Materials Processing Institute

FOUNDATION INDUSTRIES OF THE FUTURE: SECURING THE RAW MATERIALS THE UK NEEDS

A speech given at 'The Science Council Climate Conference: The UK Pathway to Net Zero', Institute of Physics, London.

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Materials Processing Institute

Historically, the major raw materials that have driven the global economy have been oil, coal and iron ore, alongside other metals. These materials, often somewhat disparagingly referred to as 'commodities' are the basic building blocks on which our lives and our economy is built.

As industries such as steel decarbonises, we will see a shift in technology, for instance from blast furnace steelmaking to new direct reduction furnaces, that will also see a shift in raw materials from coal, through first natural gas and then to hydrogen. This switch is rapidly bringing a new suite of raw materials to the fore and their importance is such that each country must act to ensure that they will secure the supplies that they need for their own economy.

Hydrogen

Of prime significance for a green industrial sector will be the future availability of hydrogen, preferably green hydrogen, in vast quantities. In fact, hydrogen will be so important in the future that I view this as the emergence of a new foundation industry. Sitting alongside materials such as metals, chemicals, and cement, hydrogen will become another pillar of our modern green economy, rapidly commoditised, but hugely valuable for our daily lives.

This hydrogen will be used for the energy, transport and industry, particularly to refine iron ore, in hydrogen direct reduction furnaces and the availability of hydrogen will be critical for any national steel sector. Investing in national infrastructure to support the generation, transport and storage of hydrogen will be critical to the success of the green steel transition.

Switching to hydrogen presents a number of technology challenges, that in most European countries are being addressed by significant public investment in pilot innovation and scale up projects. Flagship steel projects of circa 50m euros each are being carried out in Sweden, Germany and Austria, with related activities in France, Spain and Italy.

Significant progress is being made at the Materials Processing Institute, in Teesside, where we have installed a hydrogen gas network at our campus and are preparing for pilot scale studies on hydrogen iron production. However, the scale and pace of government investment in the UK falls far short of our European competitors.

One observation I drew from the recent Hydrogen 4 Life conference in London in June was how the now departed Boris Johnson-era Energy Minister Greg Hands made a request for gratitude about 250 million pounds of UK government investment in hydrogen technologies.

Yet just minutes later, hydrogen bus entrepreneur Jo Bamford rather dismissively compared that figure to the many billions being invested by Germany.

I take solace from the fact that new Climate Minister Graham Stuart was sat in the front row of the conference despite hydrogen not yet being his brief.

That's a positive sign because, despite our inherent advantages in innovation capability and assets, there is a real risk of being left behind in this race for global intellectual property and know-how. We have made a proposal to address this through a national pilot plant investment for hydrogen iron production.

Iron ore

Iron ore will remain a hugely important raw material. Currently iron ore is second as a globally traded commodity only to oil and demand will continue to increase as the global demand for steel increases. However, the switch to green steel production, reliant on replacing blast furnaces with direct reduction furnaces, presents a significant problem.

Research over many decades, at Institutions such as the Materials Processing Institute, has enabled the blast furnace to cope, both technically and economically, with a wide range of iron ore qualities. In that sense the blast furnace is a hugely flexible and forgiving process. The direct reduction furnace however is not. It requires a premium, pelletised diet, produced form only the finest of iron ores. So fine in fact that it is currently believed that less than 5% of known iron ore reserves are suitable for use in direct reduction furnaces.

This is another reason why other countries are investing heavily in research and innovation, in pilot and upscaling of the direct reduction technology, to start the process of gradually widening the range of iron ores that can be used. Gaining the necessary process know how to achieve this will be critical to ensuring that a nation's steel industry can not only compete economically, but find sufficient raw materials at all.

At the Materials Processing Institute we are already starting this research, but again the amount of funding available is significantly behind our European competitors, and I am calling on government to at least match the funding levels of our competitors in this area.

Scrap

On scrap metal, the UK produces approximately 10MT of scrap steel every year, but with only 7MT of steel produced in the UK and the bulk of that via the blast furnace route, the majority of our scrap is sent for export overseas, where it is reprocessed and imported back into the UK, either as steel products, or manufactured goods.

Increasing the use of scrap in domestic steel production is not without its challenges. There are issues in terms of matching the quality of the scrap to the quality demands of new steel products. However, it should be a cause of concern that on a per capita basis the UK is the world's largest exporter of scrap.

This model of exporting a valuable raw material and then importing finished goods is more redolent of the economies of developing nations caught in the 'resource trap' of exploitation, rather than a modern industrial economy. To some extent it is a symptom of the relative decline of UK manufacturing supply chains versus our European competitors, but it also reflects the uniquely poor competitive business environment in the UK that has driven most steel scrap melting, all primary aluminium production and all copper refining overseas.

Policies that will support the greening of the UK steel sector, by reducing the UK's economic disadvantage for energy intensive industries, will lead not only to more economic value added for our valuable steel scrap raw material, but a reshoring of production in aluminium, copper and other metals too.

Electricity

It is probably apparent now that the key raw material, the one that we really need to get right first, is electricity and green electricity in vast quantities. Given the current energy crisis, this is a timely moment to be discussing our future electricity needs and in particular energy security. For too long the UK has taken a hands off approach to energy policy, an approach that saw our industrial strategy of the last few years have a sector deal for the creative industries, but not for energy, or even steel.

I estimate that greening the steel industry will require a 10% uplift in UK energy generation – primarily for the production of hydrogen. Combine this with the forecast 25% increase in electricity demand as we switch to electric vehicles and the up to 30% of electricity currently imported to the UK via interconnectors, plus switching to electric home heating and it becomes clear that achieving a green and secure UK electricity supply could require up to a doubling of domestic energy generation.

In large part the scale of this challenge is due to the green transition, but decades of underinvestment in UK electricity generation and grid infrastructure have also left us at a serious disadvantage.

There are some who argue that the answer to this is to accept limitations in electricity supply and to look at creative ways for steel companies and other parts of the economy to balance demand with supply, by for instance stopping production at times of peak demand. Whilst this would certainly solve the problem of the energy companies, such an approach is the complete reverse of sensible economic planning.

Electricity is the blood that runs through the veins of the modern economy and to keep the economy running we need to produce more. Restricting supply will result in weakened economy and a structural competitive disadvantage.

What sense does it make that to turn off the factories, or datacentres, that are generating wealth for the nation, instead of investing further in green electricity generation. Our electrical power industry is the foundation of all foundation industries and needs to be set up to properly serve the functioning of a modern, green economy.

Whilst this challenge may seem great, it has been tackled before. In the post war period, in a little over 15 years, UK electricity supply doubled, to provide the necessary energy infrastructure for a growing industrial and manufacturing economy. This was achieved by consistent government planning and investment in infrastructure and we can see some signs of political recognition of the need for a similar intervention today, as this week the Labour Party announced a policy to create Great British Energy, a national energy company that will champion investment in renewables, sitting alongside a national wealth fund that will take a stake in infrastructure investments.

Starting as we are, in a position where the 5M UK consumers are paying their energy bills to the French government, the Swedish government owns the largest windfarm in Wales and the Chinese Communist Party owns a stake in our nuclear power, the establishment of Great British Energy would be a positive step in ensuring that our energy generation is orientated to power the homes of British people and the factories of the British economy, rather than acting as an cash cow for overseas investors.

Natural gas – A transition raw material

The final raw material I want to mention is natural gas. This is an important transition material that will see a significant increase in use as steel companies gradually switch from blast furnace to direct reduced iron production. Most steel companies that have started down this road to decarbonisation have recognised that instead of jumping directly from coal to hydrogen, they can make a transition to natural gas first, which not only reduces the technological risk, but also gives an immediate 60% reduction in carbon emissions.

Whilst this approach is both rational and environmentally positive at the level of the individual company, when taken across the whole of the steel sector it will result in a huge increase in demand for natural gas.

The sheer scale of the steel sector, is such that, just at the time when Putin's invasion of Ukraine has sent global gas prices skyrocketing, a new and huge user of gas is emerging on the market. In coming Winters we could face the situation of domestic consumer, effectively competing with global steel companies, to buy the gas that they need to heat their homes.

The answer to this has to be doing all we can to increase gas production in the short term, so that for that the next 10 to 15 years, gas is able to act as a transition fuel for industry.

Conclusion

In conclusion then, we are on the brink of a green transition that will lead to a radical reformation in the raw materials and foundation industries that provide the basic aspects of life on which we all depend.

Prime Minister, Boris Johnson was right to introduce his 10 point plan for a green industrial revolution. That commitment clearly remains in government from many despite some hostility to net zero from a couple of losing leadership candidates. It is important that we do see Liz Truss and Keir Starmer competing over positive green policies because they are just as vital for our world's future as they are for this country's growth and security.

The UK has historically neglected many of these areas, but in an increasingly uncertain world it is an imperative that we secure the resources we need for our future economy and that means investing now in innovation, alongside making plans to rapidly expand domestic production of green electricity and green hydrogen, for our communities, our economy and our national security.

Chris McDonald
Chief Executive Officer
Materials Processing Institute

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Chris McDonald is the Chief Executive Officer of the Materials Processing Institute. The Institute carries out industrial research and innovation in advanced materials, low carbon energy, digital technologies and the circular economy supporting the materials, processing and energy sectors for over 75 years. Chris led the divestment and return to independent, not-for-profit ownership of the Institute in 2014.

Chris's background is in industrial research and manufacturing, where he has worked internationally. A graduate of Cambridge University, Chris is a Fellow the Institute of Chemical Engineers and of the Institute of Materials, Minerals and Mining. He sits on industrial advisory boards at a number of universities, including Oxford and Sheffield.

Chris has an interest in innovation management and industry dynamics and in addition to leading the Institute, he provides expert opinion and consultancy support to companies, institutes, Governments and public bodies in innovation and technology strategy and management. He also advises on the technical due diligence aspects of mergers and acquisitions.

Chris is prominent in the development of public policy, around innovation, steel, SMEs, where he works to support growth and inward investment. Chris is the policy chair for Innovation and Enterprise for the Federation of Small Businesses, a member of the CBI Regional Council and Shadow Monetary Policy Committee for the North East, the Chair of the UK Metals Council and a member of the Steel Advisory Board for UK Steel (EEF).

Chris is often called to commentate in the media on innovation leadership and the steel industry.

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The Materials Processing Institute is an independent, open access and not-for-profit technology and innovation centre working with industry, government and academia worldwide. Support ranges from small scale, site based investigations, through to long term collaborative research programmes.

The Materials Processing Institute is expert in advanced materials, low carbon energy and the circular economy, specialising in challenging processes, particularly those involving high specification materials, high temperatures and difficult operating conditions.

The Institute has over 75 years' experience as a leading UK technology provider. Extensive materials processing knowledge is supported by state-of-the-art facilities with a broad range of equipment, from laboratories through to demonstration, scale-up and production plant.

Scientists and engineers work with industry and apply their expertise to develop and implement robust solutions to research and development and improvements for products and processes.

Expertise is spread across a wide range of disciplines, including:

- Materials Characterisation, Research and Development
- Simulation and Design
- Monitoring, Measurement and Control in Hostile Environments
- Process Development and Upscaling
- Specialist Melting and Steel / Alloy Production
- Engineering / Asset Management
- Materials Handling
- Minerals and Ores

Research and project management teams deliver support across a wide range of industrial and manufacturing sectors including:

- Metals and Metals Manufacture
- Chemicals and Process
- Nuclear
- Oil & Gas
- Energy
- Aerospace and Defence
- Mining and Quarrying

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