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

Discussion #21: Implementation

Ross Salawitch

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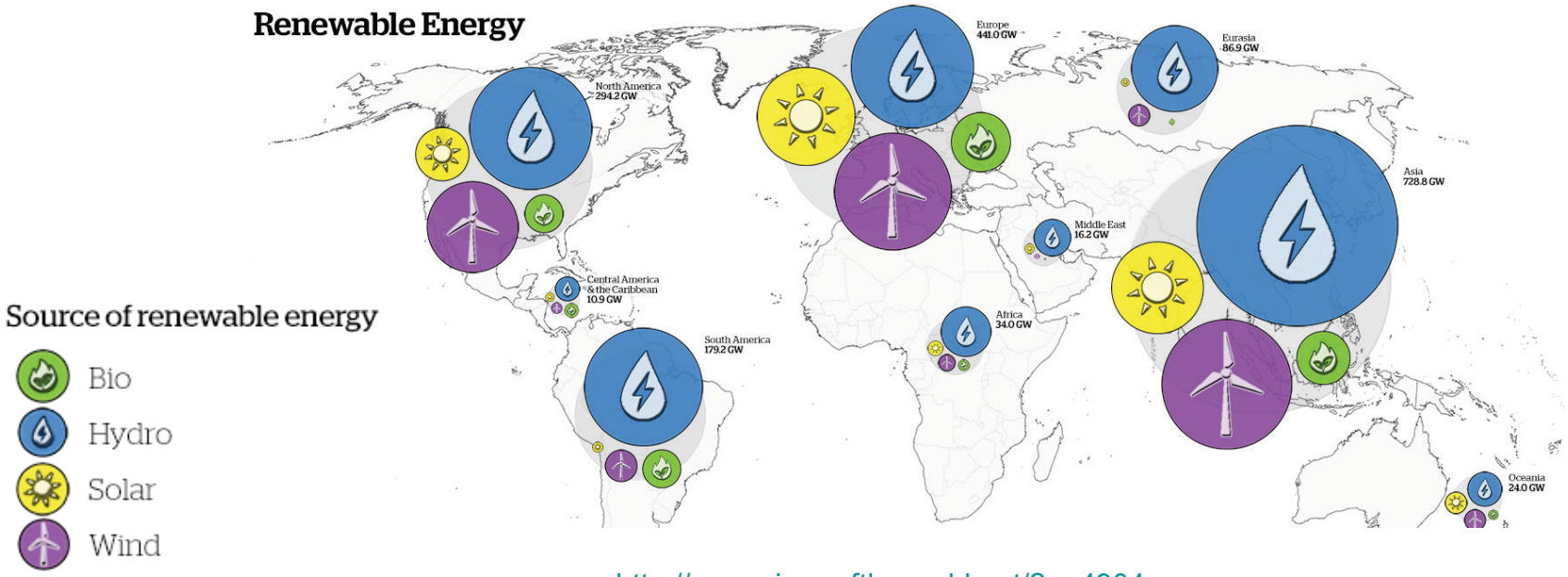
Class Web Site: http://www.atmos.umd.edu/~rjs/class/honr229L

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



http://www.viewsoftheworld.net/?p=4904

12 November 2019

Class Logistics

- Paper due on Thursday, 14 Nov
  - Will except papers without penalty until Sunday, 17 Nov at 11:59 pm
- Papers received after Sunday, 17 Nov at 11:59 pm will incur the following late penalty:
  - Half a letter grade until Tues, 19 Nov at 11:59 pm
  - Full letter grade until Thurs, 23 Nov at 11:59 pm
  - No grade (i.e., "0" into ELMS) if not received by Fri, 22 Nov at 5 pm
- Please email paper to me as a Word file

  Writing tips:

  One thought per paragraph

  Begin paragraphs with simple declarative sentences

  Strive to not use "This" or "It" as nouns

  Try to not repeat the same word twice in close succession, either in a single sentence or nearby sentences, because this becomes a distraction to the discerning reader

  Be kind to your reader: economy of words is the mark of a great writer

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AT 20, 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*)?

The most important difference between the Paris Climate Agreement and the Kyoto Protocol is that the Paris Climate Agreement has a set goal for limiting global warming. I feel that the Kyoto Protocol was a little too flexible in its goal of reducing global warming. While it was an important agreement that paved the way for future talks on GHG reductions, it could have been a little stricter to make sure that countries had a set a target. I think this is especially important for countries like the United States that sign onto agreements that have loose commitment and are not held accountable for their significant impact on climate change.

Having a temperature limit spreads the responsibility, among the world's nations, whereas having individual GHG limits does place the onus on each nation to do their part in a more direct manner. One positive of the Paris Agreement approach is we'll know, positively definitely, whether the Agreement does (hopefully!) or does not achieve its goal. An important caveat is the present existence of quite a lot of uncertainty involving how much future emissions of CO_2 can occur, while keeping the future rise of global temperature below either 1.5° or 2°C (relative to pre-industrial).

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I think the most important difference for the better between the Kyoto Protocol and the Paris Climate Agreement is the incorporation of developing countries and their GHG emissions. In the Kyoto Protocol, the task of helping developing countries with their GHG emissions was left in the hands of developed countries with little guidance and no limits on GHG emissions for those developing countries. Under the Paris Climate Agreement, developing countries have had to submit emissions goals, but they are allowed to be conditional goals that are contingent on them receiving necessary help from the developed world. I think this is a major difference between the two agreements for the better as the developing nations are now a part of the emissions goals and they have the opportunity to clearly lie out for themselves what help they need from the developing world to meet these goals.

Ironically, given the current situation with the Federal Government of the U.S., it seems that China (which had been considered to be a developing nation in 1997, when the Kyoto Protocol was negotiated) is now leading the way in terms of entrepreneurial opportunities in renewable energy:

https://www.forbes.com/sites/dominicdudley/2019/01/11/china-renewable-energy-superpower/#6c68521b745a

China Is Set To Become The World's Renewable Energy Superpower, According To New Report

"No country has put itself in a better position to become the world's renewable energy superpower than China," says the report, which was issued by the Global Commission on the Geopolitics of Energy Transformation – a group chaired by a former president of Iceland, Olafur Grimsson.

One of the key factors driving these changes is that, unlike traditional fossil fuels, renewable energy sources are widely available around the world. Whether it is solar or wind power, tidal energy or hydroelectric plants, most countries have the potential to develop some clean energy themselves. This means that many countries which currently have to import most of their energy will in the future be able to generate their own power – helping to improve their trade balance and reducing their vulnerability to volatile prices.

China also has a clear lead in terms of the underlying technology, with well over 150,000 renewable energy patents as of 2016, 29% of the global total. The next closest country is the U.S., which had a little over 100,000 patents, with Japan and the E.U. having closer to 75,000 patents each.

https://www.forbes.com/sites/dominicdudley/2019/01/11/china-renewable-energy-superpower/#6c68521b745a

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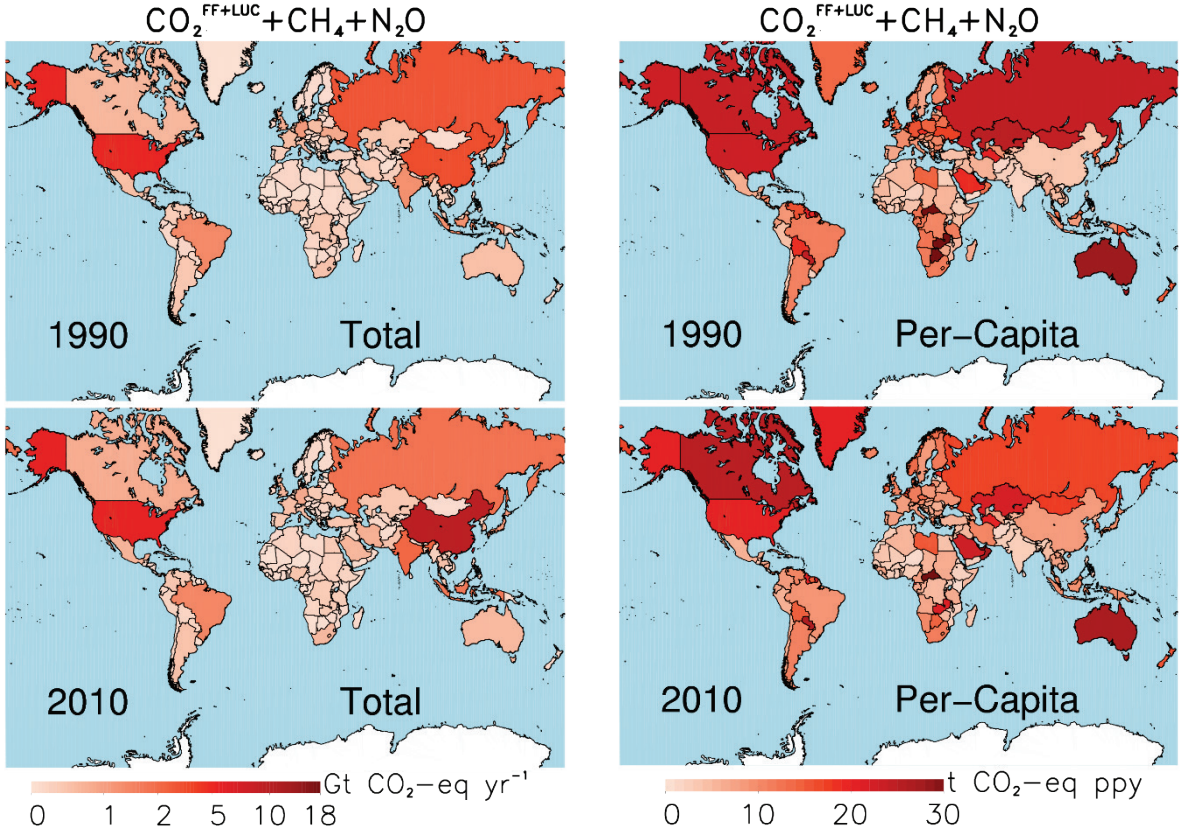
AT 20, Q2.

Figure 3.6 shows maps of emissions of the three most important anthropogenic GHGs, CO_2, CH_4, and N_2O, expressed in units of CO_2-equivalent (i.e., global warming potentials of CH_4 and N_2O are used to relate emission of these gases to those of CO_2). Figure 3.7 shows maps of the per-capita emission of GHGs. Both figures show data for 1990 (earliest possible date) and 2010.



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

I think the most vital aspect that needs to be addressed is per capita emissions … in order to reach the goal of the Paris Climate Agreement, there needs to be a worldwide initiative to decrease per capita emissions, as every little thing adds up.

Some have written the only equitable way forward is for all nations to aspire to the *same* per-capita emission of carbon, a policy termed contraction and convergence, as explained in this paper: https://iopscience.iop.org/article/10.1088/1748-9326/10/7/075004

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

As previously discussed in class, I think it will be vitally important that large, developing nations like India are allowed to develop, but that the developed nations help them to develop in a way that will help meet the goals of the Paris Climate Agreement. Figure 3.6 shows that India is emitting a little bit more in 2010 than 1990, but there has not been a major increase yet. With one of the largest populations in the world, if India ever emitted at a per capita rate similar to the United States, the result would be catastrophic. However, it would not be fair to complete stifle India and not allow them to develop. Thus, it is important for the goals of the Paris Climate Agreement that developed countries help countries like India to develop in ways that allow for their standard of living to be in line with the developed countries, but such that their GHG emissions ideally don't reach the same levels as some of the developed countries like the United States.

This comment resonates deeply with the movie we watched last night and is a good foreshadowing of our class project (to be described on Thursday).

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Attendance of class on Thursday is "mandatory", as we will begin work on our project. Any unexcused absence from class, from Thurs onwards, will "count against" the discussion and class participation component (10%) of your grade.

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

I was surprised at Australia's very high per-capita emissions

Australia's per-capita emissions are so high due to their reliance on coal for electricity, plus the small population relative to the huge size of the country, leading to large transportation emissions.

This website:

https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Completed_inquiries/1999-02/gobalwarm/report/c04

details emissions from Australia.

This article:

https://www.theguardian.com/business/grogonomics/2018/jan/09/australias-emissions-are-rising-its-time-for-this-government-to-quick-pretending

shows how far off Australia is from reaching the goal of their NDC.

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

I found it very surprising that some African countries had a huge per capita emission rate in 1990 that were even higher than that of developed countries. Additionally, I found it interesting that by 2010, those high per capita emissions were significantly lowered.

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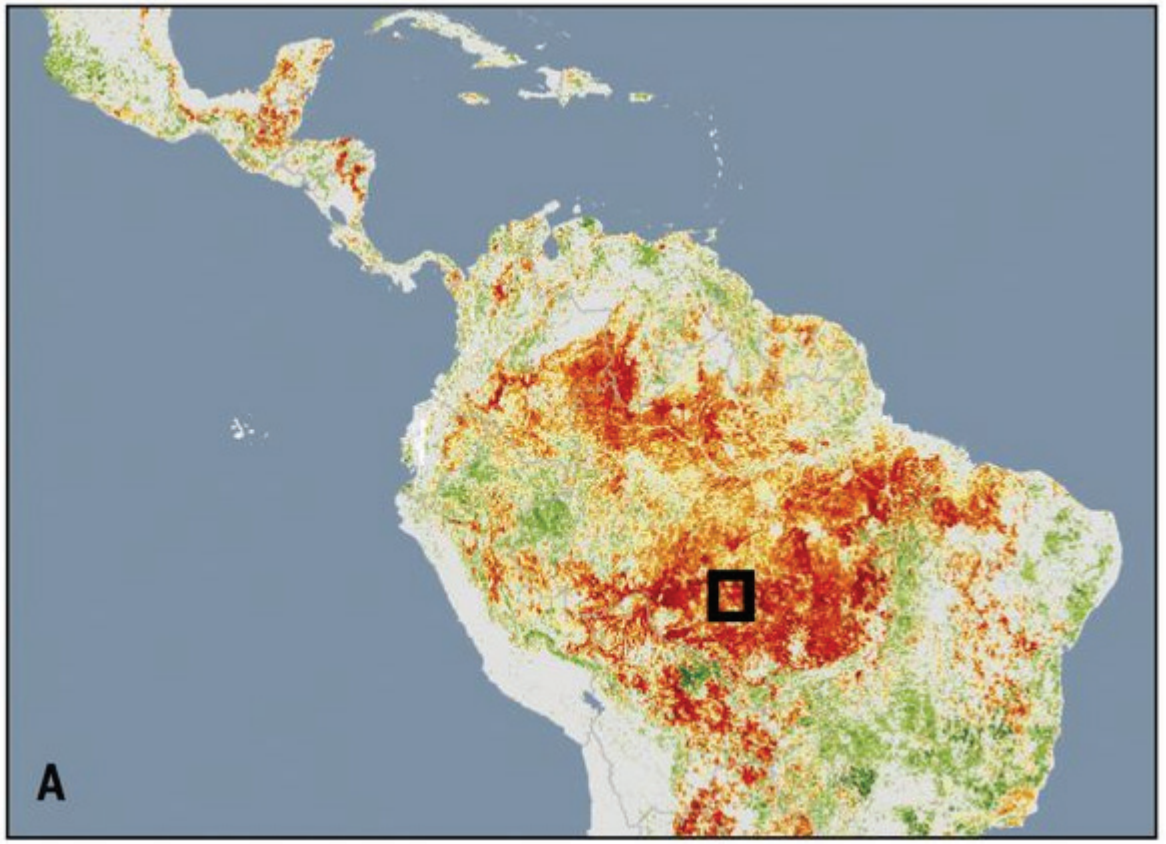

http://science.sciencemag.org/content/358/6360/230.full

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AT 20, 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.

This analysis provides three projections: Business As Usual, Attain and Hold (Unconditional), and Attain and Improve. A conclusion to draw from these results are that if nations were to follow their INDCs and honor that commitment, global emissions will be well under RCP 4.5 regardless of population. *Countries must not only meet their goals in 2030, but also continue to make improvements and reduce emissions even further*.

Indeed, the key message of Section 3.3 is the importance of the world continuing to improve the carbon efficiencies of our economies beyond year 2030, the terminal point of many of the INDCs.

This is especially important for the U.S., which has mainly relied on the transition from coal to natural gas to achieve the current reductions in GHG emissions (we get about twice as much energy, per CO_2 molecule released to the atmosphere, from the combustion of natural gas compared to the combustion of coal). Sadly, we're likely going to be "stuck" with these natural gas plants for years after 2030.

Most countries, including the U.S., do not currently have a plan in place to continue to reduce the emission of GHGs after year 2030 (or thereabout). In other words, long-term planning is a key component of achieving the goal of the Paris Climate Agreement, and this type of planning is not currently happening in much of the world.

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Long-term planning for achieving the Paris Climate Agreement is the gist of your class project.

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AT 20, 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.

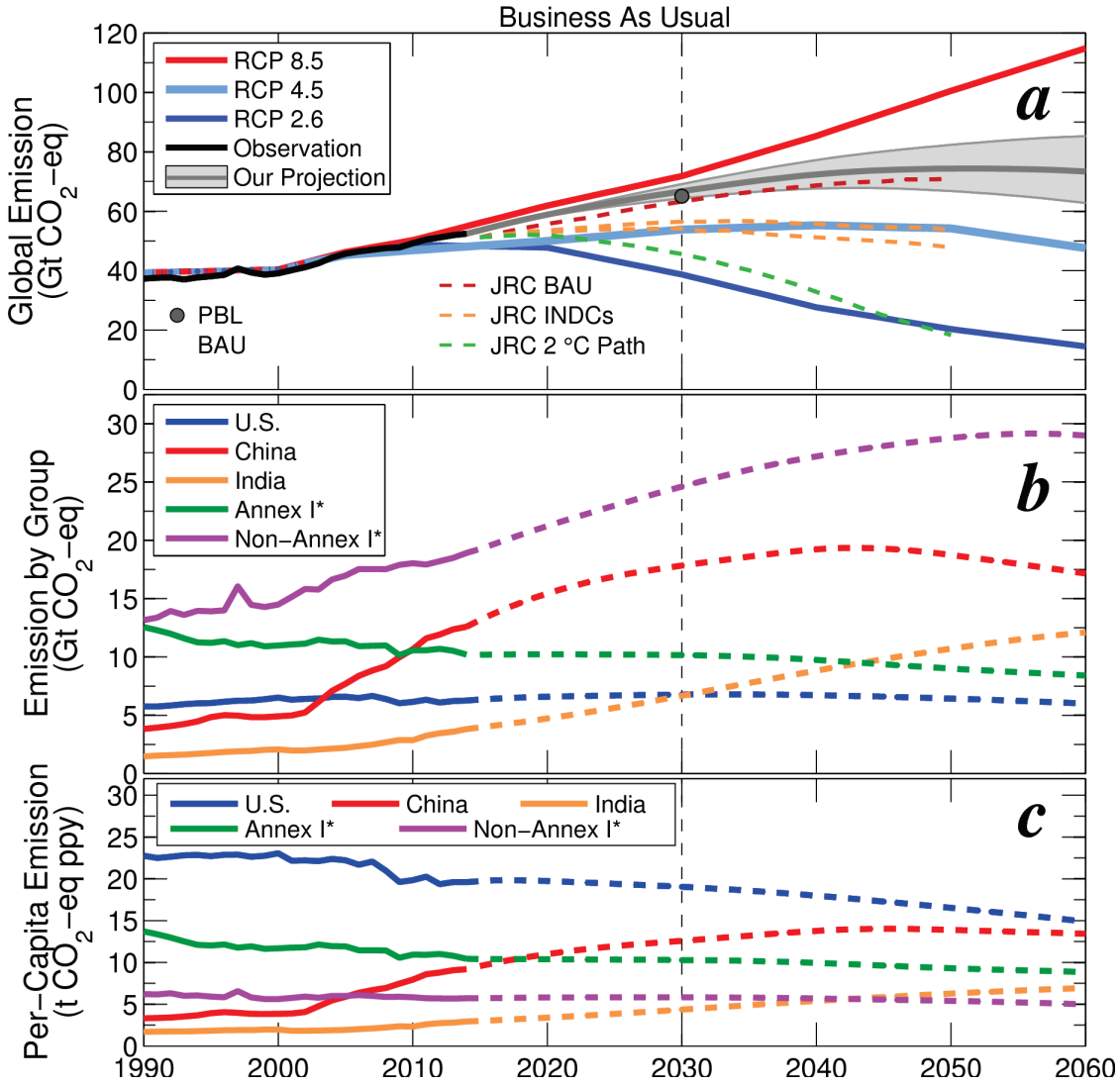

Figure 3.8 Future GHG projections, Business as Usual (BAU)

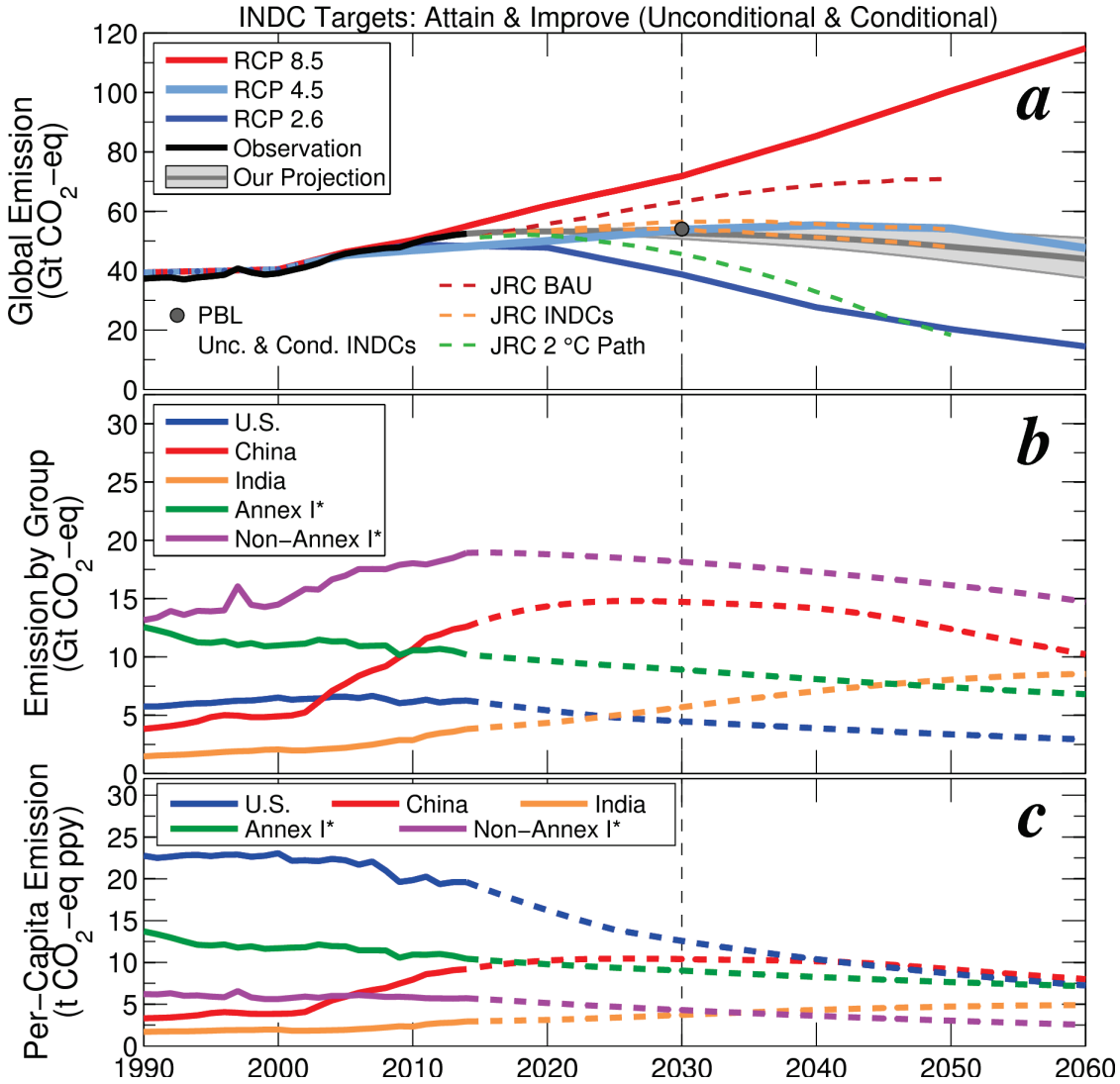

Figure 3.11 Future GHG projections, Paris Unconditional & Conditional INDCs, Attain & Improve

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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.

It is clear from figures 3.8 and 3.11 that the US and China will have to reduce per capita emissions if the Paris Climate Agreement is to be achieved. I think this is about as reasonable for China as it is for the United States even though the per capita GDP in the US is higher than that of China because their industrial revolution and overall technological advancements have occurred much later than that of the US. This means that their people may have not adopted many of the luxuries we often take for granted in our country, and would be more accepting of energy efficient alternatives. Because the US has higher per capita GDP (approx. $10,000 in China vs $62,700 according to World Bank) I think that there is potential for change and more efficient consumerism.

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As I had mentioned in class last Thursday, there are successes in the U.S. such as America's pledge:

https://www.americaspledgeonclimate.com

and the U.S. Climate Alliance:

http://www.usclimatealliance.org

and the Regional Greenhouse Gas Initiative:

https://www.rggi.org/program-overview-and-design/elements

Due to the work of local and state governments, as well as many Universities, the U.S. is projected to come close to achieving its INDC goal.

One of the current, sad consequences of the position of our Federal Government is lack of support the International Green Climate Fund:

https://www.climatechangenews.com/2019/10/25/green-climate-fund-replenishment-fails-fill-hole-left-trumps-us

Green Climate Fund replenishment fails to fill hole left by Trump's US

Published on 25/10/2019, 4:08pm

After the US, Russia, and Australia did not contribute, other developed countries fell $500m short of the fund's starting capital

The Green Climate Fund (GCF), which was created to help poor countries curb their emissions and cope with the impacts of climate change was seeking fresh contributions to replenish its funding, due to run-out at the end of the year.

Both the US and Australia said they would not pledge new money to the GCF, leaving smaller European countries along with Japan, Canada and New Zealand to compensate for a $3.2bn hole. They fell around half a billion short.

To bridge the gap, 13 countries announced a doubling or more of their contributions: Germany, Norway, France, UK, Sweden, South Korea, Denmark, Iceland, Poland, New Zealand, Luxembourg, Ireland and Monaco.

Before the conference, the GCF said contributions totalling between $9bn and $10bn would be "a big success" after 16 countries pledged $7.4bn in the lead up.

A total of 27 countries raised $9.8 billion at a pledging conference in Paris to fund green projects for the 2020-2023 period – including 4% in zero-interest loans. That was less than the $10.3bn donors promised for the first period to 2020 and not enough to fund the $15bn pipeline of projects identified by the GCF as of December 2018.

https://www.climatechangenews.com/2019/10/25/green-climate-fund-replenishment-fails-fill-hole-left-trumps-us

Implementation

Sijing Yu

12 November 2019

RCP prescribe future level of GHGs used by the climate models

RCP – Representative Concentration Pathways

PPM – parts per million

412 ppm CO_2 today -- 412 out of every million molecules of air are CO_2

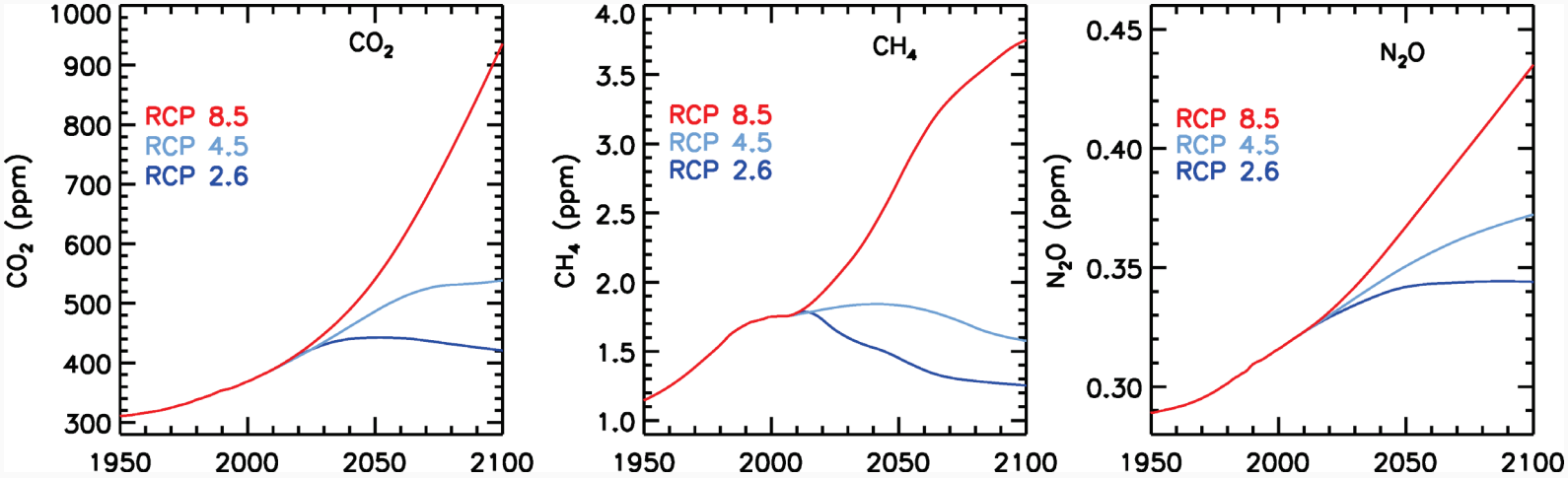


Figure 2.1 GHG abundance, 1950–2100

If the EIA projections of energy demand prove true, then how much of the world's energy needs must be met by sources that do not emit GHGs in year 2060, in order for emissions of atmospheric CO_2 to achieve RCP 4.5?

50%

What about RCP 2.6?

88%

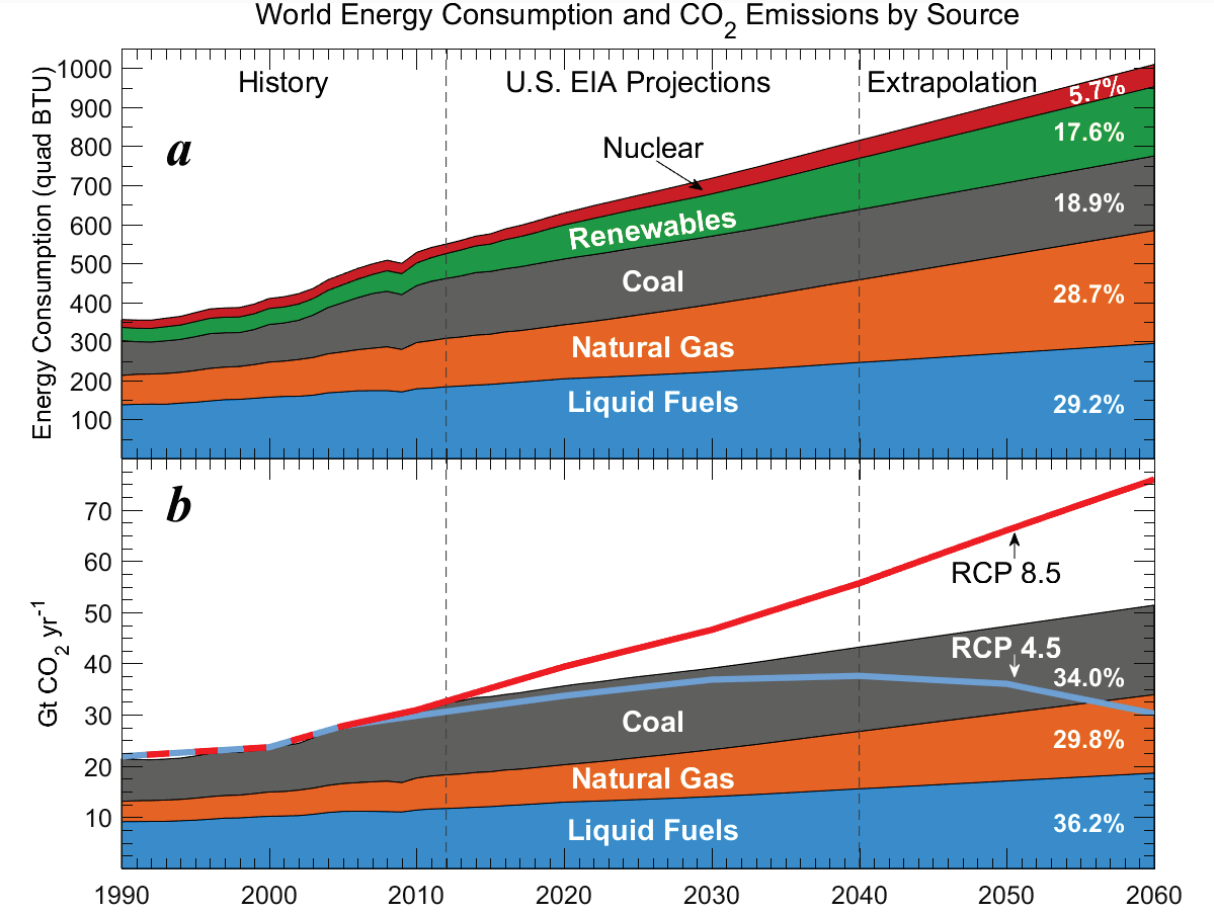


Figure 4.2 World energy consumption and CO_2 emissions

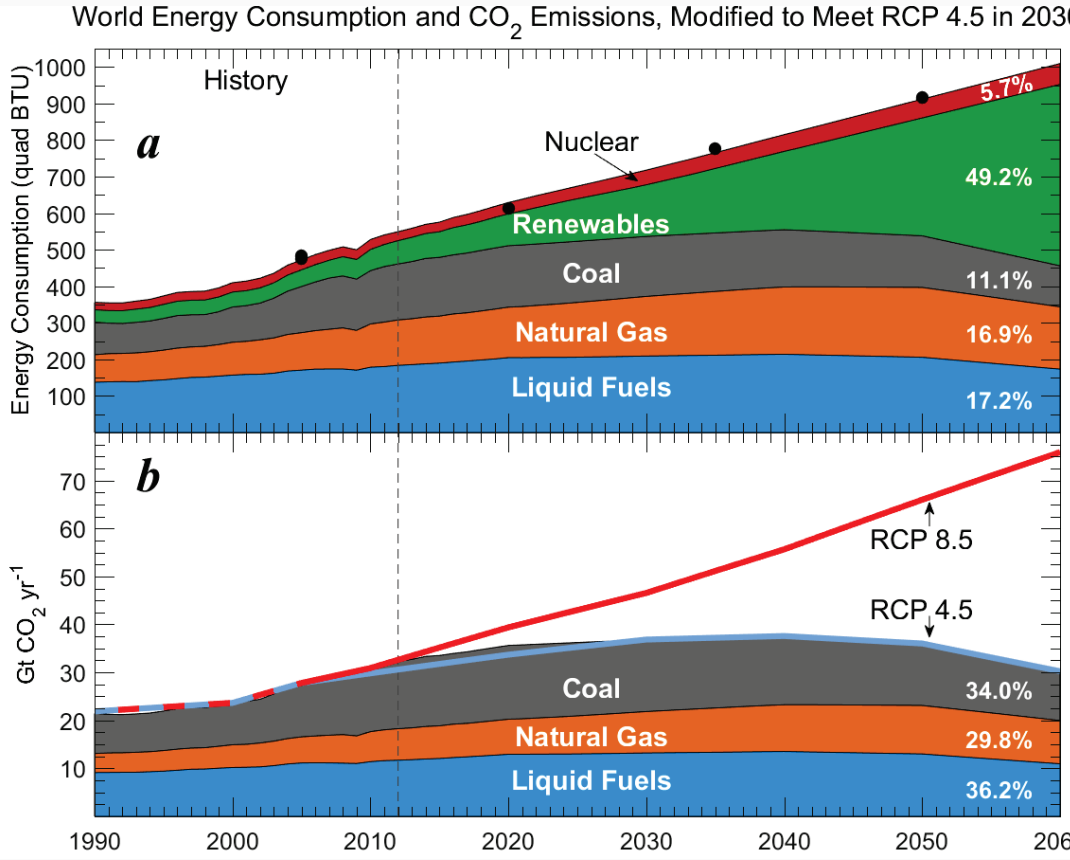


Figure 4.3 World energy consumption and CO_2 emissions, modified to meet RCP 4.5

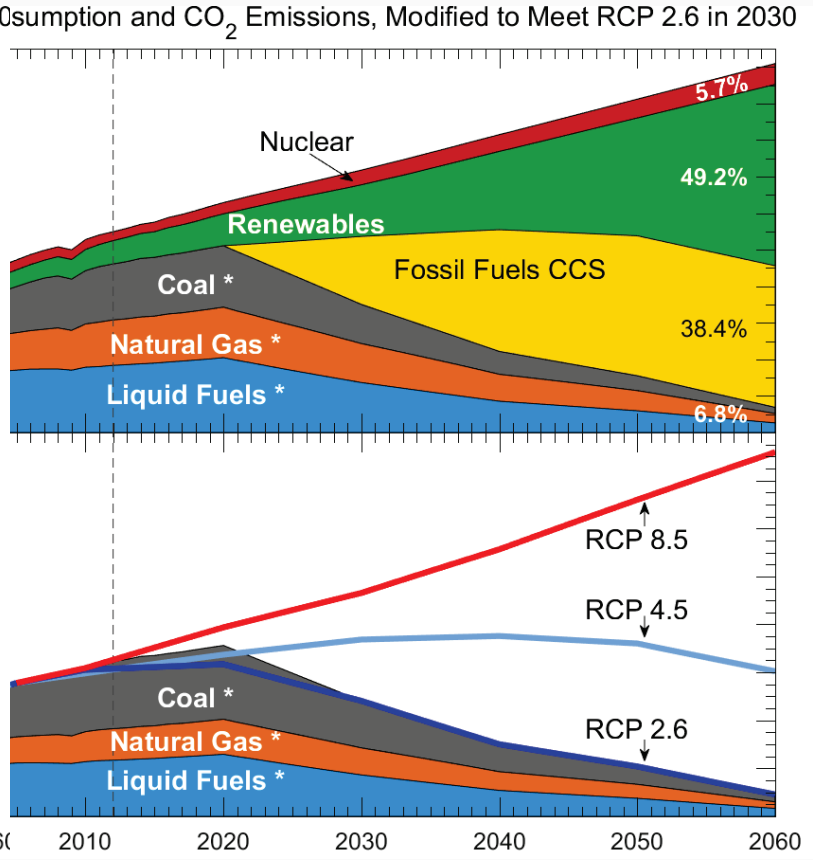


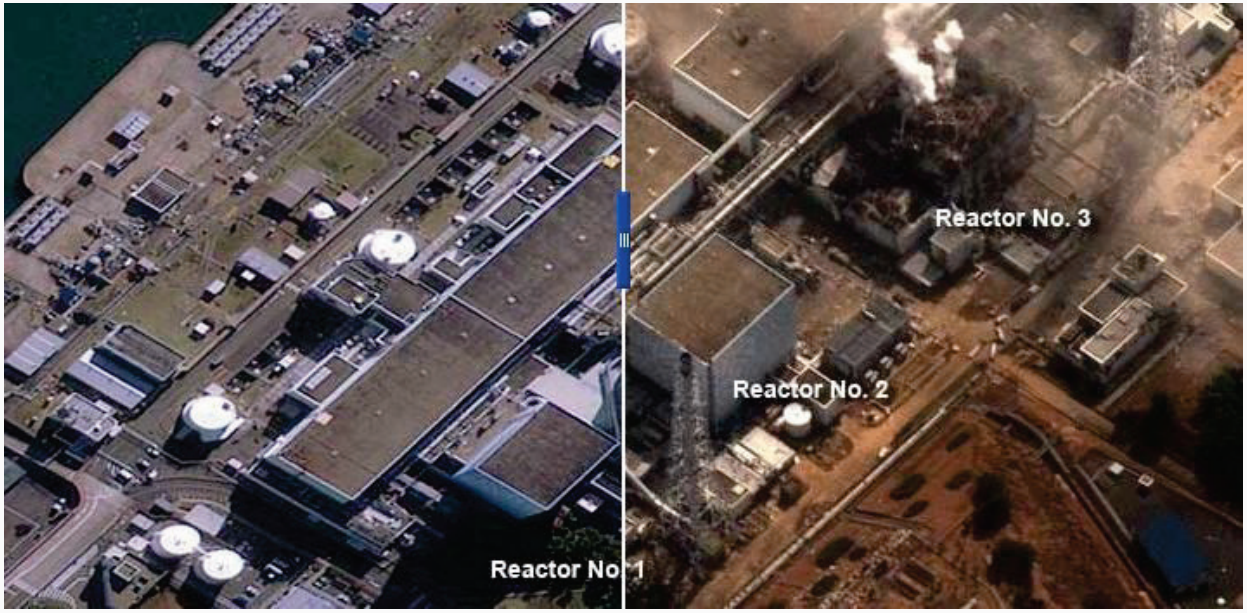
Figure 4.5 World energy consumption and CO_2 emissions, modified to meet RCP 2.6

What is: **a) one important similarity**
b) one important difference

between the projections in Chap. 4 & those in the RCP 4.5 paper of Thomson et al. (2011)

a) the assumption for future energy demand of the RCP 4.5 paper are nearly identical to the energy demand we use.

b) Fukushima



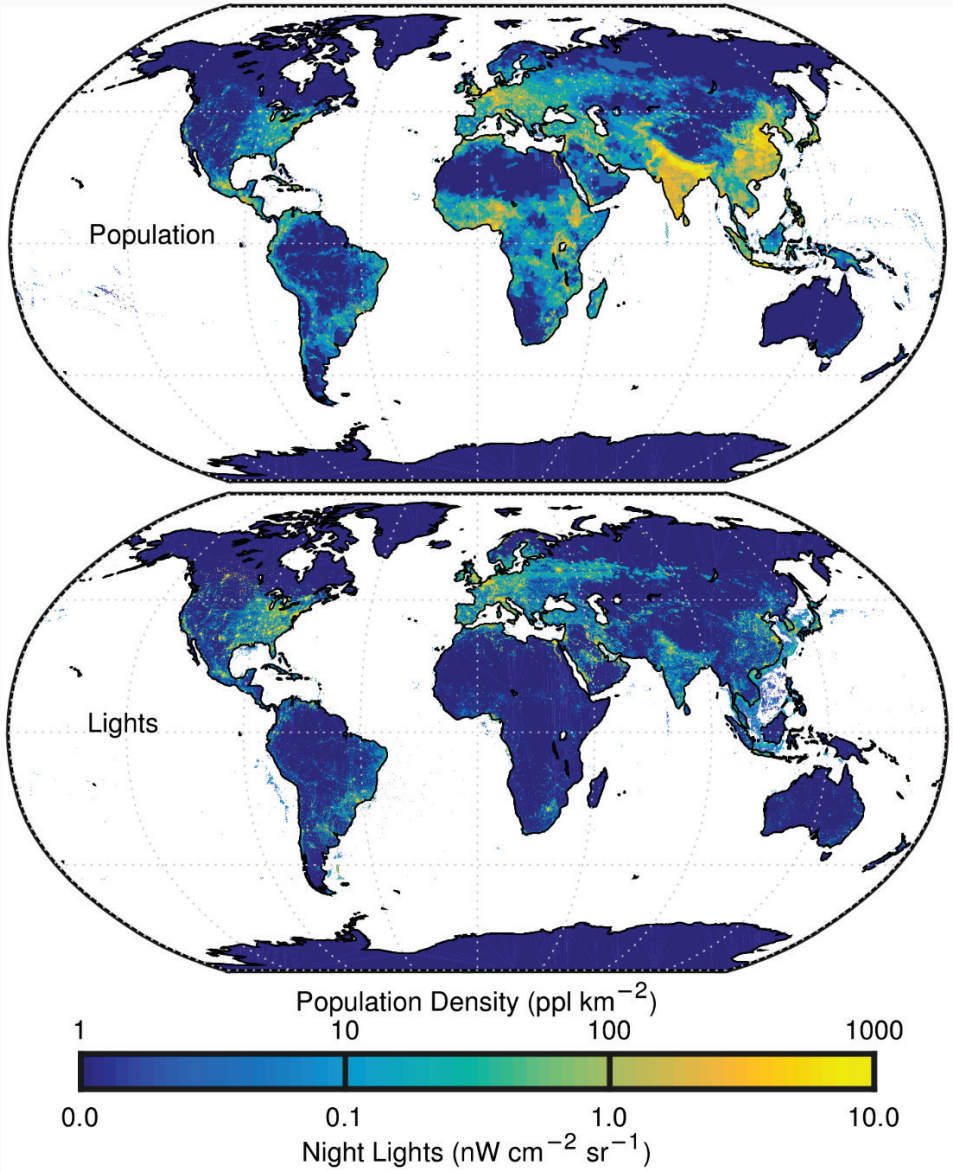


Figure 4.6 Population and night lights, global

What is the importance of Fig 4.6 (i.e., why did the authors include this figure in the chapter)?

Showing the economic disparity of the world by showing night lights and consider it when implementing policies.

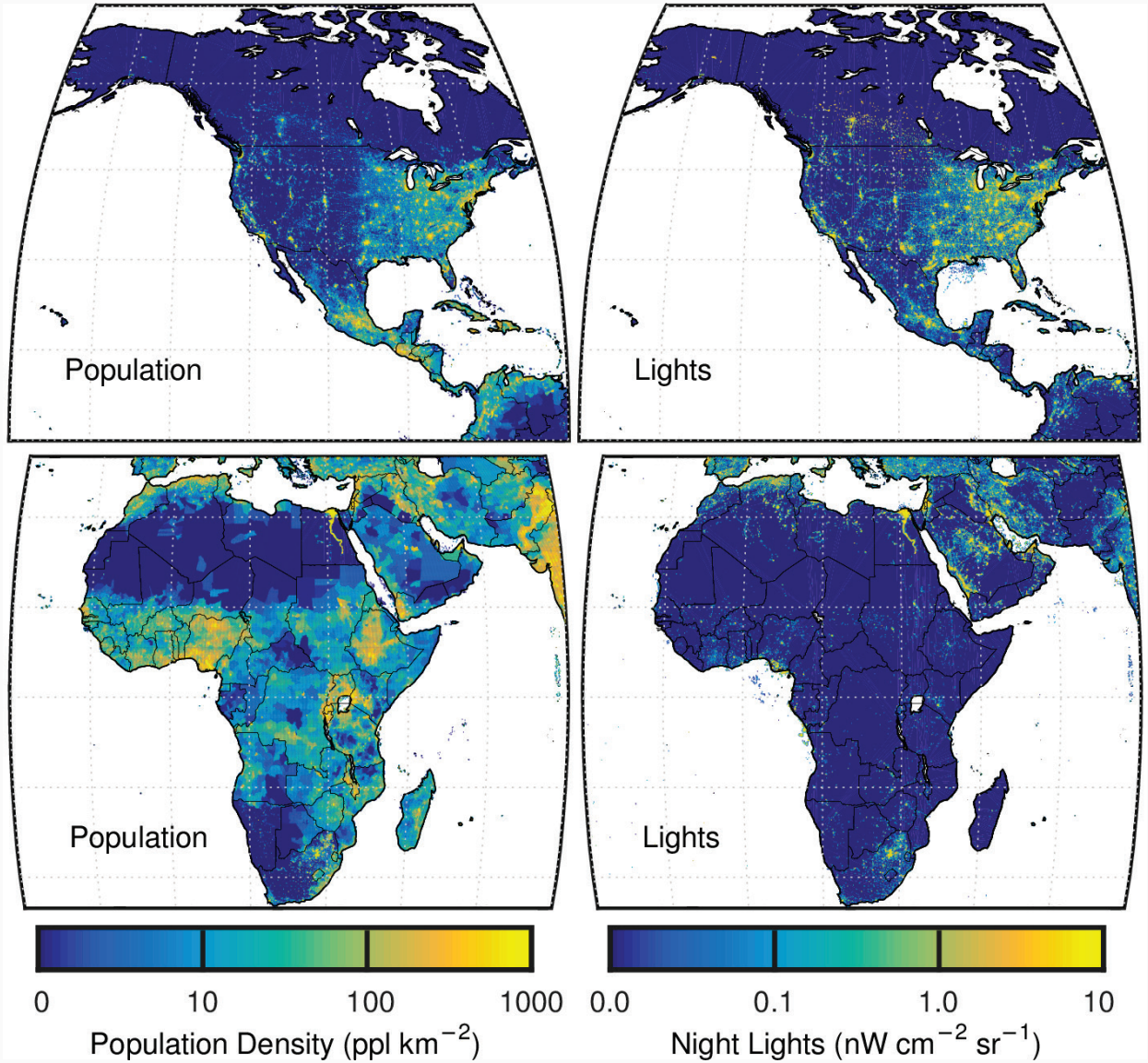


Figure 4.7 Population and night lights, North America and Africa

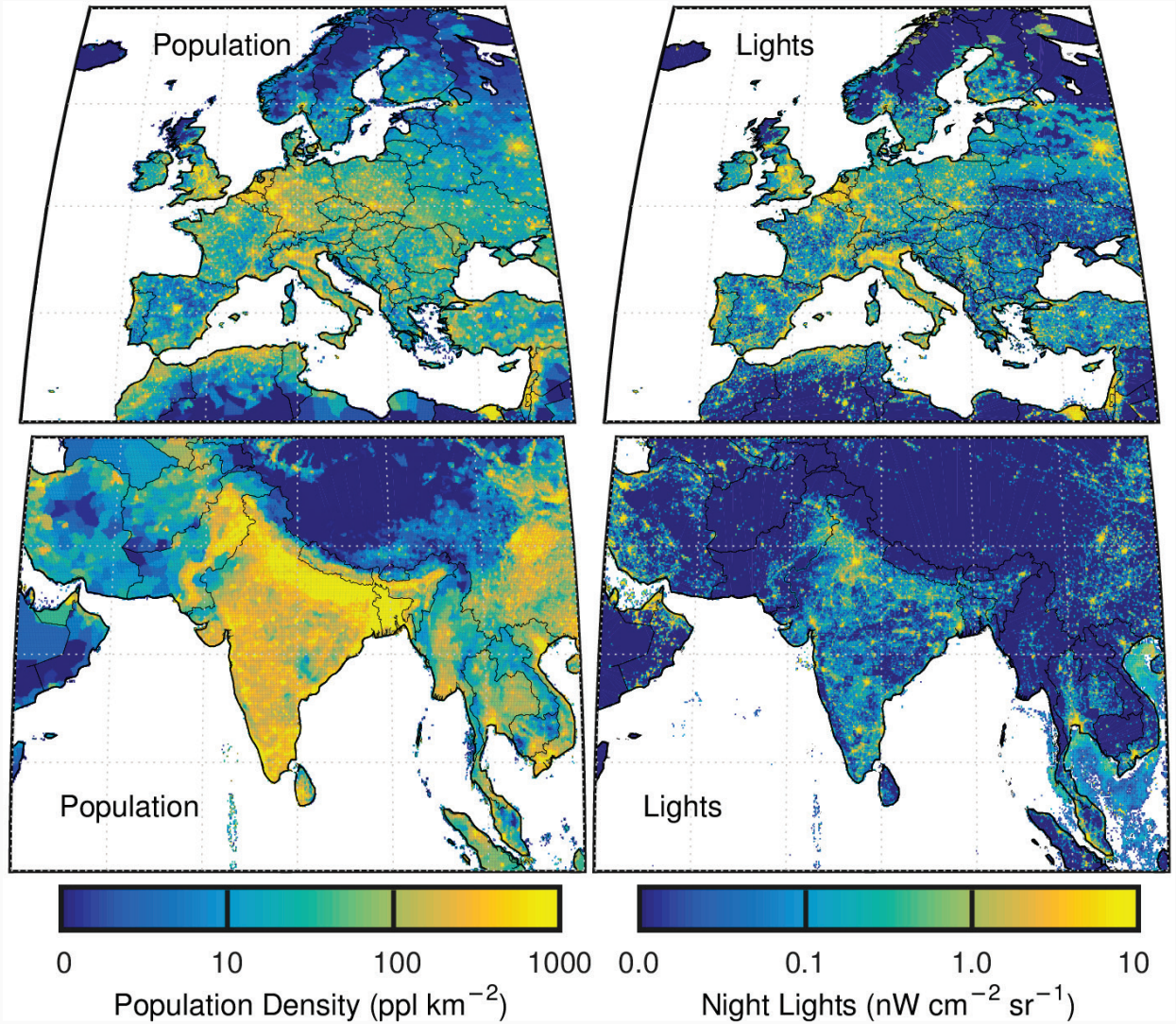
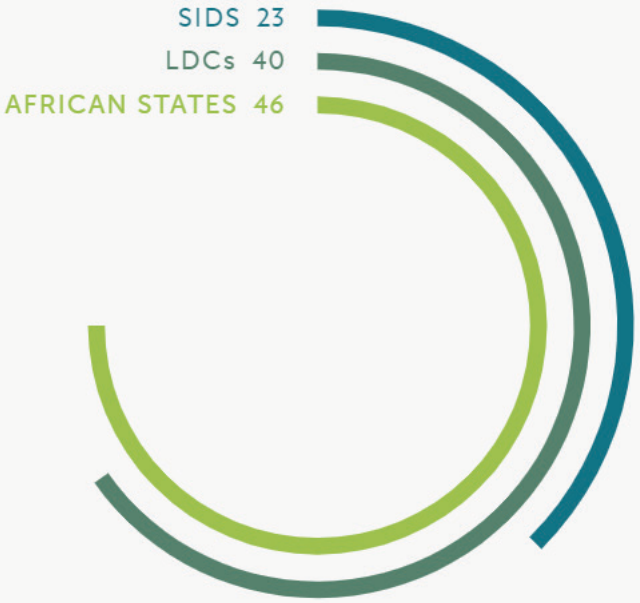


Figure 4.8 Population and night lights, Europe and India

Green Climate Fund

PRIORITY COUNTRIES



PLEDGED ⓘ

10.3

billion

COMMITTED ⓘ

5.2

billion

IMPLEMENTING ⓘ

2.8

billion

TOTAL VALUE ⓘ

18.7

billion

111

PROJECTS

310m

BENEFICIARIES

Anticipated number of people with increased resilience

1.5b

TONNES of CO_2

Anticipated tonnes of CO_2 equivalent avoided

Effective or not?

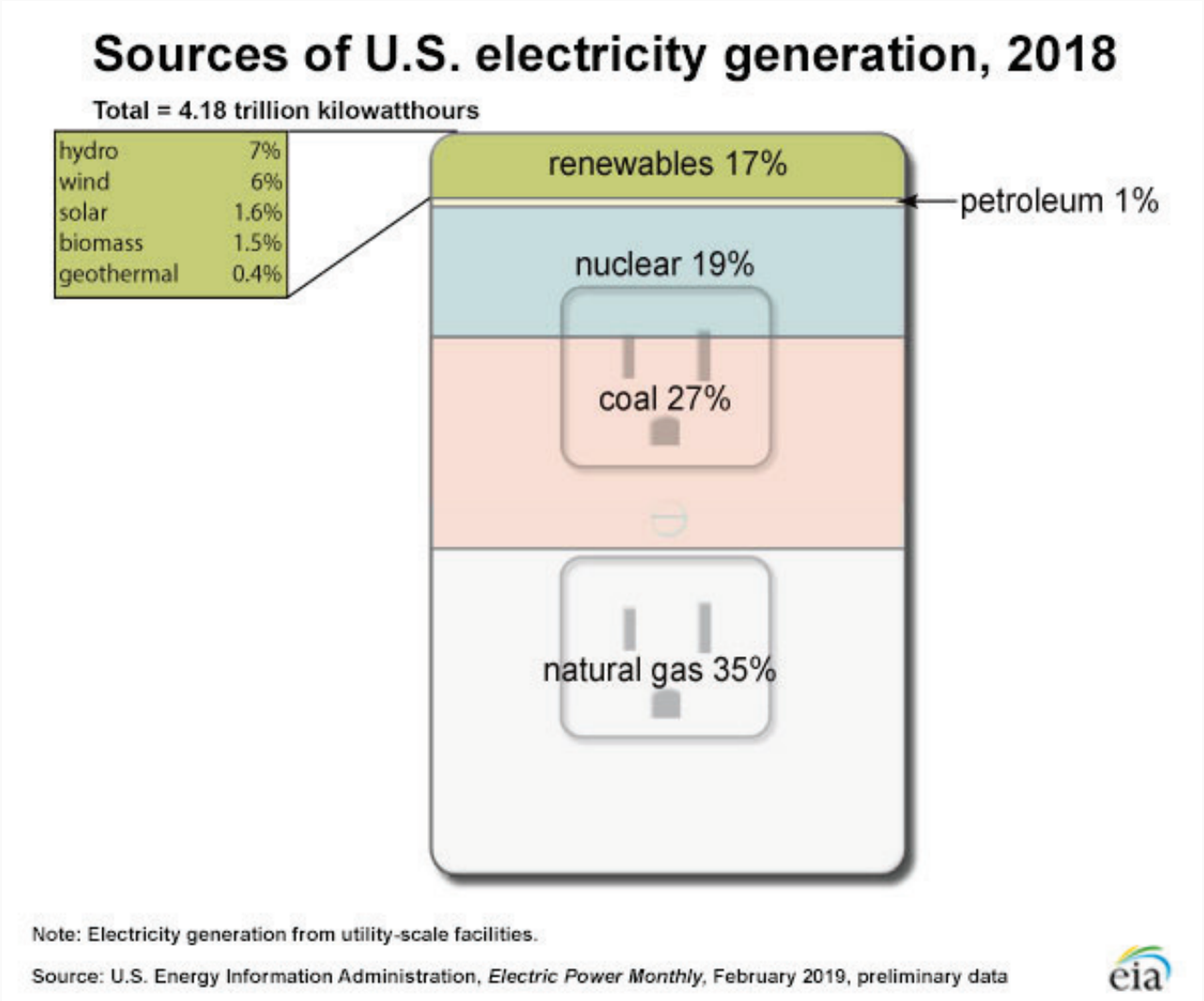
Electrify without using fossil fuels

two successful efforts?

Gigawatt Global – photovoltaic, 8.5 megawatt (MW), grid of 28,360 arrays
Riwanda since September 2014

Solar Reverse -- Power Purchase agreement (PPA), 110/100 MW in Nevada
and South Africa (2018)
Republic of Burundi and Nigeria

Electricity from Renewables?



Hydro?

Wind?

Solar?

Biomass?

Geothermal?

……

Which one for Africa and India?

How about the importance of figure 4.4?

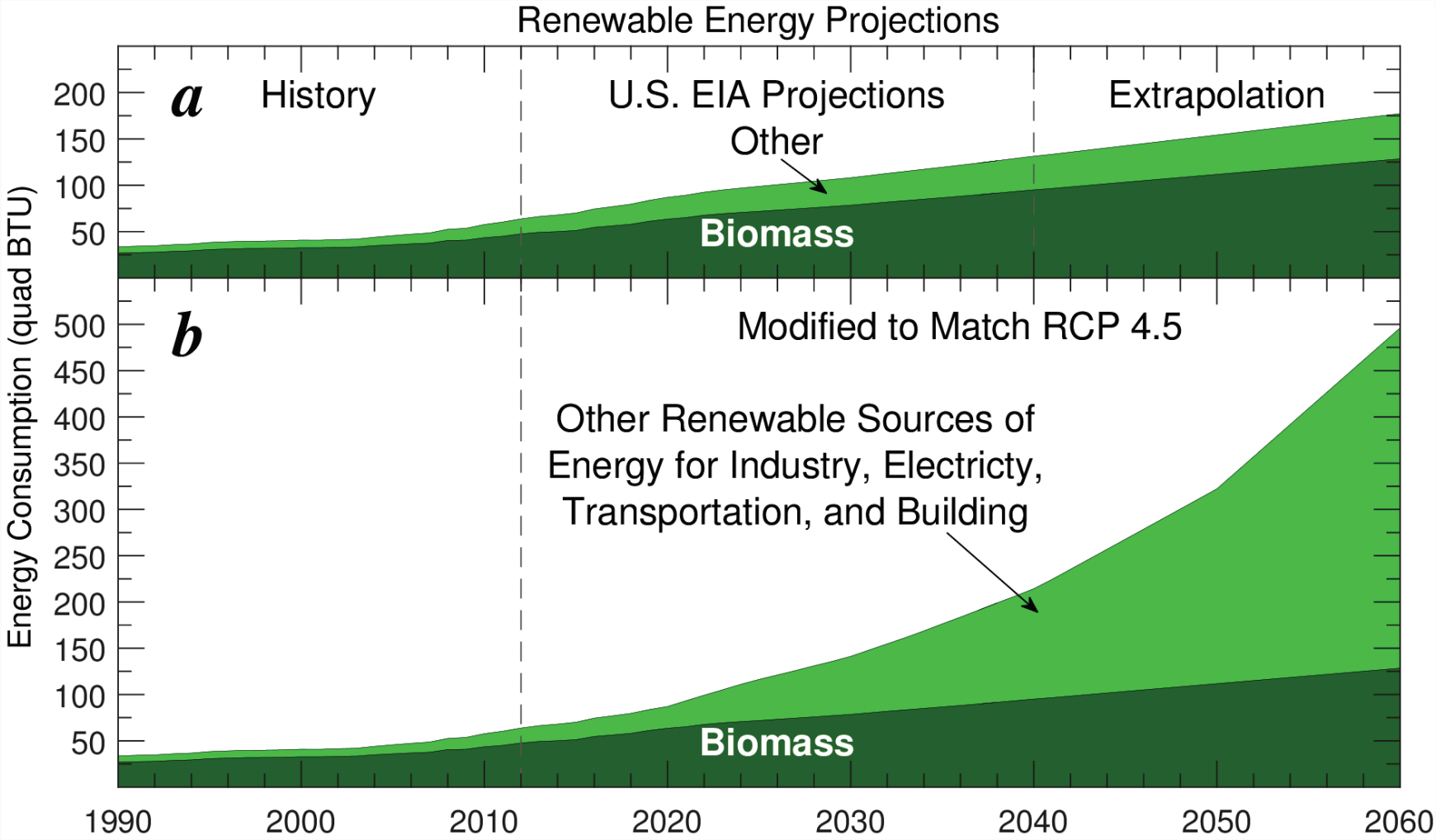


Figure 4.4 World energy consumption, renewables

Health Crisis resulted from burning wood for cooking

Household Air Pollution (HAP)

– single most important environmental health risk worldwide

– 4.3 premature deaths each year (statistics in 2012)

25% stroke, 15% ischaemic heart disease, 17% lung cancer, and more than 33% chronic obstructive pulmonary disease in low- and middle-income countries (LMICs)

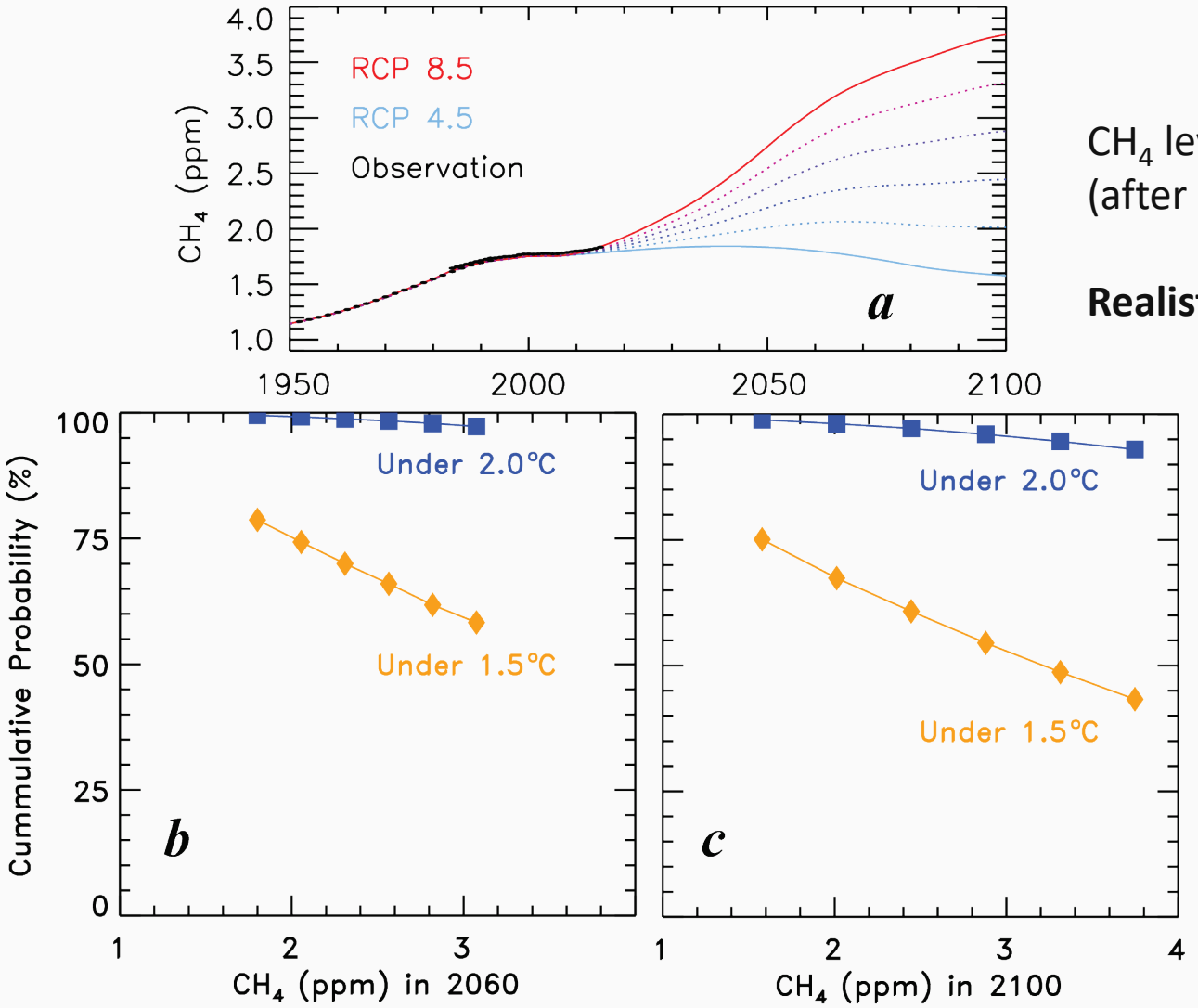
Why Women and Children at a particularly higher risk?

60 percent

Clean and polluting fuels and technologies are often 'stacked' for daily cooking activites, as in this home, where a traditional stove and LPG stove are both in use.
Credit: Jessica Lewis

Women gather to bake bread in a dung-fired oven in front of a home in Zanskar, India.
Credit: Jonathan Mingle

Is the future trajectory of atmospheric methane important for achieving the goal of the Paris Climate Agreement?



CH_4 level off for RCP 4.5 (after decreasing)

Realistic?

Figure 4.12 Impact of CH_4 on EM-GC projections using RCP 4.5

Leakage (%)	Region	Method	Citation
4.2 to 8.4	Bakken Shale, North Dakota	Aircraft sampling	Peischl et al. (2016)
1.0 to 2.1	Haynesville Shale, Louisiana and Texas	Aircraft sampling	Peischl et al. (2015)
1.0 to 2.8	Fayetteville Shale, Arkansas		
0.18 to 0.41	Marcellus Shale, Pennsylvania		
9.1 ± 6.2	Eagle Ford, Texas	Satellite sampling	Schneising et al. (2014)
10.1 ± 7.3	Bakken Shale, North Dakota		
0.42	190 production sites including Gulf Coast, Rocky Mountain, and Appalachia	In situ within facility grounds	Allen et al. (2013)
6.2 to 7.7	Unitah County, Utah	Aircraft sampling	Karion et al. (2013)
2.3 to 7.7	Julesburg Basin, Denver, Colorado	Tall tower and ground level mobile sampling	Pétron et al. (2012)

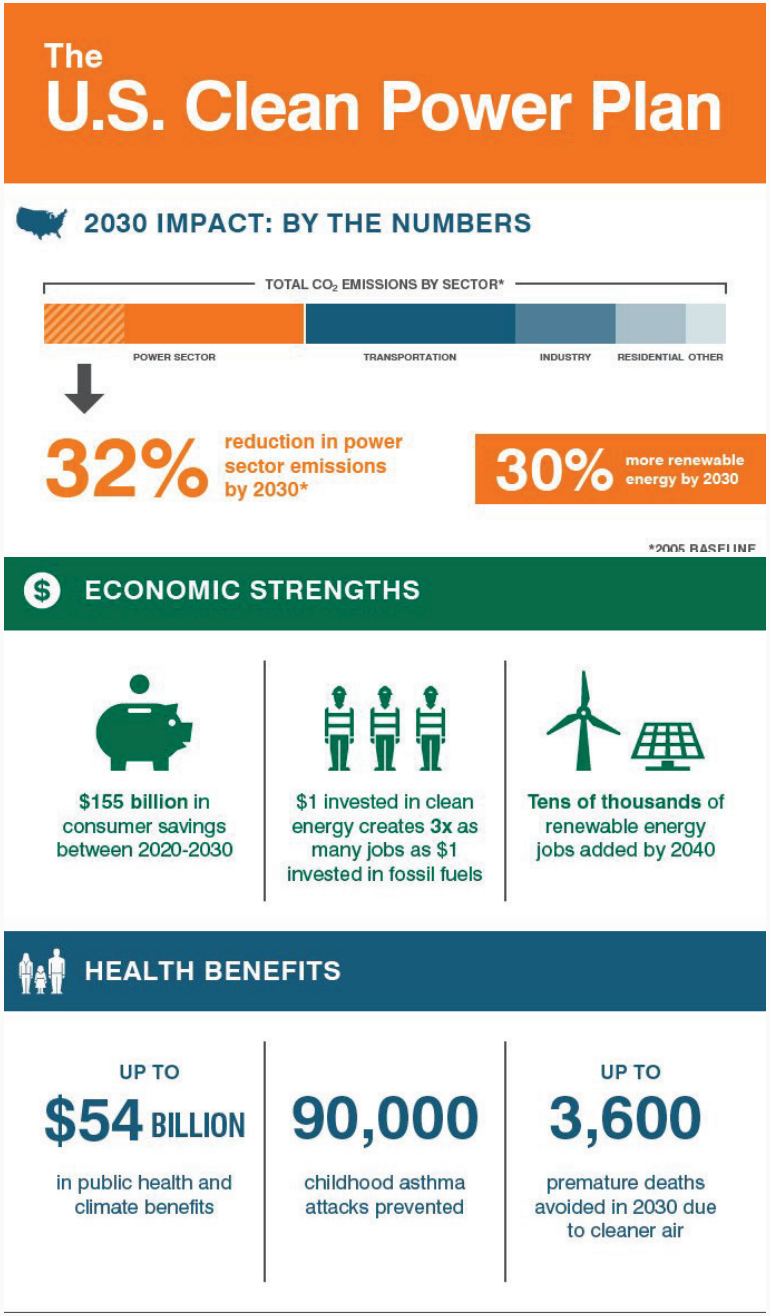
Table 4.4 Estimates of % of CH_4 leakage from fracking, relative to production in the US, selected studies

Clean Power Plan

Announced 2015 by President Obama, set the first-ever limits on carbon pollution from U.S. power plants.

The Trump administration's Environmental Protection Agency published "Affordable Clean Energy" rule to replace Obama's CPP this June, arguing the goal is cut down emissions from power sectors by 32 percent below 2005 level by 2030; 28 percent below in 2017, what about 2018?

Power plant emissions rose slightly in 2018



Emission Metrics

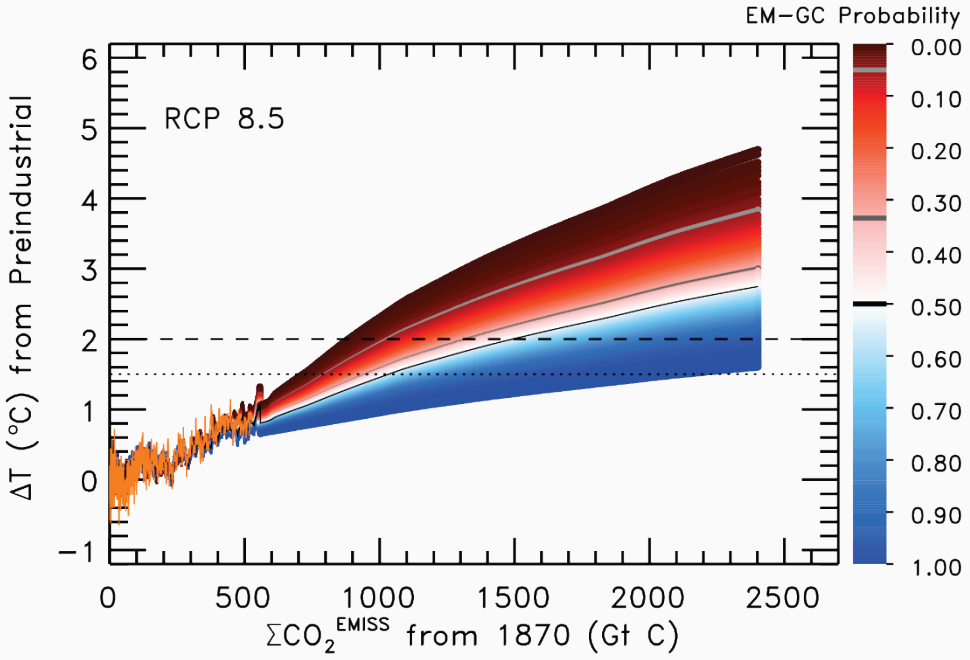


Figure 4.11 Transient climate response to cumulative CO_2 emissions, RCP 8.5

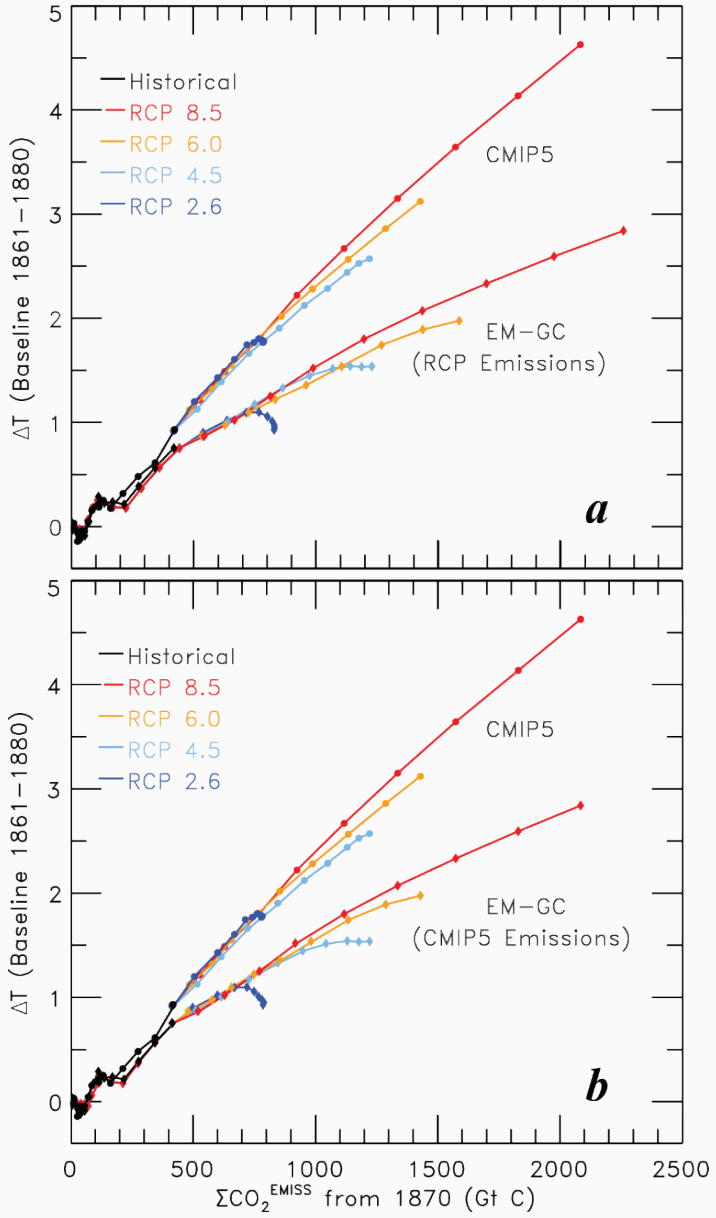


Figure 4.10 Transient climate response to cumulative CO_2 emissions, in units of Gt C

	Total ΣCO_2^{EMISS}			
Warming	CMIP5 GCMs, 50%	EM-GC, 95%	EM-GC, 66%	EM-GC, 50%
1.5 °C	633 Gt C	797 Gt C	930 Gt C	1002 Gt C
2.0 °C	842 Gt C	1010 Gt C	1300 Gt C	1480 Gt C

Table 4.2 Total cumulative carbon emission that will lead to cross Paris ΔT thresholds

	Future ΣCO_2^{EMISS}			
Warming	CMIP5 GCMs, 50%	EM-GC, 95%	EM-GC, 66%	EM-GC, 50%
1.5 °C	82 Gt C	246 Gt C	379 Gt C	451 Gt C
2.0 °C	291 Gt C	459 Gt C	749 Gt C	944 Gt C
	% of past CO_2 emissions that lead to threshold being crossed			
1.5 °C	14.9%	44.6 %	68.8%	81.9%
2.0 °C	52.8%	83.3%	136%	171%

Table 4.3 Future cumulative carbon emission that will lead to cross Paris ΔT thresholds

How do we face the challenge?

---- Paris Agreement as a Beacon

Two conditions for emission to remain below RCP 4.5 out to 2016:

(1) conditional as well as unconditional pledges are met

(2) reductions in GHG emissions needed to achieve the Paris commitments, which generally extend to 2030, are propagated forward to 2060

Many has embraced the challenges:

Green Mountain College – 100% renewable sources by 2020

Samsö, Denmark – negative carbon print due to 22 massive wind turbines

Germany -- planning to increase renewables from 12.6 % in 2015 to 60 %

There will be more and more……..

Implementation of the Paris Climate Agreement

Sijing Yu

12 November 2019

Last Word: Implementation

Ross J. Salawitch

12 November 2019

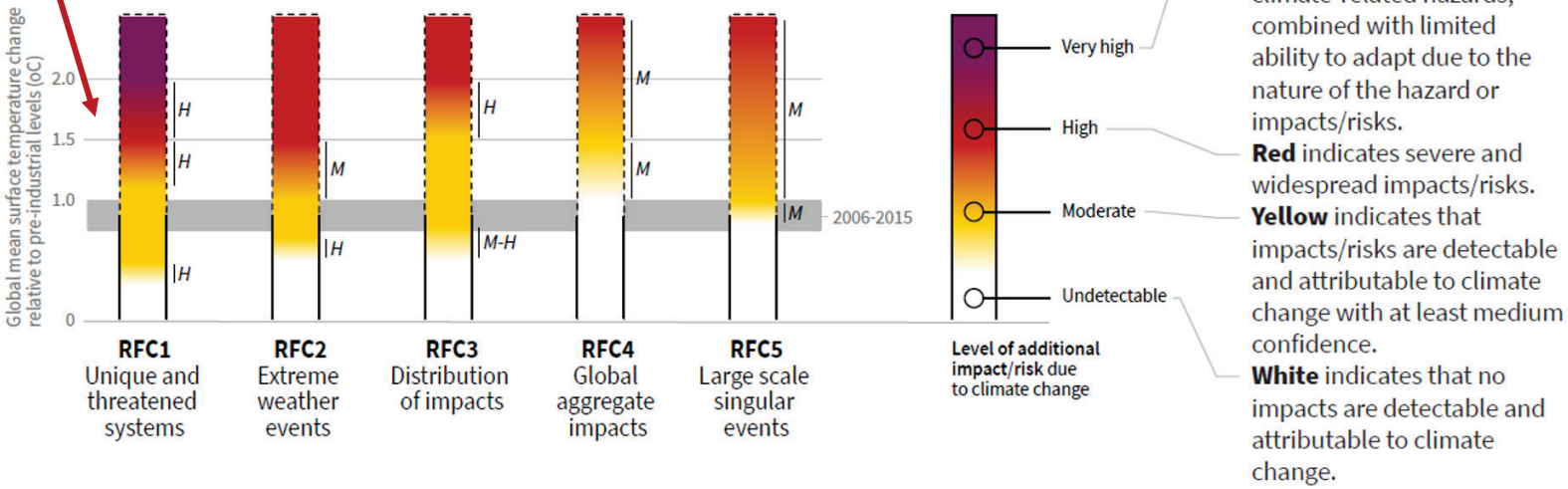
Impacts of Climate Change from IPCC 1.5°C Special Report

Tropical coral reefs face high risks of becoming unsustainable if warming exceeds 1.5°C. Coral reefs mostly disappear at 2°C warming.

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)



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

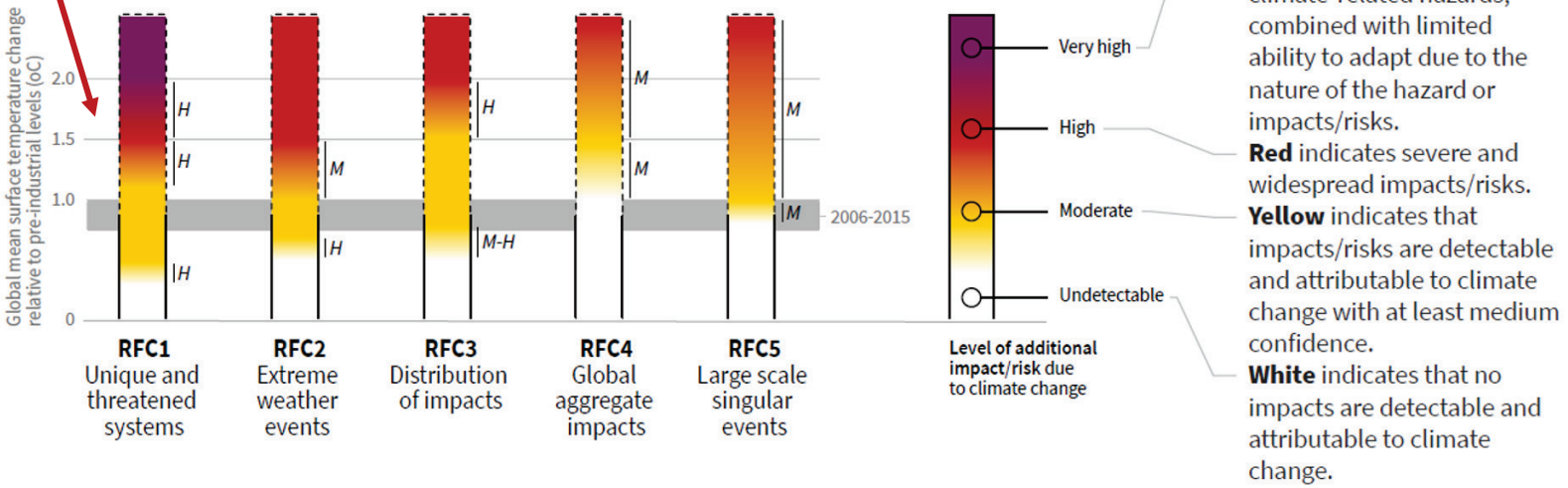
Impacts of Climate Change from IPCC 1.5°C Special Report

Of 105,000 species studied, 6% of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 1.5°C, compared with 18% of insects, 16% of plants and 8% of vertebrates for global warming of 2°C.

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)



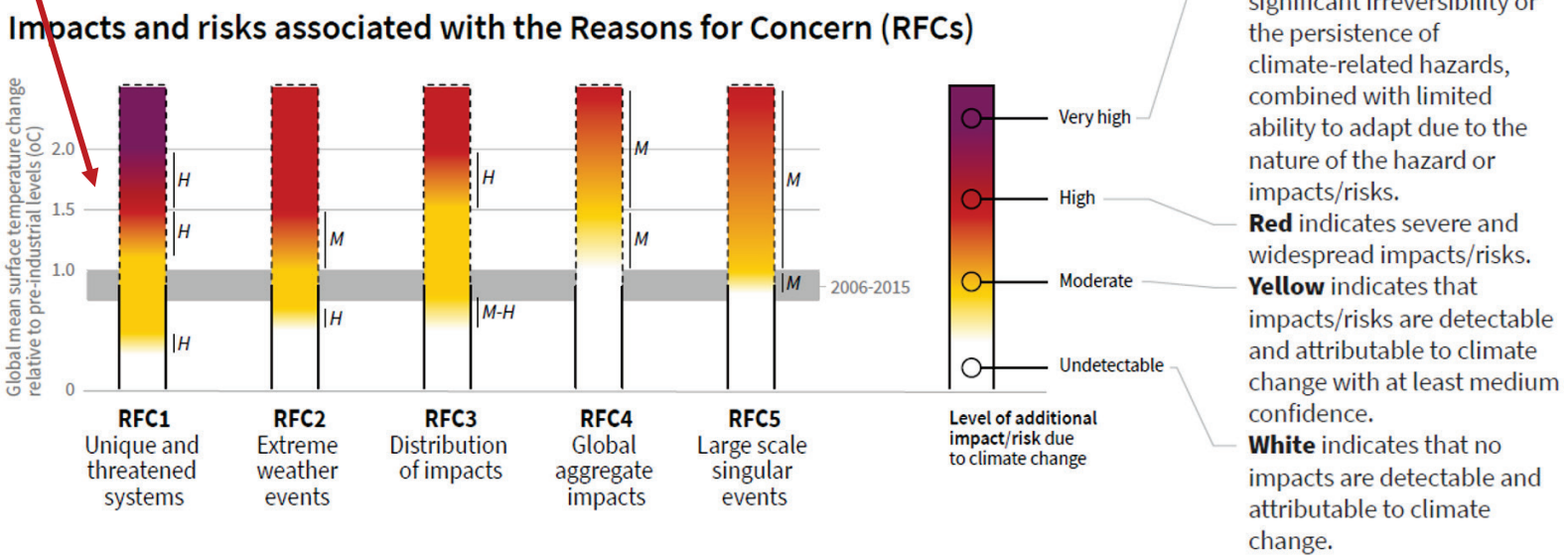
http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

Impacts of Climate Change from IPCC 1.5°C Special Report

The probability of a sea-ice-free Arctic Ocean during summer is substantially lower at 1.5°C warming compared to 2°C. With 1.5°C warming, one sea ice-free Arctic summer is projected per century. This likelihood is increased to at least one per decade with 2°C global warming.

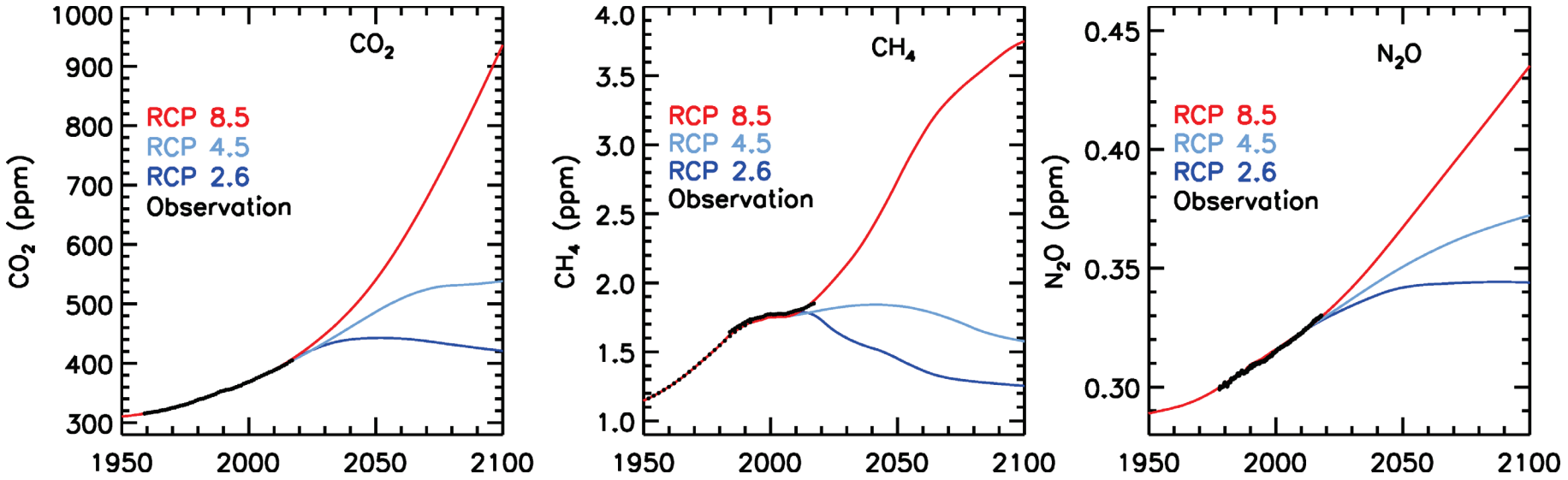
How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

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.



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

Three Futures

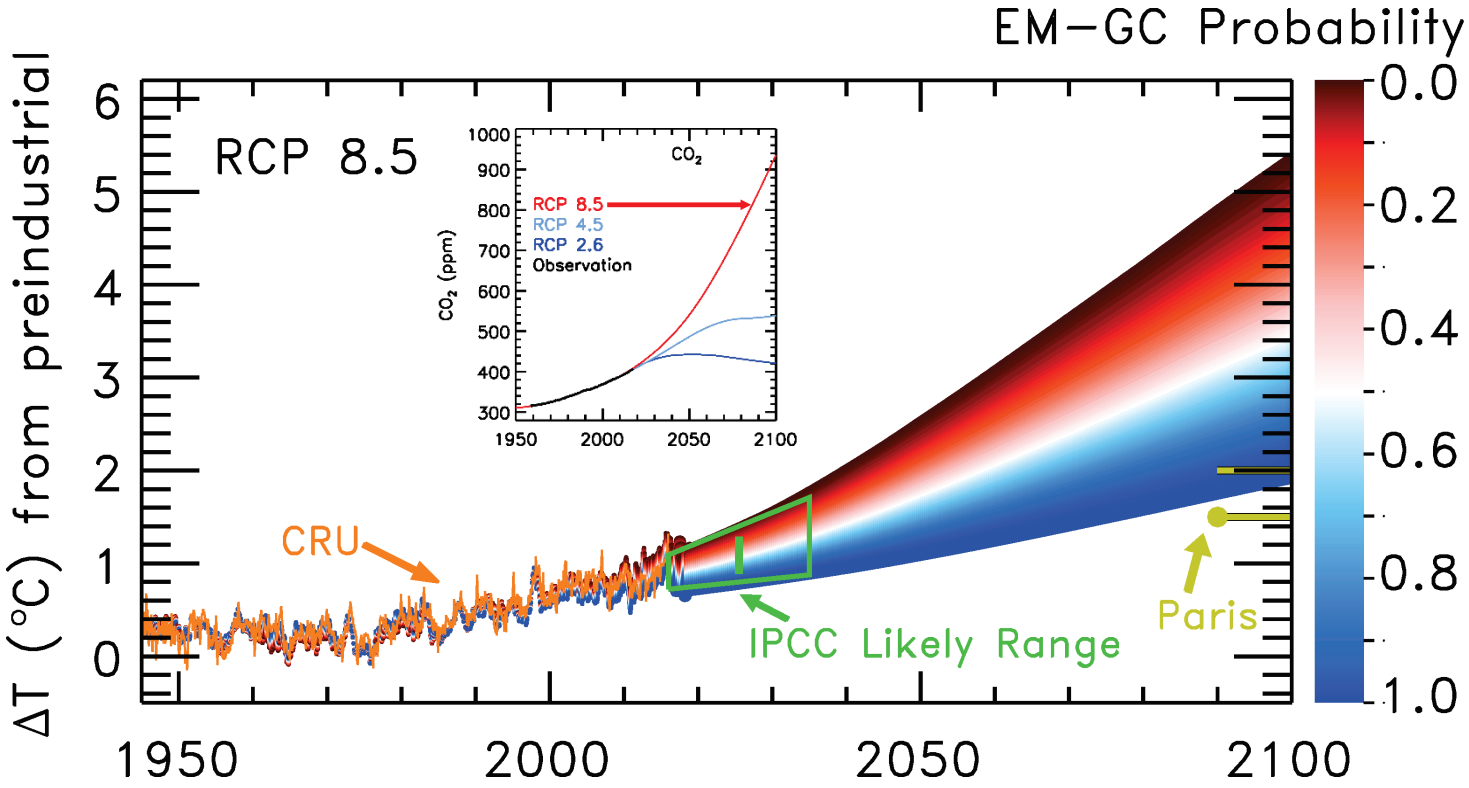


RCP: **R**epresentative **C**oncentration **P**athway

Number represents W m^{-2} RF of climate at end of century

Probabilistic Forecast of *Human-Induced Rise in GMST* for model trained on data acquired until end of 2017 and future GHG levels from RCP 8.5

Fig 2.20 (updated) ***Paris Climate Agreement: Beacon of Hope***

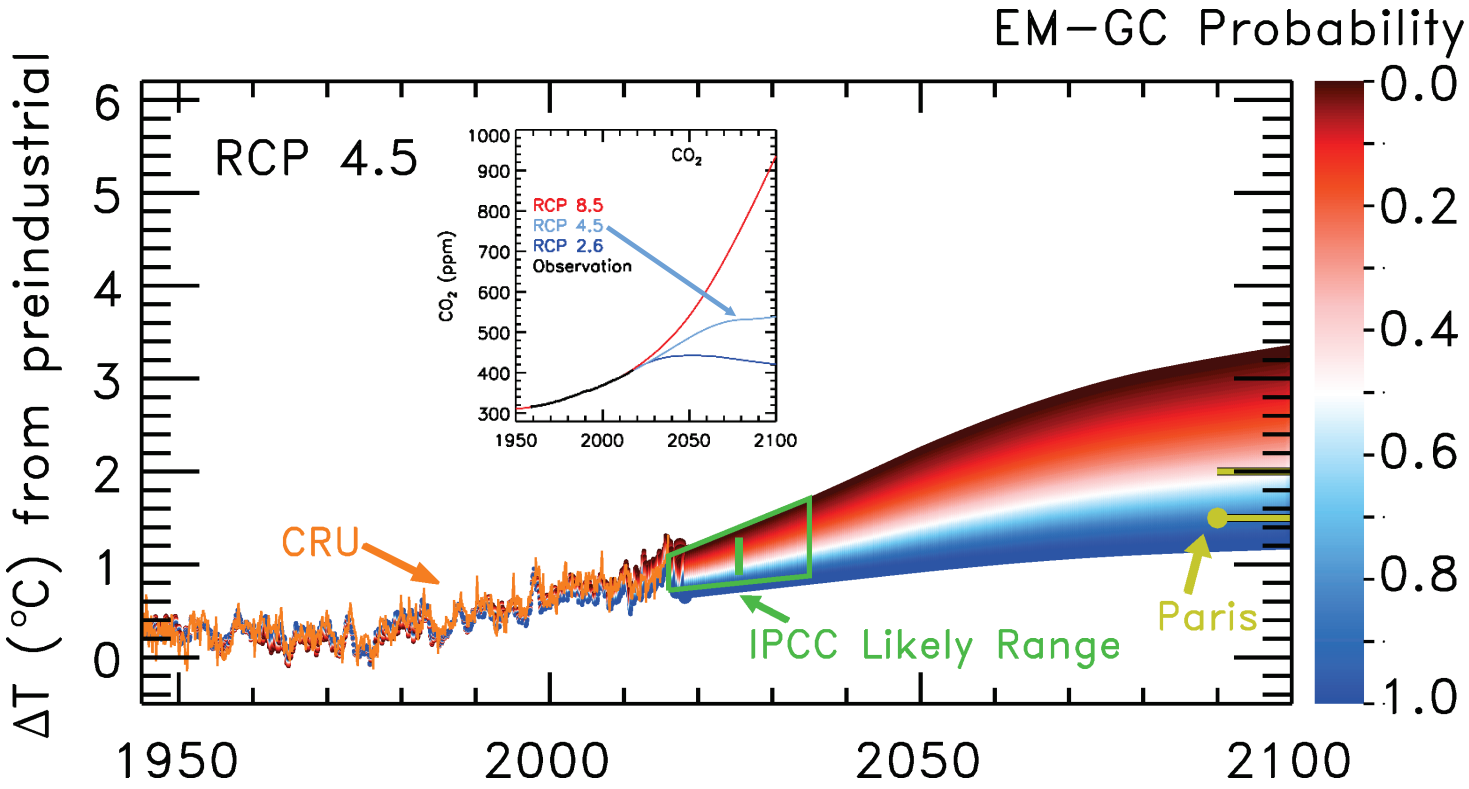


If GHGs follow RCP 8.5, **0%** chance rise GMST stays below **1.5°C** and **0.1%** chance stays below **2.0°C**

EM-GC: University of Maryland Empirical Model of Global Climate
ΔT: rise in GMST (Global Mean Surface Temperature) relative to pre-industrial
CRU: Climate Research Unit, Easy Anglia, UK: Premier source of data for ΔT
IPCC Likely Range of ΔT : From Fig 11.25b of the 2013 Intergovernmental Panel on Climate Change Report

Probabilistic Forecast of *Human-Induced Rise in GMST* for model trained on data acquired until end of 2017 and future GHG levels from RCP *4.5*

Fig 2.19 (modified) ***Paris Climate Agreement: Beacon of Hope***

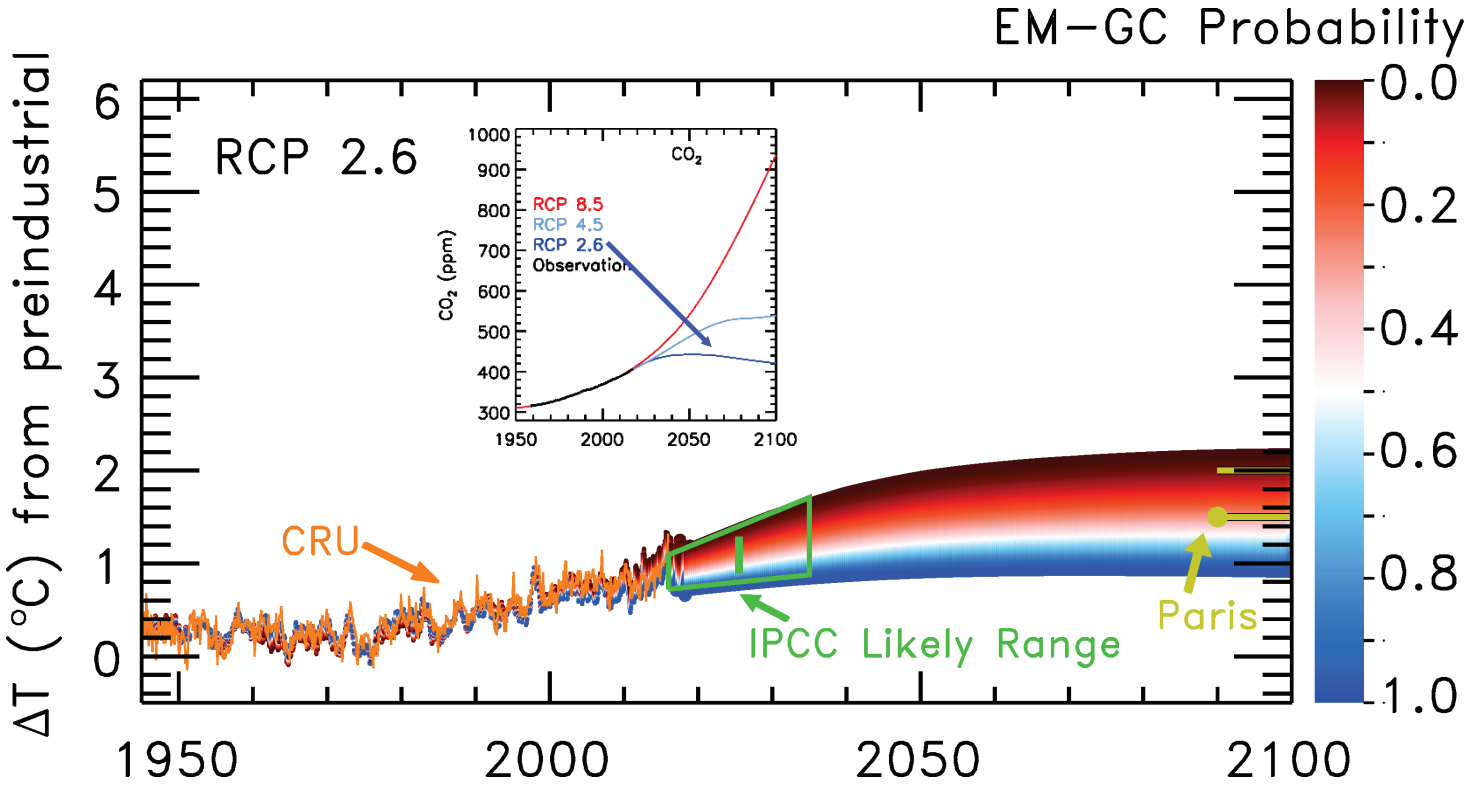


If GHGs follow RCP 4.5, **9%** chance rise GMST stays below **1.5°C** and **51%** chance stays below **2.0°C**

EM-GC: University of Maryland Empirical Model of Global Climate
ΔT: rise in GMST (Global Mean Surface Temperature) relative to pre-industrial
CRU: Climate Research Unit, Easy Anglia, UK: Premier source of data for ΔT
IPCC Likely Range of ΔT : From Fig 11.25b of the 2013 Intergovernmental Panel on Climate Change Report

Probabilistic Forecast of *Human-Induced Rise in GMST* for model trained on data acquired until end of 2017 and future GHG levels from RCP *2.6*

Fig 2.19 (modified) ***Paris Climate Agreement: Beacon of Hope***



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

EM-GC: University of Maryland Empirical Model of Global Climate
ΔT: rise in GMST (Global Mean Surface Temperature) relative to pre-industrial
CRU: Climate Research Unit, Easy Anglia, UK: Premier source of data for ΔT
IPCC Likely Range of ΔT : From Fig 11.25b of the 2013 Intergovernmental Panel on Climate Change Report

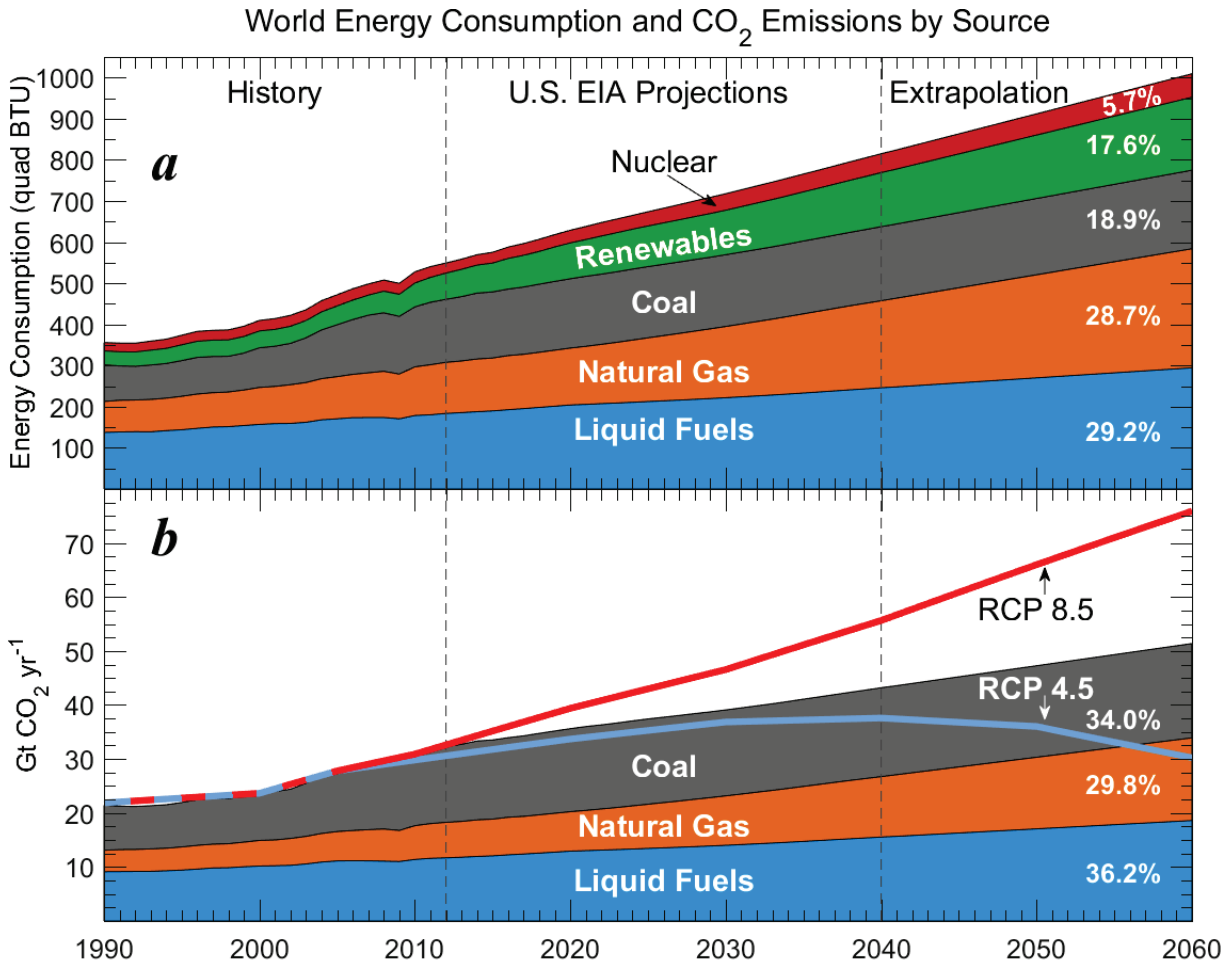


Figure 4.2 World energy consumption and CO_2 emissions

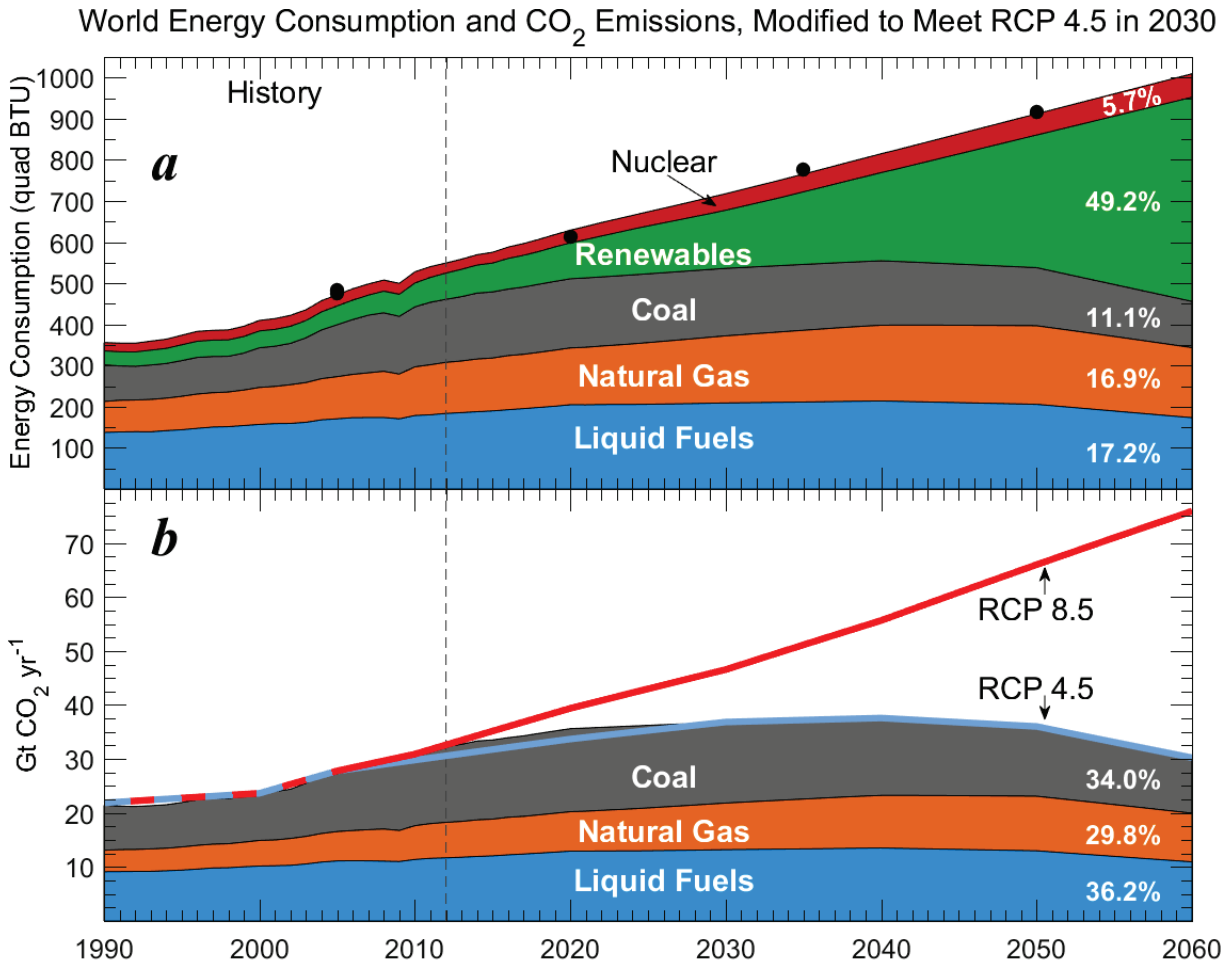
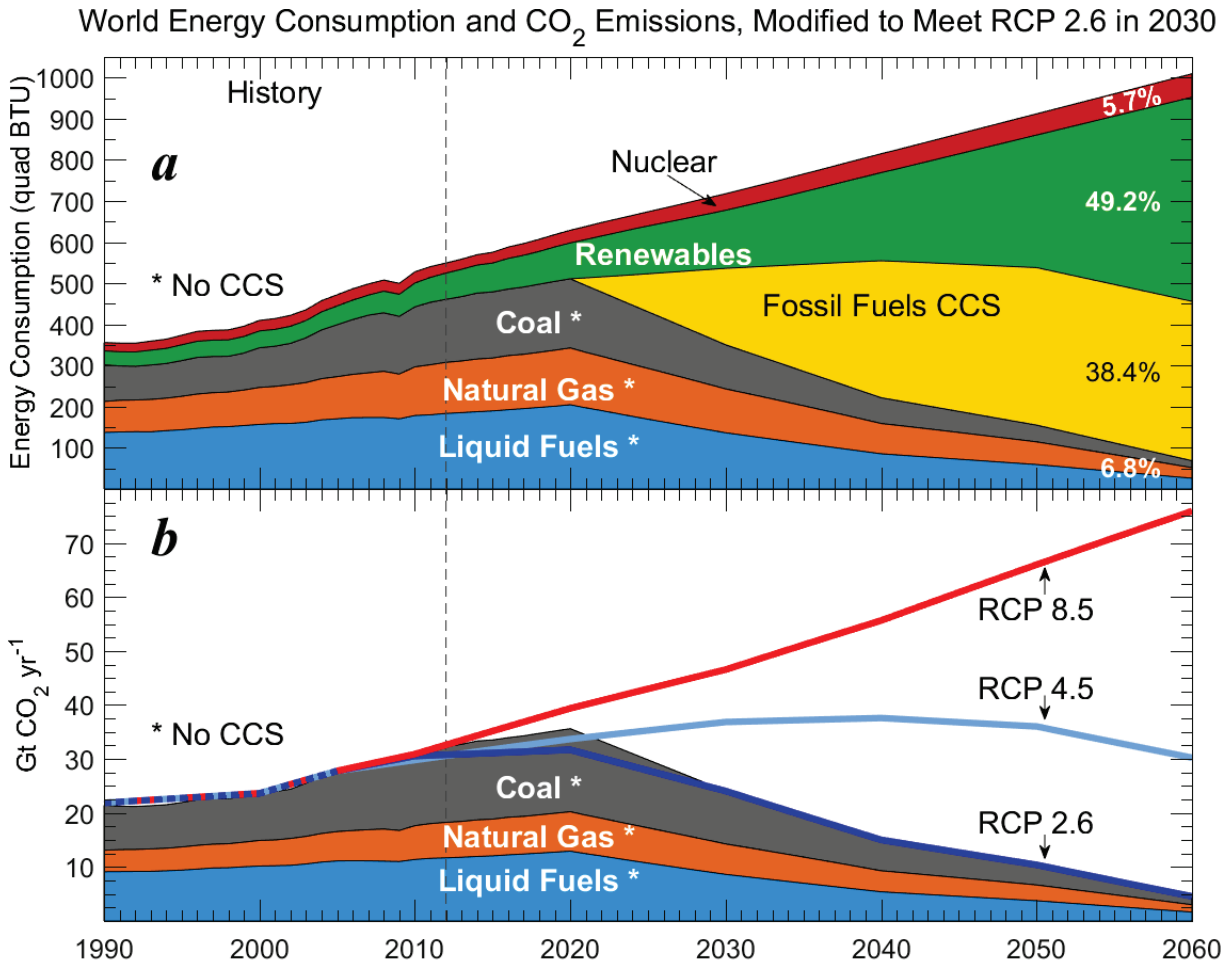


Figure 4.3 World energy consumption and CO_2 emissions, modified to meet RCP 4.5



Between now & Thurs, contemplate whether you are in favor of striving for a limit to warming of either 1.5°C or 2°C.

If you decide to strive for 1.5°C warming, the gap between RCP 4.5 & SRCP2.6 must be filled by Carbon Capture & Sequestration, which will cost $80 per ton of CO_2

Figure 4.5 World energy consumption and CO_2 emissions, modified to meet RCP 2.6