SYSTEMIQ

Renewable Futures

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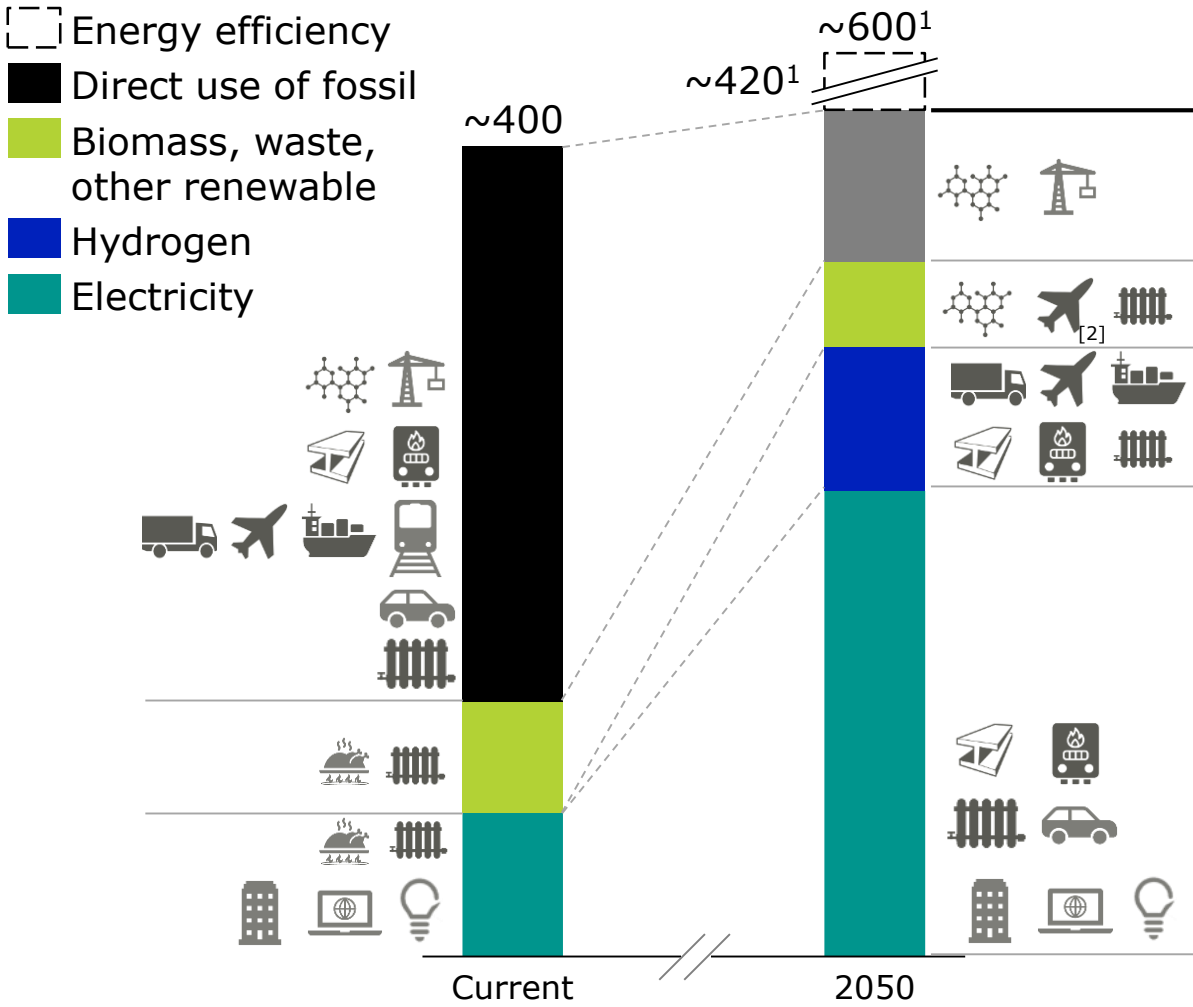
THE +1ºC WORLD
OUR HOUSE IS ON FIRE
STOP
SIGNAL WORK AHEAD

Net zero: efficiency is paramount; we then have four tools to decarbonise

Global energy sources *(EJ)*



0 ▪ **Efficiency –** buildings, industrial, etc.

4 ▪ **Carbon capture**

3 ▪ **Bioenergy –** e.g., aviation

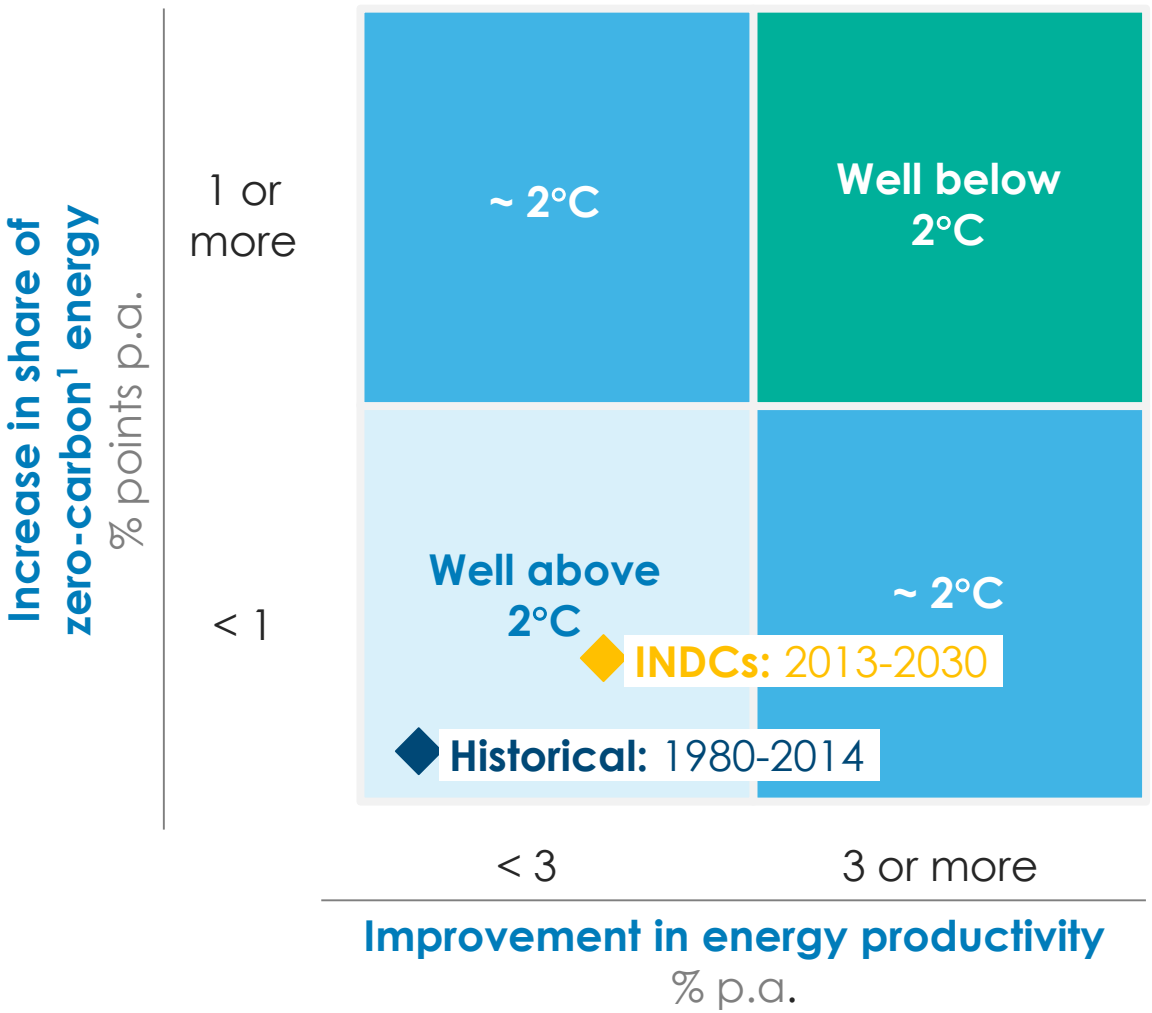
2 ▪ **Hydrogen –** industrial heat, steel (DRI-EAF), power, trucking, shipping (NH_3), aviation (H_2, synfuel), heating

1 ▪ **Electrify + zero-carbon electricity**
- electrify road transport, heating, etc.
- zero-carbon generation + flexibility

[1] 420 EJ is the final energy demand in IEA ETP 2 Degree Scenario (2014); in IEA's reference technology scenario total final energy grows to ~600EJ,

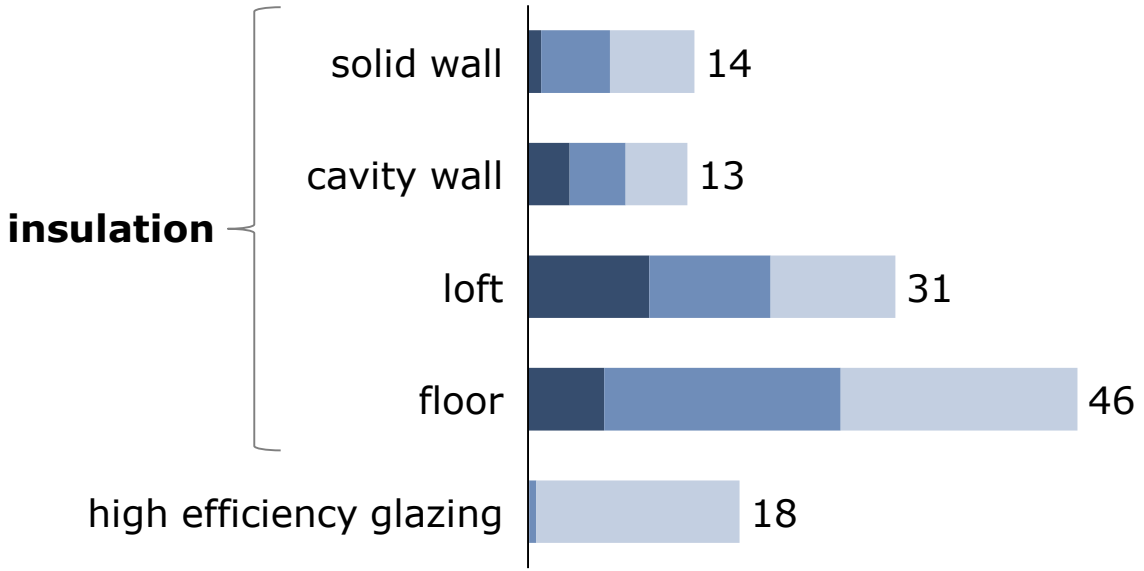
Source: **IEA** (2017), Energy Technology Perspectives; IEA (2017), Technology roadmap: Delivering Sustainable Bioenergy; **SYSTEMIQ**

0 Efficiency is paramount



	£ / tCO_2e	% heating energy reduction
low-cost	<0	7%
medium-cost	0-200	+ 9%
high-cost	>200	+ 9%
		24%

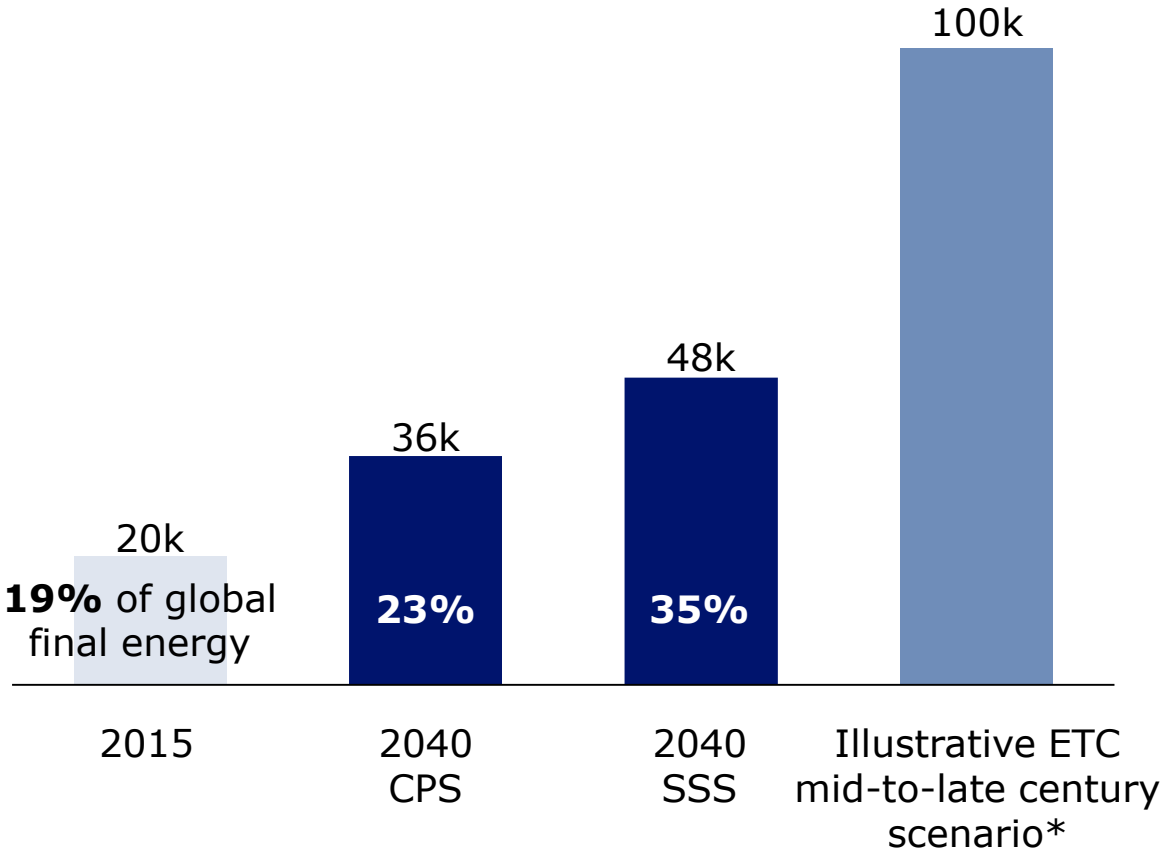
individual measures (million homes)



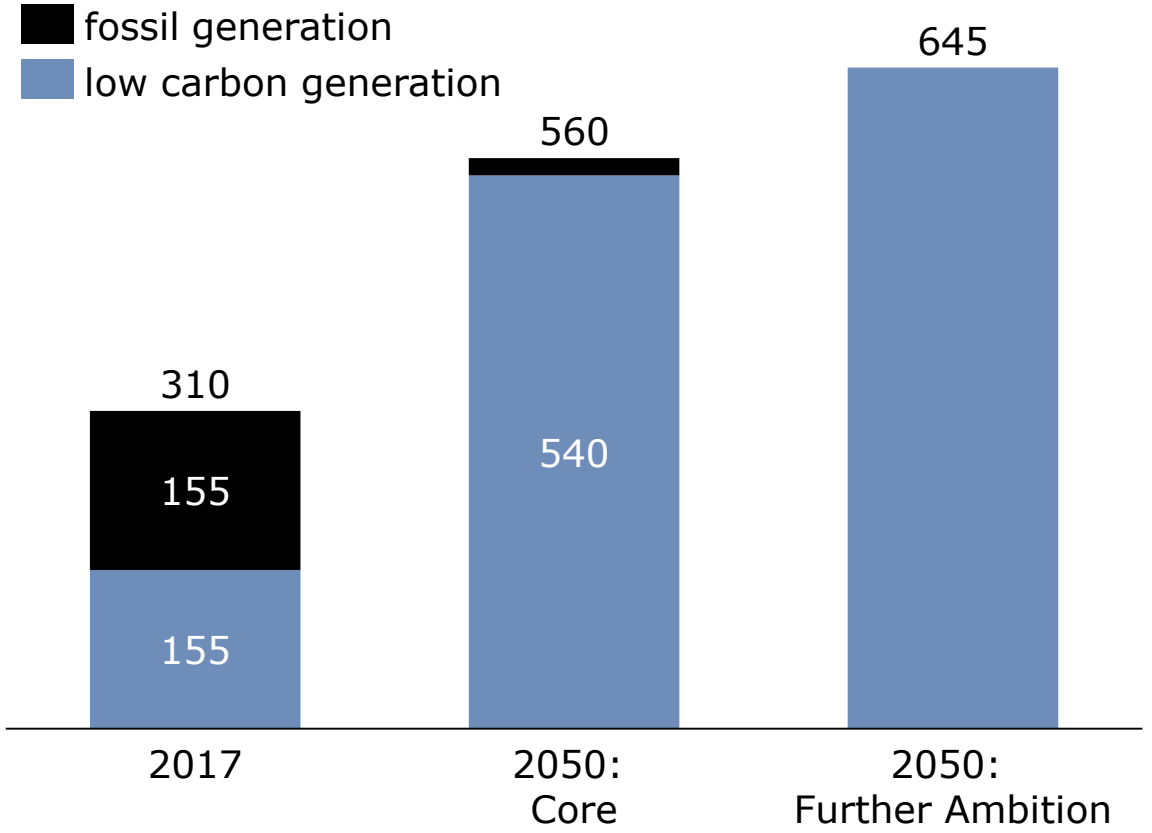
[1] include here renewables, nuclear, biomass and fossil fuels if and when their use can be decarbonized through CCS.
Source: **Enerdata** (2015), Historic actuals; **Element Energy & E4tech** for UK National Infrastructure Commission (2018)

1 Low-carbon electricity needs to grow ~4x in the UK

Global power demand according to different scenarios (TWh/year)



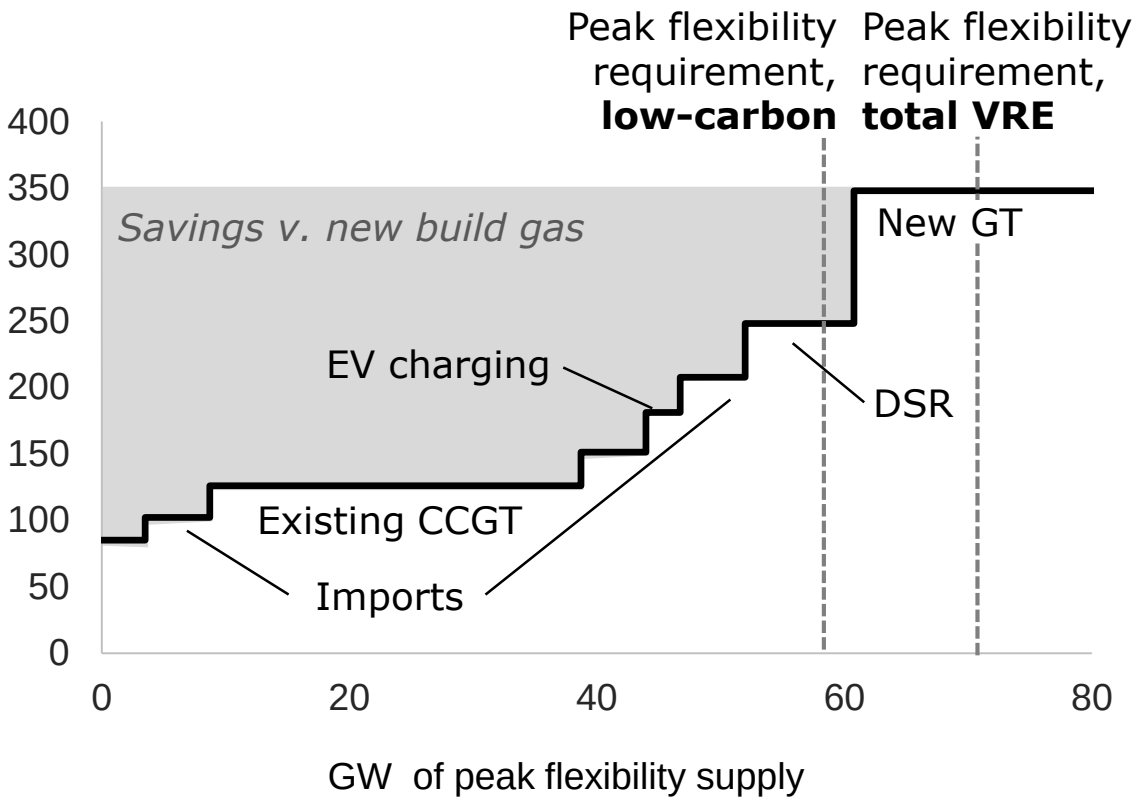
UK power demand (TWh/year)



Source: **IEA**, CPS = Current Policies Scenario from World Energy Outlook (2017) / SSS = Shell Sky Scenario (2018) / *Preliminary results; **UK Committee on Climate Change**, 'Net Zero: The UK's contribution to stopping global warming'

1 Flexibility is a critical enabler

Cost & supply of **California** peak intraday shifting using lowest-cost options (USD/MWh shifted, 2040)



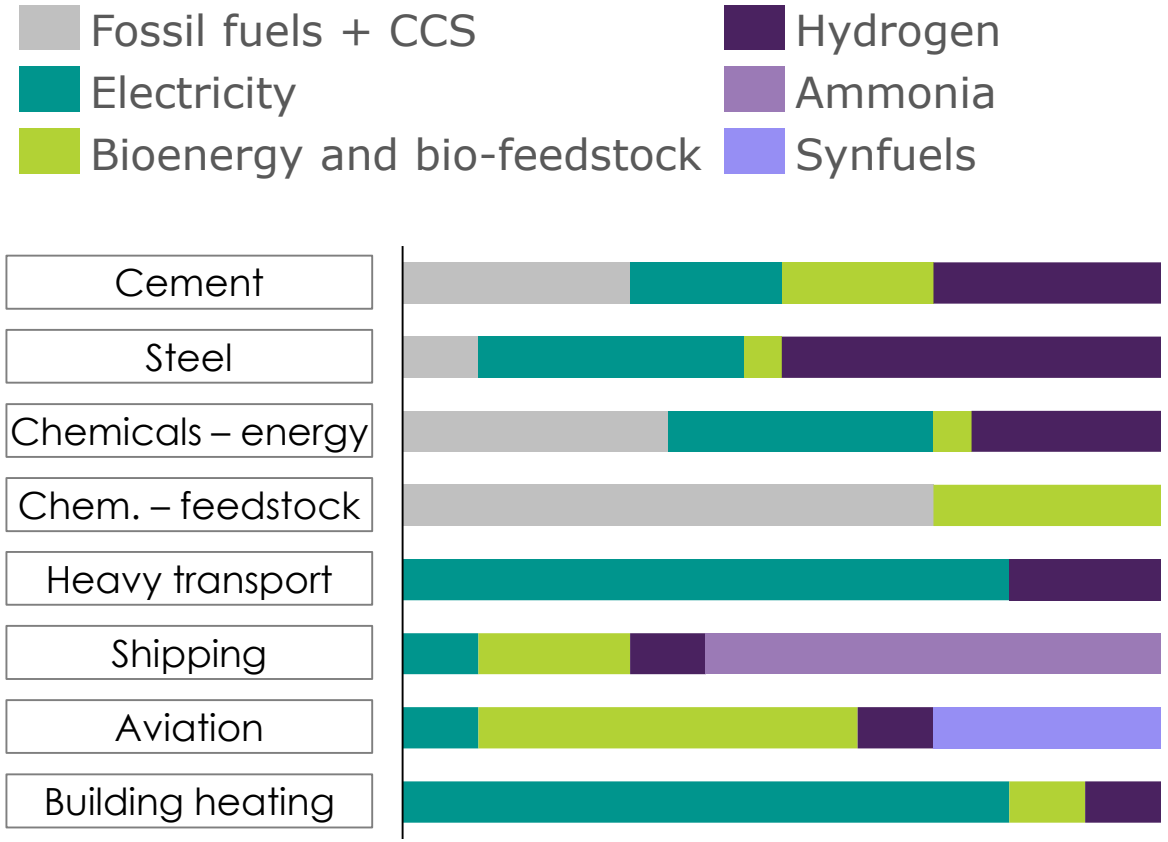
UK flexibility scenario outcomes in 2040

	System cost	Power Emissions	Fossil share of peak demand	Zero-carbon share of TWh
NEO	**39.8 £M/TWh**	**11.6 MtCO2**	**34%**	**94%**
Δ v. NEO				
Low-flex	13%	36%	45%	-2%
High EVs + flex	4%	-96%	0%	0%
High storage	0%	1%	-1%	0%
High flex demand	-5%	2%	-10%	0%
Nordic Intercon.	-2%	-24%	-10%	2%

Sources: **Climate Policy Initiative** (2017), Low-cost, low-carbon power systems: How to develop competitive renewable-based power systems through flexibility. **BNEF**, 'Flexibility Solutions for High-Renewable Energy Systems'

2+ For harder-to-abate sectors electricity often is not well suited to deliver

Final energy consumption by energy source in a net-zero economy, 2050, %



HyNet

London to have world-first hydrogen-powered doubledecker buses

The buses will only have water exhaust emissions and will be on the capital's streets by 2020

h2i

Source: **SYSTEMIQ** analysis for the Energy Transitions Commission analysis (2018)

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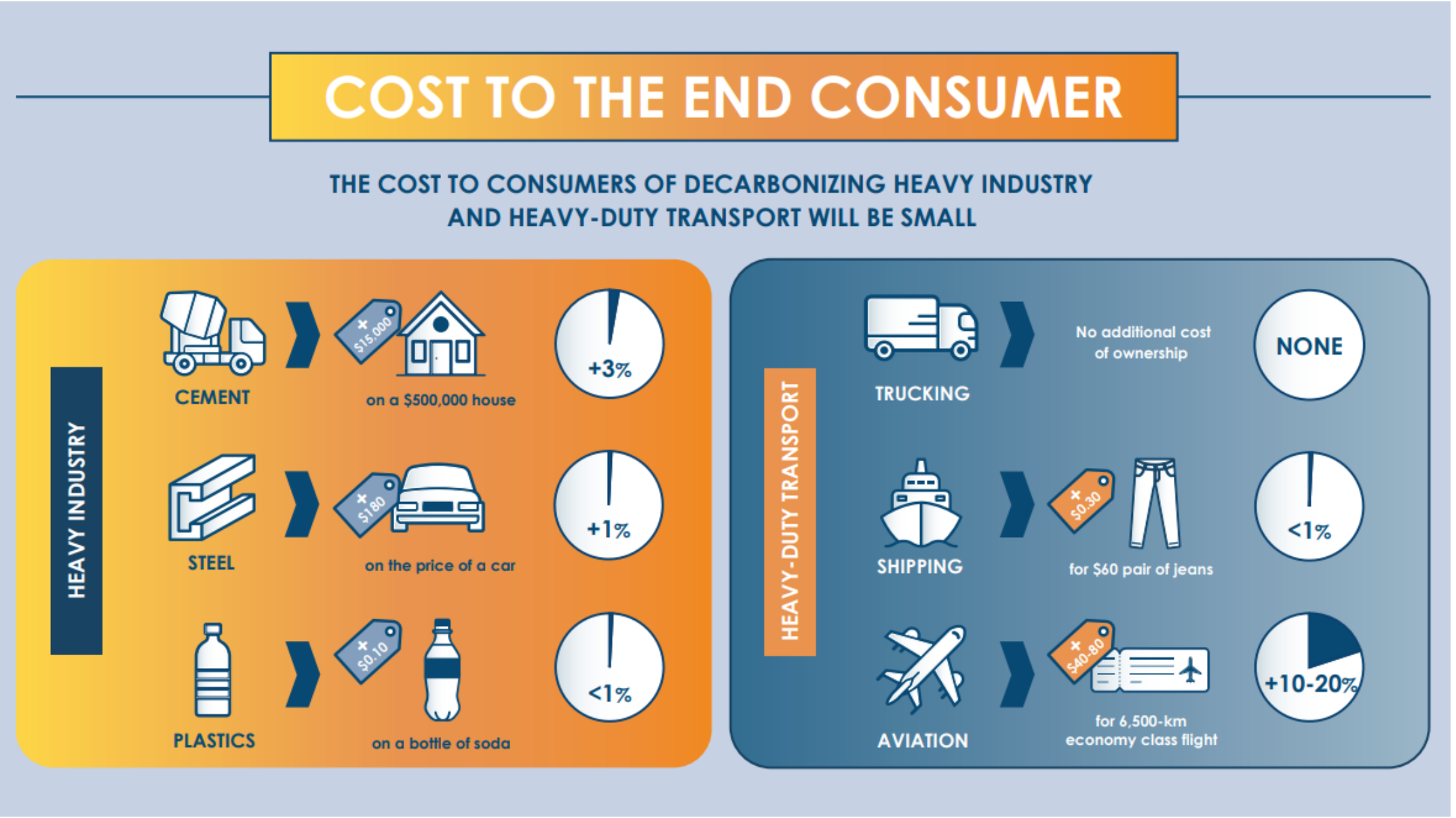
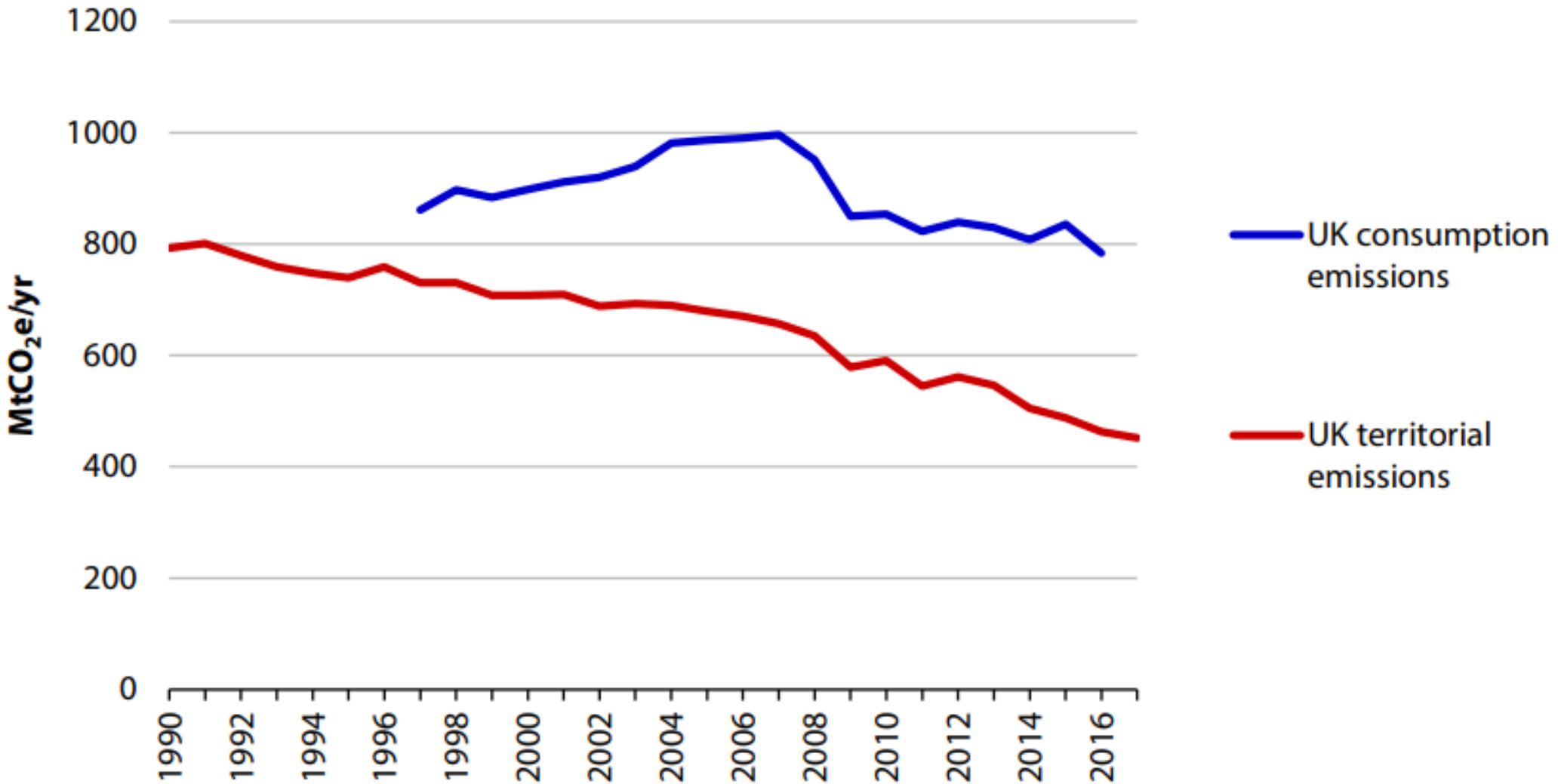
2+ Harder to abate: costs to end consumer will be small



SOURCE: **Energy Transitions Commission**, 'Mission Possible'

Additionally, we need to consider imported carbon

Historical consumption emissions in UK



Source: **UK Committee on Climate Change**, 'Net Zero: The UK's contribution to stopping global warming'


Forbes
Clean Energy Is An Investment, Not A Cost
IT'S HAPPENING
BUT NOT FAST ENOUGH