Climate Resilient Energy Infrastructure

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Outline

- Climate change and the role of infrastructure
  - » Existing vs. new
- Resnet demand scenarios
  - » Emphasis on electricity
  - » Transmission rather than distribution
- Risks of high electrification

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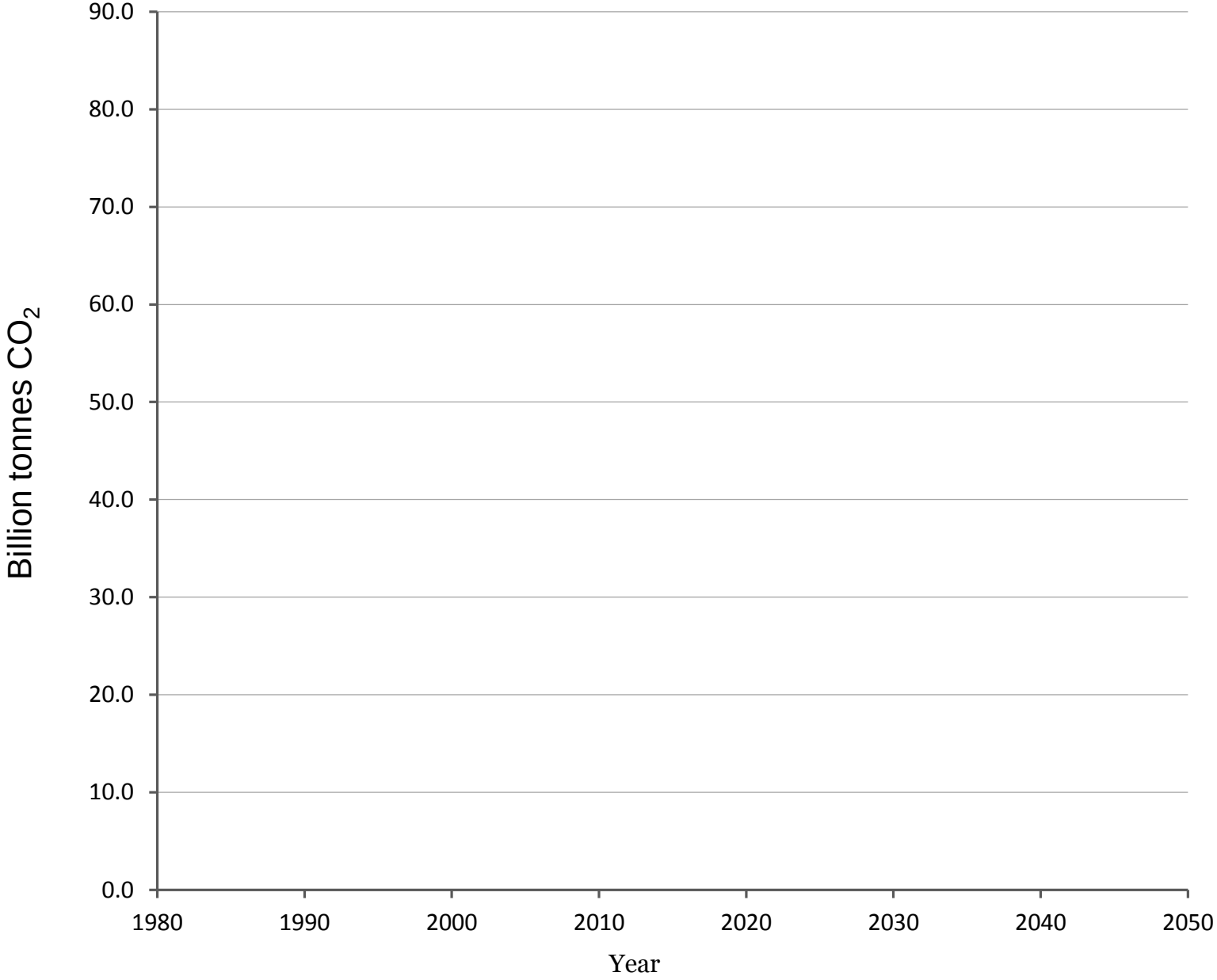
Global emission of fossil fuel CO_2 (inc. cement)



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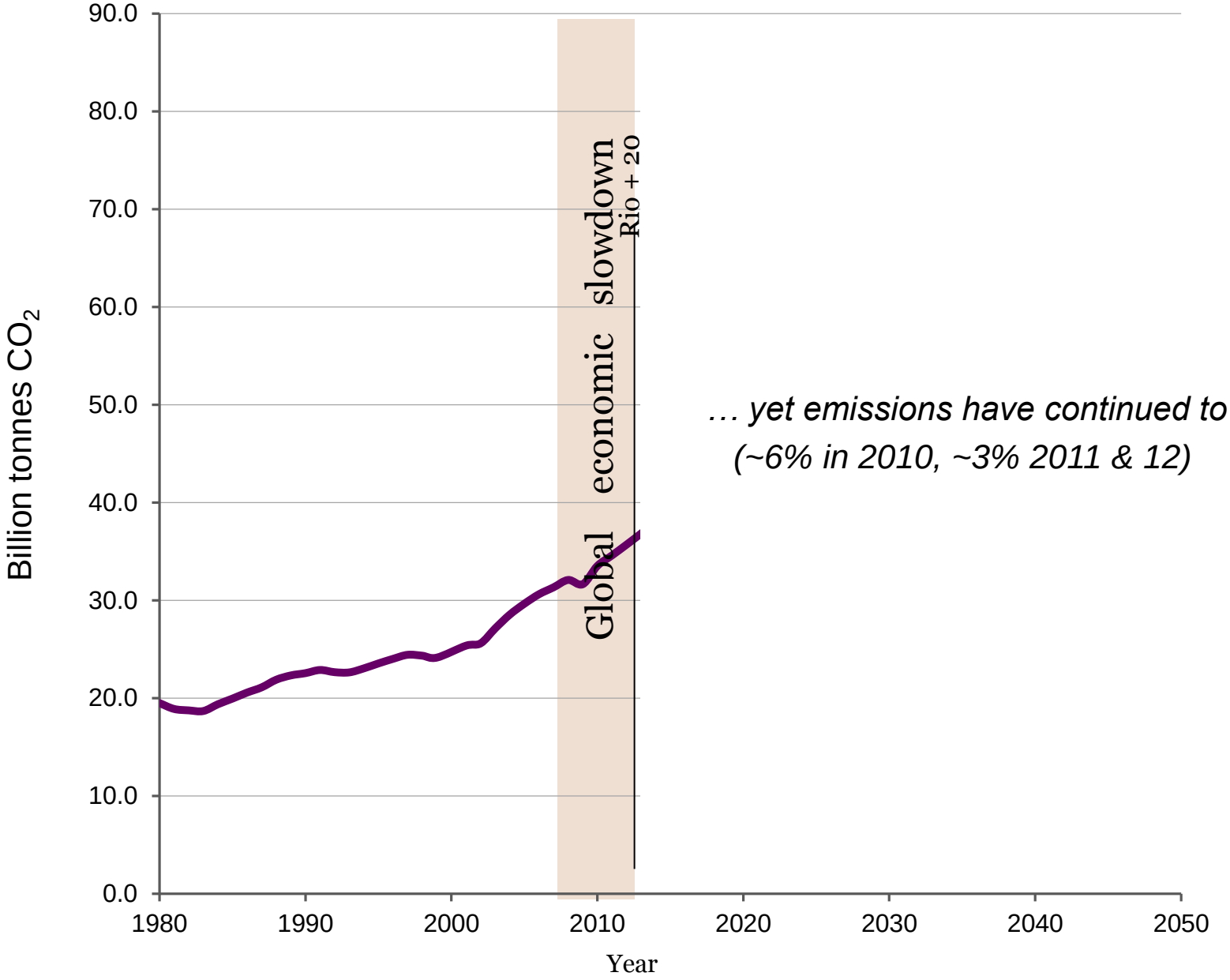

… yet emissions have continued to rise
(~6% in 2010, ~3% 2011 & 12)

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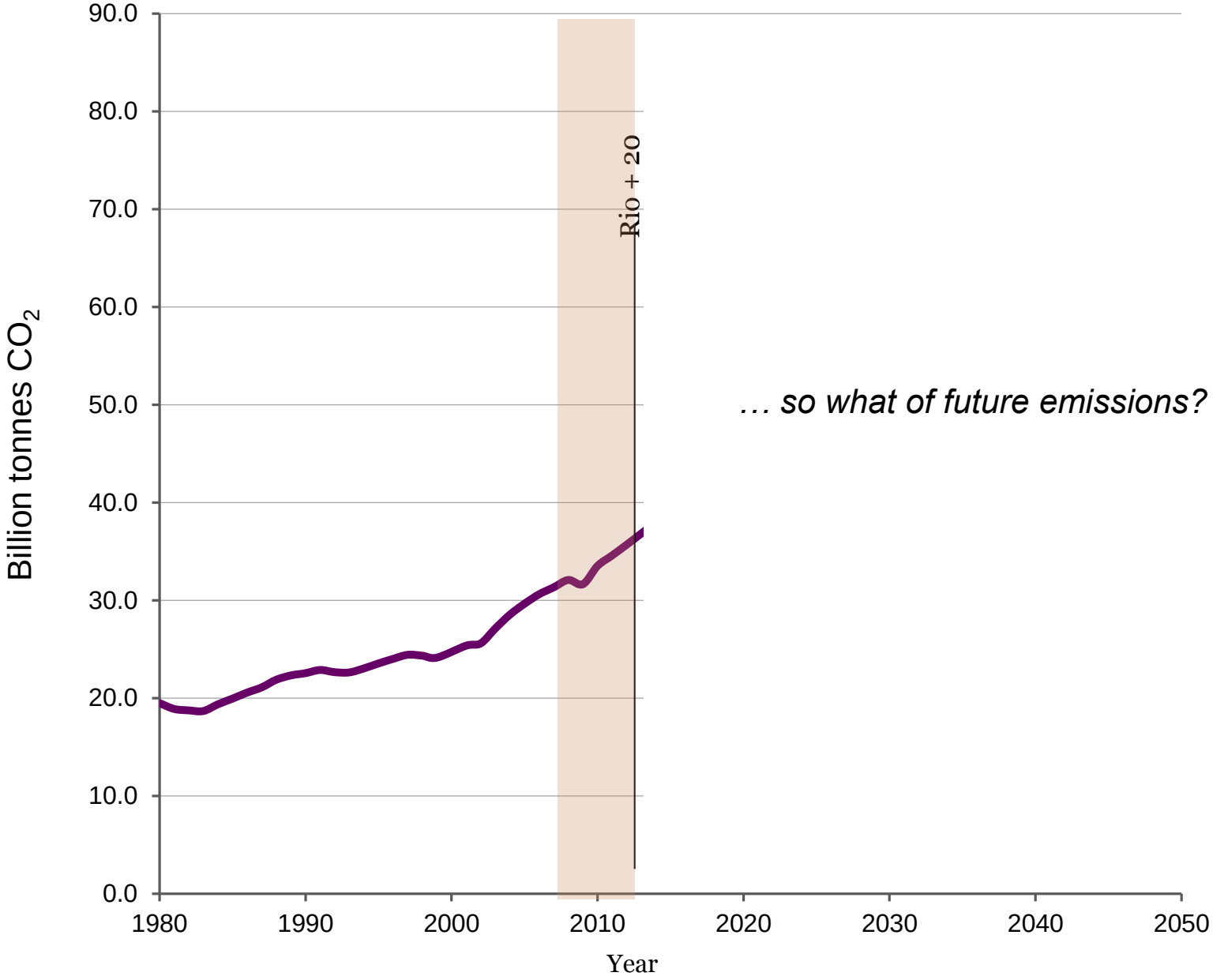

… so what of future emissions?

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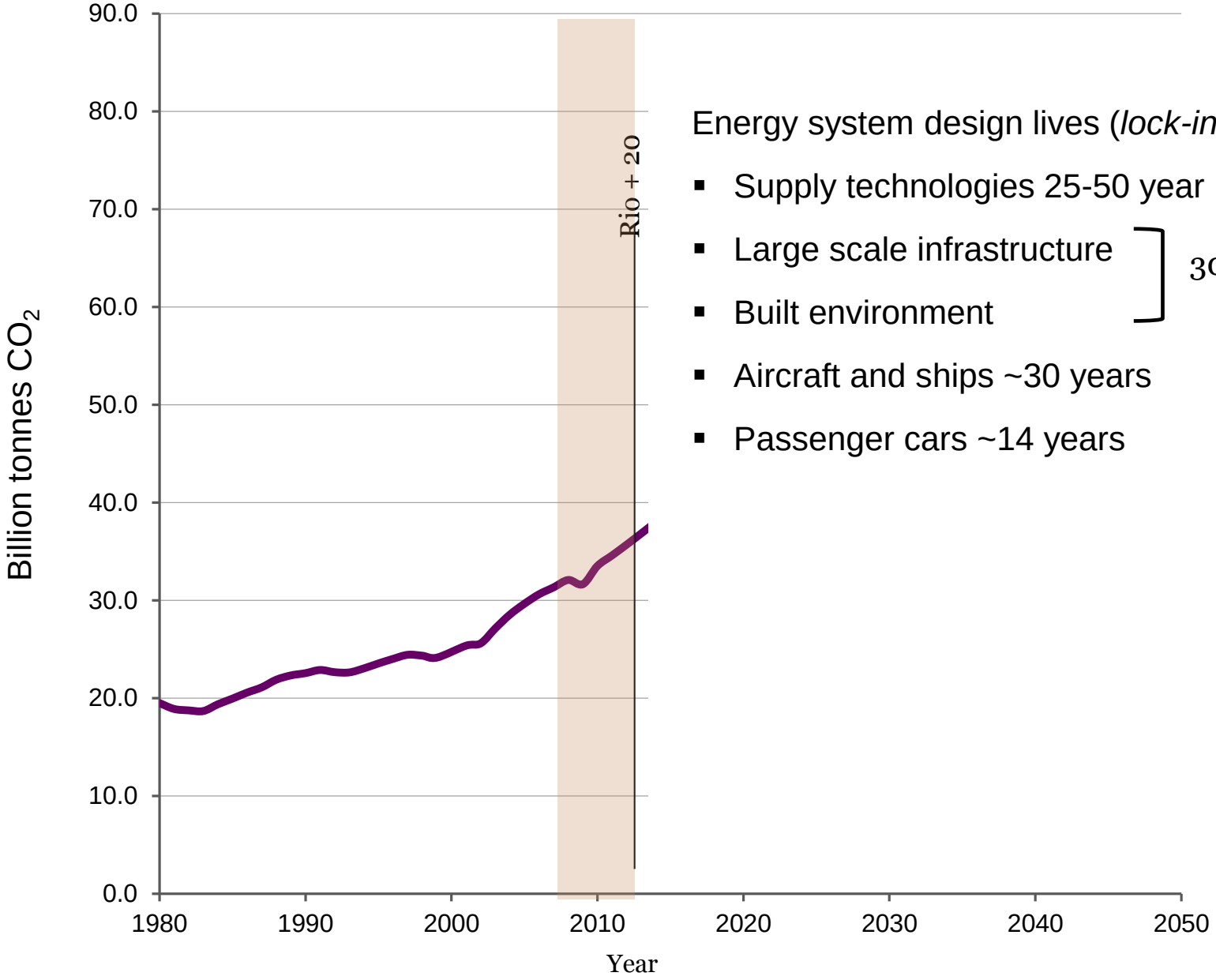

Energy system design lives (*lock-in*)

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

30-100 years

- Aircraft and ships ~30 years
- Passenger cars ~14 years

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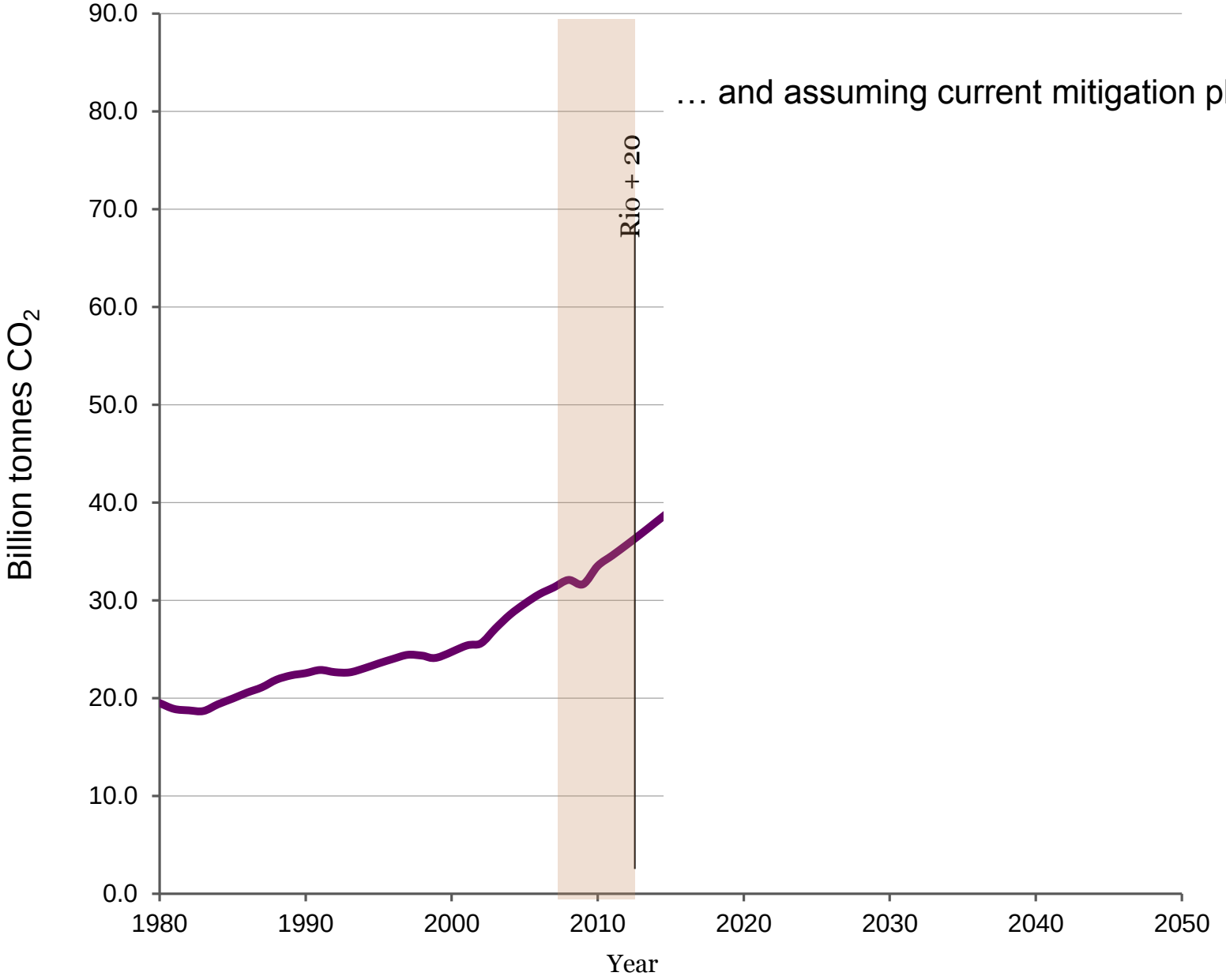

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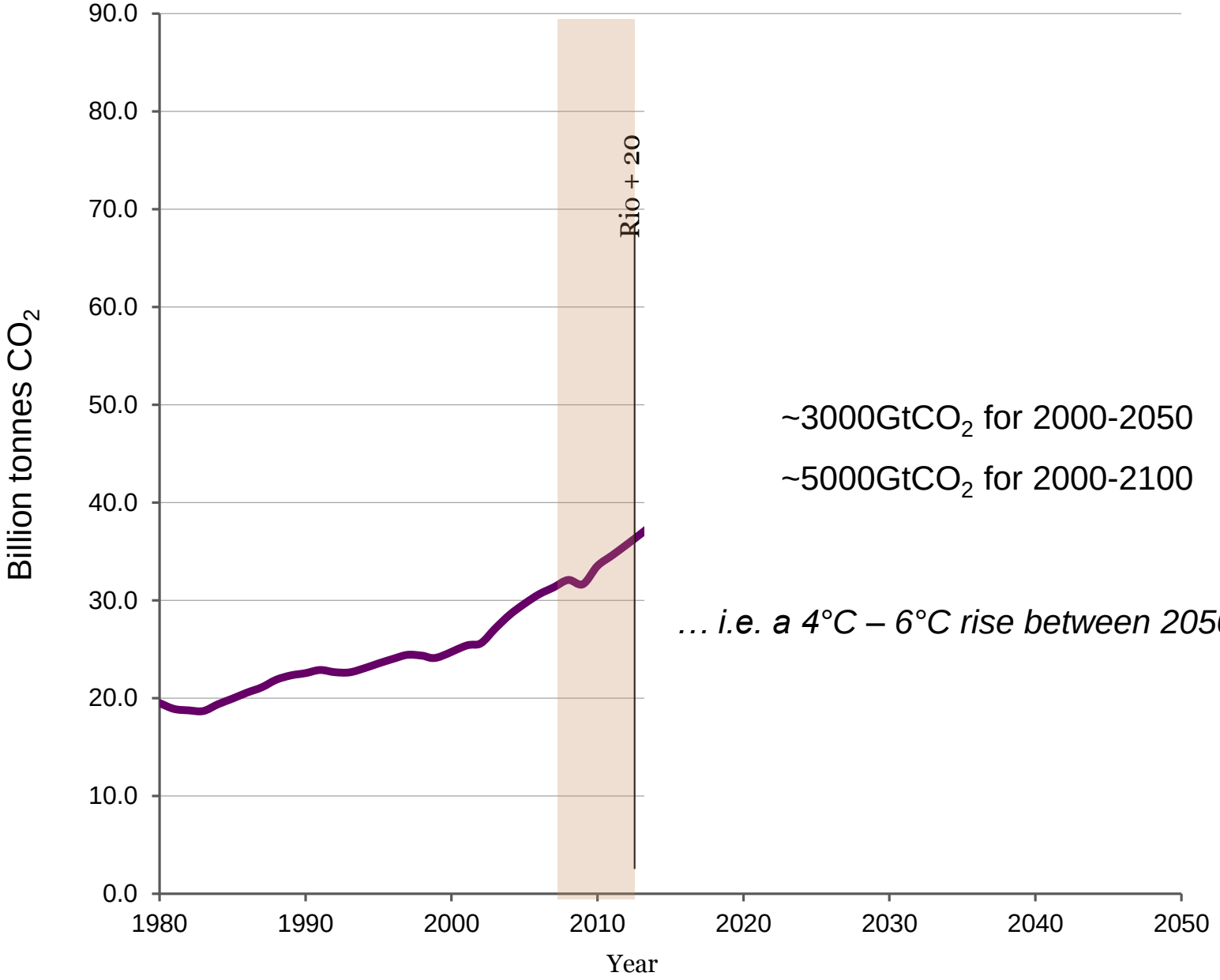

~3000GtCO_2 for 2000-2050

~5000GtCO_2 for 2000-2100

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

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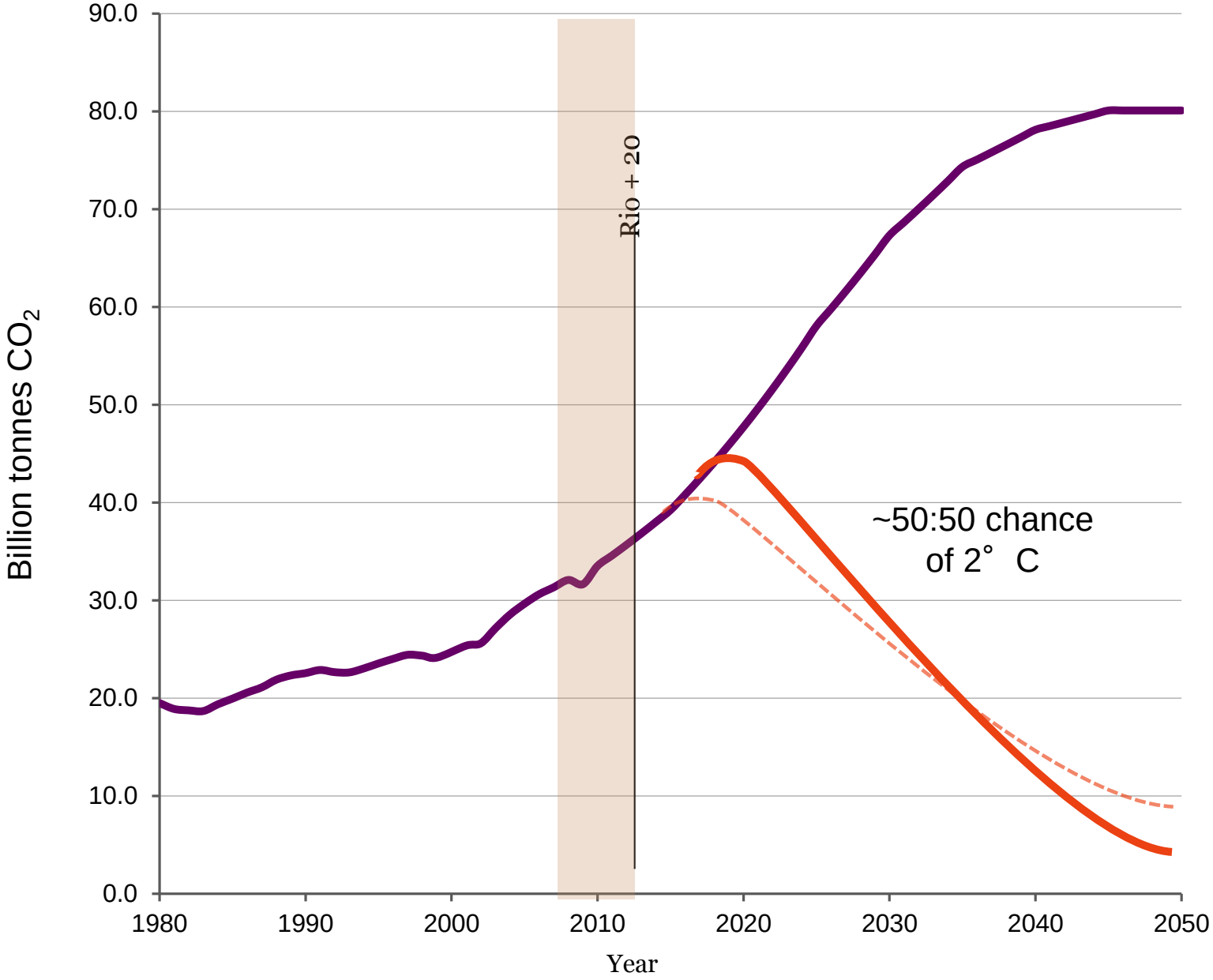

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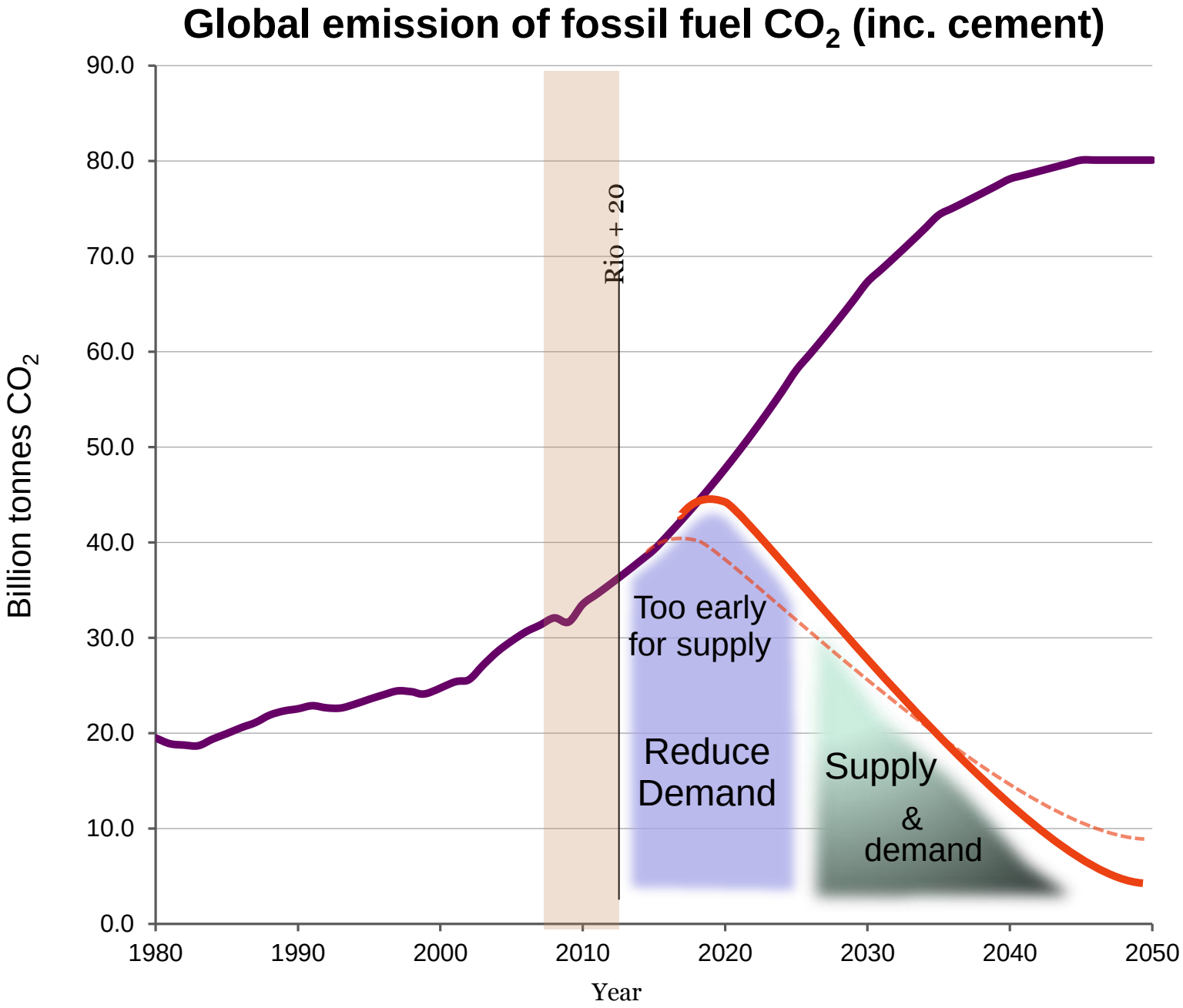
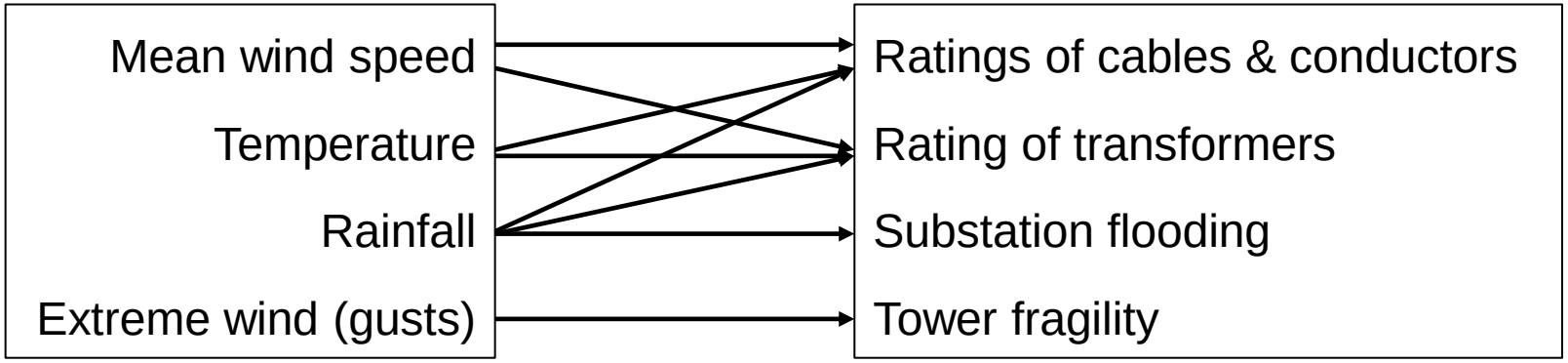


For a reasonable probability of < 2°C

- In wealthy, Annex-1 countries,
- Energy demand reduction is paramount
- Likely to mean more electricity use
- Will stress the existing transmission infrastructure

Supply-side: adaptation

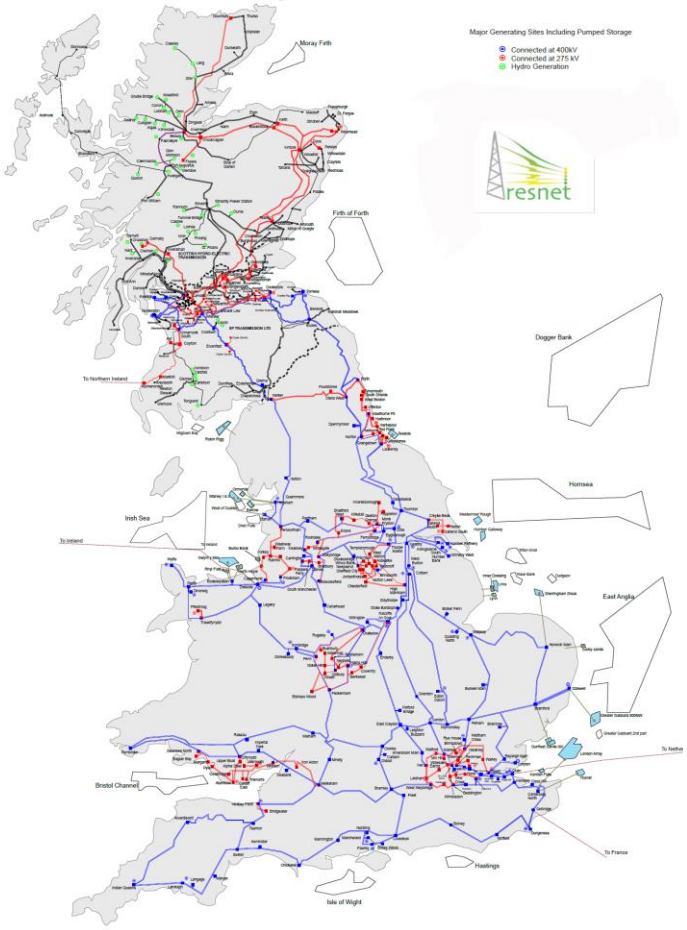
- Weather-related performance of electricity infrastructure



- Whilst coping with increased levels of demand…
- Network cascade effects

New infrastructure: the ‘thin end of the wedge’

- Decarbonisation of supply
  - » Reduction in use of fossil sources
  - » Increasing renewable generation
  - » Biofuels
  - » Nuclear



Practical resource estimates

	Tidal stream	Tidal barrage	Tidal lagoon
England	11 GW	27 GW	8 GW
Wales	9.5 GW	8 GW	3.5 GW
Scotland	11 GW	10 GW	2.5 GW

Wave nearshore		Wave offshore	
Scotland	1900 MW	west	13500 MW
England	50 MW	north	6750 MW
Wales	50 MW	south west	6750 MW

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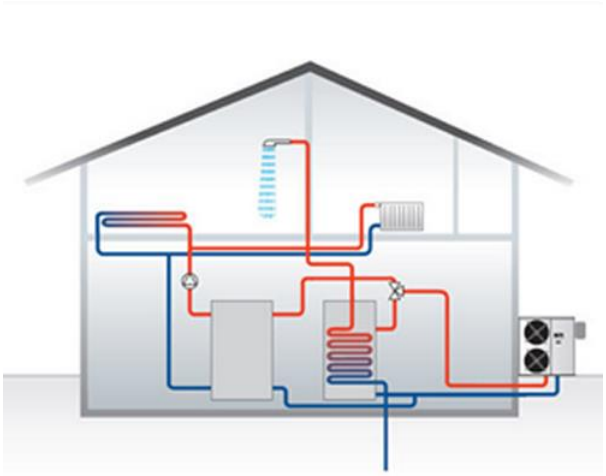
Resnet demand model

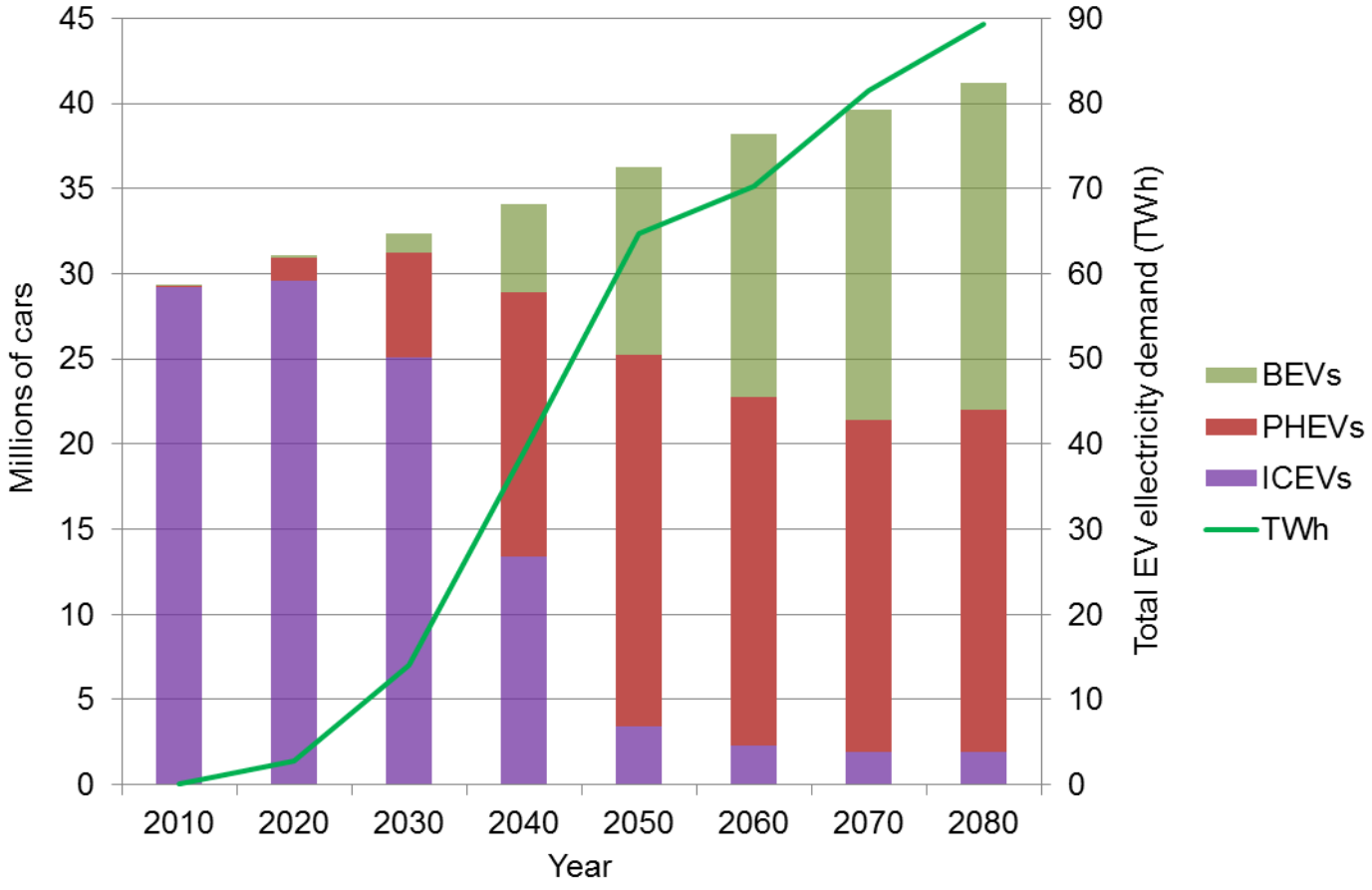
- Quantitative scenarios of demand for each sector
  - » Highly disaggregated (~150 individual demand parameters)
  - » Spatially resolved into 17 zones, grouped into 3 ‘weather zones’
  - » Future weather dependencies based on UKCP09 high emissions
  - » Focus on 2020, 2030, 2050 and 2080
  - » Core scenario based on National Grid assumptions about uptake
    - NOT premised on meeting 2°C emissions budget

Demand-side: mitigation

- Increasing electricity penetration into non-electric sectors
  - » Heating → heat pumps
  - » Private transport → plug-in electric vehicles



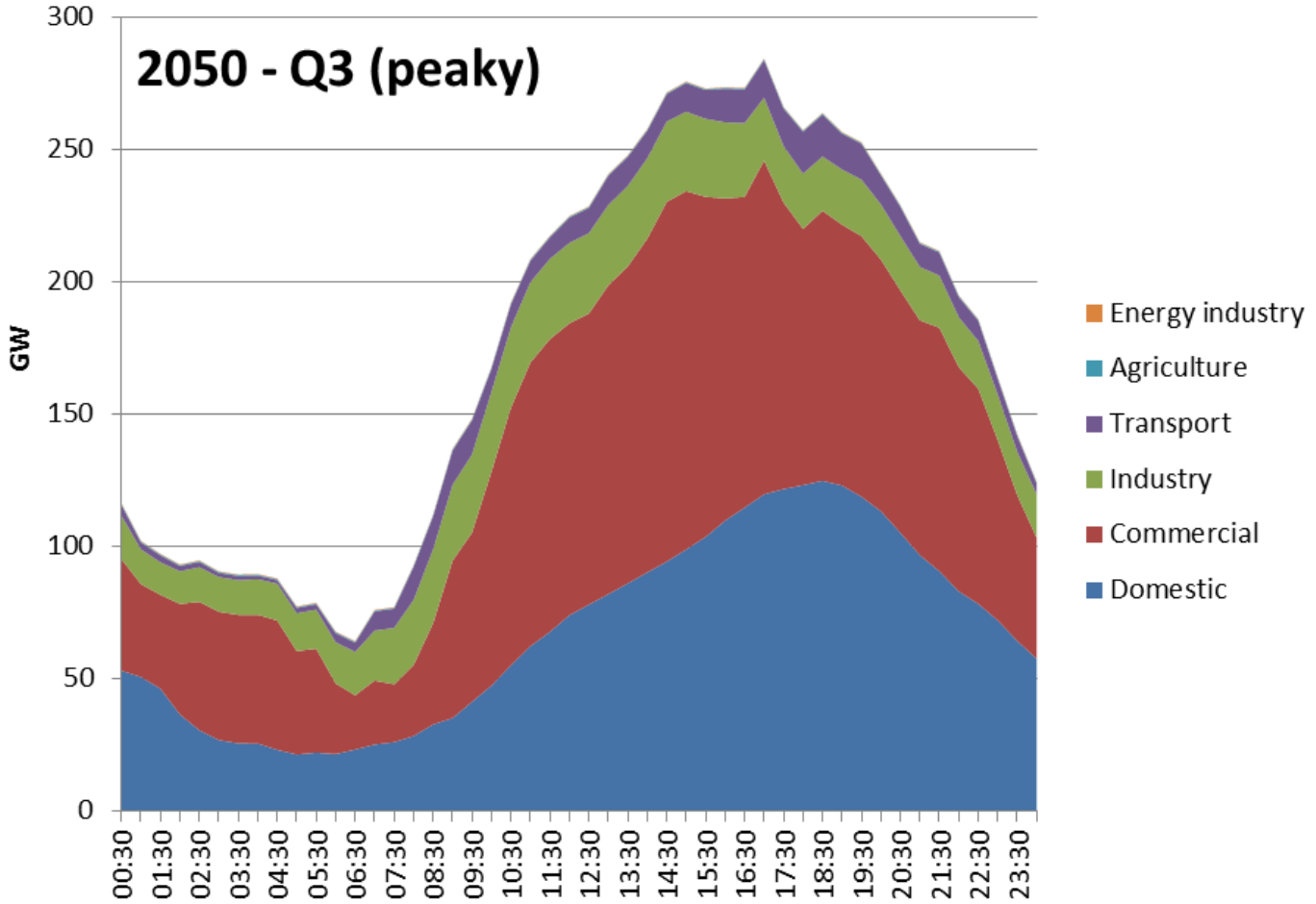
Electric vehicles



Demand-side: adaptation

- Increasing energy demand in response to climate & weather:
  - » Comfort cooling → air conditioning
  - » Industry → temperature controlled environments
  - » Agriculture → crop drying
  - » Flood protection and alleviation → water pumping
  - » Water provision → desalination

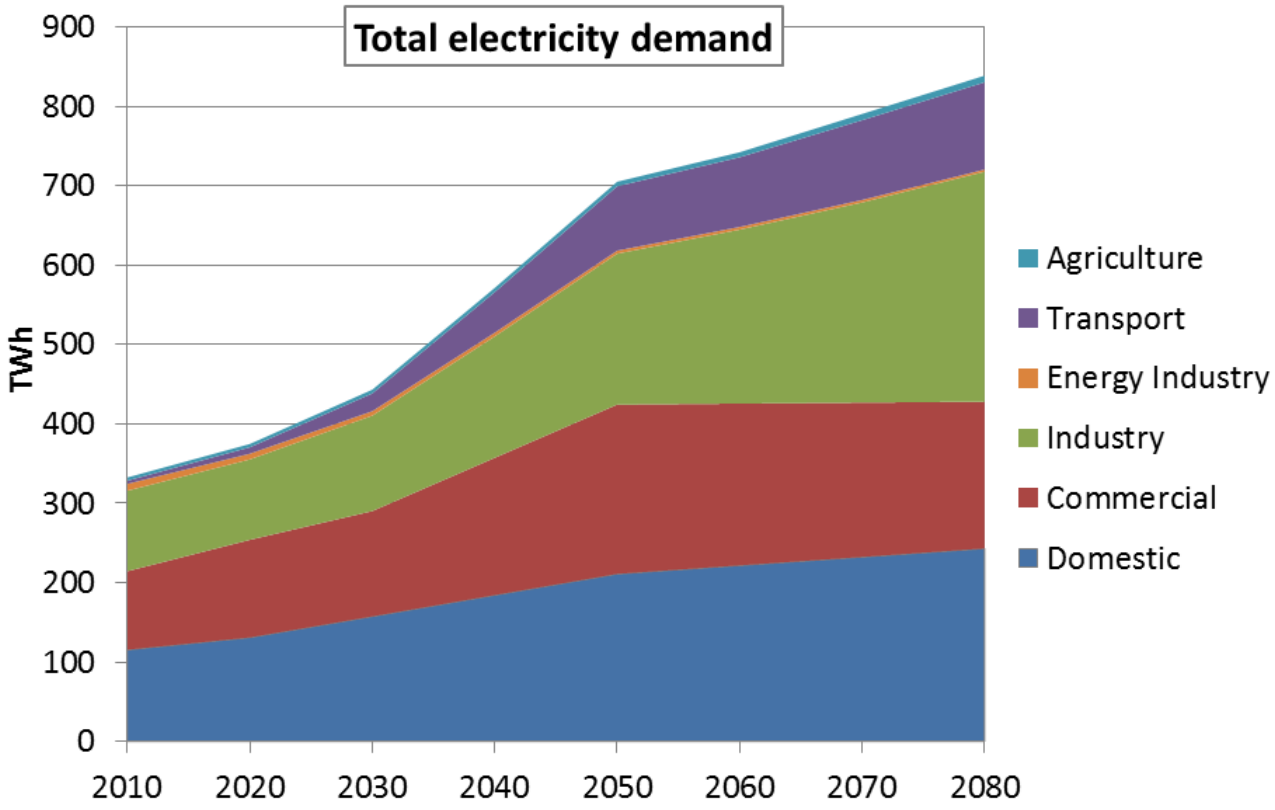
‘National Grid-based’ scenario



Weather-related demand variables

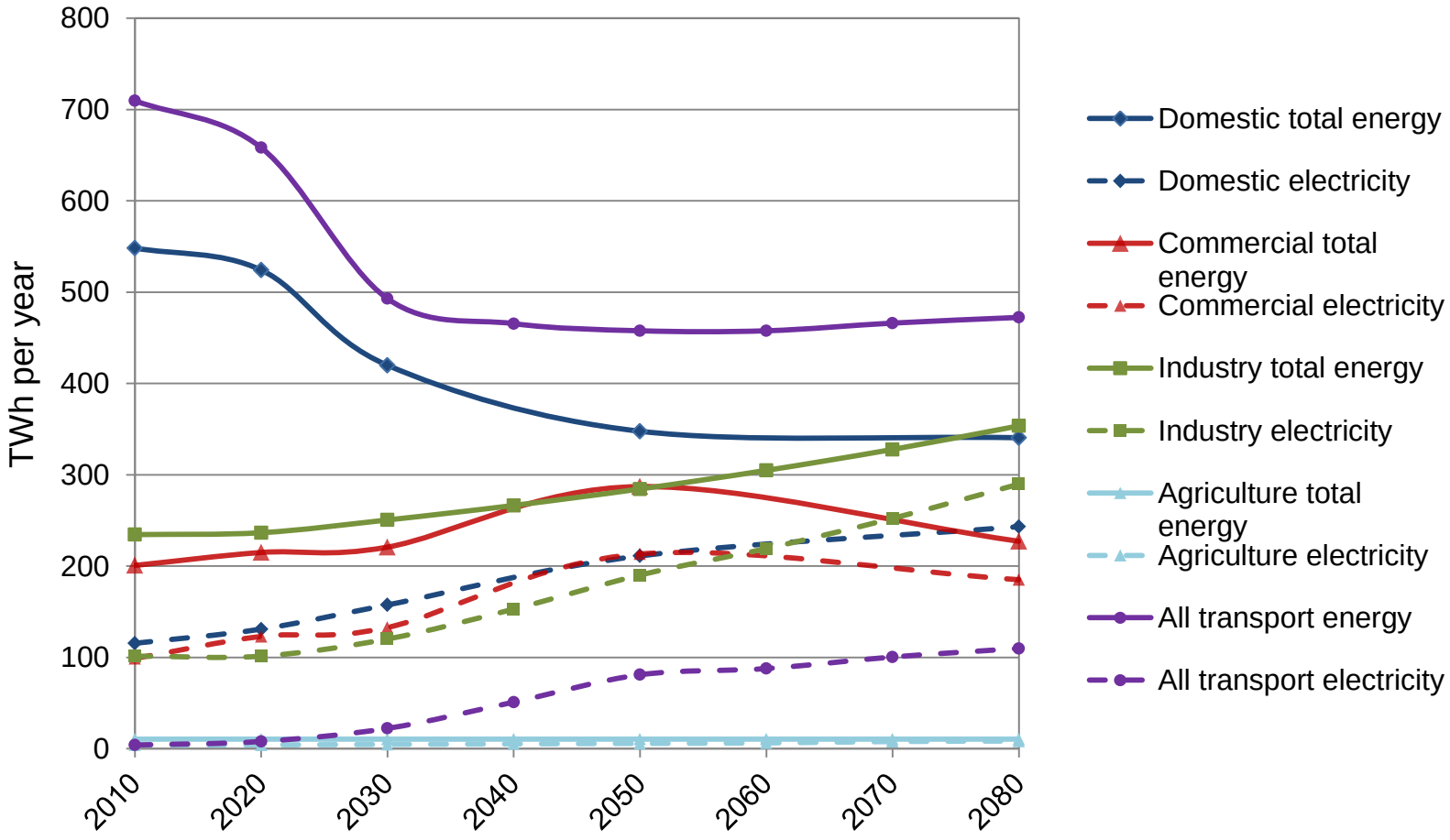
- Peak day – 95th percentile values:
  - » HDDs: slight decline over next 7 decades
  - » Domestic CDDs up from ~2 in 2020 (Slough) to ~16 in 2080s
- Heating and cooling
  - » ‘Domestic’ baselines: 16°C / 22°C
  - » ‘Commercial’ baselines: 18°C / 18°C
- Peaks in diurnal load profile could be shifted according to
  - » policy, pricing etc (e.g. time of use tariffs)
  - » rates of uptake of new energy consuming technologies
  - » changing behavioural practices & expectations of comfort
  - » optimum specification, installation and use of technology

‘National Grid–based’ scenario

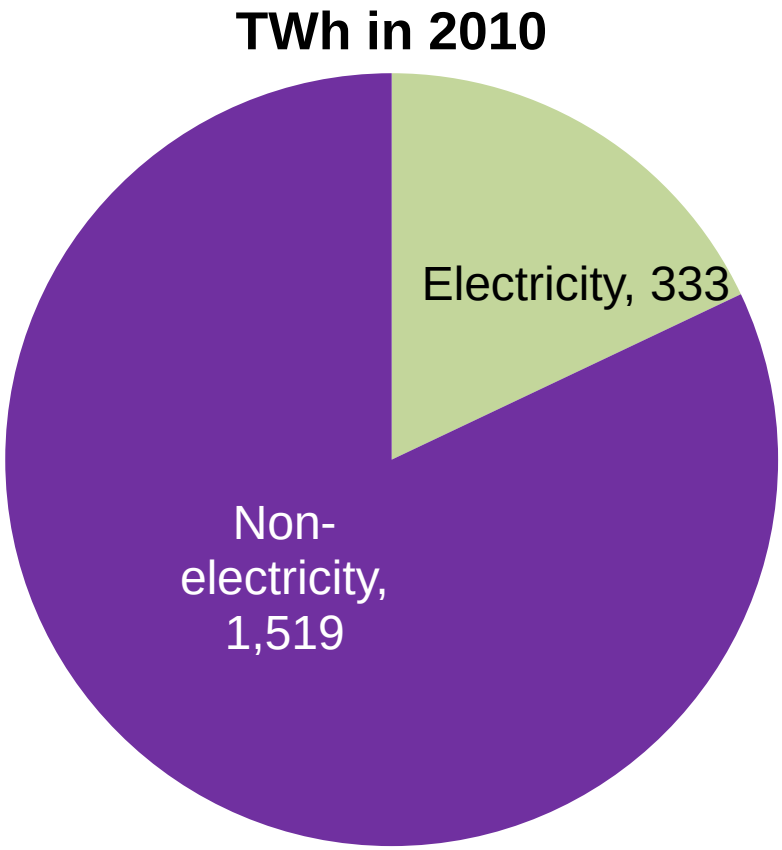


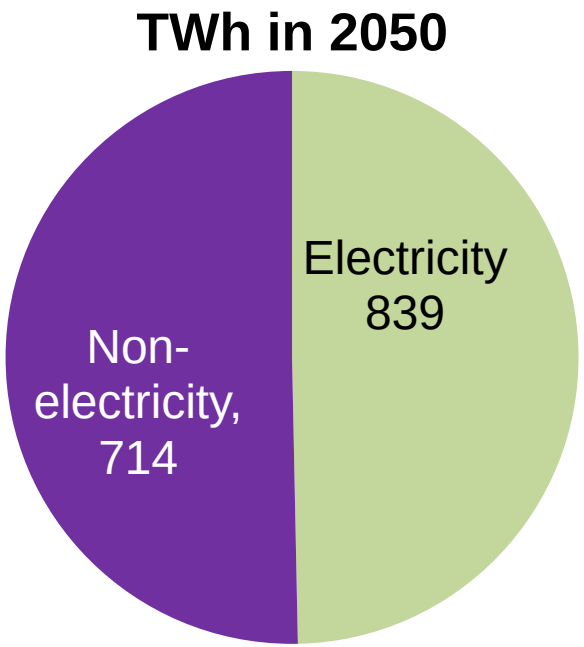
	Growth 2010–80
Domestic	111%
Commercial	87%
Industry	186%
Transport	2596%
Agriculture	109%
Energy Industry	-68%
totals	152%

Sectoral energy use in NG scenario

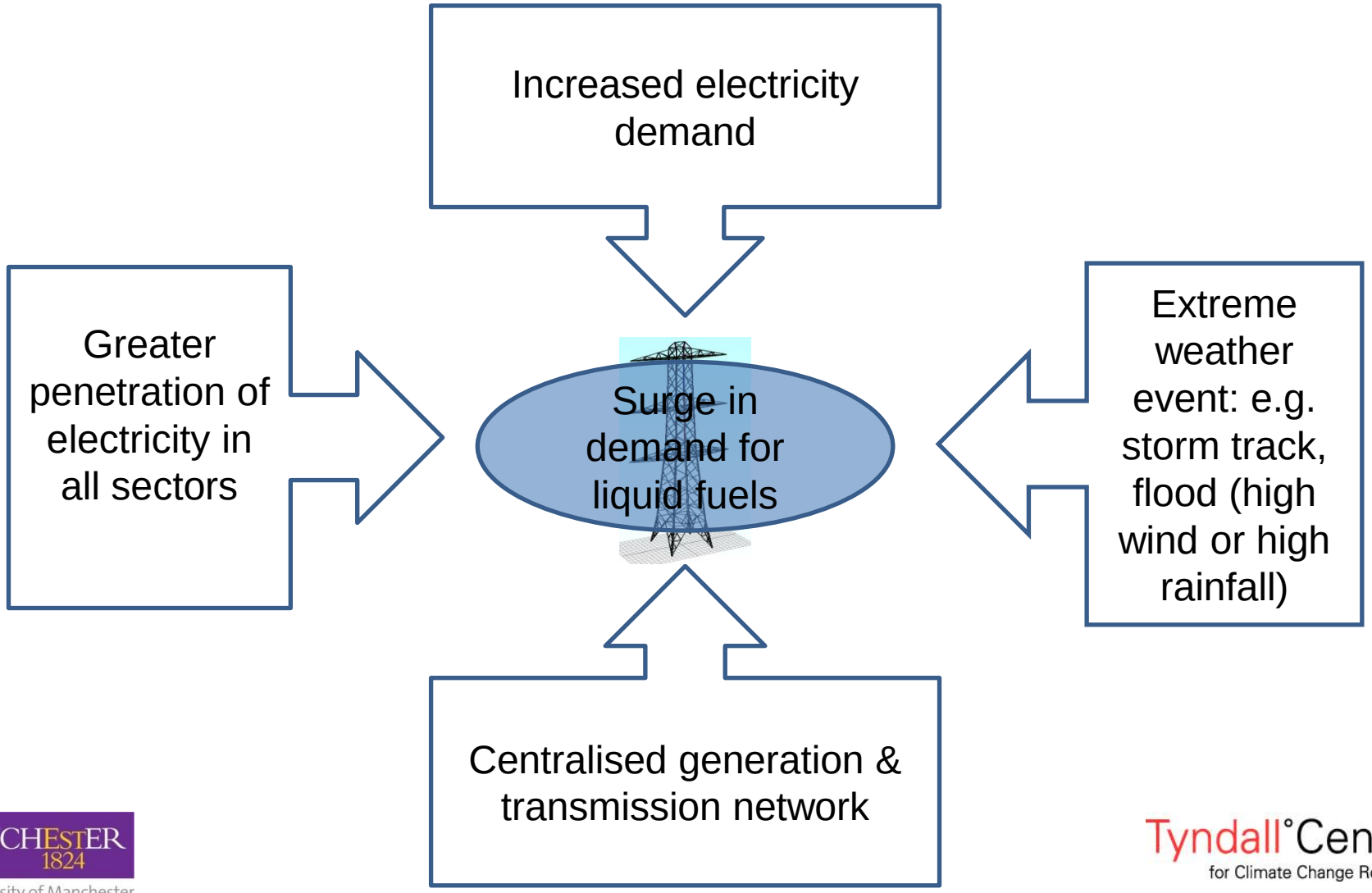


Electricity share of total energy





Climate vulnerabilities



In conclusion

- Energy efficiency can only take you so far
- To avoid climate impacts worse than UKCP09
- Demand reduction is key
  - » Especially in ‘non-electrifiable’ sectors

Thanks for listening

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With thanks to Ruth Wood, Kevin Anderson and Steven Glynn