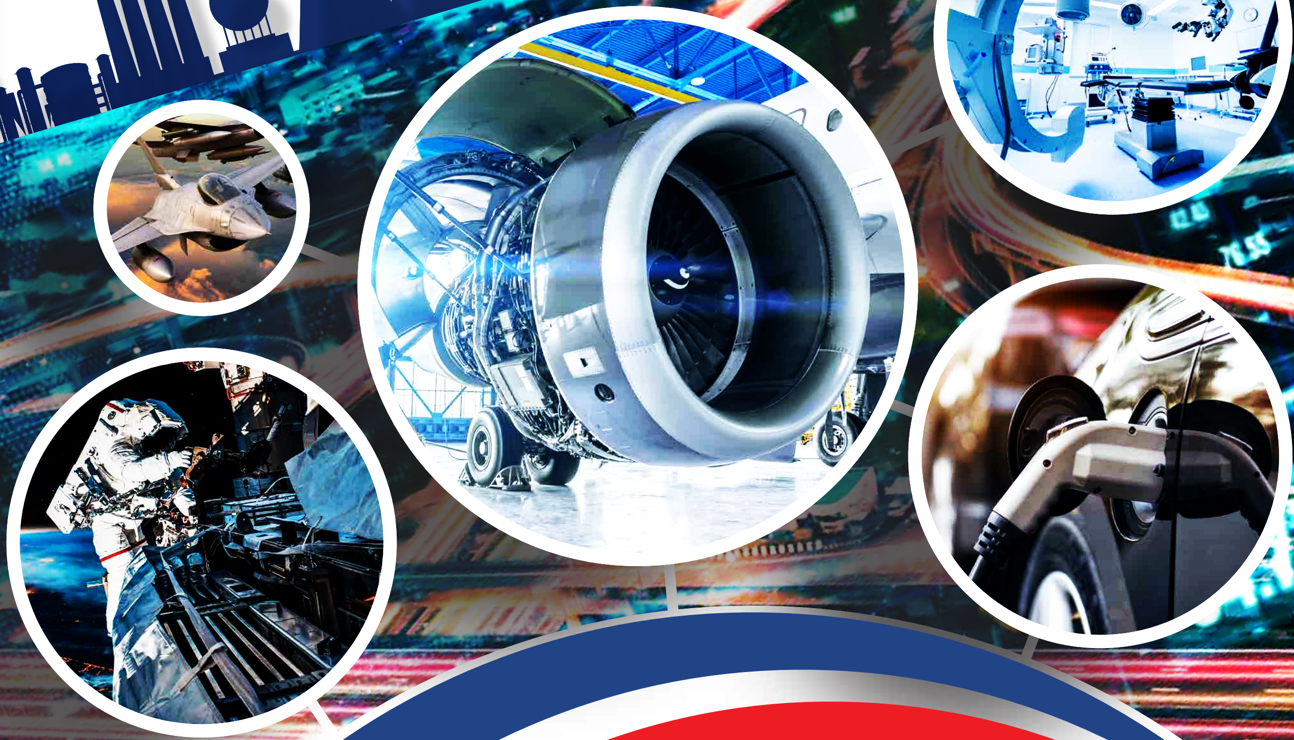
CAST METALS
FEDERATION



ROADMAP TO A GLOBALLY COMPETITIVE NET ZERO UK FOUNDRY SECTOR

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ROADMAP TO A GLOBALLY-COMPETITIVE NET ZERO UK FOUNDRY SECTOR

ABOUT THE CAST METALS FEDERATION

The Cast Metals Federation works to foster development, collaboration and innovation in the UK Foundry and Casting Industry, to represent the interests of the industry to Government and to promote good practice across the sector.

More than 85% of all UK castings are produced by CMF members, contributing over £2bn to the UK economy and underpinning strategic national supply chains including aerospace, power generation, defence, medical, automotive and marine.

CMF members produce castings in all metals and of all sizes and shapes. They use modern and automated versions of casting processes which have been at the heart of human societies for over 3000 years, including sand casting, die casting, investment casting, vacuum, centrifugal and continuous processing.

EXECUTIVE SUMMARY

UK castings manufacturers can lead in competing globally, growing our industry, decarbonising our components, providing strategic resilience to UK supply chains, and creating jobs and wealth for the UK.

Over the past 25 years continued loss of UK casting production to competitor economies has increased global carbon emissions. At the same time the UK castings sector has lost 100,000 jobs and the UK economy has lost £10bn of Gross Value Added (GVA). Critical national supply chains have become significantly less resilient to global economic shocks as a consequence. Reversing this leakage of economic strength is no easy task, but is the ambition set out in this roadmap.

To return £10 billion of GVA to the UK and support our national transition to a net zero future, we propose a partnership with government to align foundry sector investment with government industrial decarbonisation policies. These policies otherwise threaten to destroy the UK's remaining foundry capacity before the transition to net zero really begins.

We need government to provide a stable policy environment and specifically to:

1. **Reform energy markets** to enable UK foundries to access clean electricity at prices comparable to global competitors;

2. Provide **incentives for early capital investment** in zero carbon furnaces and production equipment that are as accessible for mid-sized foundries as they are for large refineries and foundation industries;

3. Accelerate development and implementation of **demand-side policies** that incentivise customer demand for **low carbon components**; particularly product-level carbon labelling and accompanying standards;

4. Support these policies with effective trade policies that **create global markets for low carbon UK components** and prevent low carbon components being replaced by high carbon substitutes;

5. Encourage **release of land** by local and regional authorities suitable for modern, **zero carbon foundries** and associated **zero carbon energy generation facilities** across the country. This will ensure that instead of our castings industry drifting offshore as it has over the past 40 years, international companies will look to relocate to the UK.

FOUNDRIES IN A CHANGING WORLD

What we do
Foundries are the critical intermediate stage in many industrial supply chains. They fit between commodity metal production facilities and final product assembly plants, converting basic metal ingots into high added-value components which are then assembled into consumer or industrial products by customers worldwide.

Without the ability to source competitively-priced cast metal components, no modern economy could survive: energy, defence, agriculture, mobility, medical and consumer products all depend on castings for critical functionalities.

UK foundry and castings sector has a strong global outlook. Over half the output of UK foundries is exported and more than 70% of CMF members supply international customers.

How we do it
The casting process is energy and capital intensive and the sector is built on deep and difficult-to-replicate understanding of materials science. Metals are melted in furnaces at temperatures ranging from 700-2000°C. These can be gas or electrically powered – in practice most UK light alloy (e.g., aluminium) foundries are gas powered, while most iron and steel (ferrous) foundries have converted to electricity.

The quality and performance of the final components will depend critically on the choice of source metal – often an engineered alloy to generate the required properties – as well as the design of the cast shape and the attention to detail in the casting process itself. Recycled metal can be used in many applications, provided the less-predictable properties of some recycled metals don't compromise the performance of the casting (e.g., the strength of an aerospace component).

UK castings are typically differentiated globally by quality, reliability, and relatively low embodied carbon. Many foundries secure long-term contracts with global OEMs to supply components specific to final product lines (such as a particular aircraft, tank or car) and work closely with their customers on design and supply chain optimisation.

Weir Group are a global engineering company operating a foundry at Todmorden in West Yorkshire. The Todmorden foundry makes large cast components for the specialist pumps that support the global mining industry. The company has a sophisticated energy management system enabling precise control over energy costs and carbon emissions. Almost all the foundry's output is exported.

The **William Cook Group** manufacture safety-critical steel components using advanced alloys for the world's defence, transport, energy and advanced manufacturing sectors. Operating from three foundries across the UK, the company employs 500 people in Sheffield, Leeds and County Durham.

Goodwin Steel Castings are world leaders in the supply of technically-advanced steel and nickel alloy castings for nuclear, renewables, turbine and defence applications, employing almost 200 people in Stoke on Trent. Over the past decade the company has delivered a number of world firsts, including some of the largest alloy castings for ultra-critical power generation. Efforts to install onsite solar generation have been held back by electricity distribution network investment priorities, which are currently preventing a proposed MW scale solar project proceeding until after 2028.

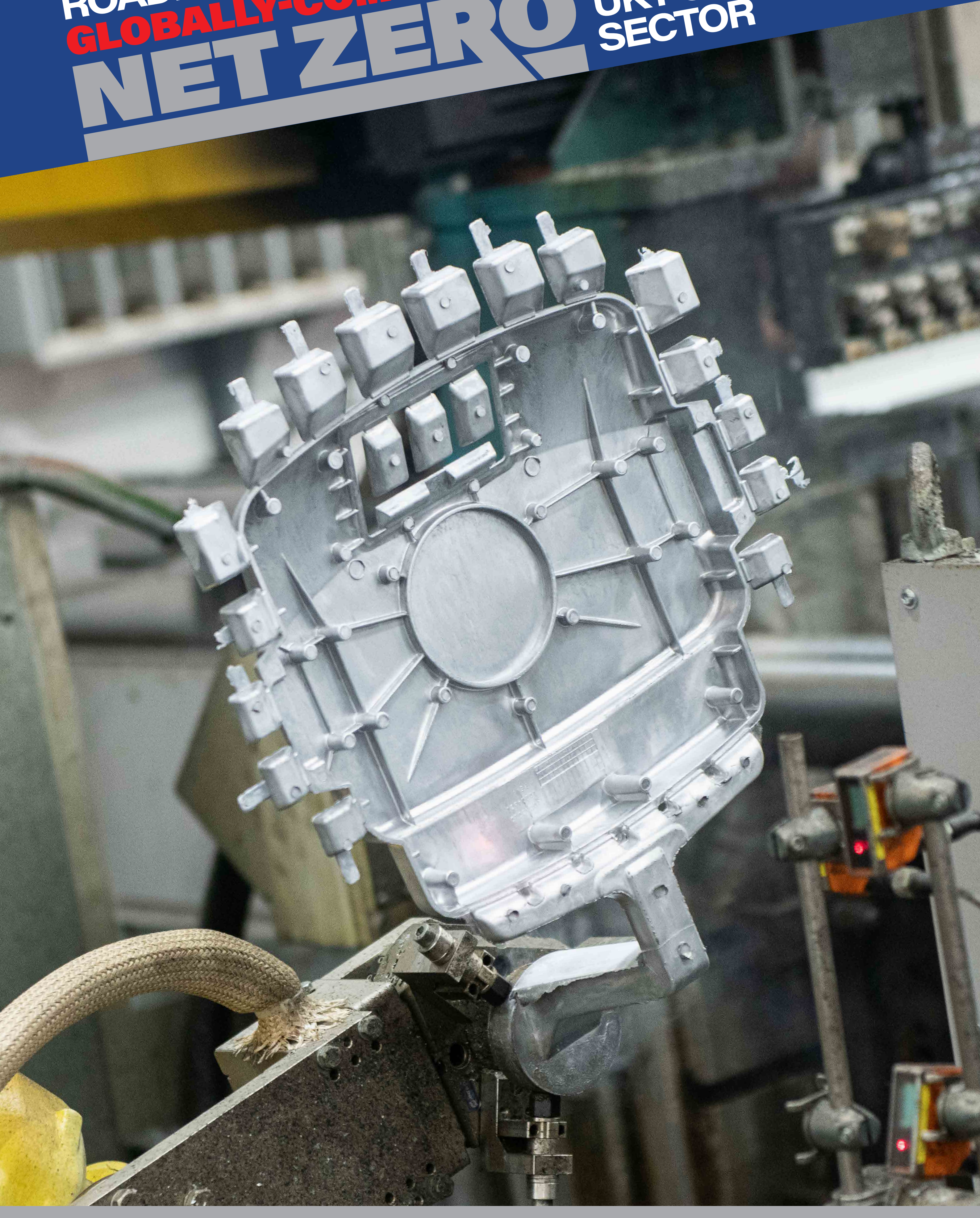
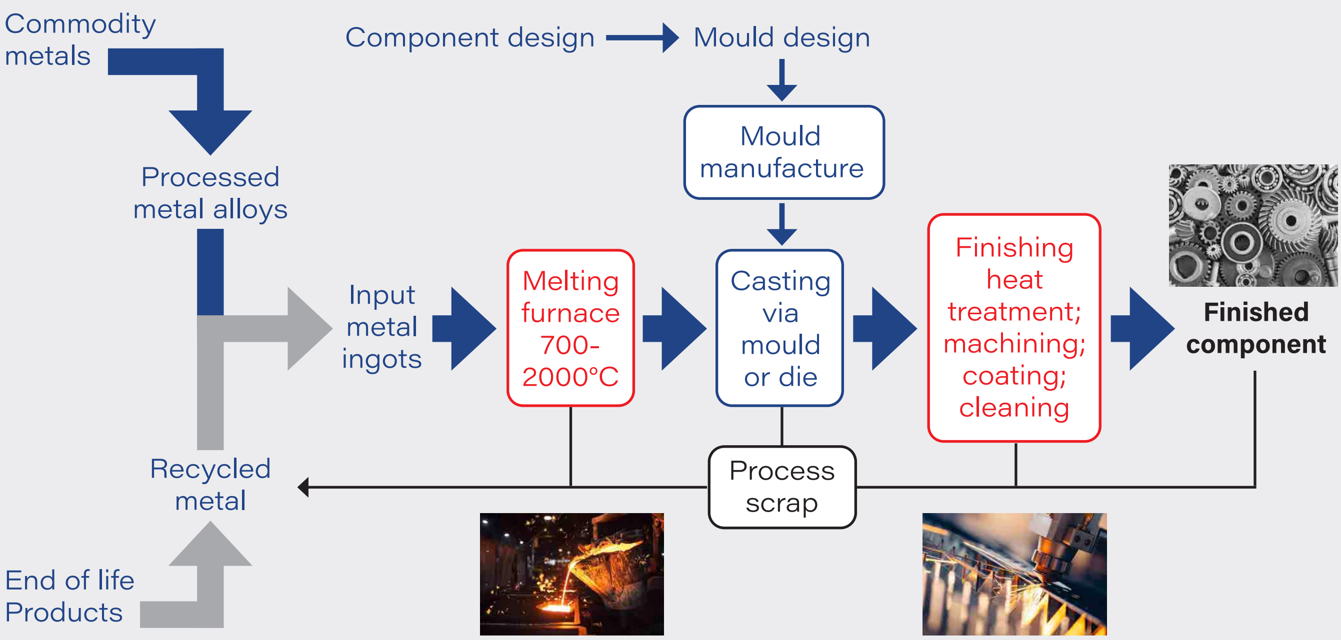


FIGURE 1: SCHEMATIC OF TYPICAL METAL CASTING PROCESS



Thomas Dudley Ltd employs 500 people and runs two foundries in the Black Country, manufacturing a range of construction and fluid technology products. Over the past 10 years they have implemented a company-wide energy monitoring and management system and energy efficiency investments that have reduced CO_2 emissions by over 430 tonnes. The company is currently investigating investment in a MW scale solar PV system which will make a further contribution towards their target of net zero production by 2040.

Capital investment cycles for foundries are relatively long. A typical furnace and casting production facility would normally be expected to last for 20-30 years, with only the tooling (die or mould) being changed at the end of product life cycles. Each product life cycle may last 5 or more years (for example, the product life cycle of a specific car model). Once a production cell is built, the company is therefore committed to the chosen fuel source (i.e., gas or electricity) for the next 20 years.

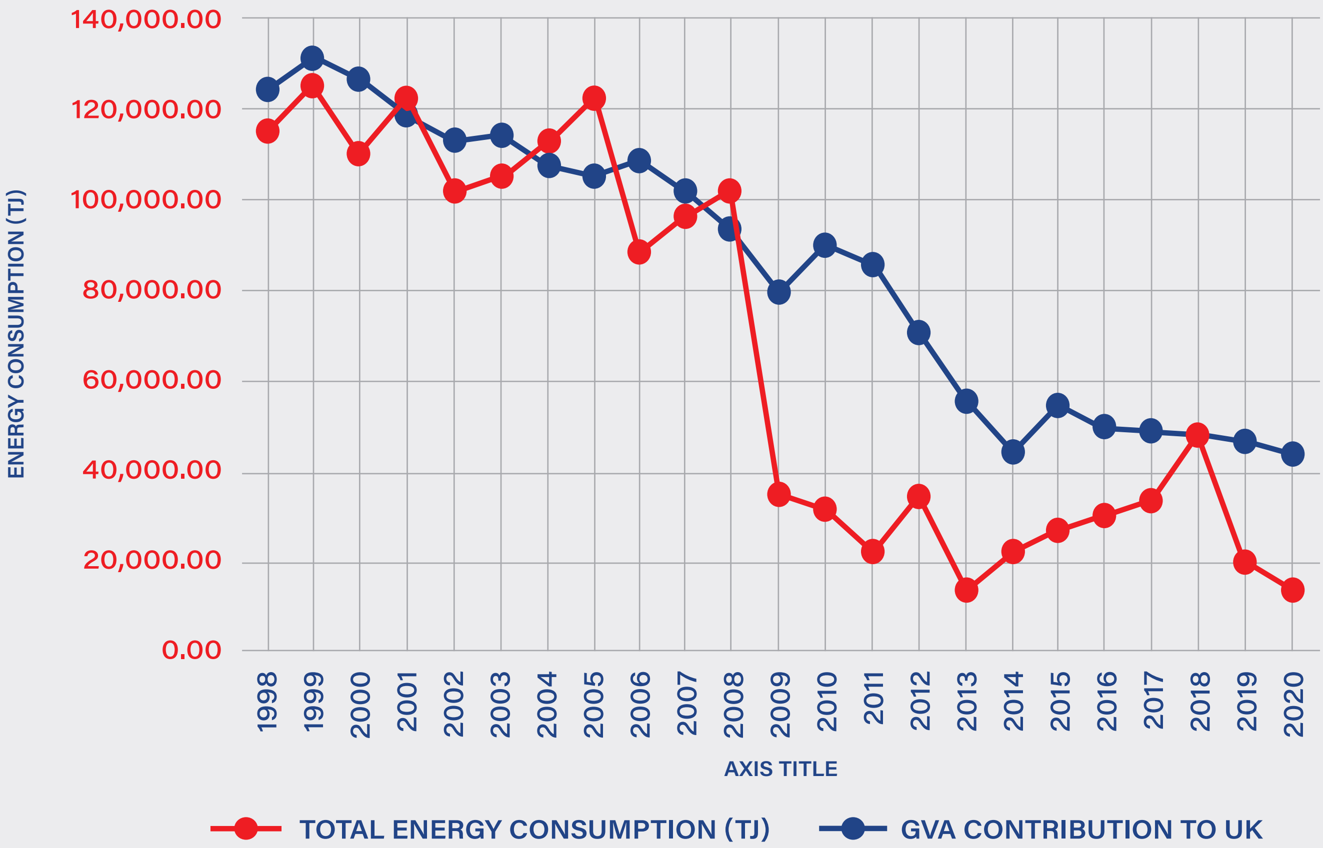
Where we've come from

Over the past 25 years, the energy use and carbon emissions of the foundry sector have fallen by almost 70%, but carbon leakage and offshoring has also resulted in an 85% reduction in UK output, or loss of £10bn of GVA contribution and around 100,000 skilled jobs (figure 2). However, the GVA contribution to the UK has remained broadly level since 2011, while energy and carbon use has halved over the same period (figure 2).

Significant reduction in UK carbon emissions has thus largely been achieved through large volumes of castings moving offshore up until 2011, followed by significant energy and carbon reduction from 2011 onwards. This has been achieved through energy efficiency improvements and fuel switching to electric induction furnaces. There have also been significant improvements in design technology, reducing the amount of metal needed per casting, and much increased use of recycled metal – reducing the overall embodied carbon of cast products.

The UK foundries that remain are very strong on compliance with environmental and health and safety legislation compared with other countries, and we are also leaders in use of recycled metals as our principal raw material.

FIGURE 2: PROGRESS IN ENERGY EFFICIENCY IN UK FOUNDRIES: UK FOUNDRY SECTOR ENERGY USE AND GVA CONTRIBUTION 1998-2020



Responding to global developments

Global political instability, higher energy prices, reliance on global supply chains and the imperative to transition to net zero create a challenging global competitive environment for the UK foundry sector, particularly if we aim to reverse the trends of the past 25 years.

In the worst case, there is a significant risk that casting of metals becomes completely uneconomic in the UK, and global carbon emissions rise as UK production continues to be transferred to countries with energy systems less committed to clean growth. This scenario will also leave strategic UK supply chains vulnerable to global shocks and international relations, with significant risks of UK automotive, defence, medical device and aerospace facilities unable to operate due to lack of key components.

In the best case, however, there are opportunities for the UK to lead the world in supply of zero carbon cast metal components and finished products. By aligning sector development and commercial investments behind a supportive national policy environment, we can envisage a roadmap to net zero over the next 30 years that not only delivers a net zero casting sector but also grows our GVA contribution and supports a globally competitive and expanding foundry industry in the UK.

W Hallam Castings Ltd was established in 1968 to manufacture pressure cast aluminium and zinc components for the UK electric motor industry. The company has expanded and diversified to make a wide range of cast and assembled products for more than 50 UK OEMs. Hallam provides state-of-the-art design and prototyping services to help customers develop products supporting sustainability and net zero initiatives, for example in the electric vehicle market.

ROADMAP TO A GLOBALLY-COMPETITIVE NET ZERO UK FOUNDRY SECTOR

Meet 'Merlin.' This CastAlum innovation enables them to track the flow of water cooling to multiple areas of the die or each individual 3D printed insert. This enables the flow temperature of the water returning from the die to be monitored and supports continuous optimisation of energy use and product quality.

CastAlum, based in Wales, specialise in particularly challenging aluminium castings for the automotive sector. Innovation- and engineering-led, many of the components CastAlum supply were previously considered impossible to make and their development work has resulted in significant cost and environmental performance benefits for their customers, in addition to the energy efficiency improvements achieved within the processes at the foundry.

GLOBALLY COMPETITIVE PATHWAYS TO NET ZERO

Where our emissions come from

The bulk of carbon emissions from foundries come from two sources:

1. Emissions from the production of the substantial amount of energy required to melt metal. This will be direct and onsite (scope 1) if gas or electricity generated onsite is used, and mostly indirect (scope 2) if grid electricity is used.

2. Indirect emissions generated upstream of individual foundries in smelting ore or processing scrap metal to create the raw metals and alloys which are the starting point for all casting process.

Sarginsons are an aluminium foundry based in Coventry who are world-leaders in light-weighting of aluminium components, reducing global carbon emissions of end-products across the automotive sector.

The remaining emissions will come from process energy used in generating compressed air; managing cooling water; managing the sand, dies and moulds used in the process; operating buildings and machining and heat treatment operations.

The diagram below shows the division of scope 1, 2 and 3 emissions for a typical foundry.

FIGURE 3: CATEGORIES OF CARBON EMISSIONS FROM FOUNDRIES

SCOPE 1
Direct emissions from facilities

- Gas combustion in furnace and boilers
- Fossil fuels in forklifts and trucks on site
- Onsite renewables

SCOPE 2
Created by procured electricity

- Grid electricity generated using fossil fuels
- Green grid electricity

SCOPE 3
Indirect consequence of company activities

UPSTREAM
- Embodied carbon in raw materials
- Staff commuting

DOWNSTREAM
- Logistics and distribution
- Component usage
- End of life fate of components

RELATIVE IMPACT

NEGATIVE — POSITIVE

Scope 1, 2 and 3 are the recognised international standards for classification of greenhouse gas emissions from industry. See ***https://ghgprotocol.org/***

LEVERS FOR DELIVERING CHANGE

There are five fundamental levers that are wholly or partly under the control of foundries themselves.

1. **Energy efficiency and good operations management**
   Good management practices to minimise the amount of energy to run a business, for example closing lids on furnaces or minimising holding times for molten metal, can generally reduce energy costs and carbon emissions by a few percentage points.

2. **Process and product improvement and/or change**
   As well as incremental efficiency, good housekeeping and continuous improvement, companies can innovate and redesign products to use less material or energy. Incremental improvements can typically deliver low (but worthwhile) percentage improvements in profitability and carbon savings. However, securing significant benefits, for example from process redesign, normally requires significant capital investment, for example in new production equipment.

3. **Materials substitution**
   Lower embodied carbon metal alloys (e.g., recycled or locally sourced) can be used for some castings without affecting engineering performance, providing customers agree. There are also some opportunities for moving from heavier alloys (e.g., steel) to lighter alloys (e.g., aluminium) in some applications, which can reduce downstream scope 3 emissions, although again, customers will be the primary decision-makers and the carbon savings are not always straightforward to establish.[ii]

4. **Securing control over energy supply, typically through on-site generation**
   Foundries can switch fuels from gas to electricity (or in theory, hydrogen) and then potentially agree 'sleeving' or power purchase agreements with individual generators at predictable costs. However, any such switch requires significant capital investment by the foundry in its core operational assets. Because of the magnitude of the energy demands for medium and larger foundries such switches may also require some infrastructure investment, either in enhanced connections to electricity distribution networks or to hydrogen infrastructure. This infrastructure investment may be outside the direct control of the foundry.

   An increasingly attractive option for energy-intense sectors like casting is also to invest directly in onsite generation. This has the major advantage of taking some or all of the energy supply to the foundry out of the volatile national and international energy markets and has potential to fix energy costs for the lifetime of the generation asset (for renewables). This option doesn't necessarily require further capital investment by the foundry if it is already using electricity to power its furnaces.

   However, accessing onsite and private renewable generation, offering fixed and globally competitive zero carbon energy costs, is easier and significantly cheaper in some locations than others. For example, hydroelectric and wind energy tends to only be available in quantity on coasts and near mountains. Solar energy is ubiquitous but insufficient to support even small foundries without excessive land use. This leads to the fifth option under direct commercial control.

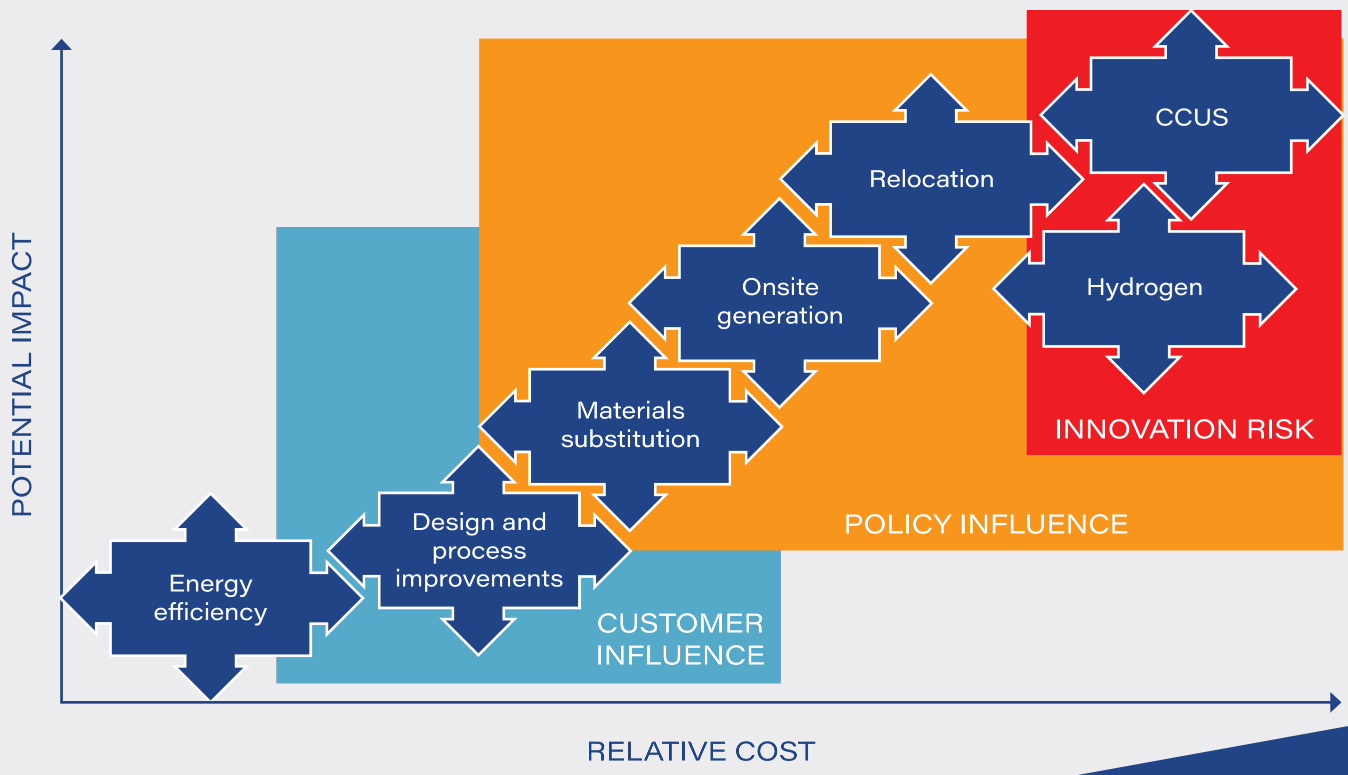
5. **Relocation**
   In principle, foundries could relocate to access cheaper, cleaner energy supplies, potentially renewing their process equipment and optimising their operations at the same time. However, this is a major investment and risk for any business, and potentially entails significant additional challenges around retention of skills, securing a suitable site, and retaining supply and customer relationships.

   For global companies in particular, once the decision is made to look at relocation, the tendency is to look globally for suitable sites, and this generates risks for the UK economy as a whole.

Carbon capture, storage and utilisation is a theoretical sixth option for emission reduction that might eventually be economic at the scale of individual foundries, but this is currently decades away from maturity, so is not considered directly in this roadmap. Similarly, hydrogen is only viable when distribution infrastructure is in place, and again this is some time away for most of the UK[iii].

MAT Foundry Group operates foundries across Europe and the world. Their EURAC facility in Poole specialises in brake discs for the automotive sector. The company has already delivered significant environmental improvements, including 100% use of renewable energy and 95% use of recycled materials, but continues to aim for improvement, targeting 97% use of recycled materials by 2040 and ongoing energy efficiency improvement of at least 1% a year. MAT also aim to procure 95% of input raw materials from the host country for each of their foundries, to minimise their scope 3 emissions.

FIGURE 4: SCHEMATIC OF LEVERS TO REDUCE CARBON EMISSIONS IN THE FOUNDRY SECTOR



The economics and attractiveness of these five levers under the direct control of the sector are significantly affected by a number of key policy enablers which are completely controlled by the Government. These are:

The rate of grid decarbonisation

Government controls the rate at which grid-supplied electricity becomes zero carbon. For foundries already operating electric induction furnaces supplied from the grid, this effectively controls the rate at which they will become net zero. The current trajectory is for this to be achieved by 2035.[iv] Since 2010 the carbon intensity of grid electricity used by industry has fallen by 70%.[v]

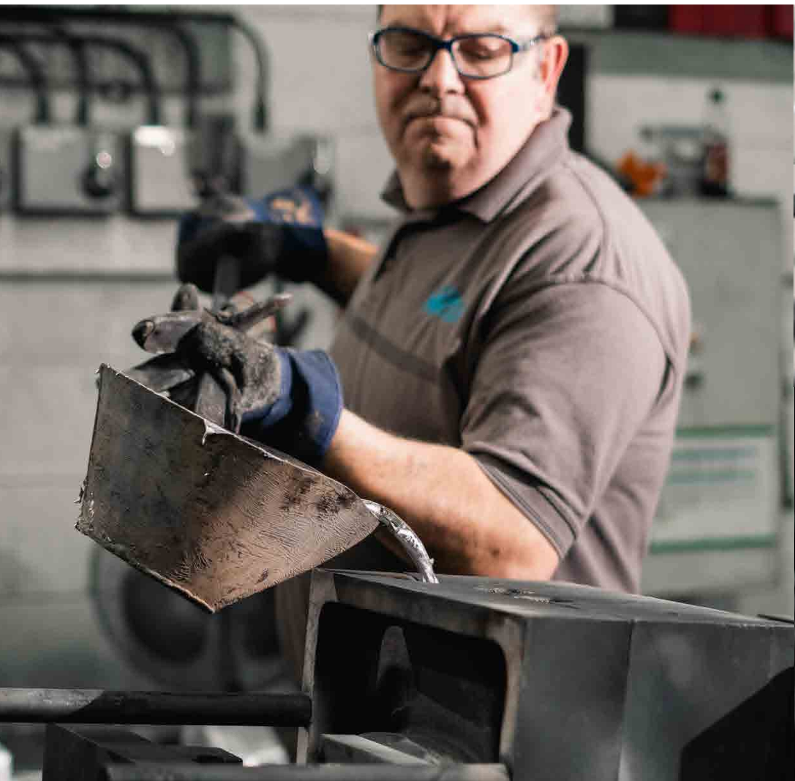
The allocation of costs within the energy system

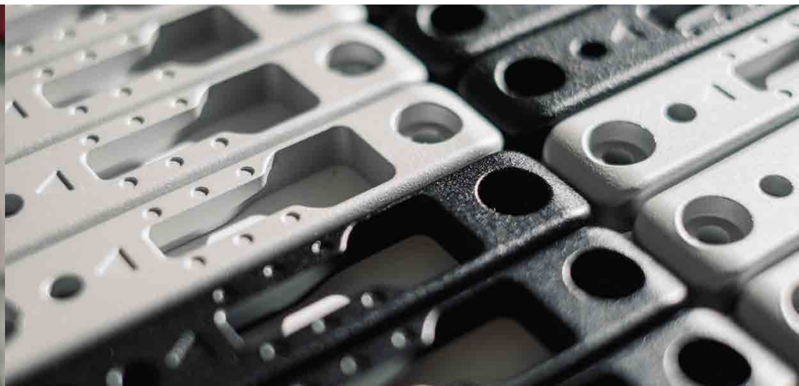
The structure of the energy market and the allocation of costs significantly affects the economics of investments in foundries and energy solutions for foundries. For example, government can choose to allocate infrastructure costs evenly, or to ask the domestic sector to bear the bulk of these, as is done in some competitor economies. Similarly, the costs of historic investments in renewables and nuclear power can be allocated to existing system users or absorbed by general taxation, and the costs of electricity can be set by global gas markets or in ways which reflect actual costs in specific locations at any moment in time.

The more stable and predictable industrial energy costs are, the more private investment is likely to flow into energy-intense manufacturing.

Carbon pricing and demand side incentives

Government can create markets for low and zero carbon products (i.e., incentives for commercial investment in carbon emission reduction) by setting minimum product standards and enforcing labelling schemes, and by creating and policing carbon prices and emissions trading schemes.





MRT Castings specialise in complex, tightly-toleranced and critical parts for hi-tech sectors such as electronics and medical devices in aluminium or zinc. Based in Andover, the company serves a global customer base, providing design engineering expertise as well as state-of-the-art manufacturing capability.

This creates customer pressure and support for carbon and cost-saving initiatives involving materials substitution and product design, effectively leveraging private and customer investment in decarbonisation at minimal public cost.

The roll-out of low carbon energy infrastructure

Clean energy solutions for industry such as hydrogen and carbon capture will only be economic when cost-effective supply infrastructure is available (i.e., new energy networks). Government controls the rate at which such networks are provided, where they are provided, and who pays for them. It's not always clear that provision of universal access to these new networks is objectively in the best economic interests of the country: the funding might better be spent on demand side policies or support for relocation and onsite generation, for example.

Trade policy

Finally, government can work with international partners to build global markets for UK products. This might include extending consistent carbon pricing across multiple jurisdictions, or applying carbon border adjustment mechanisms to prevent zero carbon castings manufactured in the UK from losing business to equivalent castings manufactured using more carbon intense processes in other countries.

ROADMAP TO A GLOBALLY-COMPETITIVE NET ZERO UK FOUNDRY SECTOR

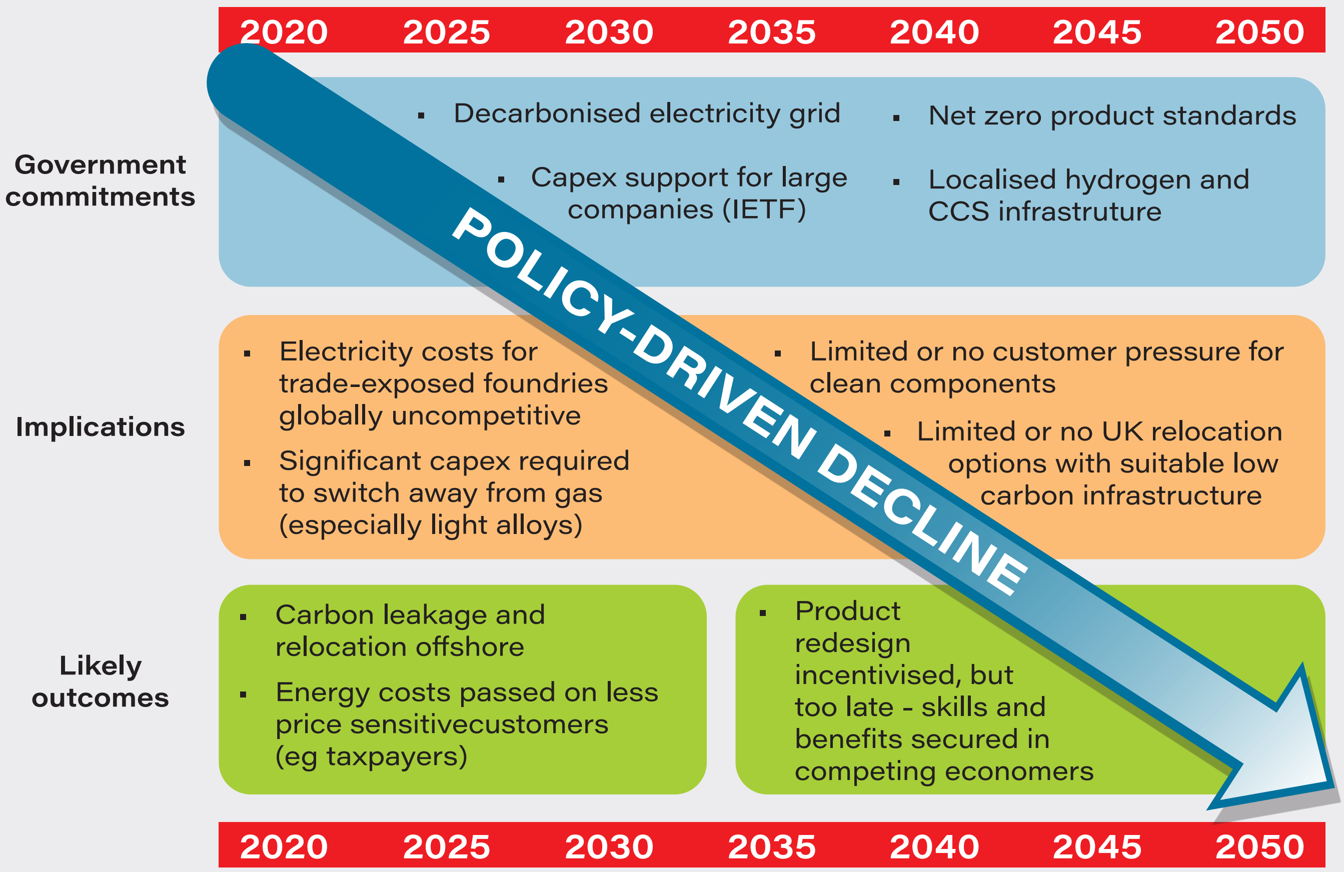
An example of the ever-increasing tooling capabilities additive manufacturing facilities give us. We're always looking for new ways to maximise this technology to provide even better-quality products to our customers.

RISKS OF INACTION

A major challenge for the casting sector is that previous governments have partly implemented a variety of different policies aimed at supporting industrial decarbonisation, the combined effect of which is to put UK foundries at a significant competitive disadvantage compared to global competitors (Figure 5). In particular:

- **UK electricity costs are 28%-90% higher than those for equivalent industrial customers in competitor economies;[vi]**
- **Support for the accelerated capital investment required to switch from gas to electric furnaces is much easier to access in the UK by companies significantly larger than typical foundries;**
- **There is limited supply chain pressure for the kind of lower embodied carbon components that UK foundries already produce, due to lack of authoritative, government-backed product standards and accounting methodologies;**
- **It is much harder to find land and low carbon infrastructure suitable for expanding or relocating foundries in the UK than in many other economies.**

FIGURE 5: IMPLICATION OF CURRENT POLICIES: UNMEDIATED RISKS OF CURRENT GOVERNMENT POLICIES FOR THE UK FOUNDRY SECTOR



The consequences of misalignment and lack of stability are thus loss of competitiveness and either excessive costs for customers or loss of investor confidence and carbon leakage; these will lead to, these will lead to significant loss of strategic resilience for the UK economy.

However, with a few small adjustments to national policies a much more positive picture could emerge.

A VIABLE ROADMAP TO A GLOBALLY COMPETITIVE ZERO CARBON FUTURE

1. The accelerated capital investment in electric induction furnaces and heat treatment equipment needed to align foundries with the zero-carbon fuel mix chosen by the UK government (i.e., electricity) needs to be supported by accessible grants and loans. The existing Industrial Energy Transformation Fund (IETF) has been designed with, and is appropriate for, heavy industry and very large sites; an equivalent scheme needs to be created that is more accessible for mid-sized energy-intense firms, such as foundries.

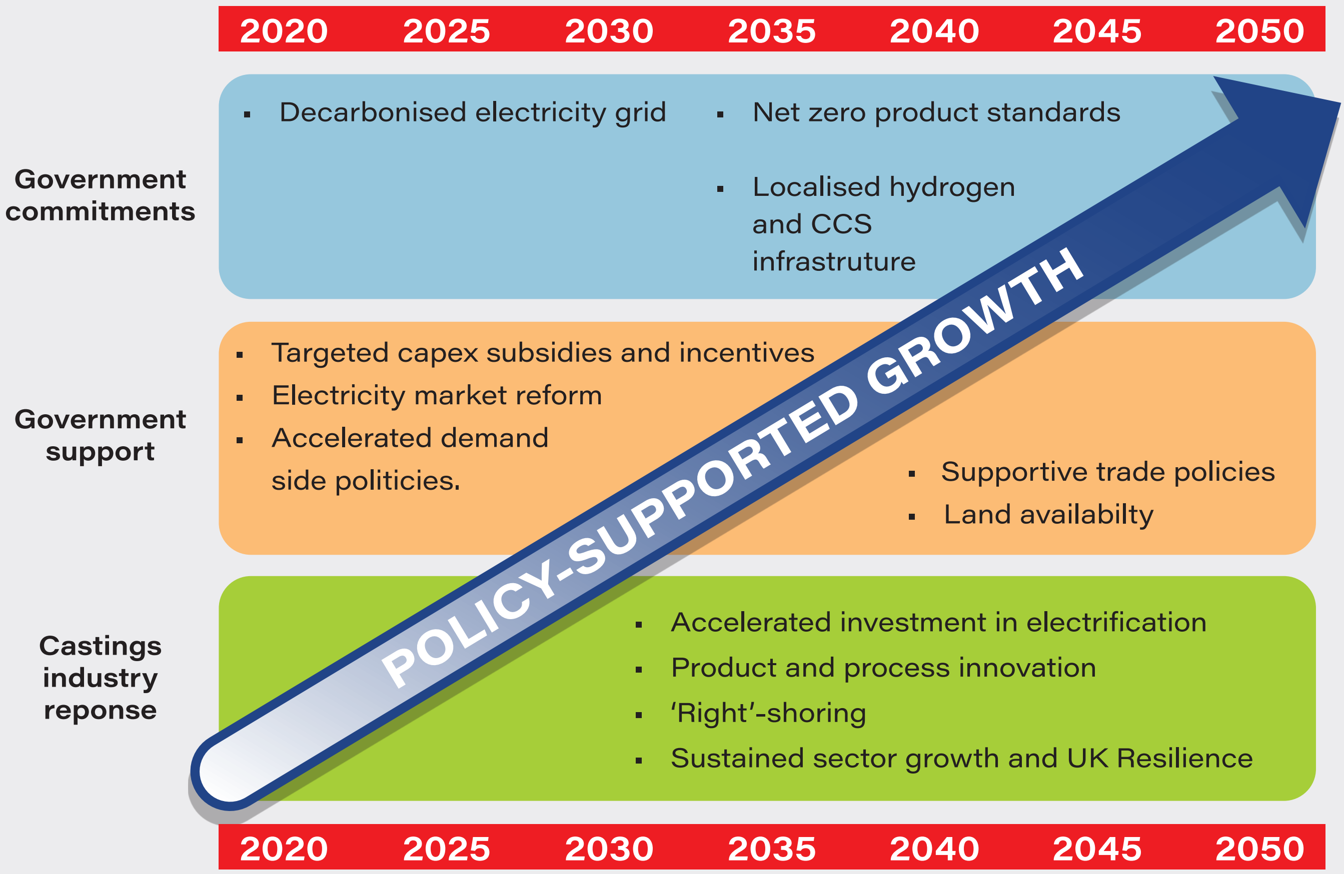
2. Industrial electricity costs must be brought into line with those of our global competitors. There are a number of ways to do this, for example:
   a. Ring-fencing of cheaper generation such as nuclear and renewables for industrial use; delinking electricity from gas pricing.
   b. Capping the cost of gas, as has been done in other European countries.
   c. Extending exemptions from levies to mid-sized, trade-exposed manufacturing; thinking strategically about these exemptions rather than applying arbitrary financial cut offs.
   d. Providing a 90% discount on network costs for energy intense manufacturers to align the UK with policies across EU competitor nations.
   e. Maintaining cost incentives for energy-intensive industries to use electricity during off-peak periods.
   f. Reforming energy market regulation to remove the bias towards consumers and to ensure industry has a meaningful role.

3. Demand side policies such as carbon labelling for intermediate industrial products need to be brought forward to encourage customer demand for net zero castings and recognise the lower embodied carbon offered by UK foundries which maximise the use of recycled metal.

4. These demand side policies need to be supported by carbon border adjustment mechanisms and wider work with international partners to create common markets and accepted international standards for lower carbon metal components and finished products.

5. The UK and English regions need to be supported and encouraged to make land available for low and zero carbon industrial areas where energy-intense mid-sized manufacturers can be supported by fixed and predictable cost energy generation at suitable scale, such as hydro-electric, wind and small modular nuclear reactors.

FIGURE 6: A ROADMAP TO A COMPETITIVE NET ZERO FUTURE FOR THE UK FOUNDRY SECTOR



These policies need to be co-designed with industry and implemented in the next decade if the UK is to retain a resilient strategic cast metals sector into the 2040s.

If we get this right, there is no reason why we can't grow the sector back to contributing £12 billion a year to the UK economy and employing 100,000 people in a decarbonised world.

ROLES & RESPONSIBILITIES

Leadership

UK foundries know how to compete internationally and deliver low and zero carbon components into strategic supply chains. They can secure investment in new production facilities and optimise sites to maximise the benefits of on-site energy generation.

Foundries are also critical to decarbonisation. Our castings are the key components in the infrastructure of a zero carbon economy, from overhead power lines, to hydrogen networks and fuel cells; pumps and turbines for nuclear power plants; wind turbine hubs; hydroelectric runners; components for electric vehicles, construction products and smart energy system controllers.

We are part of the solution, not part of the problem.

Goodwins Foundry – showing large solar PV scheme

Collaboration and support

However, like any other industry, we look to government to set a clear and stable policy framework within which to compete. The biggest single factor affecting our ability to decarbonise is how our electricity is generated, distributed and charged, and this lies almost entirely outside the industry's control. The policy environment is an area where we expect and need government to lead, and our role is to collaborate and support policy-makers in setting achievable targets; aligning energy, industrial and trade policies; and in measuring and monitoring progress.

In particular, government has a key role in establishing a competitive and supportive zero carbon energy system for industry and in encouraging our customers to demand lower carbon components from their supply chains. We need the UK to build international partnerships that create low carbon markets worldwide; and which ensure that substitution of low carbon components by higher carbon components from competitor economies is discouraged by market incentives and border adjustment mechanisms.

We look forward as a sector to working with government on delivery of this roadmap.

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Glossary of Terms

CCS Carbon capture and storage

CCUS Carbon capture, utilisation and storage

GVA Gross value added, a measure which combines profit and employee costs, so indicates total contribution to the economy.

IETF Industrial Energy Transformation Fund, a £289M fund primarily targeted at heavier industries

OEM Original Equipment Manufacturer, the companies who assemble and sell the final products for customers, often global household names.

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