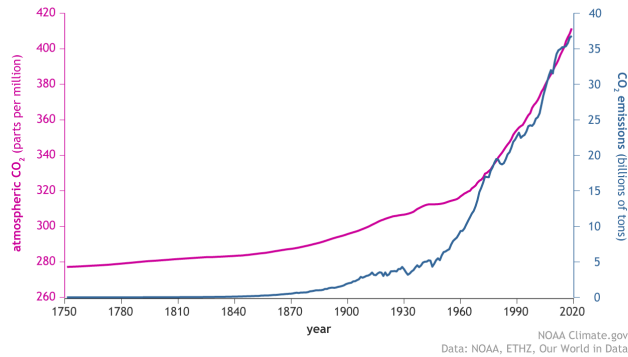


# Decarbonisation, products and digital

Tim Chapman  
Director, Arup

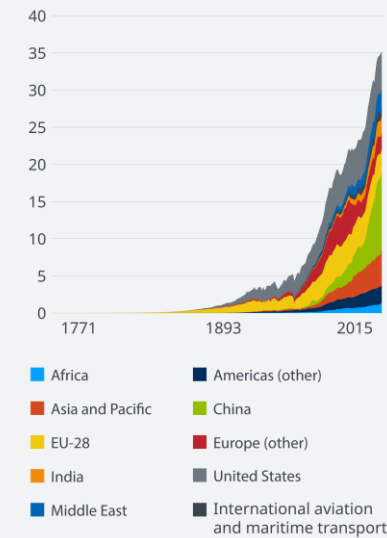
# The Carbon problem – ever rising!

CO<sub>2</sub> in the atmosphere and annual emissions (1750-2019)

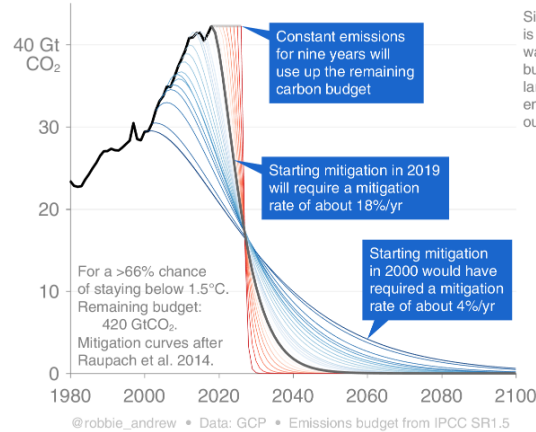


## Annual CO2 emissions by world region

in billion tonnes (Gt) per year

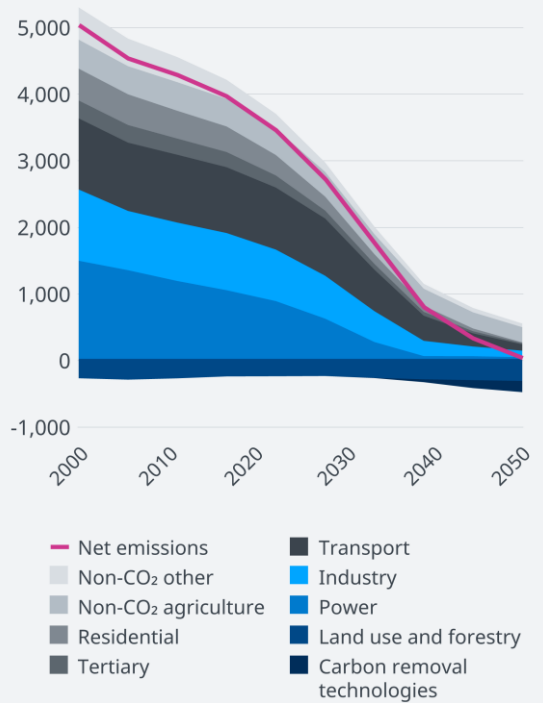


## CO<sub>2</sub> mitigation curves: 1.5°C

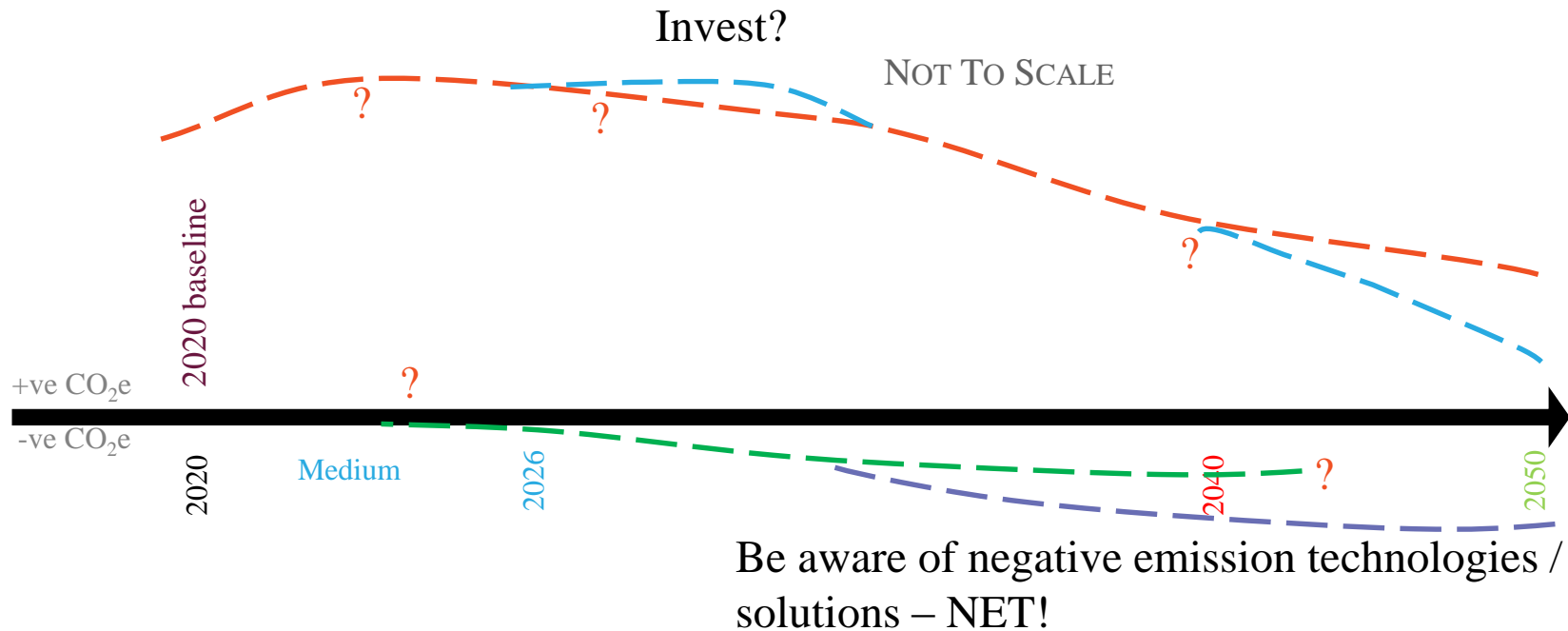


Since 18%/yr mitigation is impossible, the only way to achieve this budget is with very large "negative" emissions: pulling CO<sub>2</sub> out of the atmosphere.

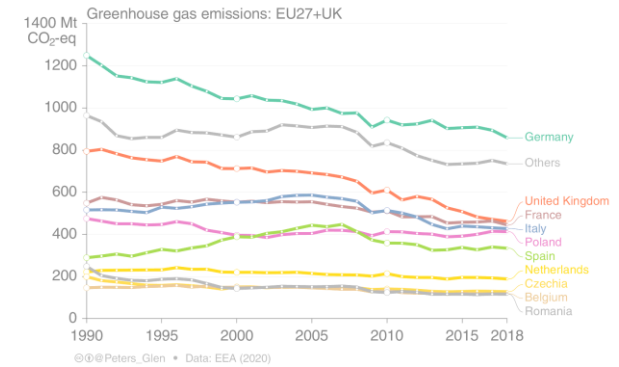
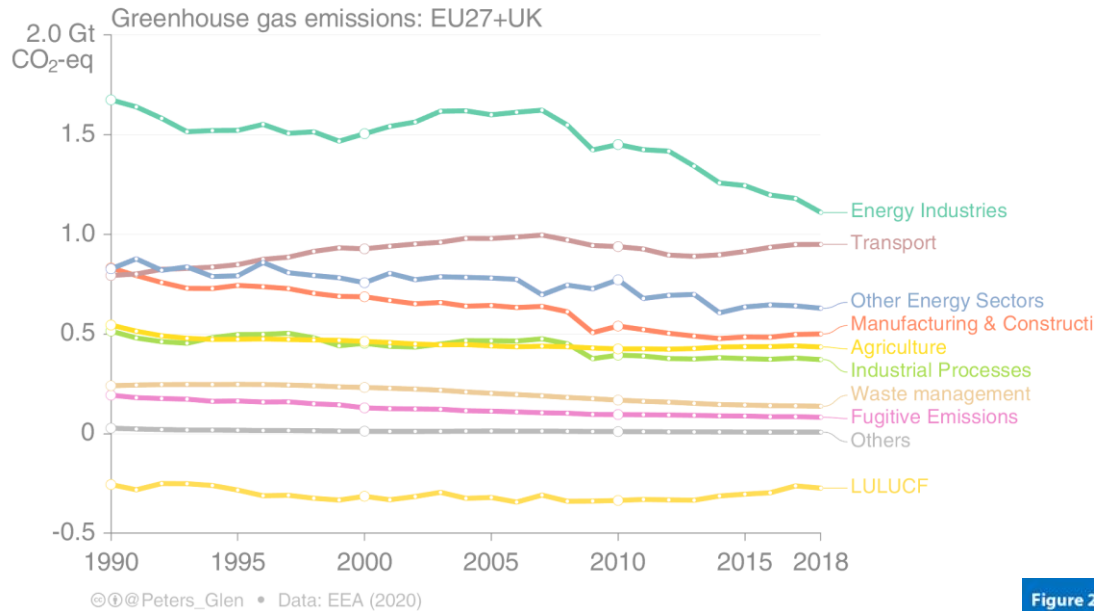
## EU emissions trajectory in a 1.5 °C scenario



# The Carbon problem – journey to Net Zero

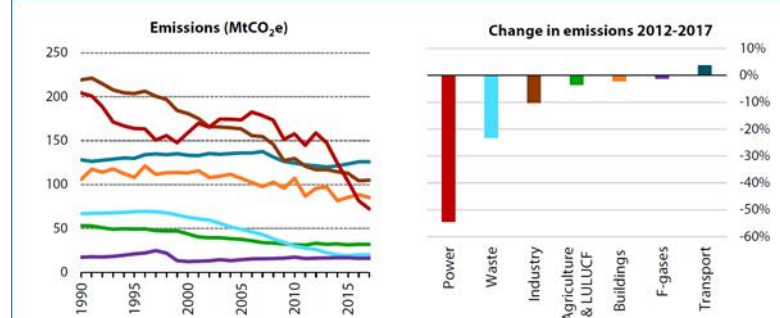


# Where is the Carbon?



Many EU countries have contributed to the decline in EU GHG emissions, but there are standouts... Germany has had an extended decline, helped initially by the 1990 reunification. UK has been a standout performer, & its departure will make EU mitigation a little lower!

**Figure 2.** Emissions reductions have been focused in the power and waste sectors



**Source:** BEIS (2018) 2017 UK Greenhouse Gas Emissions, Provisional Figures; BEIS (2018) 2016 UK Greenhouse Gas Emissions, Final Figures.

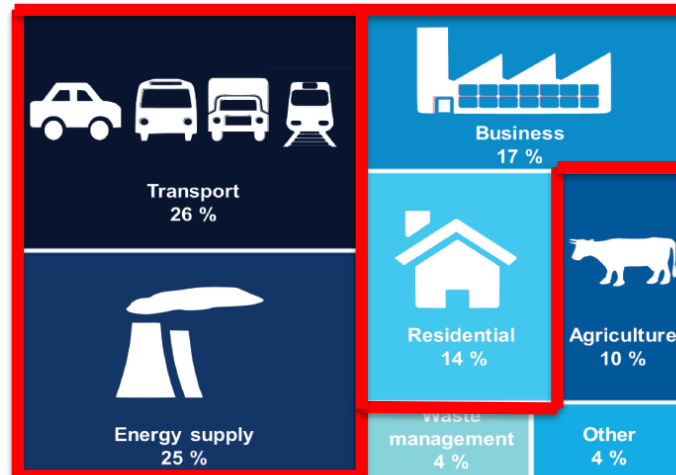
**Notes:** The chart on the right-hand side shows changes in sectoral emissions between 2012 and 2017; buildings emissions in this chart are temperature-adjusted. 2017 emissions are provisional estimates and assume no change in non-CO<sub>2</sub> emissions from 2016.

# Where is the Carbon in a developed economy?

**82%**

Transport becomes the largest emitting sector of UK 2016 greenhouse gas emissions

**“Infrastructure”  
About 50%**

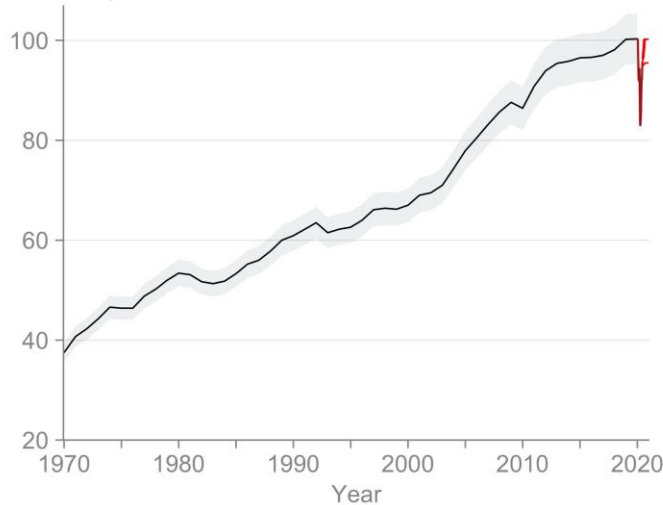


**“Buildings”  
About 30%**

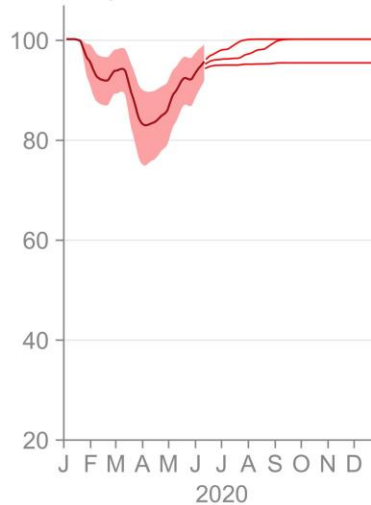
*Other includes Public and Industrial Process sectors (the Land Use, Land Use Change and Forestry (LULUCF) sector is excluded from the sector statistics above as it acted as a net sink of emissions). Please note the percentages above do not sum to 100% due to rounding.*

# And with Covid?

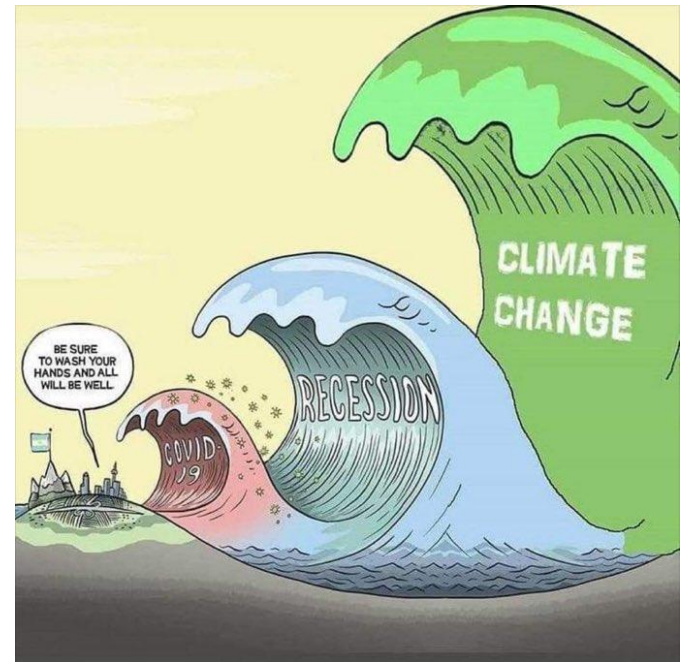
Global daily fossil CO<sub>2</sub> emissions  
MtCO<sub>2</sub> day<sup>-1</sup>



MtCO<sub>2</sub> day<sup>-1</sup>



Source: Le Quéré et al. Nature Climate Change (2020); Global Carbon Project



At the peak of the #COVID19 lockdowns, daily global fossil CO<sub>2</sub> emissions were down 17%, but they are recovering surprisingly fast & are now down ~5%. Still on track for a 4-7% decline in 2020.

<https://theguardian.com/environment/2020/jun/11/carbon-emissions-in-surprisingly-rapid-surge-post-lockdown...> <https://rdcu.be/b4lg7>

# The Green Deal

- Various ambitions to be Net Zero by 2050
- UK Climate change Act 2008
- 80% reduction by 2050
- 2019 to 100% reduction
- Is that enough?

## A European Green Deal

Striving to be the first climate-neutral continent

### Timeline

- 11 December 2019  
Presentation of the [European Green Deal](#)
- 14 January 2020  
Presentation of the [European Green Deal Investment Plan and the Just Transition Mechanism](#)
- 4 March 2020  
Proposal for a [European climate law](#) to ensure a climate neutral European Union by 2050  
Public consultation (open until 17 June 2020) on the [European Climate Pact](#) bringing together regions, local communities, civil society, businesses and schools
- 10 March 2020  
Adoption of the [European Industrial Strategy](#), a plan for a future-ready economy
- 11 March 2020  
Proposal of a [Circular Economy Action Plan](#) focusing on sustainable resource use
- 20 May 2020  
Presentation of the '[Farm to fork strategy](#)' to make food systems more sustainable
- 20 May 2020  
Presentation of the [EU Biodiversity Strategy for 2030](#) to protect the fragile natural resources on our planet



# How to decarbonise

- **Decarbonise energy**

- Renewables
- Nuclear - baseload
- Solar
- Battery

- **Electrify transport**

- Modes: road, rail, maritime, air
- Passengers and freight

- **Decarbonise heat**

- Electrify
- Heat pumps
- Natural gas to Hydrogen: green, blue and grey

	2020-2029	2030-2049	2050 Absolute Zero	Beyond 2050
<b>Road vehicles</b>	Development of petrol/diesel engines ends; Any new vehicle introduced from now on must be compatible with Absolute Zero	All new vehicles electric, average size of cars reduces to ~1000kg	Road use at 60% of 2020 levels - through reducing distance travelled or reducing vehicle weight	New options for energy storage linked to expanding non-emitting electricity may allow demand growth
<b>Rail</b>	Growth in domestic and international rail as substitute for flights and low-occupancy car travel	Further growth with expanded network and all electric trains; rail becomes dominant mode for freight as shipping declines	Electric trains the preferred mode of travel for people and freight over all significant distances	Train speeds increase with increasing availability of zero emissions electricity
<b>Flying</b>	All airports except Heathrow, Glasgow and Belfast close with transfers by rail	All remaining airports close		Electric planes may fly with synthetic fuel once there are excess non-emitting electricity supplies
<b>Shipping</b>	There are currently no freight ships operating without emissions, so shipping must contract	All shipping declines to zero		Some naval ships operate with onboard nuclear power and new storage options may allow electric power
<b>Heating</b>	Electric heat pumps replace gas boilers, and building retrofits (air tightness, insulation and external shading) expand rapidly	Programme to provide all interior heat with heat pumps and energy retrofits for all buildings	Heating powered on for 60% of today's use	Option to increase use of heating and cooling as supply of non-emitting electricity expands
<b>Appliances</b>	Gas cookers phased out rapidly in favour of electric hobs and ovens. Fridges, freezers and washing machines become smaller	Electrification of all appliances and reduction in size to cut power requirement	All appliances meet stringent efficiency standards, to use 60% of today's energy	Use, number and size of appliances may increase with increasing zero-emissions electricity supply
<b>Food</b>	National consumption of beef and lamb drops by 50%, along with reduction in frozen ready meals and air-freighted food imports	Beef and lamb phased out, along with all imports not transported by train; fertiliser use greatly reduced	Total energy required to cook or transport food reduced to 60%	Energy available for fertilising, transporting and cooking increases with zero-emissions electricity
<b>Mining material sourcing</b>	Reduced demand for iron ore and limestone as blast furnace iron and cement reduces, increased demand for materials for electrification	Iron ore and Limestone phased out while metal scrap supply chain expands greatly and develops with very high precision sorting	Demand for scrap steel and ores for electrification much higher, no iron ore or limestone	Demand for iron ore and limestone may develop again if CCS applied to cement and iron production
<b>Materials production</b>	Steel recycling grows while cement and blast furnace iron reduce some plastics with process emissions reduce	Cement and new steel phased out along with emitting plastics. Steel recycling grows. Aluminium, paper reduced with energy supply	All materials production electric with total 60% power availability compared to 2020	Material production may expand with electricity and CCS, CCL hydrogen may enable new cement and steel
<b>Construction</b>	Reduced cement supply compensated by improved material efficiency, new steel replaced by recycled steel	All conventional mortar and concrete phased out, all steel recycled. Focus on retrofit and adaptation of existing buildings	Any cement must be produced in closed-loop, new builds highly optimized for material saving	Growth in cement replacements to allow more architectural freedom; new steel may become available
<b>Manufacturing</b>	Material efficiency becomes prominent as material supply contracts	Most goods made with 50% as much material, many now used for twice as long	Manufacturing inputs reduced by 50% compensated by new designs and manufacturing practices. No necessary reduction output	Restoration of reduced material supplies allows expansion in output, although some goods will in future be smaller and used for longer than previously
<b>Electricity</b>	Wind and solar supplies grow as rapidly as possible, with associated storage and distribution. Rapid expansion in electrification of end-uses	Four-fold increase in renewable generation from 2020, all non-electrical motors and heaters phased out	All energy supply is now non-emitting electricity	Demand for non-emitting electricity drives ongoing expansion in supply
<b>Fossil fuels</b>	Rapid reduction in supply and use of all fossil fuels, except for oil for plastic production	Fossil fuels completely phased out		Development of Carbon Capture and Storage (CCS) may allow resumption of use of gas and coal for electricity

Absolute Zero – delivering the UK's climate change commitment with incremental changes to today's technologies

UK FIRES

Prof Julian Allwood, Cambridge University

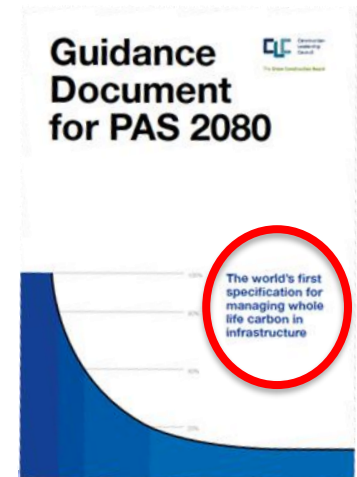
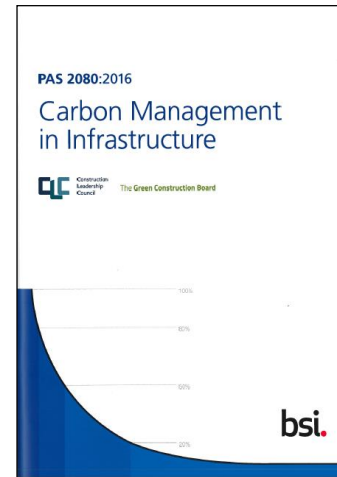


# What about projects

- What is the project for?
  - **functionality**, to serve a purpose
  - Private: to make money
  - Public: critical infrastructure to serve society
    - Economic infrastructure – systems, eg transport, power, telecoms, water
    - Social infrastructure – schools, police stations, hospitals

Think:

- Whole-life carbon effects
  - PAS2080
- Value for money
- Societal impact / environment



# PAS 2080:2016 Future Carbon saving

- Whole Life Carbon – to “correct” big picture

- National basis – no perverse incentives

- **Low carbon = CapCarb + OpCarb + UseCarb**

Invest to save

Optimise to reduce

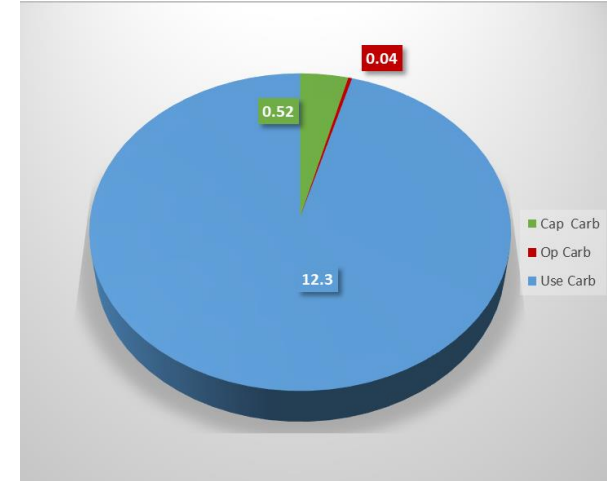
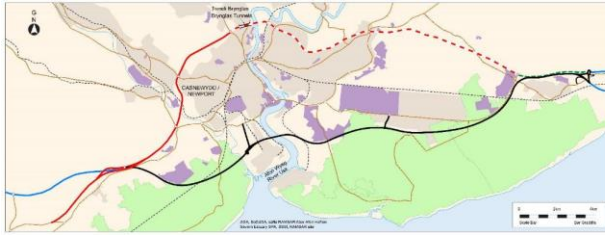


Control

Influence

- Orthodoxy for carbon accountancy – replaced 400 calculators

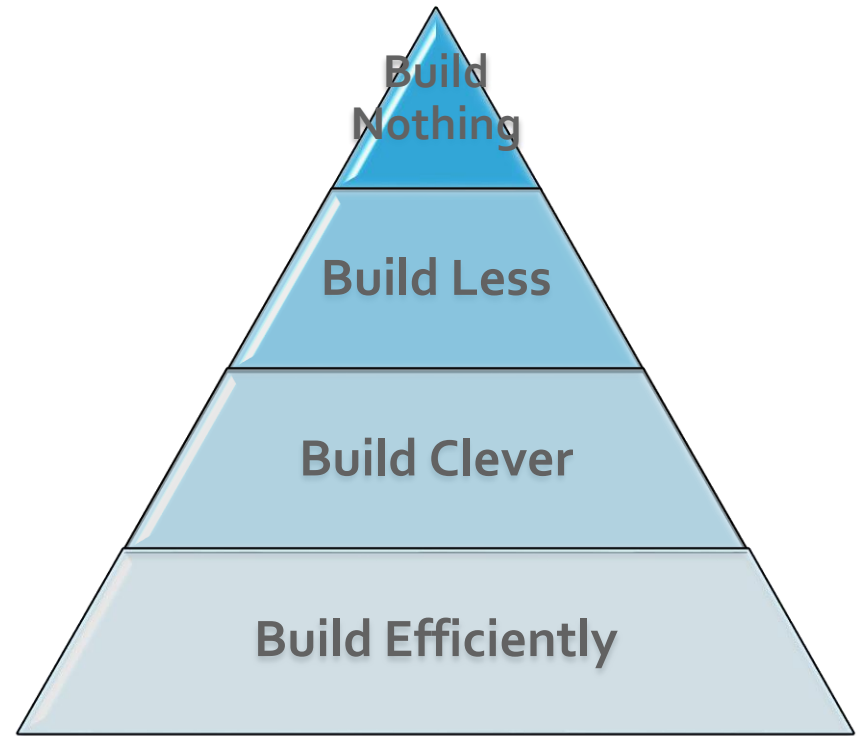
# Value for Carbon – M4



- **Cap Carb** = about 520,000 tonnes CO<sub>2</sub>e = **0.52MT**
  - [about 200,000t/yr]
- **Op Carb** = 1,600 tonnes CO<sub>2</sub> / yr      44,800 tonnes = **0.04MT** over 28yrs
- **Use Carb** = 440,000 tonnes CO<sub>2</sub> / yr      **12.3MT** over 28 yrs
- Annual saving in net Carbon at opening = 29,000 t CO<sub>2</sub>e/yr (2022) [about 7%]
  - Decreasing to 16,000 tCO<sub>2</sub>e/yr [3%] at 2037 due to improving vehicles
- Therefore achieves Carbon neutrality by about 2050 [surprisingly!]
- UK annual territorial emissions = about 600MT

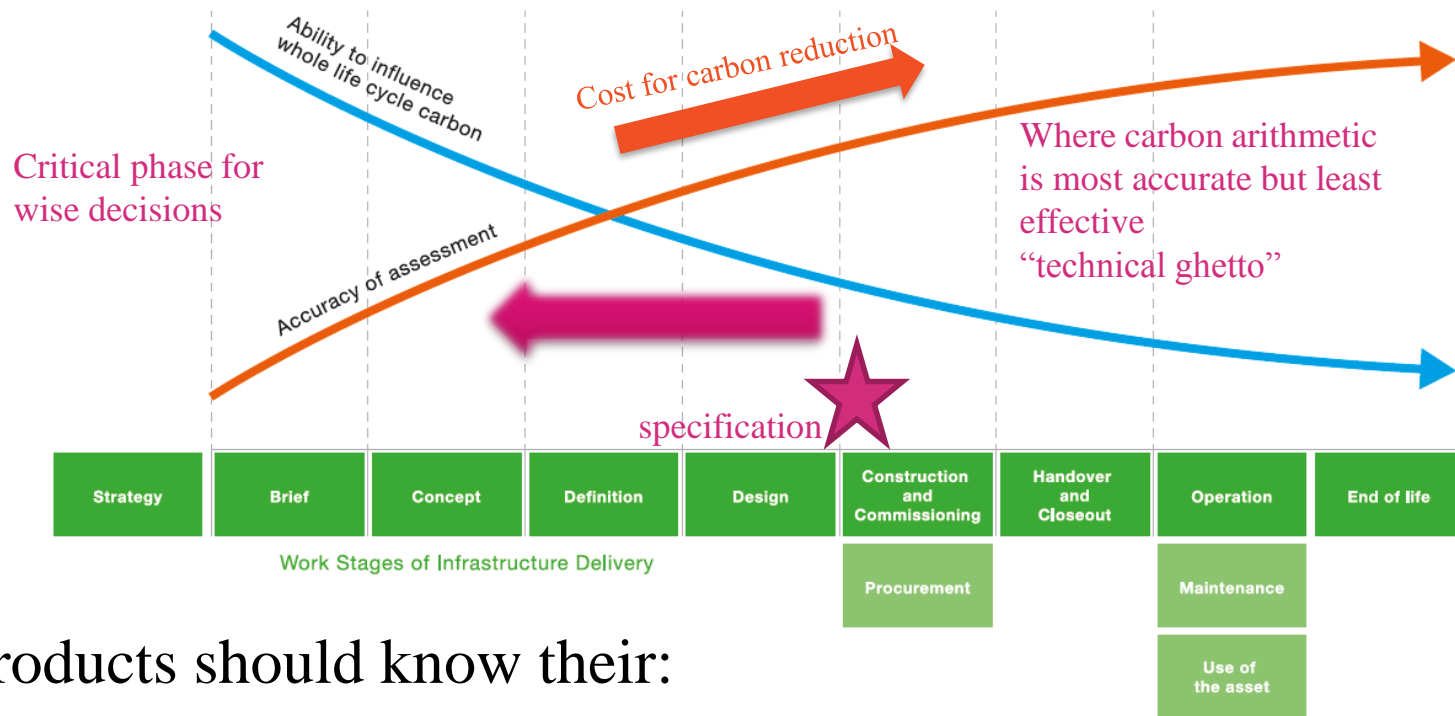
# “CapCarb”: Hierarchy

- Repurpose / reuse
- Modify / refurbish
- Build new?



- Build for reuse – circular economy principles
- Carbon is proxy for resource use – so lower carbon = lower cost
- Like for money – don’t build something incapable of fulfilling its purpose – false economy

# “within CapCarb”



- Products should know their:
- Cost - £ / € ..... as now
- Embodied Carbon - kg CO<sub>2</sub>e / unit etc
- Characteristics – for future removal and reuse – circular economy
- Digitally remember for decades – how?