Metallic Waste Treatment Opportunities

Workshop Report
Summer 2022

Cross-Industry Learning

Contents

Introduction

The waste hierarchy is clear on the process for consideration to turn waste products back into productive material and this in turn follows the theme of the circular economy.

It starts with resource efficiency in the initial conceptual design of products, through operational life and considering future possible lifecycle opportunities for refurbishment, reuse, repurposing and if possible, reprocessing. To some extent, the decommissioning process of large infrastructure projects (and smaller discreet manufactured products such as from the automotive industry) is dealing with the legacy of little consideration given to the circular economy theme which has emerged more significantly when dealing with climate change and sustainability issues categorised through the United Nations Sustainable Development Goals (UN SDGs).

Treatment of metallic wastes have long been reprocessed for sale back into the market and the industry's trade association, the British Metals Recycling Association (BMRA) represents an estimated £7bn UK metal recycling sector.

The UK metal recycling industry is so efficient at recovering metal from end-of-life products that more is recovered than can be consumed domestically, but what we lack is a UK based reprocessing capability and manufacturing industry to create new products at scale.

As a result, over 80 per cent of all waste metal is destined for export and offshore treatment. This results in the UK competing against suppliers from the USA and Japan who are not required to characterise recycled metal as waste. In 2017, the UK exported over 9 million tonnes of recovered ferrous (iron and steel) metal. From an environmental perspective it is claimed that every tonne of recycled steel saves: 1.5 tonnes of iron ore, 0.5 tonnes of coal, 70% of the energy, 40% of the water, 75% of CO_2 emissions, and 0.97 tonnes of CO_2[1].

Ultimately the purpose of the workshop was to gain a better understanding of the known-knowns as well as the known-unknowns, and to see if there was an appetite for further collaboration to help build a business case for inward investment – wherever that investment may be.

[1] BMRA response to Zero Waste Scotland's Report on How should Scotland Manage its Scrap Steel?

1 Cross-Industry Learning: Sharing Good Practice Across Industrial Sectors

At the NDA, we've been working with the North Sea Transition Authority (formerly the Oil & Gas Authority), the Environment Agency, the National Nuclear Laboratory, Defence and Renewables, to organise a series of workshops and seminars to stimulate cross-industry learning.

This collaborative working was initiated in early 2018 when the nuclear decommissioning industry recognised that it was too inwardly focused on its own mission and lacked an outward leaning posture from a learning perspective.

Initially, a number of shared common themes were identified between the NDA and the North Sea Transition Authority which were the topic of some early round table events and workshops. Over time, several themes of common interest have been identified from a wider decommissioning industry perspective. This report is one of a series of reports that shares learnings from one of these themes of common interest.

The organised cross-industry engagements have been designed to bring together not just different industries, but also a cross-section of organisations from within each industry.

Workshops and seminars have comprised relatively small, hand-picked, invited-only participation, strongly facilitated and conducted under the Chatham House rule to encourage openness.

Throughout these events we have witnessed a continued drive and determination to share decommissioning lessons learned and good practice.

Going forward we will continue to aid the discussion and identification of cross-industry themes of common interest, as well as encouraging collaborative projects.

We believe that different industries have much in common when it comes to decommissioning, and that we all stand to benefit from cross-industry sharing of expertise and learning.

2 Executive Summary

This workshop brought together some of those organisations having an interest in metals reprocessing and conjoined by others who had been researching the opportunity for building a business case to onshore the process within the UK.

Different organisations have been trying to establish the facts to answer a number of key points which include understanding the commercial benefits to the UK to create new jobs, enhance security of supply making recycled steel less prone to international market pricing, and to reduce carbon emissions with regards to transport movements and reprocessing using energy from renewable sources of power generation.

The nuclear industry has its own unique radioactive contaminated waste issues to deal with, however not all such contaminated products originate purely from nuclear sector operations. Radionuclide contaminated materials also arise from other sectors such as Academic, Health, Oil & Gas sectors.

The NDA was keen to learn from other industries and work in collaboration with others where there could be benefits which match its own mission objectives including a zero carbon future and creating a sustainable economic legacy for its communities. It became clear that the regulations and international reporting obligations that drive the nuclear industry into reporting its full waste inventory wasn't mirrored by any other waste producing sector. It was also acknowledged that even the published inventory did not necessarily have enough granularity or accuracy required by its own treatment framework supply chain, but this was a piece of work in progress.

This workshop sought to bring together existing insights and knowledge from across a range of industries regarding the quantum of metallic waste material in terms of type and availability over the coming years in order to inform the potential for further cross-industry collaboration.

When considering all that was presented by the speakers and discussed with participants, it became clear that many questions remained outstanding and it was commented on at the end of the meeting that this is often a sign of a successful workshop, providing some clear pointers as to proposed next steps, which we hope have been accurately captured by this report.

The speaker presentations gave a rich overview of the current market state of play and reflected several of the aspirations attendees were aiming for. Two distinct themes emerged and were commented on throughout the workshop discussions:

1. that outside nuclear there is no definitive overarching industry knowledge of what the material type would be for reprocessing, where or when it would occur, and
2. that it would be a 'no brainer' for industries to work together to provide better efficiencies and hopefully build the business case for the private sector to invest in suitable facilities – regardless of where such a facility may be.

On the subject of manufacturing industry requirements such as for the offshore wind or onshore new nuclear power stations, there are two important factors to be considered if recycled products are to enter the supply chain. The first is relatively easy to assess and that is in order for manufacturing businesses to thrive, it ideally is either close to source or close to market. The second is that it is important to understand what our manufacturing industry needs are in terms of raw materials to be able to produce (locally) the right grade of Stainless steel, Steel, Alloys, etc. This would contribute to the case of having smelter facilities in UK.

One of the outstanding questions from the workshop is whether there could be a market for lower contaminated waste metal.

For instance, could radioactive contaminated metal be used to construct waste packages that will be used within the future national Geological Disposal Facility? In this example the packages will be holding waste with significant radionuclide inventories and hence subjecting waste metal to a full and expensive process of decontamination seems unnecessary. Would this be practical and what potential savings could there be?

Lastly there was one overarching theme which did seem to resonate with all parties. The presentations and work clearly showed the parochiality of research to date, with each organisation looking within its own boundary of interest. Who can/should be enabled to have the mandate to lead on creating a single UK view with impartial and unfettered access to provide a whole UK-wide inventory and prepare a business prospectus which takes into account of all the 3 pillars development – the economic, environmental and societal benefits?

Such an organisation would need support, but through being able to reach out and bring together all the existing work and bridging any gaps with industry representative and research organisation, the benefit would be to UK Plc.

Post meeting feedback

"Decommissioning, especially in recent years, has become a pivoting point for several industries. It is clearer than ever before that if an energy transition is to be successful, it needs to start with a solid decommissioning strategy with evidence-based insight."

"The metallic waste workshop organised by the NDA cross-industry is an excellent example of how decommissioning is playing a central role; the workshop provided the necessary evidence that for tackling big problems such as circular economy or metal recycling, a wider approach is needed. The workshop connected people from different sectors who are facing a similar challenge. This, in turn, will help to inform and drive future decisions in the field of metallic waste, ultimately helping oil & gas decommissioning processes."

"We are 100% behind this initiative and importantly have the historical experience that can be brought to bear in providing a fast and agile solution that can be implemented quickly, efficiently and effectively. Let us keep the dialogue going and create a beacon supply chain that delivers the lowest total acquisition cost at both the front end and the back to remove waste, scrap and inefficiency from the NDA supply chain."

"It was great to hear from people, covering a range of industries and stakeholders, who are all looking at metals from different perspectives. Whilst there are some key differences across the sectors there are also many common steps in the lifecycle of metallic wastes, through its decontamination, treatment and recycling. Plans to invest in new recycling and manufacturing infrastructure in the UK will provide a true onshore circular economy and could have significant social, economic and environmental benefits."

"We are supportive of the thinking and direction of travel reflected in the report. Treatment of metal waste for reuse/recycling aligns with the principles of the waste management hierarchy, helping to embed sustainability in the waste life cycle."

3 Nuclear sector context

In the UK, radioactive wastes and materials are produced by a range of businesses and organisations across the energy, medical, research, industrial and defence sectors.

These producers are responsible for managing and maintaining information about the nature and quantities of radioactive waste and materials that they control, also known as their inventory.

Producers of radioactive wastes and materials currently contribute information about their inventories to a central, UK inventory data collection exercise once every three years.

This data collection process is managed by the Nuclear Decommissioning Authority (NDA), and is jointly funded by the NDA and the Department for Business, Energy and Industrial Strategy (BEIS). The UK Radioactive Waste & Materials Inventory (UK Inventory) provides comprehensive information on radioactive wastes and materials that were in stock and were forecast to arise across the UK at a specific point in time, called the 'stock date'.

Information on the latest UK Radioactive Waste Inventory (UKRWI)[2] (based on a stock date of 1st July 2016) is publicly available via the UK Inventory website and is due for updating towards the end of 2022.

The Inventory provides up-to-date information about radioactive waste to:

- Enable the UK to meet international reporting obligations
- Inform policy and strategy development
- Aid radioactive waste and material management planning
- Provide sufficient accessible information suitable for use by our key stakeholders

Nuclear Waste Services, through its Waste Services line of business, provides a range of Metallic Waste Treatment Services to both NDA and non-NDA customers.

The service was established with the primary aim of diverting metallic waste away from disposal at the Low Level Waste Repository (LLWR) to treatment providers who can process the metal allowing it to be recycled into new products or conditioned for decay storage and optimised disposal.

This is in line with the Government Solid Low Level Waste (LLW) Strategy by utilising the Waste Management Hierarchy; is a more sustainable solution by allowing the metal to be recycled and extends the life of the LLWR site by reducing the volume of waste requiring disposal.

[2] UK Radioactive Waste Inventory (UKRWI) (nda.gov.uk)

Over the last decade there has been on average 1,200 tonnes per annum of metallic waste treated via the framework at an average cost of ~£6.5m per year. Most of this tonnage has been containerised contaminated LLW, arising from routine operations and decommissioning activities. These types of wastes are suitable for decontamination via several different surface cleaning techniques and are regarded as 'business as usual' for processing. Metal that can't be sufficiently cleaned to the required standard would be sent for further processing via metal melting.

There are also large components such as reactor heat exchangers (aka. boilers) which require disassembly and treatment. There are no facilities for melting or large component disassembly in the UK, which means this material is sent overseas (Sweden or Germany). These same techniques could possibly be used to divert a portion of Intermediate Level Waste (ILW) metal from interim storage and disposal to the Geological Disposal Facility (GDF), but it is thought this would be at a significant cost.

HLW — Temperature must be considered in design of storage and disposal facilities

ILW — Exceeds upper boundary for LLW but does not require heating to be taken into account

LLW — Radioactive content less than 4 GBq/t α and 12 GBq/t β/γ

VLLW — Low-volume or high-volume; suitable for disposal with municipal, commercial or industrial waste, or can be disposed of to specified landfill site

The different options for make or buy therefore need to be assessed to ensure a sustainable metallic waste management offering is in place for the long-term delivery of the mission along with increased UK prosperity.

The NDA is currently considering a long list of options and is looking to share ideas with other sectors with a view of potential collaboration which could result in better efficiencies through economies of scale, reducing the carbon impact and ultimately benefiting UK

4 Oil & Gas decommissioning context

The UK is seeing radical change in the industry as it has a leading role in the Energy Transition from the production of hydrocarbon fuels to a greater emphasis on electrification of platforms, hydrogen production and using assets for carbon capture and storage (CCS).

The Oil & Gas Authority (OGA) has recently changed its name to the North Sea Transition Authority (NSTA) to reflect its evolving role, and the trade association previously called Oil & Gas UK (OGUK) has rebranded as Offshore Energy UK (OEUK) to represent an integrated offshore energy industry providing cleaner fuel, power and products for the UK. Similarly, the Aberdeen based Oil & Gas Technology Centre (OGTC) has become the Net Zero Technology Centre (NZTC).

Owners of assets in the North Sea have an additional consideration on the potential for reuse and repurposing prior to commencing any decommissioning project and this is creating the environment for greater collaboration with the renewables industry such as CCS and hydrogen generation, transportation and storage.

The decommissioning 'drumbeat' of assets across the UK Continental Shelf (UKCS) is driven by a number of factors including prevailing market conditions and the renewed emphasis on energy security. However, the OGUK Decommissioning Insight 2021 report shows that over 1,000,000 tonnes of topsides from North Sea region coming onshore over the next decade, much of which can be reused or recycled.

Topsides removals between 2021 and 2025 will average around 50,000 tonnes per year, and substructure decommissioning around 20,000 tonnes. This increases to around 90,000 tonnes of topsides removed, and 60,000 tonnes of substructures decommissioned per year from 2026 to 2030.

Naturally Occurring Radioactive Materials[3] (NORMs) may accumulate at various locations in the oil & gas production process and processing equipment can become NORM contaminated in the form of sludge, scale, scrapings and other wastes, primarily containing radionuclides from the decay chains of uranium and thorium. There are several specialist supply chain companies offering NORM decontamination and onward waste management services to the oil & gas sector.

[3] Naturally-Occurring Radioactive Materials (NORM)Radioactive materials which occur naturally and where human activities increase the exposure of people to ionising radiation are known by the acronym 'NORM'

5 A Scottish metallic waste perspective

Zero Waste Scotland exists to lead Scotland to use products and resources responsibly, focusing on where they can have the greatest impact on climate change.

They are funded by the Scottish Government and have also received funding from the European Structural Funds programme to help accelerate their circular economy and resource efficiency work with SMEs in Scotland.

Regarding onshore wind, their research suggests that by 2050, up to 5,500 turbines or up to 1.4M tonnes of materials will have to be decommissioned which by weight, the biggest material waste arisings from wind turbine decommissioning will be ferrous metals (steel, iron) that is currently exported for recycling.

Estimates for the UKCS offshore wind decommissioning suggest that up to 600 turbines are set for decommissioning by 2030 which would equate to 5.4M tonnes

In Zero Waste Scotland's report 'How Should Scotland Manage its Scrap Steel?[4], its research showed that nearly 820,000 tonnes of Scottish scrap steel were exported for remelting in 2018 from sectors such as construction, automotive, aerospace, and oil and gas decommissioning.

The paper focuses on the environmental evidence for returning steel production to Scotland in a sustainable way and ensuring valuable scrap steel is utilised most effectively. Analysts found the carbon benefits of a transition to a more local, efficient scrap steel production route to be clear and significant.

By developing an Electric Arc Furnace (EAF) plant for scrap steel in Scotland, emissions from material, transport and energy use could be reduced substantially, at a level that would make a tangible contribution to reducing Scotland's total carbon emissions.

The advantages include:

- Savings of 60 percent in carbon emissions currently incurred. Today, we export scrap steel to other countries in a process which takes up to 1.6 tonnes of greenhouse gases to produce one tonne of steel, whereas moving to EAF-based steel production in Scotland would reduce this to 0.64 tonnes;
- Creating highly skilled green jobs in Scotland, and;
- Embedding resilience in meeting Scotland's steel needs now and in the future by reducing our reliance on overseas imports.

The paper concluded that change must happen fast to capitalise on Scotland's low carbon grid advantage. Further work is required to understand the long-term environmental case more fully. This should include site-specific data of any potential EAF plants for Scotland, forecasting of national electricity grid intensity changes and the impact of EAF electricity demand.

Subsequent reports explore the economic and social case and the role of the energy transition.

[4] How should Scotland manage its scrap steel? | Zero Waste Scotland

6 Approach, Agenda & Participants

Approach

This was to be the first face-to-face event held following over two years of online meetings due to the pandemic, but with the inclusion of a dial-in Teams option.

There was a split 50/50 in terms of delegates being present and those needing to dial in – a true hybrid event. A relatively small, hand-picked group of delegates were brought together who had interest and experience in looking at the future possibilities to collaborate on what can be done to benefit UK Plc by onshoring the processing and repurposing of iron based metallic wastes across industries. Some delegates represented the existing supply chain involved in the treatment of contaminated products before processing and others were industry body representatives or economic and academic institutions having published research into this theme.

Timing was important to host the workshop as it was imperative that the output was able to help inform the internal NDA Metallic Treatment Framework review process. The workshop also links to NDA Strategic Theme: Site Decommissioning and Remediation and Integrated Waste Management, and Critical Enablers: 8.2 Sustainability, 8.5 Research, Development & Innovation, 8.8 Supply Chain, 8.10 Socio-Economics.

Participant Invited Organisations

- Aberdeen University
- Ardersier Port
- Augean
- Cyclife EDF
- Environment Agency
- High Value Manufacturing Catapult/Strathclyde University
- Magnox Ltd
- National Decommissioning Centre (NDC)
- North Sea Transition Authority
- Nuclear Decommissioning Authority (NDA)
- Nuclear Waste Services
- Steel Dynamics
- Tradebe
- Zero Waste Scotland

Agenda

Topic	Details	Organisation
Welcome & Introductions	Purpose of the workshop, agenda and round the room introductions	Nuclear Decommissioning Authority
Background to the NDA and why we have an interest	NDA senior sponsor	Nuclear Decommissioning Authority
The how and why we are external facing	NDA Cross-Industry	Nuclear Decommissioning Authority
Nuclear project detail and status	Project and process from a Nuclear perspective	Nuclear Waste Services
Break		
A Scotland waste metals perspective	Zero Waste Scotland Report	Zero Waste Scotland
Exploring Current State of Embodied Emissions & ReDisCoveR value	Catapult work to date	National Manufacturing Institute Scotland part of High Value Manufacturing Catapult
	Ideas in action	Ardersier Port
Questions – discussion		
Feedback		
Next steps facilitated discussion round the room		

7 Key Learning Highlights and Actions

Great initiative but who should lead?

There was a suggestion that perhaps this forum could be the basis of future meetings where the NDA could bring other industries into the conversation to develop the inventory. It is true that the NDA is perhaps in a unique situation whereby it has a deliberate outward facing cross-industry team, and this was created in order to connect, share, and learn in collaboration with other sectors on common interest. This theme currently remains of interest to the NDA and with the possibility of socio-economic and environmental benefits to our communities and operations but it was also suggested that, another organisation with a full mandate might be more appropriate.

Action

Cross-industry team to discuss with High Value Manufacturing Catapult and report back to delegates

Are we able to address the known-knowns and known-unknowns?

It is necessary to bring together a full understanding of both the upstream benefits for onshoring metallic waste recycling and the downstream market requirements all mapped to inventories, location, grades and timeframe. This also links to comments made at the workshop with regards to the potential reuse of radioactive contaminated metals. It needs to have dynamic integrity and reflect market changes when known – a complete picture and investable business case.

Action

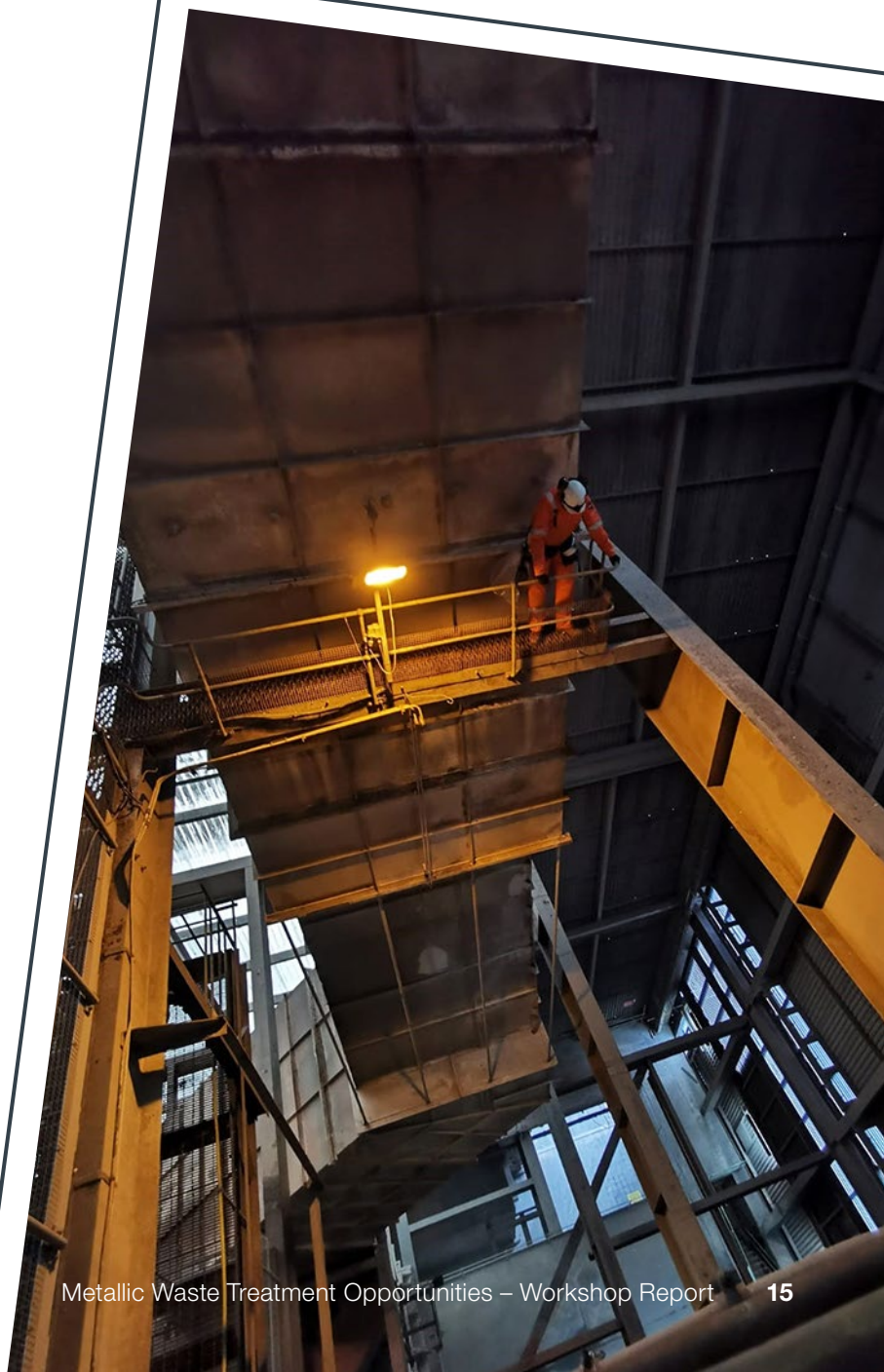
Cross-industry team to discuss possible links to the National Decommissioning Centre research capability

Do we understand the full carbon value?

A complete picture would include embedded reprocessing carbon emissions and an effective carbon tax that would encourage further implementation of the circular economy thinking, especially when using it as a comparator against using virgin steel imports. This should also include carbon emissions relating to cleaning of contaminated steel prior to reprocessing. Using renewable energy from offshore wind to power an Electric Arc Furnace (EAF) based facility would make sense, but it is equally true if the facility were to be powered by a small modular nuclear reactor, albeit not so much interest in Scotland currently due to the devolved administration policy towards new nuclear.

Action

Discuss with the High Value Manufacturing Catapult



7 Key Learning Highlights and Actions

Making connections is a good thing

Not all participant organisations were aware of the work that Zero Waste Scotland has been doing and for that alone, the workshop has played its part in connecting.

Action

Final publication of this report will include links to Zero Waste Scotland report for further distribution

Can we broaden the work to give a UK picture?

Zero Waste Scotland are conscious that it has only looked at selected elements of the potential and that perhaps the time is right for wider conversations such as this workshop has begun. There were suggestions at the meeting that a lead body should be able to corral supply chains, regulators, industries and sectors to create something of value.

Action

Zero Waste Scotland to share programme with Welsh & English comparable organisations and report back

Can we standardise standards?

Treated radioactively contaminated waste steel is subject to far more stringent regulation and barriers for reuse than other sectors. Decommissioning experts are increasingly concerned about double standards developing in Europe which allow 30 times the dose rate from non-nuclear recycled materials than from those out of the nuclear industry. For example, scrap steel from gas plants may be recycled if it has less than 500,000 Bq/kg (0.5 MBq/kg) radioactivity (the exemption level). This level however is one thousand times higher than the clearance level for recycled material (both steel and concrete) from the nuclear industry[5]. In developing a potential UK programme for recycling waste steel and aligning with where the potential reuse could be, it was acknowledged that the regulatory landscape will be a key enabler. It would be necessary to corral a single unified regulatory approach for example ONR, EA, SEPA, NRW.

Action

Cross-Industry team to work with EA support in pulling together an information sharing and action workshop

[5] World-nuclear.org. (2019). Naturally Occurring Radioactive Materials NORM - World Nuclear Association. (online)

What about the other metals we may have in our inventories?

The focus of this workshop was based on the opportunities for onshoring iron based waste metal and aligning that with the potential future use requirements of the Energy Transition. At the workshop it was noted that there may be a case to look wider at other metals and minerals which will be increasingly required by the UK if it is to meet its Net Zero ambitions confidently and securely. Coincidentally, and unknown at the time of the workshop, BEIS was about to publish a new policy paper on the 22nd July entitled 'Resilience for the future: The UK's critical minerals strategy'[6].

It is clear that a lot of thought and discussion has already taken place to consider our future requirements and what action can be taken. The strategy notes the new A-C-E approach to critical minerals as it seeks to:

Accelerate the UK's domestic capabilities, **Collaborate** with international partners and **Enhance** international markets. It identifies that we must:

- Make better use of what we have by accelerating a circular economy of critical minerals in the UK – increasing recovery, reuse and recycling rates and resource efficiency, to alleviate pressure on primary supply:
  - a) We will promote innovation for a more efficient circular economy for critical minerals in the UK.
  - b) We will signpost financial support to accelerate the development of a UK critical mineral circular economy.
  - c) We will look at regulatory ways to promote recycling and recovery.

Action

Highlight the strategy and reference in this report. Send copy of this report to the Critical Minerals Intelligence Centre [7]

[6] Resilience for the future: The UK's critical minerals strategy - GOV.UK (www.gov.uk)

[7] UK Critical Minerals Intelligence Centre (ukcmic.org)

8 Continuing to Share Good Practice Across Industrial Sectors

The backdrop for collaborative working is fuelled by a desire to reduce decommissioning costs and improve the schedule of risk reduction.

The UK government has challenged the nuclear sector to reduce the cost of decommissioning by 20% and the cost of oil and gas decommissioning by 35%.

It is recognised that by working together we stand a better chance of delivering these savings.

We will continue to facilitate cross-industry engagements and collaborative projects based on themes of common interest.

Shareable write-ups, post workshop webinars and other forms of dissemination have ensured the wider availability of learnings to those who could not be in the room, and this report adds to this body of material.

A back catalogue of reports can be found at **www.decomnorthsea.com/knowledge-hub/cross-industry-learning-nuclear-decommissioning-authority/**

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