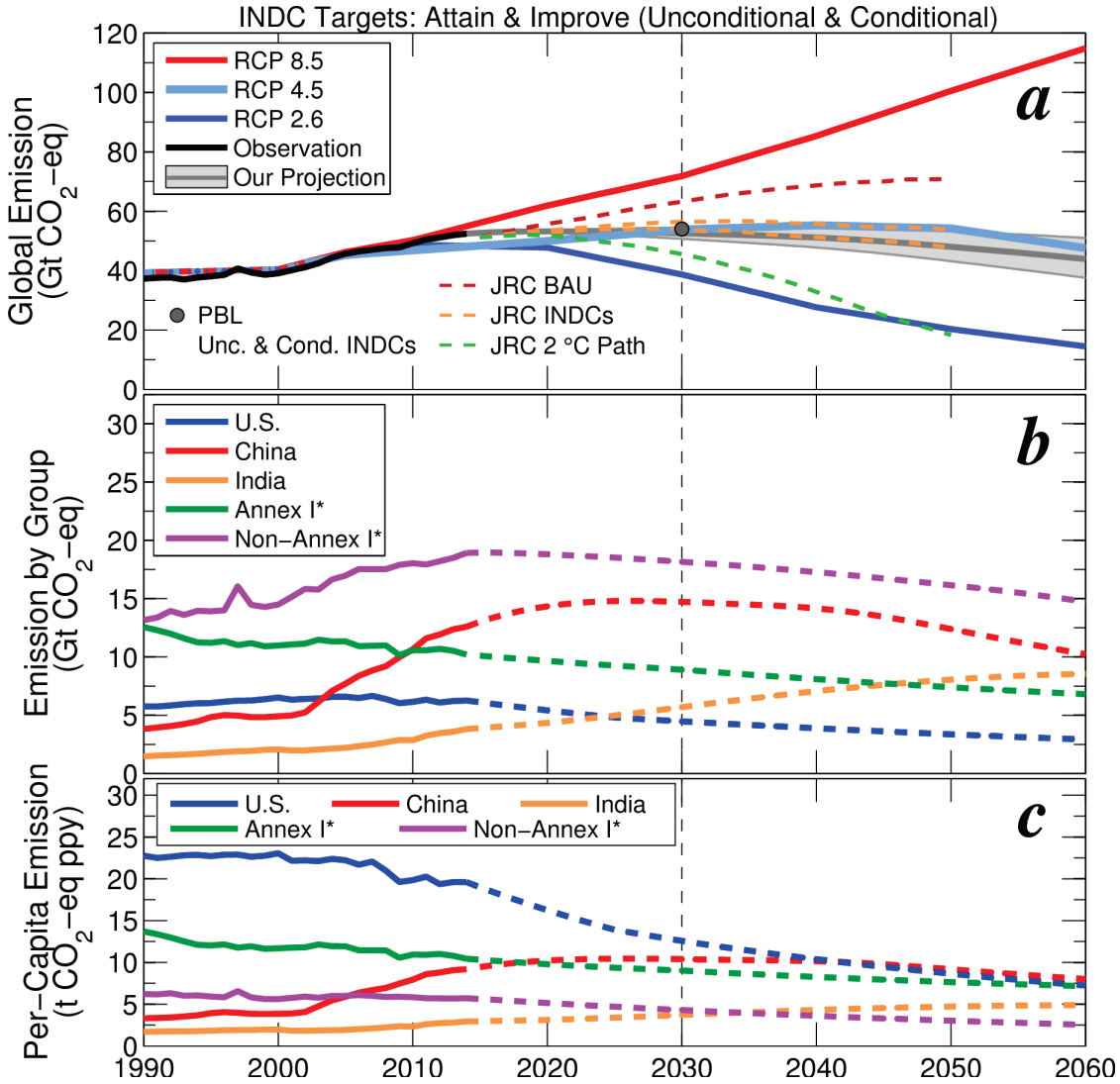

Figure 3.11 Future GHG projections, Paris Unconditional & Conditional INDCs, Attain & Improve

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AT #3

Q3. Section 3.3 presents an analysis of the Paris INDCs (Intended Nationally Determined Contributions) to reduce the emission of GHGs. Summarize the primary message of this section in a few sentences.

- Points of Emphasis
  - These pledges for reductions only extend out to 2030. We need to make sure that they are prolonged further than that
  - We MUST follow both the Conditional and Unconditional INDC's AND continue to increase the reduction of carbon emissions in order to have a good shot at getting below RCP 4.5

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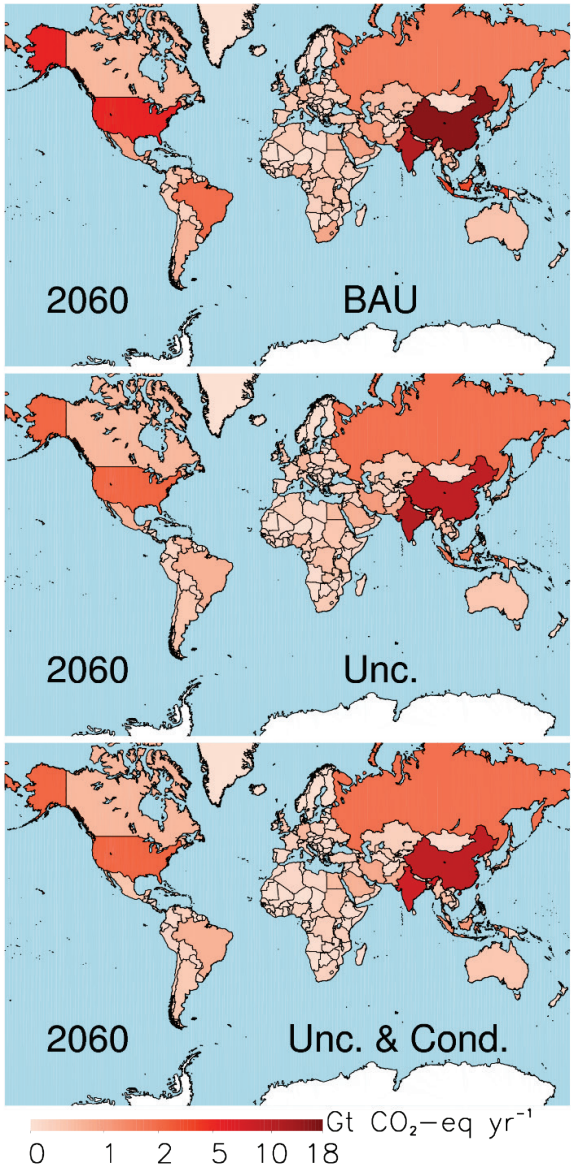

Figure 3.13 Atmospheric GHG emission maps, Paris INDCs, 2060

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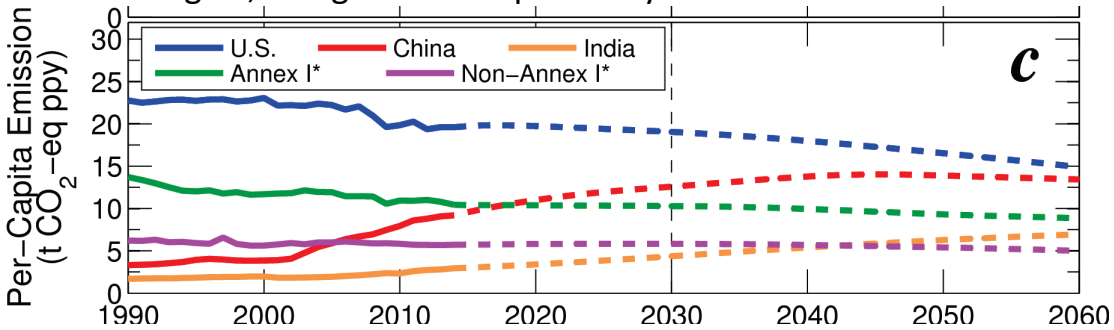
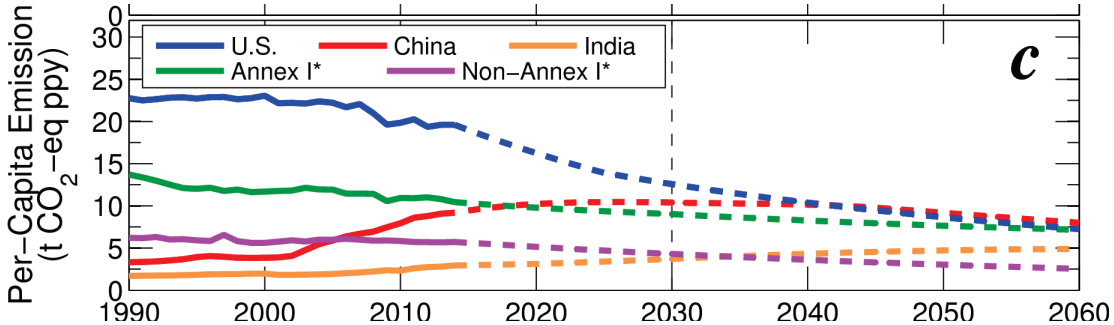
AT #4

Q4. Based upon your analysis of panel c of Fig 3.8 (Business As Usual) and Fig 3.11 (Attain and Improve), what nation (or group of nations) will have to make the largest fractional improvement in its per-capita emission of GHGs by year 2060, for the goal of the Paris Climate Agreement to be achieved?

Please also state whether or not you think it is realistic for this country (or group of countries) to achieve this goal, along with an explanatory sentence or two.





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Paris INDCs

Ryan Lau

7 November 2019

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Paris INDCs: Last Word

Ross J. Salawitch

7 November 2019

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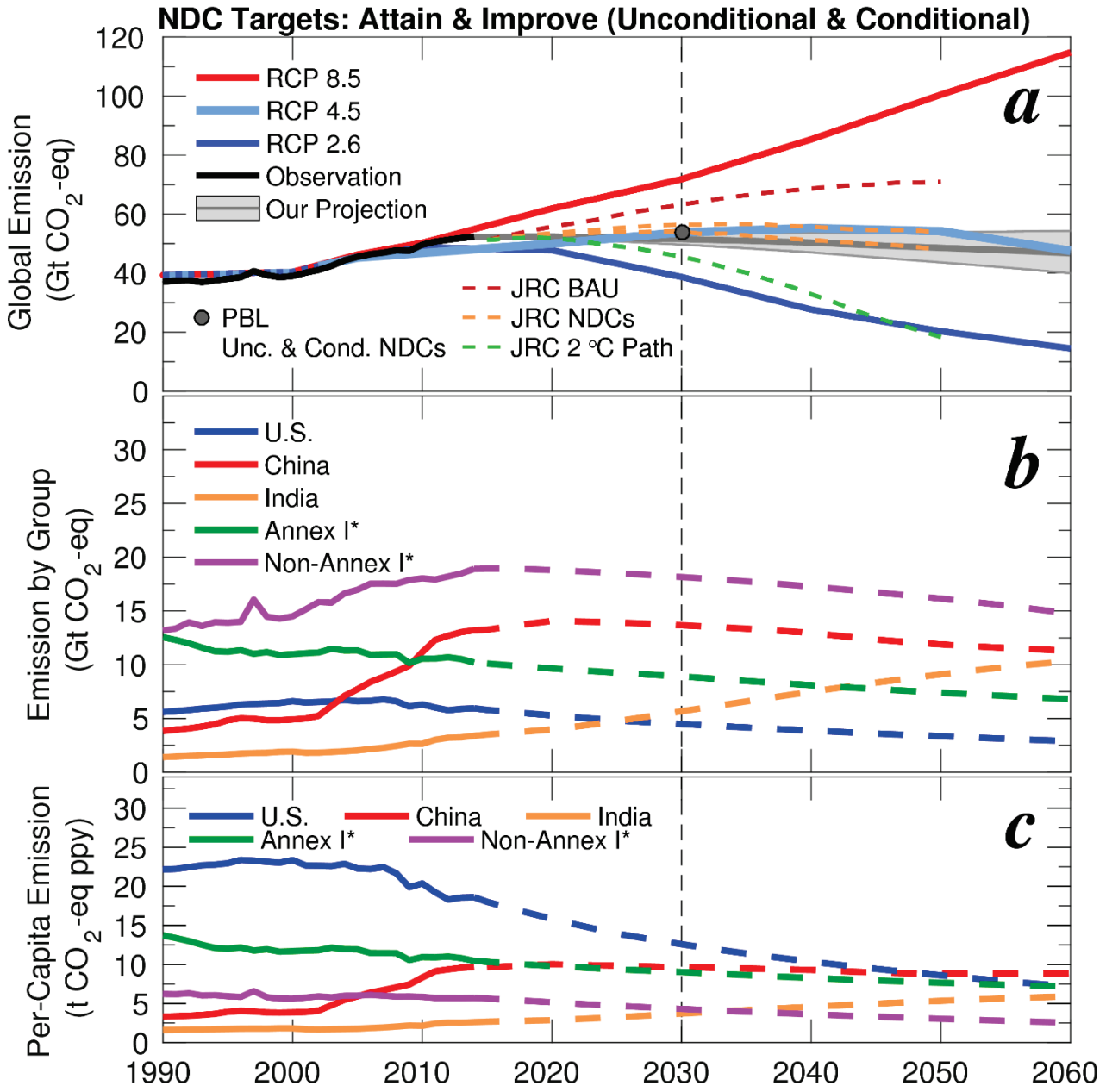

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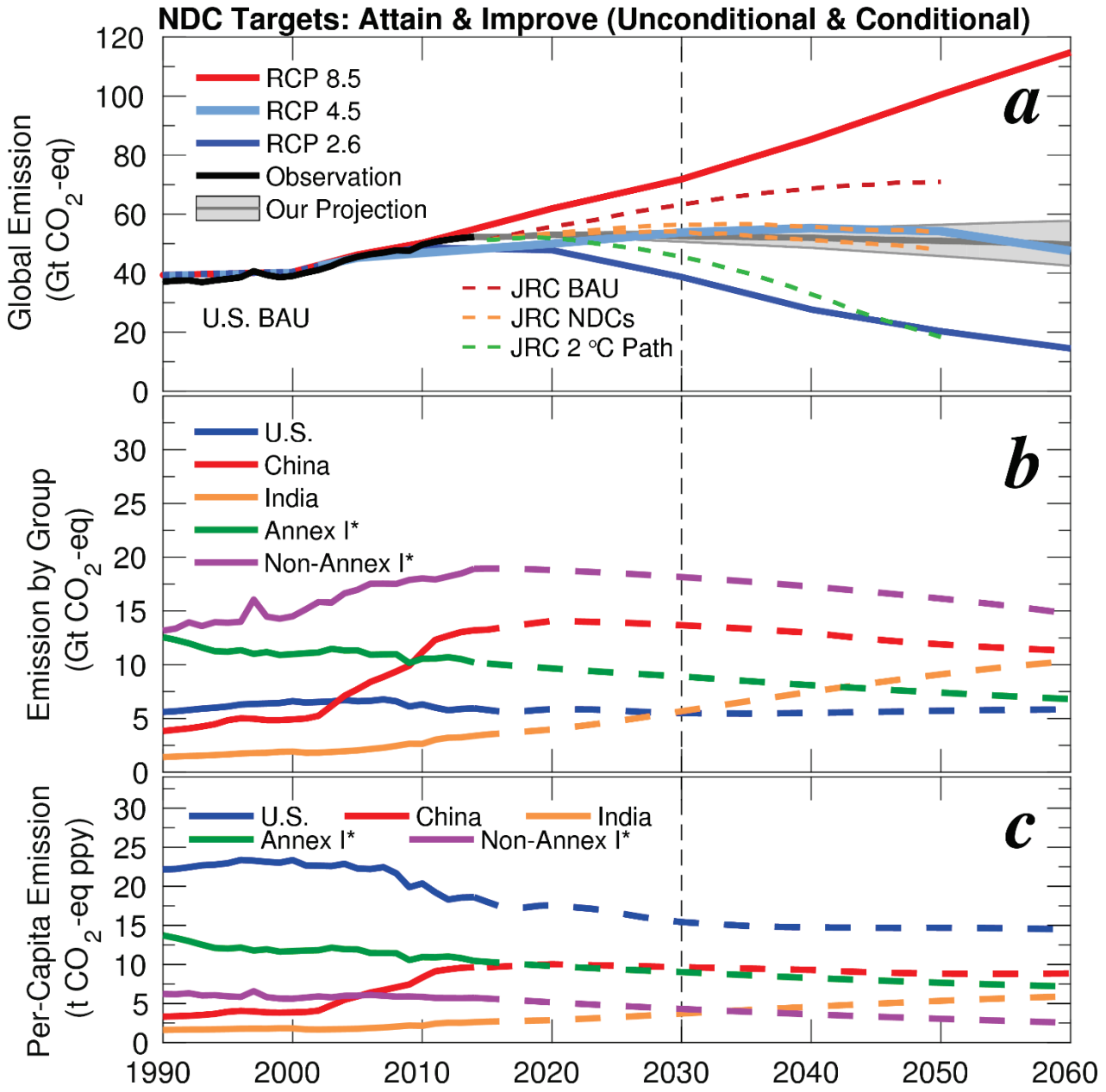

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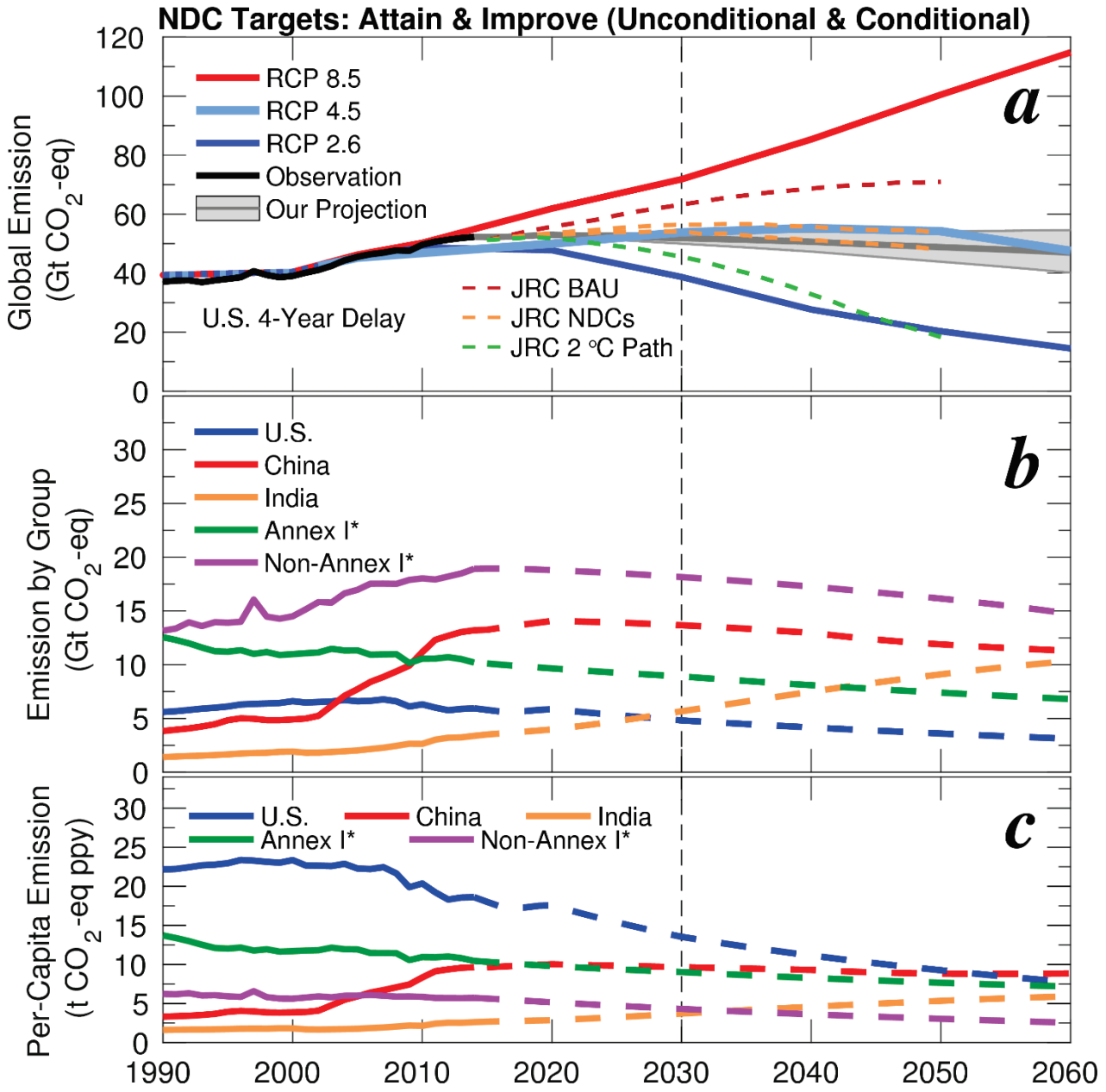

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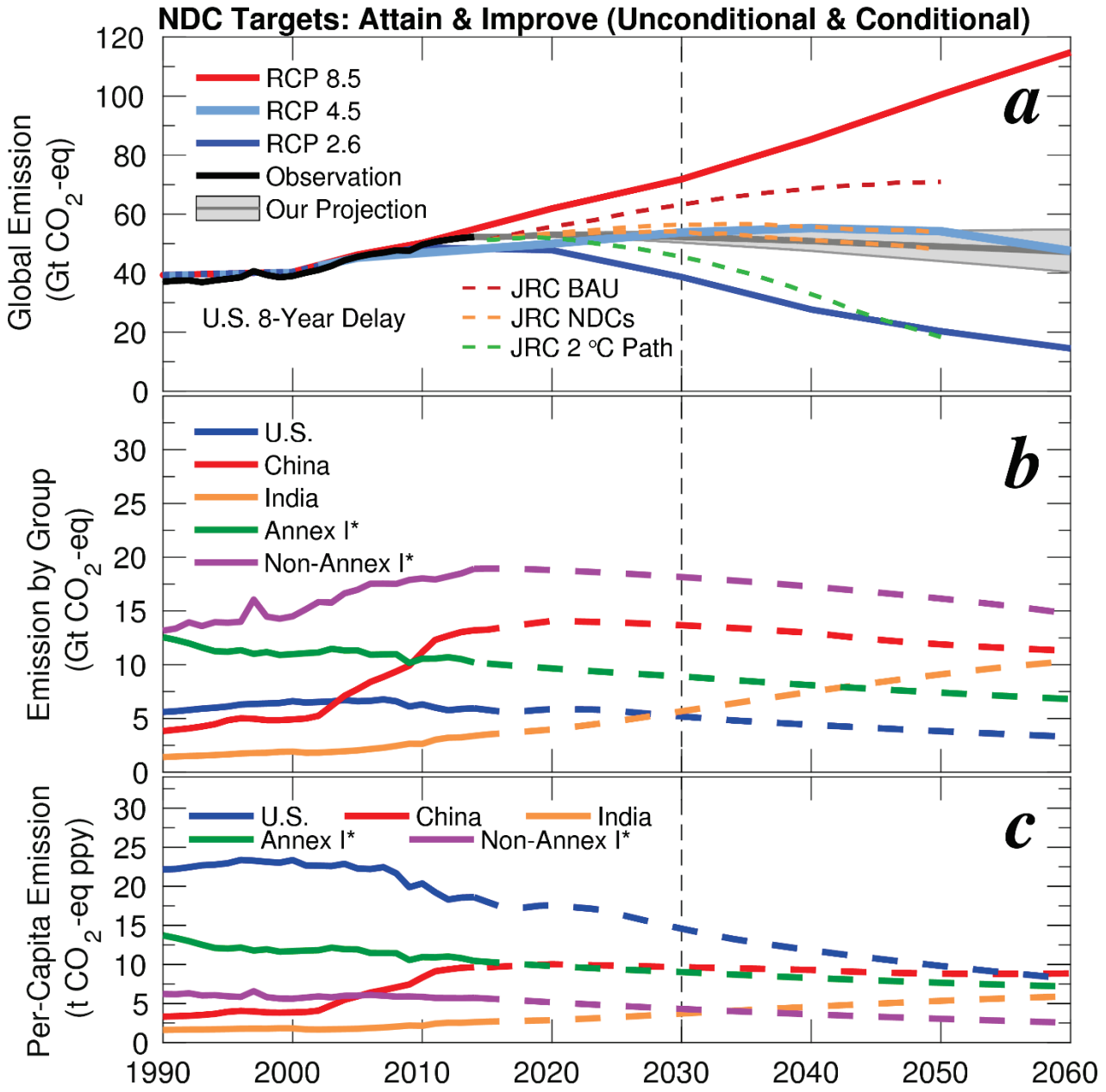

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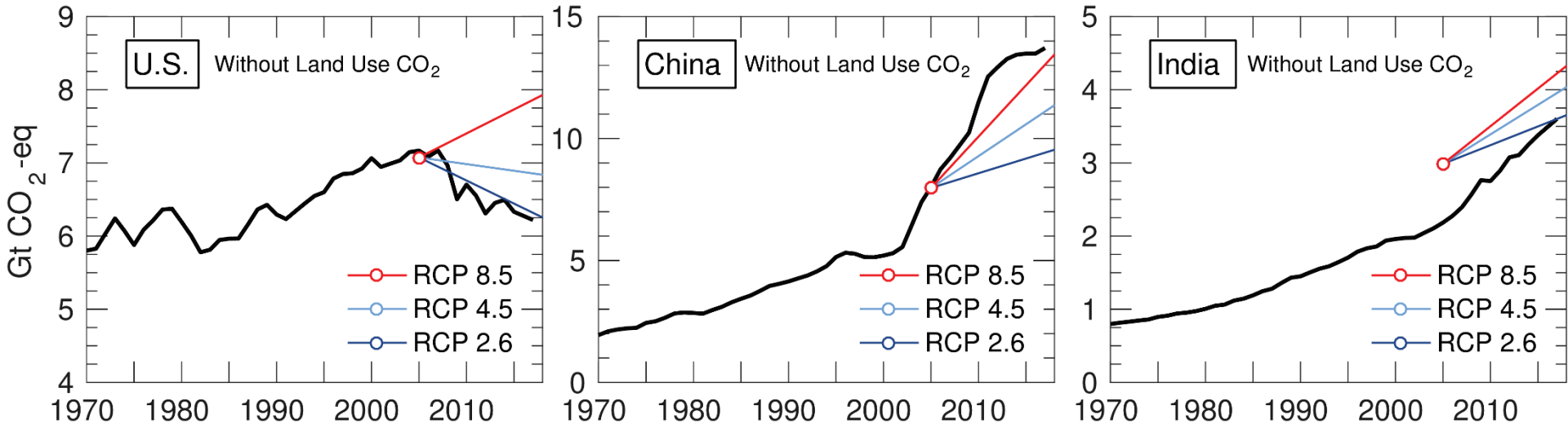
Another Look at the Top Three Emitters, Relative to RCP Projection for Each Country



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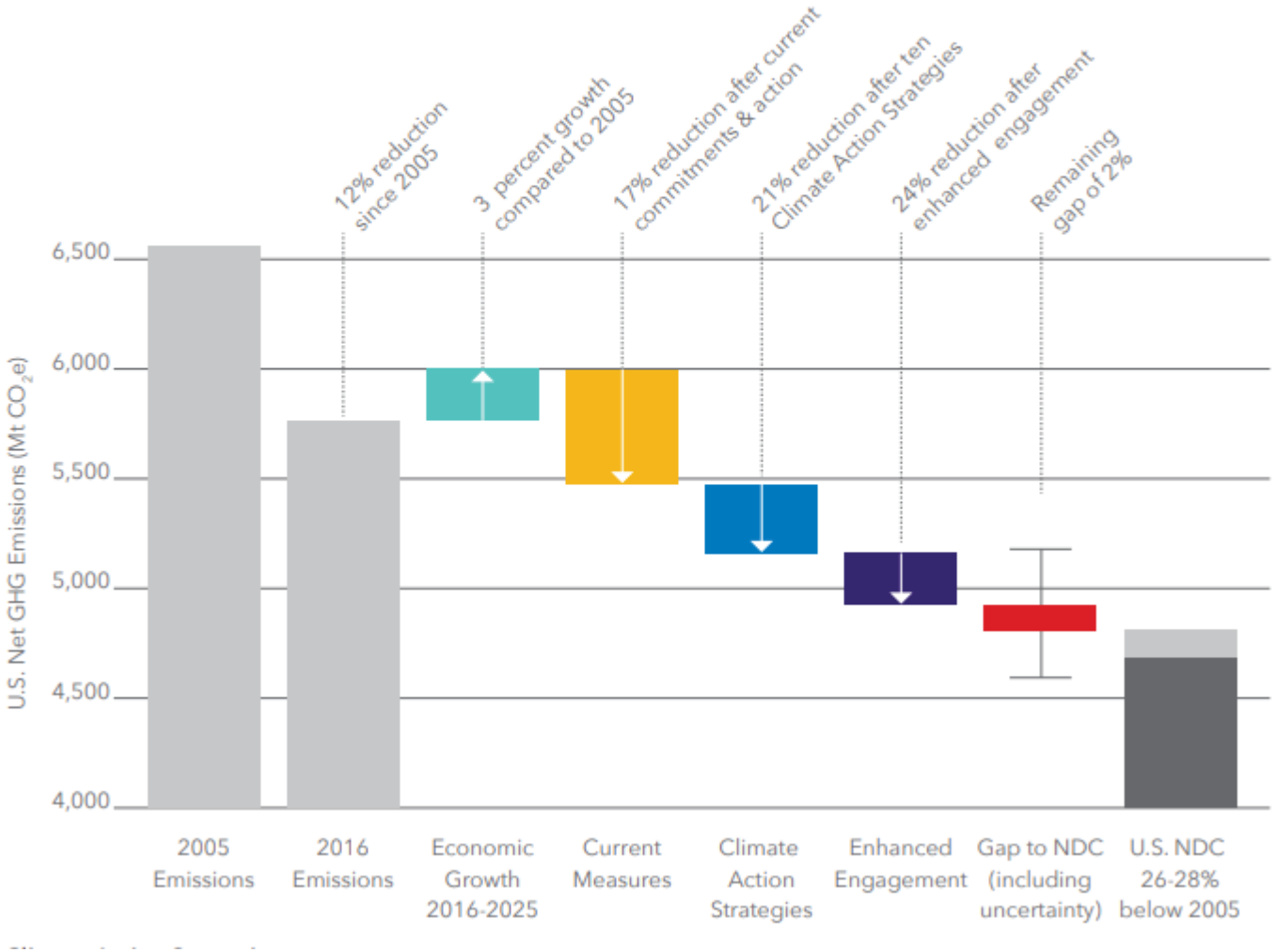
America's Pledge

Figure ES-1: State, City, and Business Actions can Significantly Cut U.S. Emissions in 2025 and Accelerate Momentum for Long-term Decarbonization



https://www.bbhub.io/dotorg/sites/28/2018/09/Fulfilling-Americas-Pledge_Executive-Summary_2018.pdf

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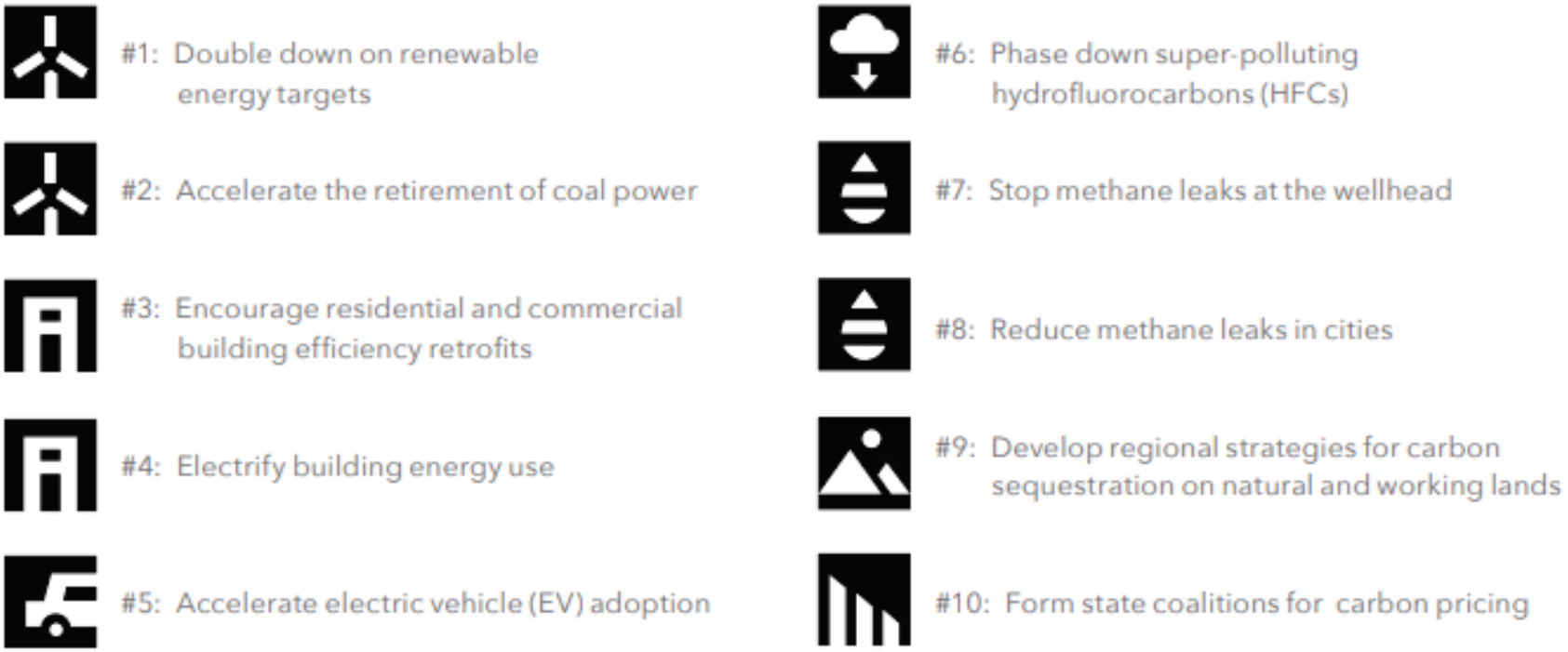
America's Pledge



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