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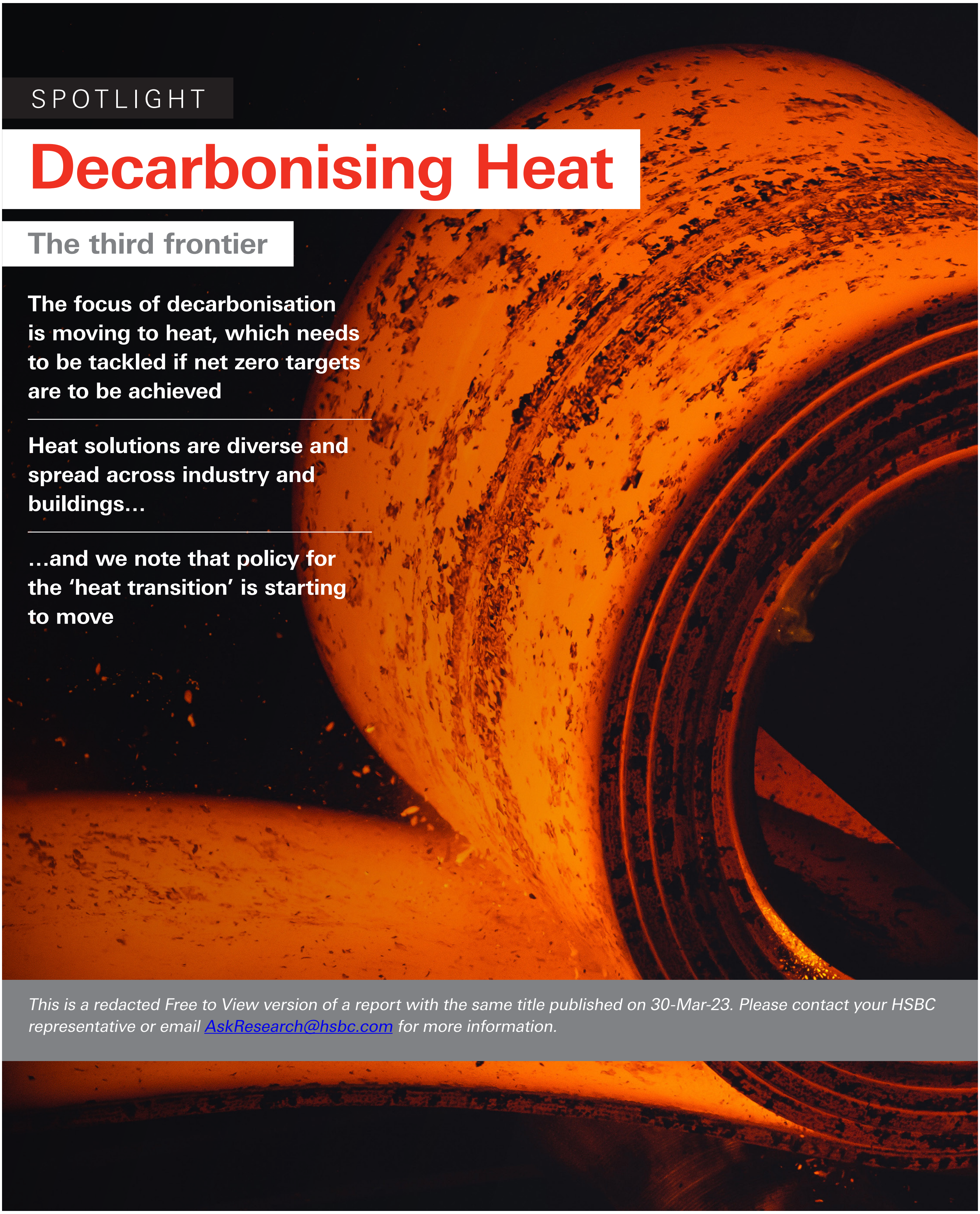

SPOTLIGHT

Decarbonising Heat

The third frontier

The focus of decarbonisation is moving to heat, which needs to be tackled if net zero targets are to be achieved

Heat solutions are diverse and spread across industry and buildings…

…and we note that policy for the 'heat transition' is starting to move

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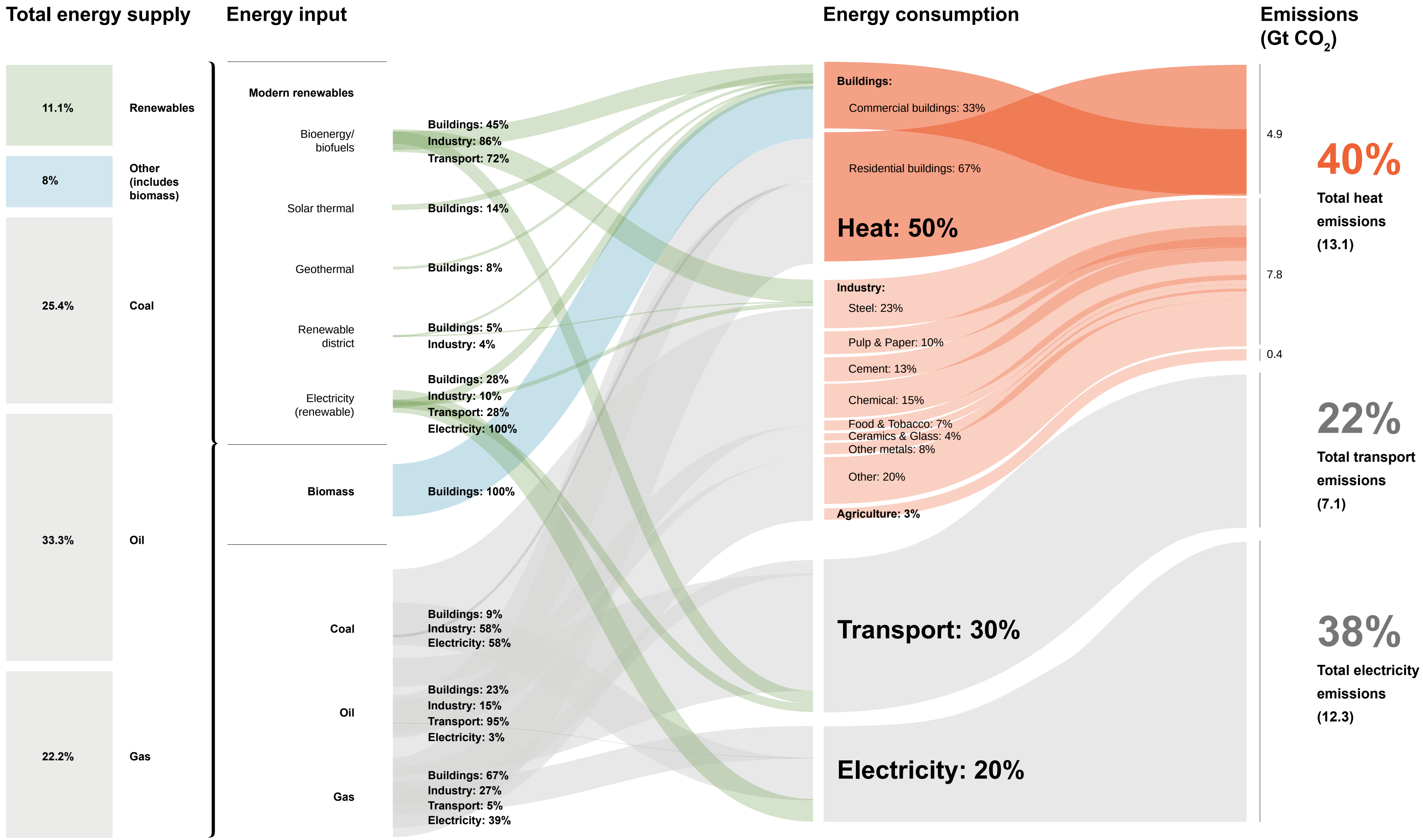
Heat makes up the largest slice of energy consumption and emissions



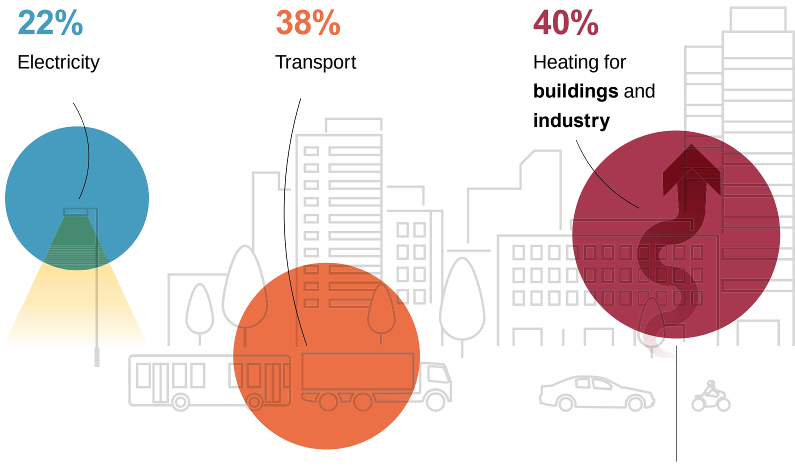
Data: Energy input (2020/21), Energy consumption (2022), Emissions (2020), Energy input and Energy consumption as percentages based on exajoules (EJ), as defined in the glossary and definitions section.

Source: Eurostat, HSBC

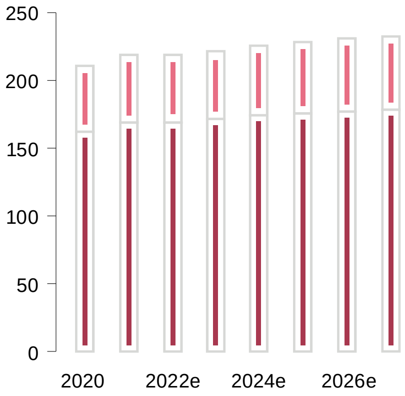
Heat emissions – the third frontier

Heat makes up the largest slice of energy consumption, and we expect consumption to grow

Heat accounts for c50% of global energy consumption and is mostly generated from fossil fuels. Global energy consumption, 2021



Global heat consumption to 2027e (EJ*)
Non-renewable / **Renewable & Biomass**



*exajoules
(EJ, equivalent to 1 billion billion joules)

70% of heating is powered by fossil fuels, globally

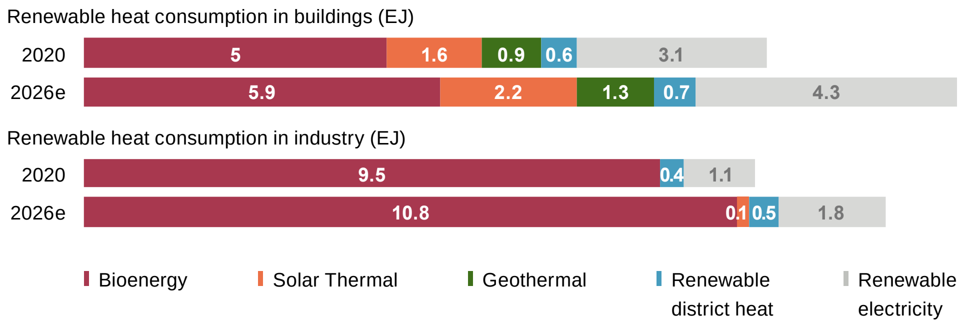
-3.6EJ expected fall in buildings heat consumption globally (2022-27)

17EJ expected rise in global industrial heat consumption (2022-27)

10% of industrially processed heat comes from bioenergy

Decarbonising heat – a slower problem to fix than power and light transport

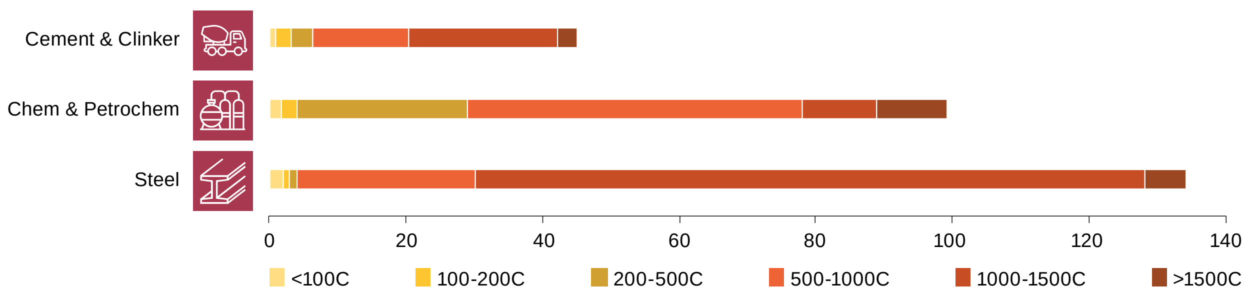
Buildings have greater scope for electrification via heat pumps for example, and efficiency solutions compared to industry



The majority of renewables of heat in buildings comes from **bioenergy**, which consists mainly of burning wood for heat. Similarly, **bioenergy** in industry comes with its own emissions problems, which is tied to specific large-scale processes

Industrial heat is concentrated in three 'hard to abate' heat-intensity sectors

Industrial heat consumption in Germany by end-use sector (TWh, 2013 data)



Source: IEA, HSBC

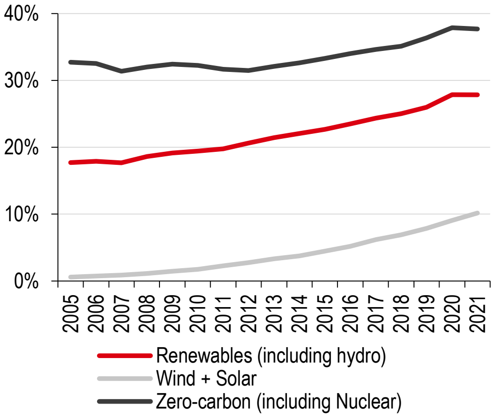
The third frontier

- Decarbonising heat – the third frontier – lags behind efforts to reduce emissions in electricity and transport, but is rising up the agenda
- The challenge spans across buildings and industry; solutions cover electrification, heat technology and heat efficiency
- In the full report, we map global heat use from source to sink and assess the diverse opportunities across fast growing low carbon heat markets

A hot potato – the decarbonisation debate is moving on to heat

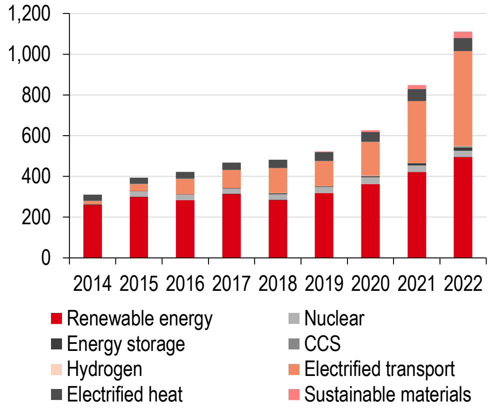
Over the past decade the focus of decarbonisation opportunities for investors has centred firstly on the power sector and more recently on the transport sector. A renewed emphasis on low carbon hydrogen has since accompanied a broadening of the decarbonisation debate to include some 'hard to abate' sectors. We believe a change in focus is now due, for both policy and investments, that is centred around heat – the third frontier.

Ex. 1: The first frontier: Renewables in the power mix



Source: BP

Ex. 2: The second frontier: investments in electrified transport are growing fast (in USDbn)



Source: BNEF

A slower problem to fix than power and light transport

Whilst the electrification of the power sector (via renewables) and of light transport (via battery EVs) has been accelerating, the process of replacing fossil fuels with low carbon energy for heat applications has been slower.

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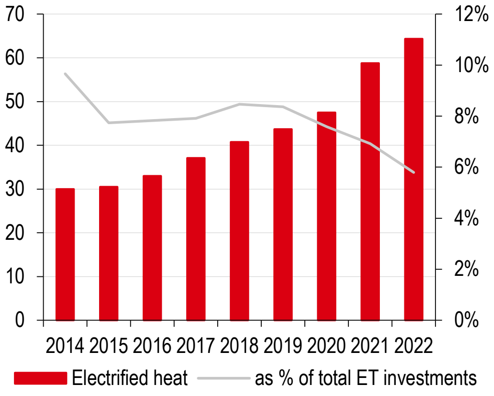
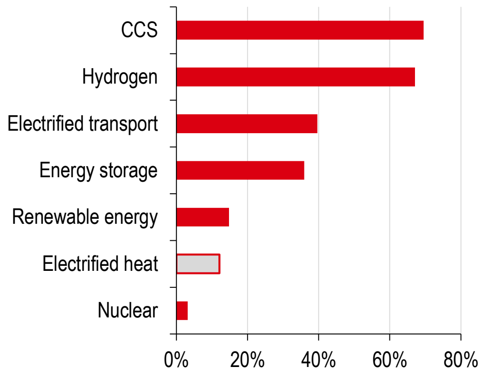
Ex. 3: Electrified heat is not keeping pace with total energy transition investments (in USDbn)



Source: BNEF

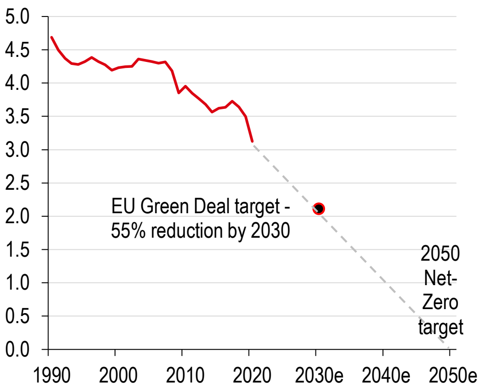
Ex. 4: Growth rate for electrified heat lower than other energy transition segments



Note: 4-year CAGR to 2022 of investments in USDbn. Source: BNEF

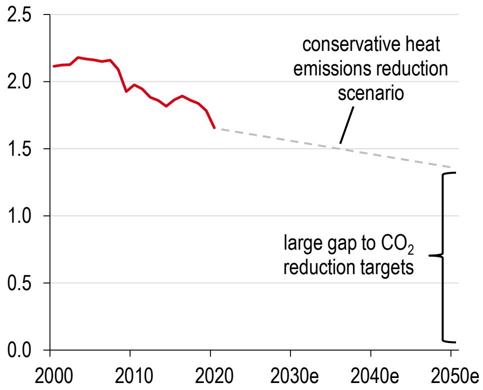
EV uptake has continued to grow strongly in the consumer vehicle segment, rising to 13% of new car sales in 2022 (from 1% in 2017). Whereas renewables in the power sector made up 28% of demand globally (and 38% including nuclear) in 2022, modern renewables for heat accounted for 13% but the growth rate has been far slower compared to EVs. Investments in electrified heat are dwarfed by those in renewable energy and in electrified transport and have been steadily falling as a percentage of total energy transition investments since 2014.

Ex. 5: EU-27 GHG emissions and 2030 / 2050 targets (MtCO₂e)



Source: European Environmental Agency, BNEF

Ex. 6: EU-27 emissions from heat (MtCO₂e)



Source: European Environmental Agency, BNEF

Despite a projected rise in renewable consumption in heat, the IEA predicts that the consumption of fossil fuels will rise in the medium term, increasing global CO_2 emissions by 7% up to 2027[1]. According to the European Environmental Agency, unless there is a clear acceleration of emissions reduction from heat, meeting net zero targets in the EU-27 by 2050 will not be possible due to a sizeable CO_2 reduction gap related to heat emissions.

1 'Renewables 2022', IEA

50%

Global energy consumed as heat – the single largest energy end-use

Addressing the heat problem

The heat transition requires a difficult behavioural change
More households worldwide are installing solar panels, driving electric cars, using low-power lighting and recycling more goods as they embrace the energy transition. Similarly, an increasing number of companies are buying more renewable power and sourcing more sustainable materials in order to lower their overall emissions. Yet a successful energy transition requires another behavioural change tied to the consumption of something that is *felt* rather than seen – heat.

Heat is essential for homes, offices and industries alike, for providing warmth to ensuring the production of goods in key industries. Forgoing warmth is not an easy option: whilst spiralling natural gas prices in Europe have driven consumers to turn down thermostats, we question how many will resist turning them back up if gas prices fade further.

Heat consumption is carbon intensive
We believe the decarbonisation of heat has largely been ignored in the public debate. A more concerted shift we believe is required in order to reduce heat emissions and continue to aim for 2050 net zero targets.

Heat is a huge end-use for energy – nearly 50% of global energy consumption, spread evenly across buildings and industry. With c.70% of heating powered by fossil fuels, staying warm is essentially helping to heat the planet. Although necessary processes, heating in buildings accounted for 51% of building emissions globally and 37% of total heat emissions in 2020 at 4.9 Gt CO_2. For industry heat is a key factor in manufacturing and processing and the emissions issue is even starker – industrial heat emissions in 2020 were 7.8 Gt CO_2, some 59% of total heat emissions[2].

70%

Proportion of heat currently powered by fossil fuels

Understanding key challenges
Firstly, heat is localised as it does not travel very far. This requires high penetration in residential markets to make a significant impact and limits industrial solutions to on-site interventions. Secondly, the choice of energy supply is usually made at the design stage of a building so often cannot be easily nor cost-effectively upgraded. Thirdly, industry uses a lot of high grade heat which is not as easy to electrify, requiring more novel approaches.

2 'Renewables 2021', IEA

What this report is not about

Heat made the headlines last summer as parts of the globe basked in record high temperatures. This report is NOT about dealing with rising global temperatures as a result of global warming. The global cooling market is growing thanks to greater affordability of air conditioning systems and the high cooling needs of data centres, even before considering global temperature patterns.

Buildings – heat efficiency solutions and electrification via heat pumps

The solutions to decarbonising heat are complex and manifold. Heat consumption is split c.50/50 between buildings and industry (though, as noted above, industry generates more heat emissions compared to buildings). Buildings have greater scope for electrification (via e.g. heat pumps) and efficiency solutions (from insulation to district heating systems) are applicable in the majority of use cases.

Ex. 7: Comparison of residential heat technologies

	Gas boilers *(benchmark)*	Heat pumps	Solar heating	Geothermal	Bioenergy	District heating	Green gas
Consumer fixed cost	=	-	-	-	-	=	-
Variable cost (fuel, electricity)	=	+	+	+	=	+	-
Technology efficiency	=	+	-	-	-	=	=
GHG emissions & air quality	=	+	+	+	+	=	+

Source: HSBC

The heat pump market is growing strongly as policy support improves in more countries. We estimate the global heat pump market has the potential to nearly double by 2030 to USD140bn from cUSD78bn in 2022, showing double-digit growth rates in Europe and the US to 2030. Assuming that half of the 1.9bn current global heating equipment stock is converted to heat pumps would peg the total addressable market at c.USD4.8trn.

Industry – heat solutions span a number of hard to abate sectors

While heating needs for residential and commercial buildings are fairly standard, industrial heat encompasses a wide variety of temperature levels for diverse processes and end-uses. For instance, cement kilns and steelmaking furnaces require a high temperature, while drying or washing applications in the food industry operate at lower temperatures.

We estimate that low- and medium-temperature heat (below 500C) accounts for c.75% of the total growth in heat demand in industry by 2040, driven by less energy-intensive industries. But high-temperature industries are arguably the hardest to decarbonise. The challenge in industry lies in a number of 'hard to abate' sectors (steelmaking, chemicals, cement) that rely on high-grade heat processes that cannot easily be made more efficient or electrified, so may require more pragmatic solutions including carbon capture. Hydrogen has promising potential to decarbonise the steelmaking process.

Policy support is improving

Emissions reduction policy for heat has historically been lacking as it has centred on the power sector. The focus has been mainly on adding insulation in buildings and replacing old oil systems, which have only a marginal effect on the carbon intensity of the heat sector.

However, we believe momentum is changing. Europe's desire to decarbonise heating has been given extra impetus by the continent's need to move away from Russian fossil fuels. The REPowerEU plan, launched in May 2022 as a response to the Ukraine war, raised Europe's ambitions for decarbonising power and heat. The EU Net-Zero Industry Act, proposed on 16 March, recognises heat pumps as a strategic low carbon technology and includes a target of 40% of annual heat pump installations in Europe to be supplied by European manufacturers.

The US Inflation Reduction Act (IRA) is bringing heat decarbonisation up the agenda in the US and large subsidies available for household purchases of heat pumps can accelerate electrification of residential heat in the US. China's Clean Winter Heating Plan calls for large-scale renewable energy deployment in clean heating, better building energy efficiency and more renewable energy resources contributing to clean heating.

A low-carbon heat playbook for investors

An overview of investment options in four heat quadrants

In the full report we explore the key issues in the main buildings and industrial verticals, dive into policy and look at new technologies trying to reduce the carbon footprint associated with heat.

Ex. 8: Heat decarbonisation – investment options by quadrant

End use	Technology solutions	Efficiency solutions
Buildings	heat pumps	district heat networks
	biomass / bioenergy	insulation and heat efficient materials
	solar thermal	appliance efficiency
	geothermal	behavioural changes
	electric boilers	waste heat recycling for home heating
	hydrogen boilers	
Industry	bioenergy	waste heat recycling for commercial / industrial heating
	electrification of steam cracking	industrial heat efficiency
	hydrogen in steel	process efficiency
	low carbon cement	
	carbon capture	

Source: HSBC

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The full report contains a further look at the business of decarbonising heat – from outlining the problem and understanding how heat affects different sectors and industries, to a review of where policy is heading and a stock screen where we use our proprietary HSBC Climate Solutions Database to identify global stocks with exposure to heat solutions and heat efficiency.

Please contact your HSBC representative or email *AskResearch@hsbc.com* for more information.

Definitions and glossary

What is heat?

Technically speaking, heat is defined as the *transfer of energy from one body or energy source to another body*. Thermal energy is a *kinetic* energy, i.e. related to the movement of atoms and molecules in a substance. Electricity is also a kinetic energy, related to the movement of charged particles.

Ex. 9: An overview of types of energy – heat is a type of kinetic energy

Potential energy – energy STORED in objects		Kinetic energy – energy of MOTION of objects	
Energy type	**Description**	**Energy type**	**Description**
Chemical	Stored in bonds of atoms and molecules	Electrical	Delivered by charged particles
Mechanical	Stored via tension in objects (e.g. a rubber band)	Motion	Contained in a moving object (e.g. a fast car)
Nuclear	Stored in the nucleus of an atom	Radiant	Electromagnetic energy, e.g. light, x-rays, radio waves
Gravi-tational	Stored in an object's height	Thermal (or heat)	Comes from movement of atoms and molecules in a substance

Source: IEA, HSBC

How do we measure heat?

There are several units for heat which can add confusion to interpreting data around heat generation and consumption. Below we show a ready reckoner for converting different heat units. In this report we have tried to stick with MWh, which can be directly compared to electricity units (also expressed in MWh), as well as joules, the international standard unit for heat. When referencing IEA figures we have used exajoules (EJ, or 10^{18} joules, equivalent to 1 billion joules).

Ex. 10: Heat measurement units

Unit	Symbol	Conversion (in kJ)	Comment
Kilojoule	kJ	1	International standard (SI) unit for heat
British thermal unit	Btu	1.055	Traditional heat unit
Kilocalorie	kcal	4.184	Traditional heat unit
Tonne of oil equivalent	Toe	41.9m	Quantifies the amount of energy released when burning one tonne of crude oil
Kilowatt	kW	1/s	Standard unit for rate of heating (in kJ per second)
Kilowatt-hour	kWh	3600	Unit of energy measuring 1kW of power for one hour

Source: HSBC

How is heat used?

Heat may be used for heating or cooling, or converted into mechanical energy for transport (e.g. via an internal combustion engine) or electricity generation (e.g. via a steam or gas turbine).

Ex. 11: An overview of heat supply and end uses

Heat supply - obtained from a variety of sources	Heat end uses - wide ranging, mostly in buildings and industry
- Combustion of fuels	- Space and water heating, and cooking (in buildings)
- Nuclear reactors	- Desalination and process applications (in industry)
- Geothermal resources	- Cooling (cooling applications not featured in this report)
- Capture of sunlight	

Source: IEA, HSBC

How hot is heat?

Heat is categorised according to its temperature. Yet a lack of standards in terms of categorisation makes it challenging to give a good and simple overview. We also note a lack of consistent and up-to-date data on heat consumption in the literature, hence why in this report we have sourced datasets from as far back as 2013. Whilst we acknowledge that the data may not reflect the latest situation, as broader changes in heat consumption over the last decade have been gradual we believe the data in this report is representative of current trends.

Most of discharged waste heat during industrial processes is qualified as low-grade heat (under c.200C) though this can vary between sources. For medium grade heat temperatures range broadly between 200-500C. High grade heat has temperatures higher than c.500C, with ultra-high temperatures >1000C and as high as >1500C in some applications (e.g. metal smelting, glass production).

Glossary

District heating

A district heating system is infrastructure used in cities that generates and captures heat and distributes it to buildings on a large scale. Heat is transferred in hot water that is pumped through pre-insulated underground pipes.

The new generation of district heating is based on replacing fossil fuels with smart and flexible solutions, such as renewable electricity, heat pumps and waste heat utilisation. Increasingly, software solutions and artificial intelligence can be used to optimise the operations of an entire system.

Electric boilers

Electric boilers are simple heat systems that convert electricity into heat at temperatures up to 500C by means of electrodes. They are similar in operation to an immersion heater that is used to boil water and turn one unit of electricity into one unit of thermal energy. Electric boilers are not well suited to waste heat applications and require large grid connections, particularly for industrial uses.

Heat pumps

Heat pump technology has existed for more than 150 years and is widely used already in residential and low-heat industrial settings. Heat pumps take advantage of thermal gradients to deliver high efficiency, turning one unit of electricity typically into 3-6 units of thermal energy. Heat pumps are well suited for conversion of waste heat from industrial processes or environmental heat.

Space heating

The heating of spaces to provide human comfort by any means such as fuel, electricity and solar radiation. The energy efficiency of the building and heating equipment is crucial to the operation of the system.

Untangling the bios

- **Biomass** – Organic material that is considered to be renewable such as wood and solid biological residue. Biomass is the material that biofuel, bioenergy and biogas are derived from, as well as range of bio-products.
- **Biogas** – Energy stores of gas that can be used for heat or electricity, captured from the anaerobic digestion of organic waste and organic matter.
- **Biofuel –** A fuel derived from biological sources (biomass); currently used a blend in automotive and commercial transport fuels. Biomass goes through a conversion process to become a refined product. Examples include ethanol and biodiesel.
- **Bioenergy –** Energy produced from burning biomass, mainly for heat but also electricity.

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