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Real Clothes for the Emperor:

facing the challenges of climate change

Kevin Anderson
Tyndall Centre
University of Manchester
2012

With significant input from:
Alice Bows & Maria Sharmina
SCI

… and based on wider Tyndall Manchester analysis

Context

The international energy agency's (IEA) view on climate change

- *on track for a 3.5°C rise by 2040 (i.e. 4.2°C relative to preindustrial)*
- *"When I look at this data, the trend is perfectly in line with a temperature increase of 6 degrees Celsius, which would have devastating consequences for the planet."*
- *"we have 5 years to change the energy system – or have it changed"*

Fatih Birol - IEA chief economist

INTERNATIONAL

Copenhagen Accord (2009)

'To hold the increase in global temperature below 2 degrees Celsius, and take action to meet this objective consistent with science and on the basis of equity'

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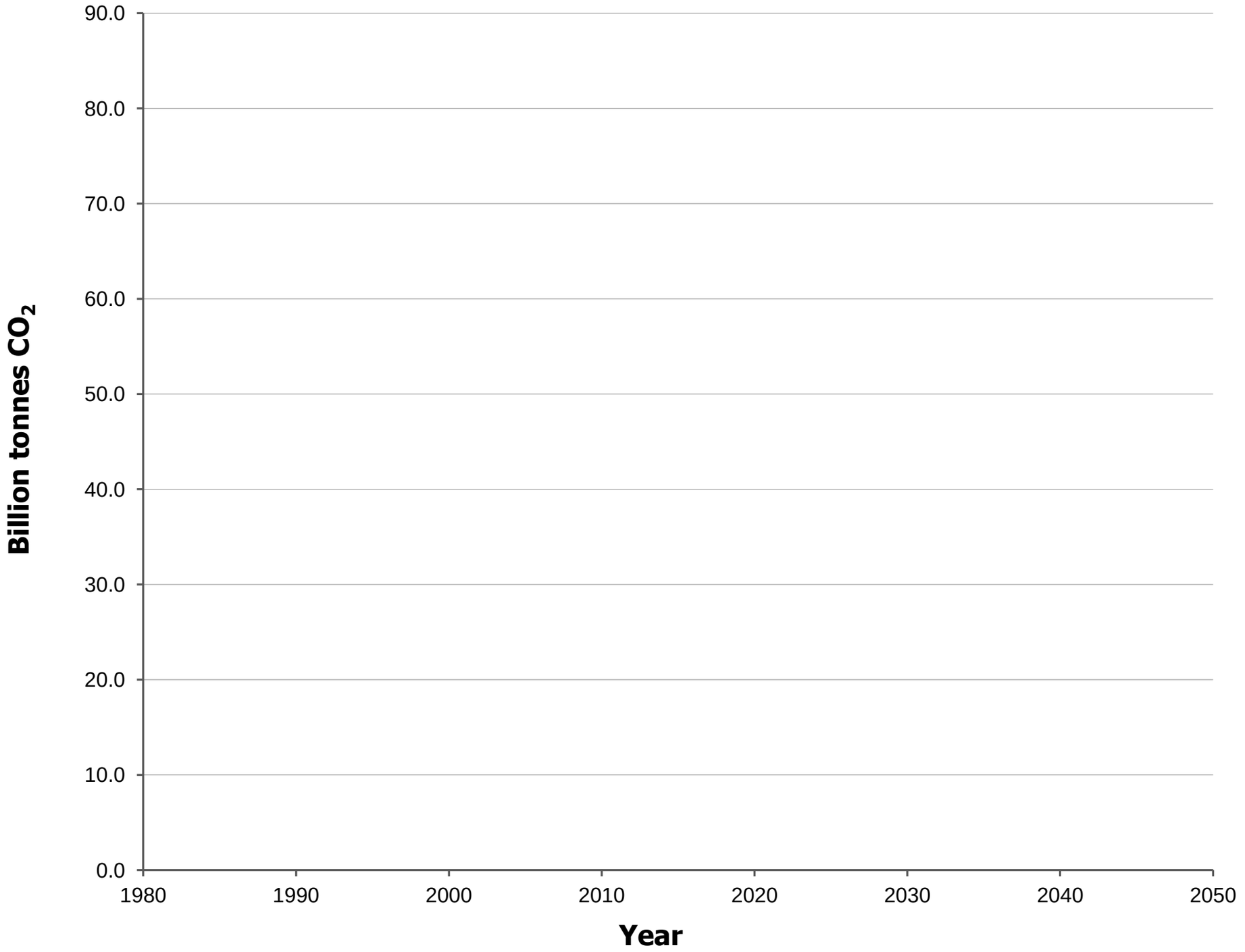
How consistent are 2°C & 4°C futures with emission trends and climate science?

Global emission of fossil fuel CO_2 (inc. cement)



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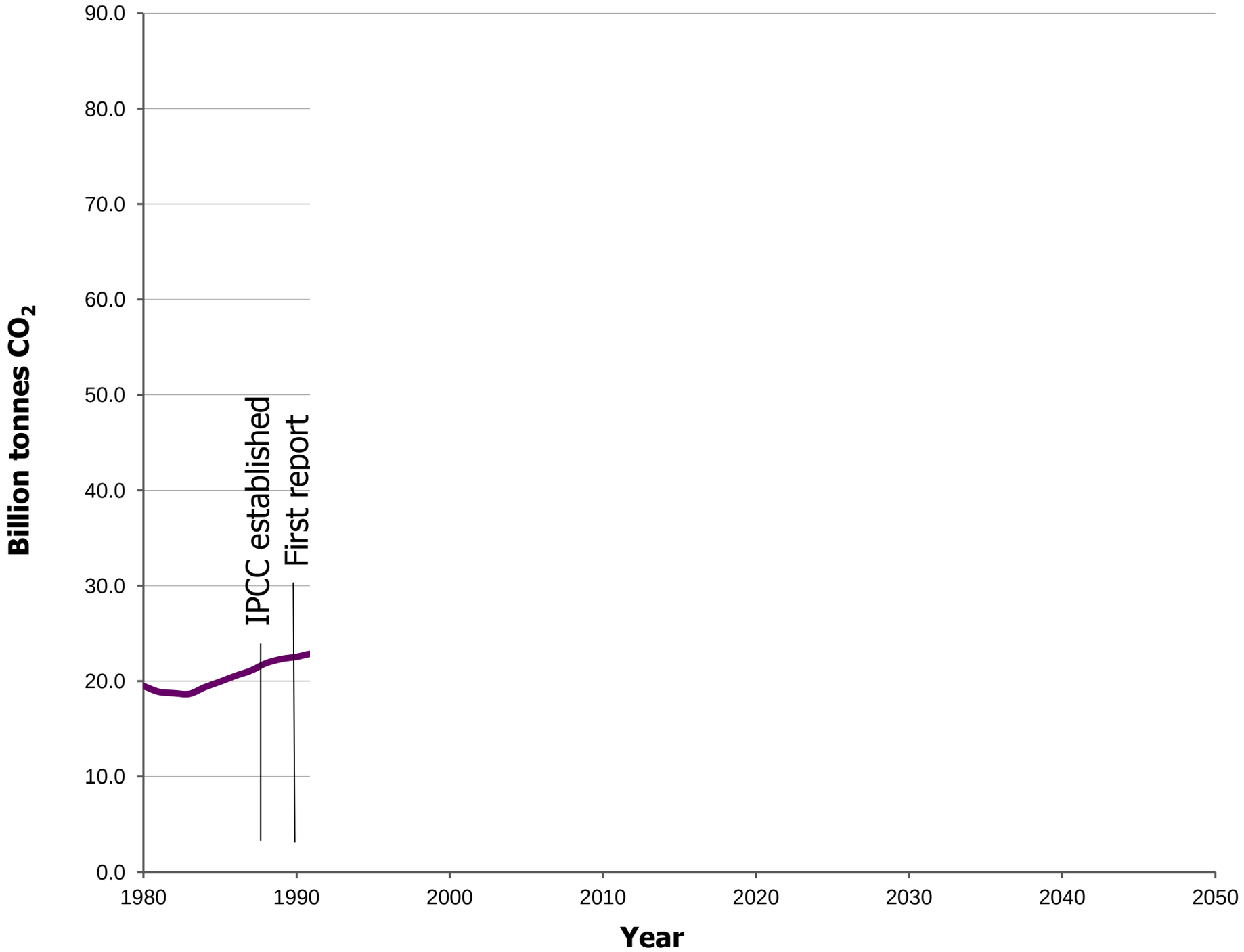

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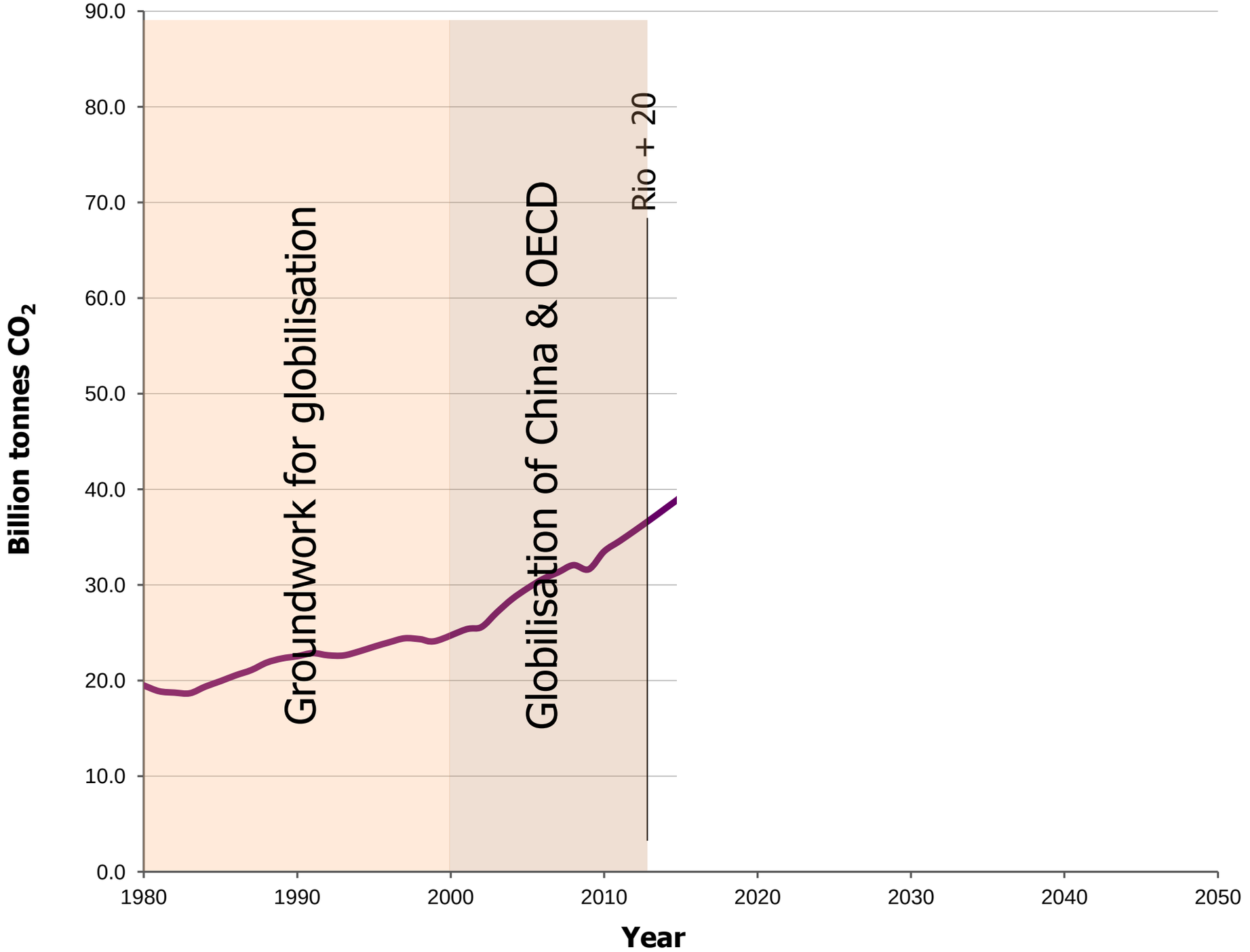

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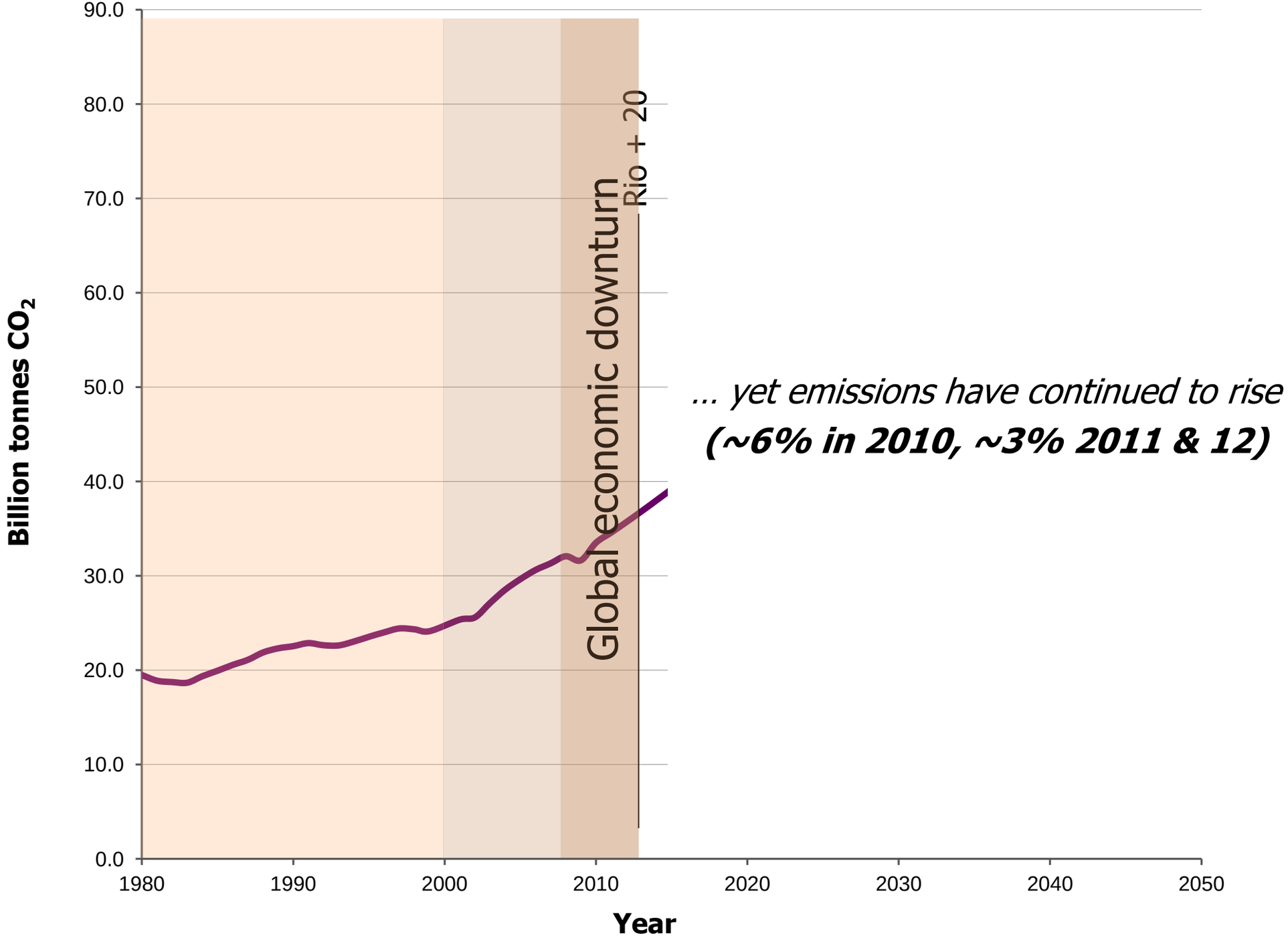

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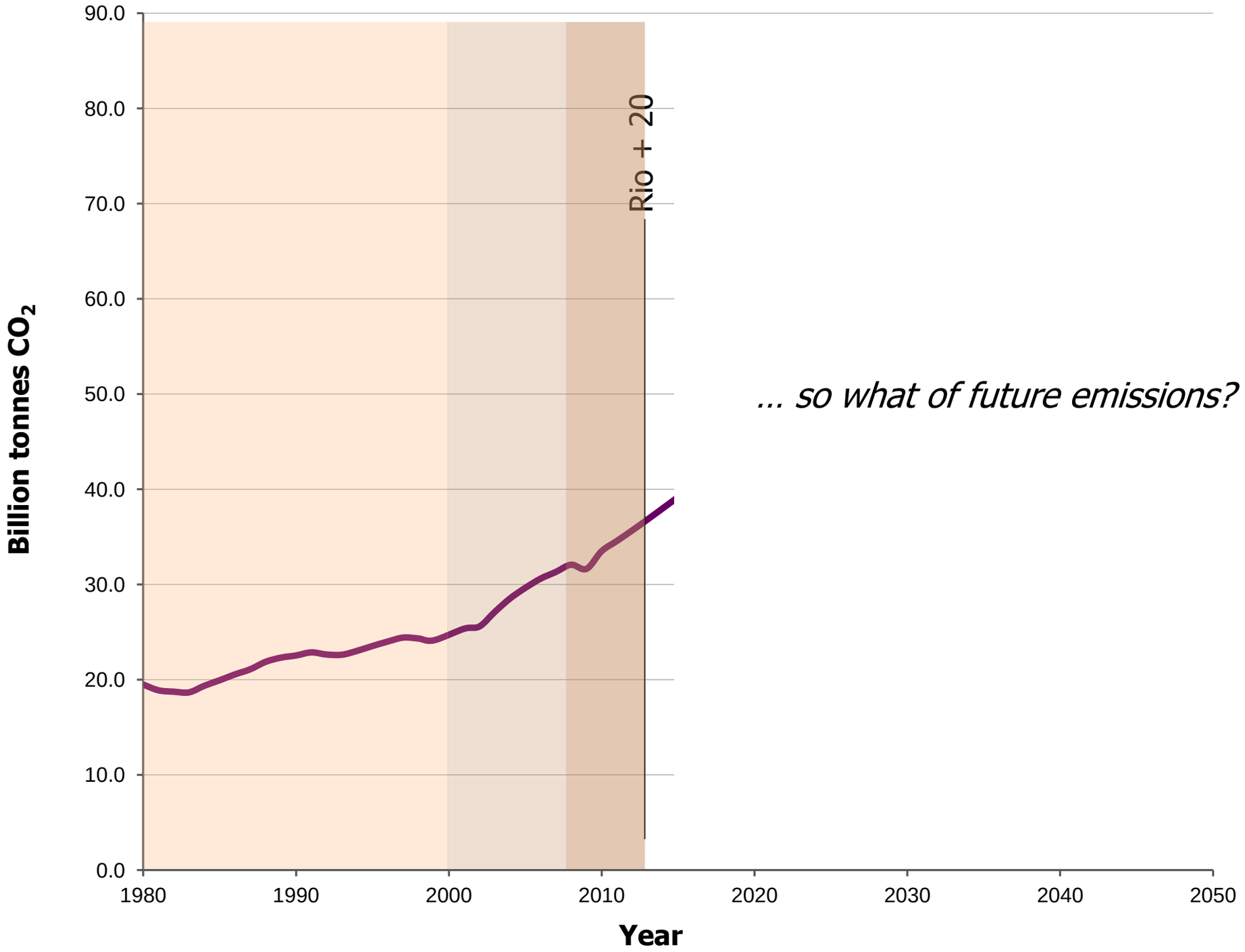
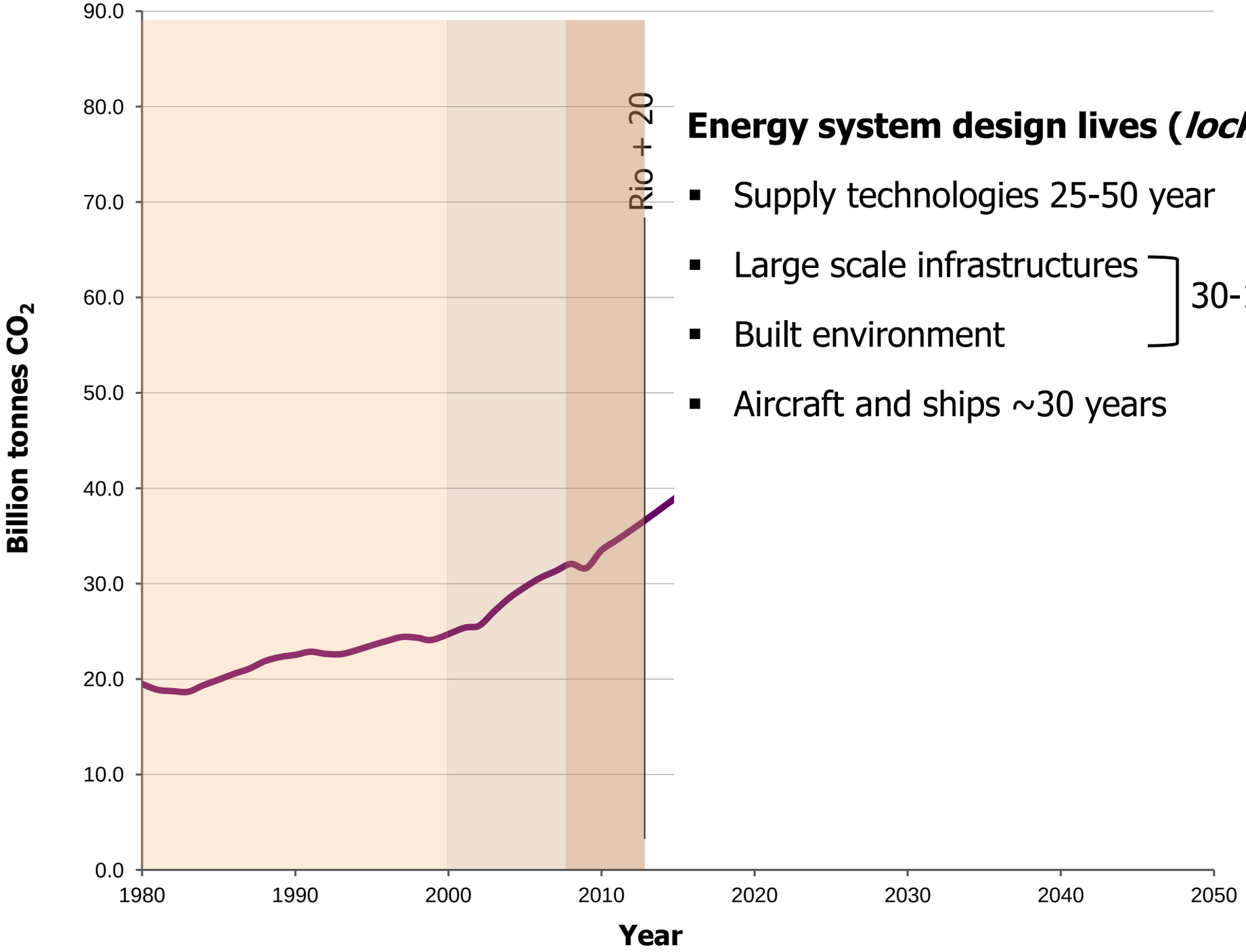


... so what of future emissions?

Global emission of fossil fuel CO_2 (inc. cement)



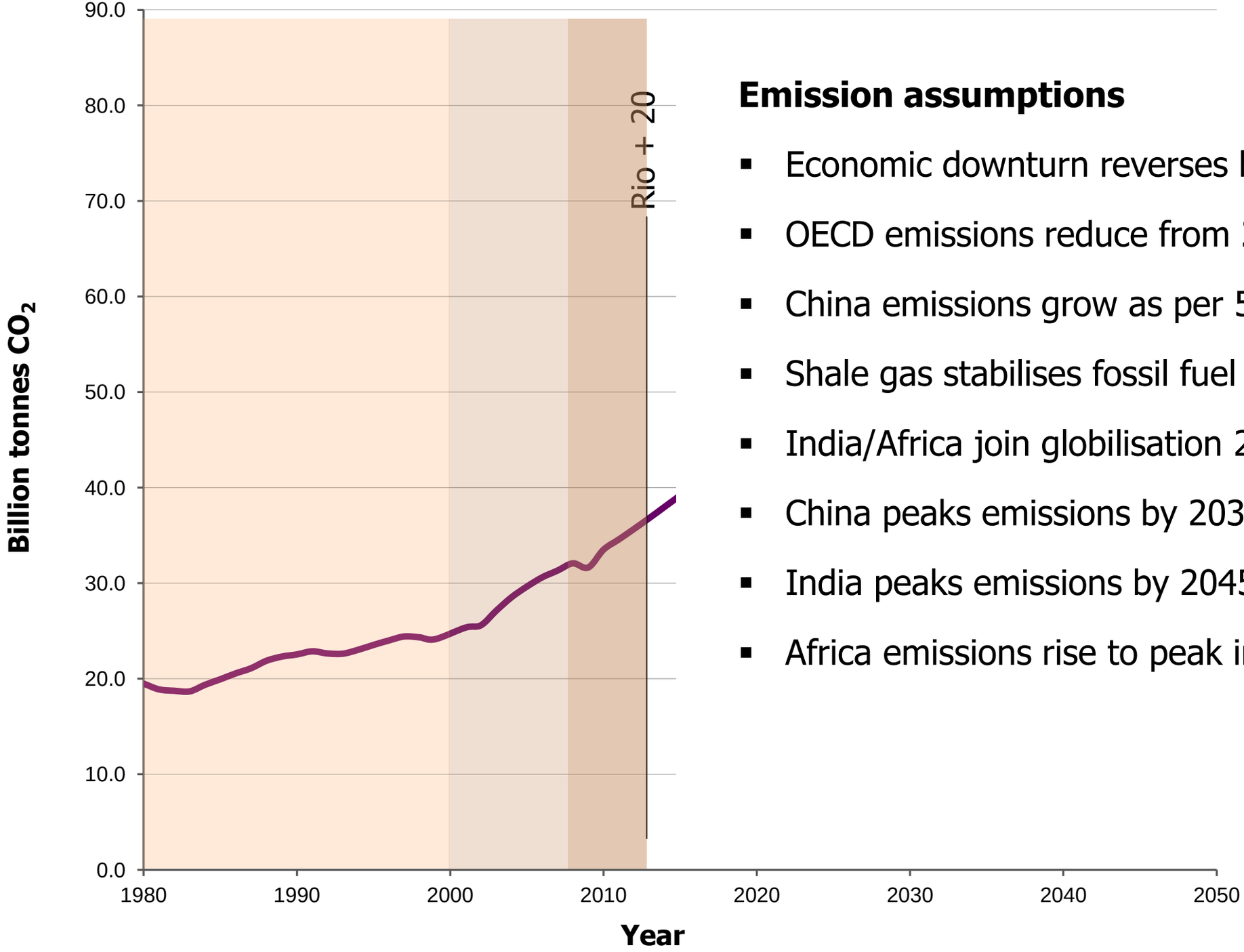
Energy system design lives (*lock-in*)

- Supply technologies 25-50 year
- Large scale infrastructures
- Built environment

30-100 years

- Aircraft and ships ~30 years

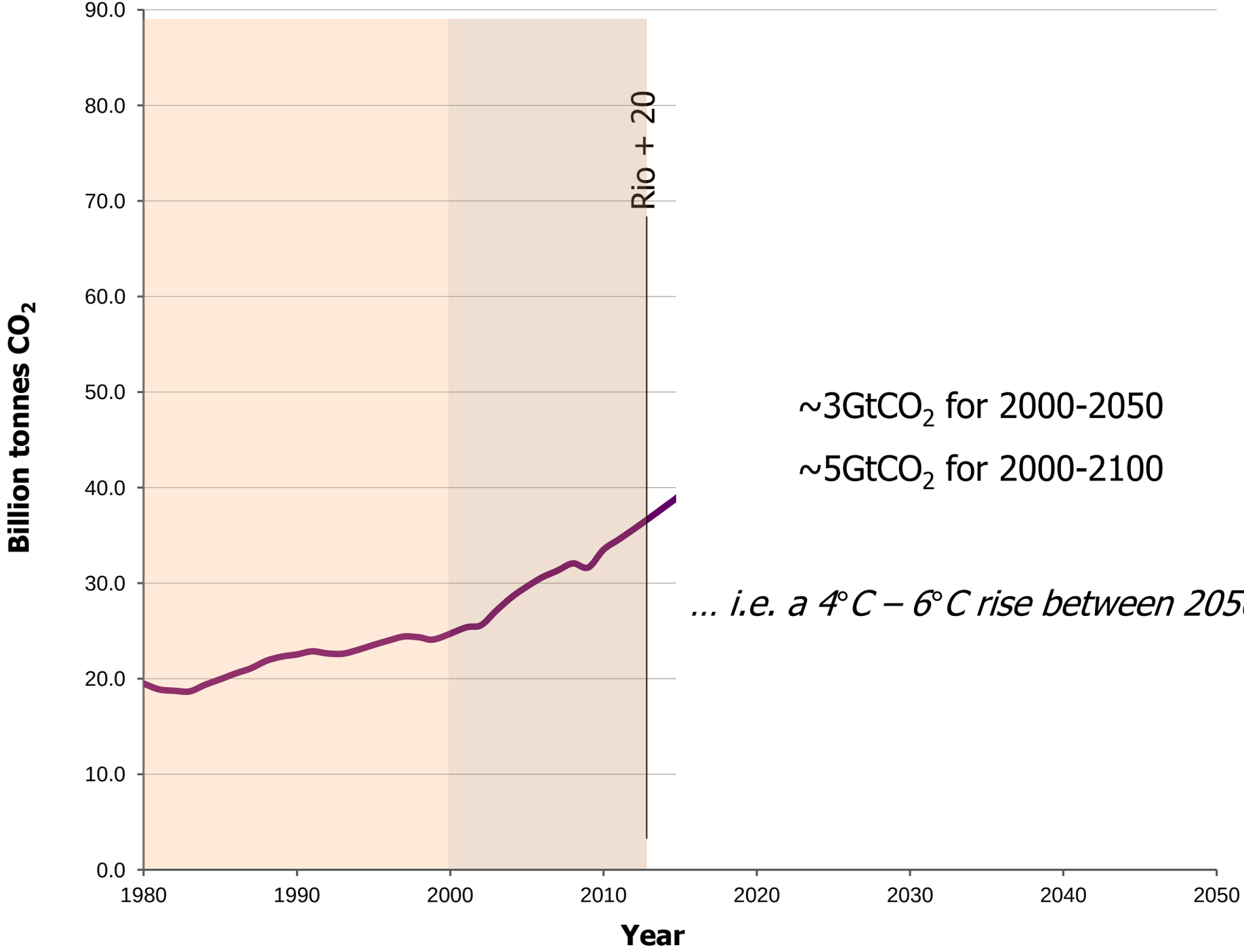
Global emission of fossil fuel CO_2 (inc. cement)



Emission assumptions

- Economic downturn reverses by 2015
- OECD emissions reduce from 2012
- China emissions grow as per 5yr plan
- Shale gas stabilises fossil fuel prices
- India/Africa join globilisation 2020/25
- China peaks emissions by 2030
- India peaks emissions by 2045
- Africa emissions rise to peak in 2060

Global emission of fossil fuel CO_2 (inc. cement)

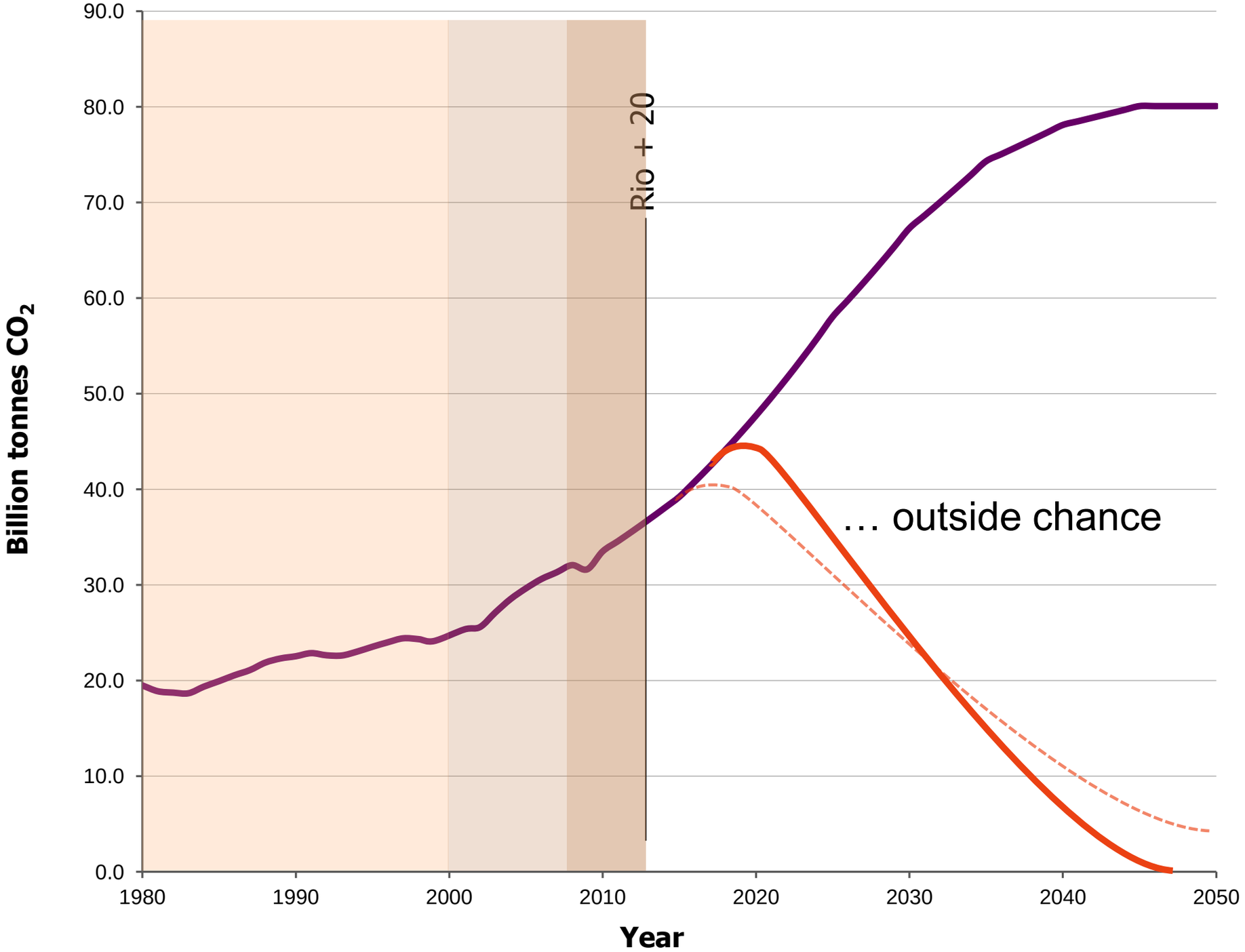


~3GtCO_2 for 2000-2050

~5GtCO_2 for 2000-2100

… i.e. a 4°C – 6°C rise between 2050 & 2100

Global emission of fossil fuel CO_2 (inc. cement)



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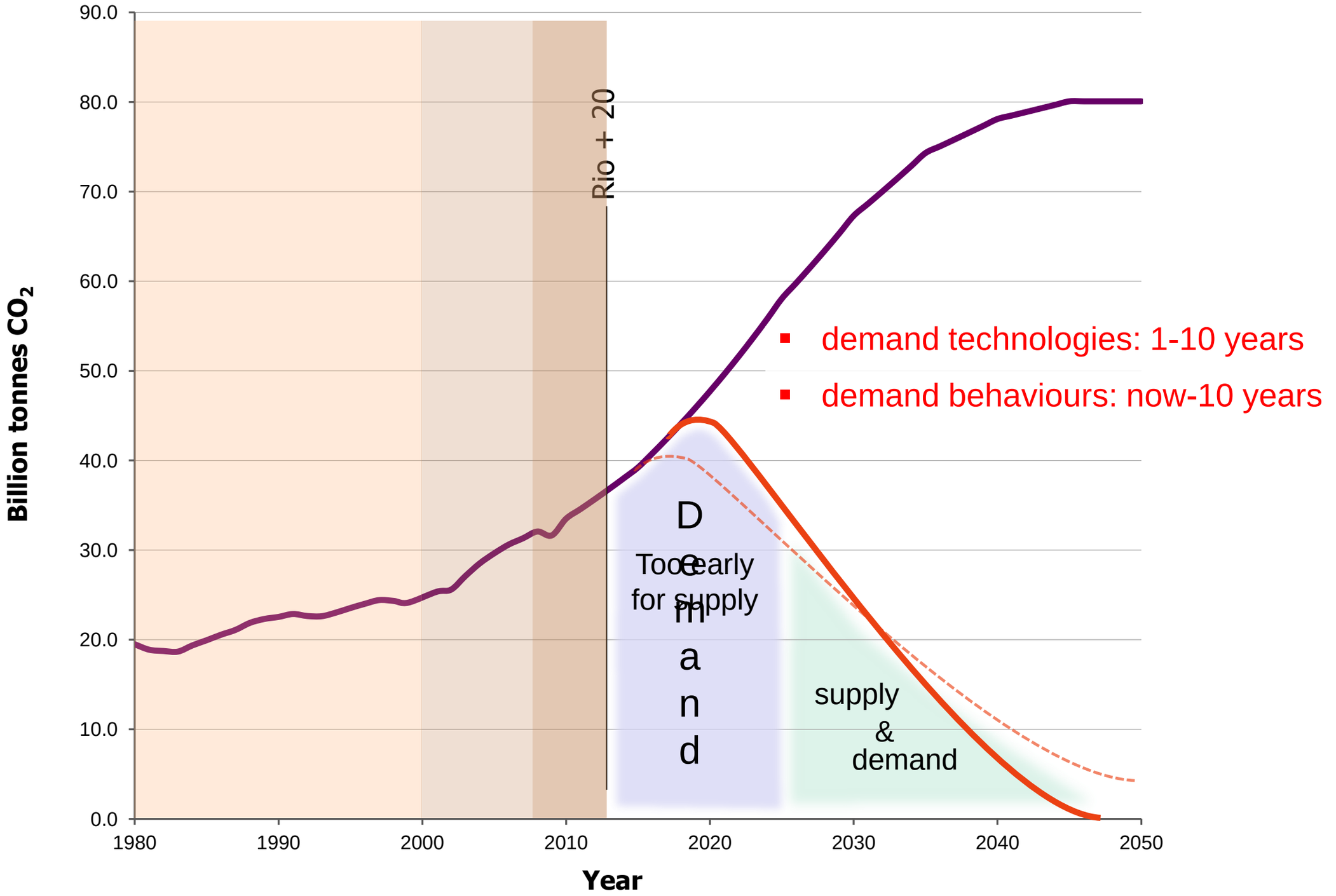

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The Emperor's undergarments

an 'orthodox' view on 2°C

"… it is possible to restrict warming to 2°C .. with at least a 50% probability … emissions peaking in 2016 and a rate of emission reduction of 4%."

AVOID (2009)

"To keep … global average temperature rise close to 2°C … the UK [must] cut emissions by at least 80% ... the good news is that reductions of that size are possible without sacrificing the benefits of economic growth and rising prosperity."

CCC first report p.xiii & 7 (2009)

"… a low stabilisation target of 400ppm CO2e can be achieved at moderate cost … and a high likelihood of achieving this goal."

ADAM/Hulme (2010)

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Still looks naked to me

2°C – a alternative take …

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"… it is difficult to envisage anything other than a planned economic recession being compatible with stabilisation at or below 650ppmv CO_2e."

Anderson & Bows 2008

" … the 2015-16 global peaking date (CCC, Stern & ADAM) implies … a period of prolonged austerity for Annex 1 nations and a rapid transition away from existing development patterns within non-Annex 1 nations."

Anderson & Bows 2011

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Do climate ‘scientists’ take any responsibility for the streaking Emperor?

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Inconsistencies in 2°C targets

- Copenhagen Accord: *"hold … below 2°C Celsius"*
- UK Low Carbon Transition Plan: *"must rise no more than 2°C"*
- EU: *"do not exceed … by more than 2°C"*

IPCC language: a *"very unlikely"* to *"exceptionally unlikely"* chance of exceeding 2°C

i.e. less than a **10%** chance of exceeding 2°C

Despite this:

- CCC global budget has **56%** chance of exceeding 2°C
- & the Government adopts a pathway with a **63%** of exceeding 2°C

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… neither can be reconciled with:

'To hold the increase in global temperature

Copenhagen Accord (2009)

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… moving further away from the science …
headline targets are typically:

UK's	*80%*	*reduction in CO_2e by*	*2050*
EU	*60%-80%*	*"*	*2050*
Bali	*50%*	*"*	*2050*

But:

- CO_2 stays in atmosphere for 100+ years
- 2050 reduction unrelated to avoiding dangerous climate change *(2*°C)
- cumulative emissions that matter (i.e. carbon budget)
- this fundamentally rewrites the chronology of climate change

- from long term gradual reductions

- to urgent & radical reductions

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How does this scientifically-credible approach change the 2°C challenge?

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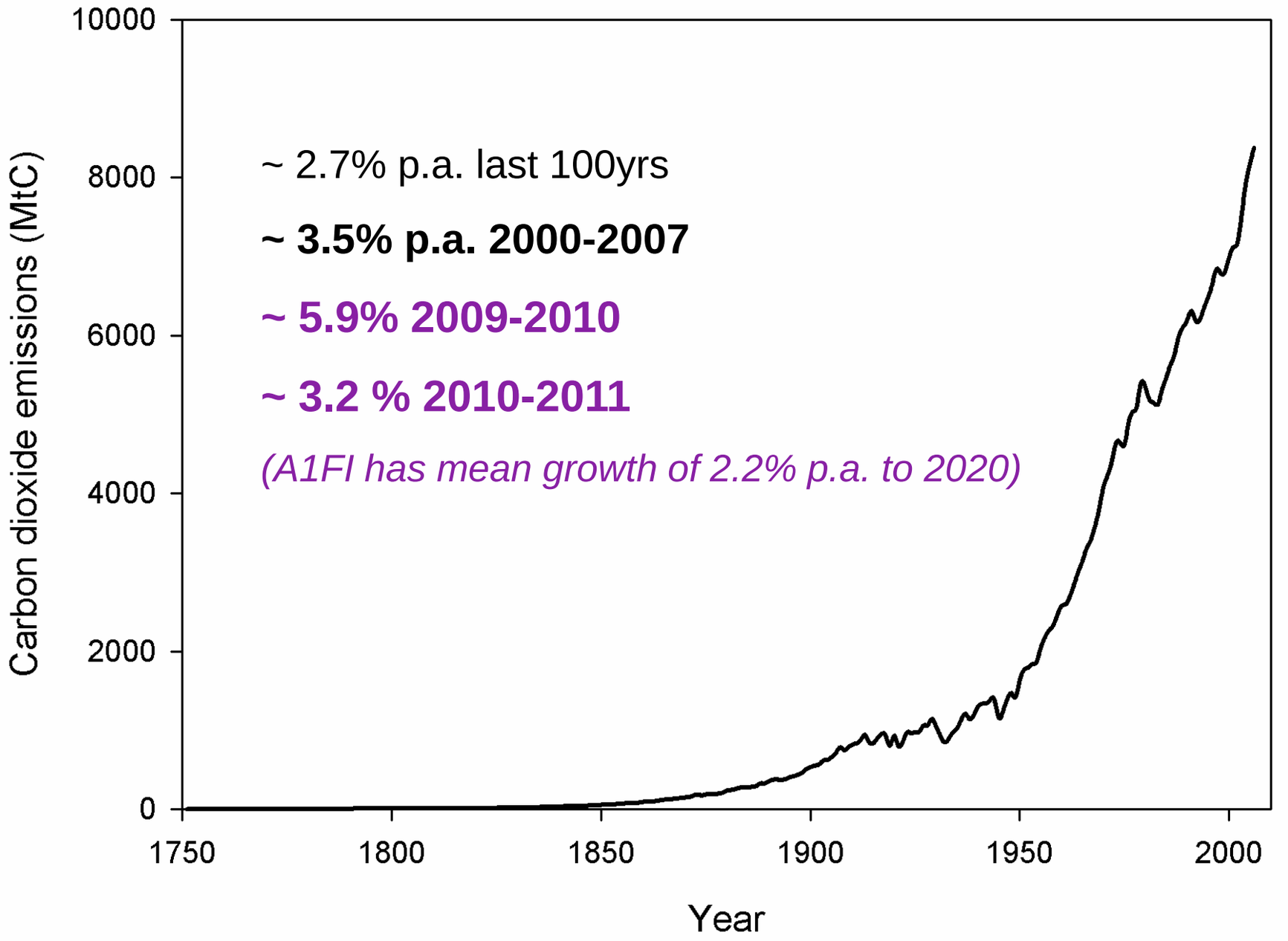
factor in…

the latest emissions data

what is the scale of the global ‘problem’ we now face?

Things are getting worse!

Global CO_2 emission trends?



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What does:

- this failure to reduce emissions

&

- the latest science on cumulative emissions

Say about a 2°C emissions reduction pathway?

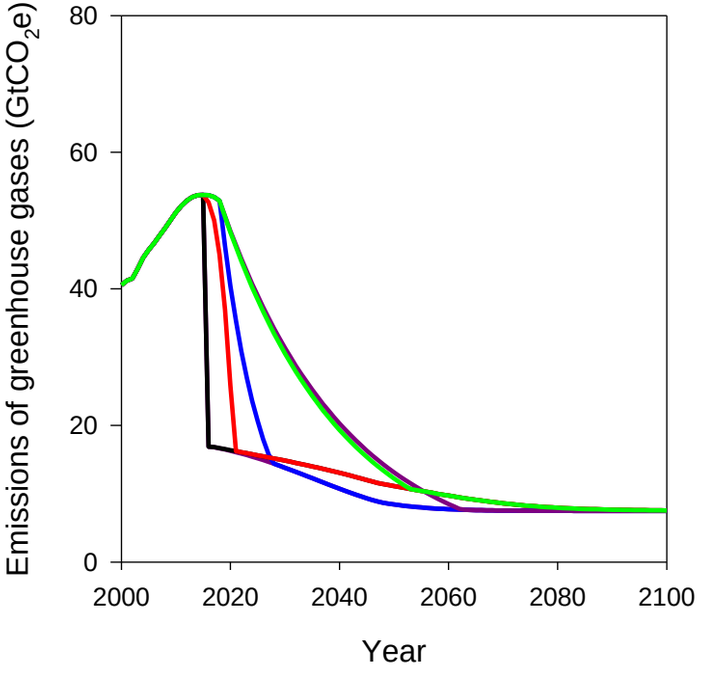
early emissions peak = lower emissions reduction/year

early emissions peak = lower emission reduction/year

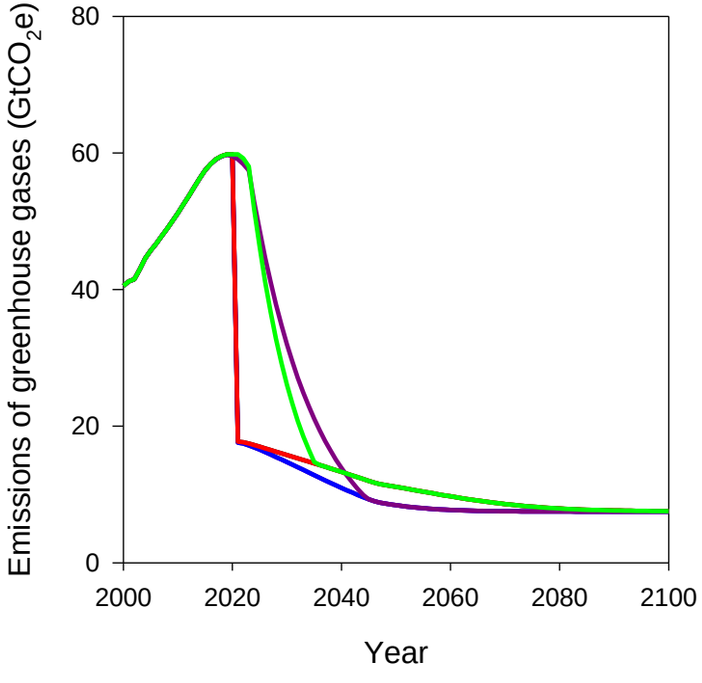
Total greenhouse gas emission pathways

AR4 – 450ppmv CO_2e stabilisation cumulative emission range

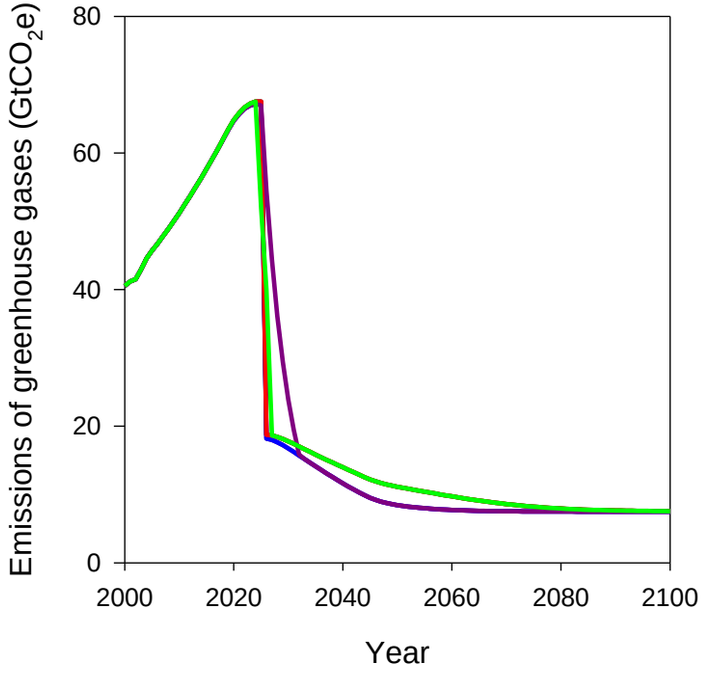
2015 peak



2020 peak



2025 peak



(Anderson & Bows. 2008 Philosophical Transactions A of the Royal Society. 366. pp.3863-3882)

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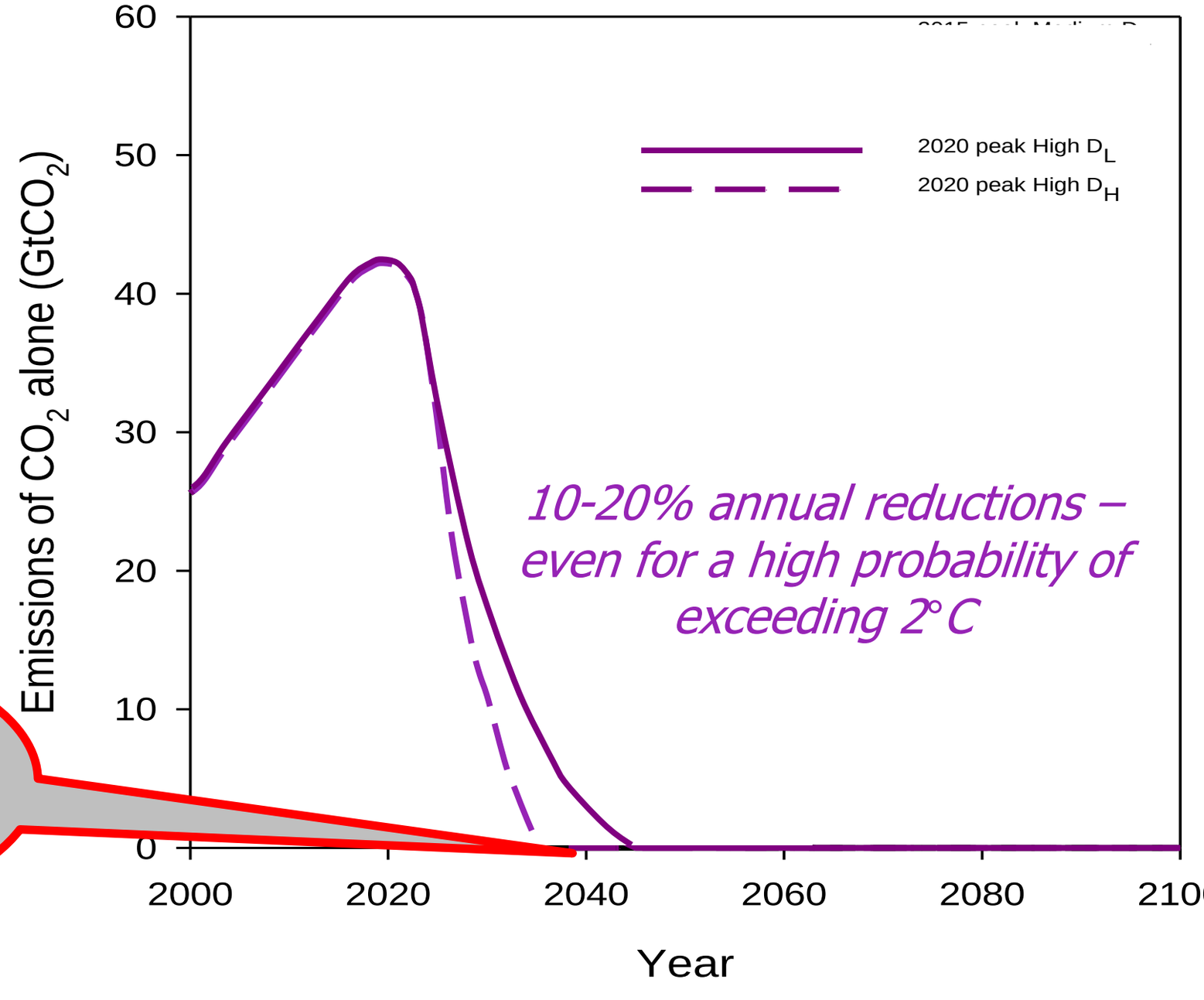
… and for energy emissions?

(with 2020 peak)

13 of 18 scenarios ‘impossible’

Even then total decarbonisation by ~2035-45 necessary

Globally: no emission space for coal, gas, or shale – even with CCS!



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A fair deal for non-OECD *(non-Annex 1)*

… what's left for us *(OECD/Annex 1)*?

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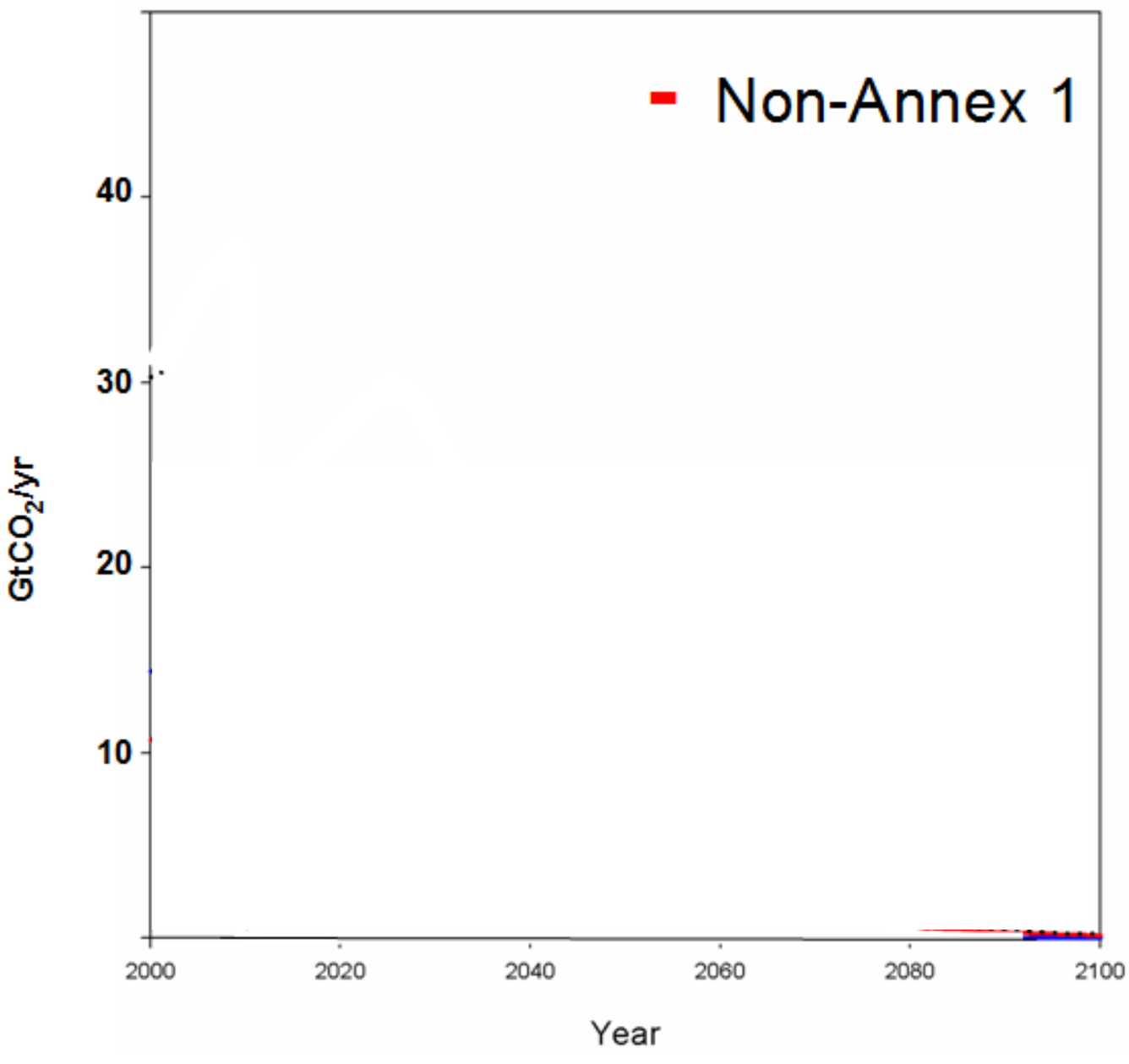
Anderson-Bows: (CO_2 only)

(Royal Society's Philosophical Transactions – Jan 2011
~40% chance of exceeding 2°C)



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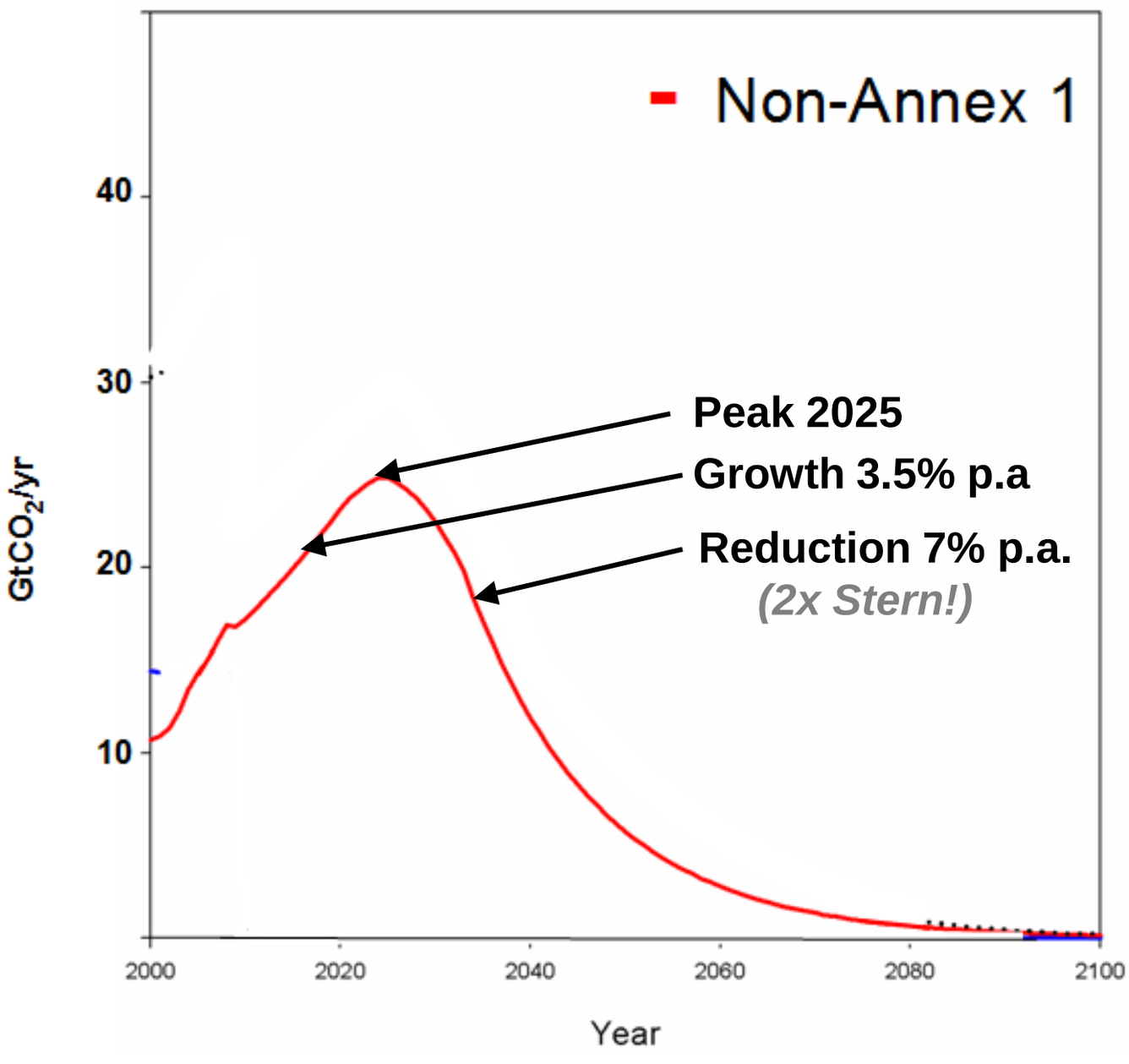

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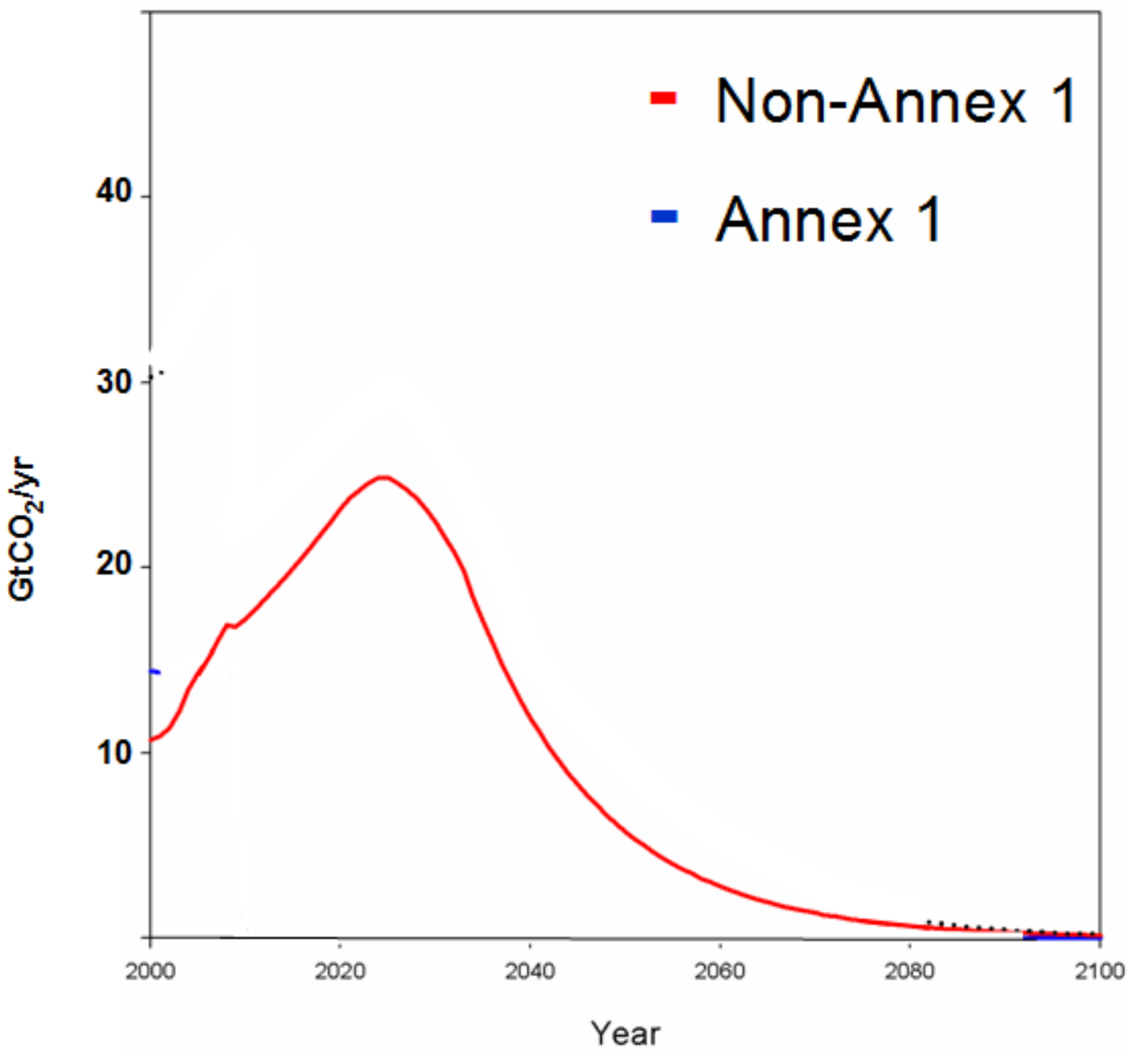

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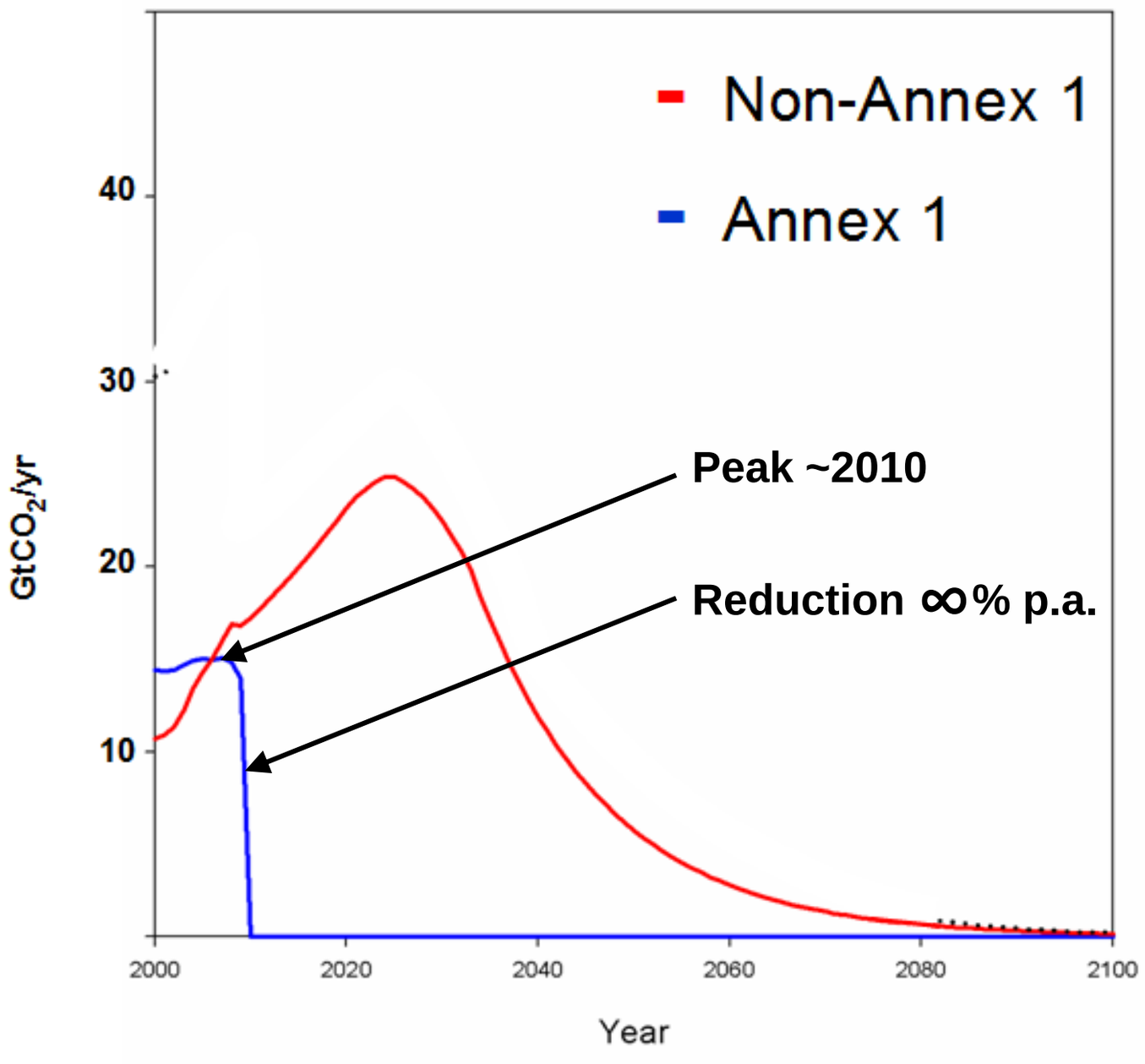

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How do two such fundamentally different interpretations of the challenge arise from the same science?

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… thinking about this graphically

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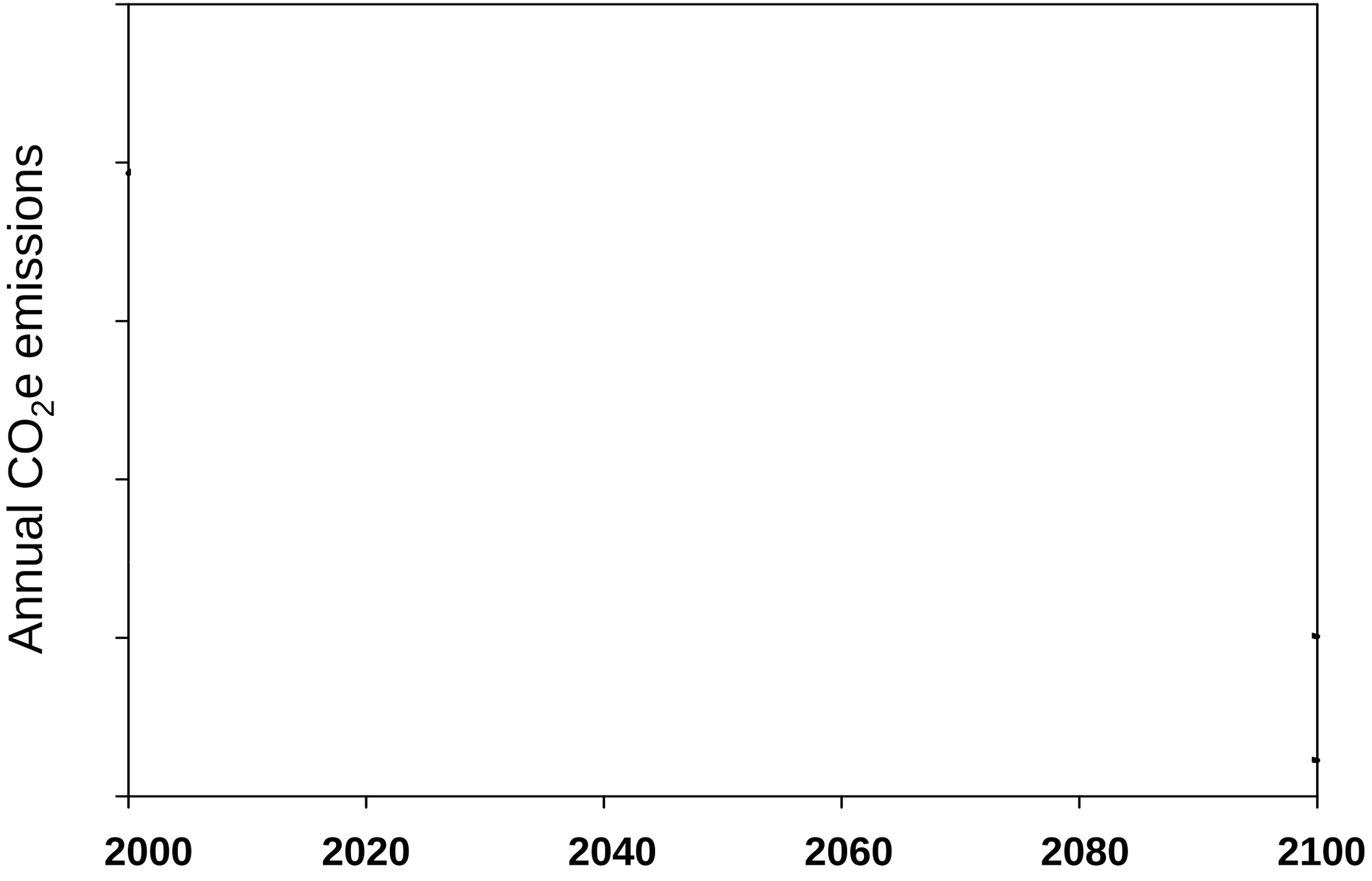
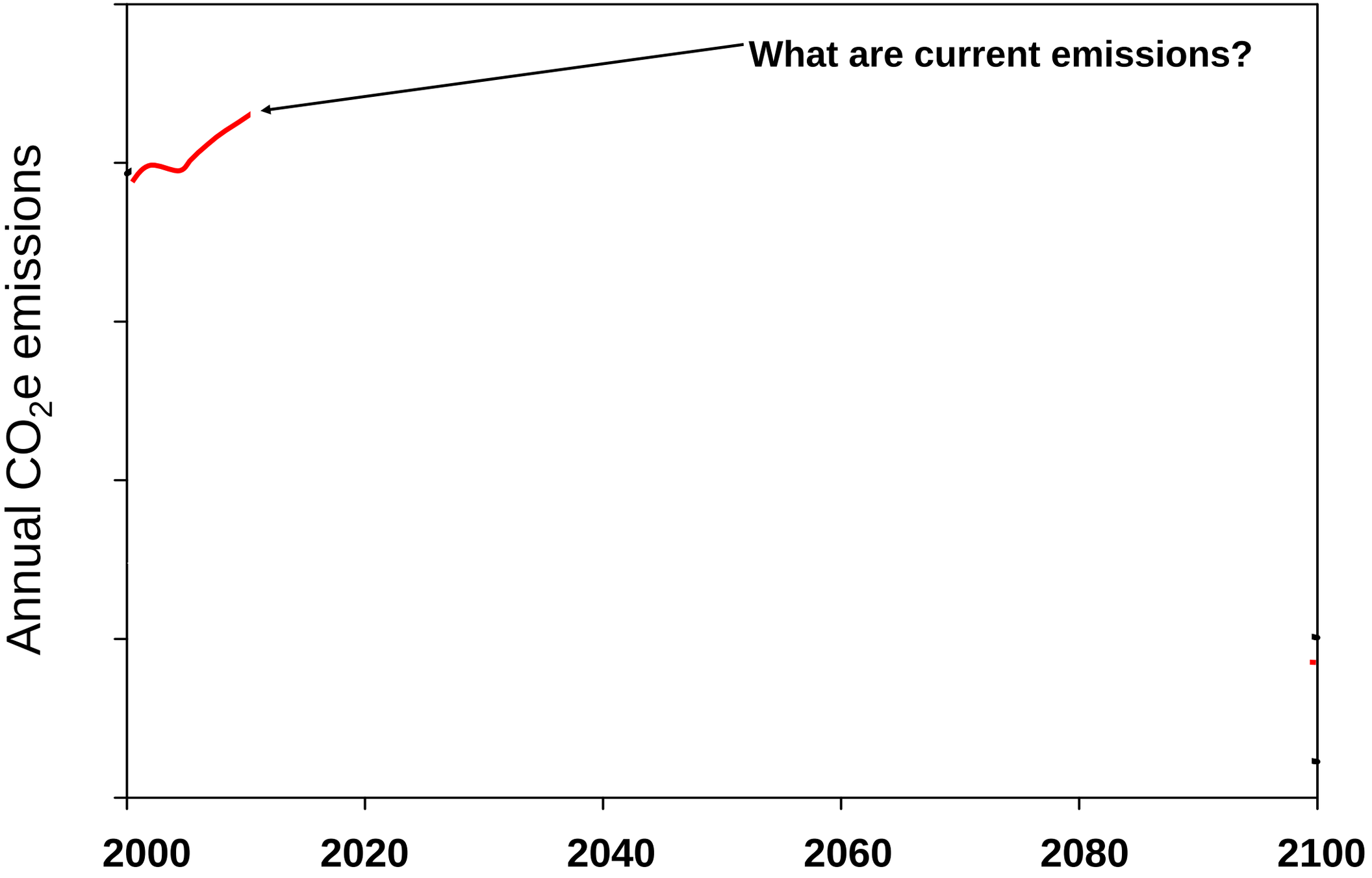
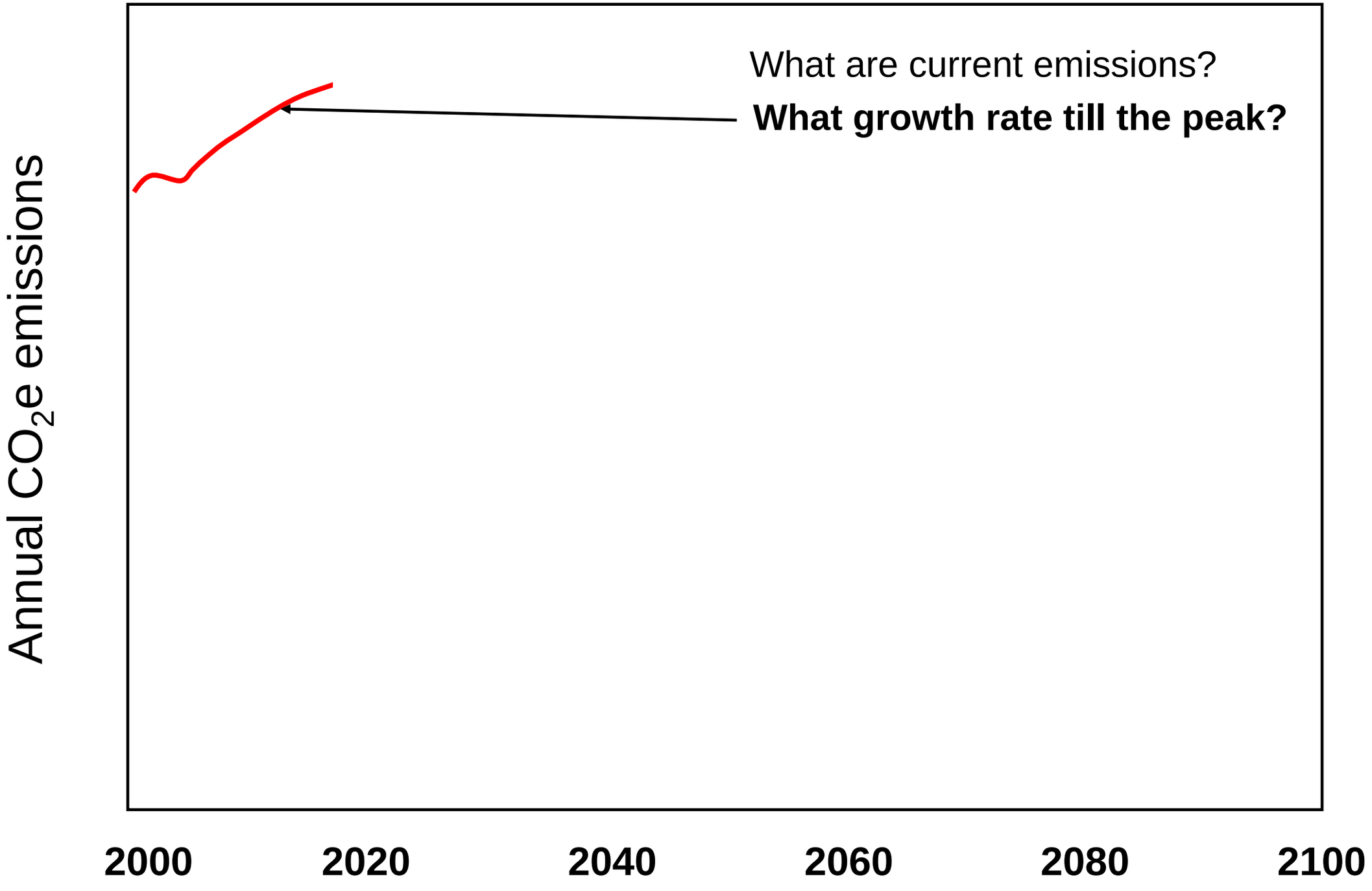
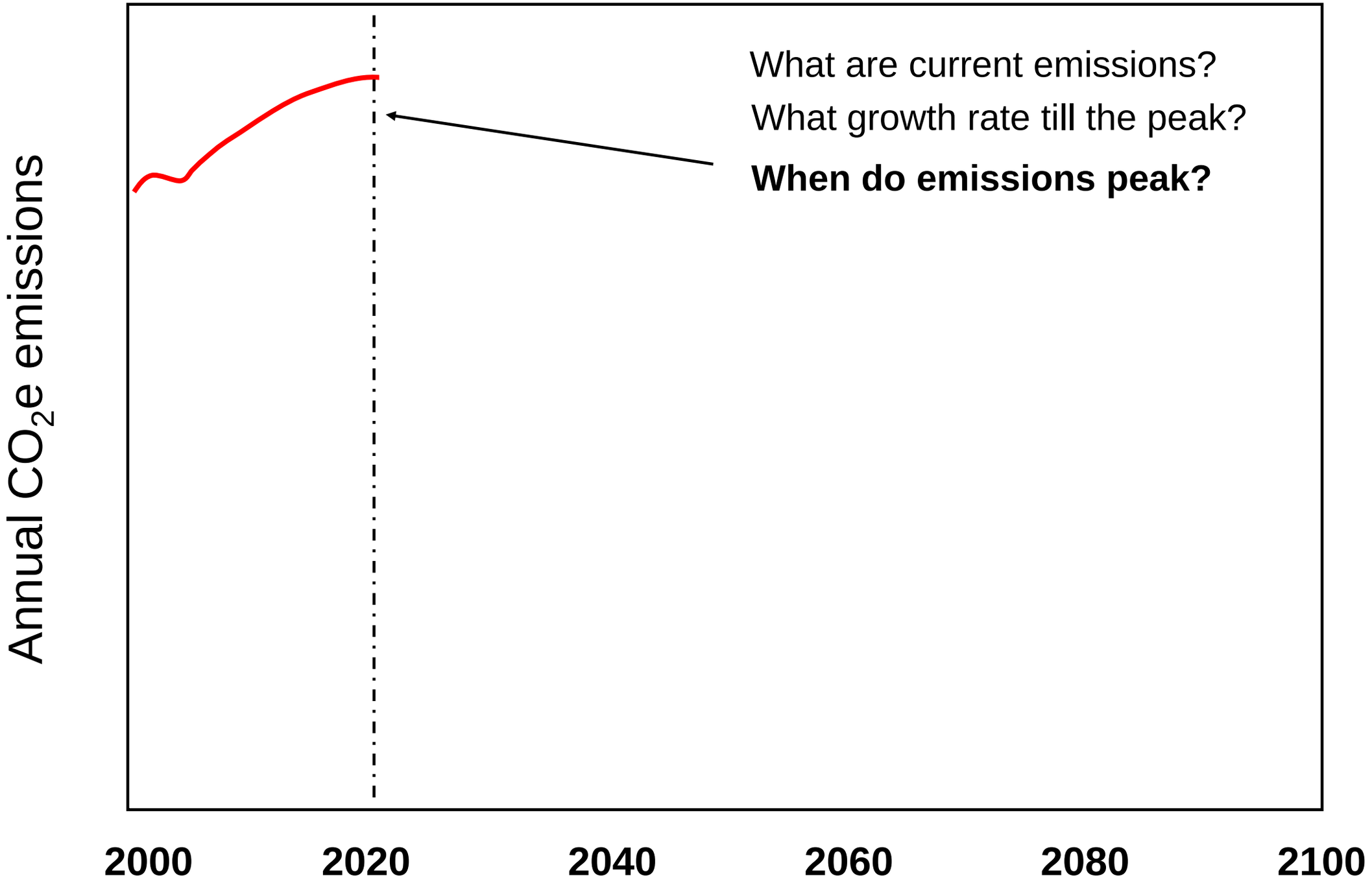

Annual CO_2e emissions
2000
2020
2040
2060
2080
2100


What are current emissions?
Annual CO_2e emissions
2000
2020
2040
2060
2080
2100


What are current emissions?
What growth rate till the peak?
Annual CO_2e emissions
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
2000
2020
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2060
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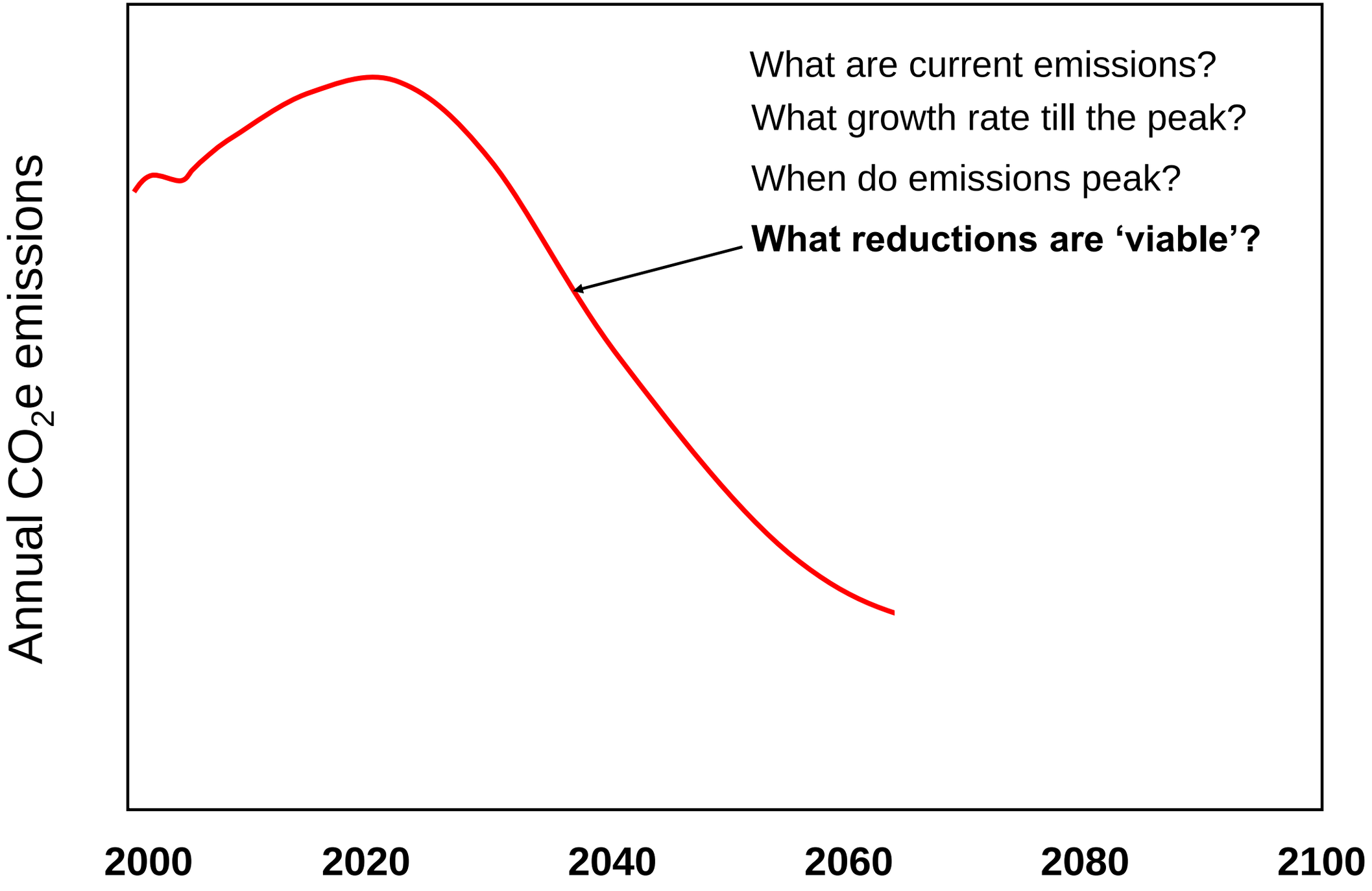
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are ‘viable’?
Annual CO_2e emissions
2000
2020
2040
2060
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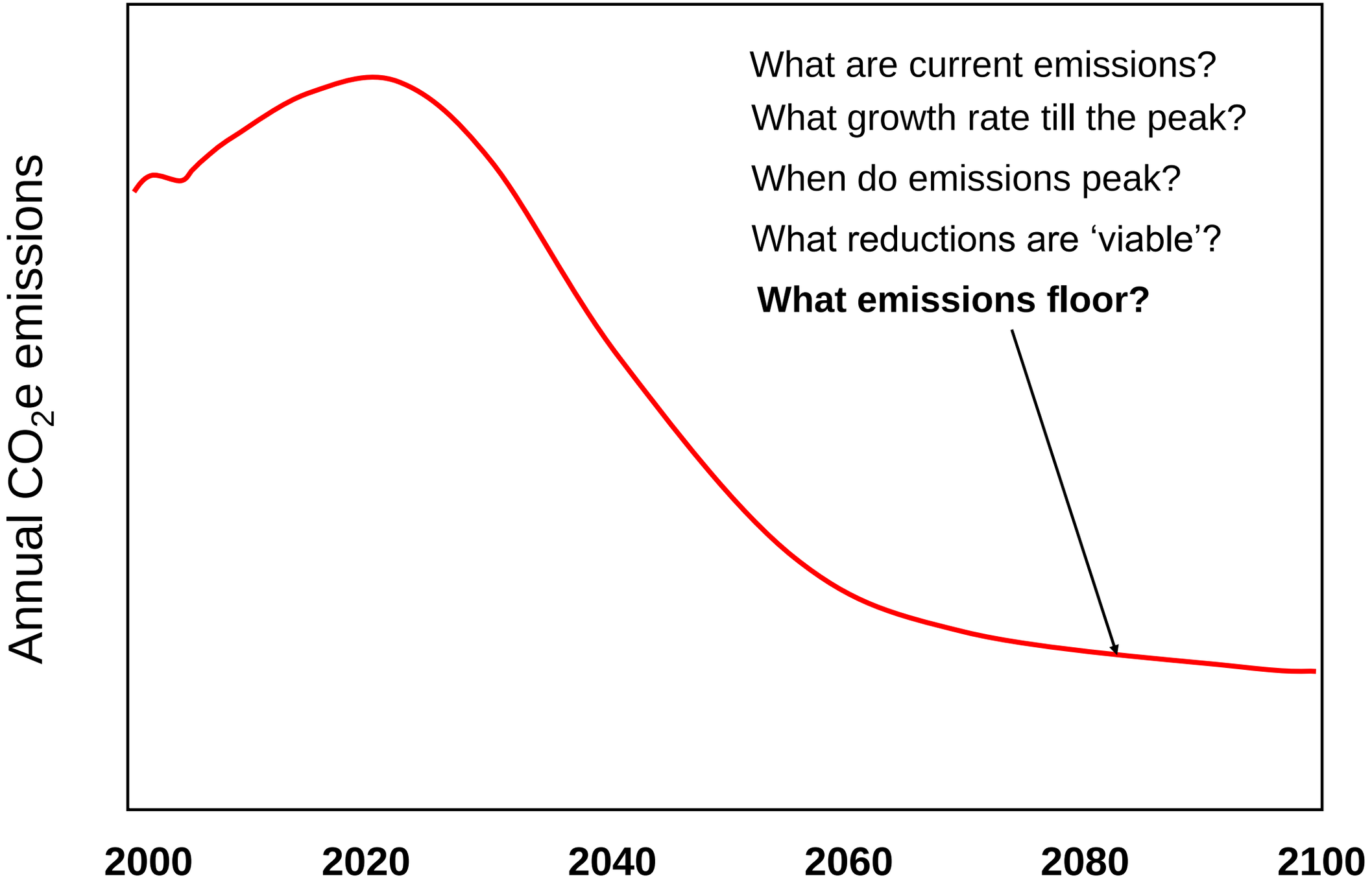
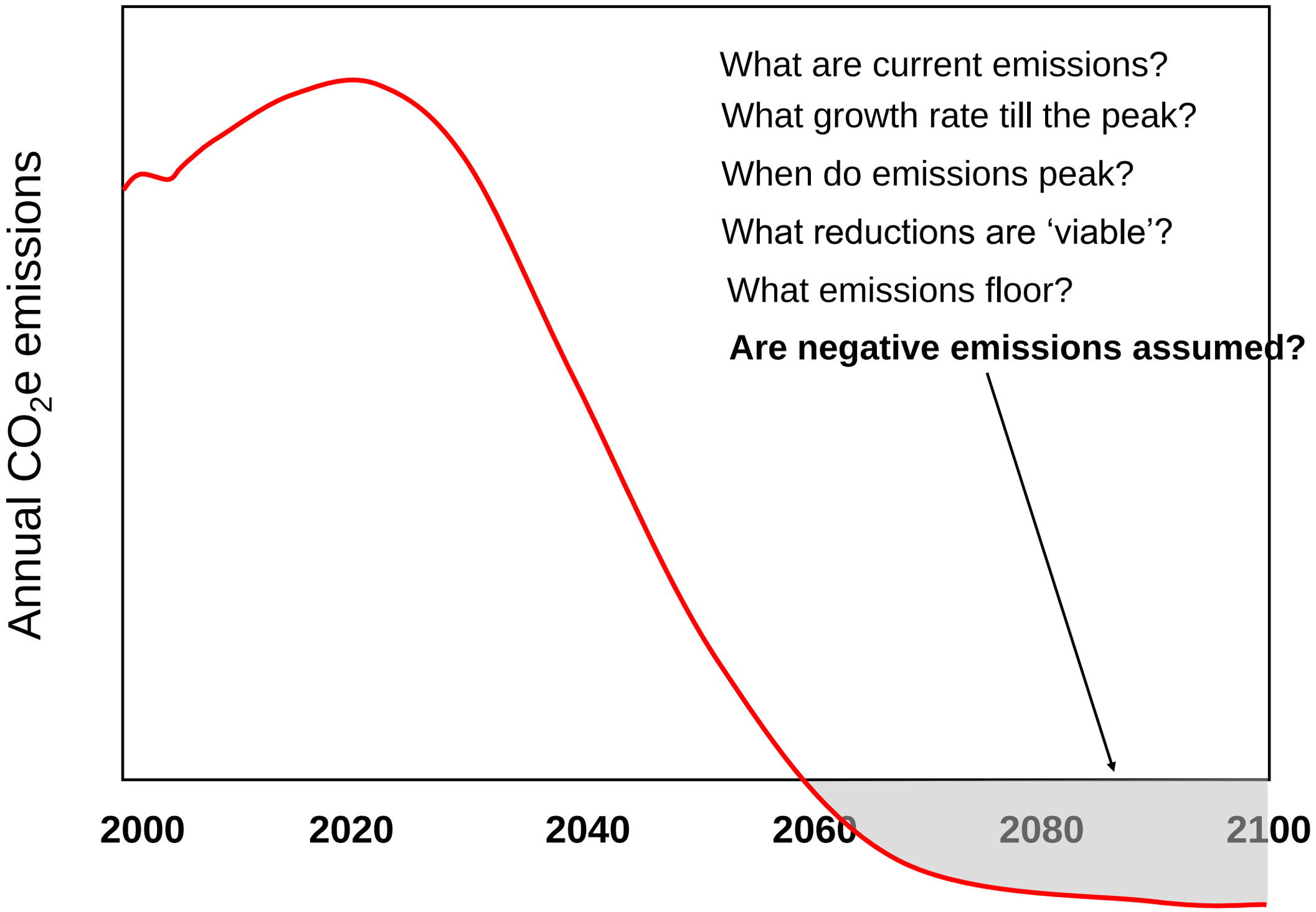
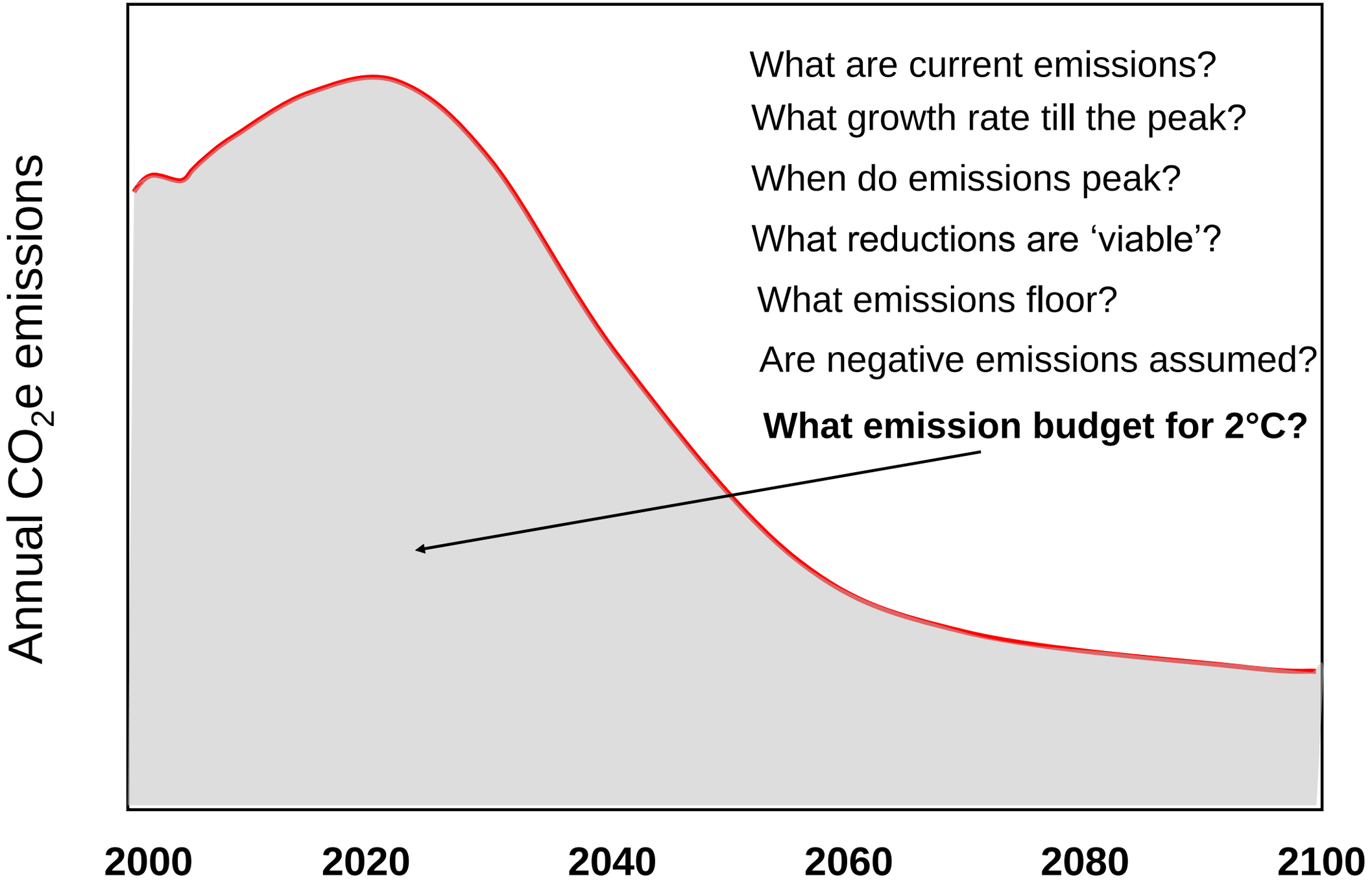

What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are ‘viable’?
What emissions floor?
Annual CO_2e emissions
2000
2020
2040
2060
2080
2100


What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are ‘viable’?
What emissions floor?
Are negative emissions assumed?
Annual CO_2e emissions
2000
2020
2040
2060
2080
2100


What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are ‘viable’?
What emissions floor?
Are negative emissions assumed?
What emission budget for 2°C?
Annual CO_2e emissions
2000
2020
2040
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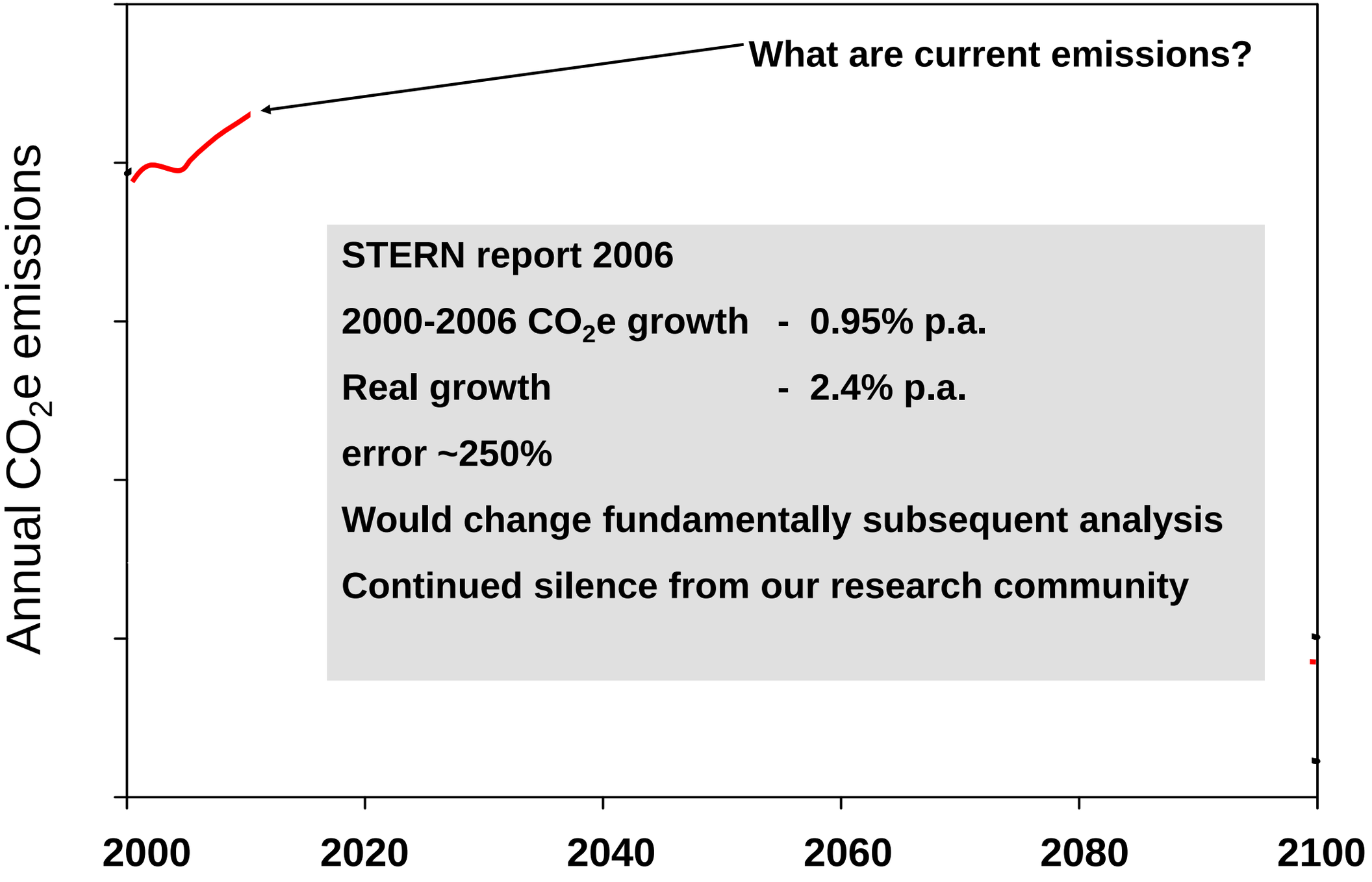
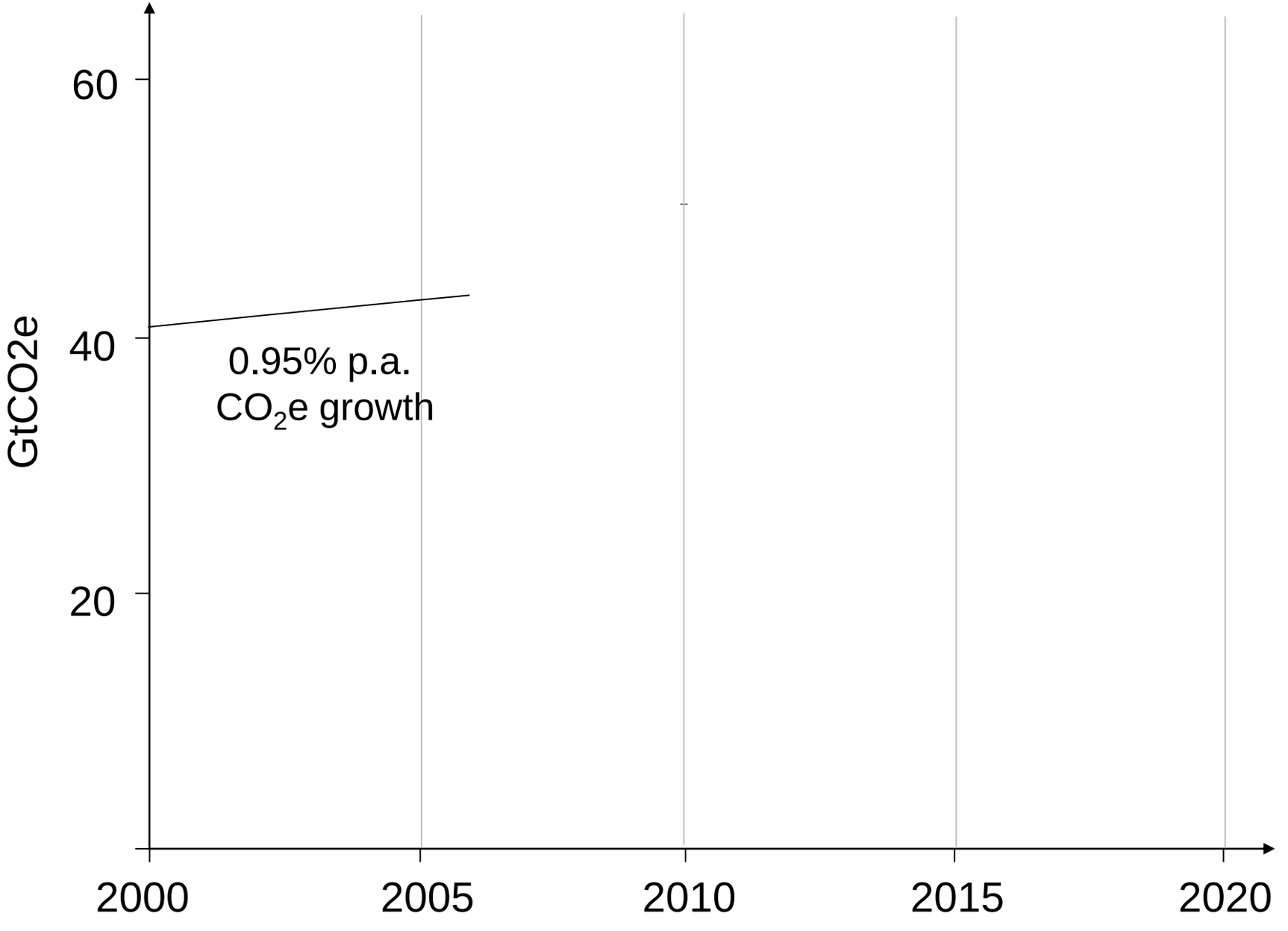
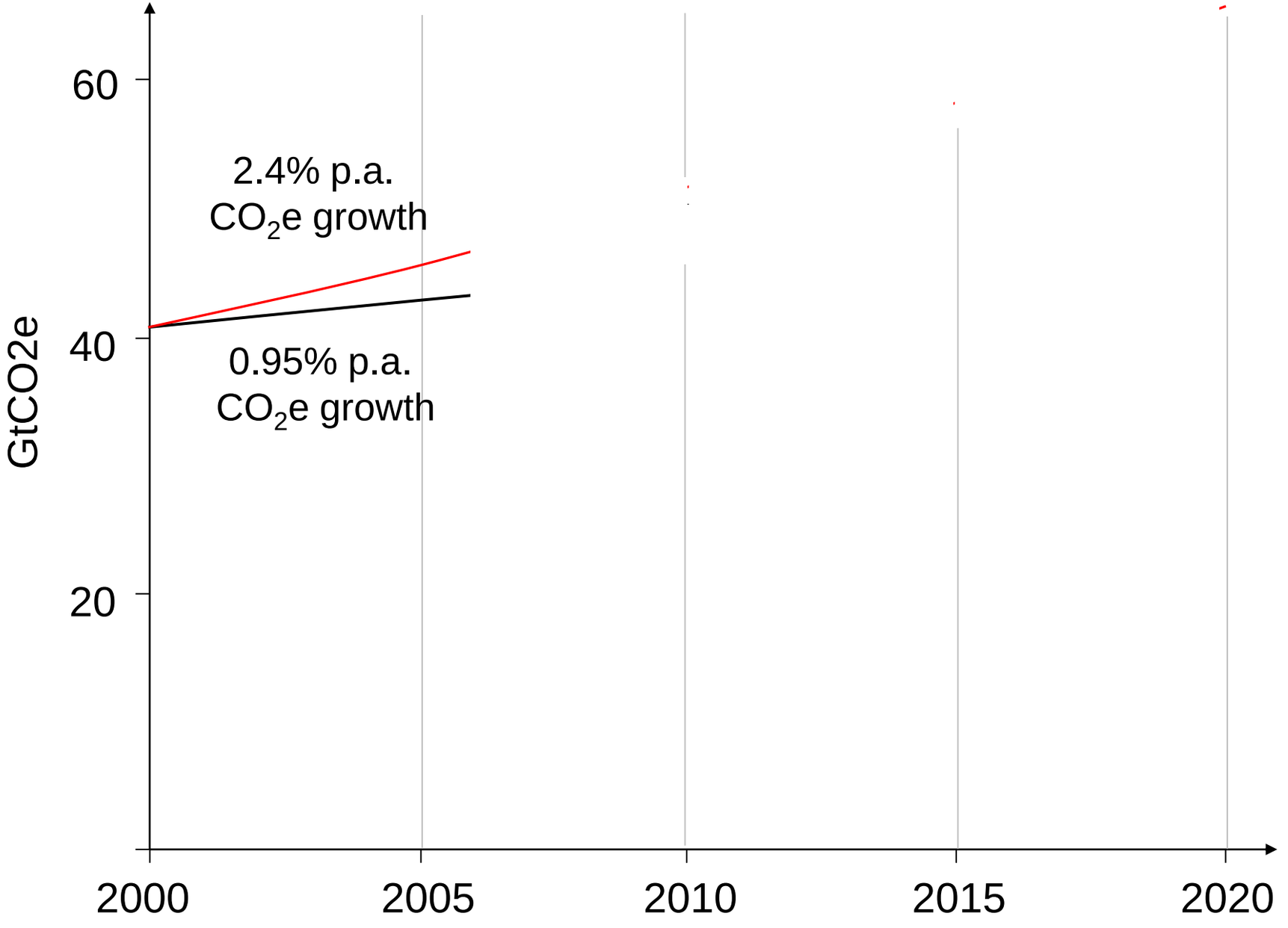

What are current emissions?
Annual CO_2e emissions
STERN report 2006
2000-2006 CO_2e growth - 0.95% p.a.
Real growth - 2.4% p.a.
error ~250%
Would change fundamentally subsequent analysis
Continued silence from our research community
2000
2020
2040
2060
2080
2100

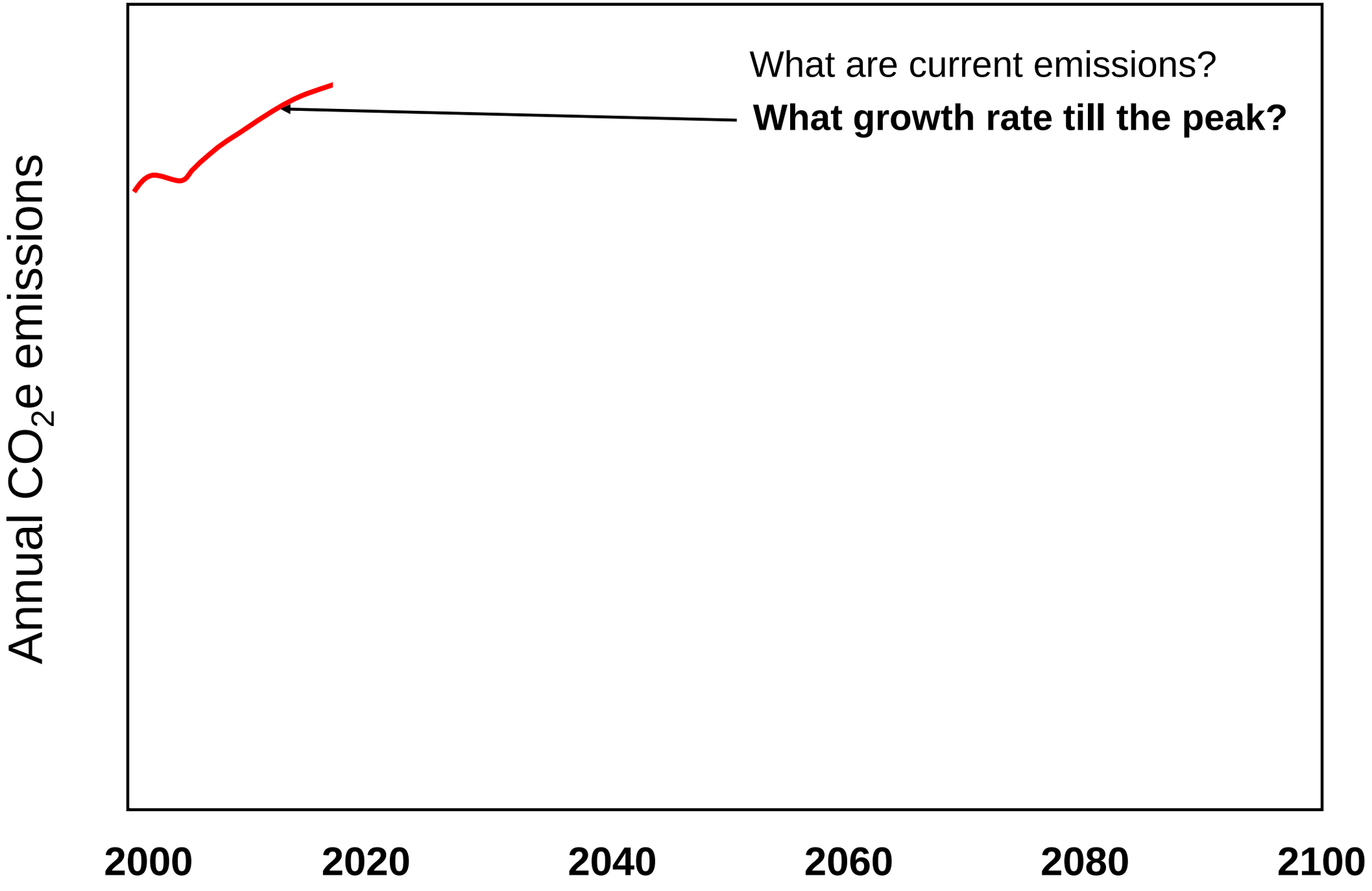
Stern vs. reality



Stern vs. reality

extrapolating different growth rates

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Annual CO_2e emissions
2000
2020
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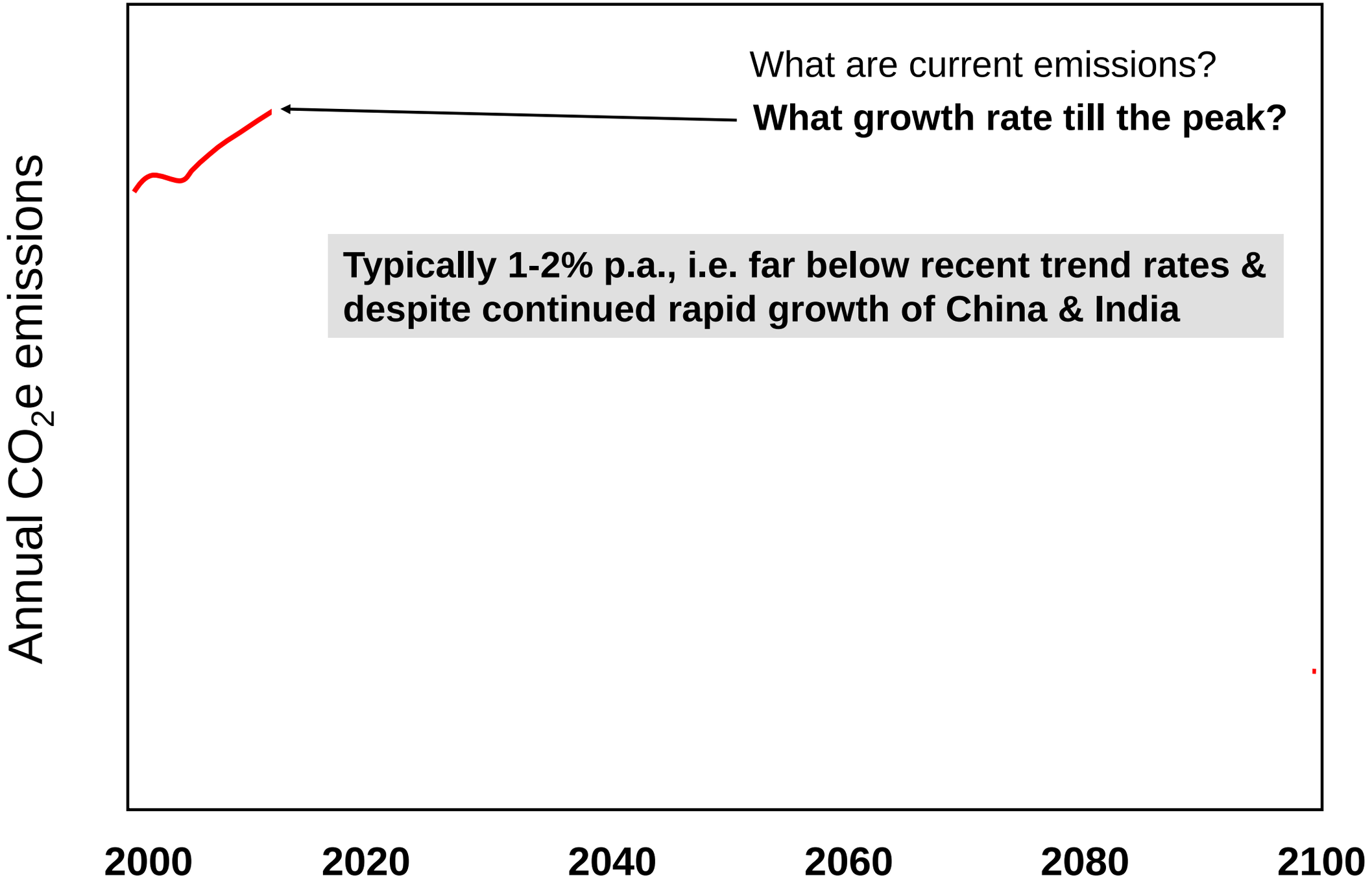
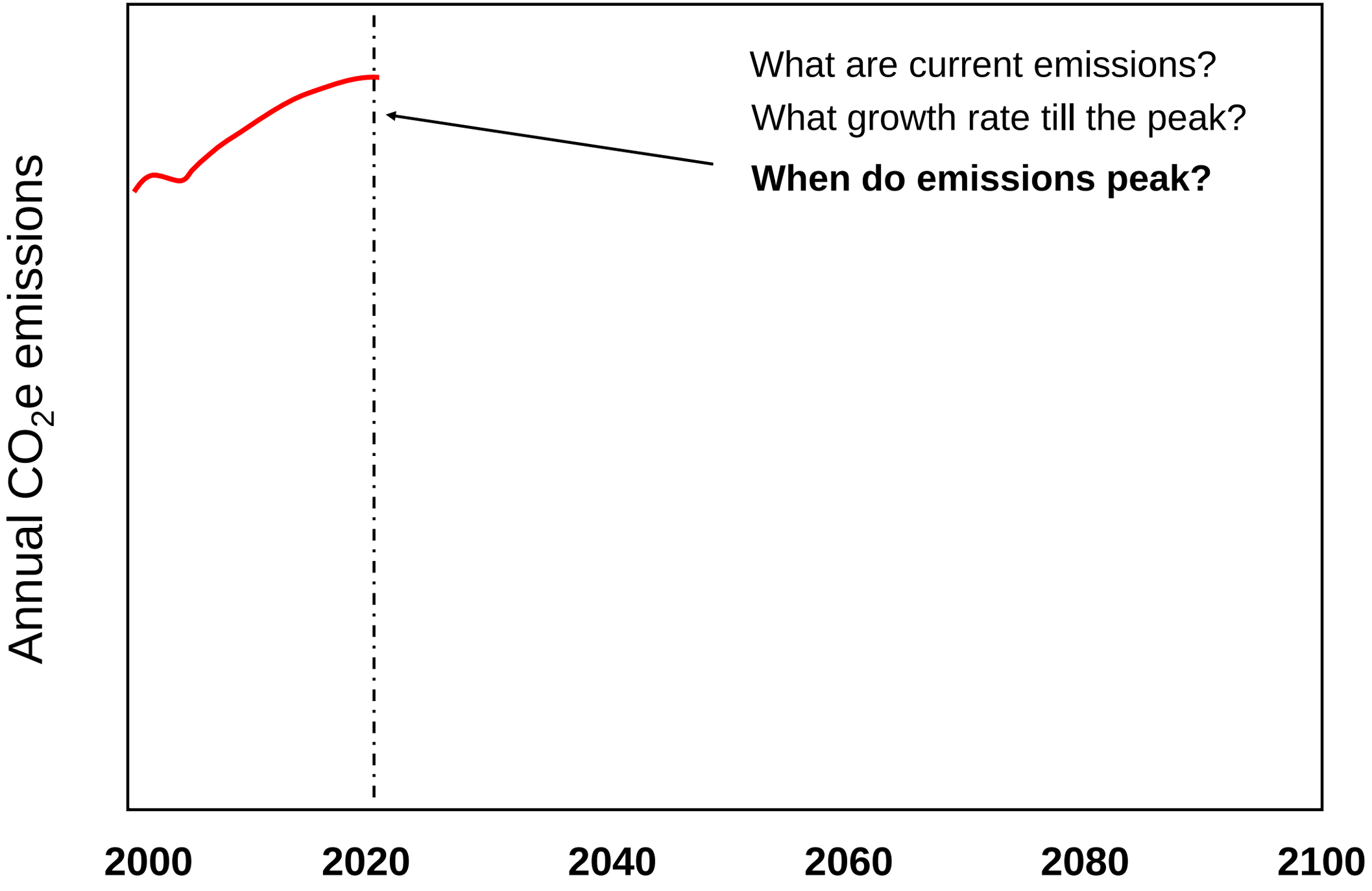

What are current emissions?
What growth rate till the peak?
Typically 1-2% p.a., i.e. far below recent trend rates & despite continued rapid growth of China & India
Annual CO_2e emissions
2000
2020
2040
2060
2080
2100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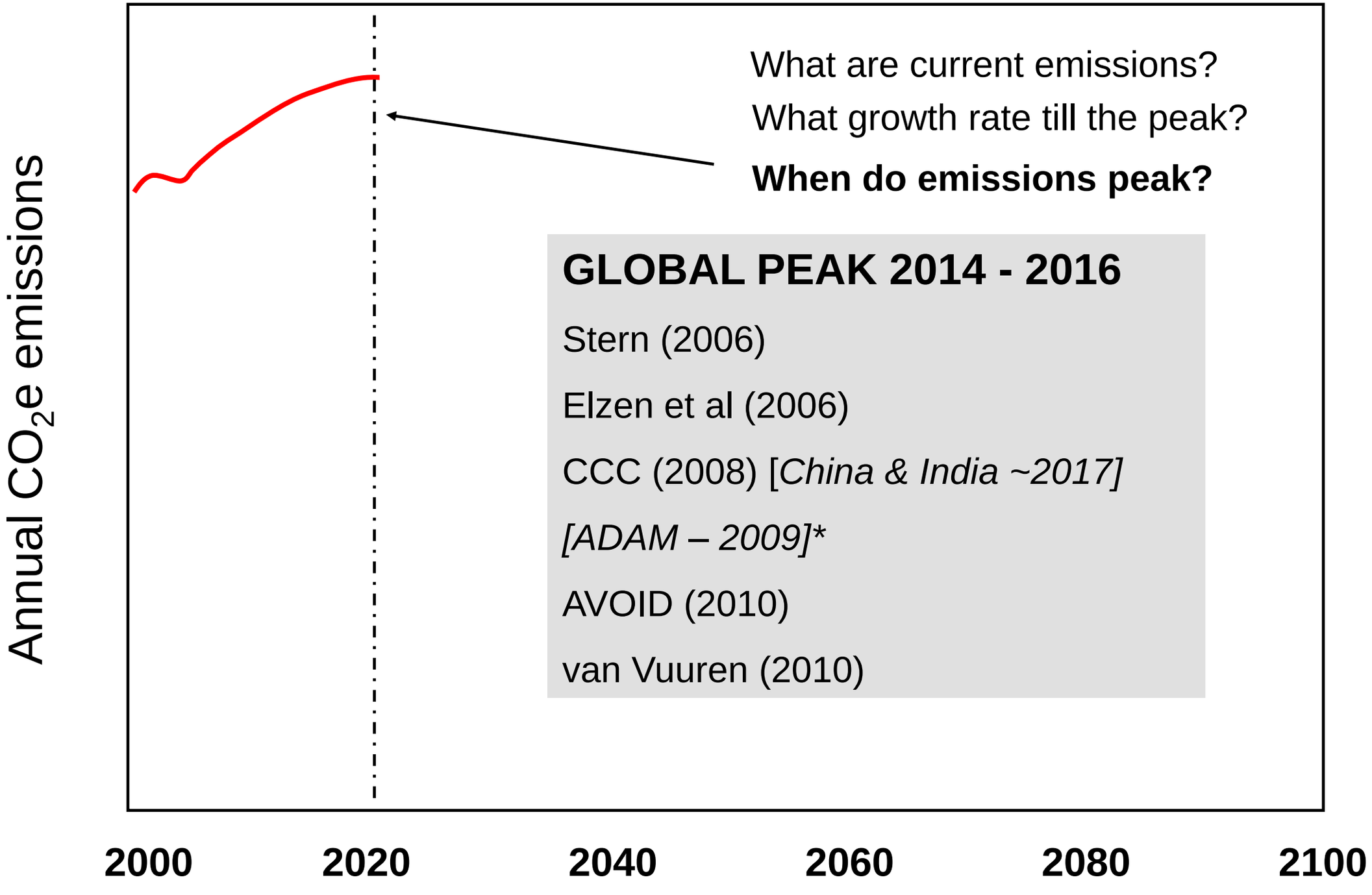
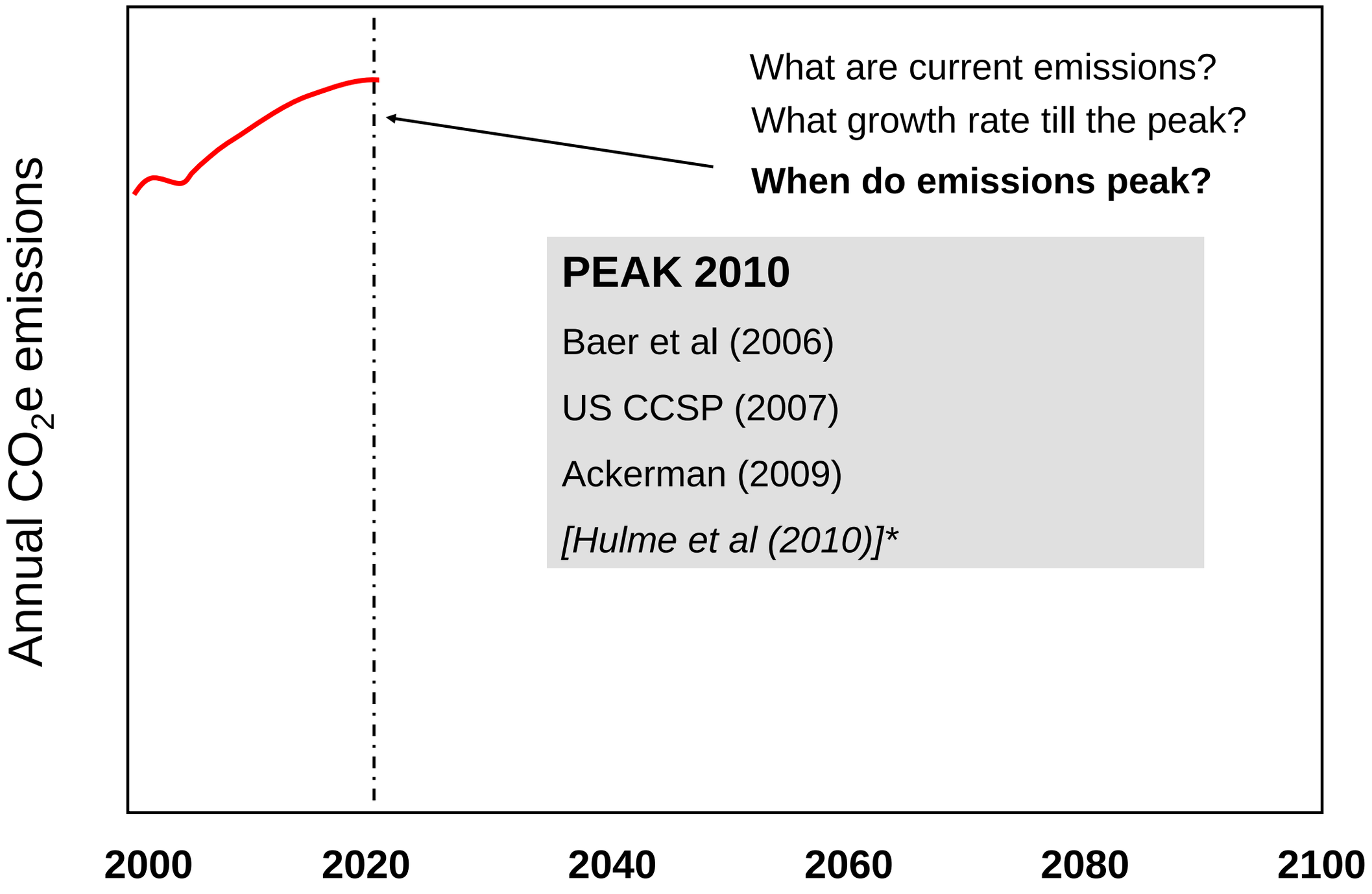
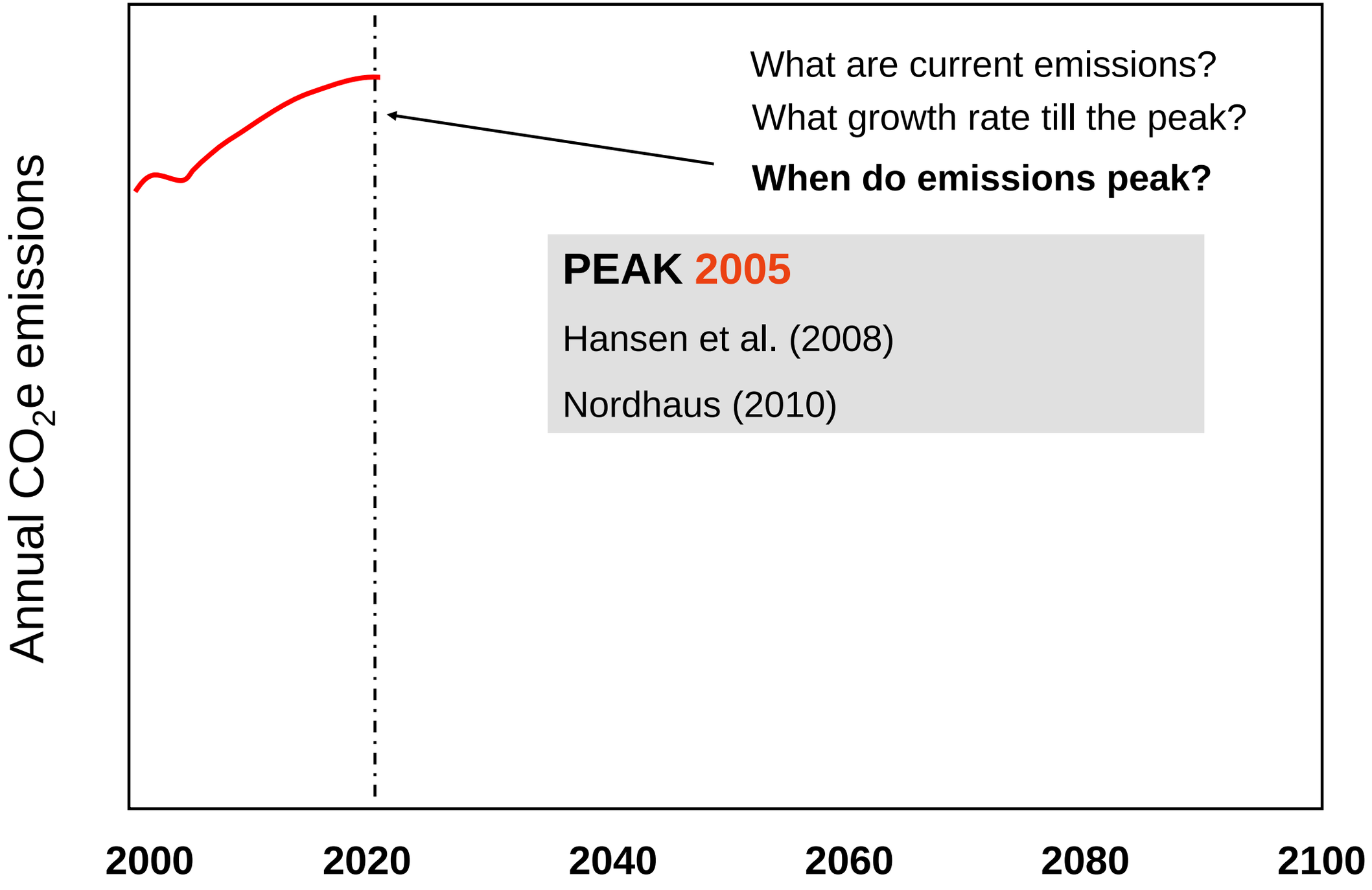
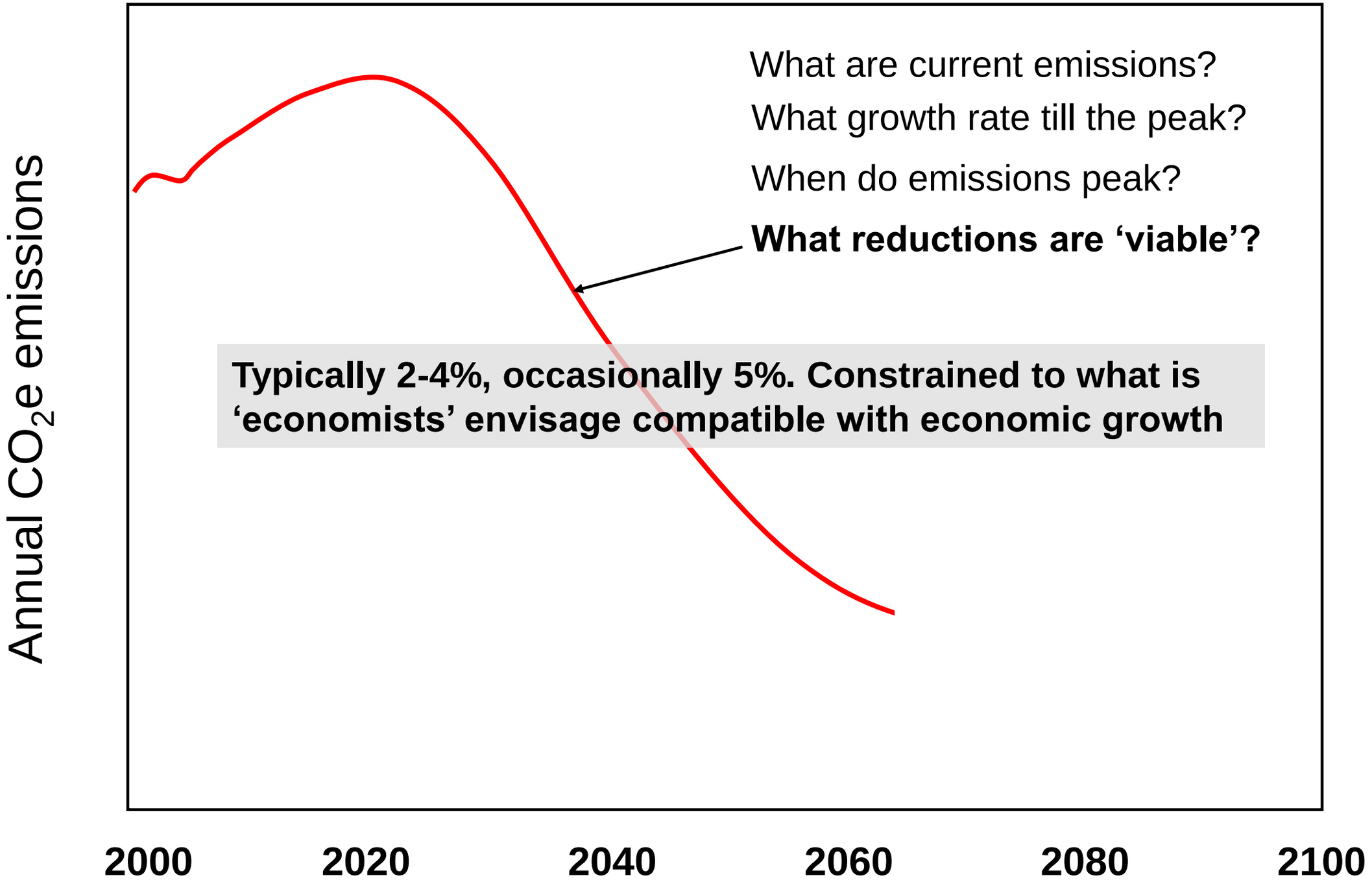
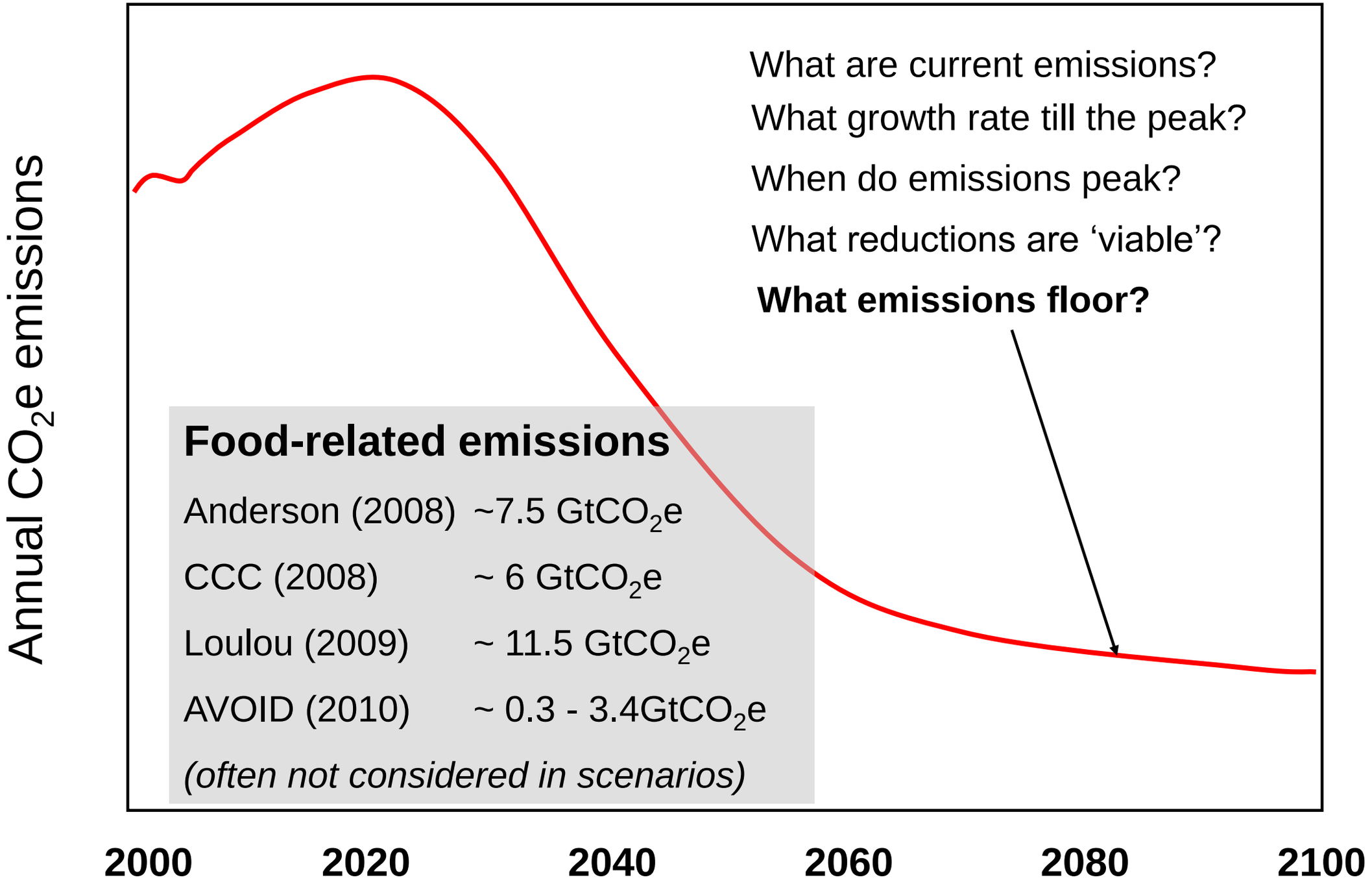
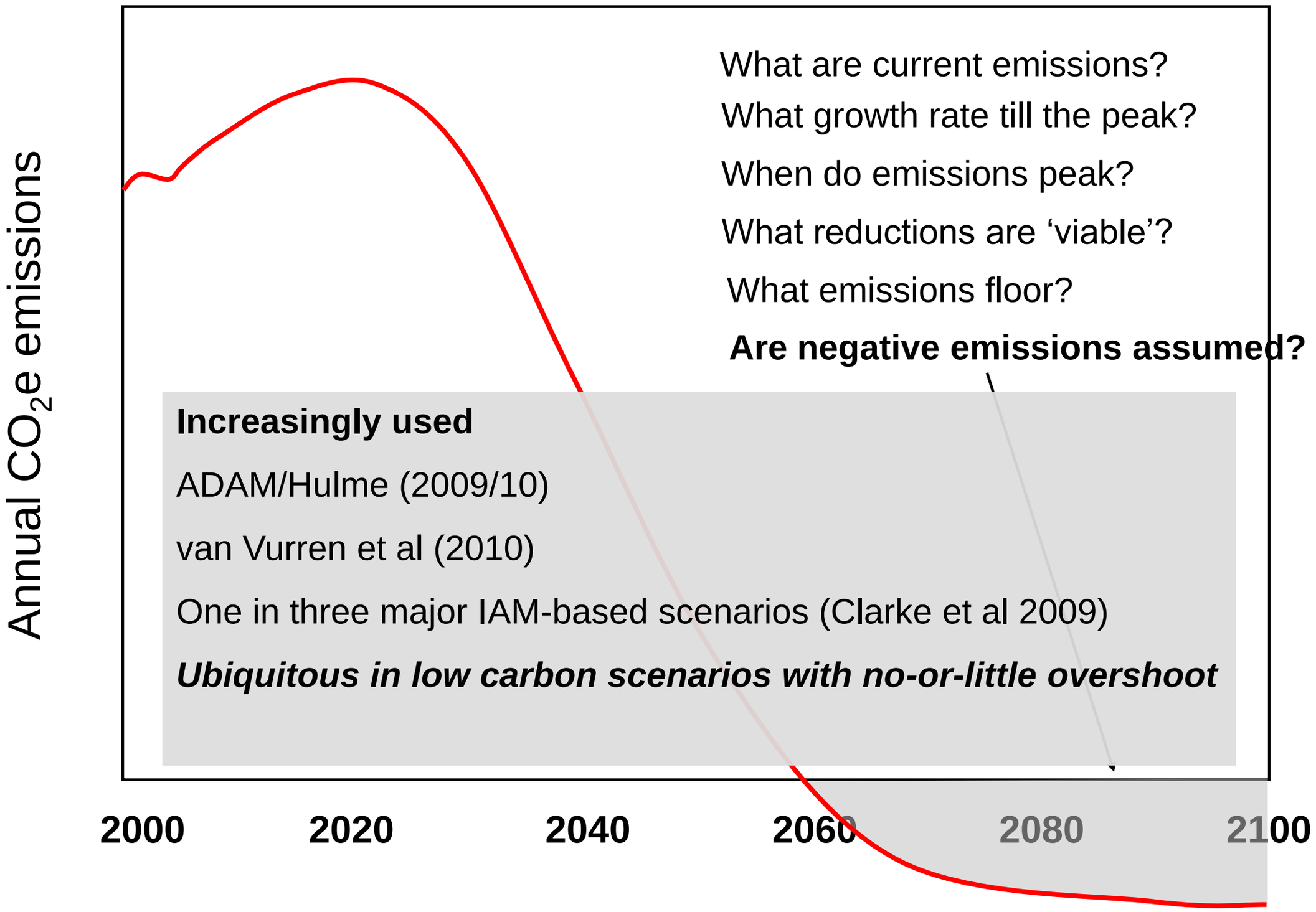

Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
GLOBAL PEAK 2014 - 2016
Stern (2006)
Elzen et al (2006)
CCC (2008) [China & India ~2017]
[ADAM – 2009]*
AVOID (2010)
van Vuuren (2010)
2000
2020
2040
2060
2080
2100

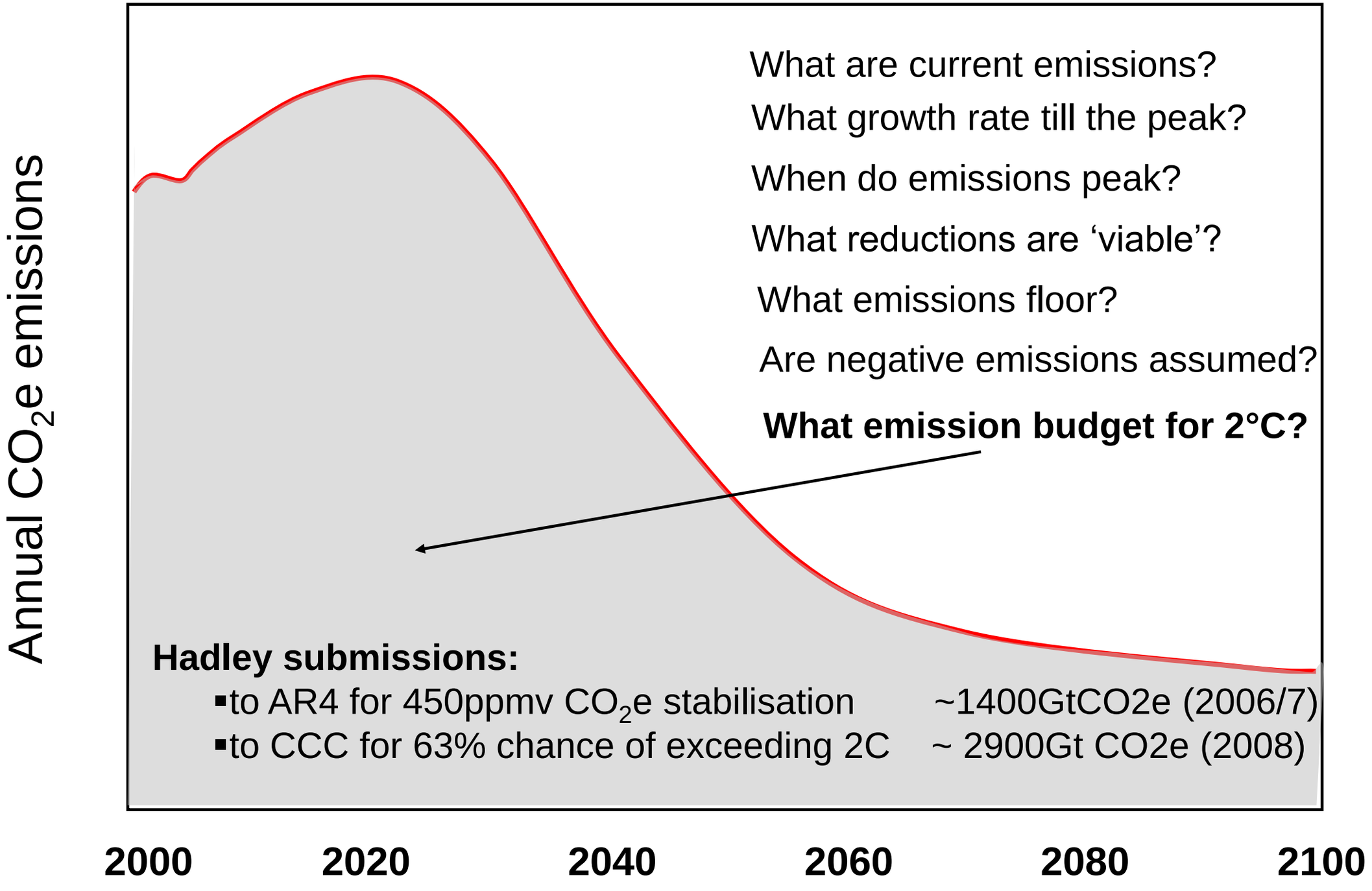

Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
PEAK 2010
Baer et al (2006)
US CCSP (2007)
Ackerman (2009)
[Hulme et al (2010)]*
2000
2020
2040
2060
2080
2100

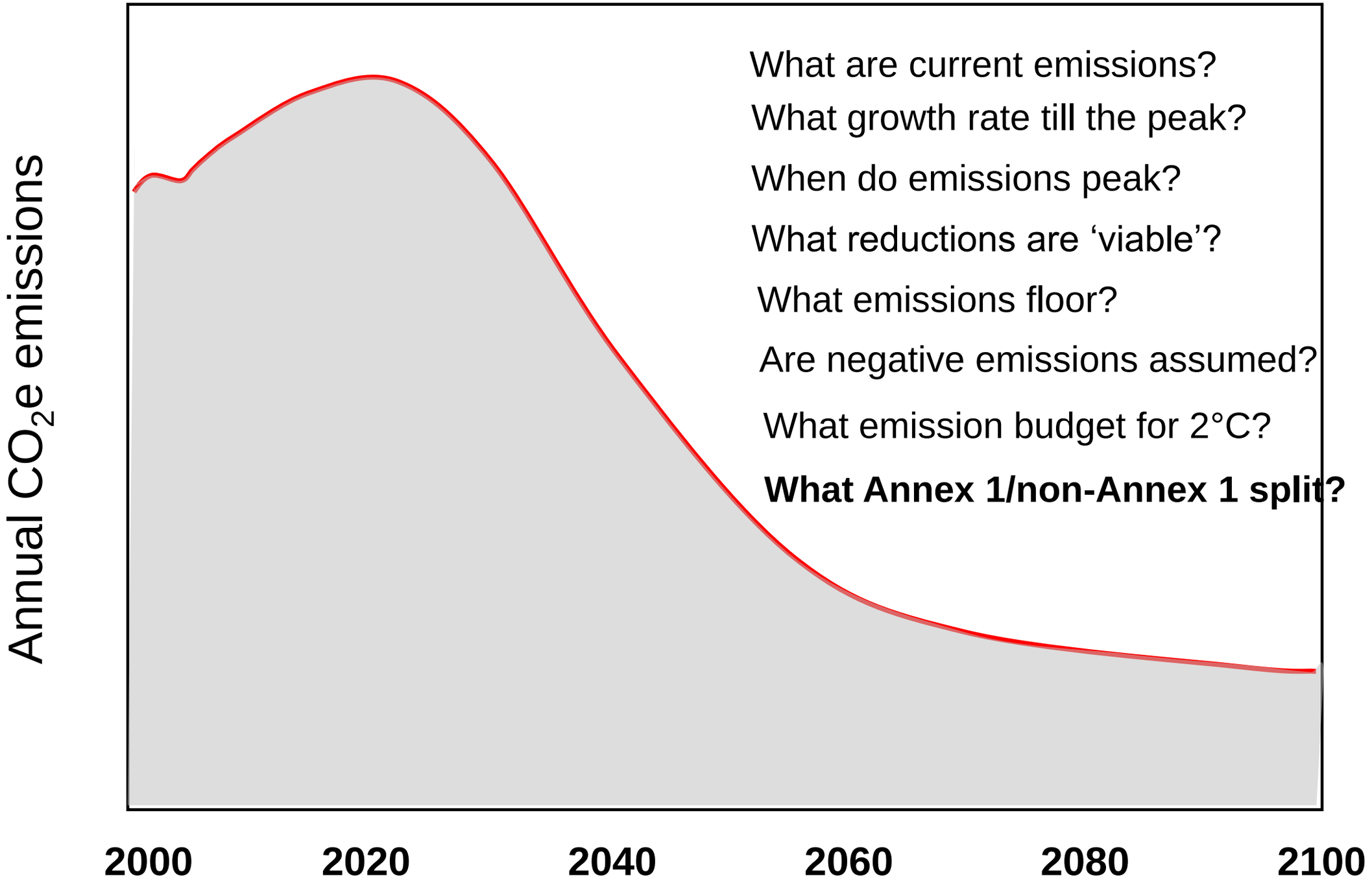

Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
PEAK 2005
Hansen et al. (2008)
Nordhaus (2010)
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are 'viable'?
Typically 2-4%, occasionally 5%. Constrained to what is 'economists' envisage compatible with economic growth
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are 'viable'?
What emissions floor?
Food-related emissions
Anderson (2008) ~7.5 $GtCO_2e$
CCC (2008) ~ 6 $GtCO_2e$
Loulou (2009) ~ 11.5 $GtCO_2e$
AVOID (2010) ~ 0.3 - 3.4$GtCO_2e$
(often not considered in scenarios)
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are 'viable'?
What emissions floor?
Are negative emissions assumed?
Increasingly used
ADAM/Hulme (2009/10)
van Vurren et al (2010)
One in three major IAM-based scenarios (Clarke et al 2009)
Ubiquitous in low carbon scenarios with no-or-little overshoot
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are 'viable'?
What emissions floor?
Are negative emissions assumed?
What emission budget for 2°C?
Hadley submissions:
to AR4 for 450ppmv CO_2e stabilisation ~1400GtCO2e (2006/7)
to CCC for 63% chance of exceeding 2C ~ 2900Gt CO2e (2008)
2000
2020
2040
2060
2080
2100


Annual CO_2e emissions
What are current emissions?
What growth rate till the peak?
When do emissions peak?
What reductions are 'viable'?
What emissions floor?
Are negative emissions assumed?
What emission budget for 2°C?
What Annex 1/non-Annex 1 split?
2000
2020
2040
2060
2080
2100

What about Annex 1 non-Annex 1 split

US CCSP (2007)

used ‘ ***“meaningful* and *plausible”*** reference scenarios from a ‘prospectus of highly regarded Integrated Assessment Models’ - in which Non-Annex 1 CO_2 exceeded Annex 1 CO_2 in:

- MiniCAM (Maryland) 2013
- IGSM (Stanford) 2021
- MERGE (MIT) 2023

Actual crossover 2006

UK CCC (2009/11)

UK carbon budgets premised on ***“feasible”*** analysis

- Global emissions peak 2016
- Annex 1 (inc. UK) peak 2007-10
- *Non-Annex 1 peak ~2018* ***(China & India ~2017)***

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Geoengineering in Integrated Assessment Models

(based on Clarke et al - 2009)

*'All' low carbon scenarios without significant overshoot use **Bio-CCS** to give negative emissions*

- *No large scale CCS power stations currently exist*
- *Major issues of food & biodiversity with Biomass production*
- *Every Bio-CCS scenario has large scale Coal-CCS*
- *Major constraints on storage capacity for coal-CCS – so Bio CCS?*

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Nuclear powerstations in Integrated Assessment Models

(based on Clarke et al - 2009)

'All' but one IAM-based scenarios had large nuclear supply

- *U235 constraints for such large nuclear expansion*
- *Fast breeder reactors could be used without fuel supply scarcity*
- *… but have major expense and other problems*
- *Thorium may have potential – but still experimental at best*

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… but scenarios are supposed to explore plausible futures

… rather than repeat hard-wired runs from the same assumptions

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… with few exceptions, these include:

- Recent historical emissions sometimes ‘mistaken’ or ‘massaged’
- Short-term emission growth seriously down played
- Peak year choice ‘Machiavellian’ & dangerously misleading
- Reduction rate universally dictated by economists
- Geoengineering widespread in low carbon scenarios
- Annex 1/non-Annex 1 emissions split neglected or hidden
- Assumptions about ‘Big’ technology naively optimistic
- *(‘Net’ Costs meaningless with non-marginal mitigation & adaptation)*

Collectively – they have a magician’s view of time & a linear view of problems ?

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2°C – a political & scientific creed?

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Senior political scientist (2010)

"Too much is invested in 2°C for us to say its not possible – it would undermine all that's been achieved

It'll give a sense of hopelessness – we may as well just give in

Are you suggesting we have to lie about our research findings? Well, perhaps just not be so honest – more dishonest …"

Senior Government Advisor (2010)

"We can't tell them (ministers & politicians) it's impossible

We can say it's a stretch and ambitious – but that, with political will, 2°C is still a feasible target"

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DECC SoS (2009)

- day before attending Copenhagen

"Our position is challenging enough, I can't go with the message that 2°C is impossible – it's what we've all worked towards"

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So, where does this leave us?

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If this all looks too difficult

… what about a 4°C future?

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For 4°C & emissions peaking by 2020 a

~ 3.5% p.a. reduction in CO_2 from energy is necessary

... & such a reduction rate is achievable

so is aiming for 4°C more realistic?

For 4°C global mean surface temperature

5°C - 6°C global *land* mean

… & increase °C on the hottest days of:

6°C - 8°C in China

8°C - 10°C in Central Europe

10°C -12°C in New York

In low latitudes 4°C gives

up to 40% reduction in maize & rice

as population heads towards 9 billion by 2050

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There is a widespread view that a 4°C future is incompatible with an organised global community, is likely to be beyond 'adaptation', is devastating to the majority of eco-systems & has a high probability of not being stable *(i.e. 4°C would be an interim temperature on the way to a much higher equilibrium level).*

Consequently …

4°C should be avoided at 'all' costs

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Before despairing …

Have we got the ***agency*** to achieve the unprecedented reductions rates linked to an outside chance of 2°C ?

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To put some numbers on this non-marginal challenge for energy

- **10% reduction in emissions year on year**

  - *40% reduction by 2015*
  - *70% 2020*
  - *90+% 2030*

Impossible?

… is living with a 4°C global temperature rise by 2050-70 less impossible?

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AGENCY

- Equity – a message of hope – *perhaps?*
- Technology – how far, how fast & how soon?

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Little chance of changing polices aimed at 7 billion

… but how many people need to make the necessary changes?

Pareto's 80:20 rule

80% of something relates to … 20% of those involved

~80% of emissions from ~20% of population

run this 3 times

~50% of emissions from ~1% of population

… as a guide 40-60% emissions from 1-5% population

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- who's in the 1-5%?

- *Climate scientists*
- *Climate journalists & pontificators*
- *OECD (& other) academics*
- *Anyone who gets on a plane*
- *For the UK anyone earning over £30k*

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Are we (principally Annex 1) sufficiently concerned to

… make or have enforced substantial personal sacrifices/changes to our lifestyles

NOW ?

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Technical AGENCY – another message of hope

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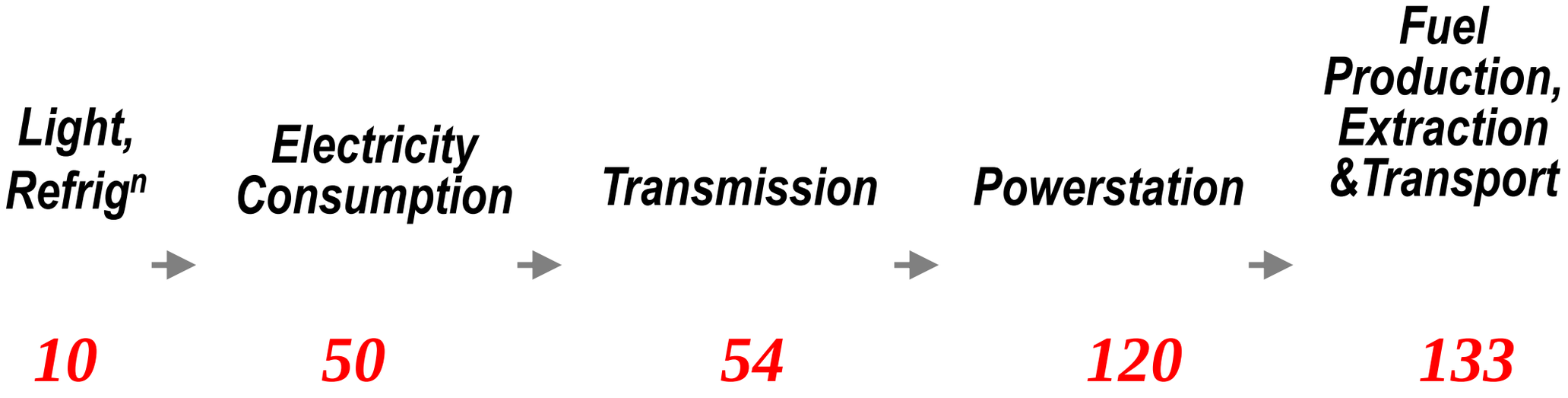
The Electricity system



Demand opportunities dwarf those from supply in short-term

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Car efficiency

(without rebound)

- UK mean car emissions ~175g/km (new ~150g/km)
- EU 2015 plan 130g/km (fleet mean with buy out)
- 2008 BMW 109g/km, VW, 85-99g/km; 1998 Audi A2 ~ 75g/km
- ~8 year penetration of new cars … ~90% of vehicle-km

~40-50% CO_2 reduction by 2020 with no new technology

- *Reverse recent trends in occupancy* ***~60-70% by 2020***

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Uncomfortable implications of conservative assumptions

If…

- Link between cumulative emissions & temp' is broadly correct
- Non-Annex 1 nations peak emissions by 2025/30
- There are rapid reductions in deforestation emissions
- Food emissions halve from today's values by 2050
- No 'discontinuities' (tipping points) occur

& Stern/CCC/IEA's "feasible" reductions of 3-4% p.a. is achieved

- 2°C stabilisation is *virtually* impossible
- 4°C by 2050-2070 looks 'likely' *(could be earlier & on the way to 6°C+)*

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But

"… this is not a message of futility, but a wake-up call of where our rose-tinted spectacles have brought us. Real hope, if it is to arise at all, will do so from a bare assessment of the scale of the challenge we now face."

Anderson & Bows.
Beyond 'dangerous climate change
Philosophical Transactions of the Royal Society
Jan 2011

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… a final message of hope ..

"at every level the greatest obstacle to transforming the world is that we lack the clarity and imagination to conceive that it could be different."

Roberto Unger

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Real Clothes for the Emperor:

facing the challenges of climate change

Kevin Anderson
Tyndall Centre
University of Manchester
2012

With significant input from:
Alice Bows & Maria Sharmina
SCI

… and based on wider Tyndall Manchester analysis