is your business sustainable?

inperpetuum

who we are

In Perpetuum is the newly created entity to deliver a Bio Energy Cluster investment portfolio around the Bio Power, Heat, Fuels and Chemicals markets globally.

Biomass and Biofuels are highly regulated global B2B commodity markets that have suffered from market disturbances.

Many have been constrained by market / country regulatory regimes, leaving them distressed or with any growth limited to short periods of profitability followed by turmoil.

what we do

In Perpetuum provides both a development engine and a marketplace for the Bio Mass, Fuel or Chemical outputs. All products and projects will deliver measurable sustainable benefits, meaning they have a positive and provable local and/or global effect on society and the environment.

The Biochemical market is an emerging sector driven by B2C demand and expectation that brands will "do the right thing" when it comes to looking after the planet.

This creates an opportunity for commercially competitive biogenic chemicals from established and novel feedstocks or technology routes.

Our analysis shows some of these opportunities will work efficiently when clustered around existing BioEnergy assets.

how we do it

Immediate opportunities exist around BioEnergy assets from field to fuel for heat, power and transport markets, where assets have become distressed in some way.

The precise investment / development solutions can only be defined following detailed investigation, analysis, "optioneering" and critical decision making to identify the most appropriate returns and societal benefits.

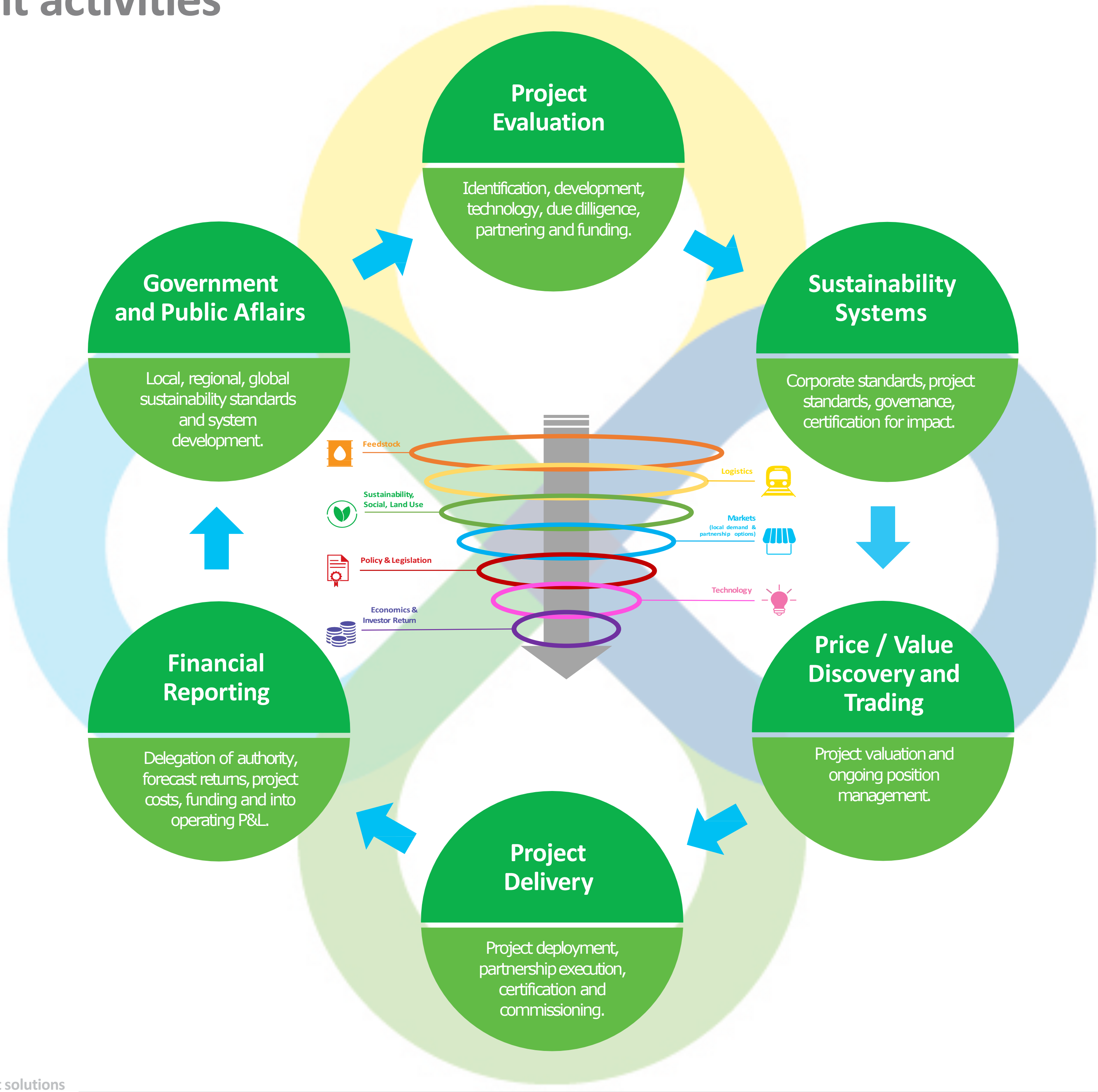
Optioneering will lead into consideration of a broad range of opportunities, including Bio chemicals as well as Biomass for heat and power and Biofuels for transport and power.

our experience

50 years of combined experience in this market sector

- Bio Mass / Fuels and Chemical markets
- New team / Market development
- Project evaluation & delivery
- Sustainability systems
- Price / value discovery and Trading
- Government and Public Affairs

development activities



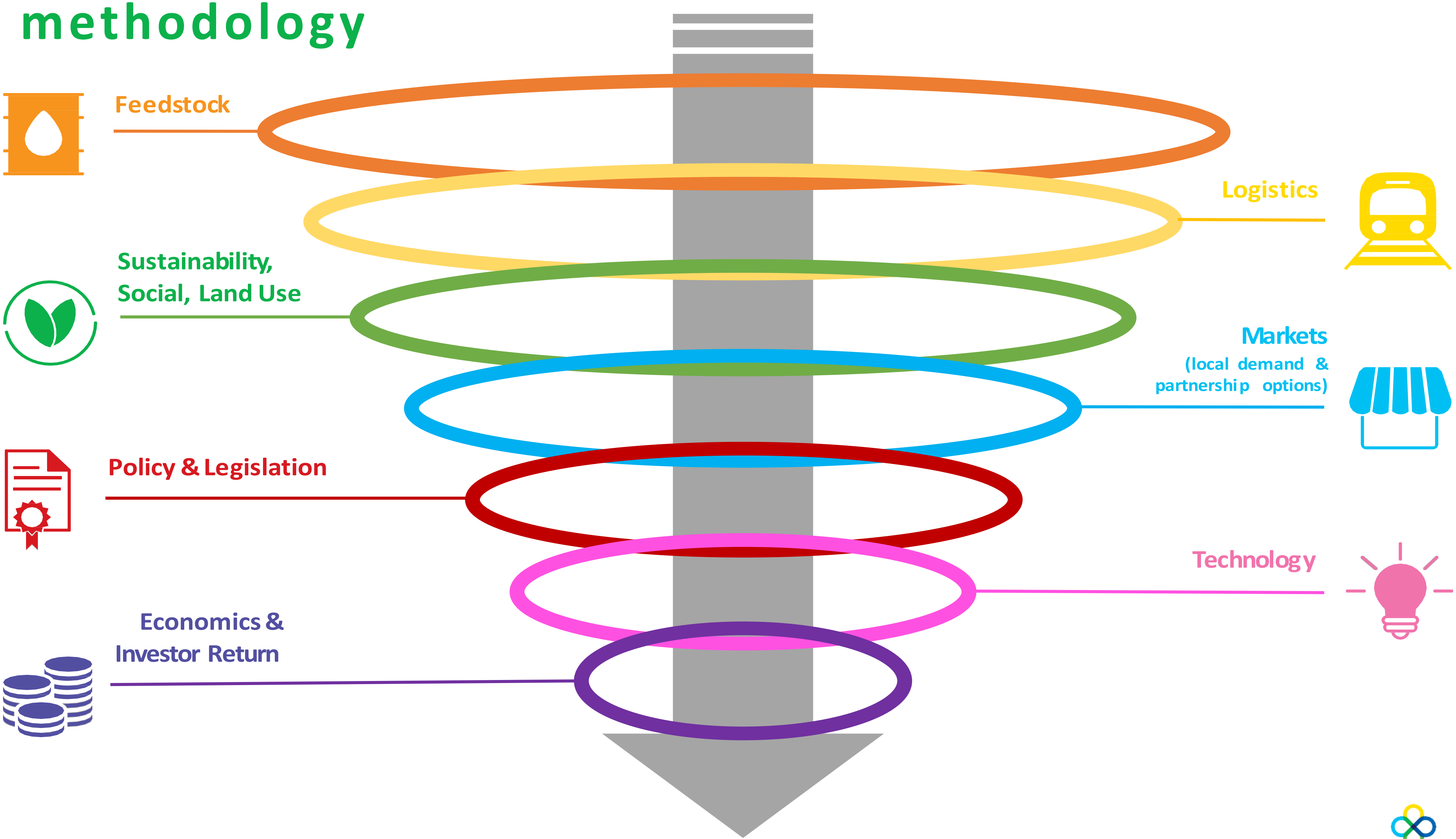
roadmap to a sustainable future

In light of BEIS intention to eliminate liquid fossil fuels, OFTEC recognises the potential demise of the oil heating sector unless an alternate feedstock is found. OFTEC and its members face potential loss of market and subsequent loss of income and business uncertainty without an alternate. Liquid biofuels may be an alternate. However, some work is needed to convince BEIS that they offer a sustainable and available solution given the policy uncertainty and flip flop around use of liquid biofuels in the transport energy sector.

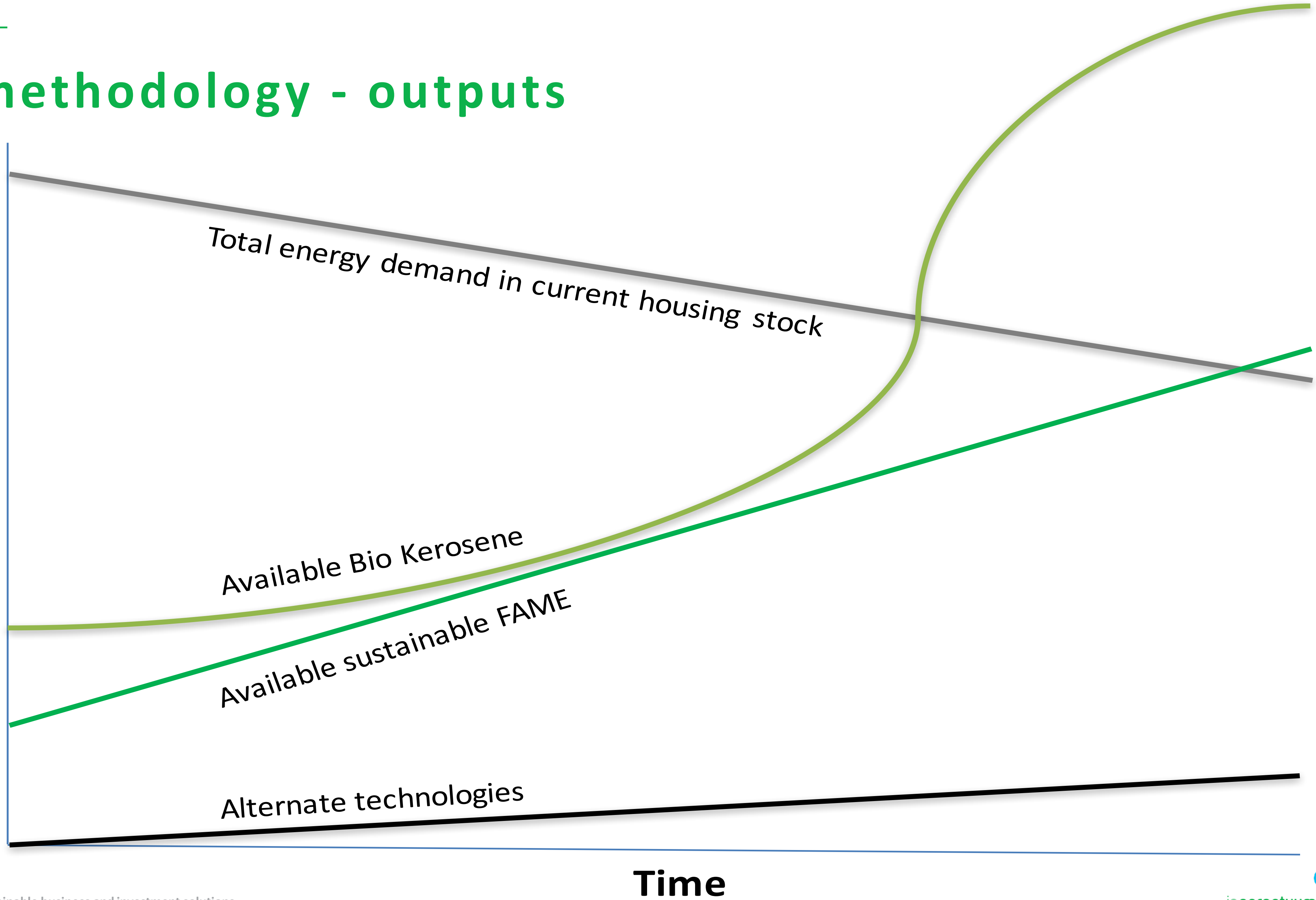
OFTEC intends to present to BEIS a roadmap of how to get to sustainable liquid biofuels in the off-gas heating network. This will be, by adopting In Perpetuum's approach to a robust analysis of the sector to underpin policy options. The approach will consider in full the following seven factors: Sustainability / Feedstocks / Technology / Logistics / Markets / Policy & Economics.

OFTEC

methodology

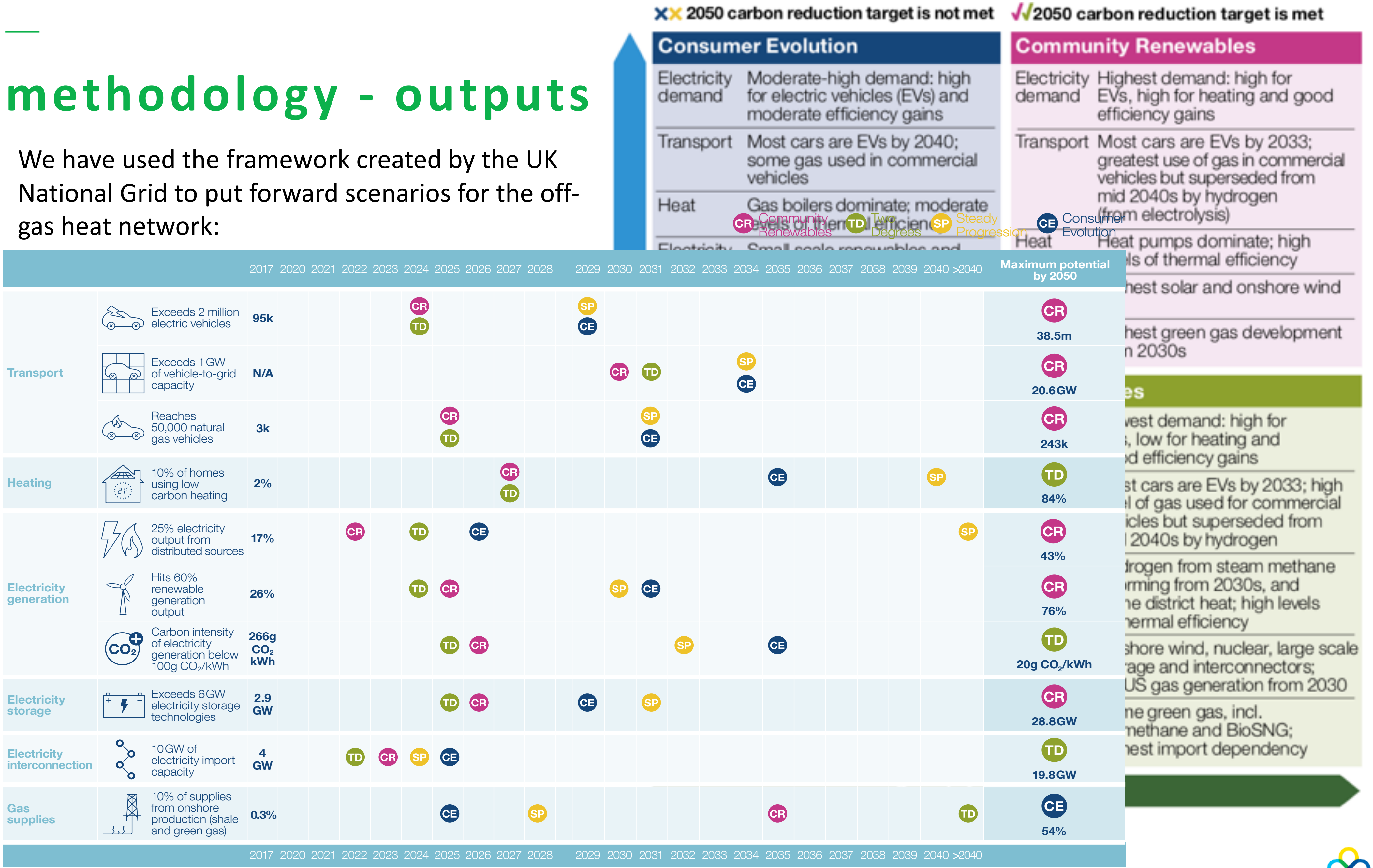


methodology - outputs



methodology - outputs

We have used the framework created by the UK National Grid to put forward scenarios for the off-gas heat network:

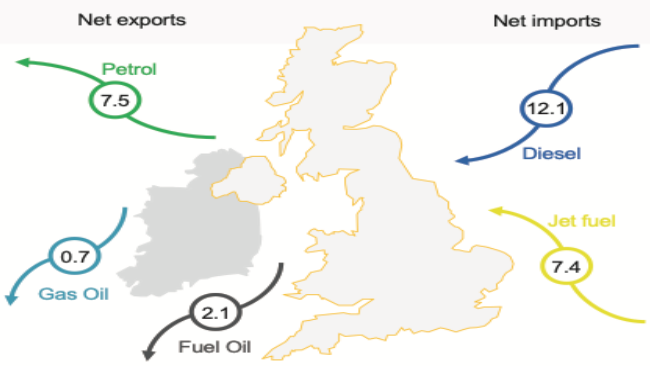


		2017	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	>2040	Maximum potential by 2050
Transport	Exceeds 2 million electric vehicles	95k					CR TD					SP CE													CR 38.5m
	Exceeds 1 GW of vehicle-to-grid capacity	N/A											CR	TD			SP CE								CR 20.6 GW
	Reaches 50,000 natural gas vehicles	3k						CR TD						SP CE											CR 243k
Heating	10% of homes using low carbon heating	2%								CR TD								CE					SP		TD 84%
Electricity generation	25% electricity output from distributed sources	17%			CR		TD		CE															SP	CR 43%
	Hits 60% renewable generation output	26%					TD	CR					SP	CE											CR 76%
	Carbon intensity of electricity generation below 100g CO_2/kWh	266g CO_2 kWh						TD	CR						SP			CE							TD 20g CO_2/kWh
Electricity storage	Exceeds 6GW electricity storage technologies	2.9 GW						TD	CR			CE		SP											CR 28.8 GW
Electricity interconnection	10GW of electricity import capacity	4 GW			TD	CR	SP	CE																	TD 19.8 GW
Gas supplies	10% of supplies from onshore production (shale and green gas)	0.3%						CE			SP							CR						TD	CE 54%

primary feedstocks and delivered fuels

2.9 UK Net Product Flows

UK Net Product Flows 2017



Unit: Mte/year

Source: BEIS, DUKES (Table ET 3.4, imports vs. exports)

- These are net product flows; they represent the overall import and export balance of the various grades shown
- UK refineries, in common with those in the EU, were configured predominantly to produce petrol and therefore have a mismatch between domestic production and demand
- Fiscal policy in the EU has driven up demand for diesel and demand for air transport has also increased aviation fuel use
- Consequently, the UK has a deficit of aviation fuel and diesel, whilst it exports surplus petrol and fuel oil

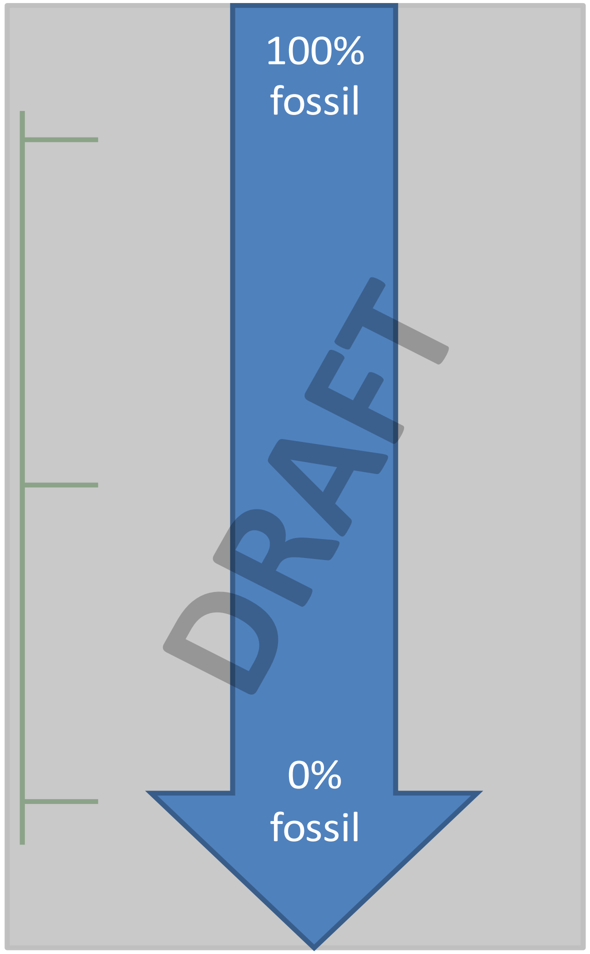
In 2017 around 70% of the kerosene heating demand and just under 50% of the aviation demand was produced within the UK, totaling 7 million tonnes of UK production and 7.4 million tonnes imported.

primary feedstocks and delivered fuels

2019 - 2027

2027 - 2032

2032 - 2050



primary feedstocks and delivered fuels

SBP
Sustainable Biomass Program

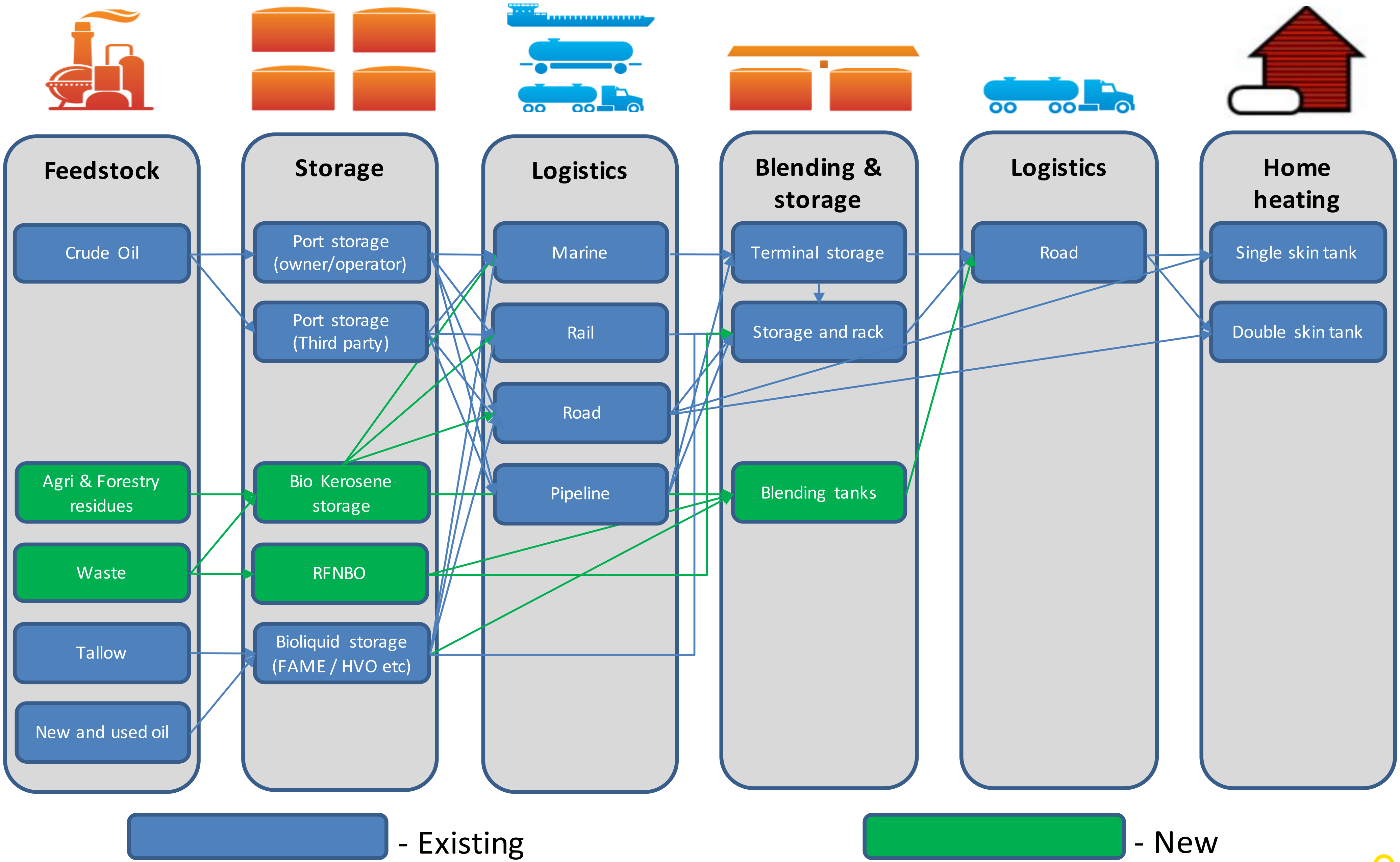
ISCC
International Sustainability & Carbon Certification

RSB
Roundtable on Sustainable Biomaterials
www.rsb.org

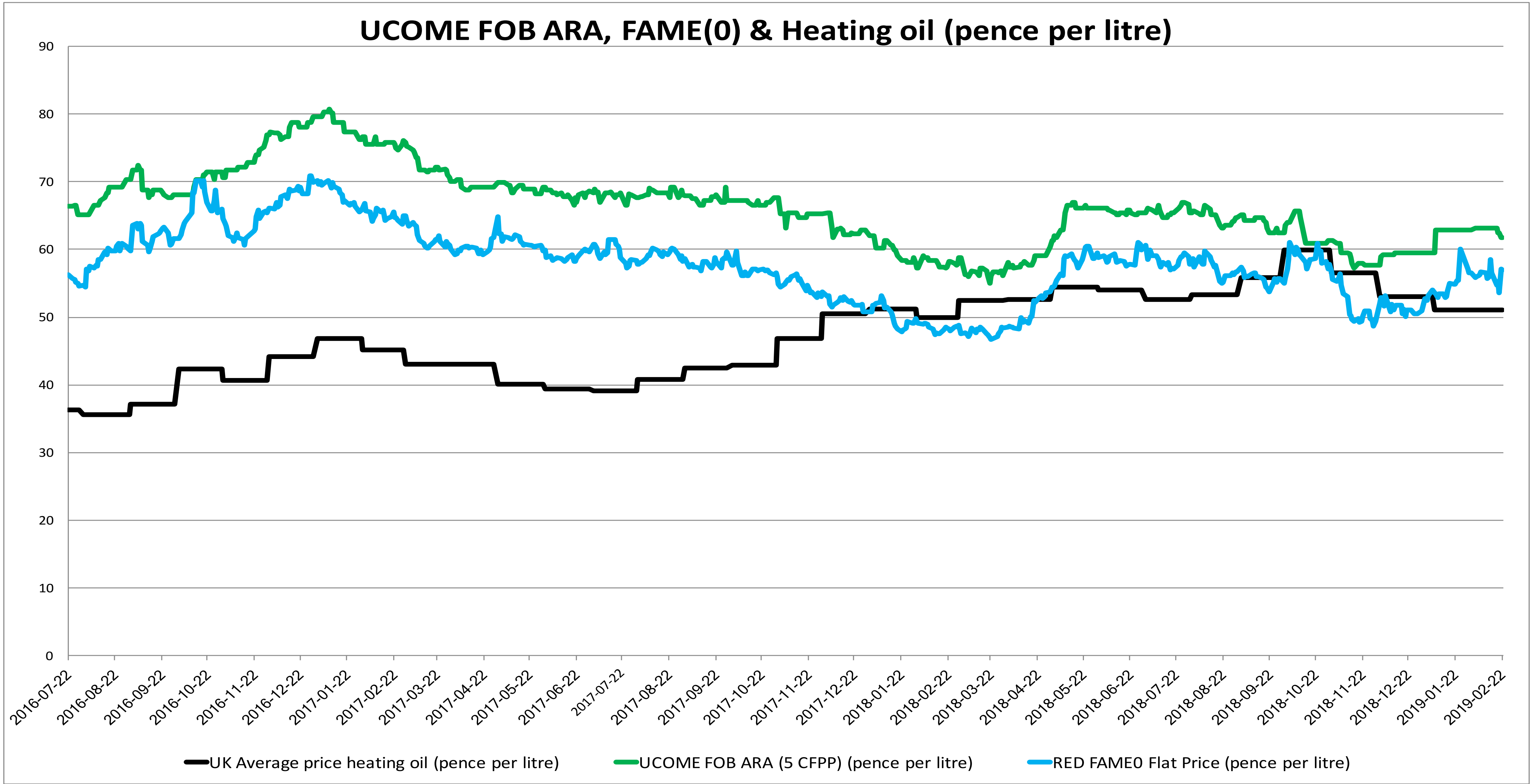
SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

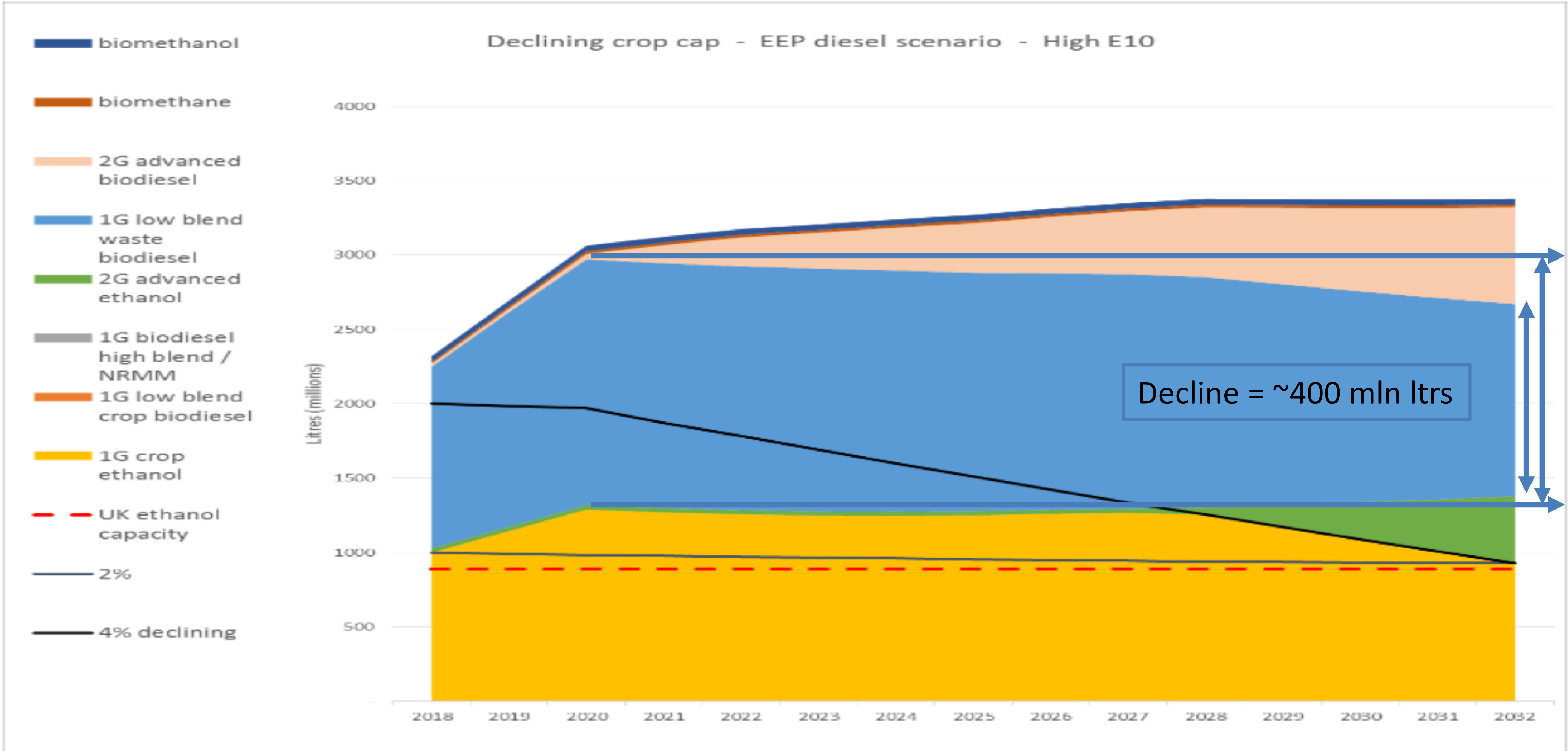
supply chain flowcharts

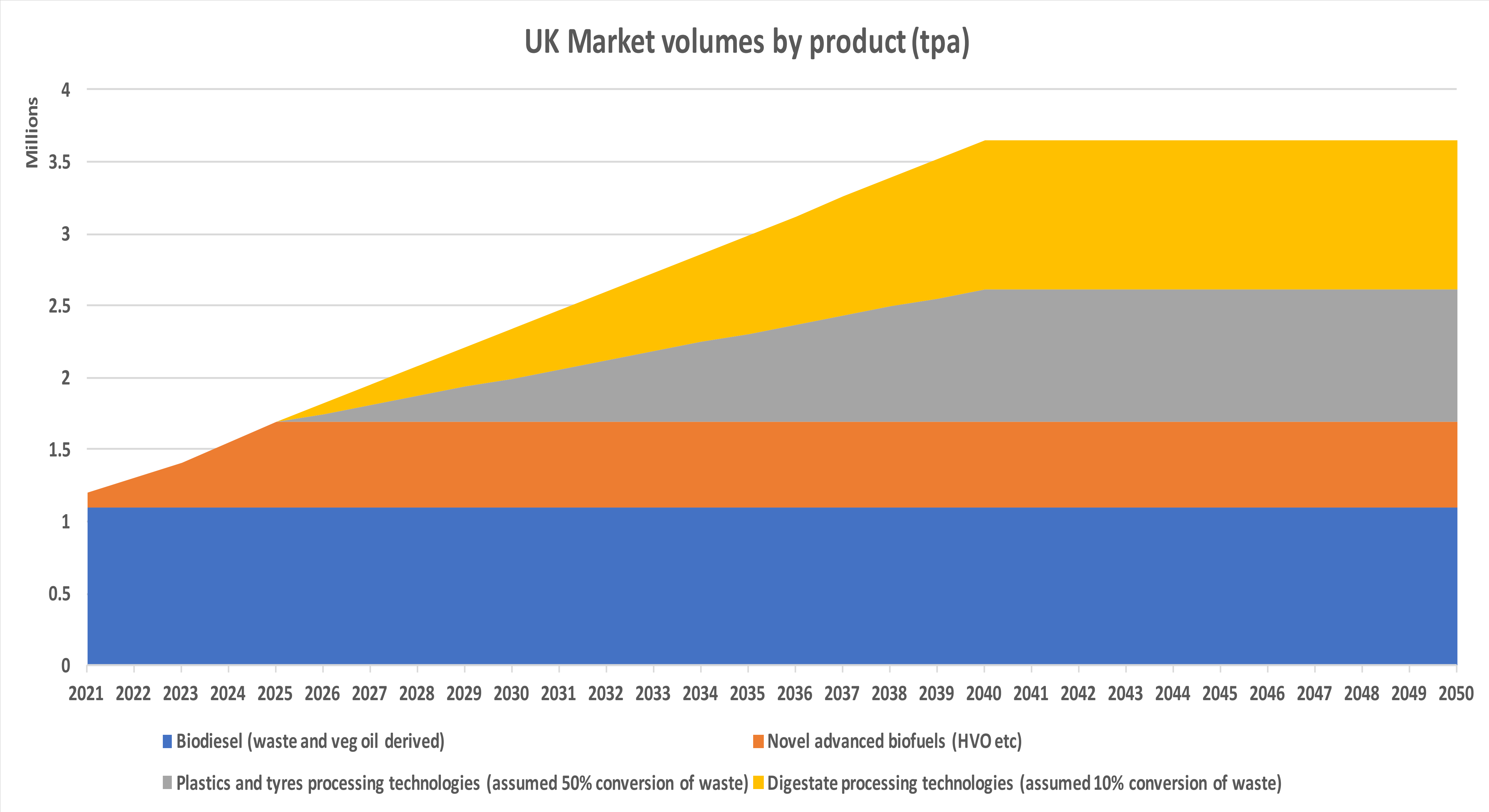


primary feedstocks and delivered fuels

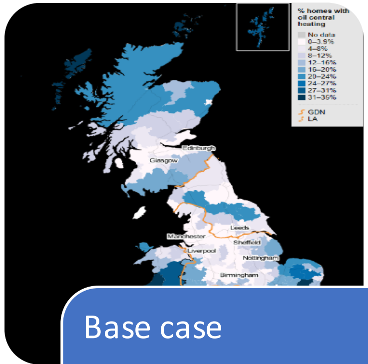


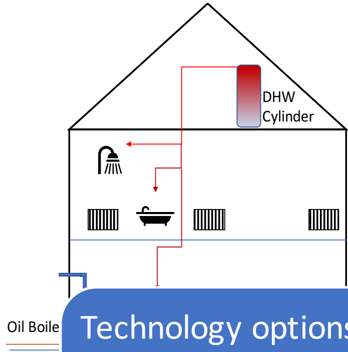
decline in waste derived FAME used in transport

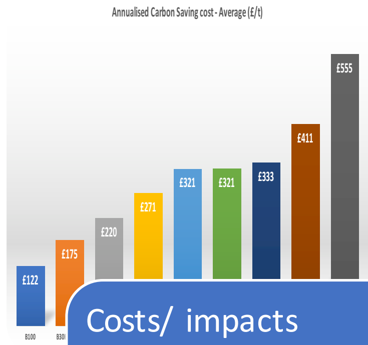



UK Market volumes by product (tpa)
Millions
4
3.5
3
2.5
2
1.5
1
0.5
0
2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Biodiesel (waste and veg oil derived)
Novel advanced biofuels (HVO etc)
Plastics and tyres processing technologies (assumed 50% conversion of waste)
Digestate processing technologies (assumed 10% conversion of waste)

Overview of the technical methodology:







Base case
- UK off-gas heat demand
- English Housing Survey
- Typical housing stock
- Typical property heating solution

Energy reduction
- Reasonable improvements
- Deep Improvements

Technology options
- ASHP
- GSHP
- LPG
- Biomass
- Sustainable liquids
- Electrical panel/ convection heaters

Costs/ impacts
- Capital costs
- Running costs
- Other factors

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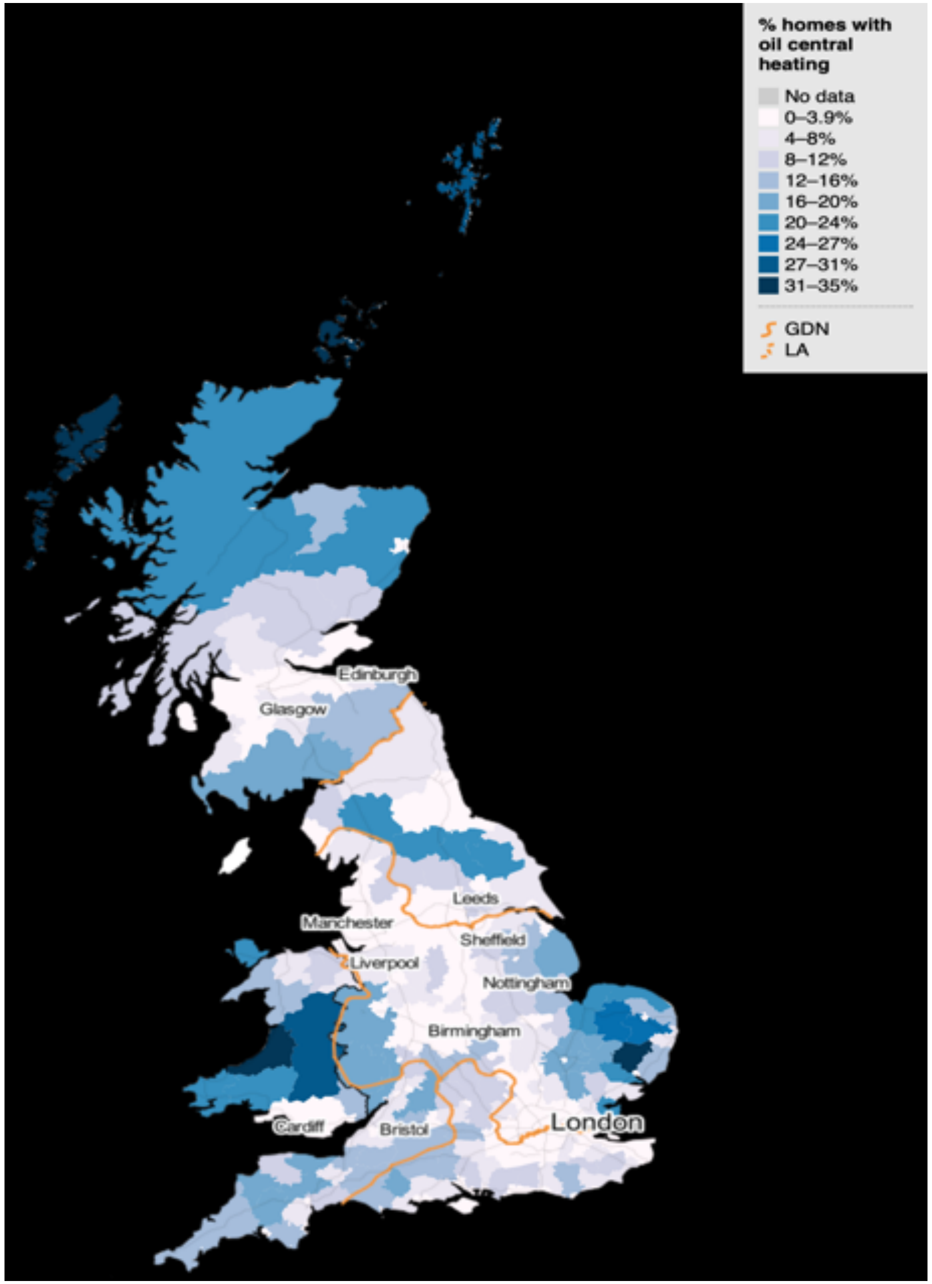
Current housing stock (England):



Estimated number of oil using homes by dwelling type and age profile

Group	Pre - 1919	1919 - 1944	1945 - 1964	1965 - 1980	Post - 1980	Total
Terraced house	80,600	4,500	6,750	10,000	6,700	108,550
Semi-detached house	81,900	23,600	40,150	27,500	14,400	187,550
Detached house	218,600	22,000	40,500	86,200	112,900	480,200
Bungalow	19,900	8,350	42,700	65,350	29,400	165,700
Total	401,000	58,450	130,100	189,050	163,400	942,000

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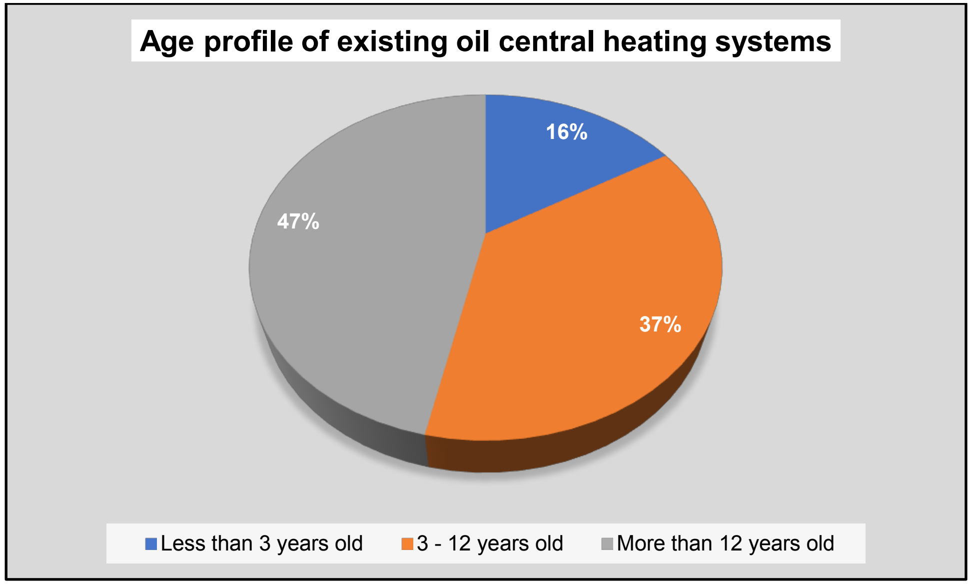
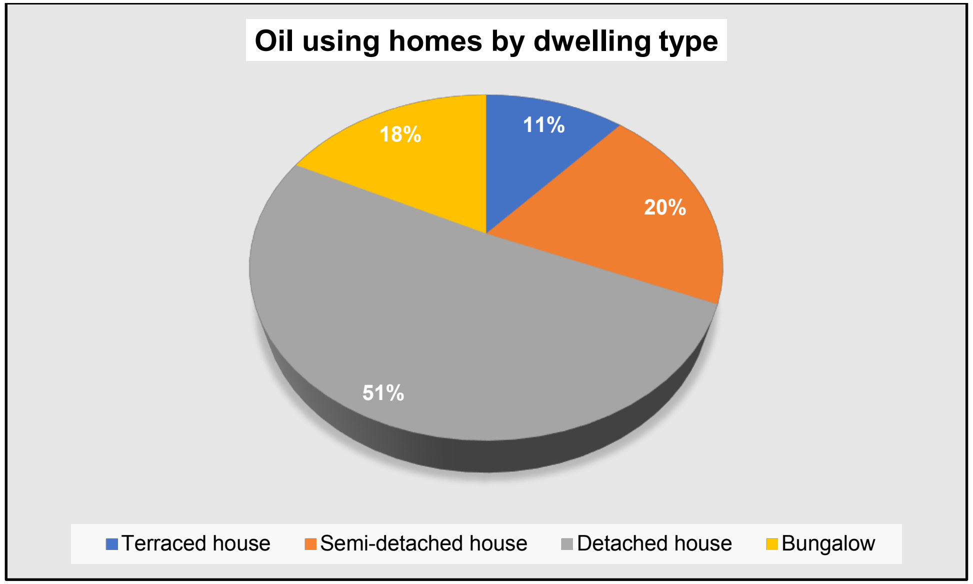
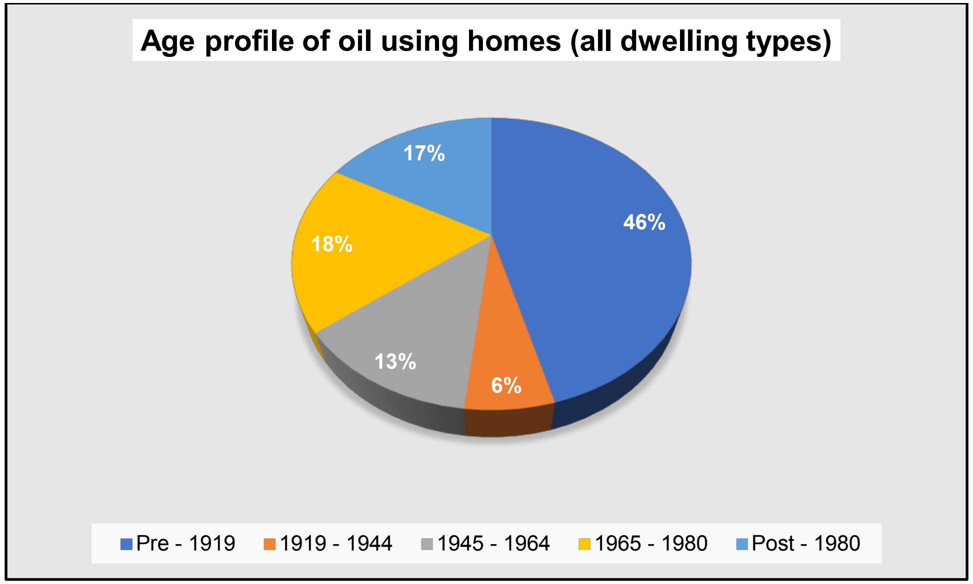
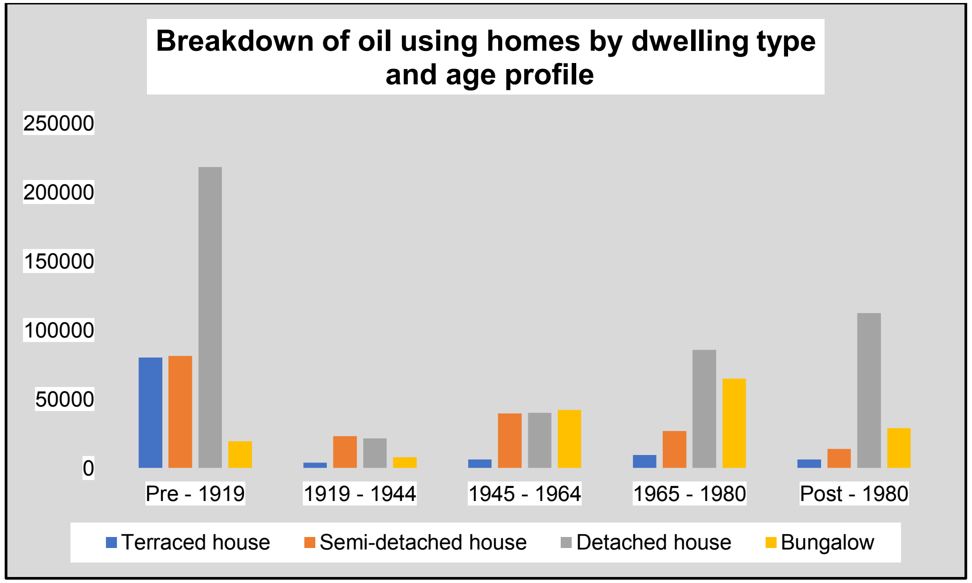
Current housing stock (England):









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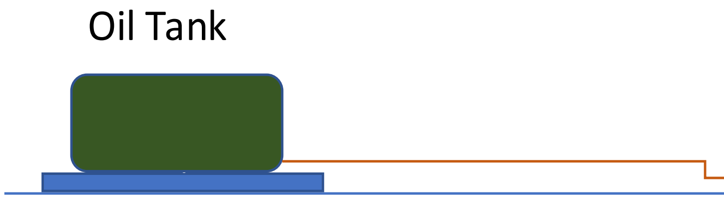
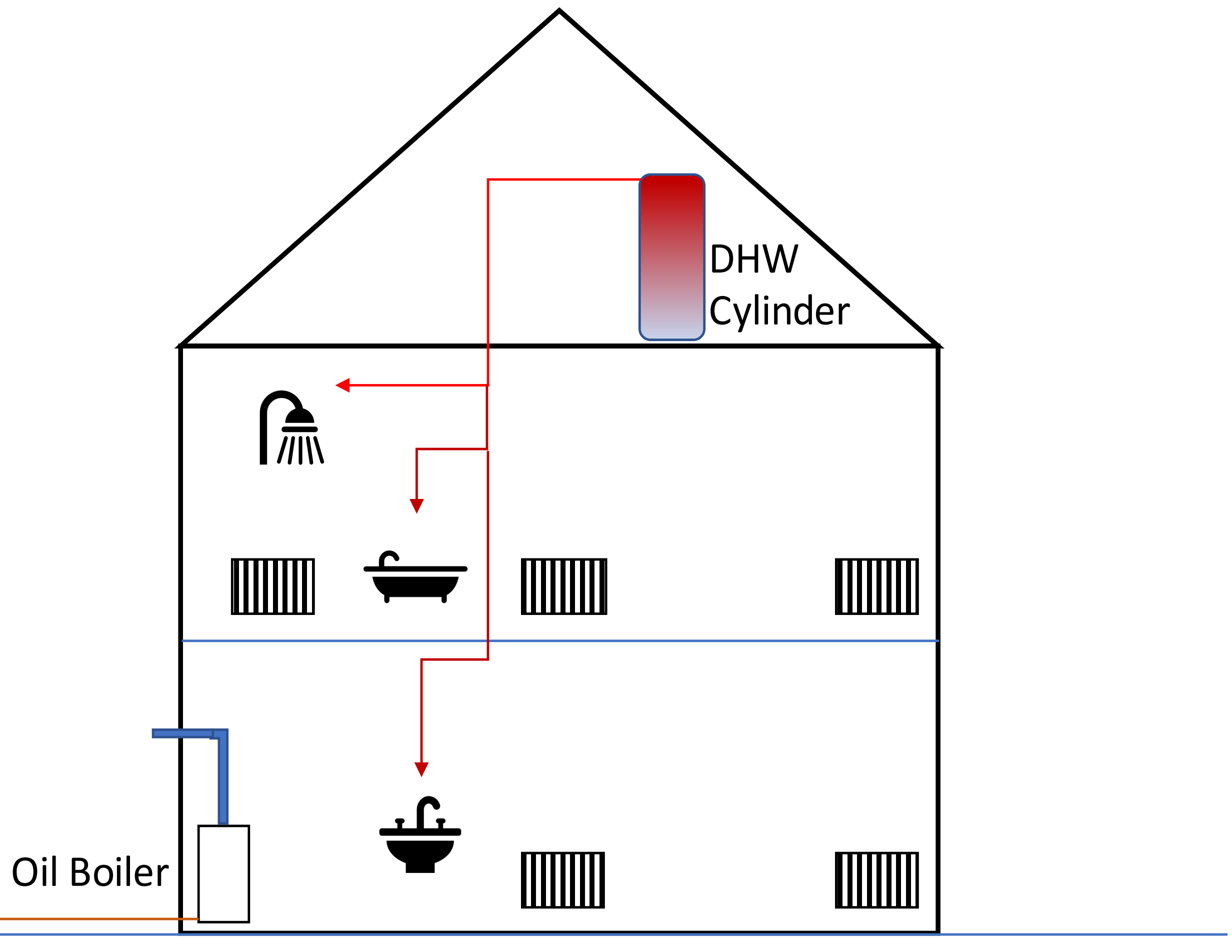
Existing heating system installed in pre 1919 detached property

Boiler size = 40kW non-condensing
Boiler efficiency = circa 70%
System efficiency = circa 55%
Oil Tank = 2000l unbunded, steel
Fuel = Kerosene
No loft insulation
Single glazing in wood frame
No wall insulation
4 x open chimneys – no throat restrictors





Total heat loss = 40kW/h
Annual Space Heat requirement = 49447kWh/Year

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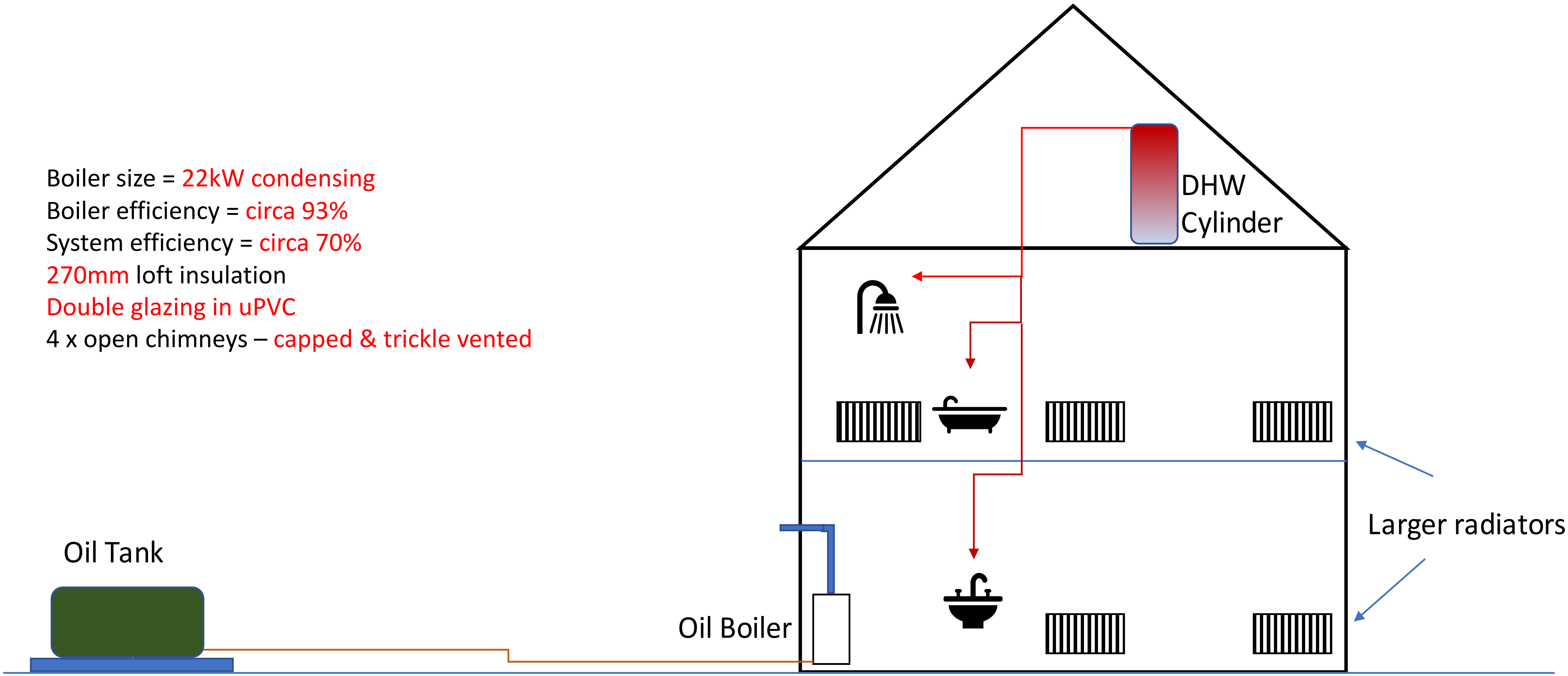
Reasonable improvements to fabric and heating system installed in pre 1919 detached property

Boiler size = 22kW condensing
Boiler efficiency = circa 93%
System efficiency = circa 70%
270mm loft insulation
Double glazing in uPVC
4 x open chimneys – capped & trickle vented



Total heat loss = 22kW/h
Annual Space Heat requirement = 24285kWh/Year

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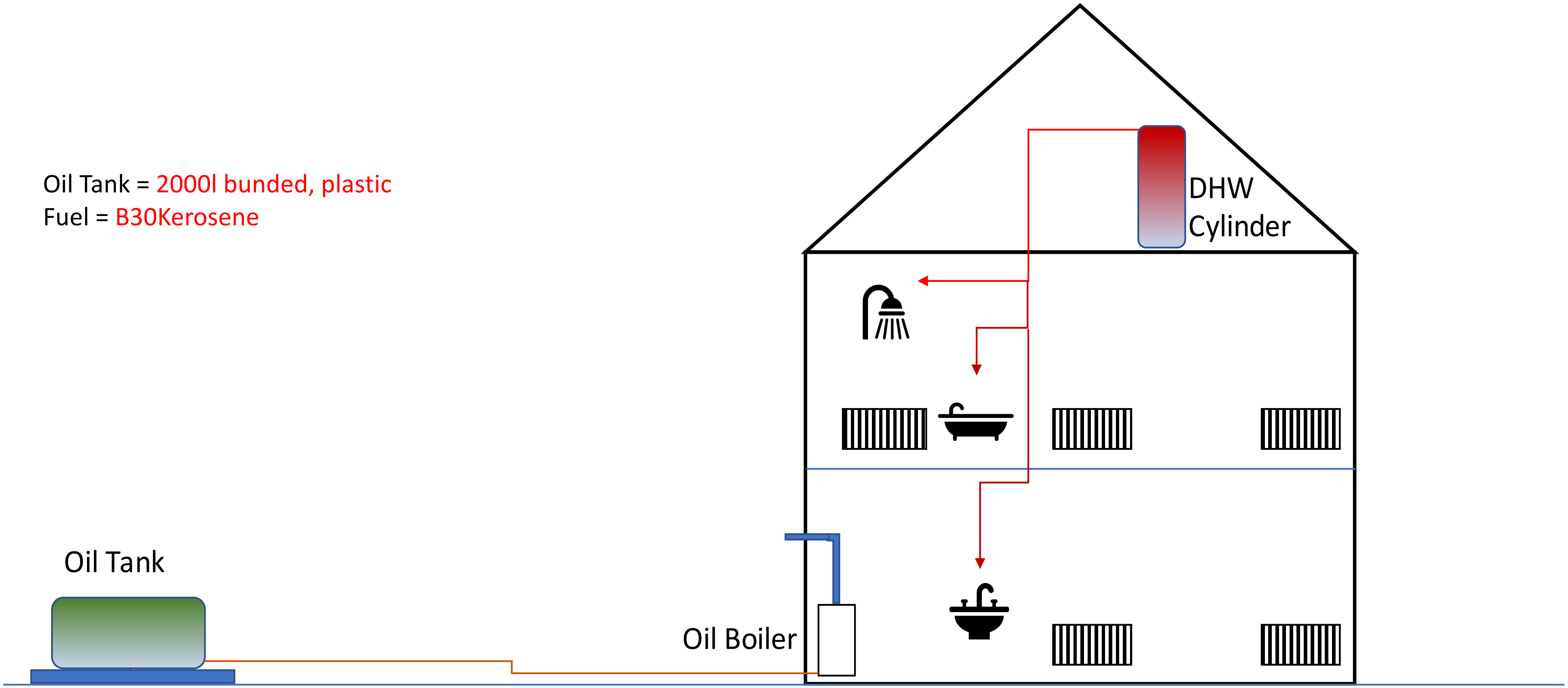
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – B30K

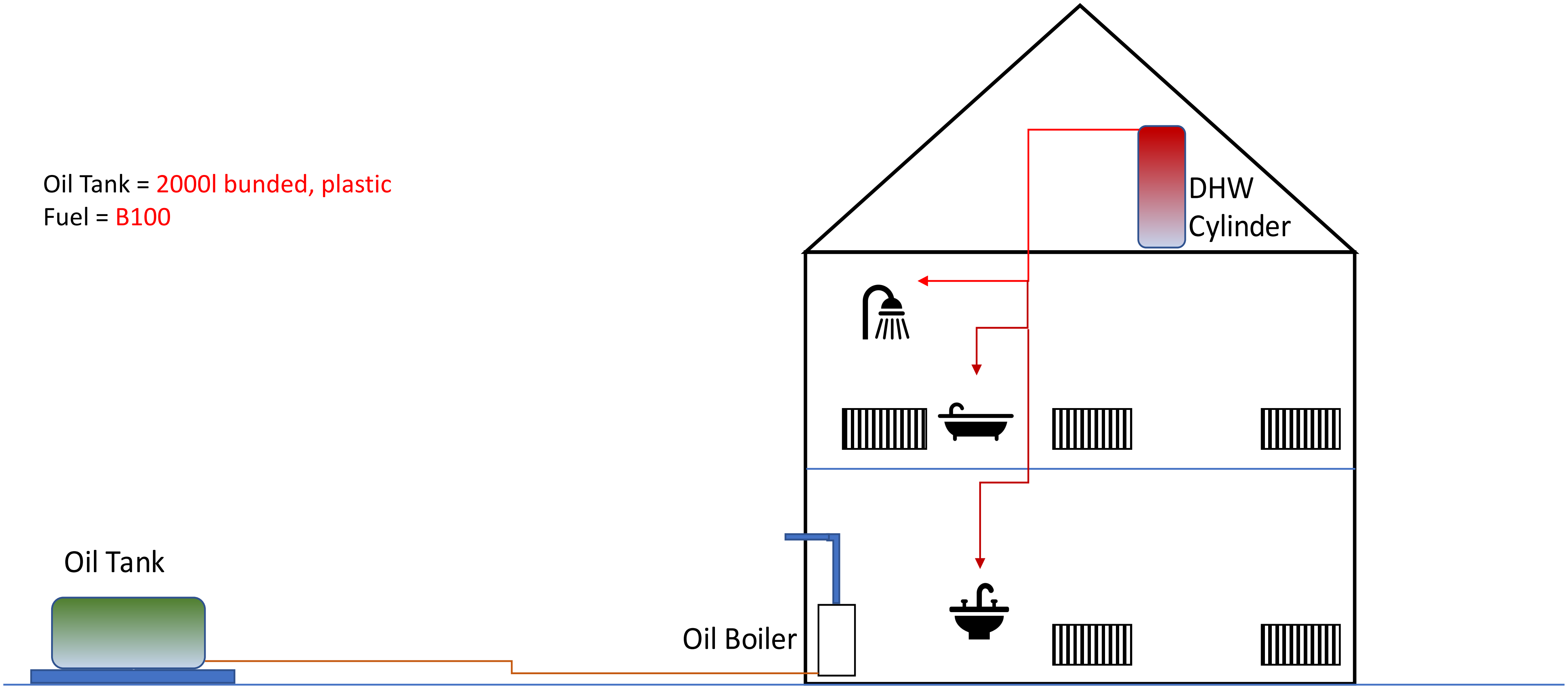
Oil Tank = 2000l bunded, plastic
Fuel = B30Kerosene



CAPEX cost per house type		Low		High
Terraced house		£750		£3,610
Semi-detached house		£750		£3,970
Detached house		£750		£3,970
Bungalow		£750		£3,610

Reasonable improvements to fabric and heating system installed in pre 1919 detached property – B100

Oil Tank = 2000l bunded, plastic
Fuel = B100



CAPEX cost per house type		Low		High
Terraced house		£1,250		£3,610
Semi-detached house		£1,250		£3,970
Detached house		£1,250		£3,970
Bungalow		£1,250		£3,610

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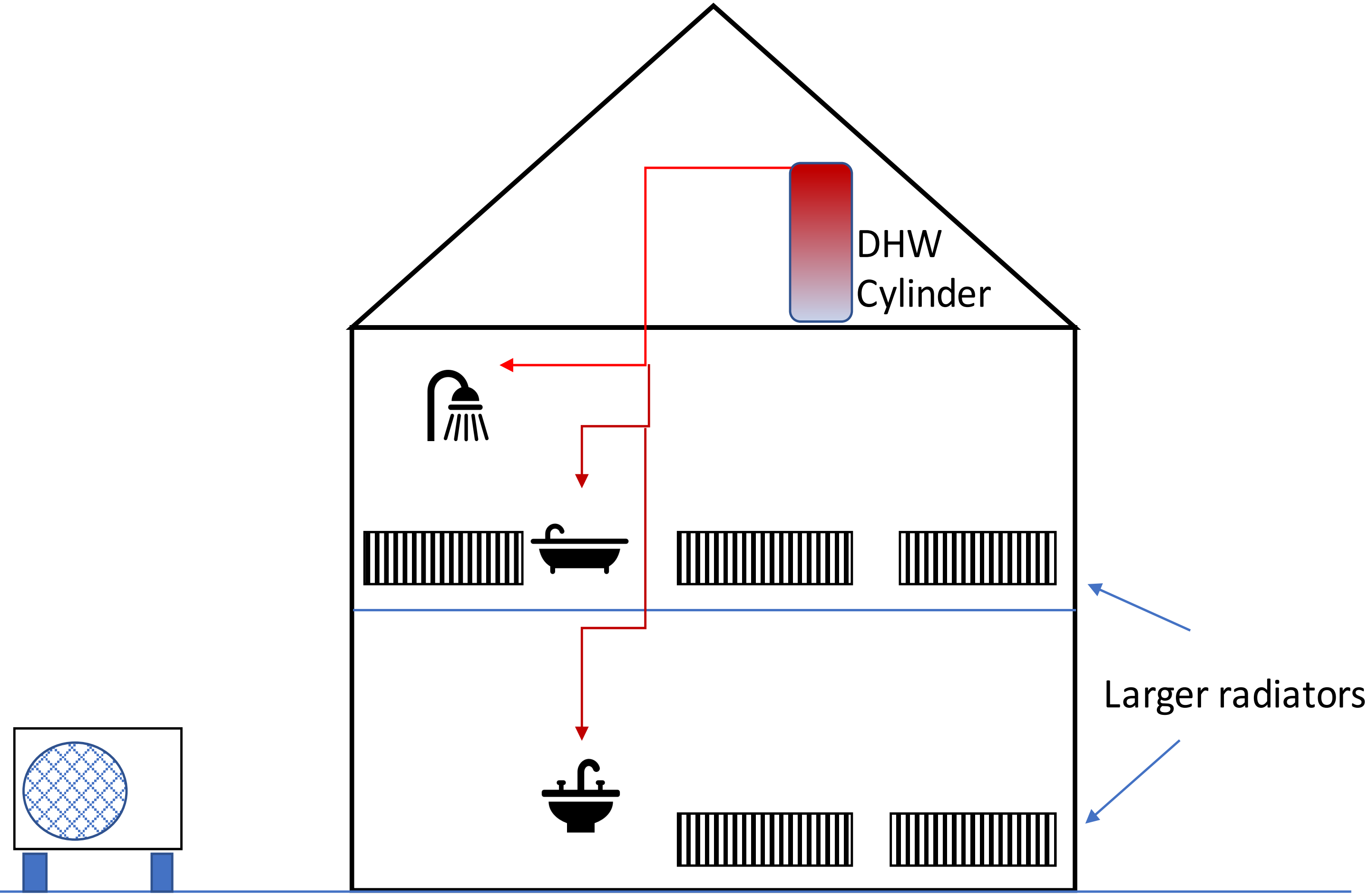
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – ASHP

Heat pump size = 17kW
HP SCOP @55°C = circa 373%
System efficiency = circa 75%
Tank = None
Fuel = Electricity



CAPEX cost per house type		Low		High
Terraced house		£6,000		£7,495
Semi-detached house		£7,600		£9,195
Detached house		£9,200		£10,895
Bungalow		£8,100		£9,695

Note: Largest single phase heat pump currently available cannot satisfy the heat loss at the design conditions – supplementary heat source is required. DNO issues need to be addressed.

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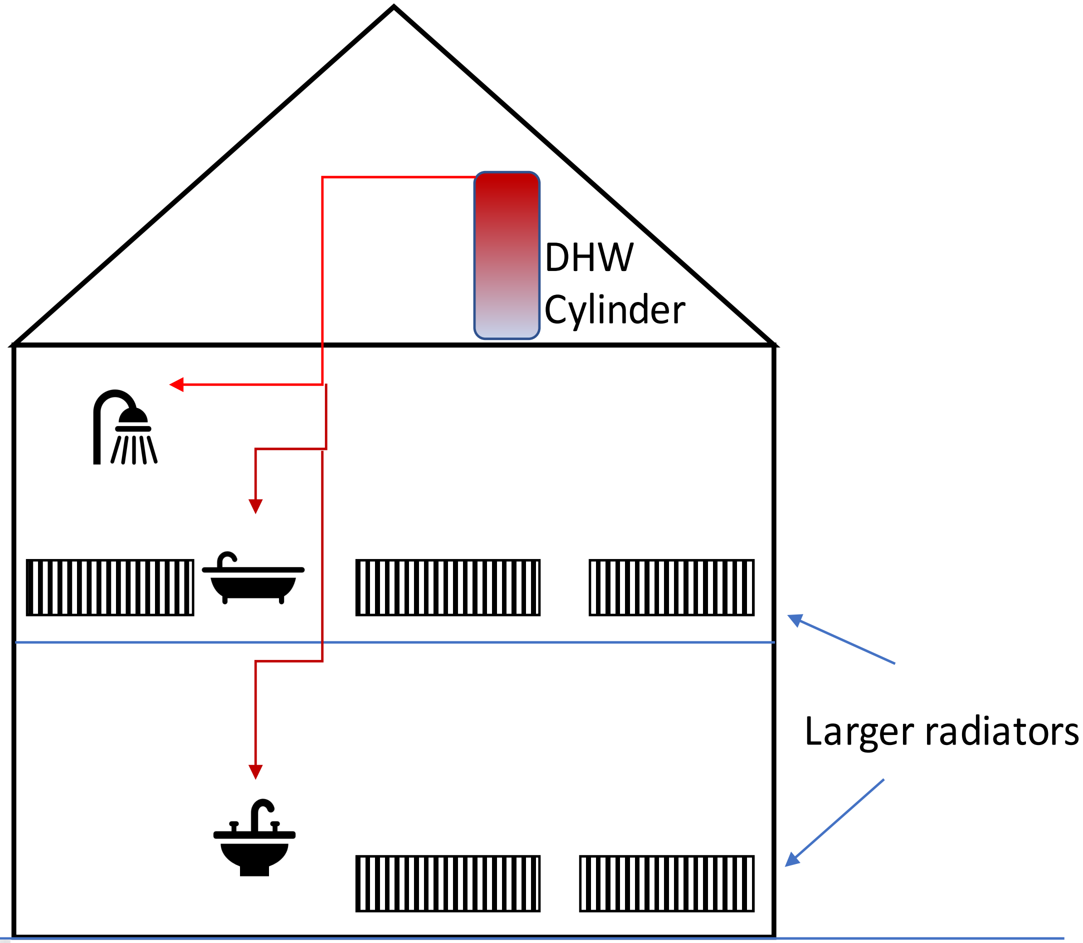
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – GSHP

Ground source heat pump
Tank = None
Fuel = Electricity



CAPEX cost per house type		Low		High
Terraced house		£12,100		£21,295
Semi-detached house		£12,100		£21,295
Detached house		£12,100		£21,295
Bungalow		£12,100		£21,295

Note: DNO issues need to be addressed.

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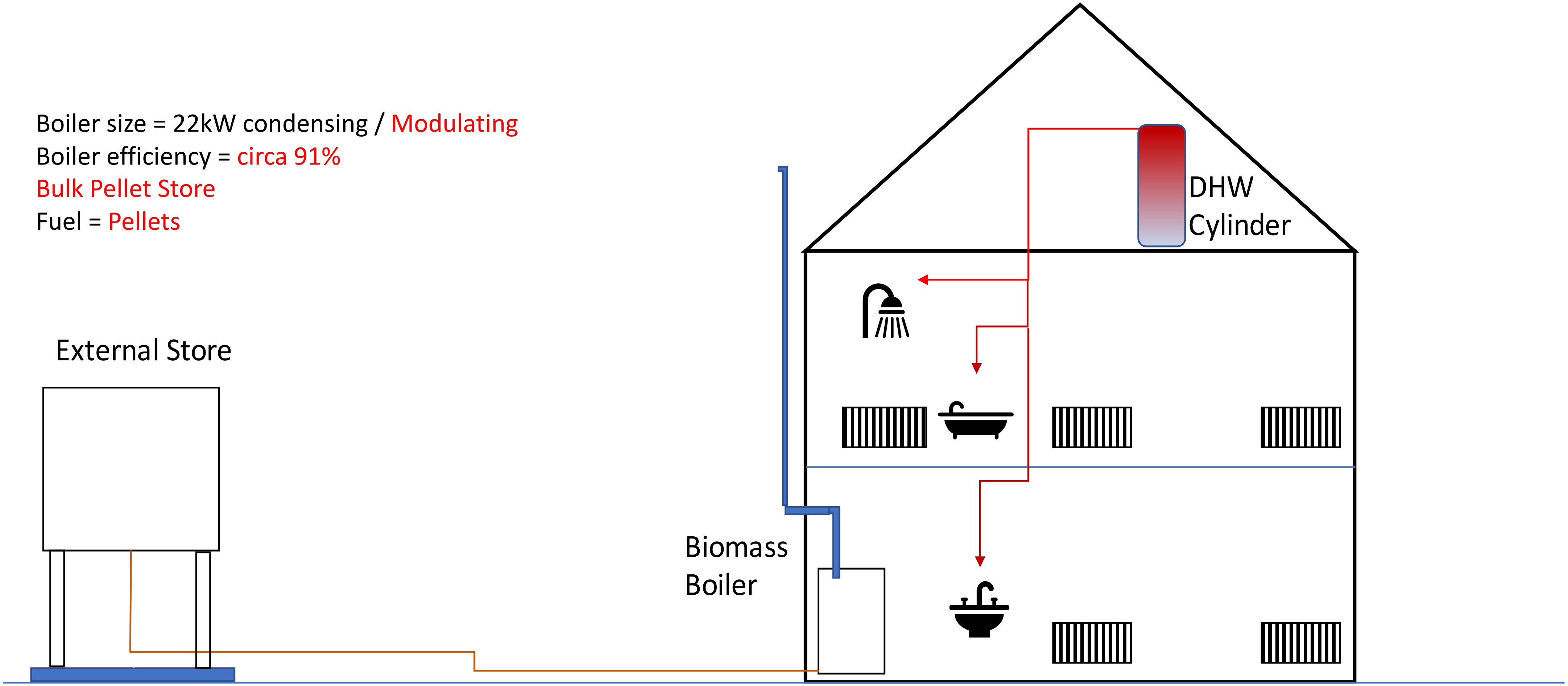
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – Biomass

Boiler size = 22kW condensing / Modulating
Boiler efficiency = circa 91%
Bulk Pellet Store
Fuel = Pellets



CAPEX cost per house type		Low		High
Terraced house		£10,100		£18,295
Semi-detached house		£10,100		£18,295
Detached house		£10,100		£18,295
Bungalow		£10,100		£18,295

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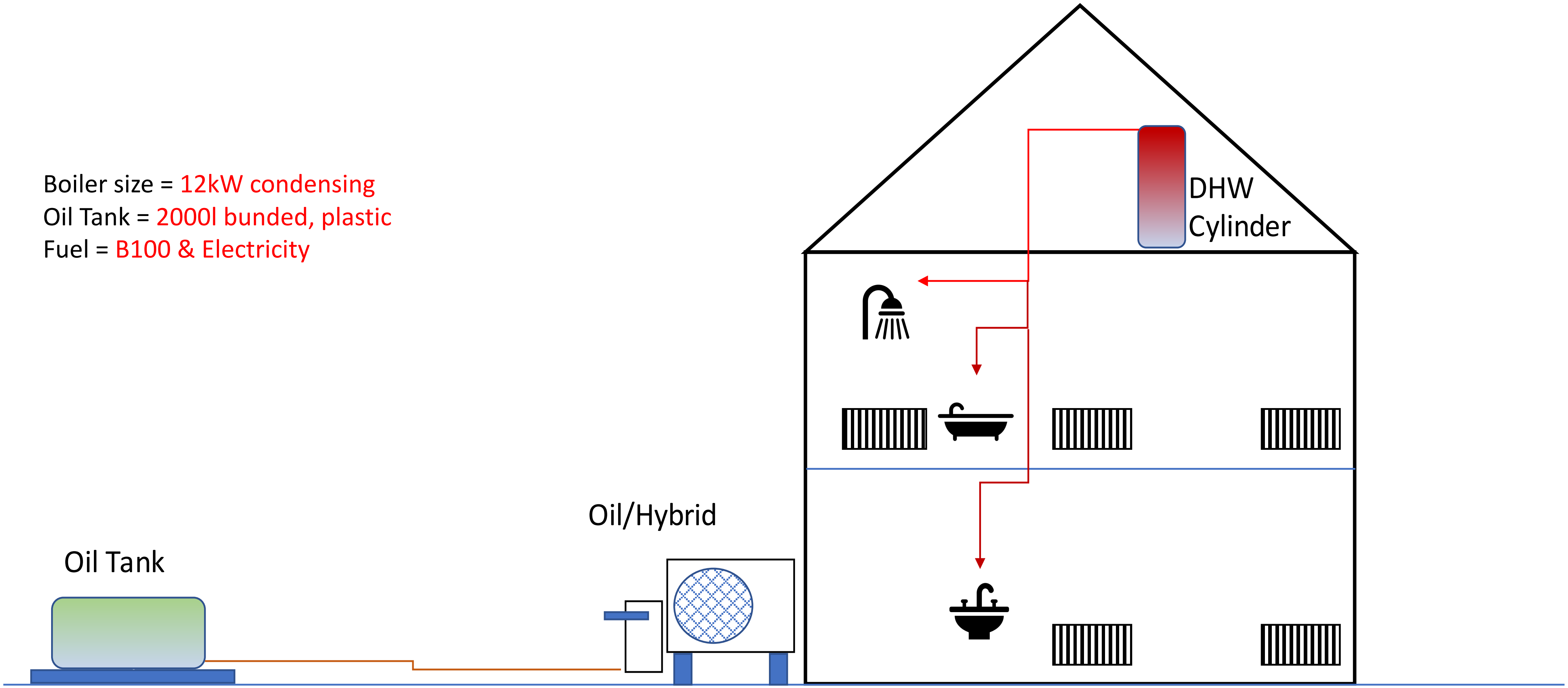
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – Hybrid

Boiler size = 12kW condensing
Oil Tank = 2000l bunded, plastic
Fuel = B100 & Electricity



CAPEX cost per house type		Low		High
Terraced house		£12,350		£13,845
Semi-detached house		£12,700		£14,295
Detached house		£13,300		£14,995
Bungalow		£12,600		£14,195

Note: DNO issues need to be addressed.

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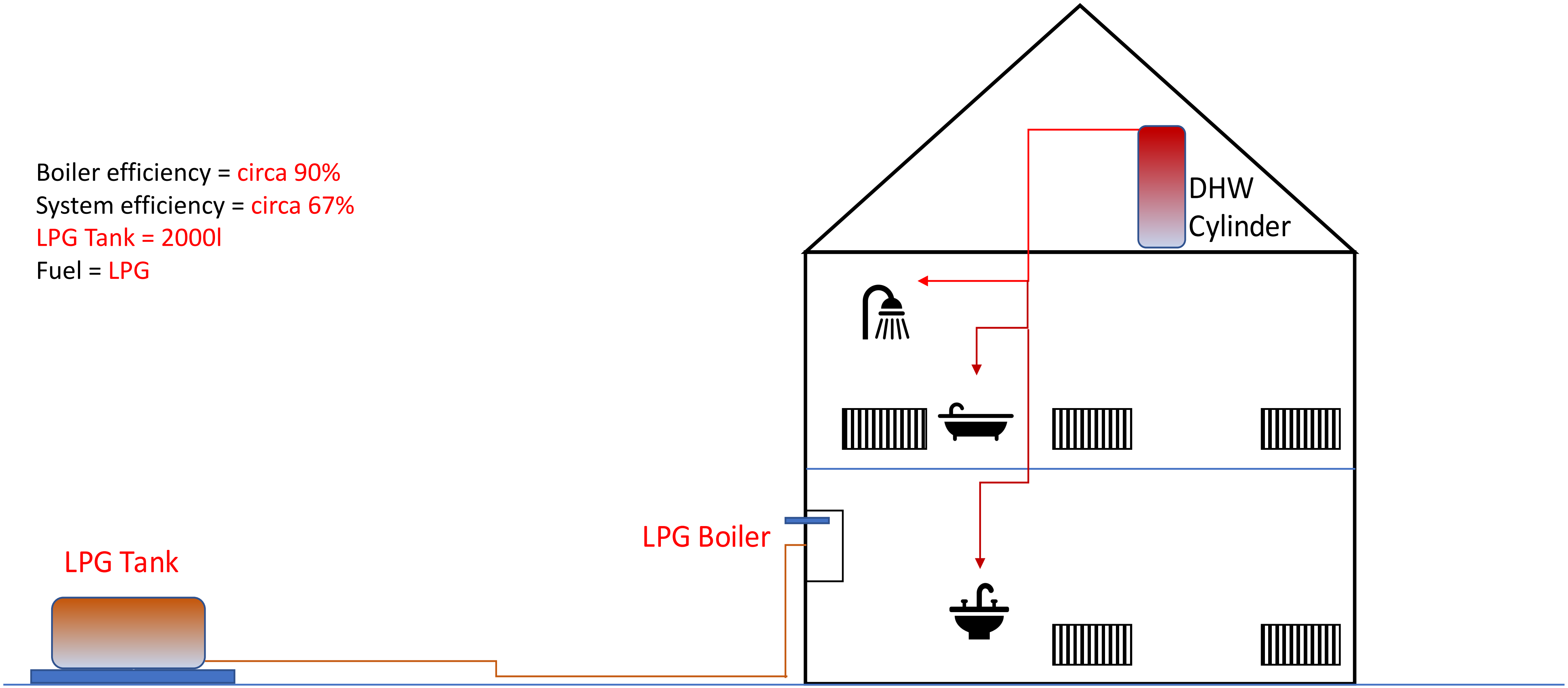
Reasonable improvements to fabric and heating system installed in pre 1919 detached property – LPG

Boiler efficiency = circa 90%
System efficiency = circa 67%
LPG Tank = 2000l
Fuel = LPG



CAPEX cost per house type		Low		High
Terraced house		£3,700		£6,795
Semi-detached house		£3,800		£8,295
Detached house		£3,800		£10,295
Bungalow		£3,800		£9,295

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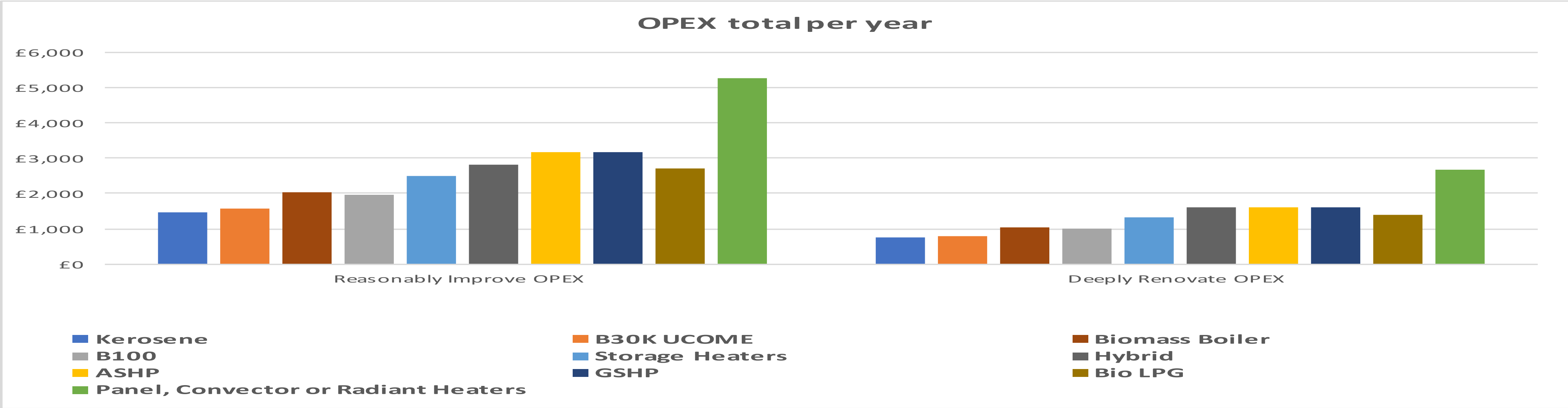
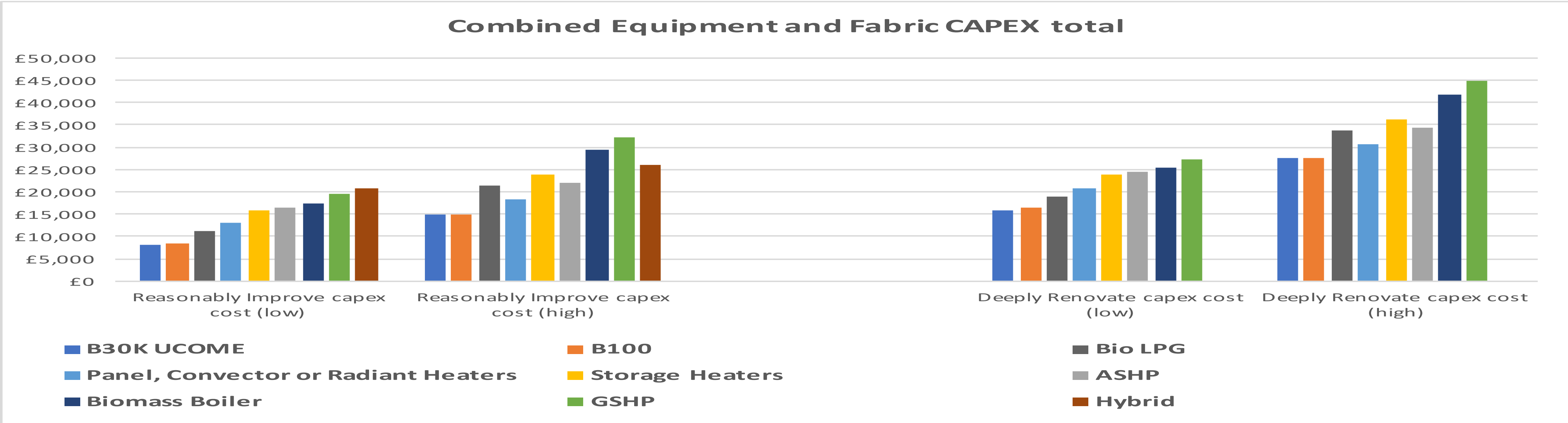
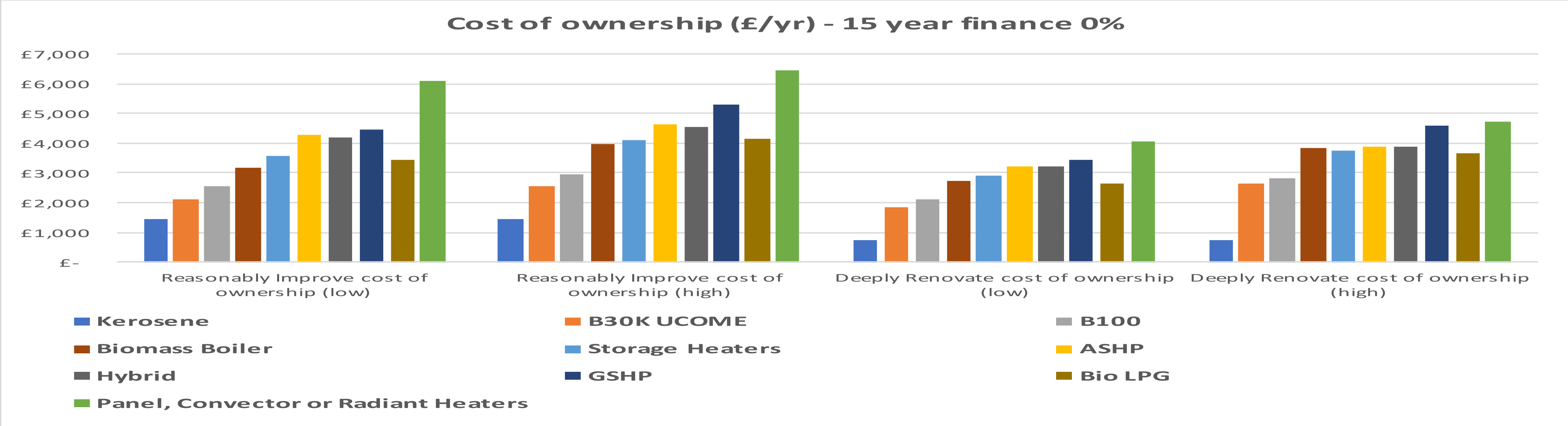
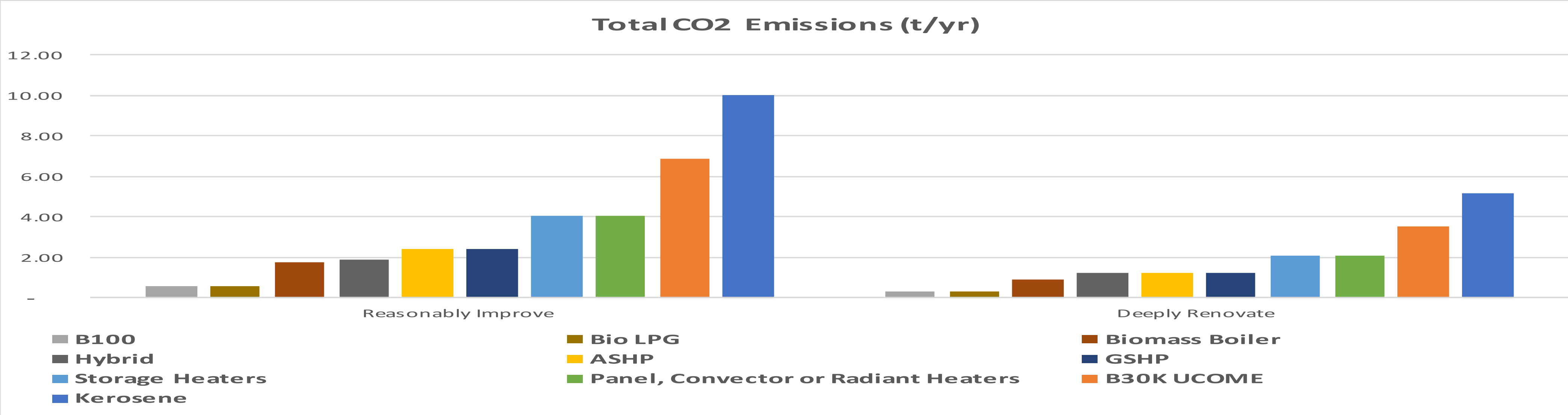
Detached pre 1919 home per technology (England):



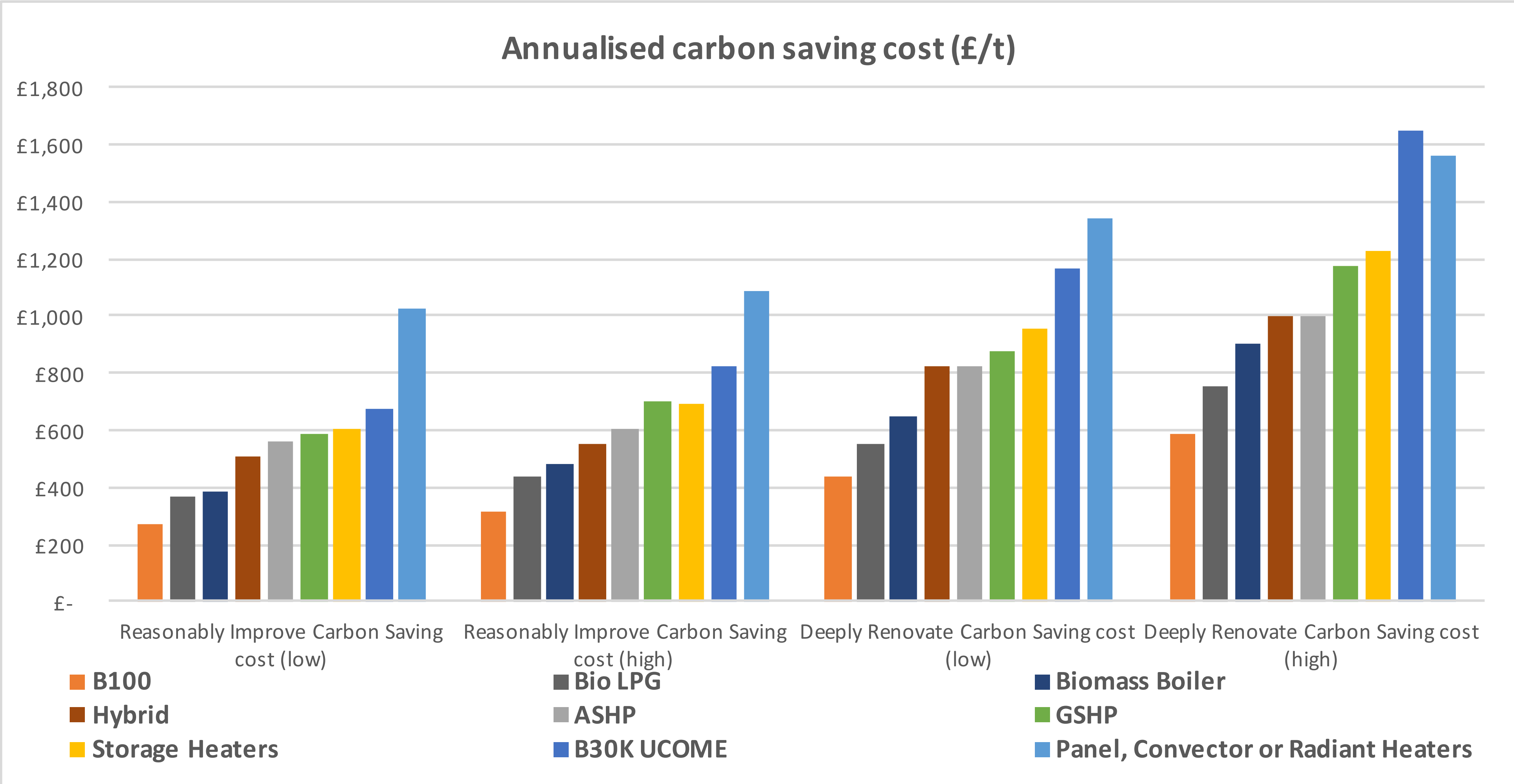


Detached pre 1919 home per technology (England):





Detached pre 1919 home per technology (England):



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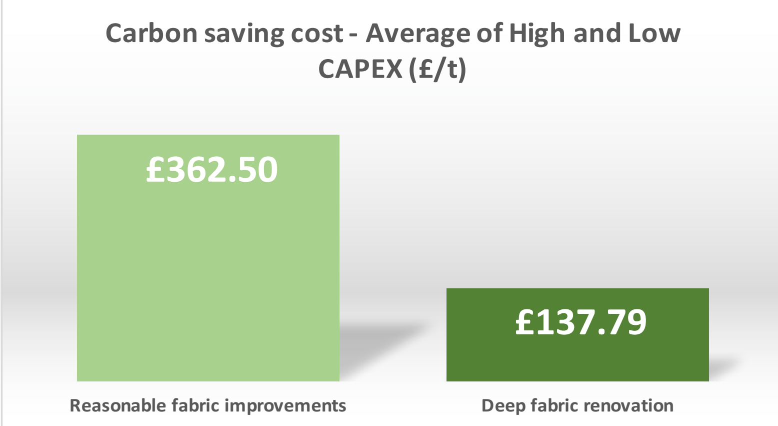
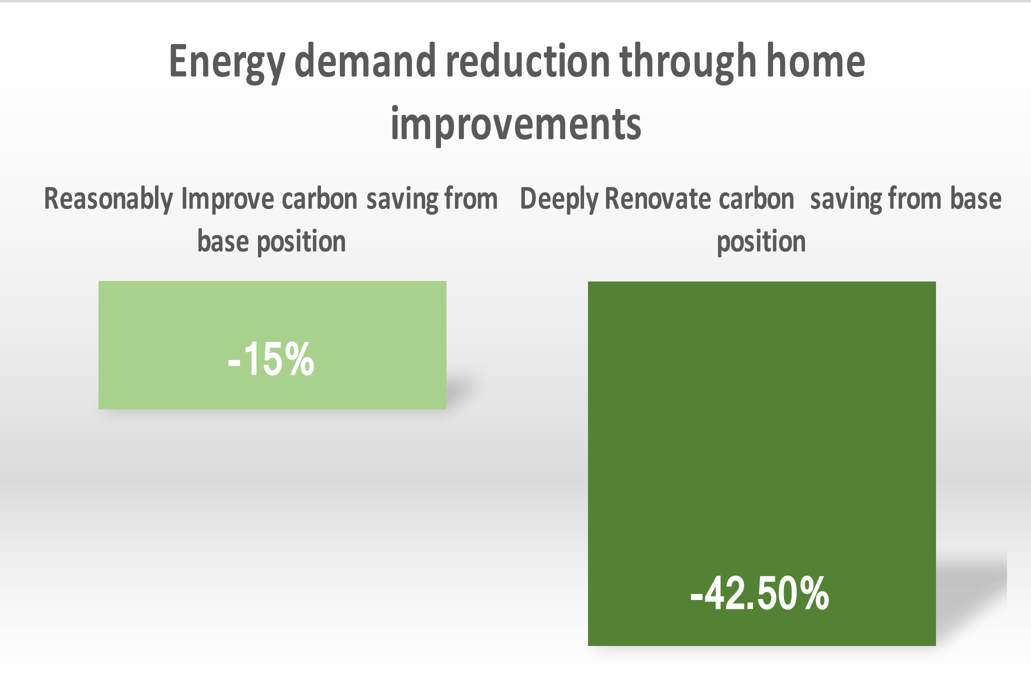
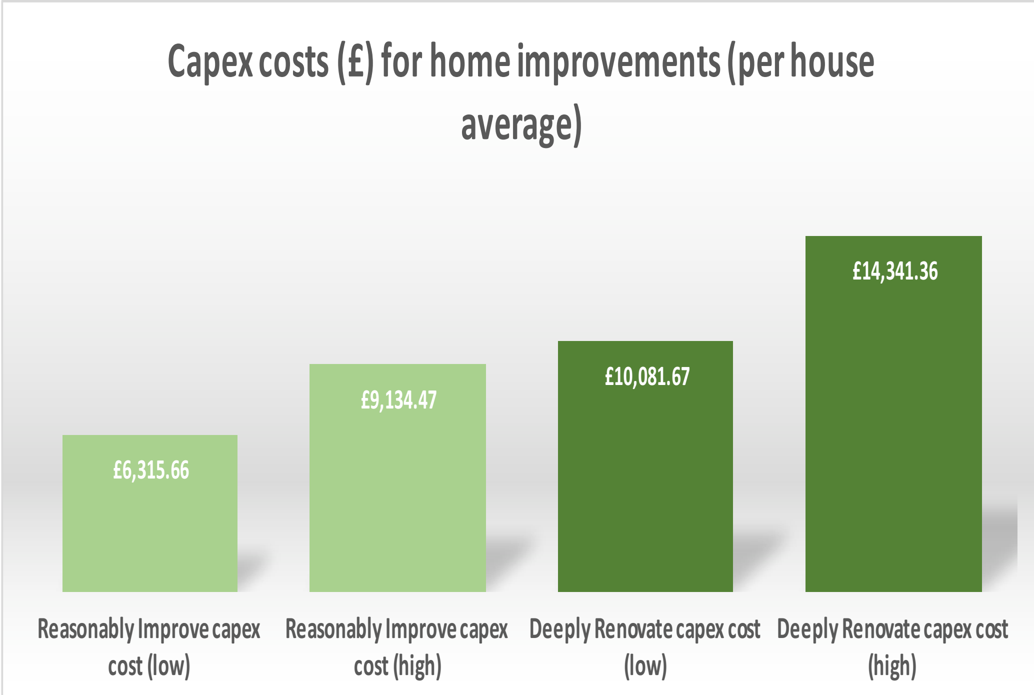
Energy Efficiency and Optimisation (England):

Estimated number of potential building energy efficiency improvements

	Reasonable < 5 days					Deep > 5 days	
Group	**First-time loft insulation**	**Loft insulation top-up**	**First-time double glazing**	**Double glazing upgrade**	**Cavity wall insulation**	**Solid wall insulation**	**Floor insulation**
Terraced house	18,370	87,835	20,370	85,835	10,050	85,100	101,850
Semi-detached house	29,130	153,380	34,630	147,880	40,590	105,500	173,150
Detached house	56,220	384,465	73,460	367,225	76,020	240,600	367,300
Bungalow	14,190	146,590	25,590	129,820	64,830	28,250	136,300
Total	117,910	772,270	154,050	730,760	191,490	459,450	778,600







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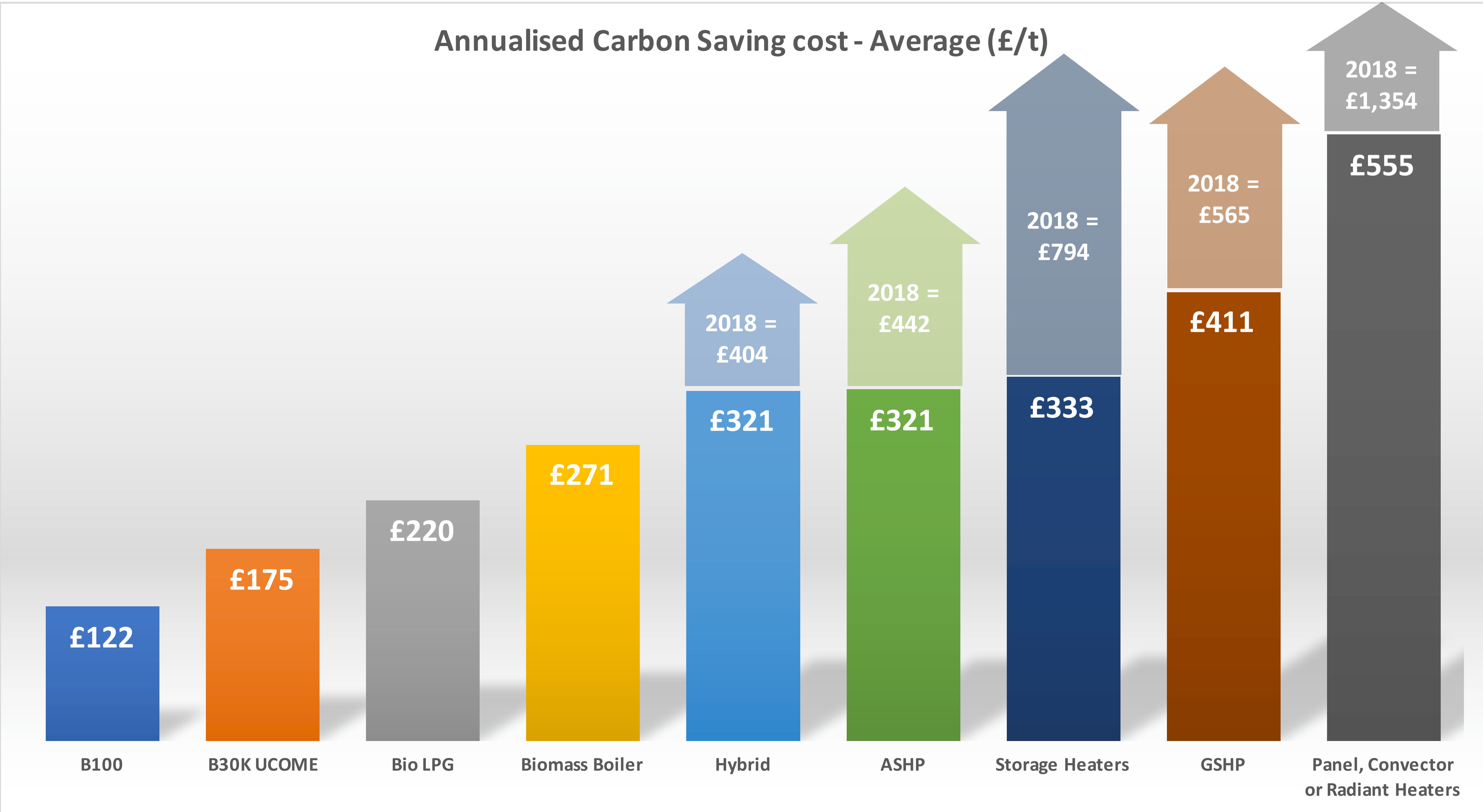
Carbon saving costs (average) per technology (England):



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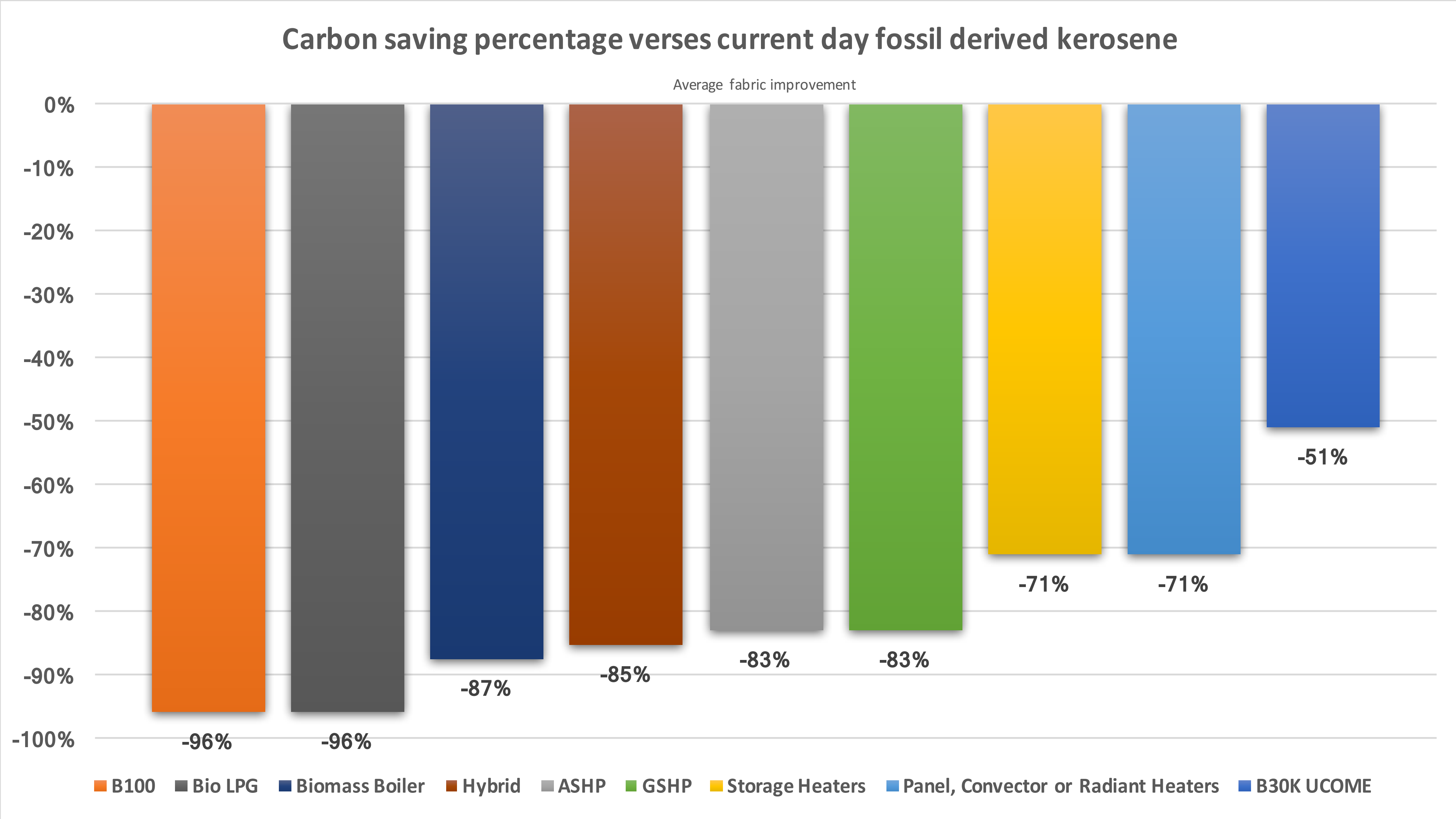
Carbon saving percentage (England):



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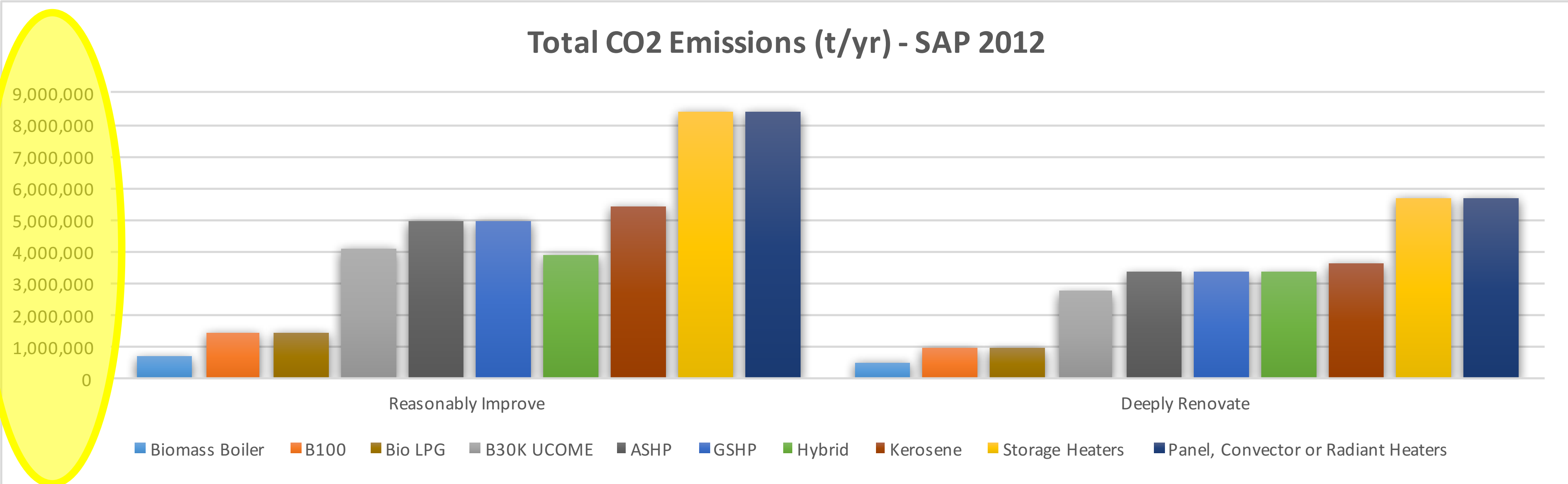
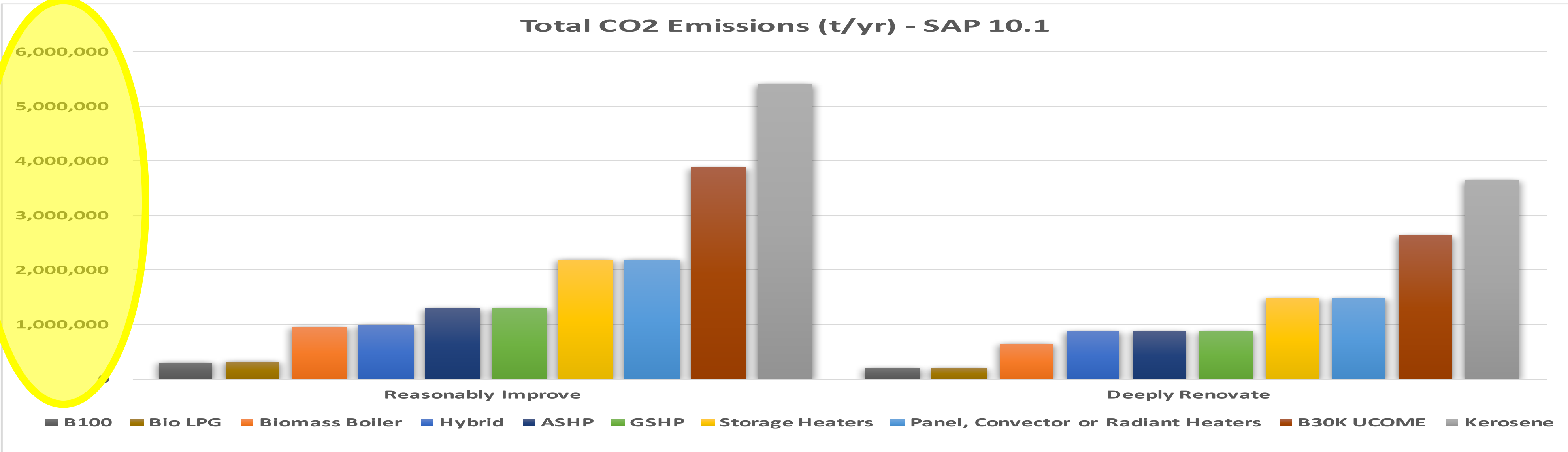
CO_2 Emissions per technology (England):





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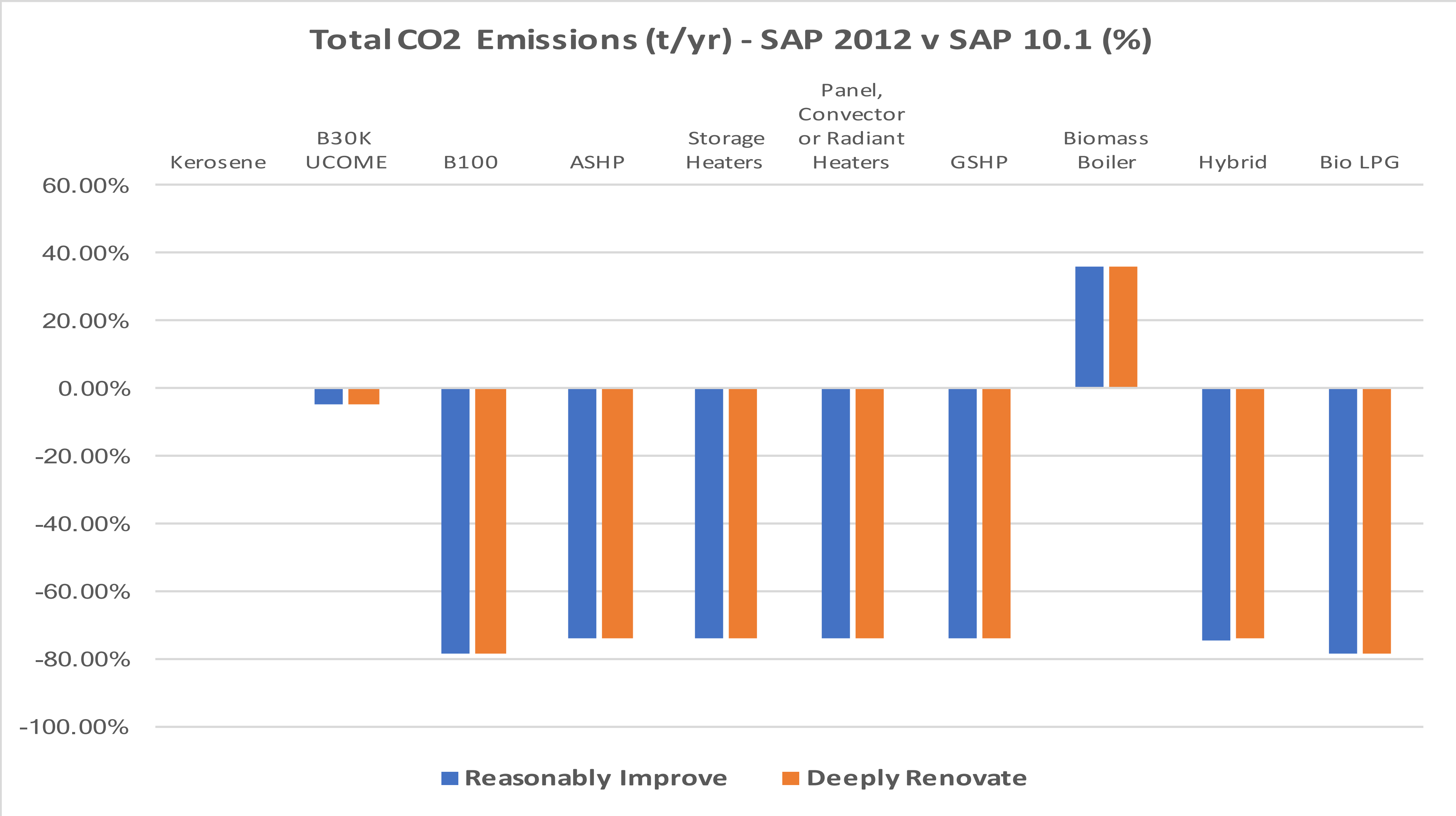
CO2 Emissions per technology (England):



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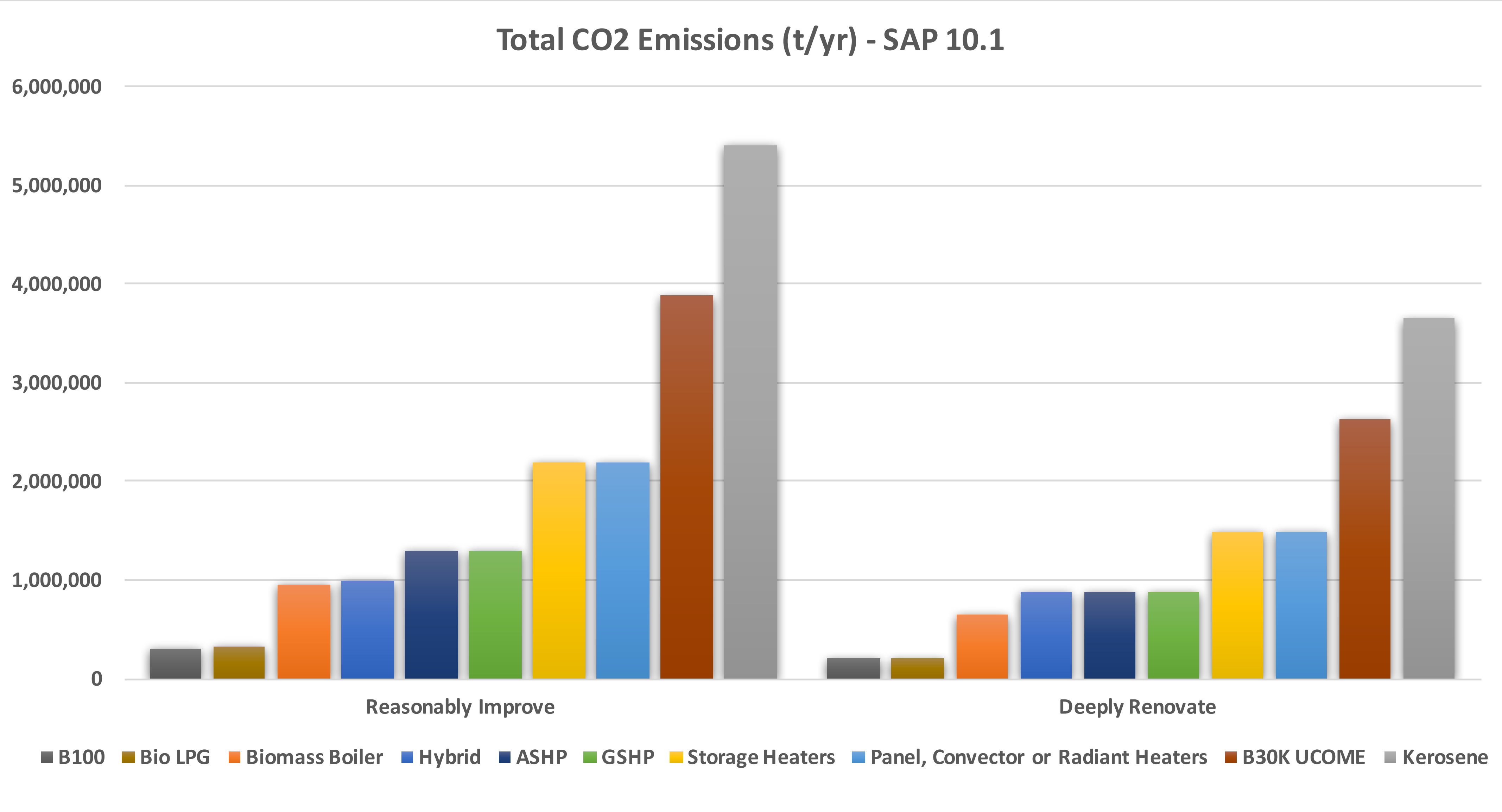
CO2 Emissions per technology (England):



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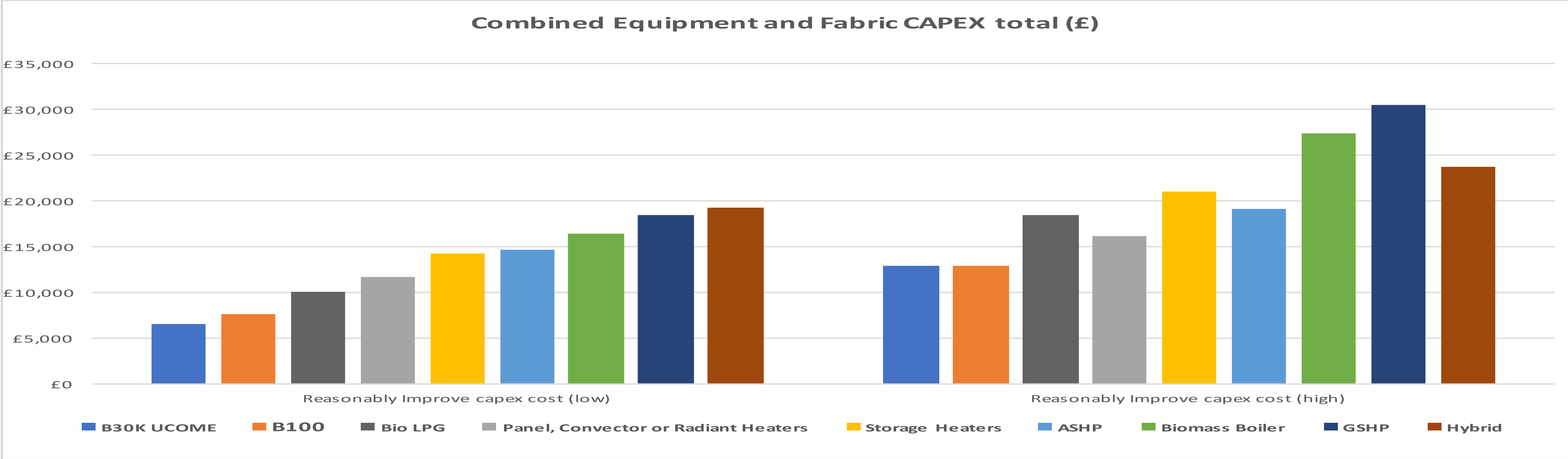
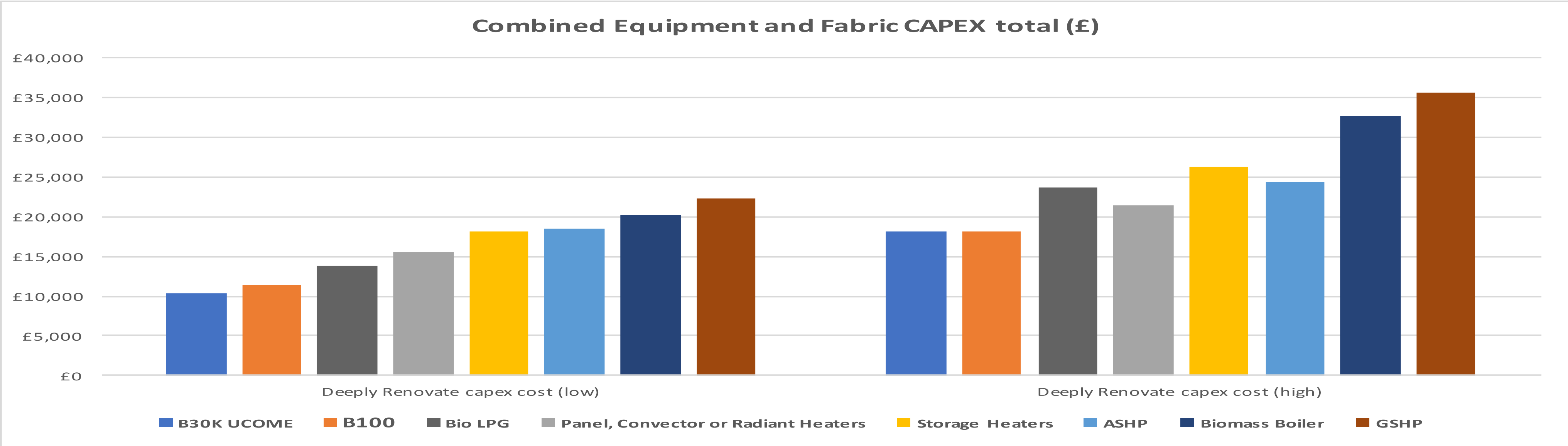
CAPEX per technology (England):





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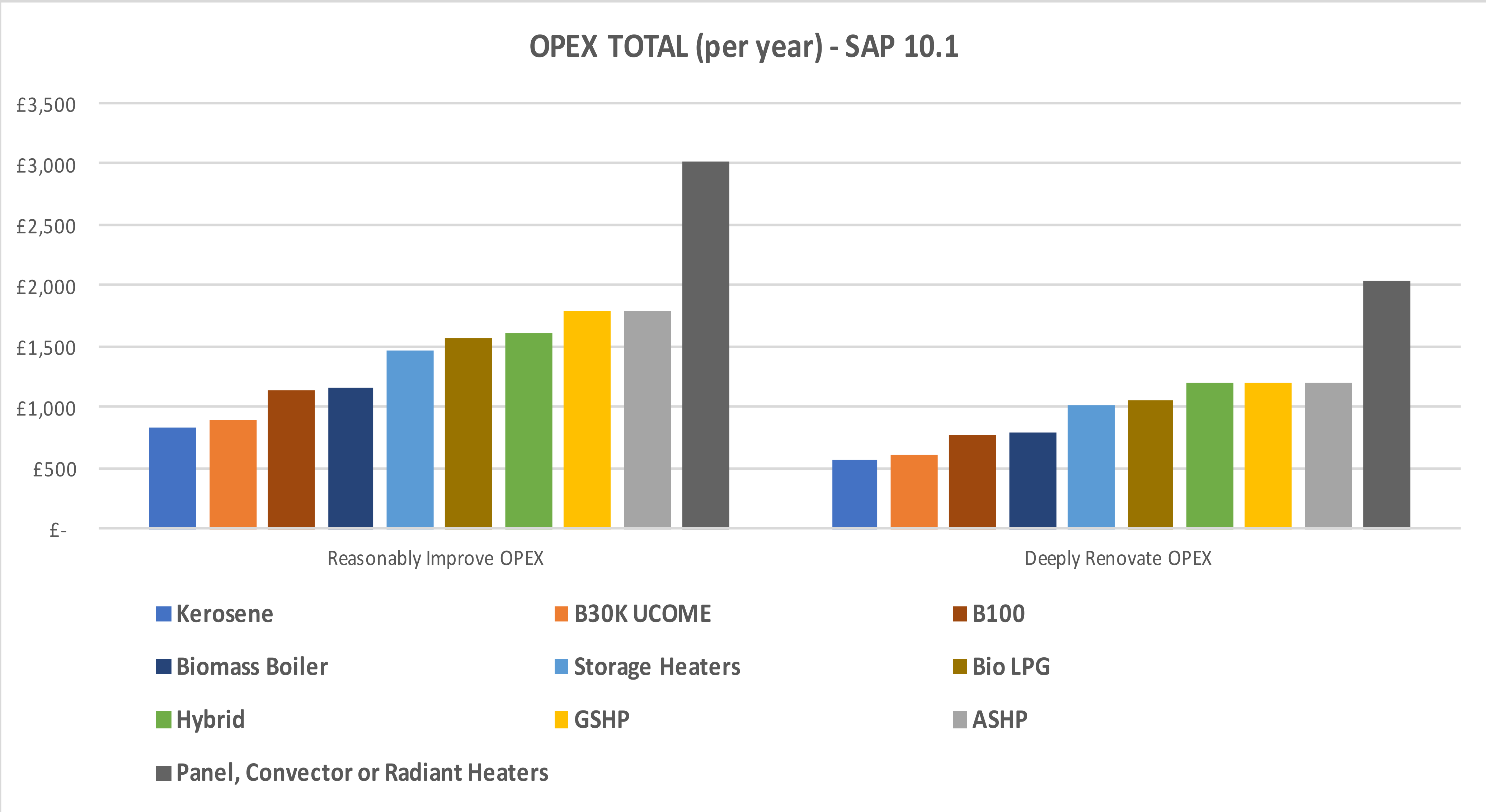
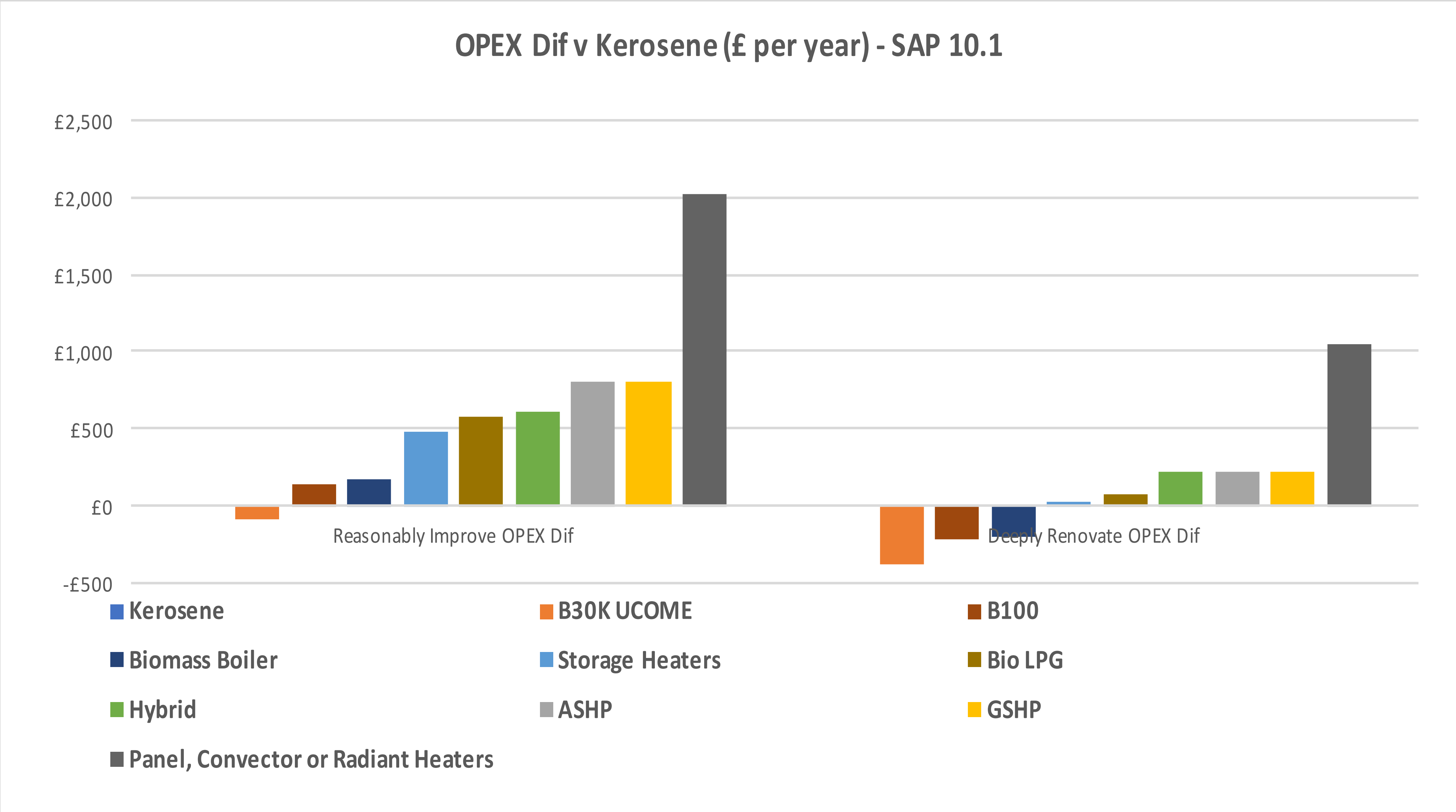
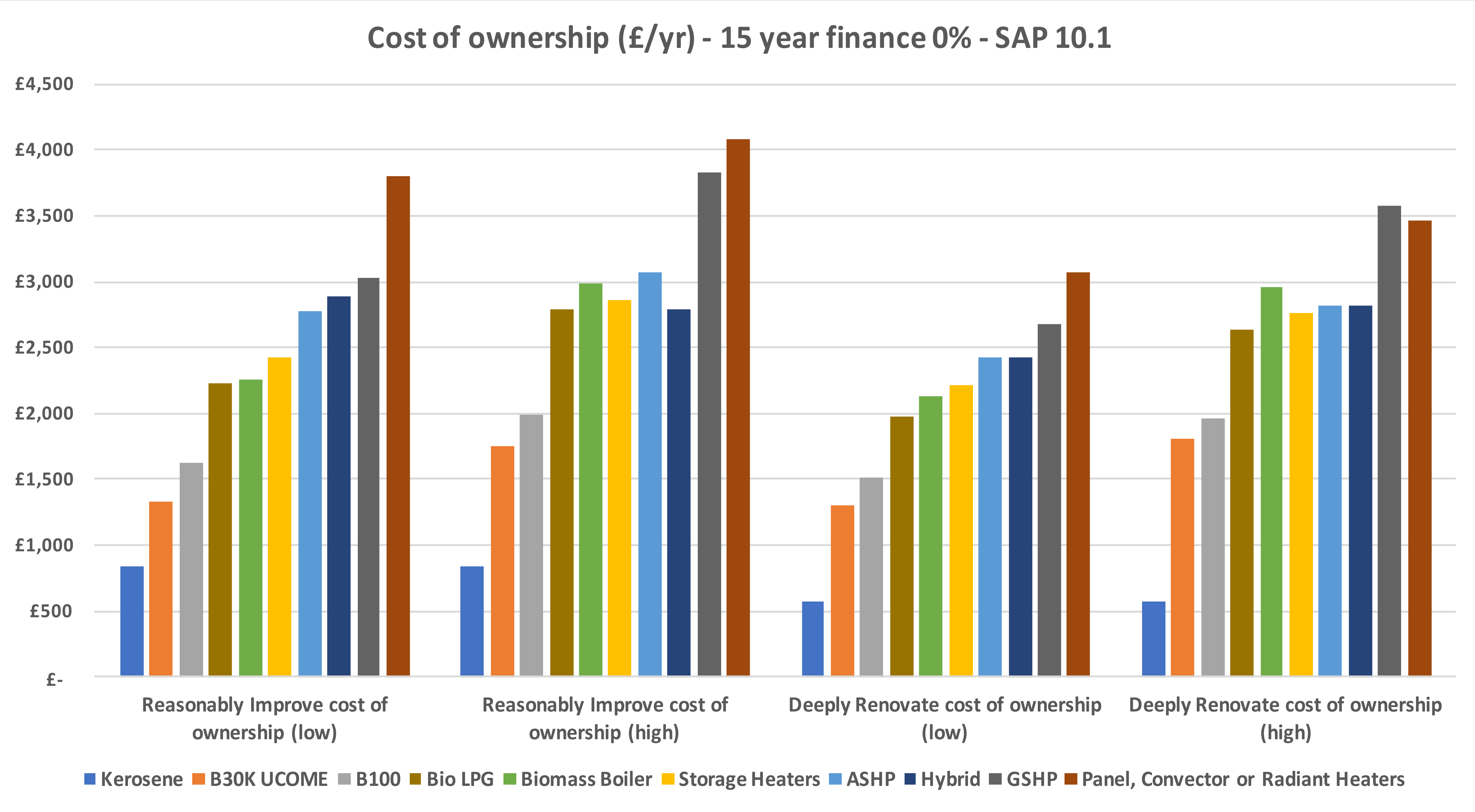
OPEX per technology (England):



OPEX v Kerosene per technology (England):



Cost of ownership per technology (England):



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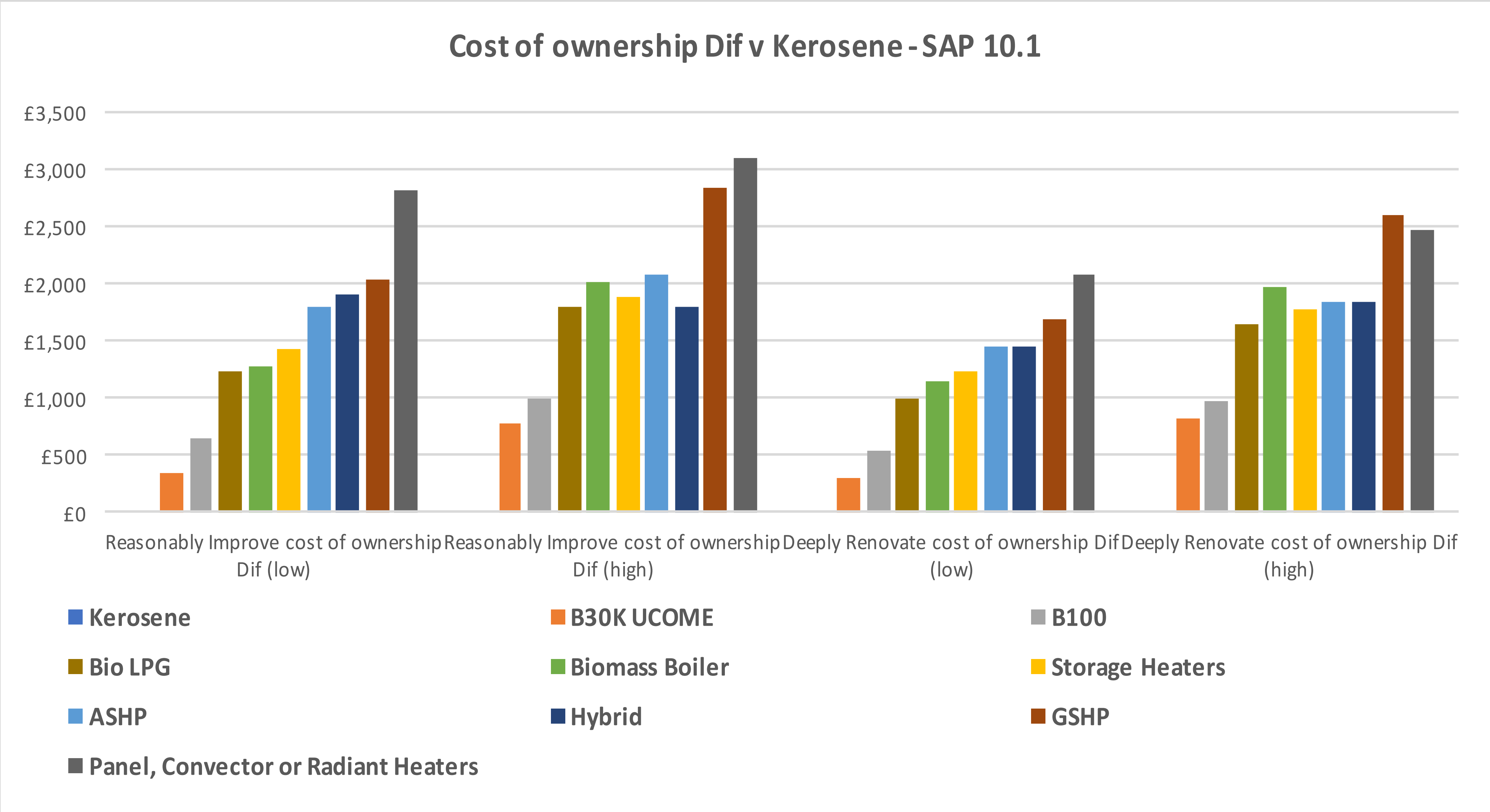
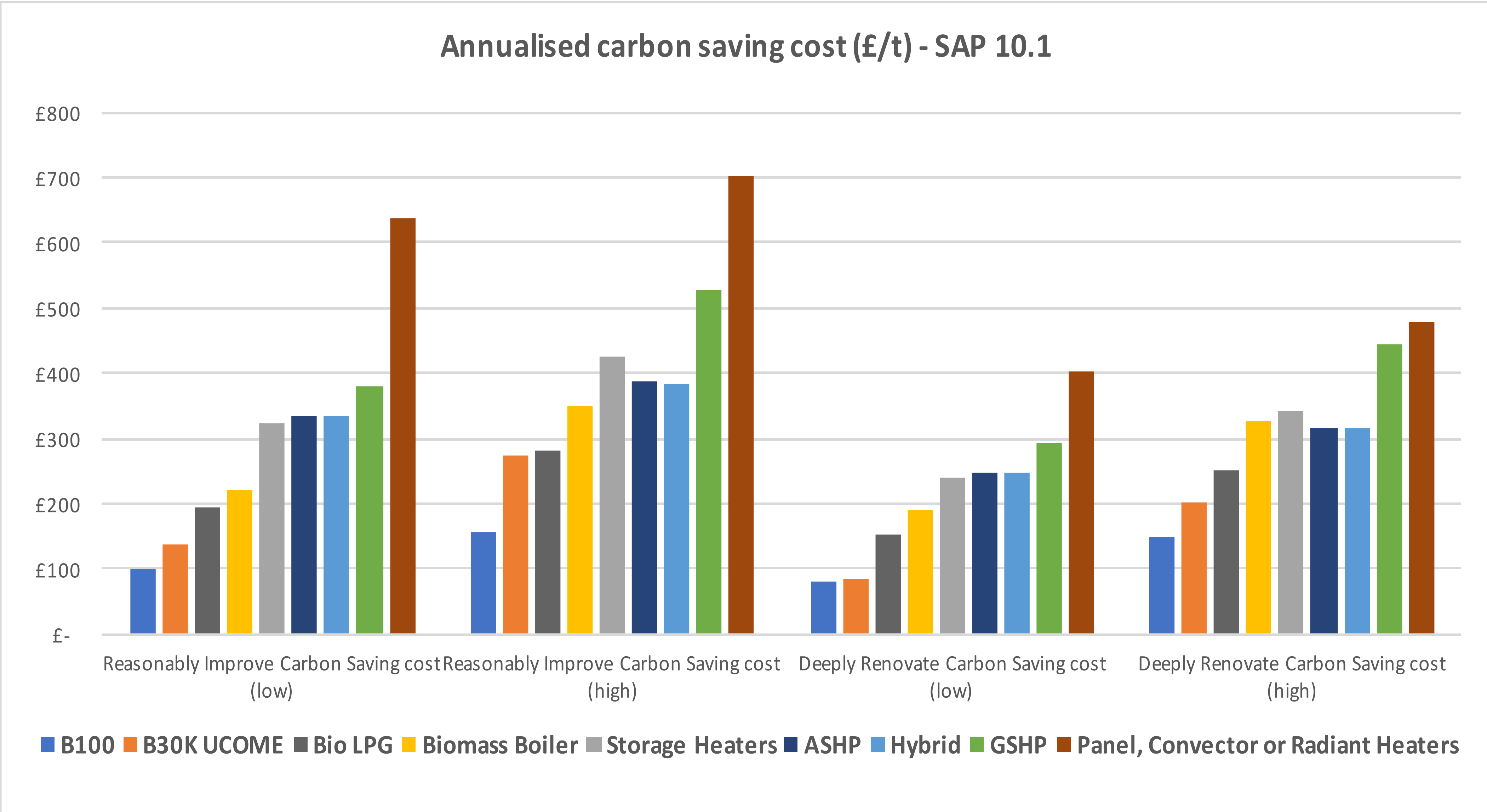
Cost of ownership per technology (England):



Carbon saving costs per technology (England):



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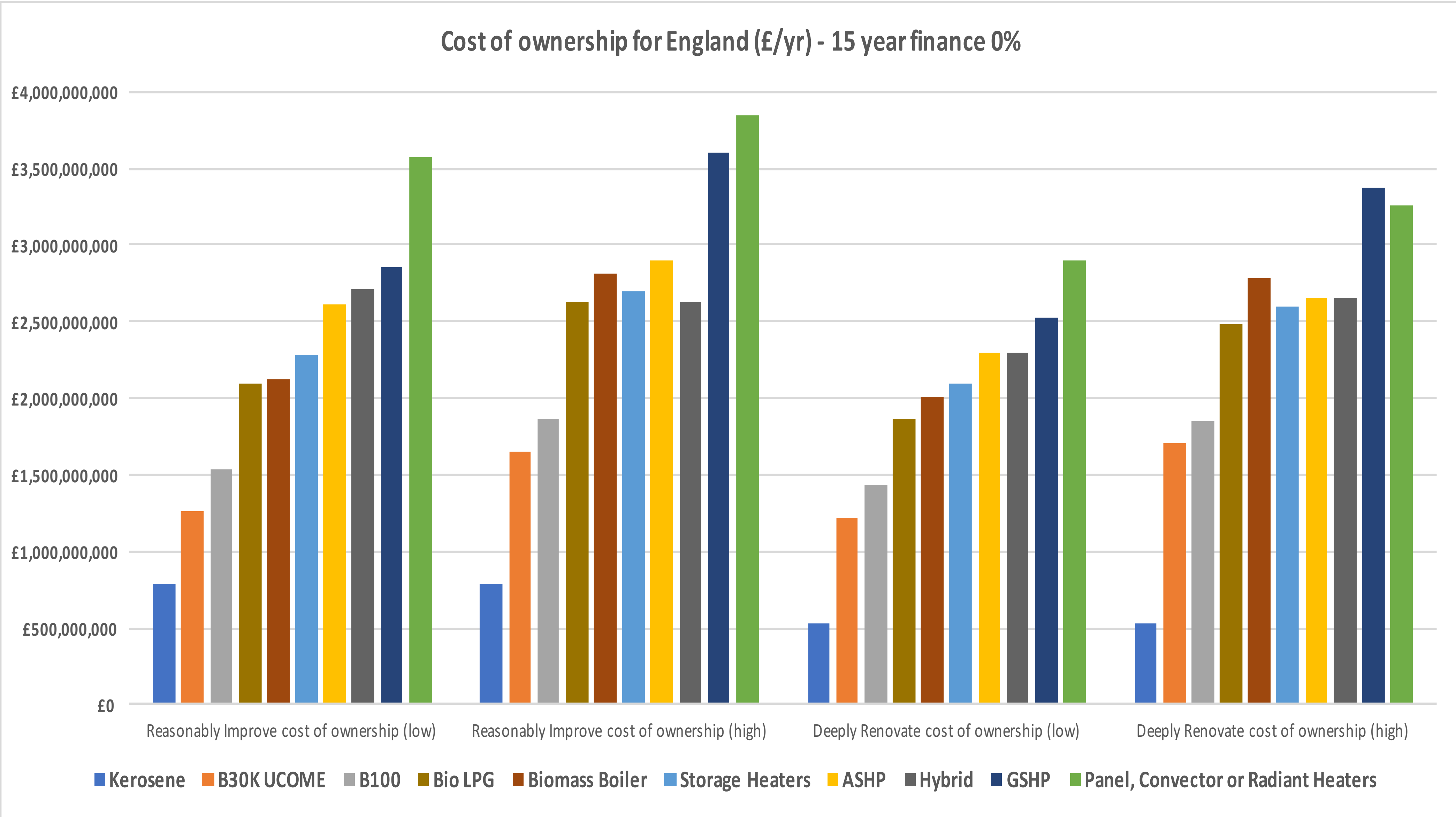
Costs per technology (England):



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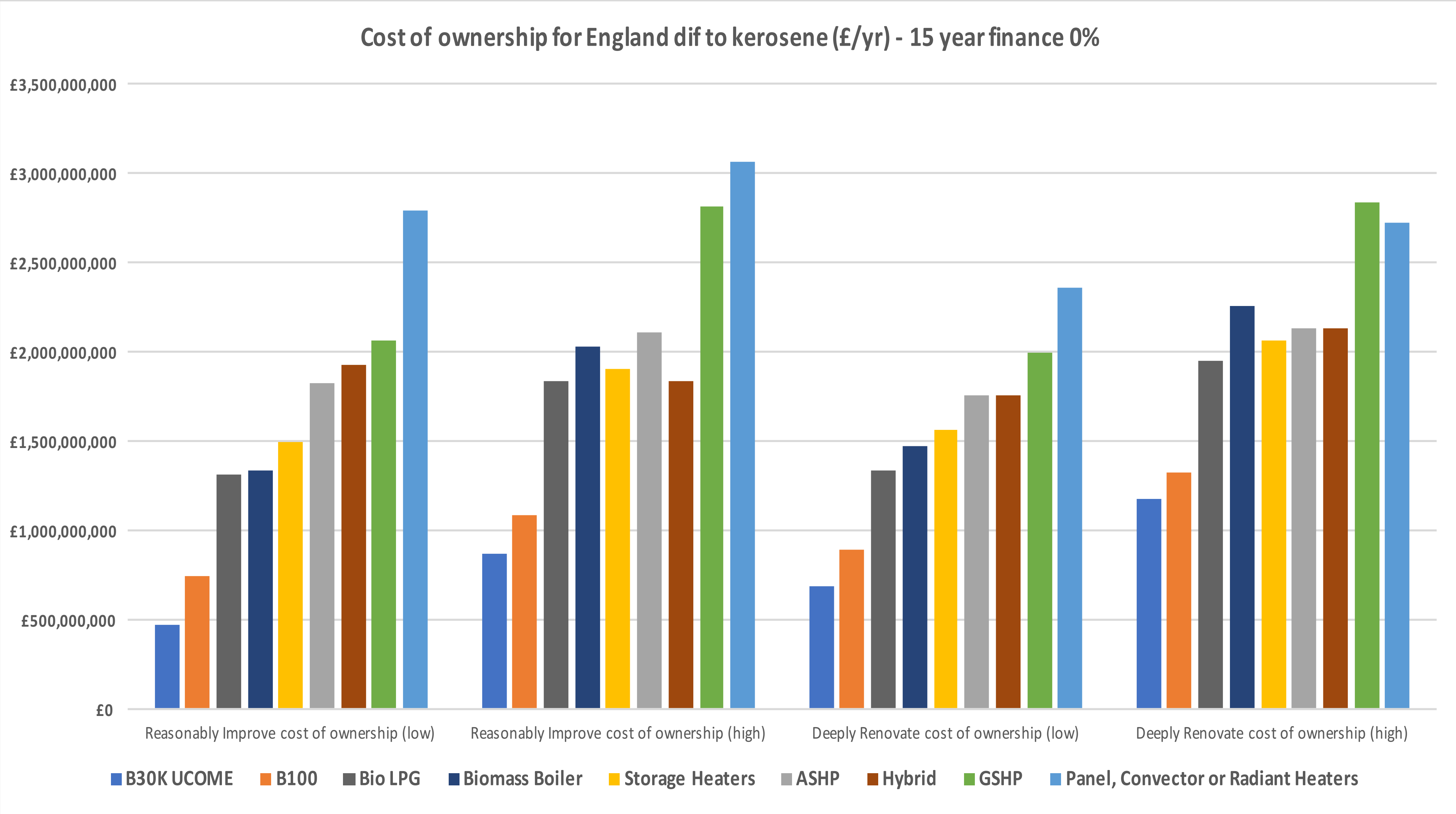

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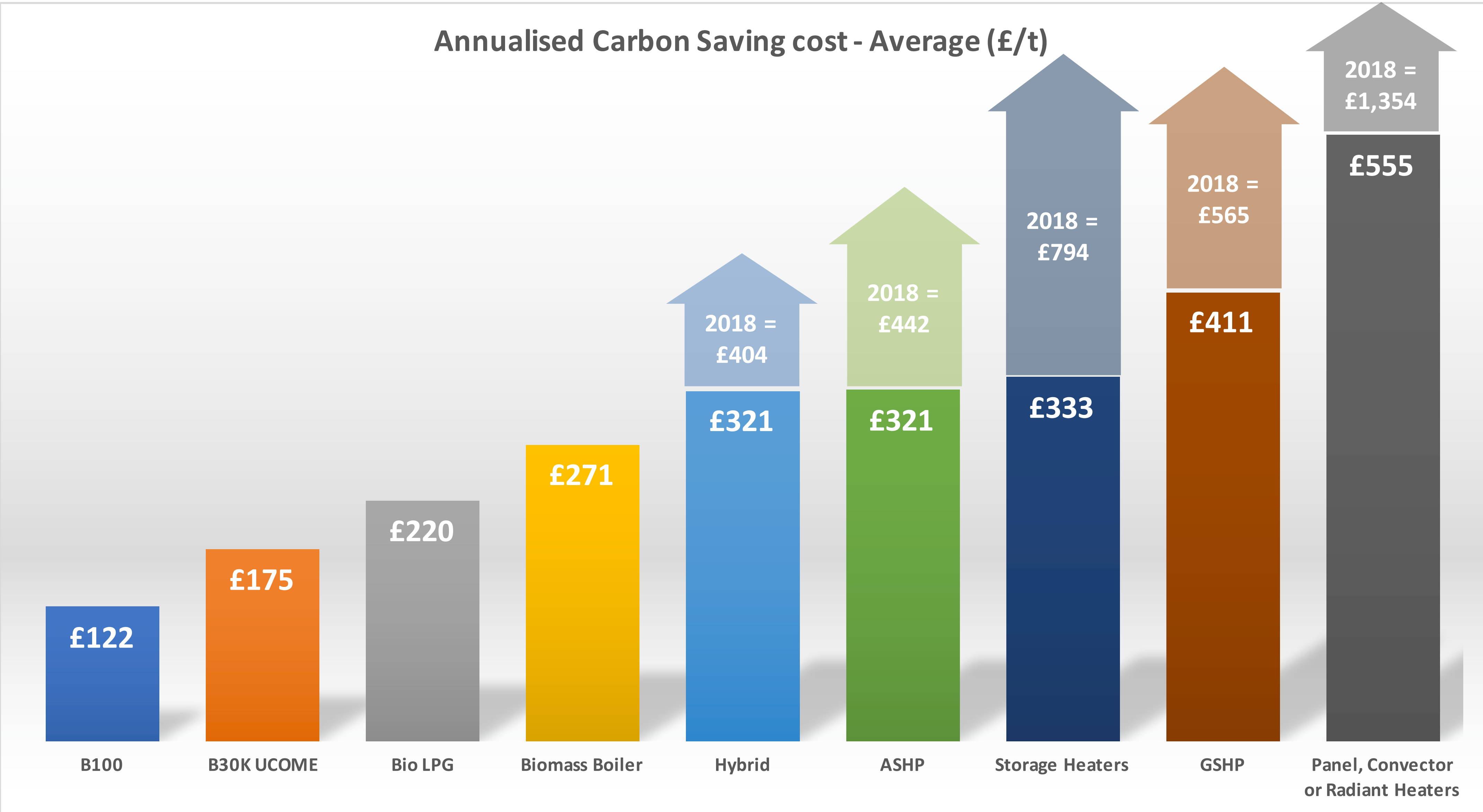
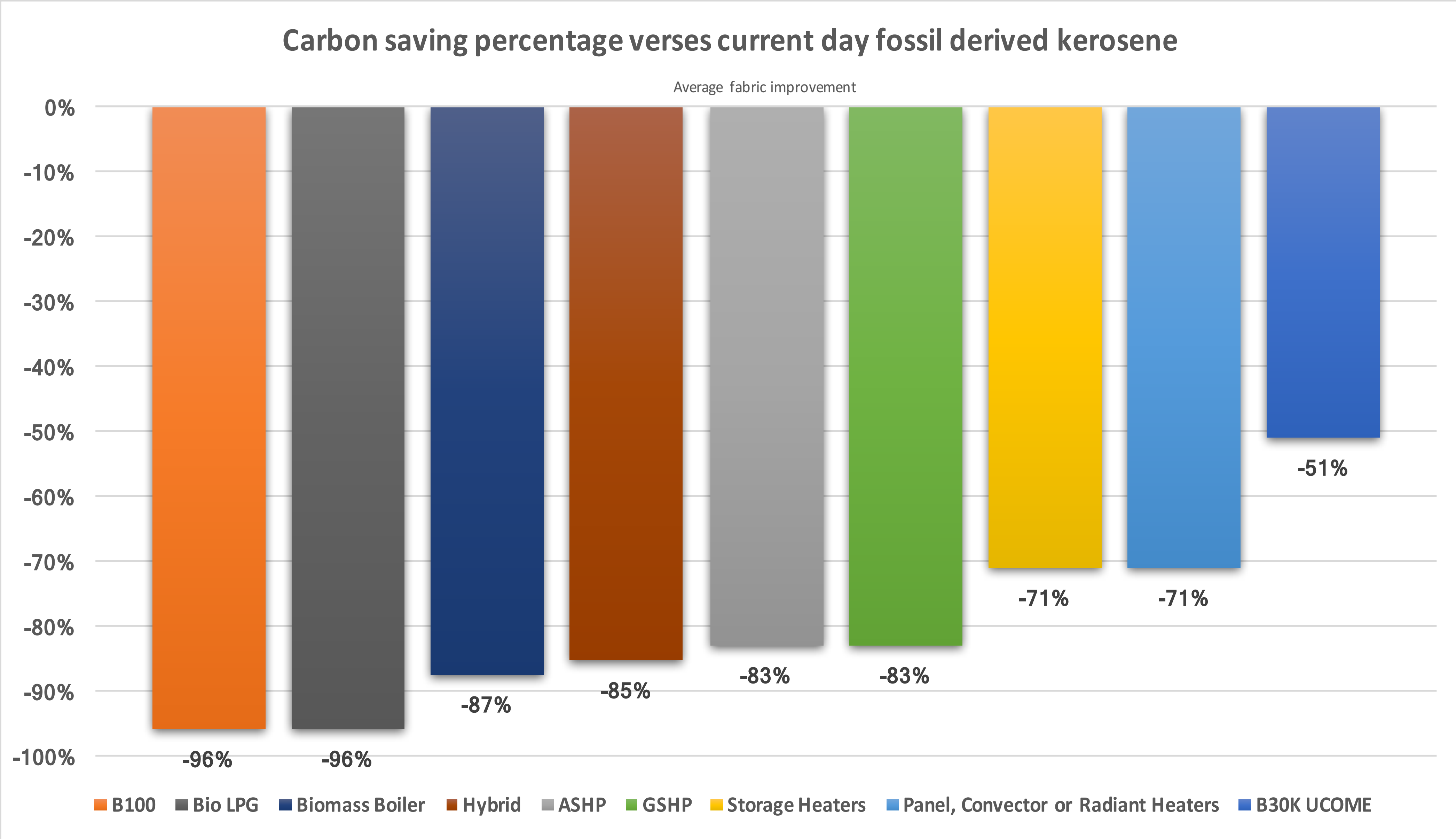


Carbon saving percentage (England):



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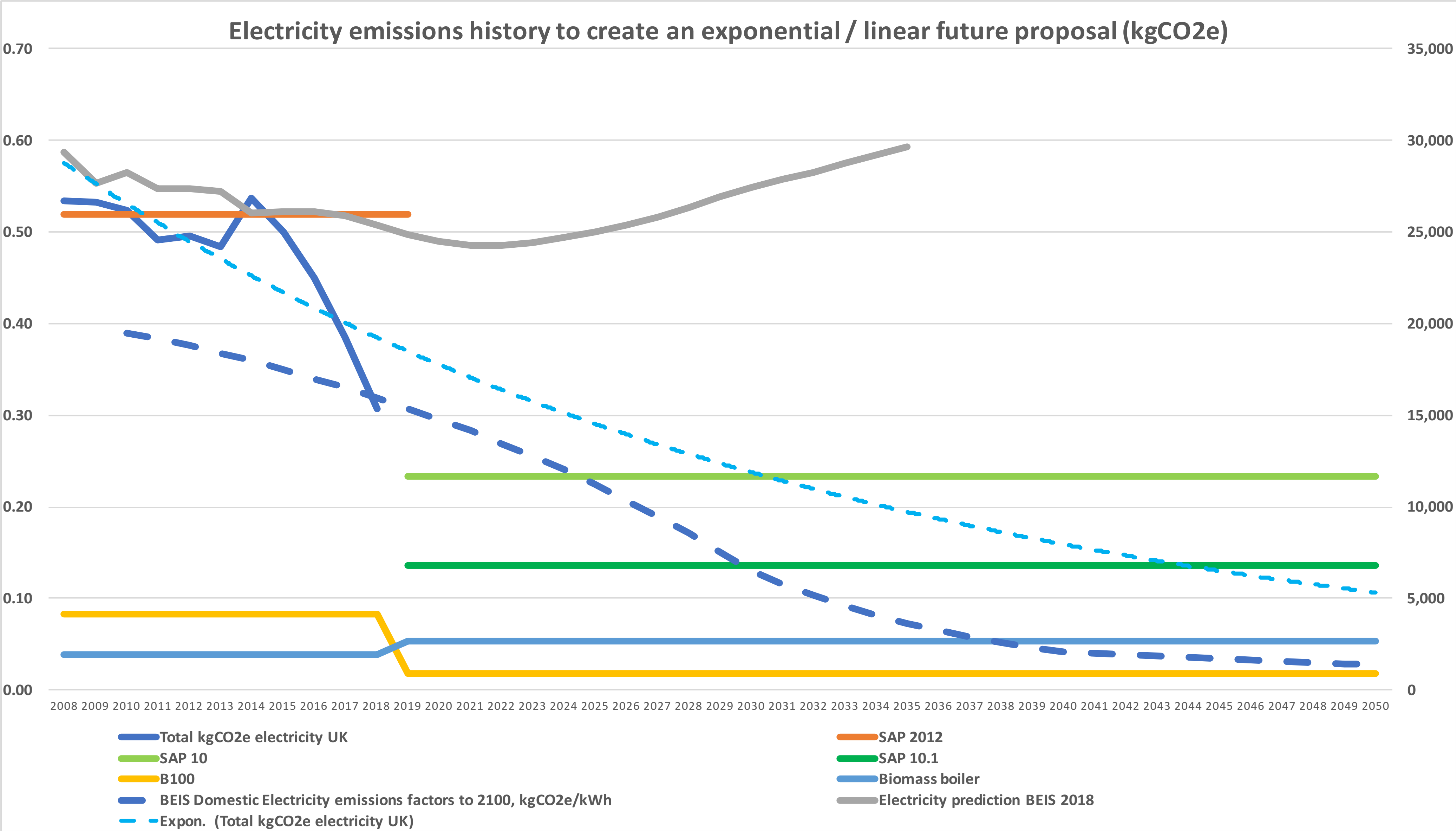
Sensitivities



UK Governments Current Policy Approach:

Decisive Near – Term Action

Targeted policies with near-term benefits, while supporting long-term options.

e.g. Heat Networks, Renewable Heat Incentive, Future Frame-work for Heat in Buildings, Buildings Mission

Energy Efficiency and Optimisation

Lower demand reduces emissions and fuel costs.

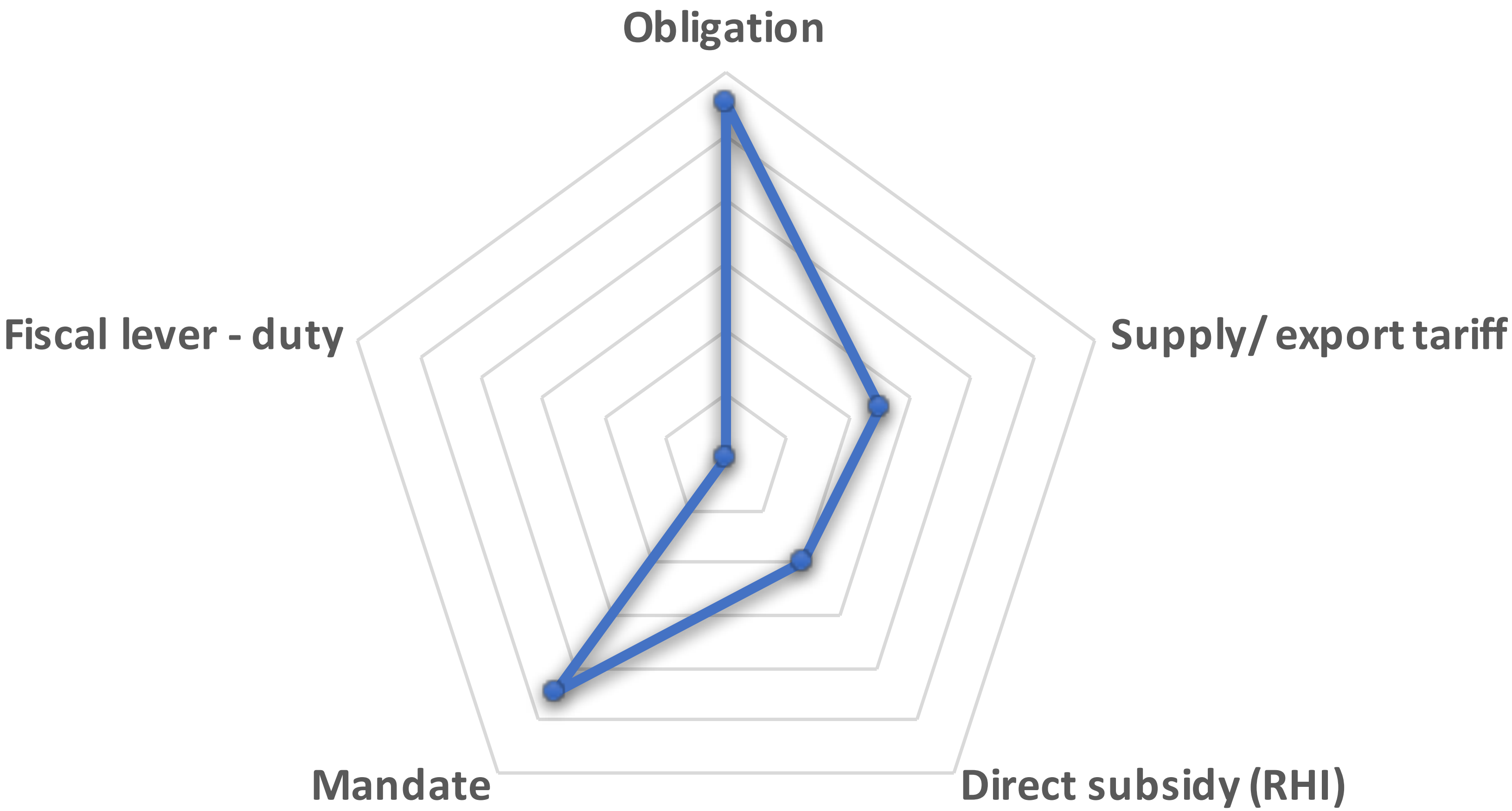
We are supporting e.g. smarter systems, more efficient buildings, increased heat recovery in industry

Development of Long Term Options

Decarbonising heat by 2050 will require a transformational change. Working with stakeholders to build the evidence base and identify the right solutions

Theresa May: "moral duty to leave this world in a better condition than we inherited"
2050 target reduced to zero carbon from 80% reduction.
UK government already missing its carbon targets.

Policy options



Policy impact	Upside - risk

Policy	BEIS	DfT	Ministers	MP's	Investors	Civil Society	Media	OFTEC	FPS	UKP	TSA	Home owner	Totals
Obligation	1	-1	1	0	0	1	0	1	1	1	1	-1	5
Supply/ export tariff	0	-1	-1	0	0	0	0	1	0	0	1	-1	-1
Direct subsidy (RHI)	-1	-1	-1	-1	1	1	-1	-1	1	1	1	-1	-2
Mandate	1	-1	1	-1	1	1	-1	1	1	-1	1	0	3
Fiscal lever - duty	-1	-1	-1	-1	0	0	-1	-1	0	0	1	-1	-6

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Committee on Climate Change

Biomass in a low-carbon economy

Biomass is a broad term covering all organic carbon-based materials including plants and animals. We use it here to refer to forests, crops grown for energy (e.g. willow and miscanthus) and organic wastes (e.g. food waste, agricultural residues and sewage).

How can biomass be used effectively?

In the future, demand is likely to outstrip sustainable supply. Harvested biomass will be used most effectively where it *maximises* the removal and *minimises* the release of carbon into the atmosphere.

- More timber used in buildings — **up to ~3 $MtCO_2e/yr$ of carbon storage by 2050**
- No new subsidies for large-scale biomass to power plants unless with CCS*
- Use biomass to produce hydrogen, electricity or industrial products whilst sequestering carbon with CCS — **up to 65 $MtCO_2e/yr$ of UK emissions saved**
- Phase out biofuels in cars and vans in the 2030s
- Plan for up to 10% of aviation fuels as biofuel produced with CCS by 2050

Between now and 2050, the current uses of biomass in the UK need to change:

	Most effective use today	2020s and 2030s	By 2050
Bioeconomy	Wood in construction	Wood in construction, potentially other long-lived bio-based products (within circular economy)	
Buildings	Biomethane, local district heating schemes and some efficient biomass boilers in rural areas		Only very limited additional use for buildings heat: niche uses in e.g. district heat and hybrid heat pumps
Industry	Biomass use for processes with potential future BECCS** applications		BECCS in industry alongside other low-carbon solutions
Power	Ongoing use in power sector in line with existing commitments or small scale uses	Demonstration and roll out of BECCS to make H_2 and/or power	Biomass used for H_2 production or power with CCS
Transport	Liquid biofuels increasingly made from waste and lignocellulosic feedstocks	Liquid biofuel transitioning from surface transport to aviation, within limits and with CCS	Up to 10% aviation biofuel production with CCS

Maximising abatement means using biomass to sequester carbon wherever possible (opportunities to do this will increase over time)

*Carbon Capture and Storage **Bioenergy Carbon Capture and Storage

Maximising abatement means using biomass to sequester carbon wherever possible (opportunities to do this will increase over time)

*Carbon Capture and Storage **Bioenergy Carbon Capture and Storage

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What does a low-carbon, sustainable home look like?

Current technology, and measures aimed at preparing for the impacts of climate change, can help new and existing homes to become low-carbon and ultra-efficient as well

Existing homes

Improving existing homes can help existing house-holders meet the challenges of climate change

1. **Insulation** in lofts and walls (cavity and solid)
2. **Double or triple glazing with shading** (e.g. tinted window film, blinds, curtains and trees outside)
3. **Low-carbon heating** with heat pumps or connections to district heat networks

with removable air brick covers, relocated appliances (e.g. installing washing machines upstairs), treated wooden floors

New build homes

New build homes can and should meet even more ambitious standards in some areas

- A – **High levels of airtightness**
- B – **More fresh air** with mechanical ventilation and heat recovery, and passive cooling measures such as openable windows
- C – **Triple glazed windows and external shading** especially on south and west faces
- D – **Low-carbon heating** and no new homes on the gas grid by 2025 at the latest
- E – **Water management and cooling** more ambitious water efficiency standards, green roofs and reflective walls
- F – **Flood resilience and resistance** e.g. raised electricals, concrete floors and greening your garden
- G – **Construction and site planning** timber frames, sustainable

What householders can do today

There are number of practical, easy and cheap steps that householde reduce their bills and carbon emissions:

1 Improve home energy, heating and water usage and efficiency

- Install low-energy lighting, hot water tank insulation, low-flow shower heads and draught-proofing
- Turn off the lights/other electricals when not being used
- Turn taps off when brushing teeth, have shorter showers, check pipes for leaks and water gardens only as needed
- Install water and smart energy meters to manage water and energy use and help identify water leaks

2 Is the heating system working correctly?

- Check your boiler annually and ensure your heating system is operating at no more than 55°C
- Install heating controls like timers and room thermostats
- Turn your thermostat temperature down to 19°C

3

4

Our recommendations to Government

The Government needs to take action in five areas NOW to improve the UK's housing stock and help achieve long-term emissions reduction targets. This includes:

1. Enforcing standards, ensuring compliance with those standards and closing the 'performance gap'
2. Delivering a step-change in construction skills
3. Retrofitting existing homes so they are low-carbon, energy efficient and resilient to a changing climate
4. Ensuring new homes are low-carbon, ultra energy efficient and climate resilient, with sustainable transport options
5. Addressing urgent funding needs

www.theccc.org.uk/publications

methodology – inputs (scenarios)

Level of decentralisation (↑) / Speed of decarbonisation (→)

2050 carbon reduction target is not met

Consumer Evolution

Electricity demand	Moderate-high demand: high for electric vehicles (EVs) and moderate efficiency gains
Transport	Most cars are EVs by 2040; some gas used in commercial vehicles
Heat	Gas boilers dominate; moderate levels of thermal efficiency
Electricity supply	Small scale renewables and gas; small modular reactors
Gas supply	Highest shale gas, developing strongly from 2020s

Add a section for off-gas grid heating

2050 carbon reduction target is met

Community Renewables

Electricity demand	Highest demand: high for EVs, high for heating and good efficiency gains
Transport	Most cars are EVs by 2033; greatest use of gas in commercial vehicles but superseded from mid 2040s by hydrogen (from electrolysis)
Heat	Heat pumps dominate; high levels of thermal efficiency
Electricity supply	Highest solar and onshore wind [illegible]
Gas supply	[illegible] development from 2030s

Add a section for off-gas grid heating

Steady Progression

Electricity demand	Moderate-high demand: high for EVs and moderate efficiency gains
Transport	Most cars are EVs by 2040; some gas used in commercial vehicles
Heat	[illegible] moderate [illegible]
Electricity supply	Offshore wind, nuclear and gas; carbon capture utilisation and storage (CCUS) gas generation from late 2030s
Gas supply	UK Continental Shelf still producing in 2050; some shale gas

Add a section for off-gas grid heating

Two Degrees

Electricity demand	Lowest demand: high for EVs, low for heating and good efficiency gains
Transport	Most cars are EVs by 2033; high level of gas used for commercial vehicles but superseded from mid 2040s by hydrogen
Heat	Hydrogen from steam methane [illegible] and [illegible] high levels of thermal efficiency
Electricity supply	Offshore wind, nuclear, large scale storage and interconnectors; CCUS gas generation from 2030
Gas supply	Some green gas, incl. biomethane and BioSNG; highest import dependency

Add a section for off-gas grid heating

CR Community Renewables | TD Two Degrees | SP Steady Progression | CE Consumer Evolution

		2017	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	>2040	Maximum potential by 2050
Transport	Exceeds 2 million electric vehicles	95k					CR TD					SP CE													CR 38.5m
	Exceeds 1 GW of vehicle-to-grid capacity	N/A											CR	TD			SP CE								CR 20.6 GW
	Reaches 50,000 natural gas vehicles	3k						CR TD						SP CE											CR 243k
Heating	10% of homes using low carbon heating	2%								CR TD								CE					SP		TD 84%
Electricity generation	25% electricity output from distributed sources	17%			CR		TD		CE															SP	CR 43%
	Hits 60% renewable generation output	26%					TD	CR					SP	CE											CR 76%
	Carbon intensity of electricity generation below 100g CO_2/kWh	266g CO_2 kWh						TD	CR						SP			CE							TD 20g CO_2/kWh
Electricity storage	Exceeds 6 GW electricity storage technologies	2.9 GW						TD	CR			CE		SP											CR 28.8 GW
Electricity interconnection	10 GW of electricity import capacity	4 GW			TD	CR	SP	CE																	TD 19.8 GW
Gas supplies	10% of supplies from onshore production (shale and green gas)	0.3%						CE			SP							CR						TD	CE 54%

Add a section for off-gas grid heating

sustainable business and investment solutions

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methodology – inputs (scenarios)

Level of decentralisation ↑ / Speed of decarbonisation →

✗✗ 2050 carbon reduction target is not met | ✓✓ 2050 carbon reduction target is met

Consumer Evolution

Electricity demand	Moderate-high demand: high for electric vehicles (EVs) and moderate efficiency gains
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Two Degrees

Electricity demand	Lowest demand: high for EVs, low for heating and good efficiency gains
Transport	Most cars are EVs by 2033; high level of gas used for commercial vehicles but superseded from mid 2040s by hydrogen
Heat	Hydrogen from steam methane reforming from 2030s, and some district heat; high levels of thermal efficiency
Electricity supply	Offshore wind, nuclear, large scale storage and interconnectors; CCUS gas generation from 2030
Gas supply	Some green gas, incl. biomethane and BioSNG; highest import dependency

Off-gas heat

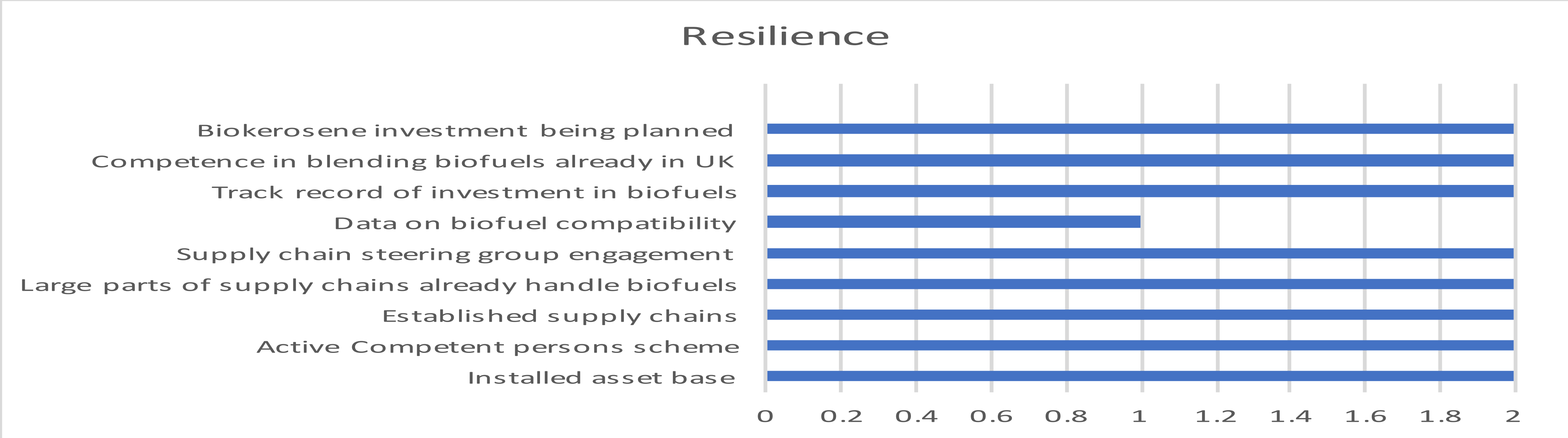
Slow decarbonisation & Low decentralisation: (bottom left):
B30k by 2032 with reasonable fabric improvements by 2045. Boilers slowly shift to 93% efficiency with some modulating burners (20%).

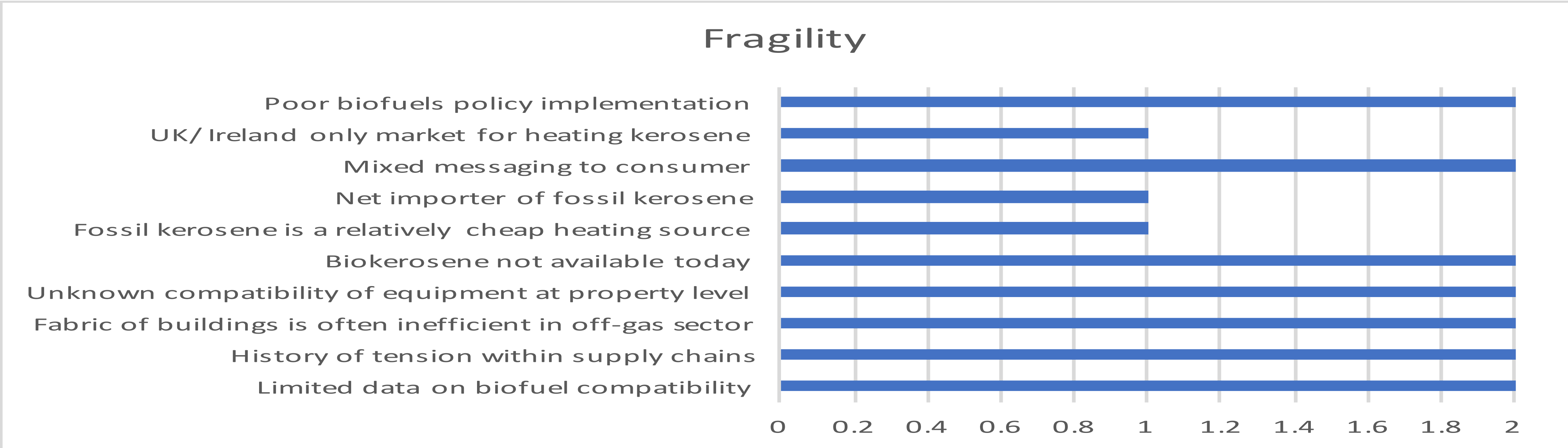
Slow decarbonisation with high decentralisation: (top left):
B30k by 2032 & B100 by 2045 with average fabric improvements by 2045. Boilers shift to modulating burners by 2045.

Rapid decarbonisation and low decentralisation: (bottom right):
B30k by 2027 with average fabric improvements by 2032. Boilers shift to modulating burners by 2035.

Rapid decarbonisation and high decentralisation: (top right):
B30k by 2027 and B100 by 2032. Deep fabric improvements by 2032. Includes boiler scrappage scheme to shift to modulating burners with controls by 2032.

Strengths and Weaknesses





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scenario outputs

We have modelled the scenarios.

This modelling makes an assessment of the type of blendstocks being adopted in a biogenic blend and when the blend would be introduced to the market.

We further assess the carbon saving delivered by the liquid fuel based on earlier technical data. The carbon savings are benchmarks against two thresholds.

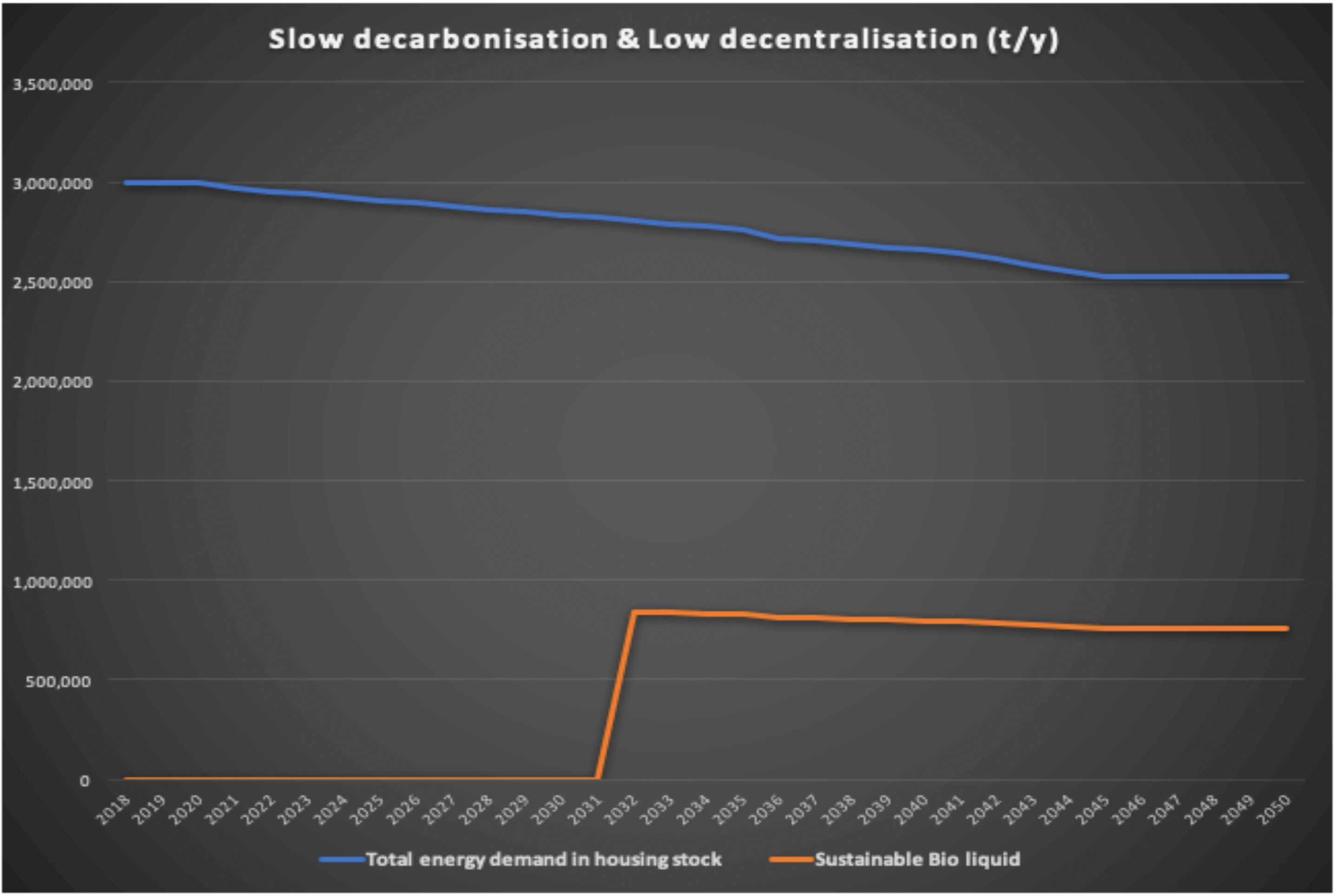
- The first indicates what the gas grid equivalent emissions would be should the properties be able to shift to gas – clearly not easily achieved without large scale investment in infrastructure.

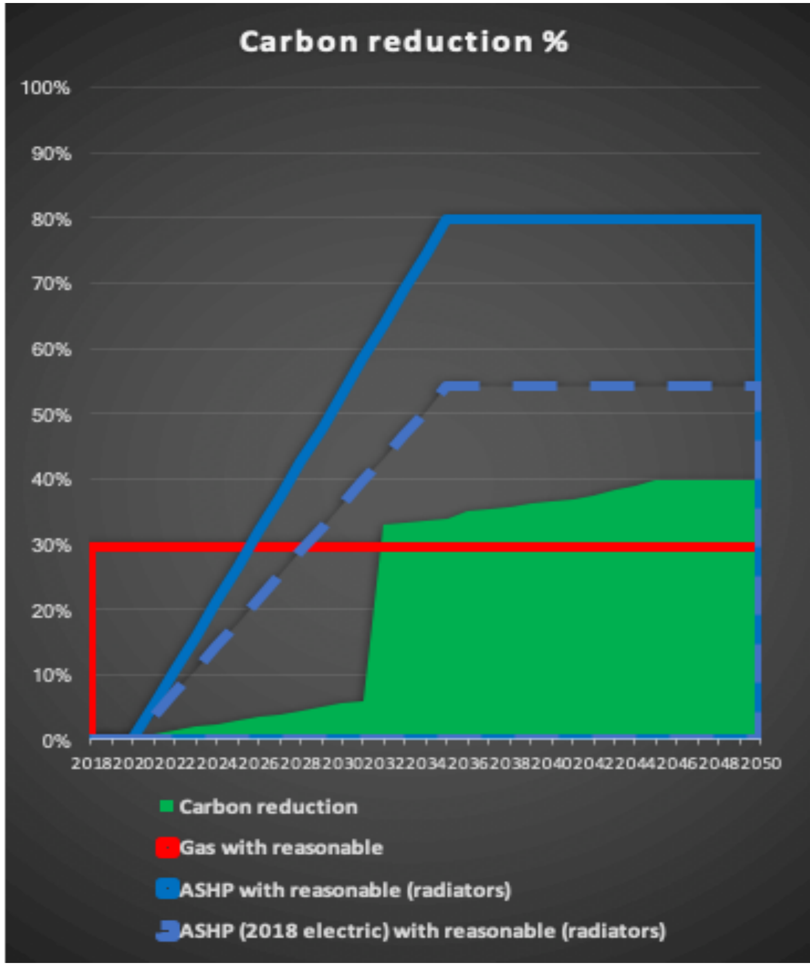
- The second shows the carbon saving should the property be suitable for adoption of a heat pump – again not easily achieved without large scale investment in improving the thermal efficiency of domestic dwellings with single brick construction and floating floors and investment would be needed in District Network Operators (DNO) and grid supply moving to a larger percentage of low carbon power.

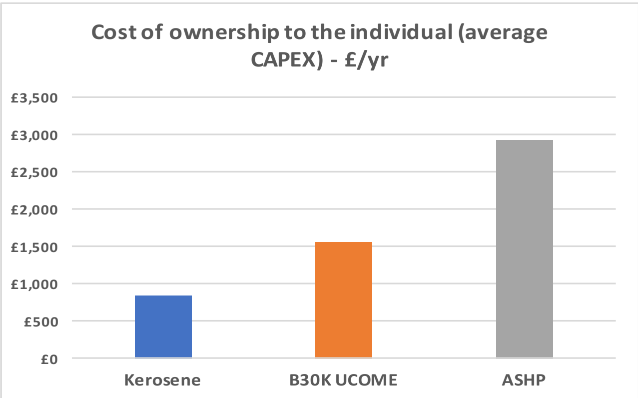
For each scenario we then add the economics of the particular option, covering cost of ownership for the individual, for treasury (covering England only) and then the Cost of Carbon Saving (£/t).

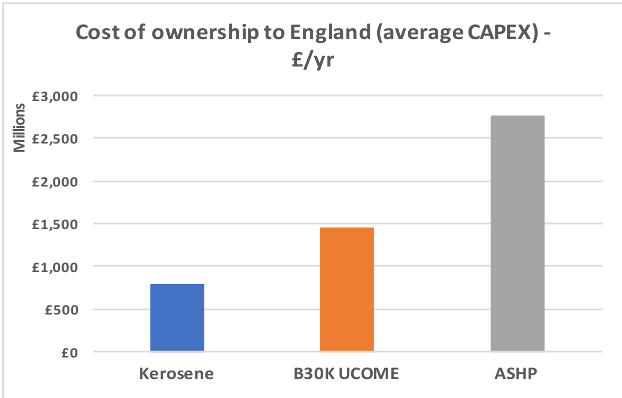
Slow decarbonisation & Low decentralisation: (bottom left)

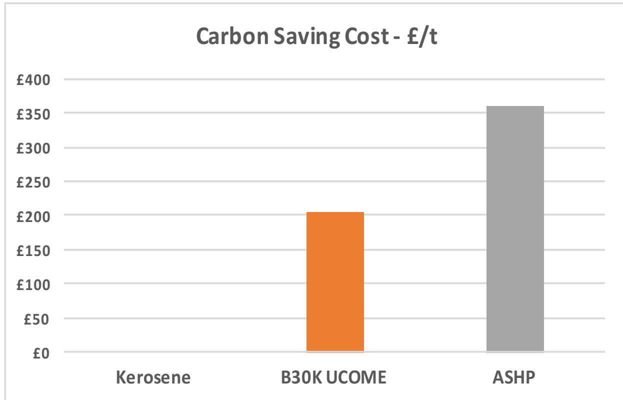
B30k by 2032 with reasonable fabric improvements by 2045. Boilers slowly shift to 93% efficiency with some modulating burners (20%).











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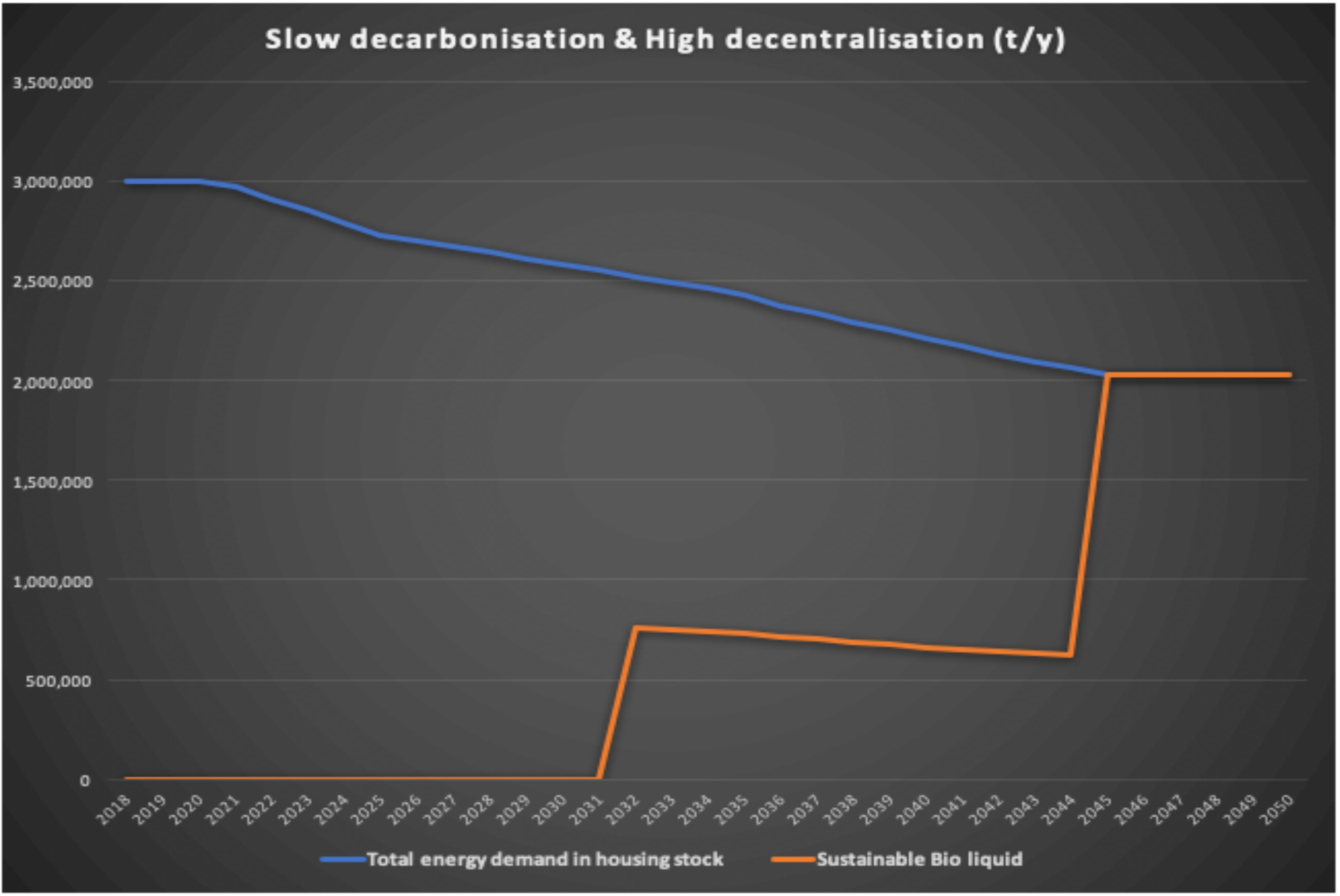
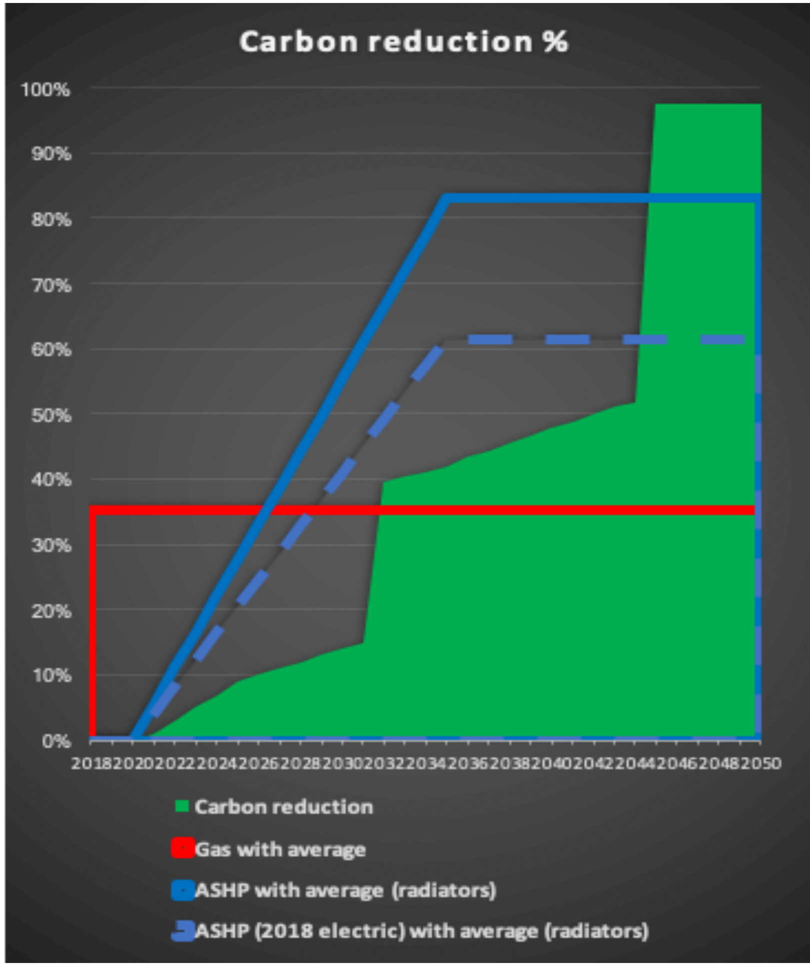
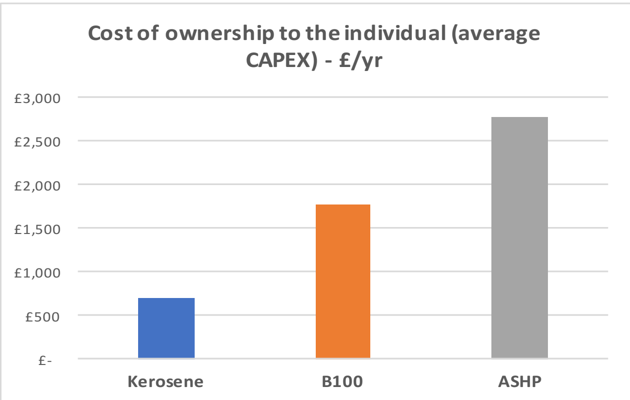
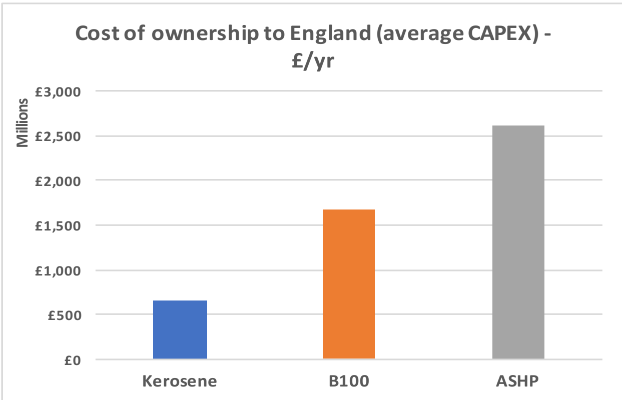
Slow decarbonisation & High decentralisation: (top left)

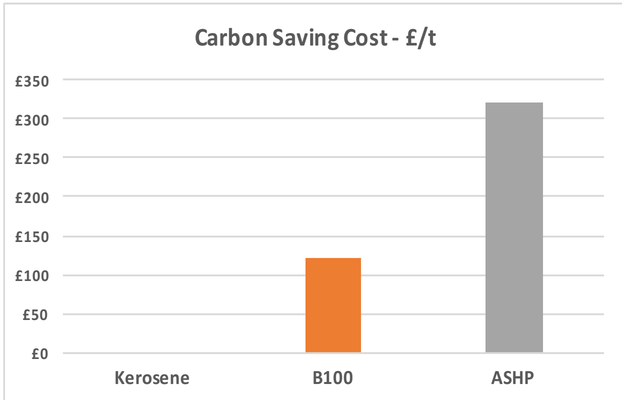
B30k by 2032 & B100 by 2045 with average fabric improvements by 2045. Boilers shift to modulating burners by 2045.











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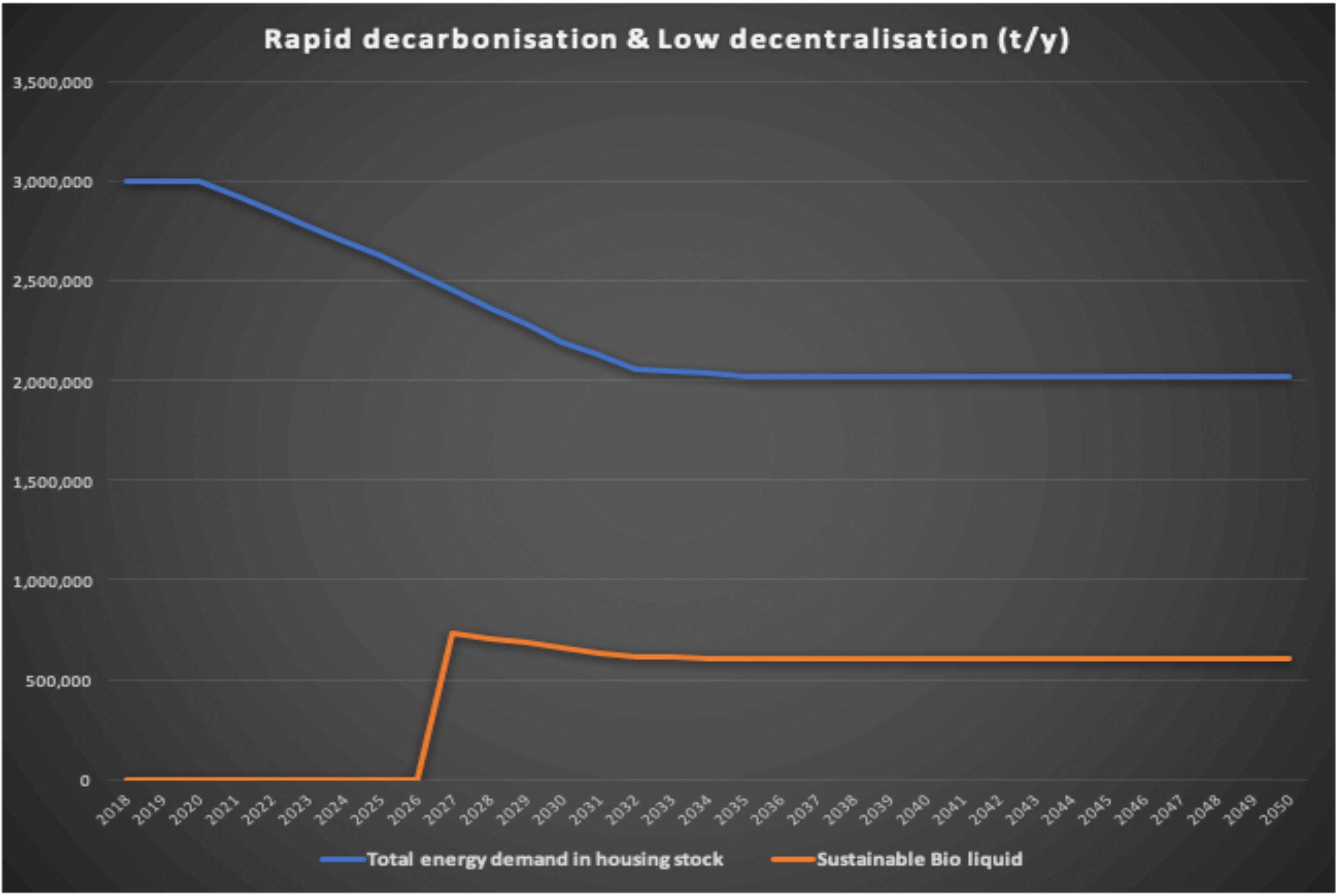
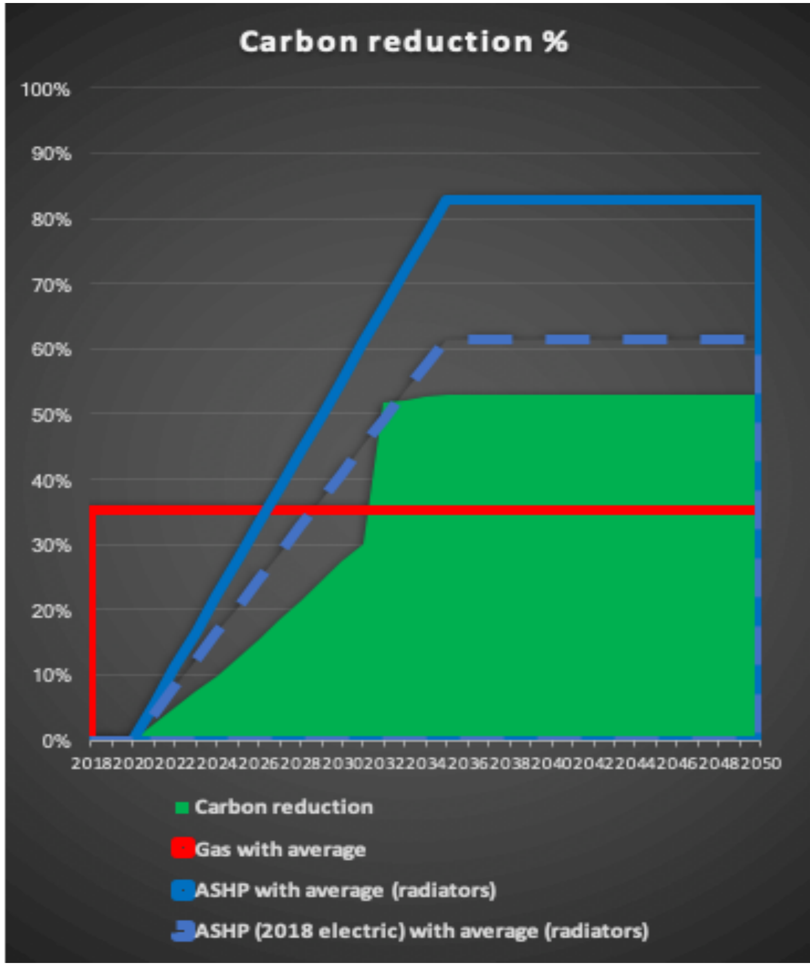
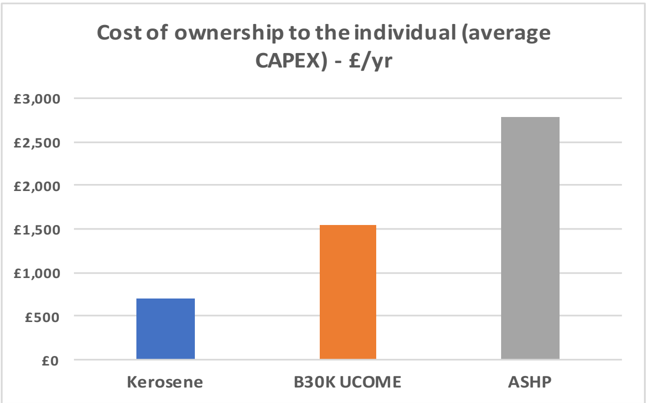
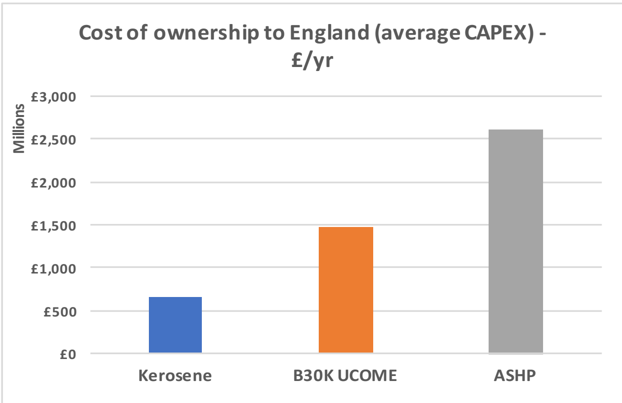
Rapid decarbonisation & Low decentralisation: (bottom right)

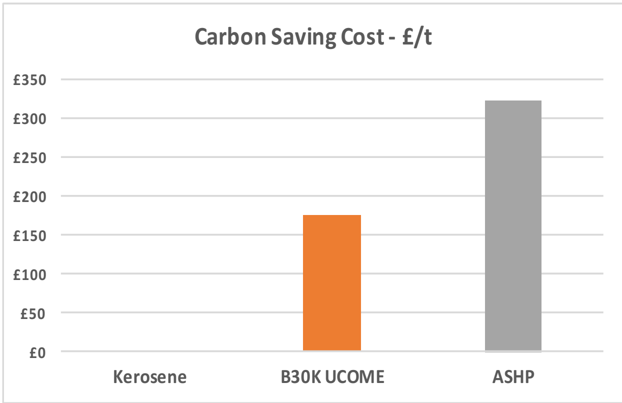
B30k by 2027 with average fabric improvements by 2032. Boilers shift to modulating burners by 2035.











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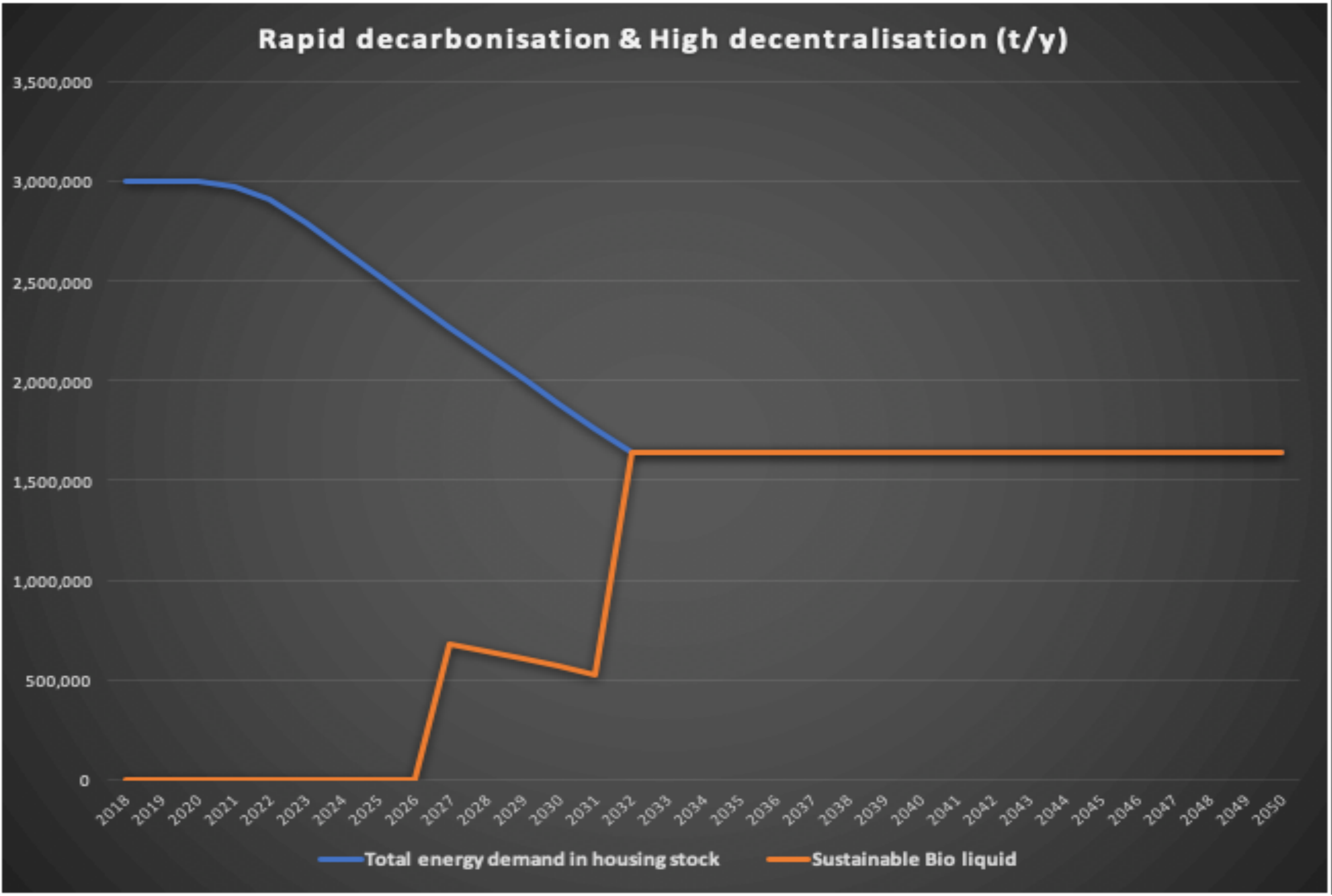

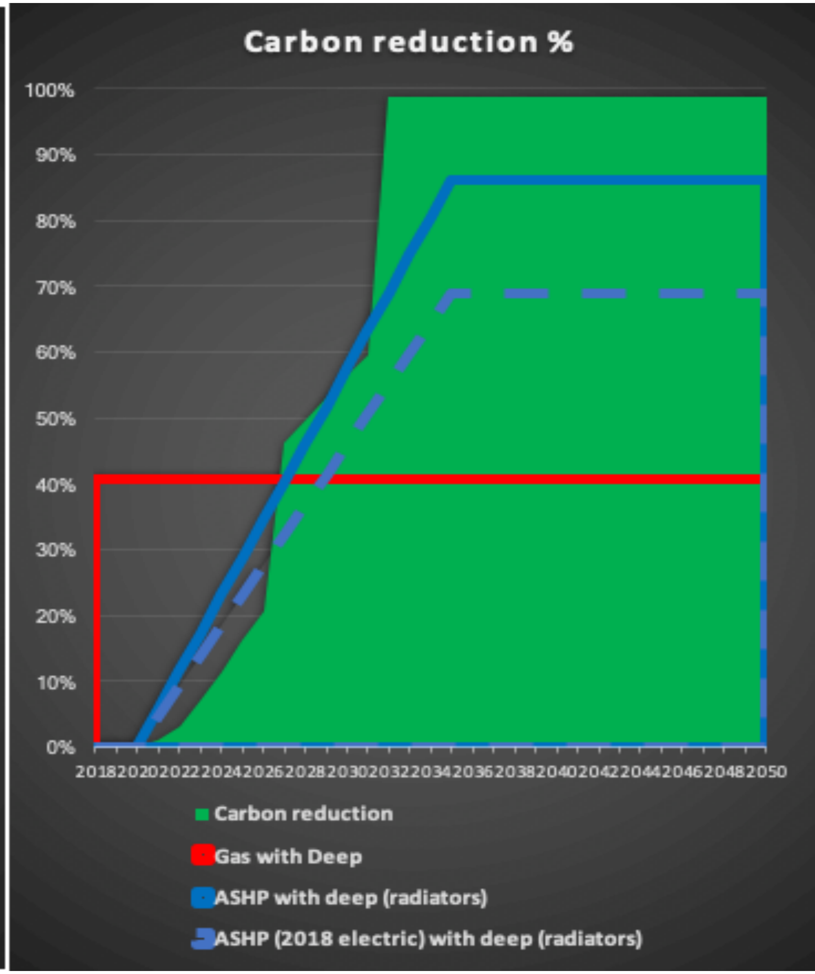

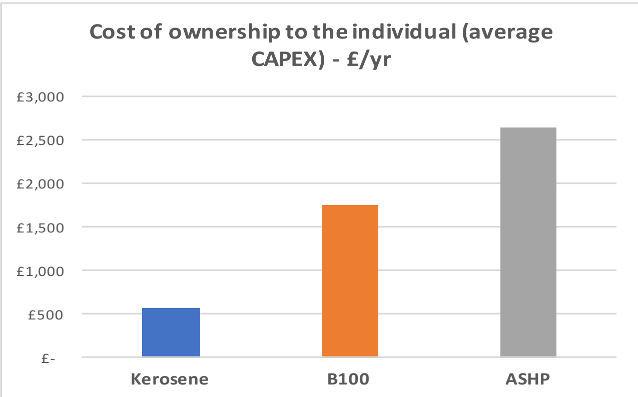

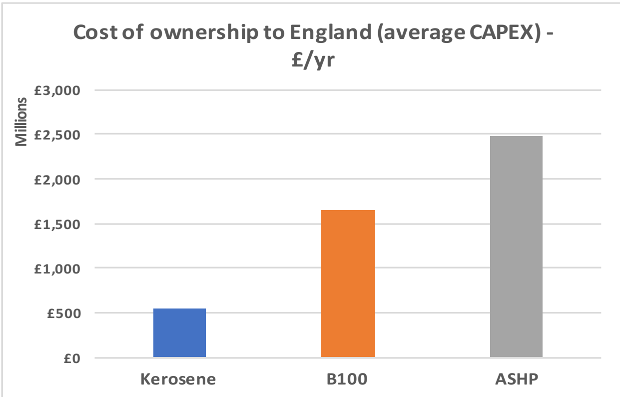

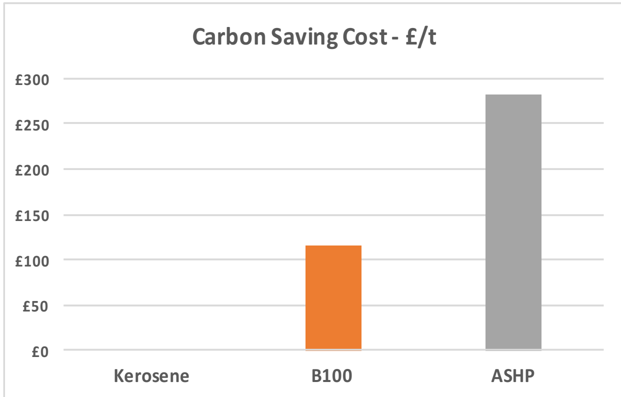

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CR Community Renewables · TD Two Degrees · SP Steady Progression · CE Consumer Evolution

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Electricity generation	25% electricity output from distributed sources	17%			CR		TD		CE															SP	CR 43%
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	Carbon intensity of electricity generation below 100g CO_2/kWh	266g CO_2 kWh						TD	CR						SP			CE							TD 20g CO_2/kWh
Electricity storage	Exceeds 6 GW electricity storage technologies	2.9 GW						TD	CR			CE		SP											CR 28.8 GW
Electricity interconnection	10 GW of electricity import capacity	4 GW			TD	CR	SP	CE																	TD 19.8 GW
Gas supplies	10% of supplies from onshore production (shale and green gas)	0.3%						CE			SP							CR						TD	CE 54%

		2017	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	>2040	
Off-gas heating	Decarbonisation of total network (>90%)														CR									CE	CR
Off-gas heating	Decarbonisation of 70% of the network														CR									CE	CR
Off-gas heating	Decarbonisation of 50% of the network											CR			TD									CE	CR

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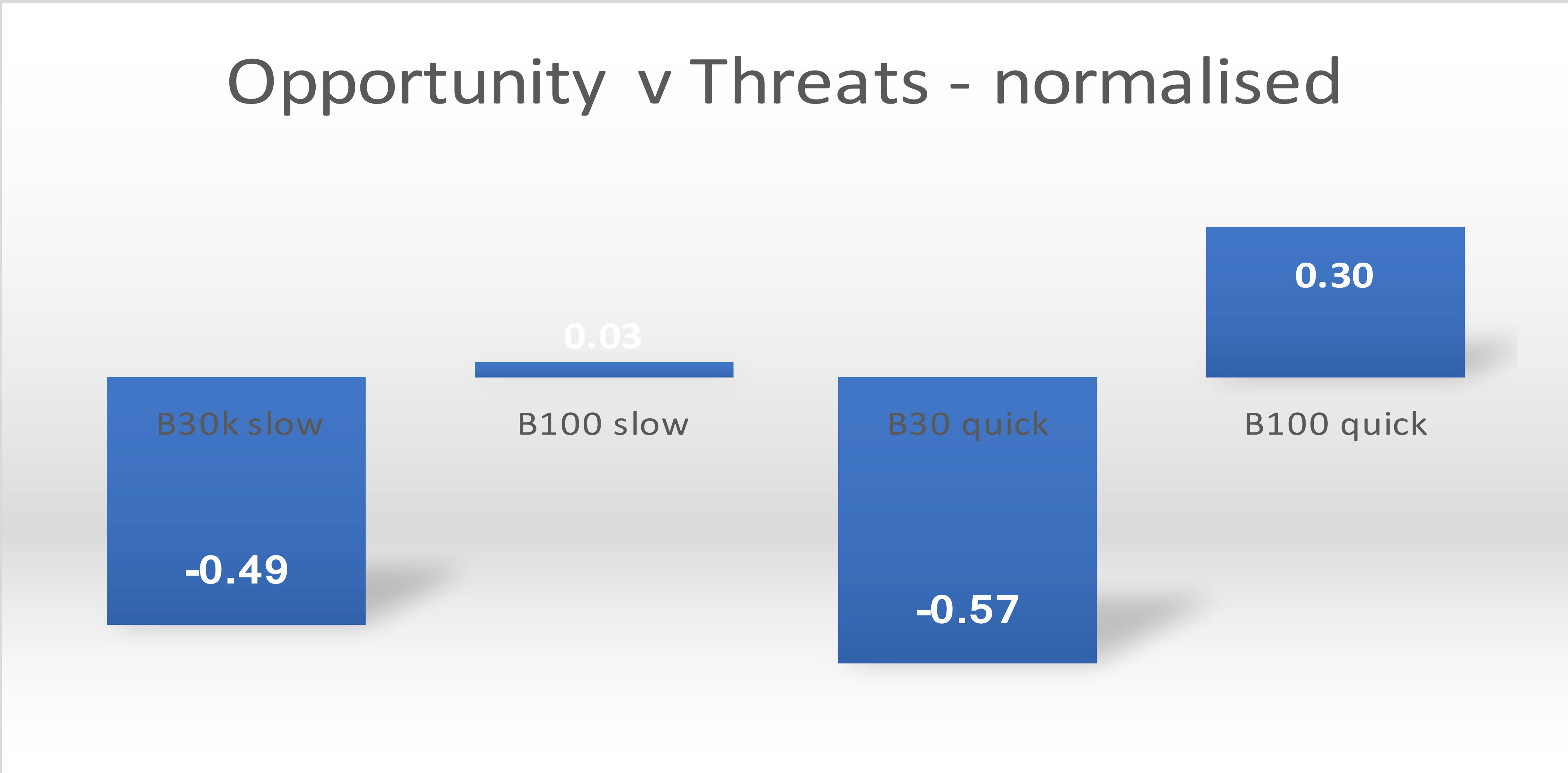
Opportunity:

- Deep and early carbon reduction
- Potential for some M&A activity
- Develop competent persons scheme
- UK enhanced independence from EU
- Policy supports investment in biofuel production
- Policy provides for fuel poor
- Independence from electricity grid

Threats:

- Potential for smaller distributors to suffer
- Negative customer acceptance
- Failure to supply
- Price increase to customer
- Competition from alternate technologies
- Failure to develop and adopt new standards
- Policy exacerbates fuel poverty
- Limited carbon reduction
- Low levels of UK investment in biofuels production



Opportunity	B30 slow Likelihood	B30 slow Impact	B100 slow Likelihood	B100 slow Impact	B30 quick Likelihood	B30 quick Impact	B100 quick Likelihood	B100 quick Impact
Deep and early carbon reduction	1	1	1	2	1	1	2	2
Potential for some M&A activity	1	1	1	1	1	2	2	2
Develop competent persons scheme	2	1	2	1	2	1	2	2
UK enhanced independence from EU	1	1	2	2	1	1	2	2
Policy supports investment in biofuel production	1	1	2	1	1	2	2	2
Policy provides for fuel poor	2	1	2	1	1	1	1	2
Independence from electricity grid	1	1	2	2	1	1	2	2

Threats	B30 slow Likelihood	B30 slow Impact	B100 slow Likelihood	B100 slow Impact	B30 quick Likelihood	B30 quick Impact	B100 quick Likelihood	B100 quick Impact
Potential for smaller distributors to suffer	1	1	2	2	2	1	2	2
Negative customer acceptance	1	1	1	2	1	1	2	2
Failure to supply	1	2	1	2	1	2	2	2
Price increase to customer	1	1	2	2	2	1	2	2
Competition from alternate technologies	2	2	2	2	1	2	1	2
Failure to develop and adopt new standards	1	2	1	2	1	2	2	2
Policy exacerbates fuel poverty	1	1	1	1	1	2	2	2
Limited carbon reduction	2	2	1	1	2	2	1	1
Low levels of UK investment in biofuels production	2	1	1	2	1	2	1	2

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is your business sustainable?

thank you

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