ndall°Centre
for Climate Change Research

Re-framing the climate change debate

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Climate change and energy: a marine perspective
January 201

Talk outline

1) Dangerous climate change

2) Cumulative emissions

3) Global GHG pathways

4) *UK responses to the challenge*

What is dangerous climate change?

UK & EU define this as 2°C

But:

… 2°C impacts at the worst end of the range

… ocean acidification devastating even at 400-450ppmv CO_2

… failure to mitigate leaves 2°C stabilisation highly unlikely

Emission-reduction targets

- UK, EU & Global - long term reduction targets

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

- CO_2 stays in atmosphere for 100+ years,

- Long-term targets are dangerously misleading

2050 reduction unrelated to avoiding dangerous climate change *(2°C)*

cumulative emissions that matter (i.e. carbon budget)

this fundamentally rewrites the timeline of climate change

- from long term gradual reductions
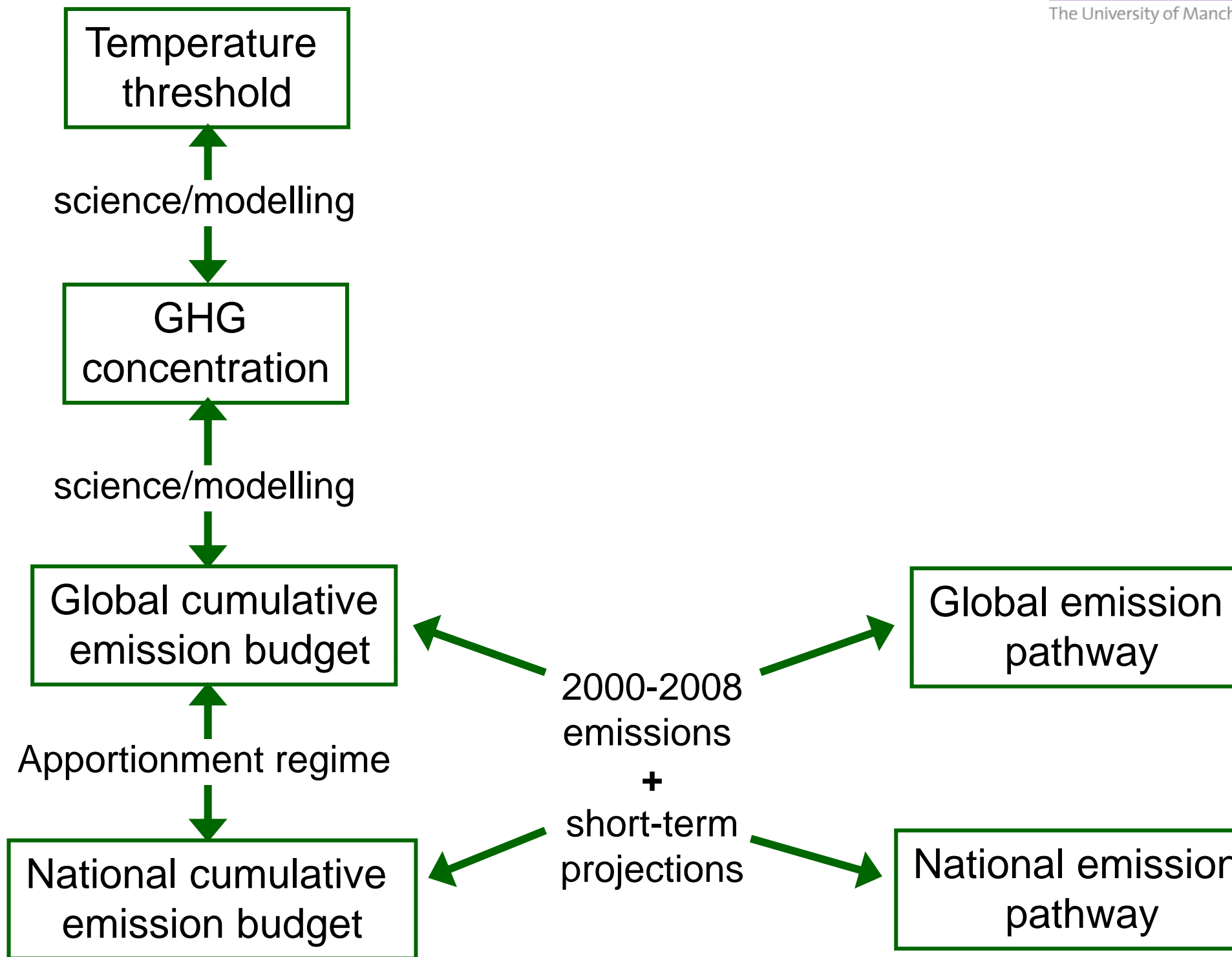
- to urgent & radical reductions

How do global **temperatures**

link to

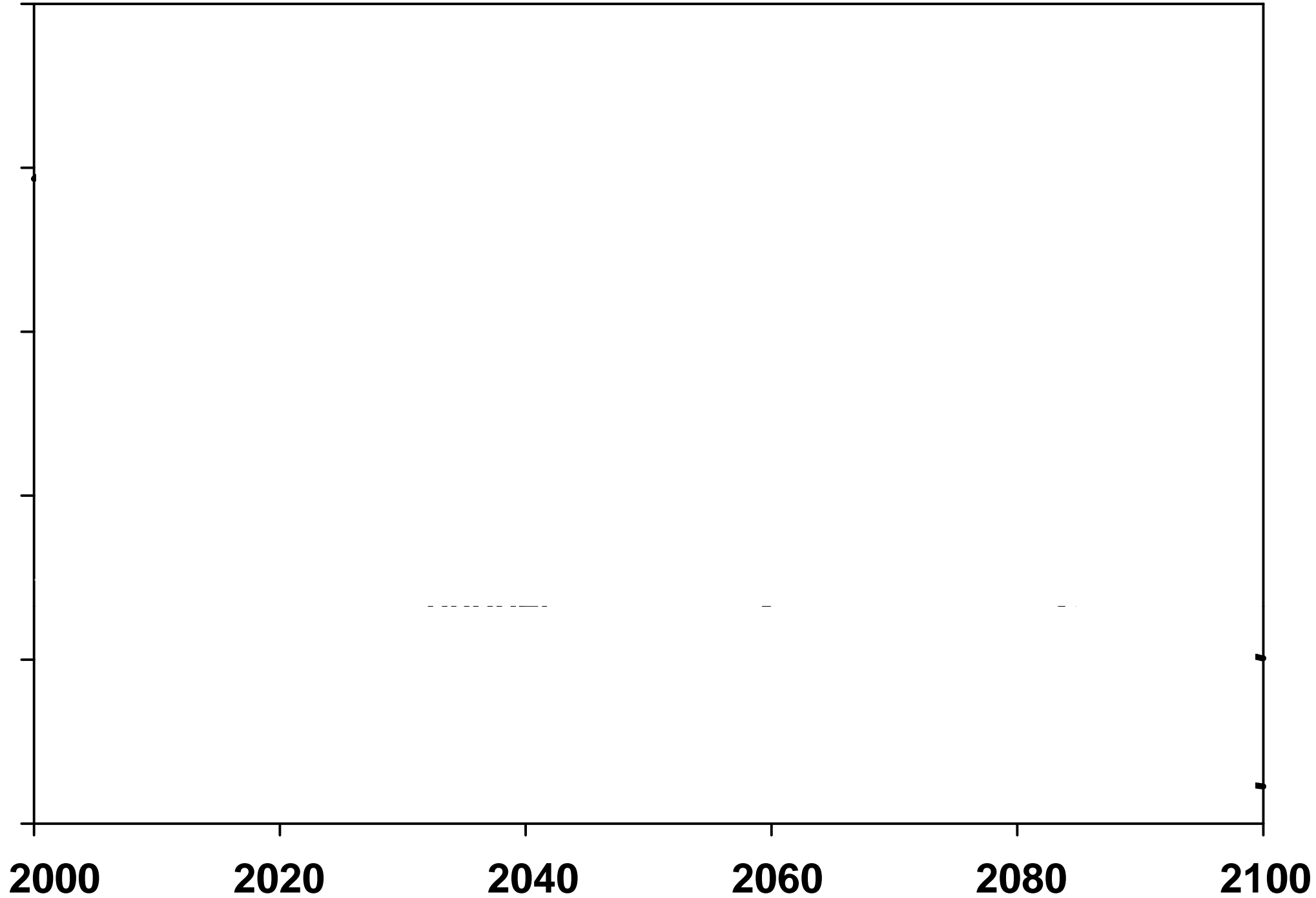global and national **carbon budgets**
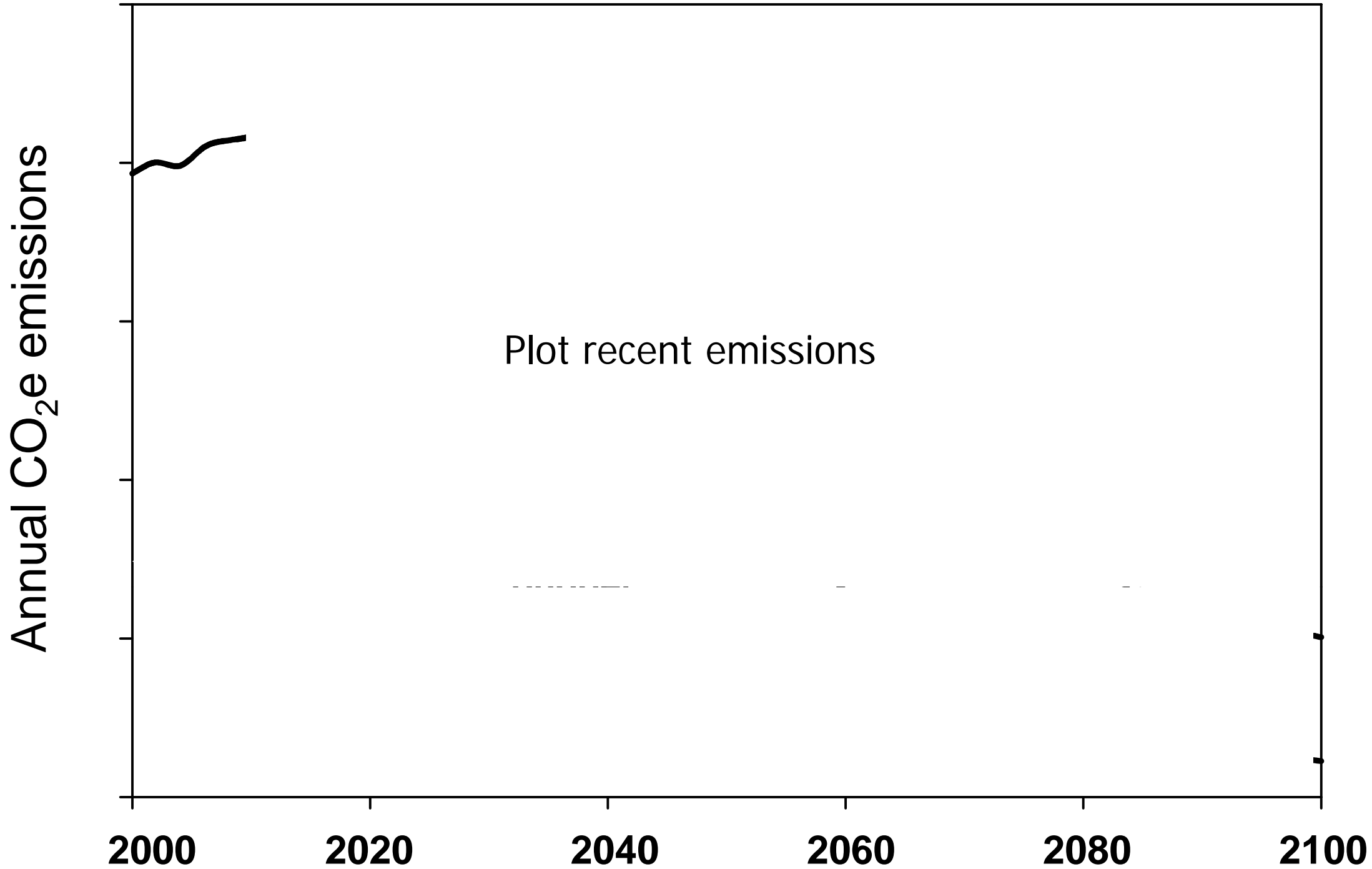
& from there to

emission-reduction **pathways**?

Temperature threshold

science/modelling

GHG concentration

science/modelling

Global cumulative emission budget

Apportionment regime

National cumulative emission budget

2000-2008 emissions + short-term projections

Global emission pathway

National emission pathway

pathway for a CO$_2$e budget

pathway for a CO$_2$e budget
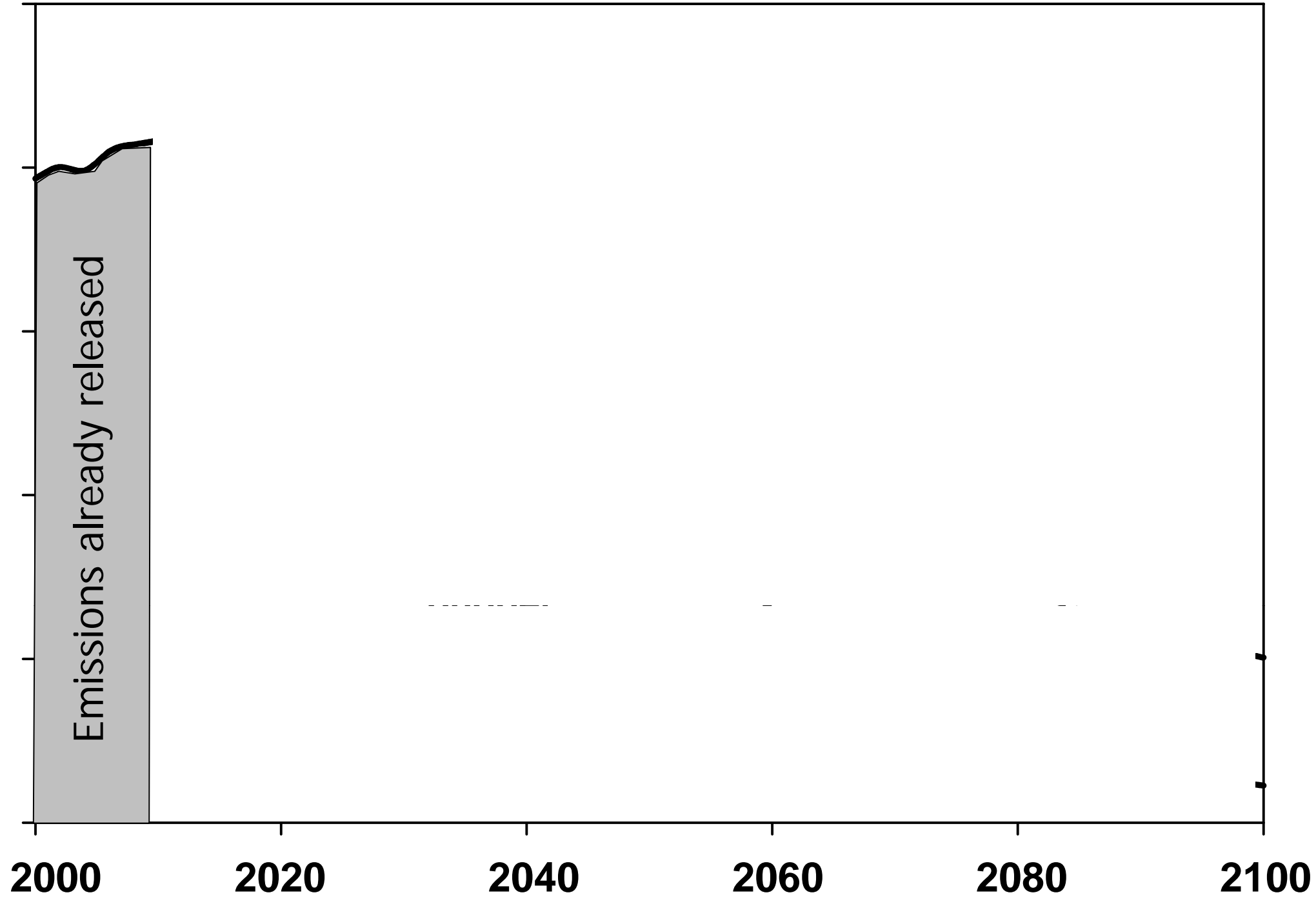
Annual CO$_2$e emissions

Plot recent emissions

2000　2020　2040　2060　2080　2100

pathway for a CO$_2$e budget

Annual CO$_2$e emissions

Emissions already released

2000   2020   2040   2060   2080   2100

pathway for a CO_2e budget

Annual CO_2e emissions

Emissions already released

We can project:
- *Short-term emissions to peak year/s*

We know:
- *Cumulative emissions for 2°C*

2000   2020   2040   2060   2080   2100
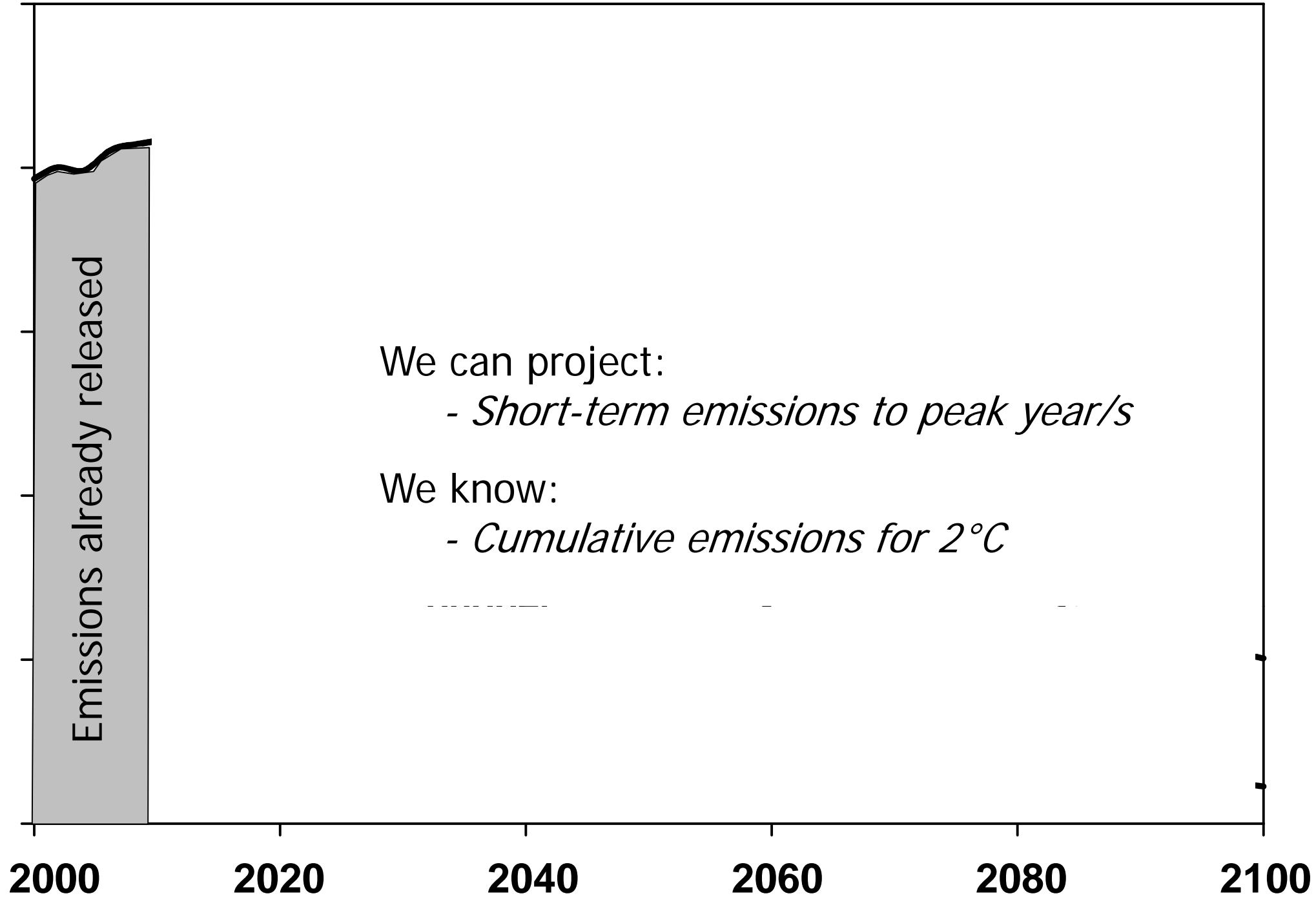
pathway for a CO$_2$e budget

Annual CO$_2$e emissions
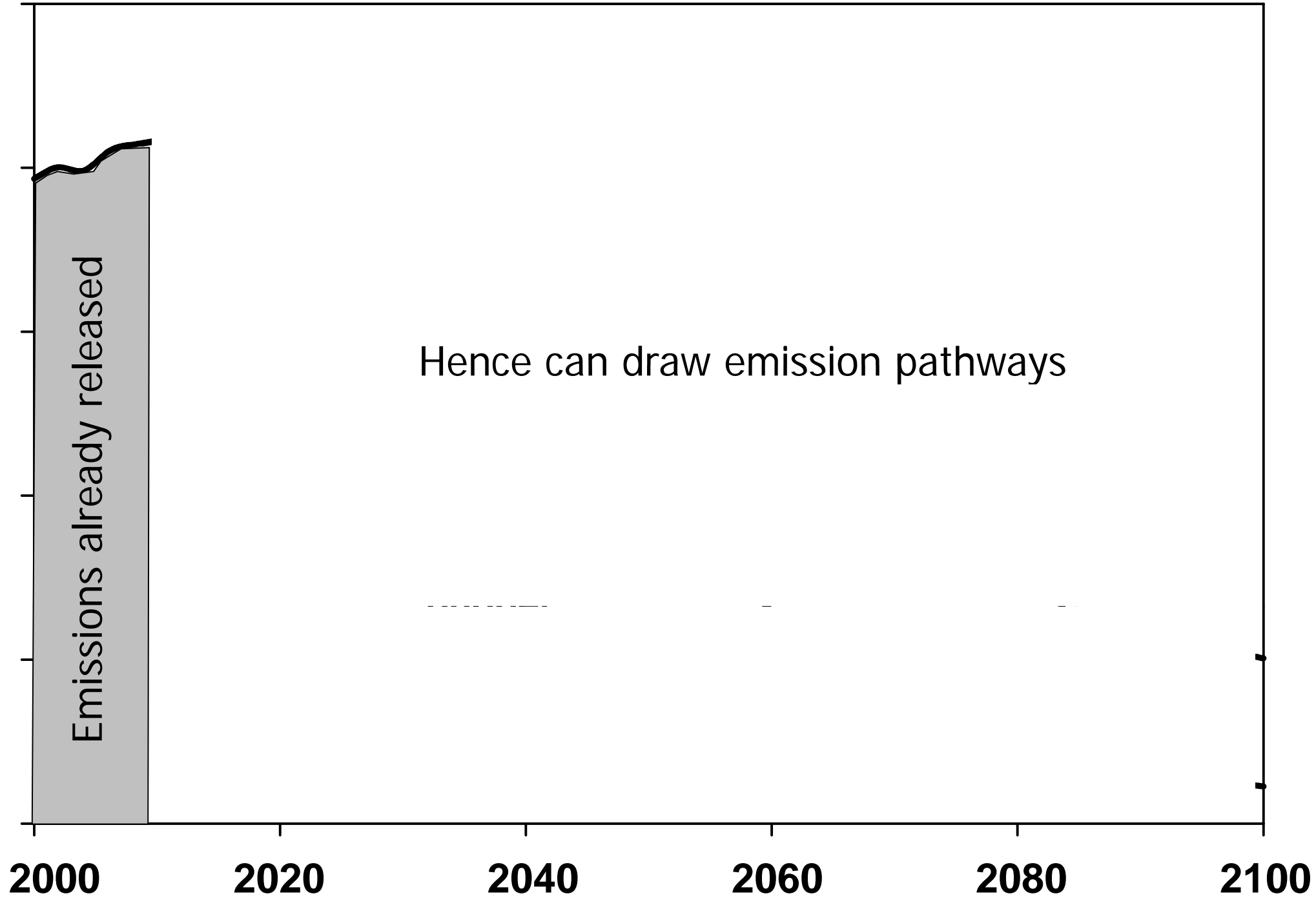
Emissions already released
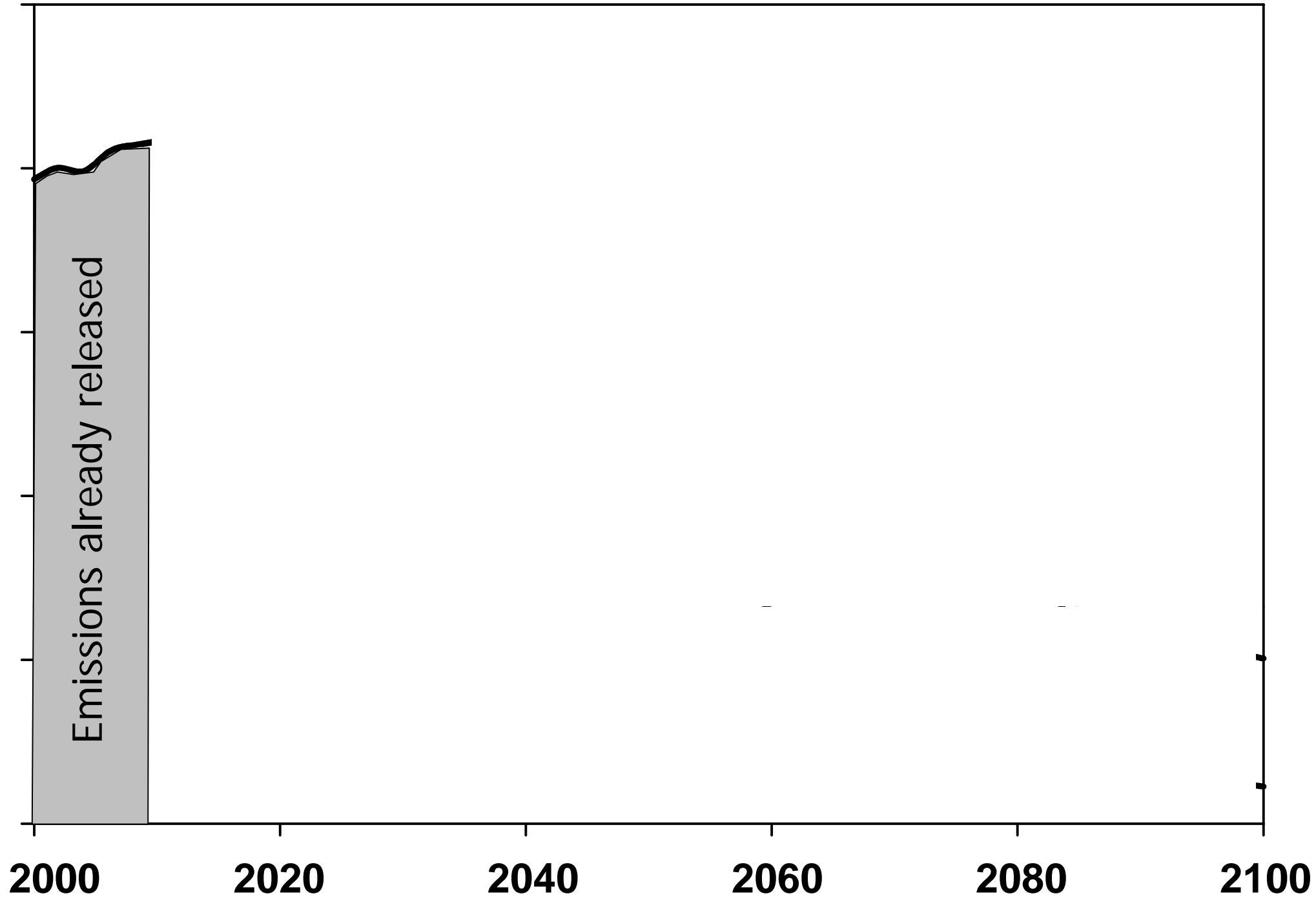
Hence can draw emission pathways

2000   2020   2040   2060   2080   2100

pathway for a CO$_2$e budget

Annual CO$_2$e emissions

Emissions already released

2000   2020   2040   2060   2080   2100

Tyndall's
emission scenarios
(2000-2100 CO_2e)

To consider:

    *1. CO_2 emissions from landuse (**deforestion**)*

    *2. Non-CO_2 GHGs (principally **agriculture**)*

What emission space remains for:

    *3. CO_2 emissions from **energy?***

Tyndall's
emission scenarios
(2000-2100 CO$_2$e)

- Included very optimistic:
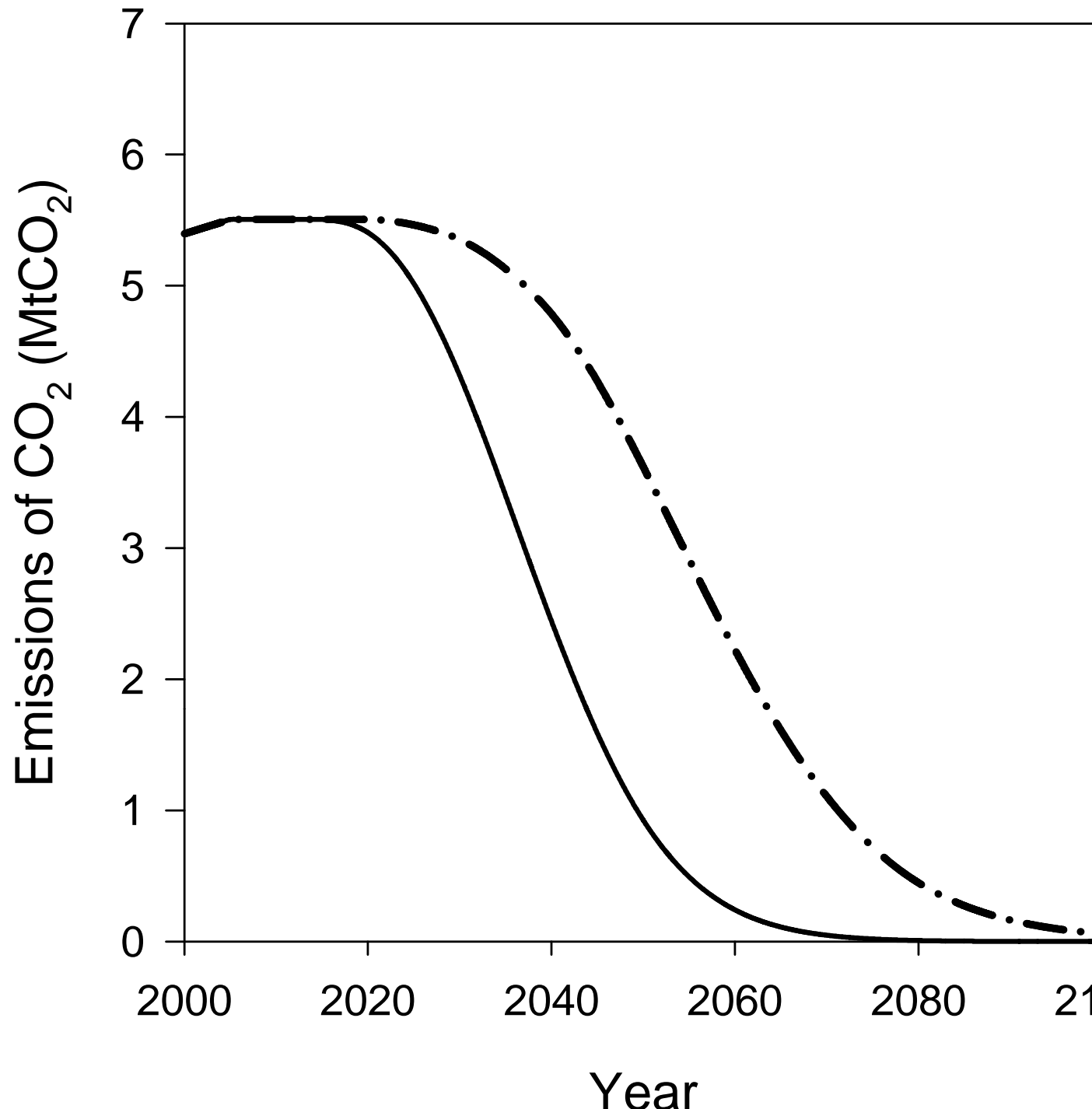
    - CO$_2$ from land-use & forestry emission scenarios

Tyndall's
emission scenarios
(2000-2100 CO_2e)

- Included very optimistic:

    - CO_2 from land-use & forestry emission scenarios

- CO_2 from land-use & forestry emission scenarios

Characterised by high
uncertainty *(principally driven
by deforestation; 12-25% of
global CO_2e)*

Two Tyndall scenarios with
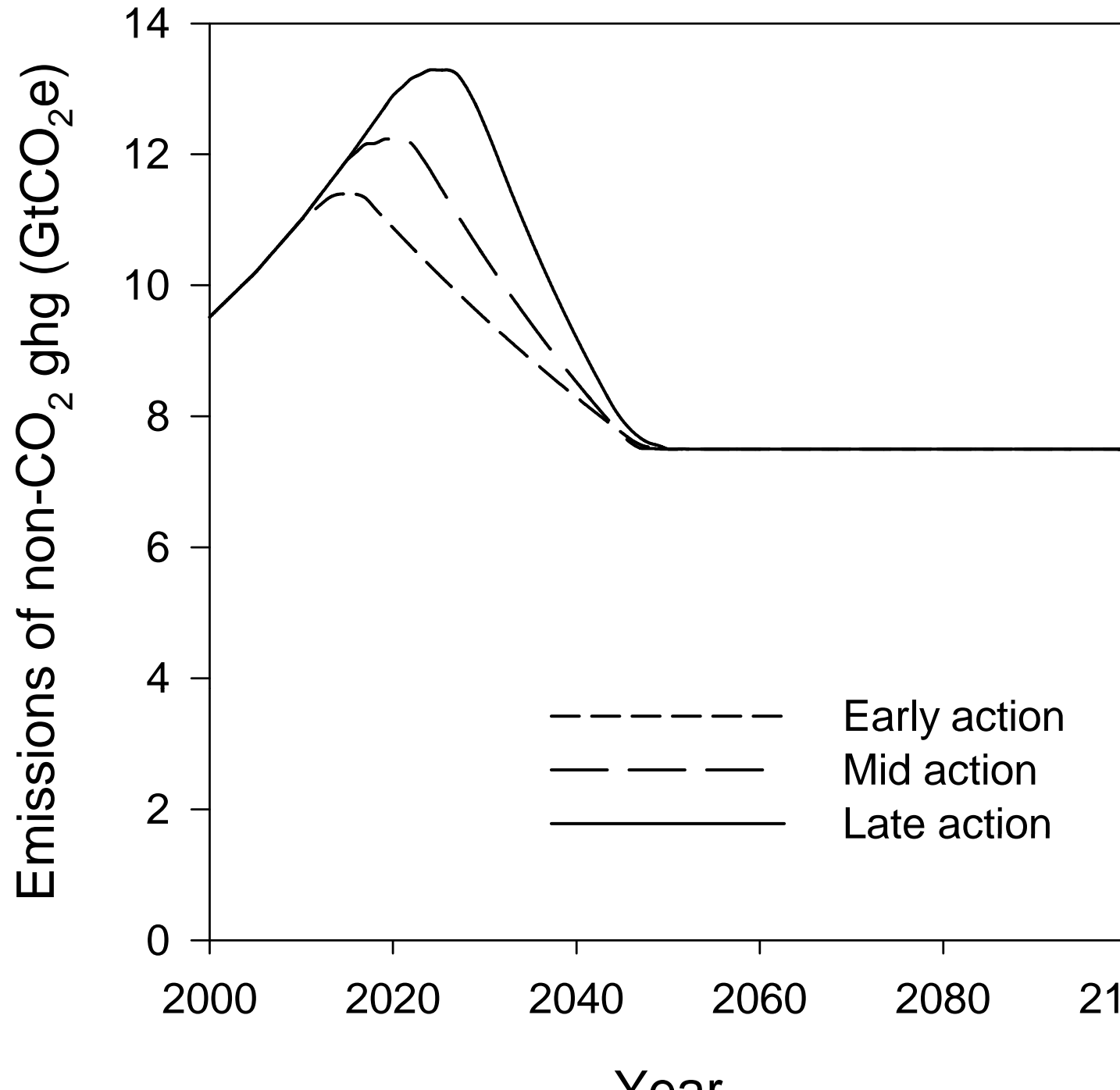different carbon-stock levels
remaining: *70% & 80%*

Tyndall's
emission scenarios
(2000-2100 CO$_2$e)

- Included very optimistic:

    - land-use & forestry emission scenarios
    - non-CO$_2$ greenhouse gas emissions

Tyndall's
emission scenarios
(2000-2100 CO_2e)

- Included very optimistic:

  - land-use & forestry emission scenarios
  - non-CO_2 greenhouse gas emissions

- non-CO$_2$ greenhouse gas emissions

Marked tail from food related emissions

Food emissions/capita assumed to halve by 2050

Emissions of non-CO$_2$ ghg (GtCO$_2$e) vs Year

- - - - - Early action
- - - Mid action
——— Late action

Tyndall's
emission scenarios
(2000-2100 CO_2e)

- Included very optimistic:

  - land-use & forestry emission scenarios
  - non-CO_2 greenhouse gas emissions?
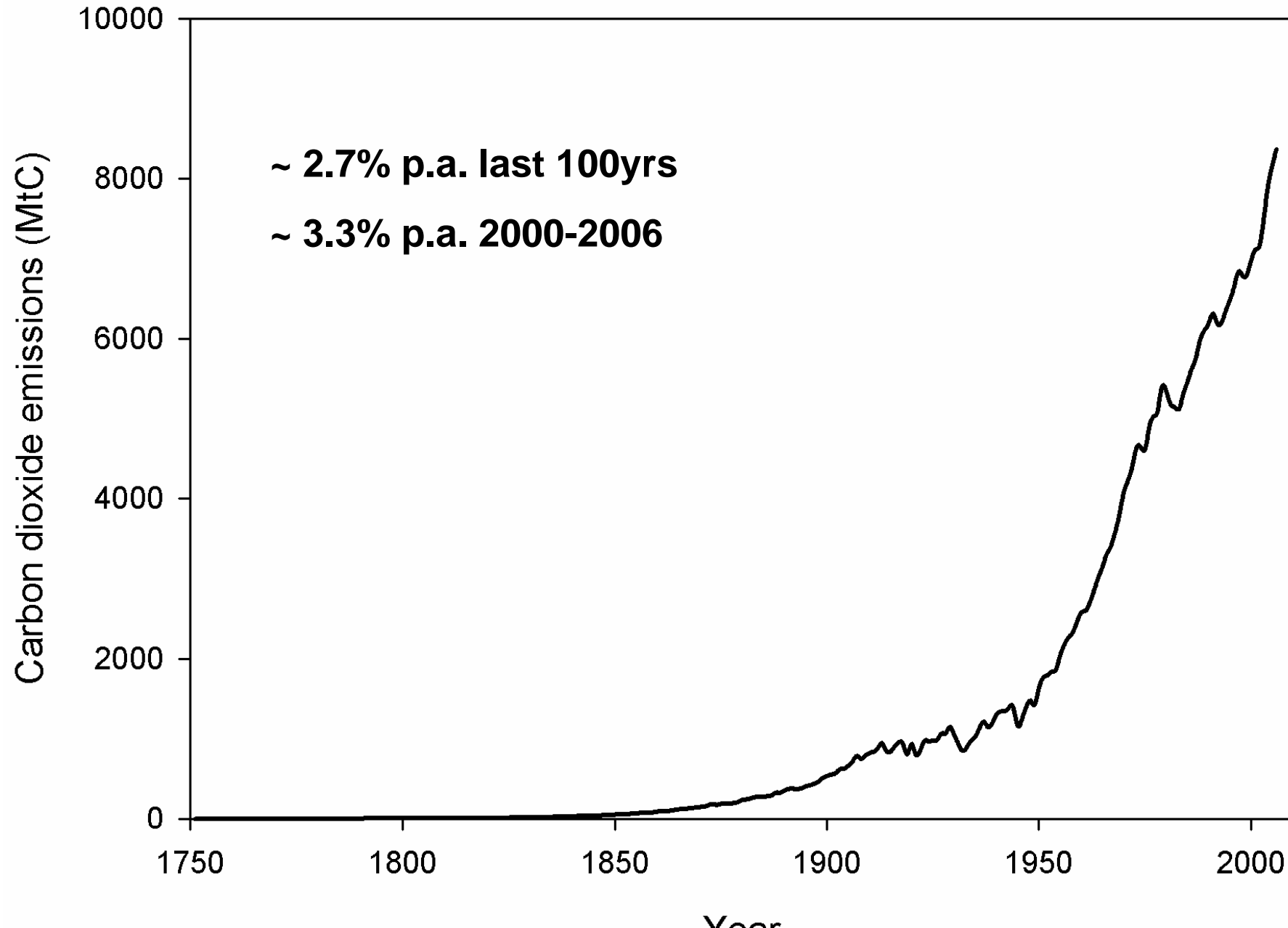
- Global CO_2e emissions peaks of 2015/20/25?

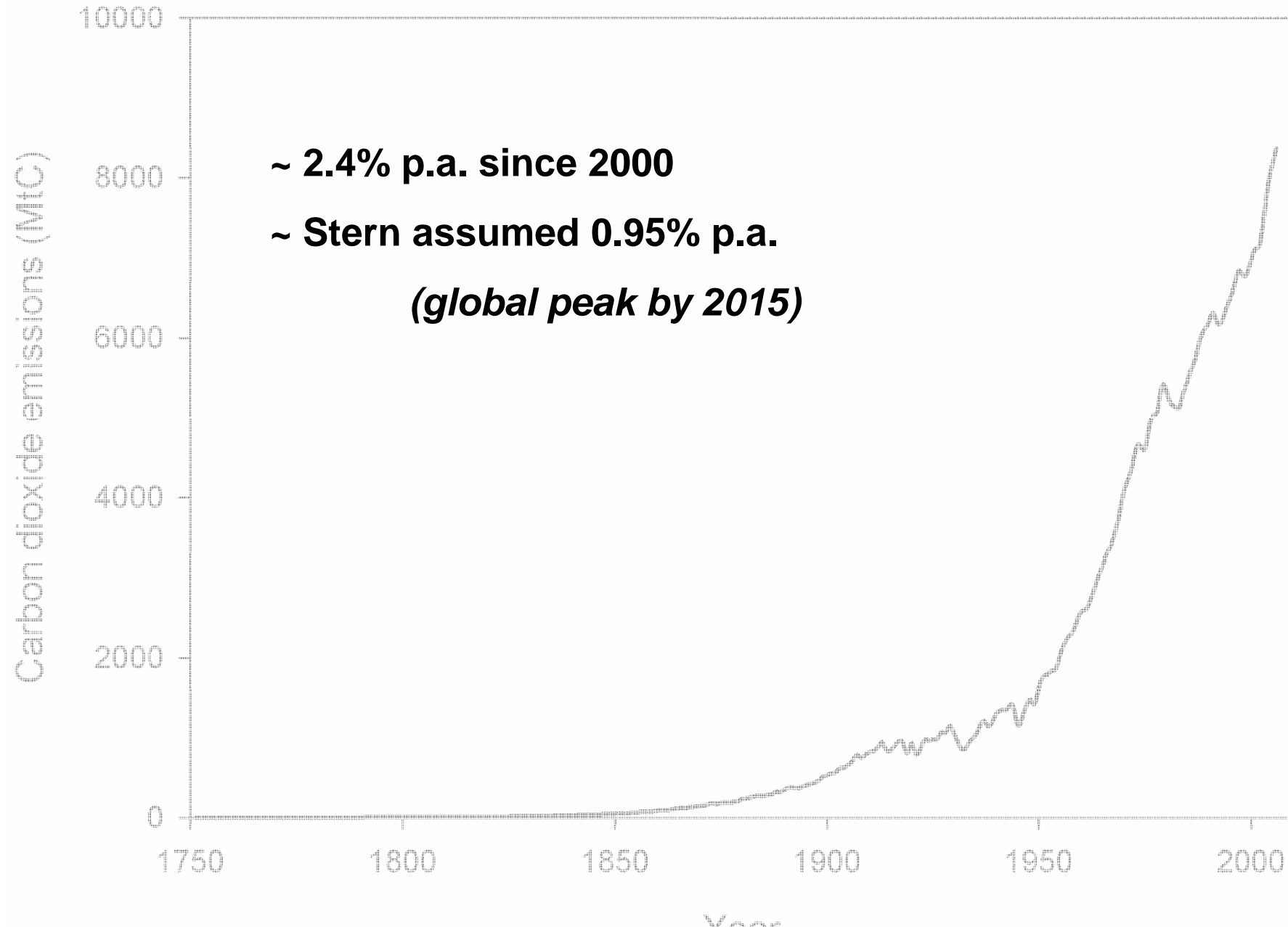# factoring in...

the latest emissions data

what is the scale of the global 'problem' we now face?

It's getting worse!

Global CO_2 emission trends?

~ 2.7% p.a. last 100yrs

~ 3.3% p.a. 2000-2006

latest global CO$_2$e emission trends?

~ **2.4% p.a. since 2000**

~ **Stern assumed 0.95% p.a.**

(global peak by 2015)

What does:

- this failure to reduce emissions
  &
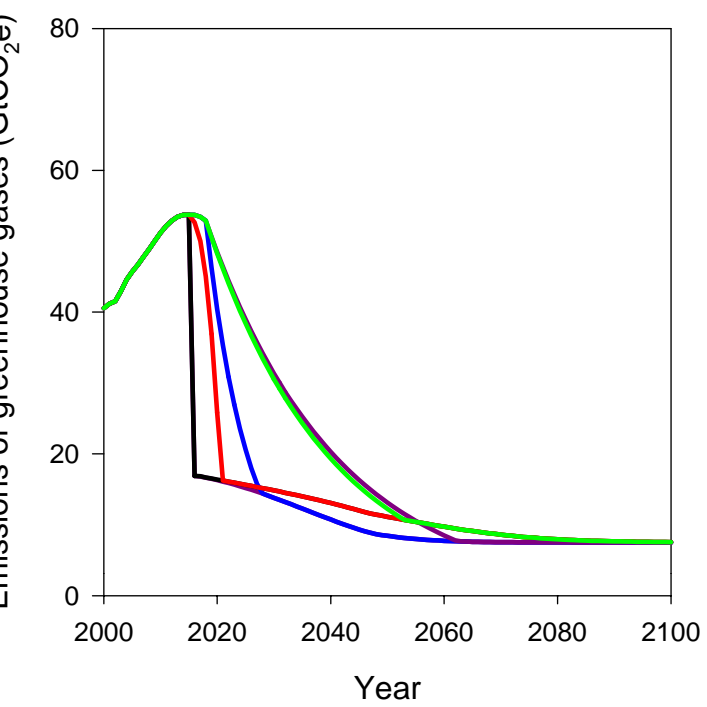- the latest science on cumulative emissions

Say about a 2°C future?

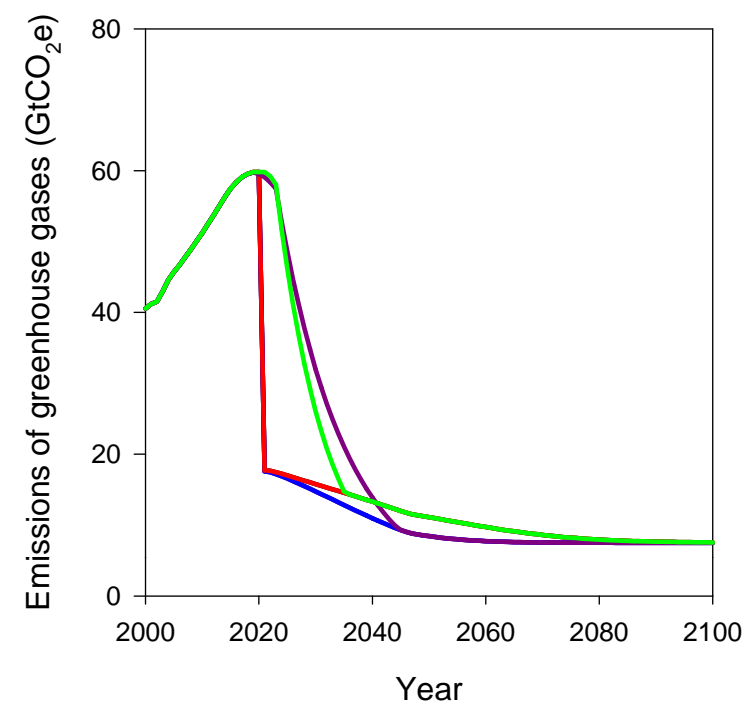# What greenhouse gas emission pathways for 2°C

Assumptions

- 2015/20/25 global peak in emissions

- Highly optimistic deforestation & food emission reduction

- 2°C global carbon budget

  __1400 to 2200 GtCO$_2$e__ for 2000-2100

- ~10% to 60% chance of exceeding 2°C
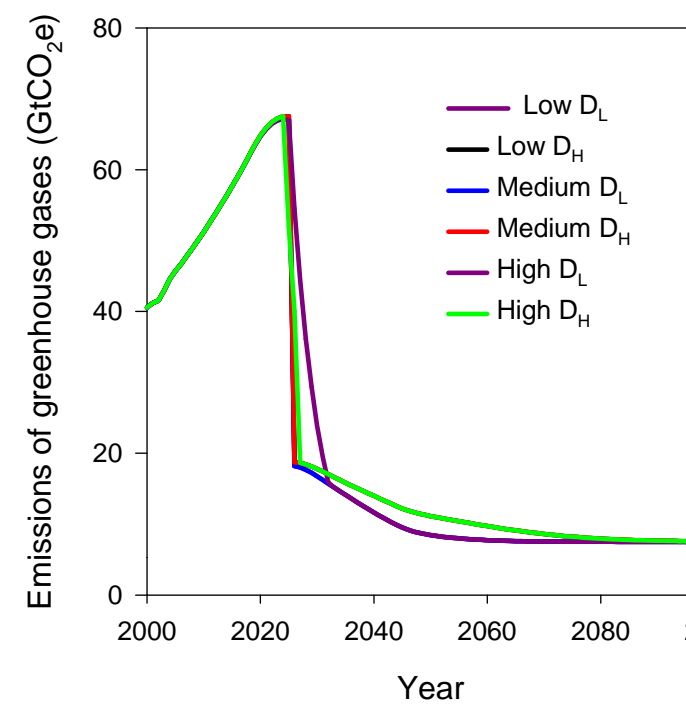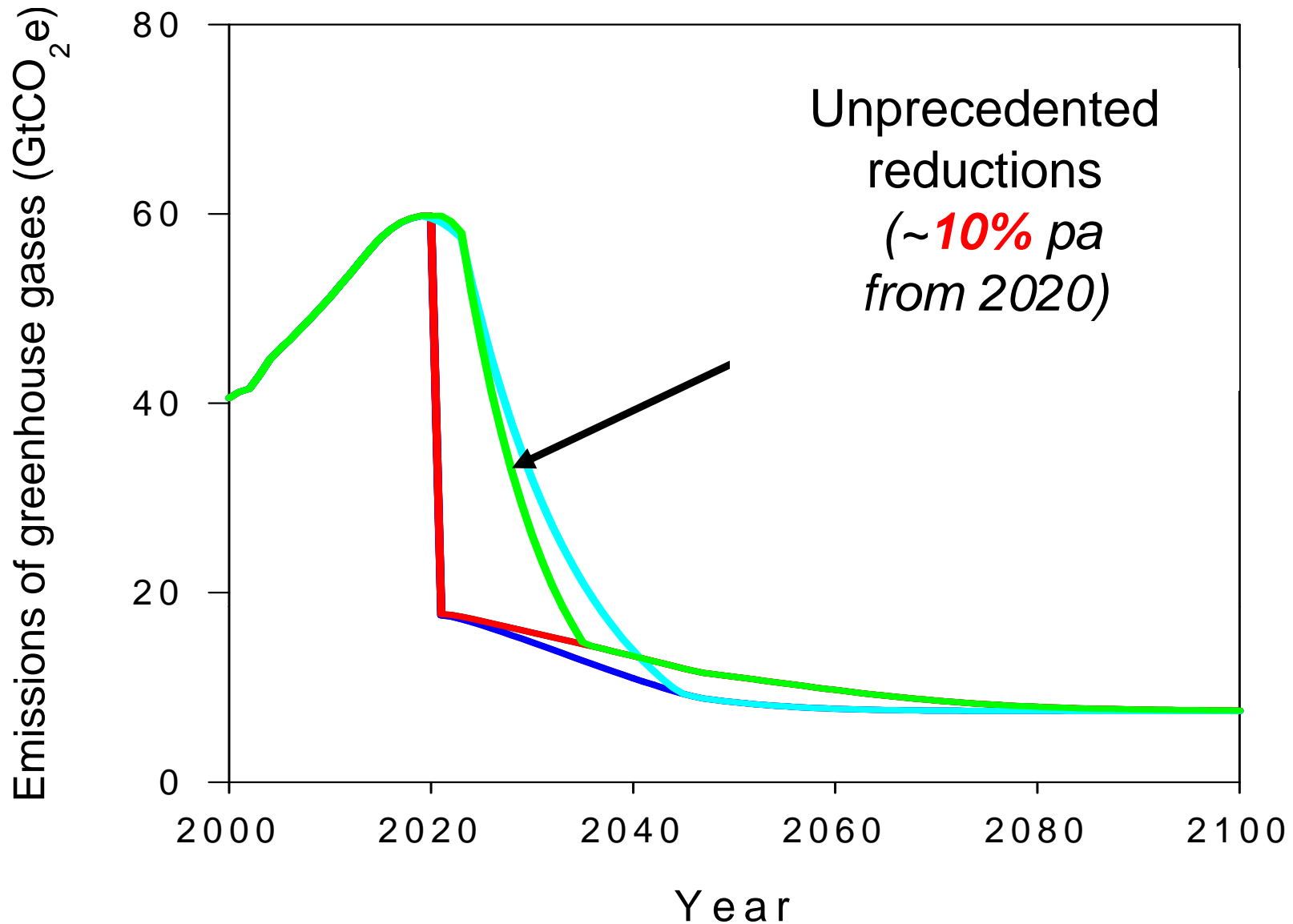
# **Total** greenhouse gas emission pathways

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

10% - 60% chance of exceeding 2°C & with a 2020 peak

Unprecedented reductions (~**10%** pa from 2020)

Emissions of greenhouse gases (GtCO$_2$e)

Year

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

... and for energy emissions?
(with 2020 peak)

Even then total
decarbonisation by
~2035-45 necessary

Emissions of CO_2 alone ($GtCO_2$)

Legend:
- 2020 peak High D_L
- 2020 peak High D_H

Year
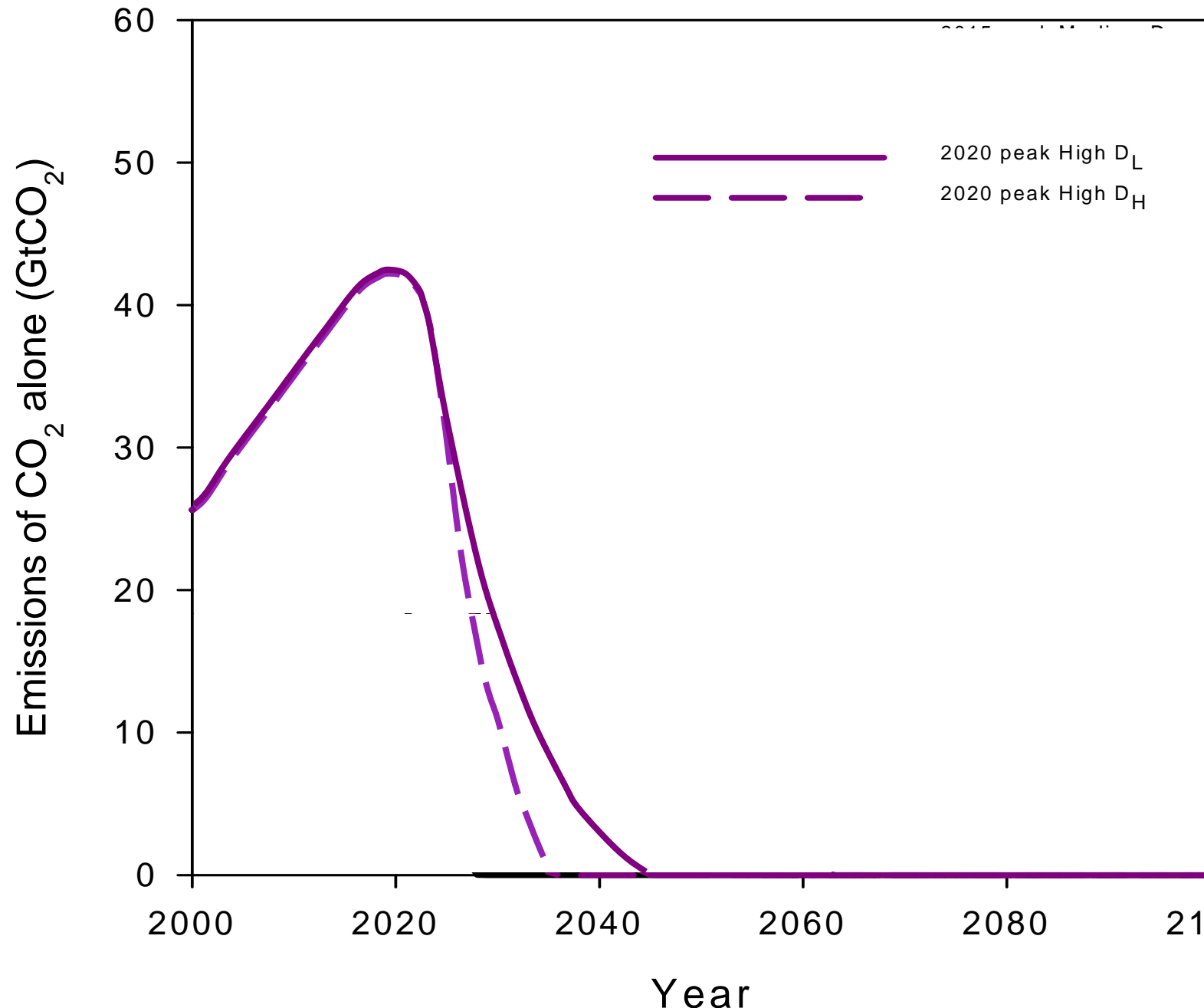
What annual global emission reductions

from energy for 3°C and 4°C

Assume

- *2020 global peak in emissions*
- *Highly optimistic deforestation & food emission reductions*
- *~ **50%** (?) chance of exceeding 3°C & 4°C*

For **3°C** & emissions peaking by 2020:

... 9% annual reductions in CO_2 from energy

For **4°C** & emissions peaking by 2020:

... 3.5% annual reductions in CO_2 from energy

What are the precedents for such reductions?

Annual reductions of greater than 1% p.a. have only

"been associated with economic recession or upheaval"

Stern 200

- *UK gas & French 40x nuclear ~1% p.a. reductions*

    (ex. aviation & shipping)

- *Collapse Soviet Union economy ~5% p.a. reductions*

450ppmv

greenhouse gas emission pathways

(50% chance of exceeding 2°C)

For a 450ppmv CO_2 future,

… the UK can emit ~ **4.8 billion tonnes of carbon**

between 2000-2050

Note: this is based on how the UK Government apportioned global emissions to the UK in order to calculate the '60% by 2050' target

From this two questions arise...

Question 1...

.......what were UK emissions between 2000 & 2006?

Emissions: 2000-2006 = ~1.2 billion tonnes carbo

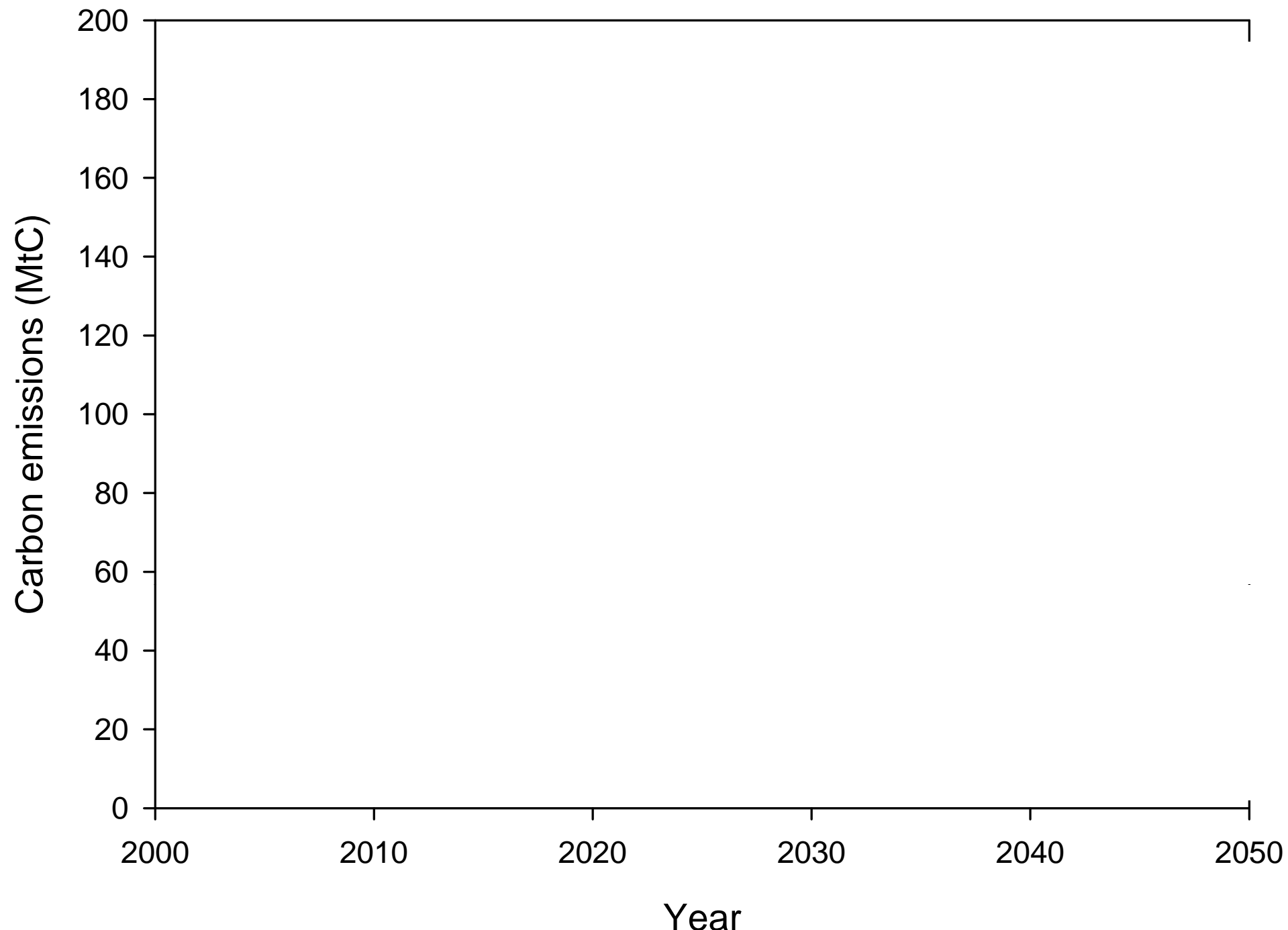For a 450 future,

this leaves 3.6 billion tonnes for 2007-205

... i.e. we've used ¼ of our permitted emissions fo
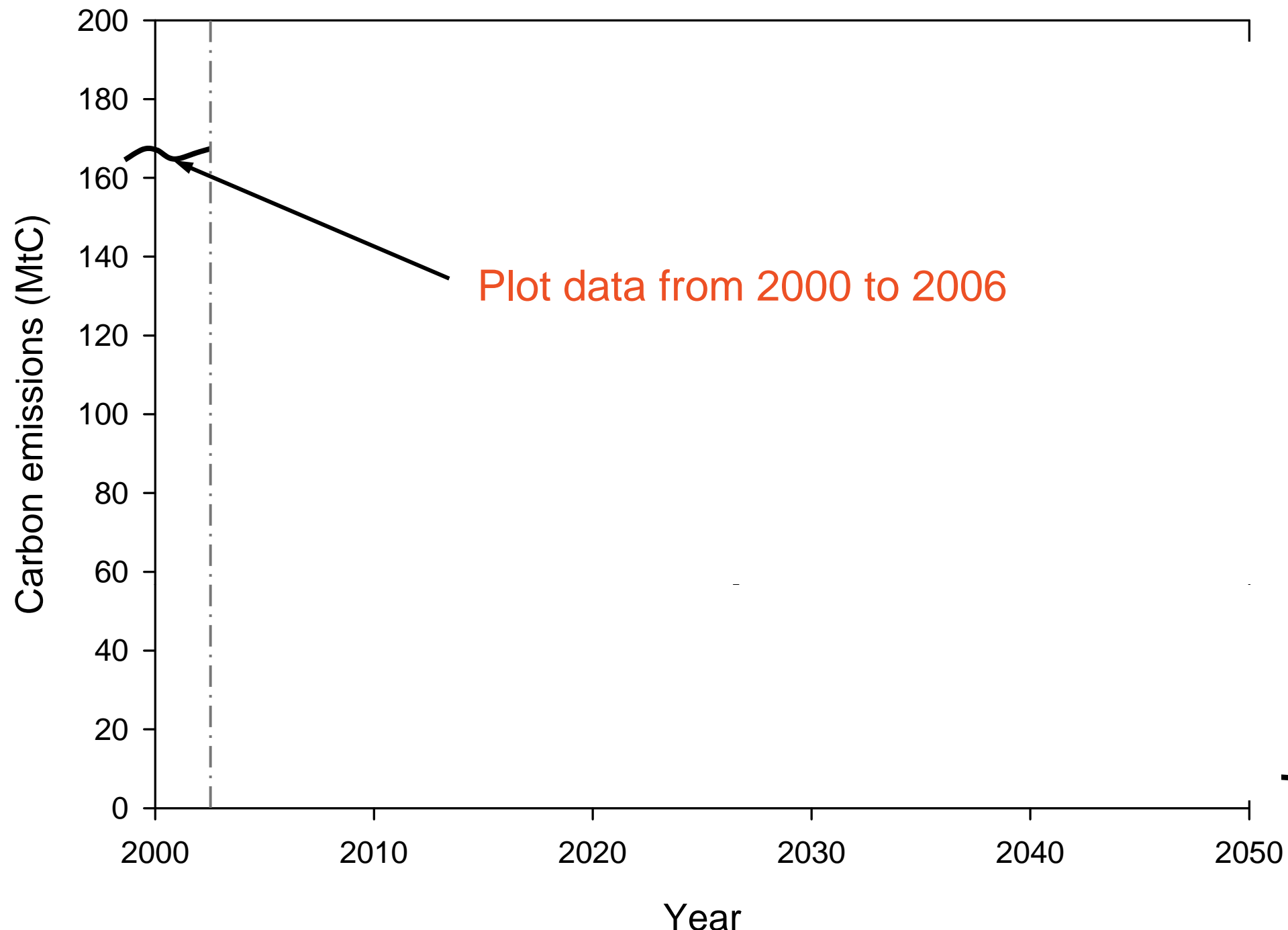
50 years in just 6½ years!

Question 2...

..... what emissions are we locked into in the immediate future?
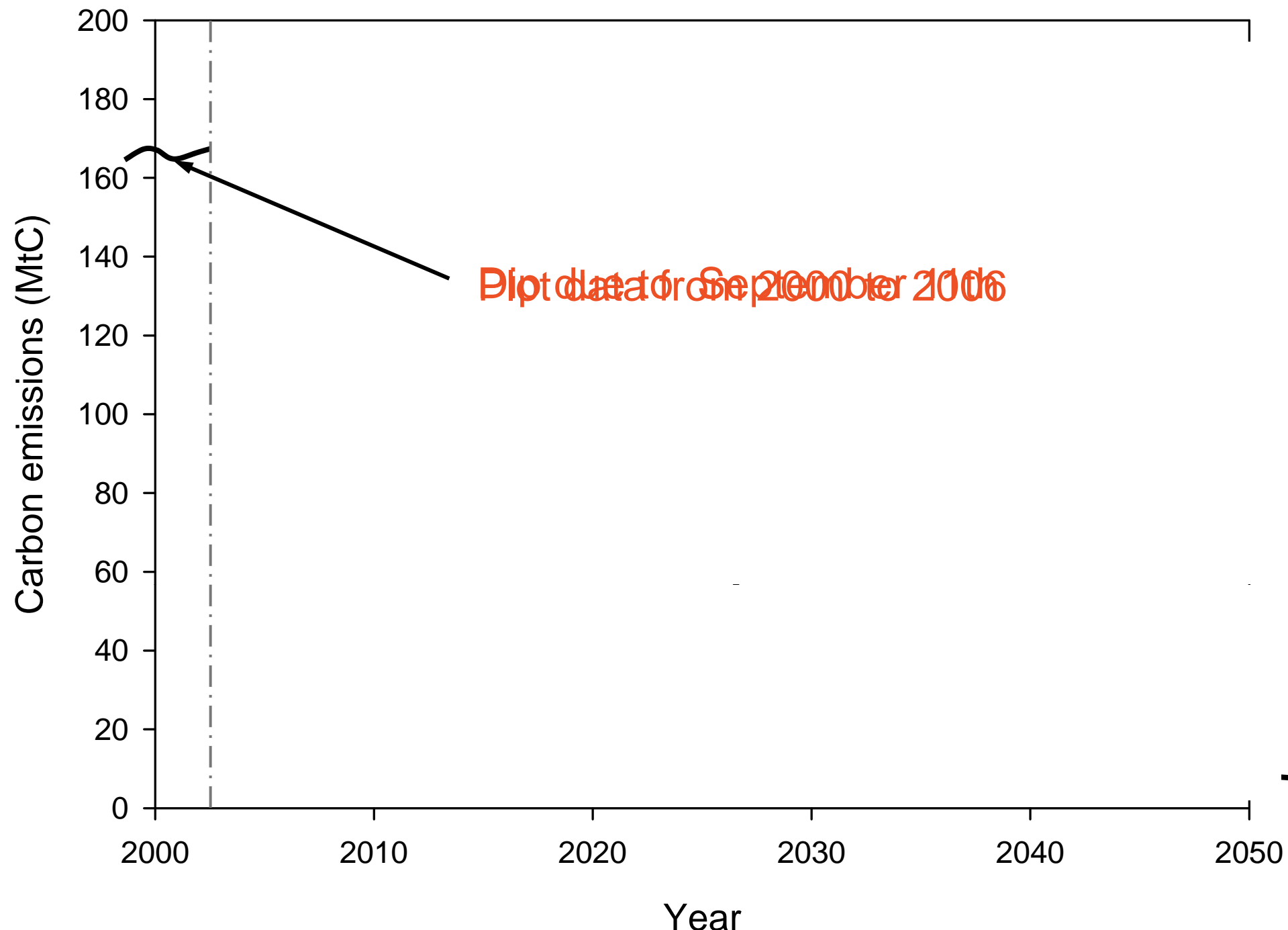
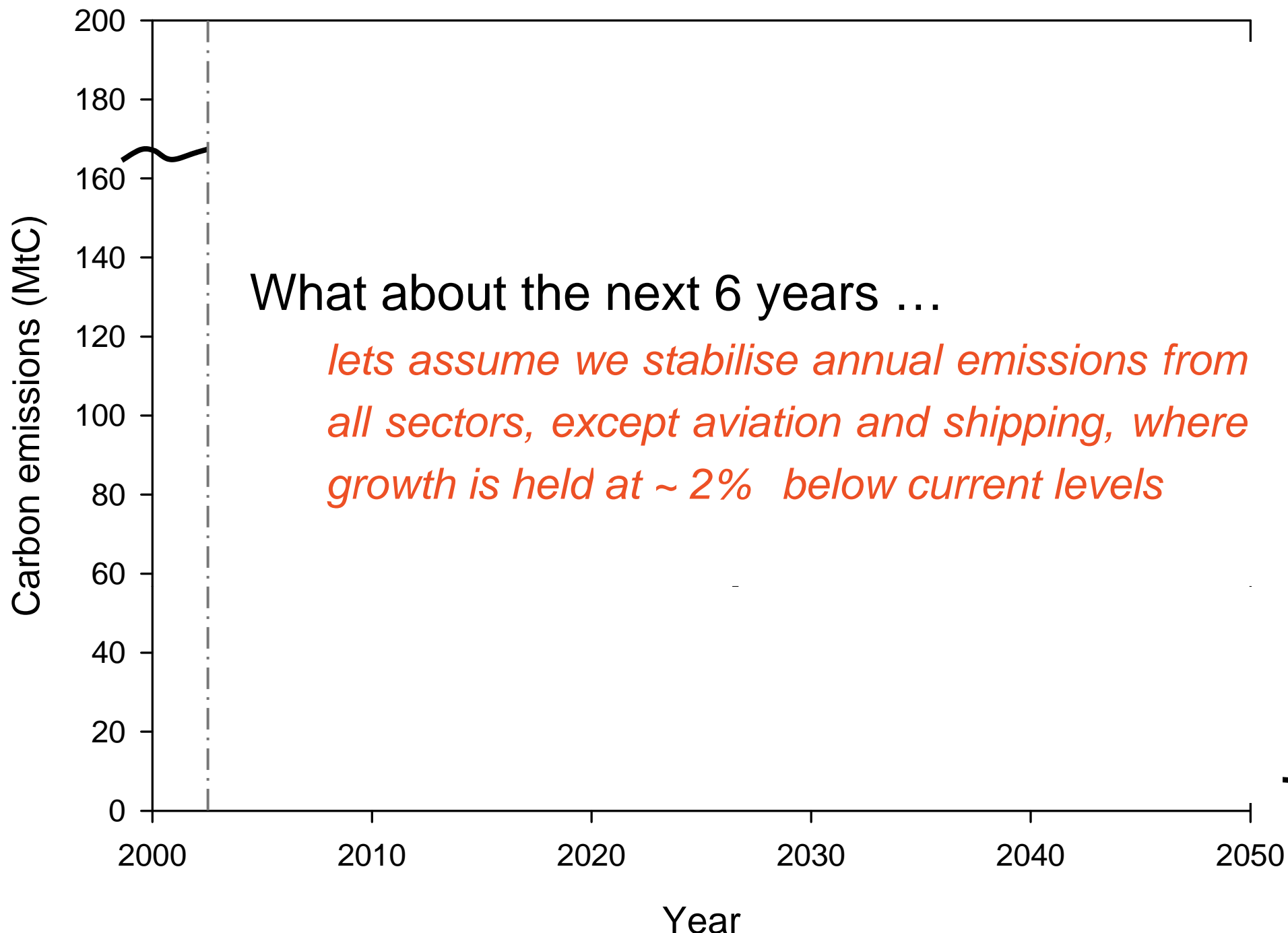# Looking at 450ppmv target graphically ...
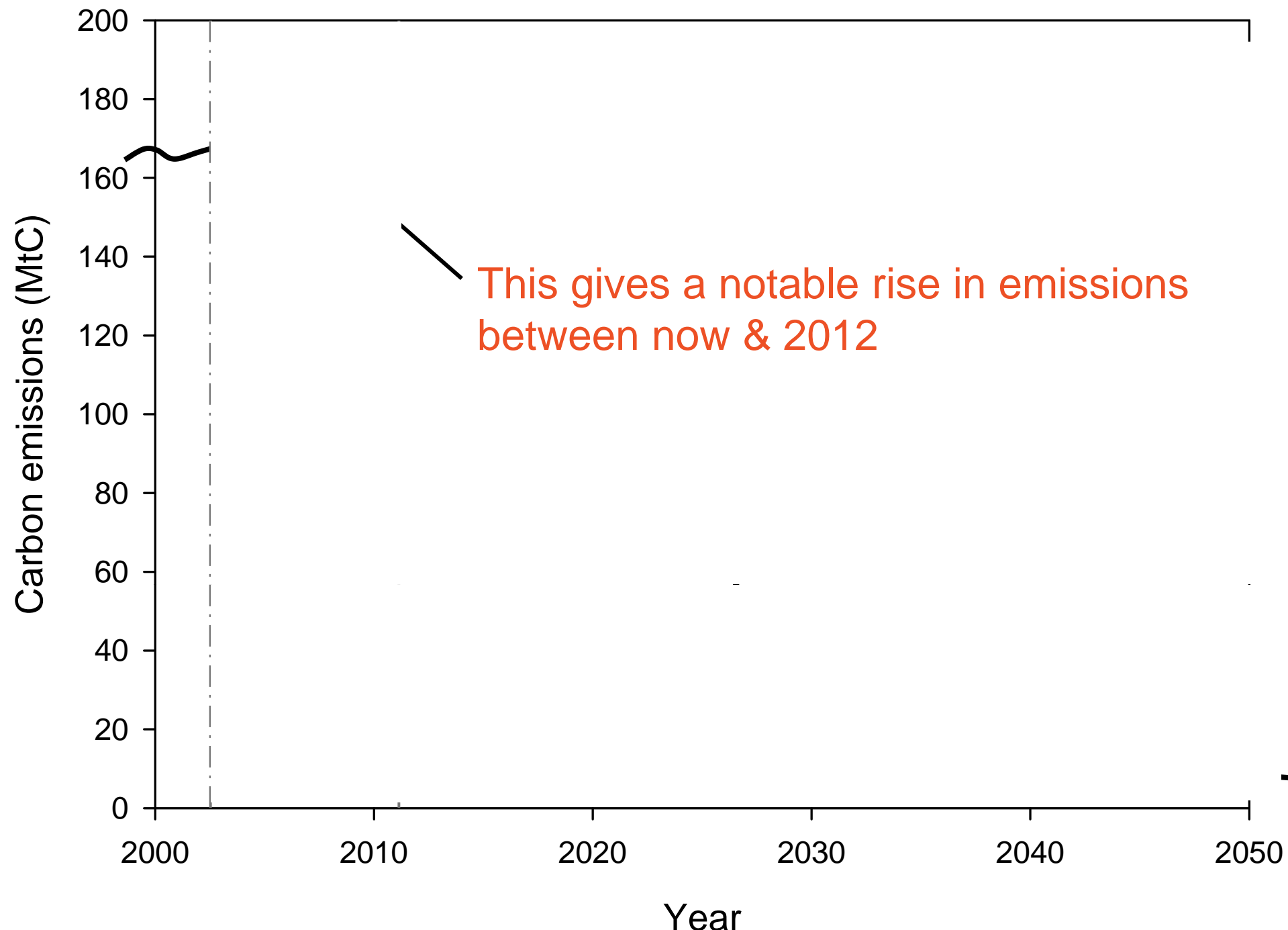
Carbon trajectories

Carbon trajectories

Carbon emissions (MtC)

Year

Plot data from 2000 to 2006

Carbon trajectories

Plot data for September 2006

Carbon emissions (MtC)

Year

Carbon trajectories

Carbon emissions (MtC)

Year

What about the next 6 years …

lets assume we stabilise annual emissions from all sectors, except aviation and shipping, where growth is held at ~ 2% below current levels

Carbon trajectories

This gives a notable rise in emissions between now & 2012

700 —

600 —

500 —

400 —

300 —

200 —

100 —

0 —

Carbon dioxide emissions (MtCO$_2$)

2000   2010   2020   2030   2040   2050

locking nation into unprecedented annual CO$_2$ reductions for ~2 decades, beginning 2012-14

But UK can emit only

17 to **23 GtCO$_2$**

6% p.a.

9% p.a.
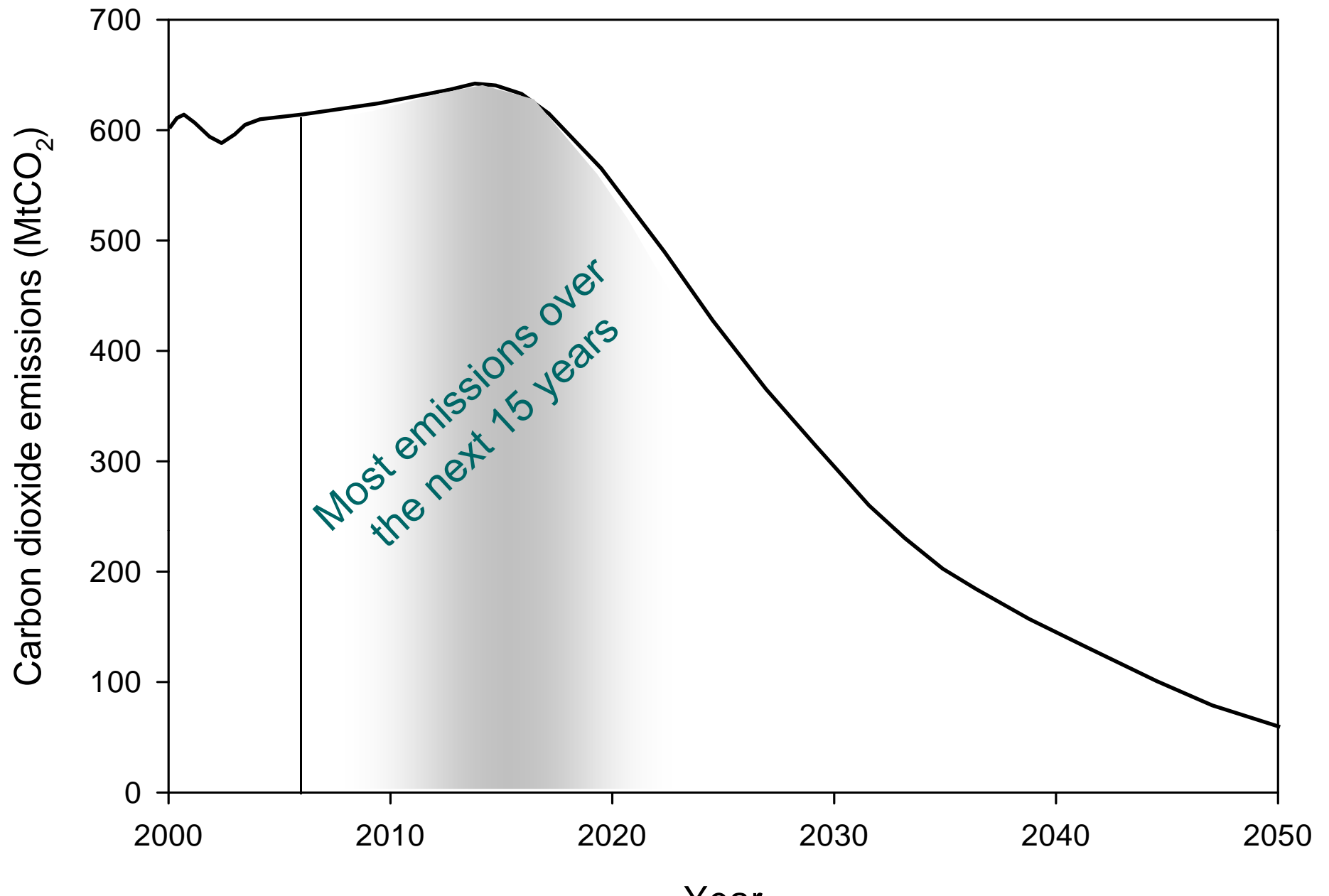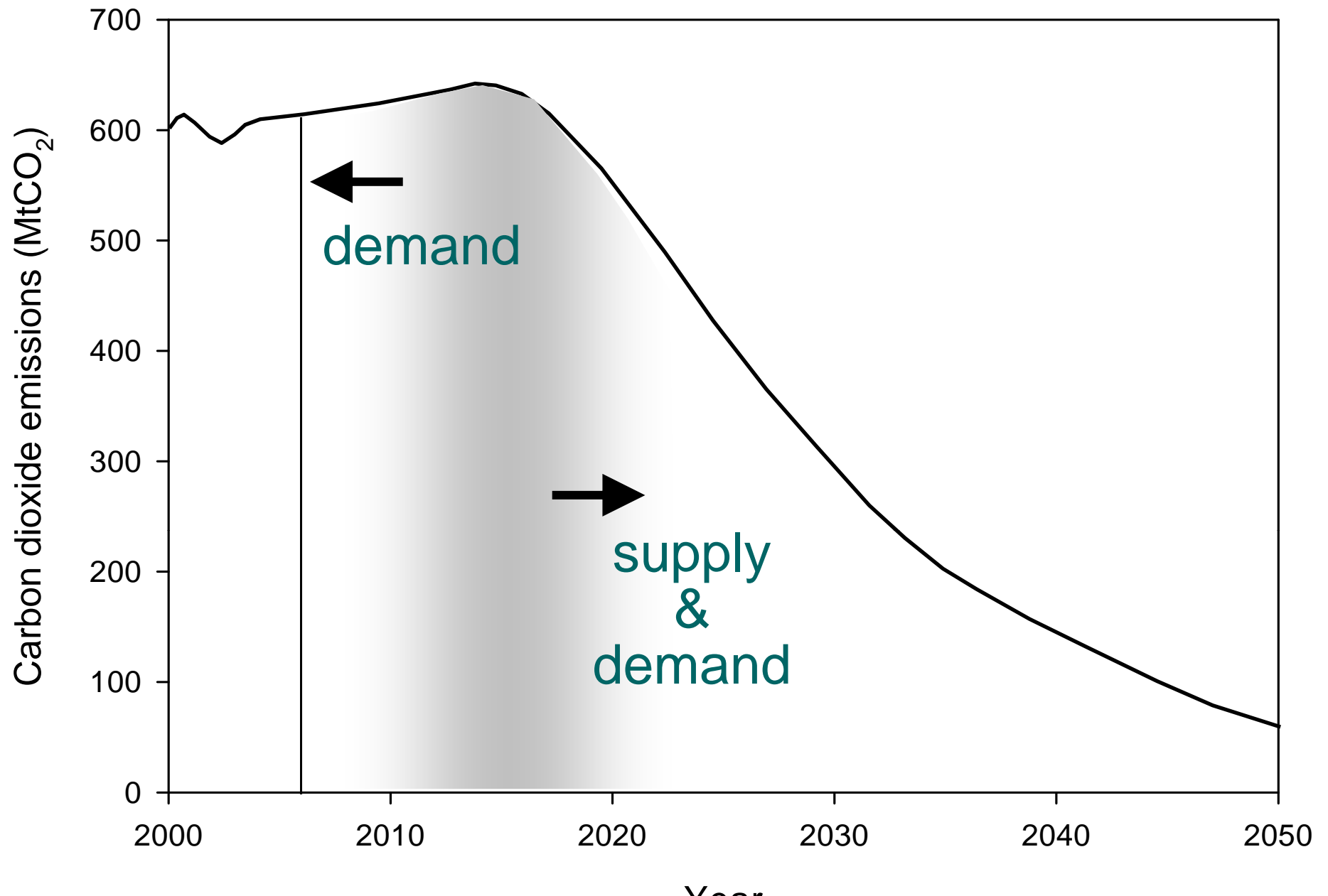
What does the pathway approach say about UK emission policies ?

Mitigation

Short-term: 2010-2015

- Rapid reduction in emissions through behaviour change
  voluntary & enforced (via regulation)
- Low emission diets

- Afforestation – combined timber new-build

- Moratoriums on:
  sale of inefficient appliances (all A++ from 2010)
  sale of any cars under 60mpg
  airport, sea port and road expansion
  any new fossil-fuel powerstation (without CCS & CHP)

Mitigation

Short-Medium term: 2015-2025

- Rapid deployment of low-carbon energy supply
    - rapid renewables (Severn barrage?)
    - massive biomass programme
    - widespread micro-grids
    - coal with CCS & CHP nuclear
    - nuclear with CHP

- Massive shift to electricity for transport & heat

- Hydrogen infrastructure (?)

Reducing carbon emissions (mitigation)

To avoid dangerous climate change we need a reduction in carbon emissions in the region of:

90% !!

Remember – almost all carbon emissions are from energy & 80% of all emissions come from 20% of the global population !

Thank you