The Built Environment and Climate Change

Philip Oliver to U3A Sustainable Energy Group

Agenda.

Cement.

Steel.

Structures - Construction.

Structures - Use.

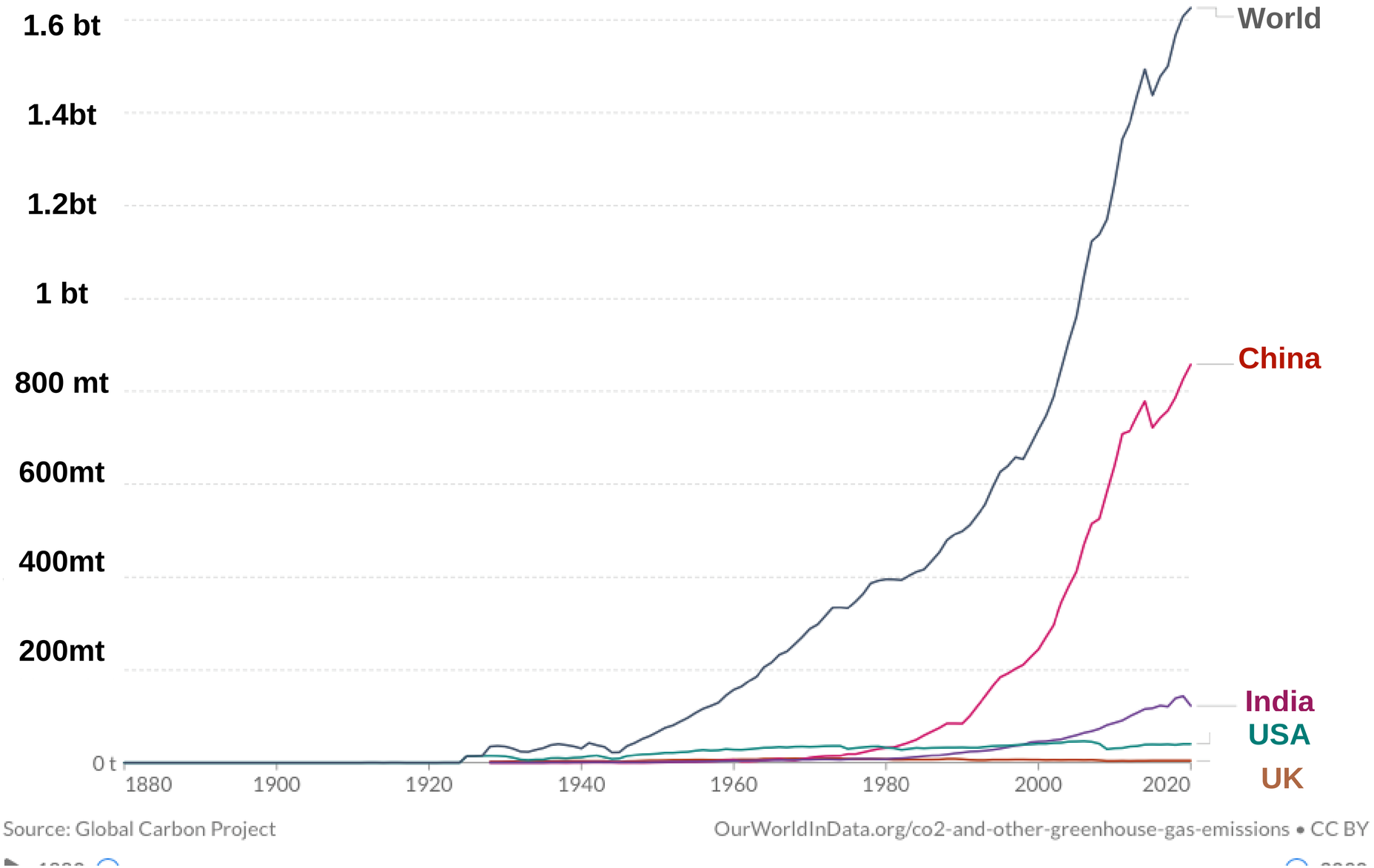
Actions on us.

Questions and Discussion

Cement.

Cement.

Annual CO_2 emissions from cement



Cement. Five facts.

1. If cement were a country it would be in the top 10 countries in emissions terms.

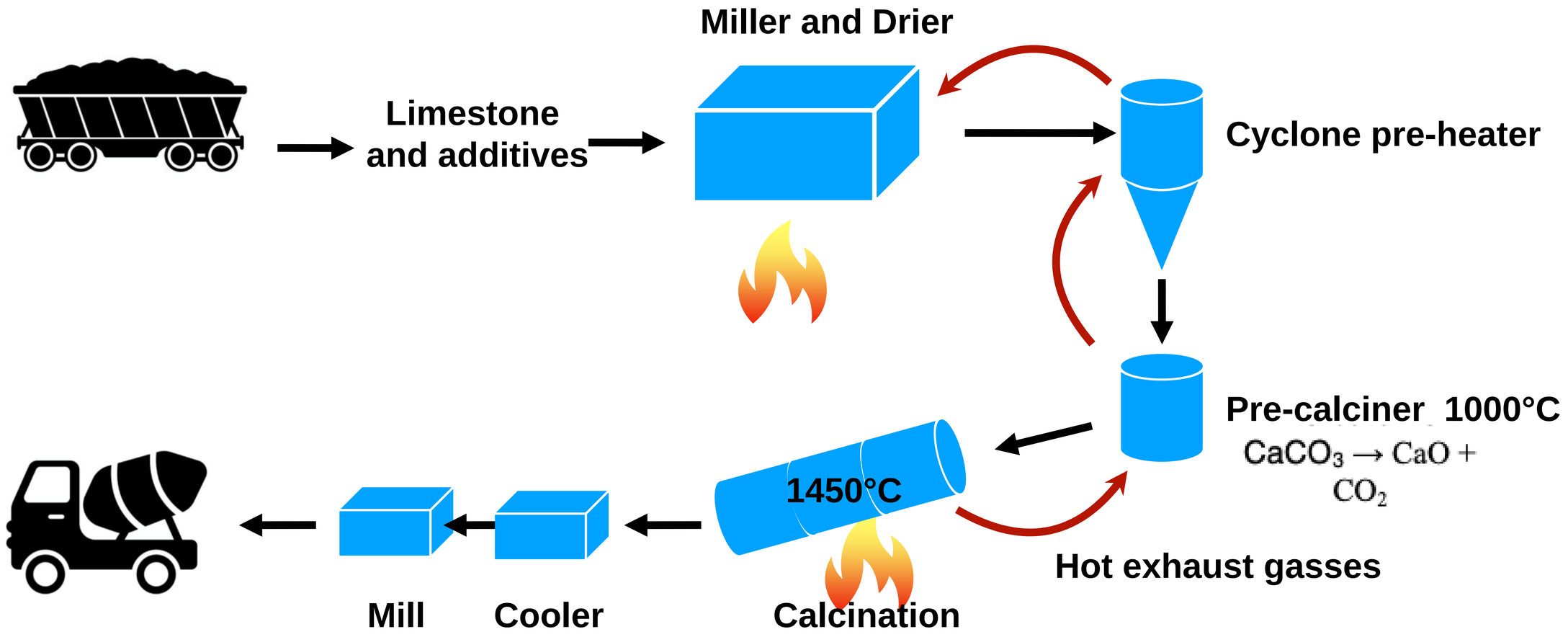
2. After water, concrete (cement + aggregates + water (+ steel)) is the most widely used substance on earth.

3. Cement production is the industry with the greatest carbon emissions in the world. (Steel’s a close second)

4. A 10th of the world’s industrial water supply is used to mix cement, while only coal, oil and gas emit greater levels of greenhouse gases.

5. Every second, the global building industry pours nearly 2,000 tonnes of concrete, and this is growing.

Cement. Where does all this CO_2 come from?



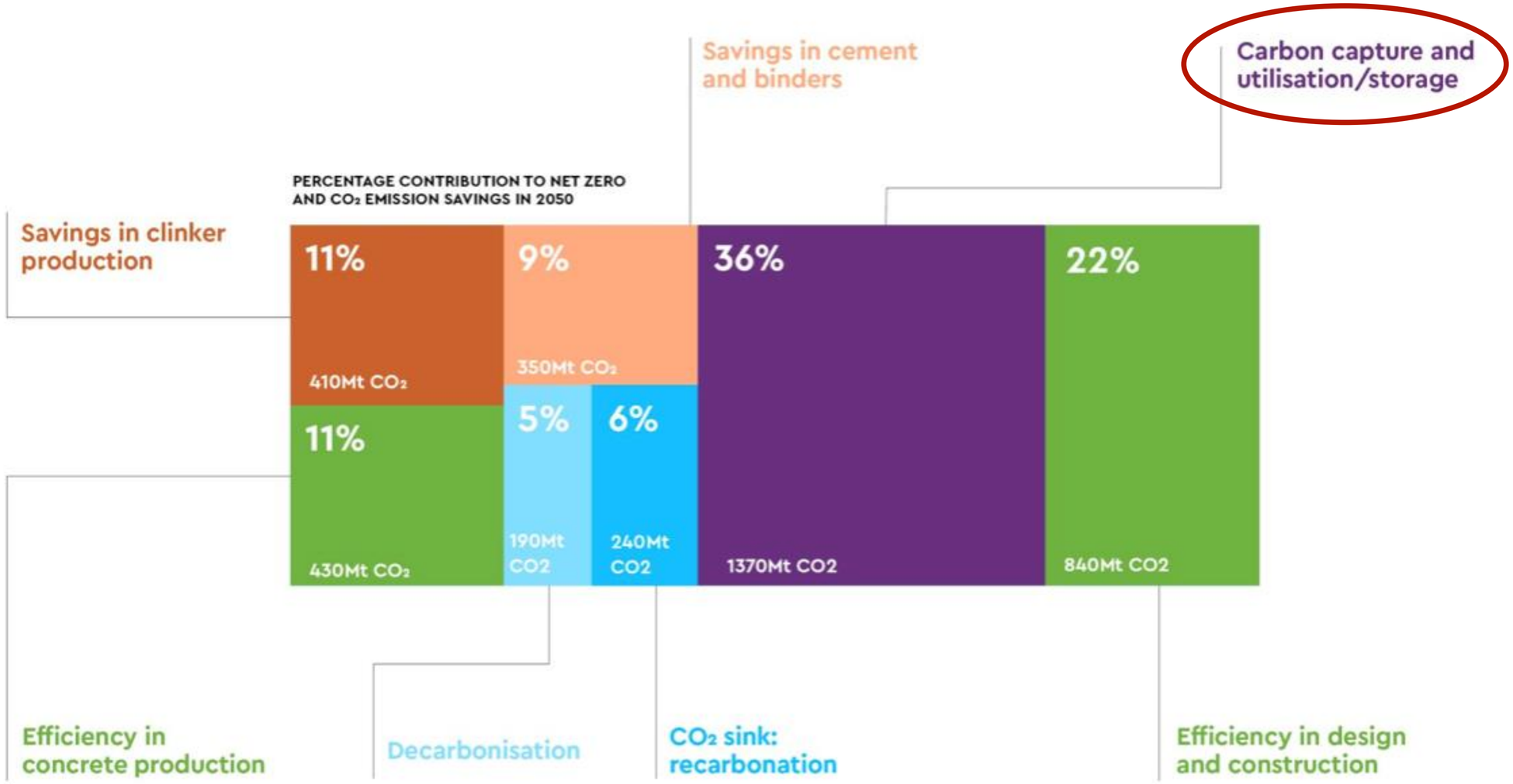
The best plants today produce 630-700kg of CO_2 per ton of cement, the worst produce 1000+kg. 60% is from calcination, 40% from fuel,

Cement. Some Answers.

- Reduce demand by better structural design, better mix design and reuse of existing assets.
- Many plants still use coal - switch to greener energy and biomass.
- Re-use all the waste heat.
- Carbon capture use and storage is relatively straightforward as these are point sources
- Many countries, including China, are proposing or using carbon taxes to encourage reductions in CO_2 in cement and steel making..

Conclusion - Cement is one of the more difficult problems to fix, not least because of the scale of production, but emissions/ton are falling, probably considerably more than halving by 2050 but not yet on track for net zero.

How the Concrete Industry sees a Net Zero 2050



Global Concrete and Cement Association

Steel.

Steel. Five facts.

1. Every ton of steel produced in 2018 emitted and average of 1.85 tons of $CO_{2.}$ 7% of world carbon emissions (2018).

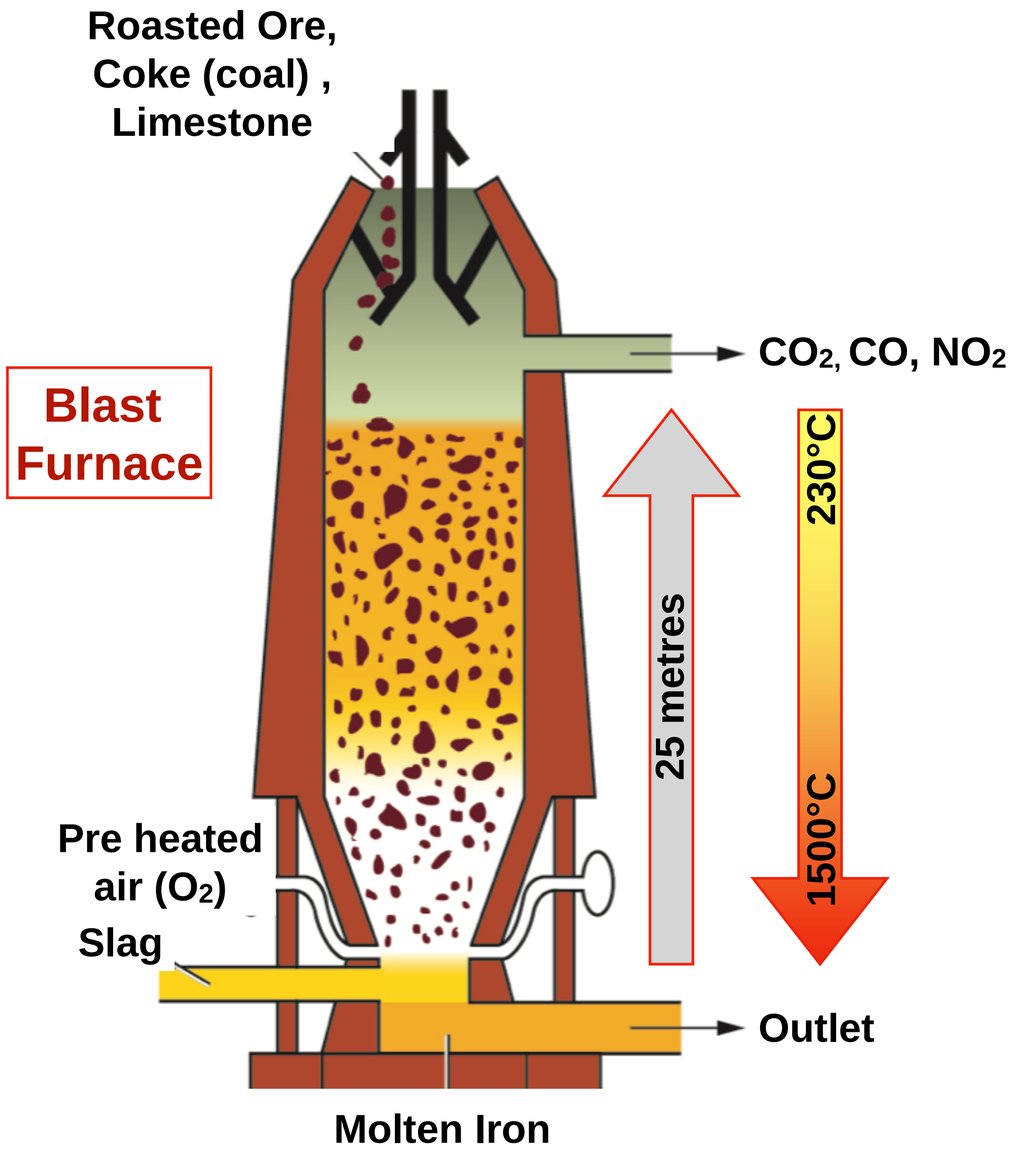
2. Emissions per ton vary widely, based on the production process.

3. Users (e.g, VW, Toyota) are already demanding low and zero carbon steel to fulfil their climate obligations.

4. Steel production has a long (10-15yr) investment cycle.

5. 51% of all steel is used in construction, 17% in road and sea transport, 15% in other mechanical equipment . Nearly half the steel in construction is rebar.

Steel. Where does all this CO_2 come from?



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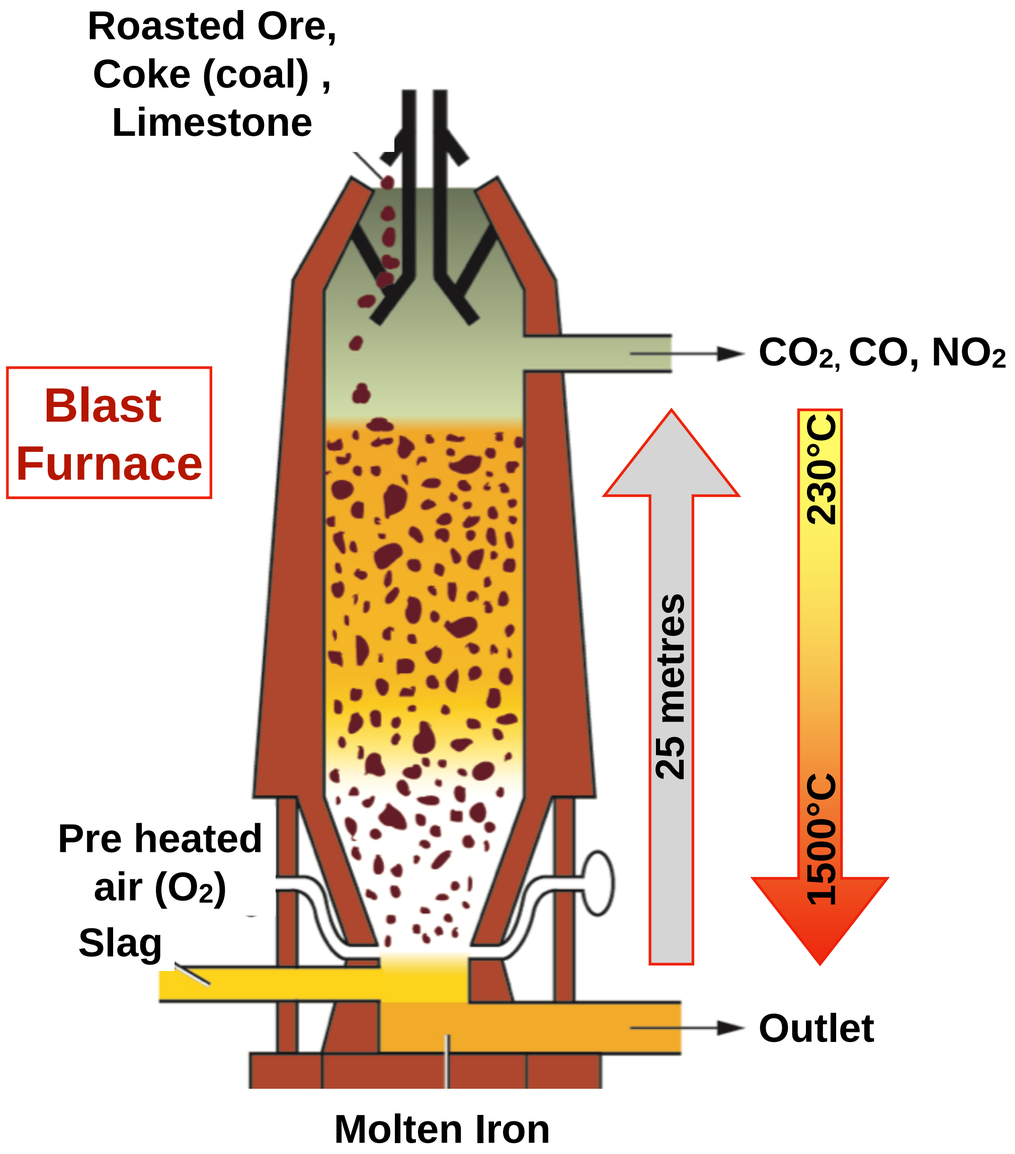
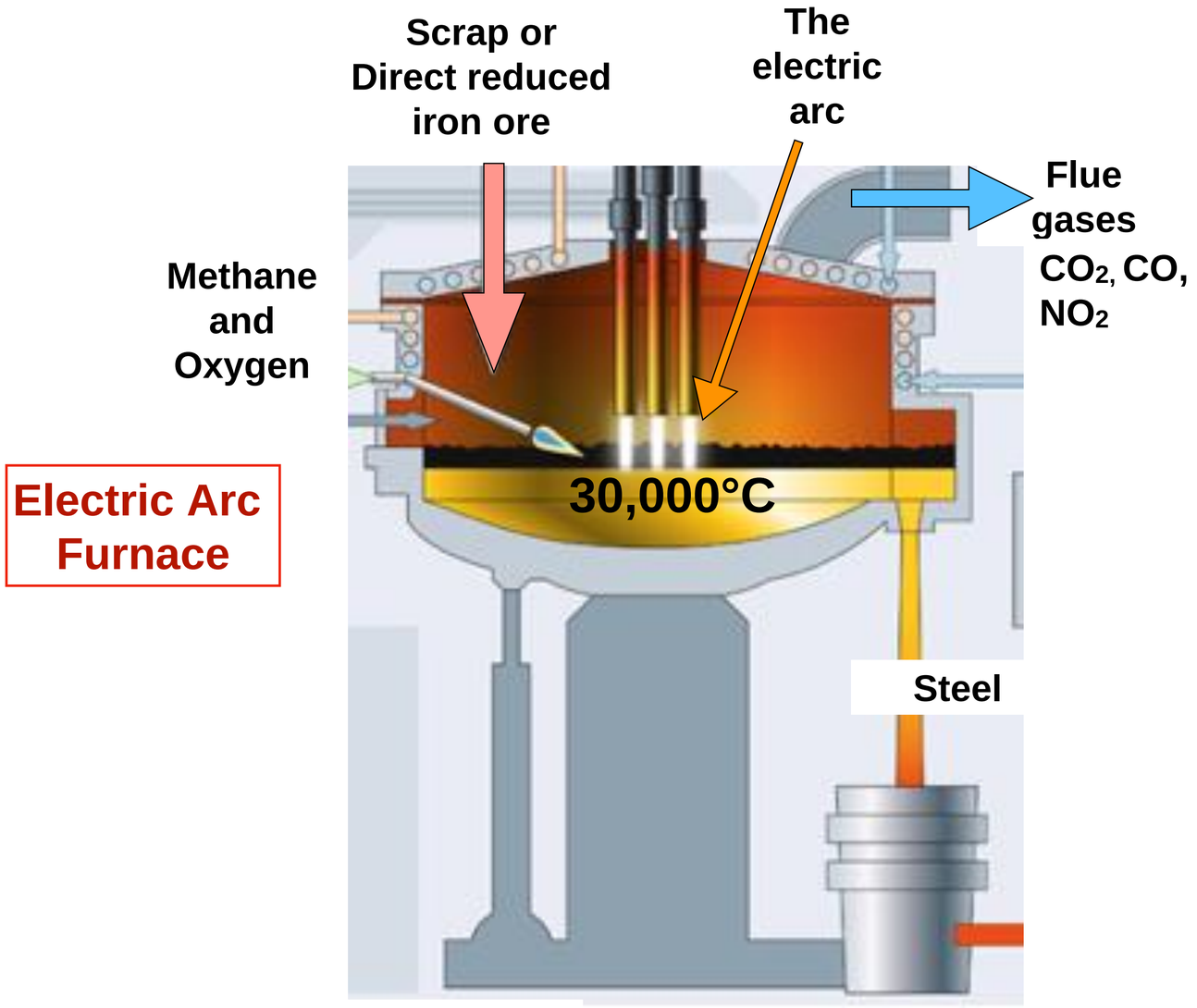
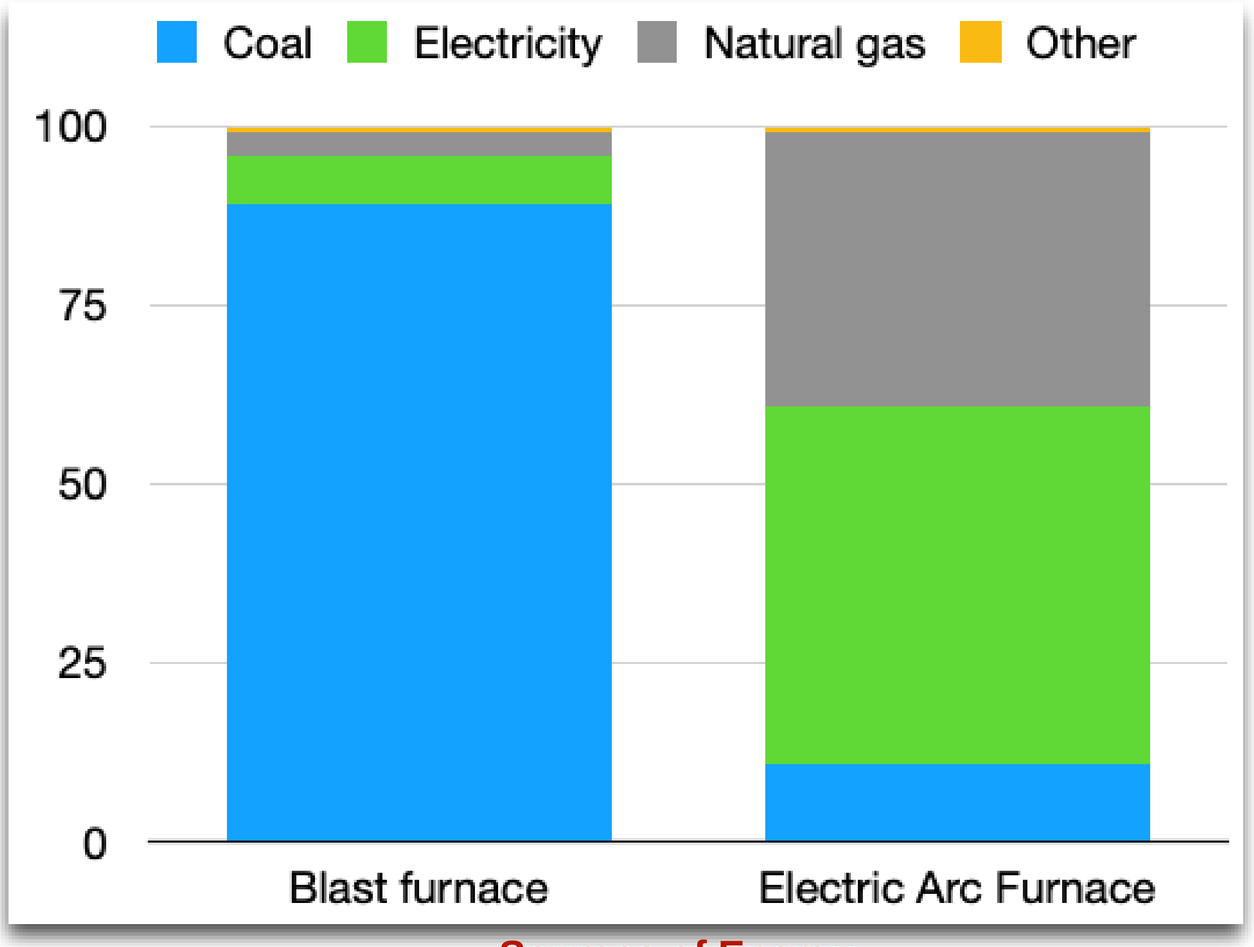




Steel. Some facts.

75% of world steel is produced in blast furnaces, 25% in electric arc furnaces.

Both methods are energy intensive. Cost of energy is between 20 and 40% of the cost of steel. For blast furnaces this energy is 89% coal.



Sources of Energy

Steel. Some answers.

1. Blast furnaces can be improved with better technology, better use of wastes, improved feedstocks (pulverised coal injection), green hydrogen and CCUS. They will never be zero carbon.

2. Most scrap steel (90%+) is already recycled and arc furnaces can use this more efficiently than blast. The other major input to EAF's is Direct Reduced Iron (DRI), pig iron produced at lower temperatures (1000°C) using hydrogen and carbon monoxide

3. The only viable way to get to net zero is to combine;

    1. Scrap and DRI (itself produced using green hydrogen),
    2. Arc furnaces fuelled by green hydrogen and green electricity.

Conclusion - All the major European steel manufacturers are setting up pilots for green steel. Hybrit, a Swedish steel maker, has delivered its first trial batch to Volvo. Full production will start in 2026.

Structures

Construction

Structures - mostly buildings - houses, shops, offices, factories, warehouses….

1. Together, buildings and construction are responsible for 39% of all carbon emissions in the world. We must build back better… and retrofit.

2. In a well constructed building, over the lifetime of the building, the build accounts for 40% and the use 60% of the energy. In a badly built (old) building it's 10% and 90%. The embodied carbon in a new build office block today can be one ton/m^2 or 250 kg.

3. The carbon footprint of the construction and structure of a building is driven by standards, practices and choices of materials. Both practices and choices of material are heavily influenced by standards. Standards reflect policy.

4. Standards are mostly national and local. Passive House is a German originated national standard which has been gaining acceptance.

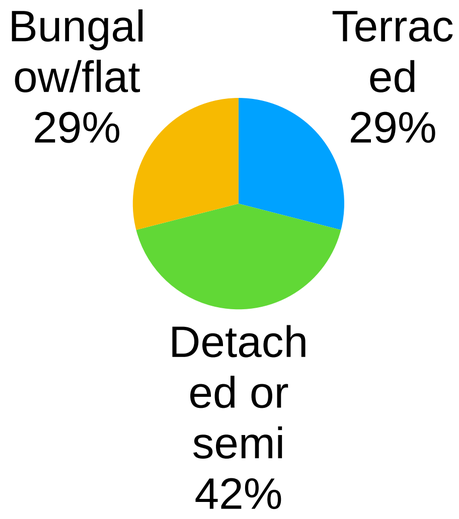
5. In the UK, building standards have chequered history….but first some data

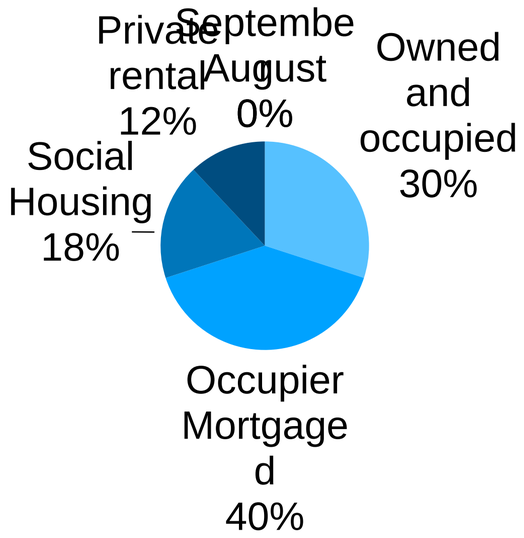
Housing data (2010 - but it hasn’t changed very much)

There are 27 million dwellings in the UK.

20% of dwellings were built before 1919

15% were built post 1990.





The mean floor area of a UK dwelling is 95 square metres.

Average energy consumption for UK housing is 120kWh/m^2/year.
Passive standard is 15kWh/m^2/year

UK Standards, a short history..

London, 1189 - controls on privies, party walls and gutters….'viewers', skilled masons and carpenters, were appointed to advise the authorities on dispute resolution.

London, 1666 - The Great Fire wiped out 80% of the City. The 1667 London Building Act forbade the building of timber houses, limited heights and set street widths..these Building Acts spread throughout the towns and cities.

London, 1841 - the first attempt was made to pass a national building Act, primarily to set some health standards, but it failed to pass.

London, 1858 - Local Authority Act gave LA's some powers to regulate the structure of buildings through bye-laws.

Edinburgh, 1959 The Building (Scotland) Act allowed the setting of National standards which were first published in 1963, England followed a couple of years later.

UK Standards, more recently…

Some steady but slow progress in the 21st century until in 2015 the Government withdraws The Code For Sustainable Homes (new homes Zero Carbon from 2016), probably wisely and under pressure from builders, but then explicitly prohibits LA's;

'from setting any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings.'

In 2018 Gov't revised the National Policy Planning Framework and allowed LA's to set higher energy efficiency standards. Few, if any, have as they have no funds for inspection, much of which is now privatised.

In 2020/1 the Government began to address to the climate emergency…..

UK Standards, UK Gov’t 10 point plan

More efficient and better insulated buildings

The Future Homes standard will produce low or zero energy homes, existing estate will be upgraded (1.5M homes to EPC C by 2030). Public sector building consumption reduced by 50% by 2032. £1B+ of Gov’t funding, 50,000 new jobs by 2030.

UK Standards, a CCC proposed direction …

1. Measure and disclose carbon: Carbon is the ultimate metric to track, and buildings must achieve an annual operational net zero carbon emissions balance based on metered data.

2. Reduce energy demand: Prioritise energy efficiency to ensure that buildings are performing as efficiently as possible, and not wasting energy

3. Generate balance from renewables: Supply remaining demand from renewable energy sources, preferably on-site followed by off-site, then offsets

4. Improve verification and rigour: Over time, progress to include embodied carbon and other impact areas such as zero water and zero waste

UK CCC 2021 report to Parliament…..and Gov't actions in the 2021 Heat and Buildings Strategy

Standards to support phase out of liquid, solid and gas domestic heating

2021

2021 priority ?

Skills strategy

30 year heat strategy for all segments of the building stock

2022

2021 priority

Policy framework for energy efficiency and heat pump growth

Work to support heat networks.

2022 ?

Multiyear programme to reduce emissions from new and existing public buildings

2022

Collect and report data on embodied and 'use' carbon

2022

Improve EPC and SAP systems

2022 ?

Schemes to prevent overheating in existing residential buildings

2022

All private and public social housing to be EPC C PRS by 2028 - non domestic to be EPC B

2021 ?

Locally (WBC) - new build…

Waverley BC declared a climate emergency on 18th September 2019 and subsequently stated the planning policy impact as:

“Planning Policy

The council’s Planning Department, through their processes, will use the legislation, Local Plans and Supplementary Planning Documents to ensure developments are sustainable, energy efficient, use renewable energy and Passivhaus standards where possible.

To meet this objective the council will:

- Take into account the potential impact on the climate and the environment in all Council decisions. This will be embedded in strategic decision making, budgets, approaches to planning decisions and through updates to policy and guidelines; “

What have they done? let’s have a look.

Waverley BC plan

Submitted the local plan suggesting for new builds a 20% improvement on level 4 of the Code for Sustainable Homes ~ 35kWh/m^2/year - good compared to today's 120 kWh/m^2/year, but nowhere near Passive standards 15kWh/m^2/year.

They could probably have gone ahead outside the local plan by issuing Supplementary Planning Documents.

Waverley BC plan , what could they do?

The UK Green Building Council suggests:

Minimum target:

- A 31% reduction on the heat losses for existing houses . Prioritise a fabric first approach, The energy use intensity (EUI) for new homes should be reported on a kWh/m2/year basis.

Stretch target:

- An EUI of <70 kWh/m2/year operational energy use (Typical UK house - 120kWh/m2/year)
- New build homes shall deliver ultra-high levels of energy efficiency consistent with a space heat demand of 15-20kWh/m2/year. (EPC A)
- Design and measure performance using a design for performance methodology such as Passivhaus (~ ditch EPC)

Use

Housing data (2010 - but it hasn’t changed very much)

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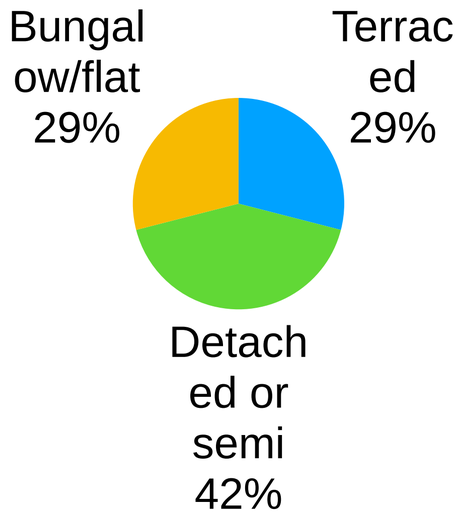

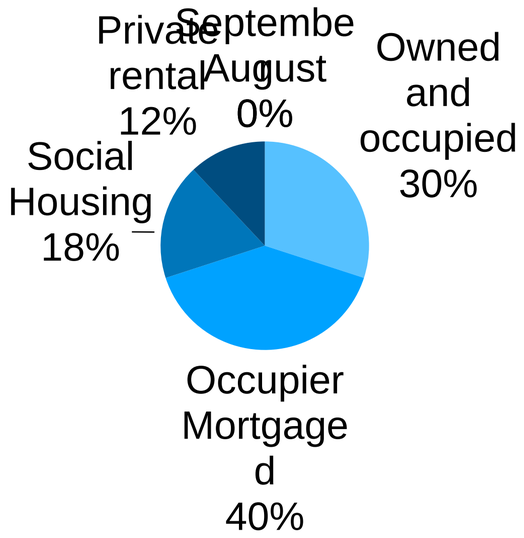

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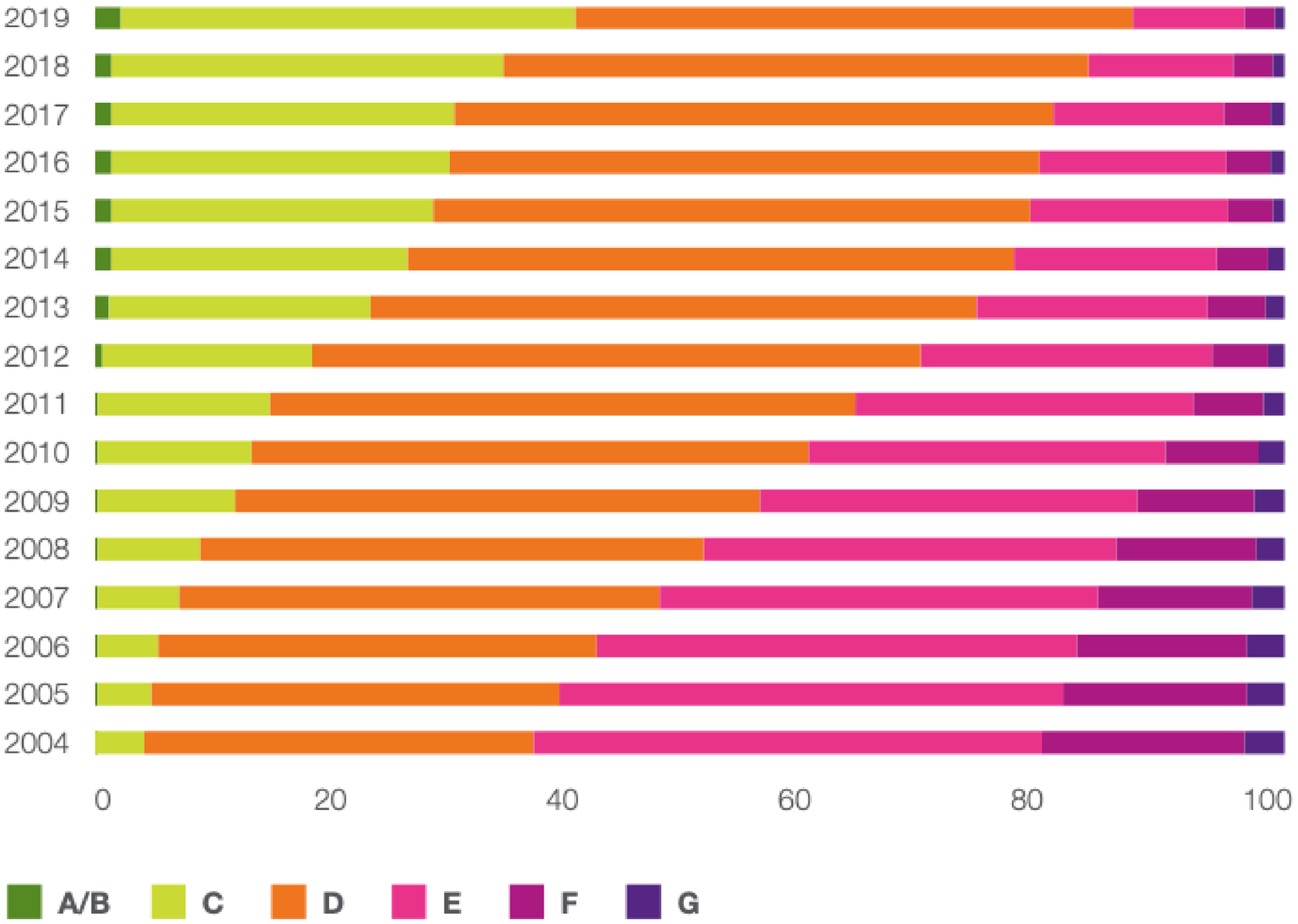
Percentage of UK Homes rated EPC A-G 2004 -2019



BEIS

How to deal with the 85% of the housing stock that won’t be new.

- **The risk** is that this will be charter for cowboys. This is a system problem not a heat source problem. It needs heating engineers, not fitters. It is a massive employment and re-skilling opportunity.

- **Low hanging fruit.** Since 2005 all gas boilers have to be condensing. Over 80% have been incorrectly commissioned and can run with a 6-8% improvement in efficiency with a simple adjustment. Retrofit 5% a year?

- **A national retrofit programme** of energy efficiency measures is going to be expensive. Best, well respected estimates are about that it will cost 10% of the value of the property. 10% of £6Trn is £600Bn. Mortgage balances account for 20%.

How to deal with the 85% of the housing stock that won’t be new - 1.

- **From the finance industry perspective.**
  Mortgages on poorly insulated houses are ‘Brown - EPC F/G’ relative the ‘Green - EPC A/B’.
  The brown assets will perform poorly compared with green and this will be material over the lifetime of the mortgage. This data (the quality of the mortgage book assets) will have to be declared under new finance regulations. Loaning retrofit money at Gov’t backed very low rates will be zero risk with a guaranteed return.

- **Aim at 5% of housing per year.** Start with the worst performing. For **occupiers** this will deliver immediate energy savings of many hundreds of pounds year, every year. For **owners, public and private landlords,** it will increase the value of homes. It will generate many thousands of skilled jobs. It is a no risk job creation scheme if it is properly managed.

How to deal with the 85% of the housing stock that won't be new. - 2

- **Follow the Welsh way - Comfort not Kilowatts.**

  The Welsh government is sponsoring pilot work, initially for social landlords, to get their existing estates to net zero by 2050 . They are calling it 'Optimised Retro-fit" .

It starts with a full survey of the house then establishes a long term plan (10 years +) for each individual property setting out a pathway to nett zero. They might fit a new high efficiency boiler with intelligent controls, then new radiators, sized for heat pumps, then do some insulation, then draft proofing, then a heat pump, by this time many years down the road.

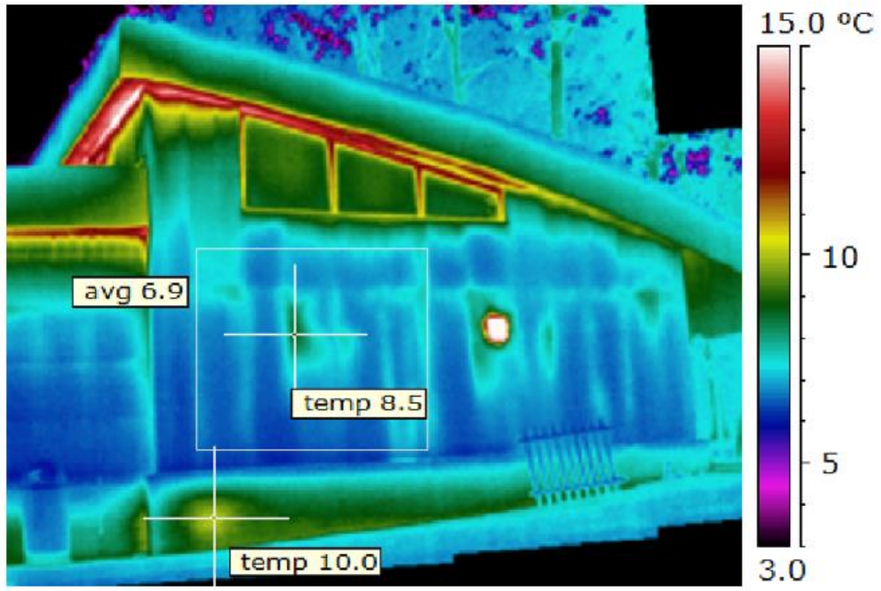
- A small number of firms (see Sero who are doing 1800 homes) are offering **'Comfort as a service'** where the user pays only for an agreed temperature plan, by room and season and an agreed hot water plan. The responsibility of providing this and reaching nett zero by 2050 rests with the service provider who takes over all design and provision duties. This has the benefit of aligning incentives to the benefit of us all. Maybe best for new homes?

Actions on us.

Actions on us.

1. Get a decent heating engineer to survey your home and check your boiler and controls. Does your combi condensing boiler actually condense? Check flow temperatures. Most don't. Try turning your boiler down by 5°C (Not your room thermostat.)..and then try it again….

2. Consider a thermal imaging survey of your house (in winter) . GBC used to offer this, WBC ?



(Image -Scantherm)

3. If you are thinking about changing your boiler consider using a proper environmental consultant. Consider it a system, not a heat source, problem..

4. Continue to press our politicians, both local and national, to regulate the building and the heating industry in the way that the motor industry is. The Strategy Paper is a decent start but it's easy for them to backslide….

In Summary…

Construct only near zero carbon buildings

Retrofit at least 5% of the worst performing buildings annually

Ensure the use of electric and efficient appliances and equipment

“If nobody asked questions, then we would never learn anything.”

Brandon Sanderson, Oathbringer

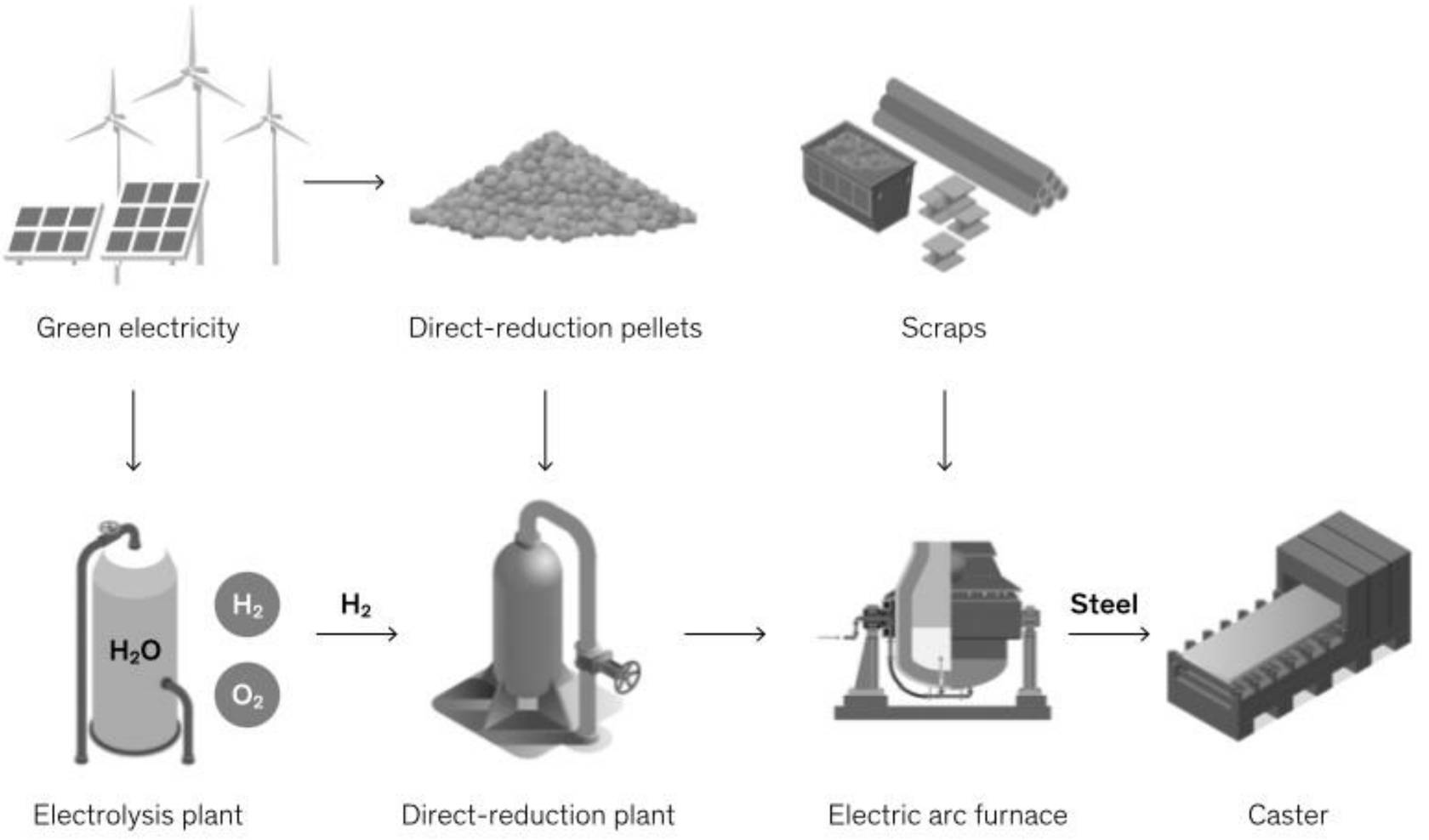
What is the UK Approach?

An Example: Building Regulations

- **There are existing standards which could simply be taken off the shelf.**

Fabric 'U values (W/m^2K)	2018	2021	2025	Wayside (2020)	Passiv	Typical UK House	Notes
external walls	0.28	0.18	0.15	0.12			
floors	0.22	0.13	0.11	0.10			
roof	0.18	0.11	0.11	0.10			
windows	1.6	1.2	0.8	0.7			
air permeability	?	5	5	0.47	0.6	>10	air changes per hour
Annual Specific Heat Demand	-	-	-	15 - 20	15	120	kWh/m^2

Hydrogen-based steel production involves efficient steps.



McKinsey & Co

Exhibit 1 Top categories for reducing embodied carbon

Source RMI

The Essential Truth About Climate Change in Ten Words

The basic facts of climate change, established over decades of research, can be summarized in five key points:

IT'S REAL	Global warming is happening.
IT'S US	Human activity is the main cause.
EXPERTS AGREE	There's scientific consensus on human-caused global warming.
IT'S BAD	The impacts are serious and affect people.
THERE'S HOPE	We have the technology needed to avoid the worst climate impacts.