Consultation Response

Review of Net Zero: call for evidence

27 October 2022

About us

With about 50,000 members in over 100 countries and a £56m knowledge business that spans the globe, the Royal Society of Chemistry is the UK's professional body for chemical scientists, supporting and representing our members in large multinational companies and small and medium enterprises, universities, schools, government and regulatory agencies.

We also draw on chemistry using professionals' expertise to provide advice to Government to help it achieve its ambitions, whether regulating chemicals appropriately[1] and responsibly, identifying priorities, opportunities and challenges in chemical science[2], or supporting the development of a UK circular economy[3]. In 2021 we committed to achieve net zero greenhouse gas emissions by 2040 as part of the UN Race To Zero.

Our submission responds to questions addressed to businesses, the public and academics because of the Royal Society of Chemistry's diverse roles and interests. We would be happy to discuss any of the issues raised in the submission in more detail. If you have any questions or you wish to engage further, please contact us at policy@rsc.org.

Question 3: What opportunities are there for new/amended measures to stimulate or facilitate the transition to net zero in a way that is pro-growth and/or pro-business?

Enabling the green technology and circular economy sectors across the UK will be key to our transition to net zero and presents a significant economic opportunity for the whole country, creating jobs and ensuring that our industries can compete globally.

Chemical scientists will have a major part to play in our journey to net zero. In 2019, UK's 275,000 chemistry-using professionals contributed an estimated £87billion to GDP and over the period 2012-19, contributed £83 billion per year[4]. They bring vast and varied knowledge and skills to a diversity of economic sectors which will contribute to, and undergo significant change in, a low-carbon and circular economy future. Key sectors include education, chemical feedstock production, energy supply, waste and recycling, and our world-leading research organisations.

[1] A chemicals strategy for a sustainable chemicals revolution. Royal Society of Chemistry, 2020.
[2] Science Horizons. Royal Society of Chemistry, 2019.
[3] Progressive Plastics. Royal Society of Chemistry, 2019-2022.
[4] Chemistry's contribution: workforce trends and economic impact. Royal Society of Chemistry, 2019.

Job opportunities

The chemical sciences community already makes substantial contributions to the green economy, developing new products and processes for sustainable plastics; developing new battery chemistries and scaling up production of the latest technology; and monitoring and testing approaches for chemicals in the natural environment, including remote monitoring of the potent greenhouse gases. For more detail, see our response to the Environmental Audit Committee inquiry on green jobs[5].

The transition away from a linear economy rooted in supply chains that rely on carbon-intensive primary raw material extraction and processing is central to achieving net zero. This transition will also lead to job creation in sectors such as remanufacturing and recycling. By moving to a circular economy, an estimated 450,000 additional green jobs[6] could be created in different parts of the UK by 2035, thereby spreading opportunity across the country.

Critical raw materials

The economy of critical raw materials (CRMs), while fundamental to decarbonisation, still operates in a largely linear fashion. CRMs are materials that are of strategic importance to an economy and that have a high risk linked to their supply and cannot be substituted easily for other materials[7]. These materials are essential for most of the technologies that will enable us to cut our emissions and decarbonise our economies[8], and for the healthcare, aerospace and consumer electronics sectors. Materials vital for clean energy technologies include the rare earth metals dysprosium and neodymium in the permanent magnets of wind turbine generators; gallium, indium and tellurium as silicon dopants, conductive layers and semiconductors across a range of photovoltaic technologies; and lithium, graphite and cobalt in energy storage solutions such as the lithium-ion cells used in electric vehicle (EV) batteries[8].

Over the coming decades, widespread deployment of renewable energy generation, energy storage systems and electrification of transport[9, 10] will lead to a dramatic rise in demand for CRMs, putting substantial pressure on the supply side[11]. This increase is anticipated in both absolute quantities of material and the relative proportion required by low-carbon development.

Moving to a circular economy for CRMs requires greater recovery of the materials from end-of-life batteries and waste electrical and electronic equipment (WEEE). This will help to cut waste, reduce embodied energy of second-life products, and increase supply security of CRMs by reducing price volatility and reliance on primary extraction. In turn, limiting extraction of virgin CRMs will also reduce the energy requirements and environmental impacts associated with mining and refining materials, by orders of magnitude in many cases[12]. In addition, the global material value of WEEE is estimated to be US$ 62.5billion annually due to the precious metals and CRMs that are contained in products[13].

To be successful, collaboration will be required between academia, industry and government. For example, the electrification of transport plays a key part in our decarbonisation journey, and the transition to electric vehicles at scale relies on the interplay of electric vehicle manufacturers, EV battery manufacturers, the material extraction, refining and processing sector, as well as the waste management

[5] Written evidence submitted to Environmental Audit Committee Green Jobs consultation. Royal Society of Chemistry, 2021
[6] Levelling up through circular economy jobs. Green Alliance, 2021.
[7] What are critical raw materials? British Geological Society.
[8] Decarbonisation: materials and circularity challenges for clean technologies. Royal Society of Chemistry, 2021.
[9] Net Zero Strategy: Build Back Greener. UK Department for Business, Energy and Industrial Strategy, 2021.
[10] UK electric vehicle infrastructure strategy. UK Department for Transport, 2022.
[11] The Role of Critical Minerals in Clean Energy Transitions. International Energy Agency, 2021.
[12] Report on Critical Raw Materials and the Circular Economy. European Commission, 2018.
[13] A New Circular Vision for Electronics. World Economic Forum, 2019.

and recycling sector. It will be underpinned by researchers driving innovation in battery design for recovery, green and urban mining and optimisation of end-of-life approaches, and by government departments supporting innovation and regulating polluters.

Foundation materials

To achieve our net zero ambitions, the UK needs to not only scale up the green technologies that enable greater renewable energy coverage and low-carbon transport, but also drastically reduce emissions from carbon-intensive foundation industries such as the steel and cement sectors[14, 15]. The transition of these industries to greener processes and supply chains relies on much greater access to high-quality secondary raw materials (for example those recovered from scrap, rubble and construction waste), making the strategic case for an integrated circular materials economy that covers both CRMs and key foundation materials.

The government has a unique opportunity to position the UK as a global champion for more integrated approaches to materials circularity. A long-term materials strategy that is coordinated across government and across the economy will help retain jobs linked to currently carbon-intensive material production and develop new low-carbon jobs, many of which will be held by chemistry-using professionals.

Question 4: What more could government do to support businesses, consumers and other actors to decarbonise?

A circular economy of materials

The government has an important role to play in enabling the creation of a circular CRM (and broader materials) economy which will not only help the UK transition to net zero, but also lead to job creation and economic growth.

As we highlighted in our response to Question 3, decarbonisation will rely on access to a range of critical raw materials. Therefore, we recommend that government:

- Conducts regular assessments of the criticality of raw materials across all sectors of the domestic economy, including the EV and energy storage industries
- Ensures that CRM streams are covered in the National Materials Datahub so that CRM use and reuse can be mapped and tracked
- Incentivises closer collaboration between academia and industry to support the development and deployment of economically viable CRM recovery technologies

Measures should also focus on reducing the amount of CRMs being used and re-using devices containing them, following the principles of the 'waste hierarchy'[16], rather than primarily focusing on increasing recycling.

[14] Net Zero Steel - A Vision for the Future of UK Steel Production. Make UK, 2022.
[15] Decarbonising UK Concrete and Cement: Accelerating the net zero journey. MPA UK Concrete, 2022
[16] The waste hierarchy ranks waste management options according to what is best for the environment. It gives top priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, recovery and, last of all, disposal. From: Guidance on applying the Waste Hierarchy. Department for Environment, Food & Rural Affairs, 2011.

To support UK industry in their efforts to electrify transport, government should:

- Update the legal framework governing end-of-life vehicles and batteries to support the circular economy and harmonise legislation with our biggest markets
- Build and invest in a domestic EV battery collection and recycling infrastructure
- Foster the development of internationally competitive sustainable EV battery designs by promoting engagement between academic research and industry
- Support the EV and battery manufacturing sector in the UK to encourage use of secondary CRMs, including to comply with the rules of origin for battery cathode materials specified in the EU-UK Trade & Cooperation Agreement

To work towards a circular economy of materials that enables decarbonisation, unlocks business opportunities for the whole of the UK and contributes to more secure raw material supply, we recommend that government:

- Takes an integrated view across industry sectors and across departments to drive a circular economy strategy that minimises environmental impacts and maximises resource efficiency and recovery of both CRMs and foundation materials such as steel and concrete, putting these sectors on a sustainable and competitive trajectory
- Incentivises product design for efficient and simple deconstruction, reuse and recovery, including through regulation
- Supports coordination and collaboration:
    - Between different industrial sectors (e.g. steel manufacturers and businesses relying on CRMs) to share best practice and understand each other's needs
    - Between manufacturers and the waste management sector to 'close the loop' and maximise the use of high-quality secondary raw materials recovered from waste
    - Between academic research and industry to foster development of more sustainable product designs and deployment of economically viable material recovery technologies

Skills needs for the net zero transition

Employees in a range of sectors, including those working in carbon-intensive industries, will need policies in place to support the reskilling and upskilling that will be required to adapt to new opportunities in the net zero transition. Hard-to-abate sectors which will need to see some of the most significant changes in operational and skills requirement are regionally clustered, largely concentrated in Scotland, Wales and the North of England, and will need to form part of the considerations for achieving equality of opportunity across the UK.

RSC research[17] has shown that chemistry-using professionals in these sectors are similarly concentrated, with 58% of those employed in the manufacture of basic metals located in Wales, and 63% of those in the mineral industries (including glass, ceramics and cement) based in the North-East, Yorkshire & Humber regions. The ongoing work of the Just Transition Commission[18] will inform the Scottish Government on a long-term path for these currently high-emissions workforces. However, other nations of the UK should recognise this issue and prepare policy responses.

[17] Chemistry's contribution: workforce trends and economic impact. Royal Society of Chemistry, 2019.
[18] Just Transition Commission. Scottish Government.

Sustainability skills and knowledge are becoming increasingly important to the chemical sciences. The majority of respondents to our Science Horizons Researcher Survey said that their work had potential applications in one of the global challenge areas we identified, with 86% identifying applications in relation to the environment and 68% to energy[19]. However, practising chemists working in academia and industry report a gap between chemical scientists' current skills and knowledge and those needed for green jobs now and in the future. 94% of those who identified a gap said it is at least moderately significant[20].

In our recent research, Green Shoots: a sustainable chemistry curriculum for a sustainable planet[21], teachers, pupils and practising chemists working in academia and industry told us their views on sustainability and climate change in the school chemistry curriculum. We are calling on Government to urgently prioritise updating the school chemistry curriculum so it prepares all young people to fully participate in efforts to tackle climate change and sustainability challenges and ensure young people have the skills and careers information needed to progress into green jobs in the chemical sciences and contribute to the future green economy.

Question 5: Where and in what areas of policy focus could net zero be achieved in a more economically efficient manner?

The drive towards net zero will significantly impact air quality: policymakers will need to consider this fully and take coordinated action to address both areas. The health impacts associated with air pollution have an economic cost in addition to a cost to public healthcare services. In 2020, CBI Economics reported that the UK could gain an additional 3 million working days by reducing the morbidity associated with its air quality, making a £600 million gain in reduced workplace absences[22].

Climate change and air quality are linked[23]. Often, measures to reduce carbon emissions towards net zero are expected to have a positive impact on air quality. Indeed, Defra's impact assessment in developing a new target or particulate matter 2.5 (PM2.5, one of the most harmful pollutants), estimated that 72% of the £135 billion total benefit resulted from greenhouse gas reduction[24]. However, there are also policy options to achieve net zero which could result in trade-offs with air quality, for example uncertainty of the impact of hydrogen blending in domestic gas supply[25], or large scale and urban tree-planting that could increase emissions of biogenic volatile organic compounds leading to an increase in ozone and organic PM2.5 formation.[26] Impact on air quality should be considered in developing and implementing net zero policy options and vice versa.

[19] Science Horizons: leading-edge science for sustainable prosperity over the next 10-15 years. Royal Society of Chemistry, 2019.
[20] Green Shoots part 2 – sustainability and the chemistry curriculum: the view chemists in academia and industry. Royal Society of Chemistry, 2022.
[21] Green Shoots: a sustainable chemistry curriculum for a sustainable planet. Royal Society of Chemistry, 2021.
[22] Breathing life into the UK economy: quantifying the economic benefits of cleaner air. CBI, 2020.
[23] Effects of net zero policies and climate change on air quality. Royal Society, 2021.
[24] Air quality targets Impact Assessment. UK Department for Environment, Food & Rural Affairs, 2022.
[25] Optimising air quality co-benefits in a hydrogen economy: a case for hydrogen-specific standards for NOx emissions. Alastair C. Lewis (2021), Environmental Science: Atmospheres, 1:201-207.
[26] Effect of VOC Emissions from Vegetation on Air Quality in Berlin during a Heatwave. Galina Churkina et al. (2017), Environmental Science & Technology, 11:6120–6130.

Question 8: What growth benefits/opportunities have you had, or do you envisage having, from the net zero transition?

The RSC's role is to have a positive impact on the world through the chemical sciences. Our global not for profit publishing and knowledge business offers scientific journals, books and data products generating £56m revenues in 2021[27].

Net zero technologies and green chemistry are increasingly active areas for us. We have recently launched four new journals on these topics to add to our existing portfolio of 49 (RSC Sustainability, Environmental Science: Advances, Environmental Science: Atmospheres, Energy and Environmental Science: Catalysis), in addition to multiple special issues and themed collections covering next generation batteries, hydrogen production and greenhouse gas removal. A net zero transition will undoubtedly require significant international scientific activity and we will actively support this.

Question 9: What barriers do you face in decarbonising your business and its operations?

Sustainability is a long-term organisational commitment for the RSC, including our operational activity. We have committed to the UN Race to Zero to reduce our net carbon emissions to zero by 2040 and published our comprehensive greenhouse gas emissions inventory[28]. The largest parts of our carbon footprint are indirect emissions (GHG Protocol Scope 3 classification) from business travel, commuting, supply chain and investments. There are different barriers in each of these areas.

In business travel, the slow progress of international regulation, technical improvements and the questionable efficacy of the offsetting introduced by ICAO mean that we anticipate air travel will be a persistent and problematic source of emissions. We are an international knowledge business with offices in the USA, China, India, Japan, Brazil and Germany and even with improved telecommunications some degree of long-distance travel will be necessary to operate effectively.

Conversely, in surface transport for commuting we see that EV options are available and the total costs are lower in the long term, however, the high up-front cost is in some cases a barrier. We will monitor the commuting patterns of staff and support those without off-street parking with chargers on our premises.

We have also encountered information barriers which slow action particularly in our supply chain and investments. Government could help by taking action directly (an update to DEFRA's 'Indirect emissions from supply chain 2007-2011' dataset would aid us in calculating more accurate supply chain emissions as it is out of date). In time, we hope to see the benefit of mandatory disclosure of climate-related financial information in informing our investment decisions.

Question 13: What impacts have decarbonisation/net zero measures had on your business?

Staff engagement on our net zero goals has been positive, as well as from our wider community of members and authors. It is important when working actively in the scientific community that our initiatives are aligned with scientific evidence of the need for action. Positive feedback on net zero is motivating for all concerned and connects to our strategic goal of "helping the chemical science community to make the world a better place".

[27] Trustees' report and financial statements 2021. Royal Society, 2021.
[28] Net zero progress report 2021-2022. Royal Society of Chemistry, 2022.

Question 14: What more could be done to support your business and/or sector to decarbonise?

As noted in our response to Question 9, using regulation intelligently to drive innovation on aviation emissions and deliver sustainable aviation fuel at scale would support organisations like the RSC to decarbonise. We currently see this as a persistent source of emissions from our operations and have limited direct influence.

Question 19: Do you face any barriers to doing this? What are they?

A nationally-representative survey by the RSC revealed a concerning trend in consumer habits regarding their household electronics[29]. Currently, 68% of UK households with unused devices, including mobile phones, computers, smart TVs, MP3 players and e-readers, have no plans to recycle or sell these after they fall out of use. Waste electrical and electronic equipment (WEEE) is the fastest growing waste stream in the world, and the UK is the second largest producer of WEEE globally per capita, generating 1598 kilotonnes (kt) of WEEE in 2019[30]. A range of factors prevent people from recycling their devices, including keeping them as spares, fears around data security, not knowing where to take them, and preferring to sell them on. In a follow-up survey[31], just over half of respondents said they worry about the environmental effect of the unused devices they have at home, but either do not know what to do with them or are unconvinced the current processes available in their local area deal with e-waste effectively.

In our response to Q3 and Q4 we highlighted the opportunities presented by moving to a circular economy for critical raw materials (CRMs). Over the coming decades, widespread deployment of energy storage systems and electrification of transport[9,10] will lead to a dramatic rise in demand for CRMs, putting substantial pressure on the supply side[32]. This increase is anticipated in both absolute quantities of material and the relative proportion required by low-carbon development.

Moving to a circular economy for CRMs requires greater recovery of the materials from end-of-life batteries and WEEE. This will help to reduce reliance on primary extraction of these materials, reduce price volatility, reduce embodied energy of second-life products, and cut waste. In turn, limiting extraction of virgin CRMs will also reduce the energy requirements and environmental impacts associated with mining and refining materials, by orders of magnitude in many cases[33].

CRMs are vital for clean energy technologies, and in the aerospace and healthcare sectors as well as in many consumer electronics such as mobile phones and laptops.

Question 20: What would help you to make greener choices?

Key to enabling a greener circular economy for CRMs will be empowering consumers to use and dispose of electric and electronic devices in more sustainable ways, emphasising the importance of repairing and reusing devices before recycling them.

In a recent survey[31], we asked 10,000 people across 10 countries about their attitudes towards sustainability and electronics and we found that there is appetite for sustainable choices. While the vast majority of consumers said they wished their devices lasted longer, they find it too difficult (68%) or too expensive (71%) to repair them when minor things go wrong. 60% of those surveyed said they would be

[29] Elements in danger. Royal Society of Chemistry, 2019.
[30] The Global E-waste monitor 2020: quantities and the circular economy potential. United Nations University, 2020.
[31] Precious Elements. Royal Society of Chemistry, 2022.
[32] The Role of Critical Minerals in Clean Energy Transitions. International Energy Agency, 2021.
[32] Igniting Innovation. Royal Society of Chemistry, 2022.
[33] Report on Critical Raw Materials and the Circular Economy. European Commission, 2018.

likely to switch to a rival of their preferred brand if they knew the product was made in a sustainable way. Almost three quarters of people we surveyed said they believe the government should take urgent action to tackle e-waste before the situation gets any worse.

Question 29: How can we ensure that we seize the benefits from future innovation and technologies?

Public procurement can be used as a driver of innovation through the adoption of novel solutions promising transformative capabilities. The Government should create ambitious tenders designed and structured to attract innovative proposals, allowing an enhanced risk appetite to encourage innovative solutions including those from research-driven SMEs. Efforts to minimise the bureaucracy involved in submitting proposals may increase accessibility for SMEs with lower resources and/or little experience in submitting proposals to government (though due diligence remains important, as well as tracking impact). Procurement processes may also want to consider UN sustainable development goals and the SMEs working to further them.

Innovative chemical technologies will be key to solving many of the challenges associated with reaching net zero including energy generation and storage, carbon capture and storage, and reducing the impacts of farming and food supply among others. We have published research[34] into how government actions could support the innovation ecosystem in *Igniting Innovation*, in order to ensure that more home-grown innovative solutions are providing benefits both towards achieving net zero and for the UK economy.

In short, R&D-driven chemistry SMEs need access to the people, facilities and funding that will allow them to pursue disruptive, capital-intensive research over long and uncertain timescales. Government support plays a vital role in this ecosystem to boost early-stage companies and address market failures where venture capital and other private funding is not available, such as for chemistry companies needing to buy equipment to scale up their production. Efforts to reach net zero could be boosted by supporting relevant companies, as science and innovation will be needed to solve climate challenges. Behavioural change alone will be insufficient to meet agreed targets.

Question 30: Is there a policy idea that will help us reach net zero you think we should consider as part of the review?

As we have detailed in our responses to Q4 and Q5 government could develop policy in a number of areas to support a flourishing net zero economy, specifically:

- Creation of a circular economy of materials
- Updating the school chemistry curriculum to ensure young people have the skills and careers information needed to progress into green jobs
- Considering the impact on air quality of net zero policy options and vice versa.

[34] Igniting Innovation. Royal Society of Chemistry, 2022.