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Supporting the Era of Green Pharmaceuticals in the UK

CONSULTING | REPORT
NOVEMBER 2022

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Please cite this report as:
Firth I., Hitch J., Henderson N., Cookson G. 2022. Supporting the Era of Green Pharmaceuticals in the UK. OHE Consulting Report, London: Office of Health Economics. Available at: https://www.ohe.org/publications/supporting-era-green-pharmaceuticals-uk-0

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Funding and Acknowledgements

This consulting report was commissioned and funded by The Association of the British Pharmaceutical Industry (ABPI). We thank all of the experts who contributed to the interviews and roundtable undertaken as part of this project.

Report Amendments

A minor amendment was made to this report in December 2022 based on feedback from a relevant stakeholder.

Foreword from ABPI

As we approach COP27, it's clear that the pharmaceutical industry in the UK is moving from the stage of making commitments to taking meaningful steps forward. As I have experienced in my regular meetings with the leaders of our member companies, sustainability is now a massive and growing part of pharmaceutical companies' day-to-day work and is at the heart of their operations.

Coming out of COP26, we wanted to understand from our members in more detail the shape of the challenges they were facing as they tackled climate change within their operations and responded to the UN's sustainability goals. We commissioned OHE to find out more about the key breakthroughs, collaborations and policy actions across Government and the NHS as well as industry that would be needed in order to address and meet the UK's ambitions.

This is a global industry with global supply chains. As a consequence, the industry in the UK must act in partnership with other regions, if we are to create lasting, effective change.

We're starting to see initiatives from companies all across the world, from investment in renewables, to low-carbon inhalers, to net-zero buildings. However, as this report demonstrates, companies face some key challenges in the drive for sustainability which they cannot address alone. As well as collaborating between different regions of the world, we need to build strong collaborations with Government, regulators and our health systems partners like NHS England.

Much is already underway across the life sciences sector and the NHS should be applauded for the steps it has taken to date. But systemic issues remain, and the task now is to accelerate progress and generate lasting momentum. There is a clear opportunity for industry and Government, working together, to build the green pharmaceutical industry of the future.

We hope that this report will be a useful guide for both strategic planning and concrete actions. At ABPI, we will be drawing upon its themes as we continue to drive forward policy discussions with stakeholders, in the context of COP27 and beyond.

Dr Richard Torbett
ABPI Chief Executive

Foreword from OHE

At OHE, we believe in better healthcare policies supported by evidence. In many areas of health policy, the impact of healthcare beyond human health is not evidence based, and often ignored. As the impact of climate change becomes increasingly apparent, stakeholders involved in delivering healthcare need to recognise the impact the sector has on the health of the planet.

Health economics has an important role to play in shaping how the healthcare market rewards investment in decarbonisation. The value assessment structure within the UK, managed by NICE, helps the NHS to allocate its resources to maximise health. As the process of improving health has a significant impact on the environment, the environmental health impact of healthcare should no longer be left out of decision making. Without better structures for decision making, informed by evidence, the market will continue to incentivise innovation in an environmental vacuum, and will fail to support human and planetary health.

This report shows how the UK government, the NHS and pharmaceutical companies can take action to reduce the environmental footprint of pharmaceuticals. Our recommendations, which were informed by desk-based research and interviews with experts, focus on the highest impact areas for action. We hope our work supports engagement on the barriers the pharmaceutical industry faces to reducing its emissions while continuing to develop lifesaving therapies.

Thank you to the Association of the British Pharmaceutical Industry for funding this important work.

Professor Graham Cookson
OHE Chief Executive

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Executive Summary

Tackling the climate crisis is an international priority. While it attracts less attention than other sectors, healthcare has a high carbon footprint, accounting for 5% of the UK's carbon footprint (Lenzen et al., 2020). NHS England has estimated that the manufacture, supply, and use of pharmaceuticals account for 25% of the NHS's total carbon footprint (NHS England, 2020).

The UK government and the NHS in England have shown international leadership by setting ambitious net zero targets in recent years. However, it is widely recognised that to meet net zero targets, the private sector has an important role to play in reducing the carbon and broader environmental footprints of the products and services they supply to society. Many pharmaceutical companies have made commitments to reach net zero carbon across their operations, but in order to deliver, several significant challenges must be overcome, and this requires action from the UK government and NHS.

CHALLENGES FOR THE PHARMACEUTICAL INDUSTRY

Companies face challenges to achieving net zero that will slow progress on carbon reduction, and sustainability goals beyond greenhouse gas emissions, within the industry. The key challenges are:

Challenge 1: Pharmaceutical products are highly refined, and safety for the end-user is prioritised by all stakeholders, limiting the ability of companies to quickly change processes to increase sustainability while maintaining product safety.

Challenge 2: Pharmaceuticals are highly regulated and are typically supplied through complex global supply chains involving a large number of stakeholders. Therefore, effective change will require a high degree of collaboration and coordination.

Challenge 3: Due to the resource intensity of pharmaceutical manufacturing and low success rates in pharmaceutical research and development (R&D), the waste-to-product ratio on the supply side of the medicines market is high. Supply side waste is compounded by wasteful practices on the demand side (e.g., over-prescription and low adherence).

Challenge 4: The pharmaceutical industry is highly innovative and companies must continue to innovate to deliver medicines. However, future technologies are likely to have a different environmental impact profile compared to established small molecule technologies, generating a moving target for sustainability.

Challenge 5: Health systems do not reward sustainability. This compounds the other challenges and means the financial incentive for the pharmaceutical industry to make the large, coordinated investments required to reach net zero is missing.

To overcome the challenges and accelerate progress on carbon reduction and other sustainability goals, the pharmaceutical industry needs to engage in partnerships with the NHS and UK government, in addition to the need for more cross-industry collaboration. There are a number of high-priority activities that the NHS, UK government and industry should undertake to tackle these challenges.

RECOMMENDATIONS FOR THE UK GOVERNMENT TO SUPPORT PROGRESS ON GREENING WITHIN THE PHARMACETUICAL INDUSTRY

Government recommendation 1: Investment and long-term strategy development for grid decarbonisation. The UK government should continue investment in decarbonisation of the grid

and develop a long-term energy strategy for its transition away from fossil fuels which will be particularly beneficial for energy intensive industries like pharmaceuticals.

Government recommendation 2: The UK government should take a lead role in convening countries to generate common regulatory standards and environmental reporting standards, particularly between the US and Europe medicines regulators.

Government recommendation 3: The UK government should support the NHS's sustainability activities, both financially and with international leadership, as it makes large, long-term investments in the sustainability of its operations, such as electrification of the NHS fleet.

Government recommendation 4: The UK government should invest in implementation projects to accelerate the adoption of greener technologies by industry and the NHS. Many carbon-reducing technologies exist but are currently at low technological readiness levels (TRLs). The government has an important role to play in scaling up the adoption of these technologies.

Government recommendation 5: Invest in the institutions required for green innovation across the UK and in the development of relevant skills in England. The UK government can help ensure there is a strong pipeline of knowledge and skills that can support the industry to improve environmental sustainability in the long term.

RECOMMENDATIONS FOR THE NHS TO SUPPORT PROGRESS ON GREENING WITHIN THE PHARMACEUTICAL INDUSTRY

NHS recommendation 1: The NHS should continue to develop and implement its Supplier Roadmap to ensure there are clear objectives and milestones for suppliers, while engaging proactively with national and international partners.

NHS recommendation 2: The NHS should implement effective, sustainable procurement processes. To support this, NICE should work with industry to incorporate environmental sustainability into health technology assessment (HTA) methods.

NHS recommendation 3: The NHS should implement models of circularity to align incentives for suppliers toward reducing waste.

NHS recommendation 4: The NHS should become an innovation partner with industry to develop solutions to sustainability challenges. The NHS can become a partner for piloting proofs of concept and become a test bed for sustainability schemes that can then be scaled across the system and internationally.

NHS recommendation 5: To address the shared challenges of sustainability, the NHS should become a co-invest with industry on key infrastructure projects through public-private partnerships.

RECOMMENDATIONS FOR THE INDUSTRY TO SUPPORT PROGRESS ON GREENING WITHIN THE PHARMACETUICAL INDUSTRY

Industry recommendation 1: The industry should report and publicly disclose their emissions and progress against targets using standardised metrics that allow the rate of progress to be continually and reliably assessed.

Industry recommendation 2: Companies should invest in the development of life cycle analysis (LCA) of their products to help the NHS incorporate sustainability into procurement decision-making.

Industry recommendation 3: Industry should partner with the NHS to achieve collaborative and innovative solutions in areas such as waste management. This engagement should move beyond product-specific, small-scale pilot projects to develop interoperable and scalable circularity.

Industry recommendation 4: Companies should continue to invest in making energy efficiency improvements. There are actions that companies can take within existing structures of regulation and reimbursement to improve the energy efficiency of energy-intensive sites that have a good financial and environmental return on investment.

Industry recommendation 5: Companies need to collaborate with each other to share knowledge to accelerate progress and generate industry-wide solutions. This is particularly important given the importance of indirect scope 3 emissions where suppliers are shared across companies who can therefore exert joint influence to generate change.

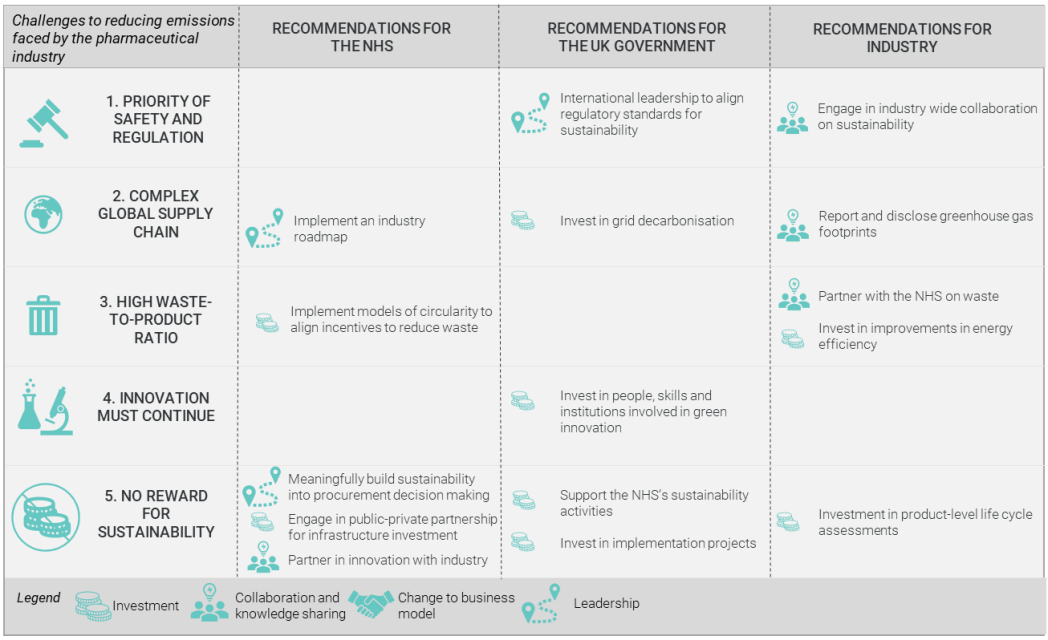

FIGURE 1: CHALLENGES IN DECARBONISING THE PHARMACEUTICAL INDUSTRY AND RECOMMENDATIONS FOR ACTION
Source: Stakeholder interviews and expert roundtable conducted by OHE

To adopt these recommendations, investment is needed from the industry, the UK Government and the NHS - no one actor can be expected to foot the bill for the upfront and ongoing investment needed to achieve long-term sustainability within the pharmaceutical industry. Many of the recommendations presented above are not novel, but instead focus on stakeholders taking existing activities and investing to do them on a larger scale and at a quicker pace.

While the UK has a vital leadership role to play on the international stage, action taken in the UK will need to be replicated internationally to have any impact. Greater involvement from the World Health Organization (WHO) or the United Nations (UN) on sustainability in the pharmaceutical industry could help ensure harmonisation across countries. Ultimately, meaningful engagement, collaboration and action need to be taken now by governments, health systems, medicines regulators and companies globally to secure the era of green pharmaceuticals.

1 Introduction

Tackling the climate crisis has become an international priority. The UK government has ambitious plans to reach net zero carbon emissions by 2050 and has supported a number of initiatives on net zero during its G7 Presidency and the COP26 meeting in 2022. To reach its targets, the UK government is relying on private companies to invest in reducing the carbon, and the environmental impact more broadly, of products and services used within the UK. Beyond policymakers, the public and shareholders are demanding meaningful environmental action from companies across a range of sectors.

The NHS has taken an important first step by being the first health system in the world to publish a net zero strategy. The analysis undertaken by NHS England estimates that the supply chain for goods and services used within the health system is the largest source of emissions for the NHS (NHS England, 2020). Indeed, following the publication of the report, the NHS has scaled up its resources to drive ambitious sustainable procurement goals- to reduce emissions, waste and other areas of environmental impact. However, given the share of emissions from suppliers like pharmaceuticals, the NHS will not be able to achieve its sustainability targets alone.

In the coming years, the NHS and its suppliers, including pharmaceutical companies, face the significant challenge of creating year-on-year carbon savings while continuing to deliver high-quality care and innovative products. Many pharmaceutical companies have already matched the UK government's commitment to reach net zero carbon by 2050. However, the challenge for industry will be reaching their own net zero targets and influencing their own suppliers to do the same. If effectively coordinated across all relevant stakeholders, including the NHS, initiatives to curb emissions in the pharmaceuticals supply chain will have a large impact on the NHS's and the UK's carbon footprint.

Recognising the mutual benefit of industry engagement on net zero, the UK government has shown a willingness to support industry to transition to net zero in the form of grant funding and tax incentives for high emitting industries (HM Government, 2019, 2020, 2022). While general support is undoubtedly beneficial, the pharmaceutical industry faces a unique set of challenges to decarbonisation that require targeted support (the challenges are expanded on in Chapter 3 of this report).

Looking to the future, the race to net zero is the beginning of a transition to more sustainable business practices beyond 2050. As a result, the UK has an opportunity to become a world leader in 'green pharmaceuticals' and 'green healthcare' if it is able to help industry to make the transition to more environmentally conscious business practices. The pioneering work of the NHS, as part of a wider ambition of the UK government to develop a green economy, sets the stage for change (HM Government, 2011).

Coordinated action is required to deliver on this key component of the sustainability agenda. The aim of this report is to inform the design of policies from the UK Government and the NHS to accelerate sustainability in the pharmaceutical industry, with a focus on carbon reduction. The recommendations set out in this report focus on areas of collaboration between stakeholders to accelerate change.

1.1 Methods and report overview

This report is informed by a rapid, pragmatic review of the evidence on carbon emissions in the pharmaceutical industry. It involves a discussion of both published journal articles and grey literature including commentaries and company websites. The results from 14 semi-structured interviews with academics, industry representatives, and experts in sustainability and manufacturing and a roundtable of industry representatives and sustainability experts also feed into this report.

1.2 Definition and abbreviations

Sustainability: meeting the needs of the present without compromising the ability of future generations to meet their own needs. Environmental sustainability is just one aspect of sustainability alongside social equity and economic development and encompasses concerns such as greenhouse gas emissions and depletion of natural resources. However, we use sustainability throughout the report to mean environmental sustainability.

Carbon emissions: the release of carbon-based greenhouse gases such as carbon dioxide and methane into the atmosphere. These gases affect temperatures on earth and contribute to climate change. While there are many natural sources of carbon emissions, the leading source of carbon emissions is the burning of fossil fuels for electricity, heat and transport.

Carbon footprint: the total quantity of carbon emissions associated with a particular source. This may be a manufacturing facility, the value chain associated with a specific product, or an entire country.

Net zero (carbon): a situation in which a source makes no net contribution to greenhouse gas emissions. For a company to achieve net zero, it will have to offset any residual carbon emissions associated with its operations and supply chain by some form of carbon sequestration (i.e., removing carbon from the atmosphere). In theory, the sequestration could take place anywhere on the planet.

2 Sources of carbon emissions within the pharmaceutical supply chain

SECTION SUMMARY:

- Healthcare has a high carbon and environmental footprint accounting for up to 10% of the carbon footprint of the UK.
- Pharmaceuticals have been estimated to account for 25% of the carbon emissions associated with the NHS in England with 5% of the footprint due to metered dose inhalers and anaesthetic gases. Precise estimates of the share of the UK health system carbon footprint attributable to pharmaceuticals vary from 12.1-25% depending on the methodology used.
- Emissions for pharmaceuticals are often concentrated during early stages of the supply chain during raw material extraction and manufacture of the Active Pharmaceutical Ingredients (APIs). However, sources of emissions vary across products
- According to industry experts, scope 3 emissions, which are outside of the direct control of the company, account for 70-90% of the total carbon footprint of pharmaceutical companies

2.1 Scale of emissions from the pharmaceutical industry

The contribution of healthcare to the UK's total carbon footprint is likely to fall within the range of 4.4-10%. Health Care Without Harm and ARUP (2019) estimate that 4.4% of global net greenhouse gas emissions are attributable to health care, and if the health sector were a country, it would be the fifth largest emitter on the planet. below shows that the UK ranks highly compared to other countries in terms of the contribution of healthcare to national carbon footprints.

Emissions associated with pharmaceuticals are one input into the total carbon footprint of the healthcare sector. Pharmaceuticals are a large, global industry accounting for around one per cent of global gross domestic product (GDP), equivalent to the GDP of the Netherlands (IFPMA, 2020). Health Care Without Harm and ARUP (2019) also estimate that 71% of health care's climate footprint[1] is primarily derived from the health care supply chain, including the manufacture, transport, and disposal of pharmaceuticals.

[1] *Climate footprint is a more comprehensive measure of greenhouse gas emissions than carbon footprint so should always be at least as large as the carbon footprint*

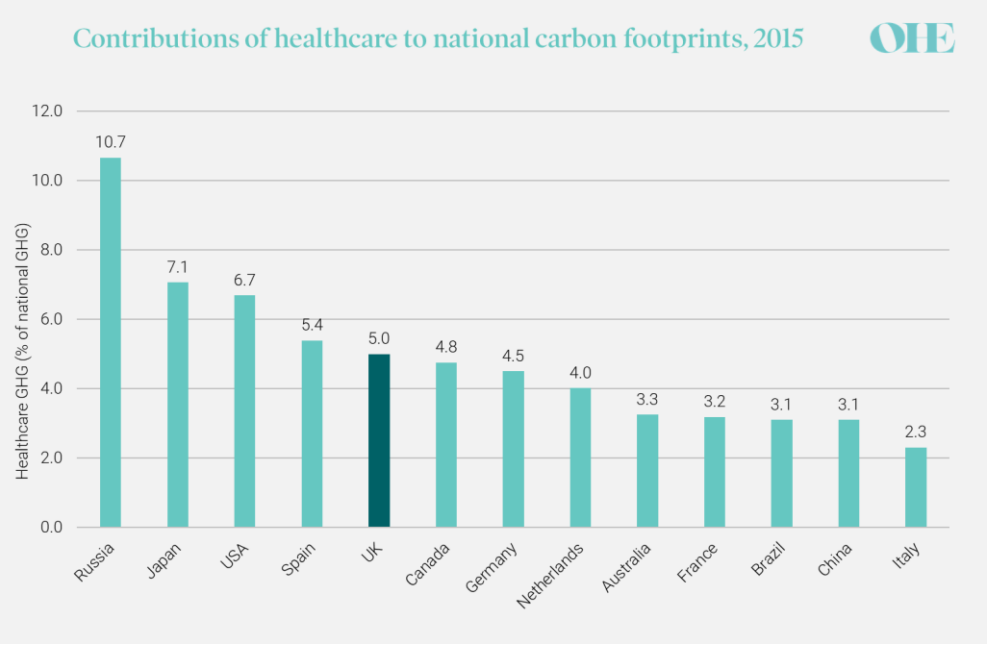

FIGURE 2: HEALTHCARE CARBON FOOTPRINTS AS PERCENTAGES OF NATIONAL CARBON FOOTPRINTS FOR SELECTED COUNTRIES
Source: Lenzen et al. (2020) *supplementary materials*

Pharmaceutical emissions in the NHS

NHS England (2020) estimated the total direct and indirect carbon emissions of NHS England in 2020, the first health system in the world to do so. Box 1 below provides detail on the methodology used to estimate the health provider's carbon footprint and compares their estimates of the contribution of pharmaceuticals to previous estimates.

Box 1: Deep Dive into the NHS Greener methodology

The four main elements of the NHS's modelling and analytical approach are:

1. Estimation of NHS carbon footprint baseline emissions from 1990
2. Projection of NHS carbon footprint emissions to 2050
3. Model impact of proposed and agreed policy wedges on NHS carbon footprint
4. Model impact of specific interventions within policy wedges on NHS carbon footprint

The NHS has used an expenditure-based approach to estimate many domains of its carbon footprint, including the procurement of medicines. This means that the contribution of a given product to the NHS's total footprint is essentially the product of the NHS's expenditure on the medicine and the relevant carbon emission intensity factor. Expenditure-based estimation is an established approach to estimating carbon footprint. However, tying estimates to expenditure instead of volume means that an increase in the price of a medicine will translate into an incorrect increase in the carbon footprint estimate. The emissions intensity factors used in the calculations also come from 2016 and were therefore already four years old at the time of publication.

NHS CARBON FOOTPRINT

The authors break down the NHS's emissions, which together have been estimated to account for 4% of the country's total carbon footprint, into the emissions associated with direct NHS activity (NHS Carbon Footprint) and add to this the indirect emissions associated with the procurement of medicines for example as well as patient and visitor travel to NHS services (NHS Carbon Footprint Plus). Both the NHS Carbon Footprint and the NHS Carbon Footprint Plus have decreased since their 1990 levels (by 26% and 62% respectively).

OTHER EVIDENCE ON THE CONTRIBUTION OF PHARMACEUTICALS TO NHS CARBON FOOTPRINT

The NHS has published estimates of the contribution of pharmaceuticals to the total carbon footprint of the NHS in the past. Table 1 presents some selected estimates. The estimates vary from 12.1 - 35% but this is largely because these studies take different measures of the NHS carbon footprint as the denominator. For example, NHS England and Public Health England (2018) present a breakdown of the aggregate Health and Social Care carbon footprint whereas Connor et al. (2010) look at the carbon footprint of an individual NHS renal service.

TABLE 1: ESTIMATES OF THE SHARE OF HEALTH SERVICE/HEALTH SYSTEM CARBON EMISSIONS ATTRIBUTABLE TO PHARMACEUTICALS

Publication	Contribution of pharmaceuticals to respective carbon footprint (%)	Measure of overall carbon footprint
NHS England and Public Health England (2018)	12.1%	Carbon footprint of the NHS Health and Social Care system, 2017
NHS Sustainable Development Unit (2014)	16.25%	Carbon footprint of the NHS, Public Health and Social Care system
NHS Sustainable Development Unit and Stockholm Environment Institute (2008)	22%	NHS carbon footprint, 2004
NHS England and NHS Improvement (2020)	**25%**	**NHS Carbon Footprint Plus 2020**
Connor et al. (2010)	35%	Total carbon footprint of the Dorset Renal Service

The estimated carbon footprint of the direct activities of the NHS in England in 2020 was 6.1 $MtCO_2e$, while the indirect activities that NHS England does not have direct control over were 24.9 $MtCO_2e$ (more than 4 times higher). Therefore, the majority of the emissions associated with the NHS are not

under the direct control of the NHS but instead originate in the NHS supply chain. Figure 3 provides a detailed breakdown of NHS greenhouse gas emissions by source, and Figure 4 provides breakdowns of acute and primary care emissions, the two biggest sources of total NHS emissions.

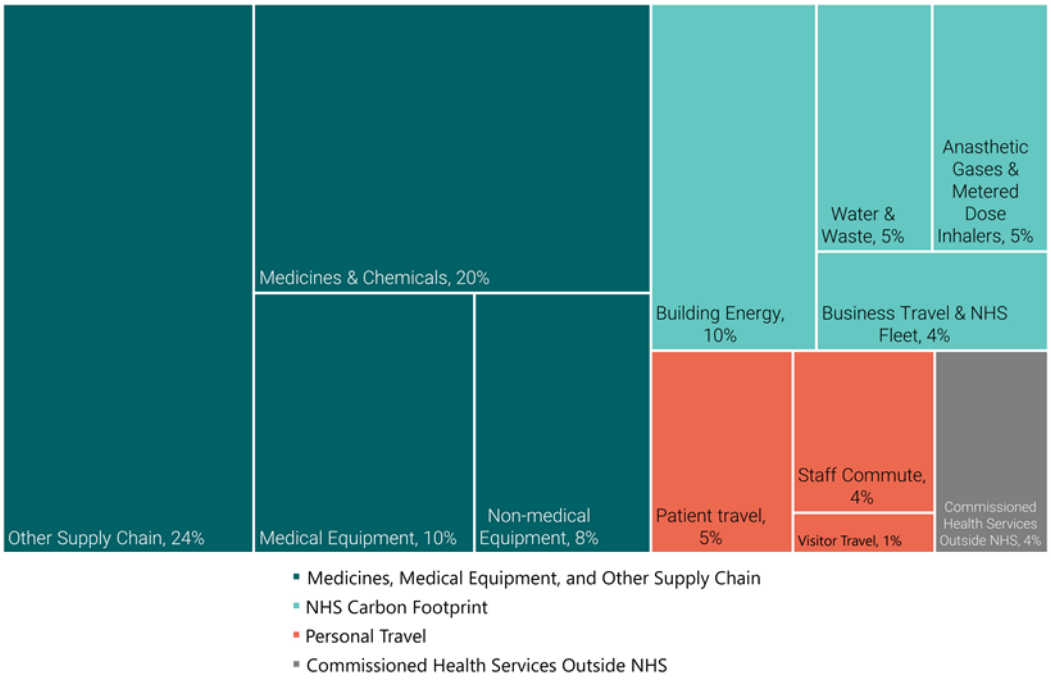

FIGURE 3: BREAKDOWN OF NHS CARBON FOOTPRINT PLUS
Source: NHS England (2020)

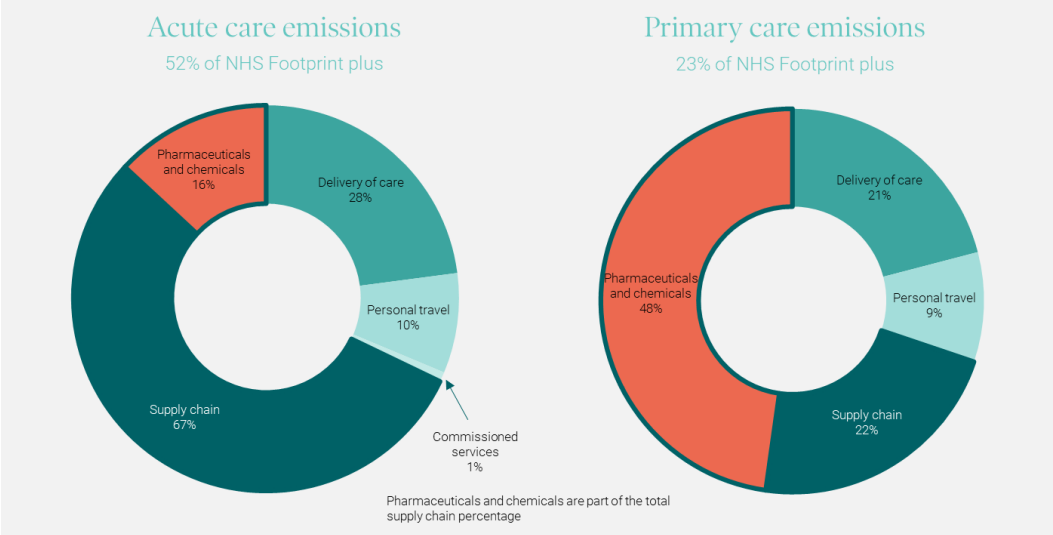

FIGURE 4: COMPARISON OF SOURCES OF ACUTE AND PRIMARY CARE EMISSIONS
Source: NHS England (2020)

The NHS estimates that medicines account for a quarter of the NHS's total emissions (which includes both direct and indirect emissions). 80% of the emissions related to medicines are due to

the manufacture and supply of drugs procured by the NHS and 20% is estimated to come from the on-site use of anaesthetic gases (8%) and metered dose inhalers (12%). Previous estimates of the contribution of pharmaceuticals to NHS emissions vary from 12% to 25% (see Box 1 above).

Emissions also vary across care settings. The majority of NHS emissions come from acute care (i.e., short-term treatment, usually in hospitals), and the majority of these emissions are supply chain emissions, i.e. they are embedded in the pharmaceuticals, chemicals, equipment and other goods that the NHS procures from industry. The manufacture and supply of pharmaceuticals make up 16% of total acute care emissions, while in primary care, this category accounts for 48% of total emissions.

2.2 Sources of emissions in the pharmaceutical supply chain

For the NHS to reach net zero, reductions in emissions from the pharmaceutical industry – which makes up a significant proportion of the NHS's total emissions – will be vital. Understanding where in the supply chain most emissions are generated will be important to target interventions to have the biggest impact on emissions. Figure 5 illustrates the main steps in the lifecycle of a pharmaceutical product, from research and development (R&D) to the end of a product's life, including estimates of the contributions of each set of stages to the medicine's total carbon footprint. The footprint shares across the supply chain are, however, highly variable from product to product.

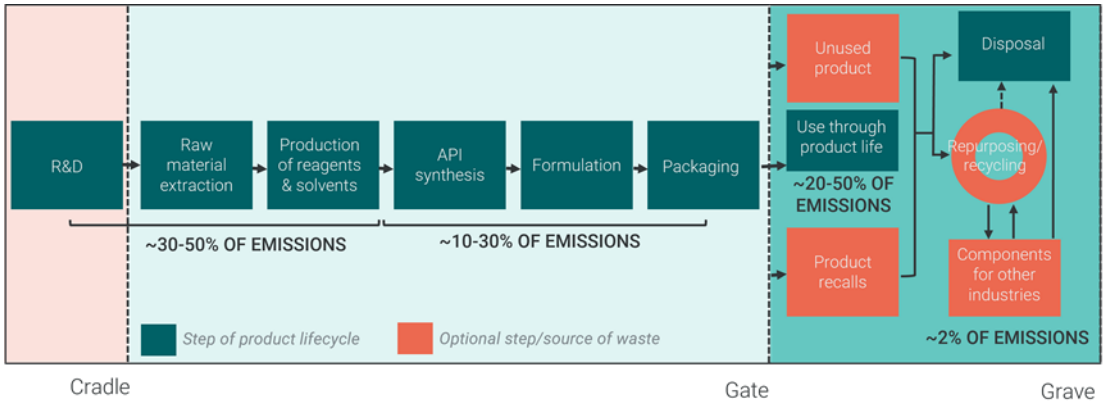

FIGURE 5: GENERALISED PHARMACEUTICAL SUPPLY CHAIN DIAGRAM
Source: High Value Manufacturing Catapult Sustainability Report (unpublished)

RAW MATERIALS AND API MANUFACTURING

Exactly where in the supply chain most emissions are generated varies depending on the product. Generally, raw material extraction and API synthesis generate the highest proportion of emissions for small-molecule pharmaceuticals. Manufacturing is also often a source of significant emissions because it requires a substantial amount of energy to generate the heat, pressure, and sterility required within the processes (Belkhir and Elmeligi, 2019).

PACKAGING AND DISTRIBUTION

The emissions associated with packaging and distribution vary substantially depending on the kind of pharmaceutical product. For biologics, for example, emissions associated with transport and packaging are likely to be greater per unit than for small molecules. Being temperature-sensitive, they likely require more protective secondary packaging, refrigeration in transport, and are usually transported by air rather than by lower-emission transportation methods like freight. While they are designed to help guarantee patient safety, which is of paramount importance, regulatory obligations such as the compulsory inclusion of patient information leaflets (PILs) also add to emissions and packaging waste.

EMISSIONS DURING USE AND LEAKAGE
Certain health technologies emit greenhouse gases due to leakage during use. This is the case for most anaesthetic gases, particularly desflurane and metered dose inhalers which contain hydrofluorocarbon propellants, a highly potent greenhouse gas (Janson et al., 2020).

2.3 Sources of emissions within the pharmaceutical value chain

Analysing emissions associated with individual products is illustrative; however, companies think about their emissions aggregated across their activities and the activities of other actors in the supply chains across their whole portfolio.

The carbon emissions associated with a pharmaceutical company are commonly categorised into one of the three Greenhouse Gas Protocol (GHGP) scopes, which together describe how emissions are distributed across the value chain. The GHGP scopes are summarised in Box 2 below. Using the GHGP framework highlights that, like the NHS, there are many sources of emissions that the pharmaceutical company themselves does not have direct control over.

Box 2: Greenhouse Gas Protocol (GHGP) scope definitions

SCOPE 1
Emissions that come directly from company sites and vehicles. In pharmaceuticals, an example of scope 1 emissions would be those from manufacturing processes at a plant owned by the company.

SCOPE 2
Emissions that relate to the use of purchased electricity, steam, heating, and cooling. Together, scopes 1 and 2 typically make up only a small proportion of total value chain emissions associated with a pharmaceutical product.

SCOPE 3
Scope 3 emissions can be separated into upstream and downstream emissions. Upstream scope 3 emissions are those which are associated with the production and transport of the goods and services that the organisation uses. In pharmaceutical manufacturing these will likely include excipients and machinery. Downstream scope 3 emissions are those associated with the transport, use and disposal of the company's final products.

The overwhelming majority of the emissions of any pharmaceutical company fall into scope 3. Figure 6 below gives an overview of the main sources of emissions of a branded pharmaceutical within each GHGP scope. As with the supply chain, the precise share of emissions across scopes will vary depending on the make-up of a company's product portfolio.

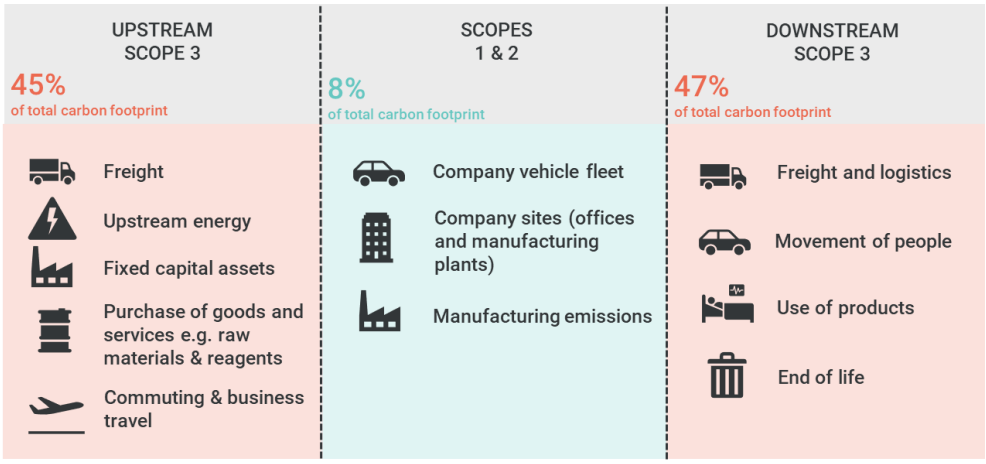

FIGURE 6: EXAMPLE SOURCES OF EMISSIONS ACROSS THE DIFFERENT GREENHOUSE GAS PROTOCOL (GHGP) SCOPES FOR INHALERS

Source: GSK value chain carbon footprint

3 Opportunities to reduce emissions within the industry

SECTION SUMMARY:
Many pharmaceutical companies have made commitments to reach net zero carbon across their operations but there are five major challenges which could slow progress on carbon reduction and other sustainability goals:

- Challenge 1: Pharmaceutical products are highly refined, and safety for the end-user is prioritised by all stakeholders, limiting the ability of companies to quickly change processes to increase sustainability while maintaining product safety.
- Challenge 2: Pharmaceuticals are required to meet high regulatory standards and are typically supplied through complex global supply chains involving a large number of stakeholders. Therefore, effective change will require a high degree of collaboration and coordination.
- Challenge 3: Due to the resource intensity of pharmaceutical manufacturing and low success rates in pharmaceutical research and development (R&D) the waste-to-product ratio on the supply side of the medicines market is high and this is compounded by overprescribing and adherence issues on the demand side.
- Challenge 4: The pharmaceutical industry is highly innovative and companies must continue to innovate to deliver life-enhancing medicines. However, future technologies are likely to have a different environmental impact profile compared to established small molecule technologies, generating a moving target for sustainability.
- Challenge 5: Healthcare systems do not currently reward sustainability. This compounds the other challenges and makes that one important incentive for the pharmaceutical industry to make the large, coordinated investments required for the impactful sustainability projects needed to reach net zero is missing

Industry requires support from the NHS and the UK government in alignment with global regulations as well as cross-industry collaboration to overcome the challenges it faces.

3.1 Net zero commitments from the industry

Many global companies have made some public commitment to net zero carbon, including a large number of large pharmaceutical companies. 21% of the Forbes Global 2000 list have made a net zero commitment, including over two-thirds of corporates in the Household & Personal Products sector, the sector most similar to pharmaceutical products for which data is available (ECUI and Oxford Net Zero, 2021).

Industry-wide net zero pledges

UN GLOBAL COMPACT
The United Nations (UN) Global Compact is a non-binding pact to encourage companies worldwide to adopt sustainable and socially responsible policies and to report on their implementation. One objective of the pact is to support the sustainable development goals (SDGs). The corporate participants include 289 pharmaceutical and biotechnology companies, which together account for 1.8% of all corporate signatories.

SCIENCE BASED TARGETS INITIATIVE
The Science Based Targets Initiative accredits the net zero plans of companies to ensure they align with global warming limit targets (Science Based Targets Initiative, 2022). Eighty pharmaceutical and

biotech companies have science-based targets, with a doubling of companies involved in the initiative since 2020.

RE100

RE100 is a global corporate renewable energy initiative that encourages companies to commit to sourcing 100% of their energy from renewables (excluding nuclear) (RE100, 2022, p.100). Fourteen pharmaceutical companies are signed up to RE100, including Astra Zeneca, J&J, Novartis, Novo Nordisk, Sanofi, Zoetis, Biogen, Daiichi Sankyo, Eisai, Gilead and GSK.

RENEWABLE POWER PURCHASE AGREEMENTS AND ENERGIZE

Power Purchase Agreements (PPAs) are long-term electricity supply agreements, usually between a power producer and a customer. Given the reliance on renewable energy to reach net zero targets, many companies are using PPAs to support renewables. In a PPA, companies generally purchase renewable energy equivalent to a share of their total energy consumption, and this feeds into the national grid where the renewable producer is based (Kobus, Nasrallah and Guidera, 2021). They are a mechanism by which private capital can support the development of additional renewable energy sources and lower the price of renewable energy.

The adoption of PPAs has grown relatively quickly in the pharmaceutical industry compared to other industries. Energize is a programme designed to facilitate green power procurement to decarbonise the pharmaceutical global supply chain by increasing pharmaceutical suppliers' access to renewable energy (Supply Chain Renewables Initiative, 2022). The Energize sponsors are AstraZeneca, Biogen, GSK, Johnson & Johnson, MSD, Novartis, Novo Nordisk, Pfizer, Sanofi and Takeda (Energize, 2021).

Company-specific net zero targets

Many individual pharmaceutical companies have company-specific sustainability plans, as outlined in Figure 7 below. Most of the pledges are relative (i.e. carbon neutrality or net zero by a certain date) accompanied by an absolute reduction in emissions relative to a previous year (the reference year varies across companies). Many of the targets are accredited by the Science Based Targets Initiative as aligning with global pledges to limit global warming to 1.5˚. Most pledges concern scopes 1 and 2 emissions; however, some companies have pledges around scope 3 emissions. Scope 3 pledges mainly focus on supporting suppliers to reduce their emissions by sharing knowledge or through some form of mandate.

The methods by which companies propose they will reach their net zero targets are very similar. Many pledges are highly reliant on reaching 100% renewable energy supply and electrification of vehicles to meet targets. Three companies mention 'carbon removal' (i.e. carbon offsetting or carbon capture) as part of their strategy. None mention the use of carbon credits to offset their carbon usage, although the use of this method is likely to be more widespread than is reported.

	BIOGEN	GSK	AZ	J&J	MSD	NOVARTIS	NOVO NORDISK	PFIZER	SANOFI	TAKEDA
NET ZERO TARGET YEAR	Fossil fuel free by 2040	2030 (full value chain)	2026 to reduce scopes 1 and 2 by 98%	2045 (full value chain)	2025 (scopes 1 and 2)	2040 (full value chain)	2045 (full value chain)	2030 (carbon neutral across internal operations)	2050 (net zero emissions as per Race to Zero)	2040 (carbon net zero in operations)
REFERENCE EMISSIONS YEAR	2019 (for scope 1+2 reduction target of 100% by 2040)	Not reported	2015 (for reductions in operations and value chain emissions)	Not reported	Not reported	Not reported	2019 (for 100% scope 1+2 reduction by 2030)	2019 (46% reduction in direct emissions by 2030)	2019 (for global operations and full value chain reductions)	2016 for emissions from operations and 2018 for scope 3 emissions
RENEWABLES COMMITMENT	By 2040, operations powered entirely by renewable energy	100% renewable electrical by 2025 (scope 2)	All imported energy comes from renewable sources	By 2025 source 100% of electricity needs from renewable sources	Source 100% renewable energy for purchased electricity by 2025	Not reported	All direct suppliers to use 100% renewable power by 2030. In 2020, 100% of power sourced from production sites was from renewable energy.	By 2030, all purchased electricity to be from renewable energy sources	100% renewable electricity across all global operations by 2030	No quantitative renewables commitment found.
RELIANCE ON OFFSETTING	Not reported	Aim to use carbon removals for around 20% of carbon footprint	Will identify carbon removal options that will help achieve net zero	Not reported	Reduction in scope 1 and 2 emissions allows for removals from bioenergy feedstocks	Not reported	Not reported	Not reported	Not reported	Use of carbon removal to eliminate any remaining scope 1 and 2 remissions by 2040
SCOPE 3 COMMITMENTS	90% of suppliers by spend to source 100% of their electricity from renewable sources by 2040	Transition to low carbon inhalers. Work with EcoVadis to provide an independent assessment of third parties.	By 2030 , 50% absolute reduction of scope 3 emissions compared to 2019	By 2030, reduce absolute upstream scope 3 emissions by 20% from 2016 levels	By 2030, reduce absolute scope 3 emissions by 30% compared to 2019	2030 target for carbon neutrality across scopes 1, 2 and 3	All direct suppliers to use 100% renewable power by 2030. 100% reduction from business flights and product distribution	Reduce indirect emissions from product distribution by 10% by 2025	By 2013, 14% reduction in value chain GHG emissions	By 2040, 50% reduction in scope 3 emissions compared to FY2018.

FIGURE 7: ENERGIZE MEMBERS' NET ZERO TARGETS
Source: S&P Global Market Intelligence (2022) and individual company websites

3.2 Biggest challenges the industry faces to reduce emissions

Despite having net zero pledges as set out above, pharmaceutical companies face five challenges to meeting them.

Challenge 1: Pharmaceutical products are highly refined, and safety for the end-user is prioritised by all stakeholders

Due to the importance of maintaining and guaranteeing the safety and efficacy of pharmaceutical products, the industry is highly regulated at every stage in the product lifecycle.

Pharmaceutical products are highly refined and must follow the highest standards for safety, consistency, and sterility and meeting these standards relies on carbon-intensive activities. For example, a significant amount of energy is needed to refine raw materials, generate the heat and pressure for manufacturing processes and support cold-chain distribution. After a product is used, end-of-life waste management often follows the safety requirements associated with the disposal of medical waste to prevent contamination and infection. Other regulations introduced to improve patient safety increase the environmental footprint of medicines; for example, in the UK, blister packs, which generate high levels of waste, are used instead of the pill bottles used in the US to reduce the risk of patients over-dosing.

Regulatory standards (such as Good Manufacturing Practice [GMP]) are vital to product quality and safety but also represent a constraint for companies seeking to reduce their environmental impact through process improvement. Companies cannot easily adapt processes for existing products after the manufacturing process has been approved as meeting GMP by the regulator. Changes to increase energy efficiency are possible, and these changes are being made by some companies, but there is often fear of regulatory repercussions to any changes to the manufacturing process or manufacturing site.

Where companies can adapt processes, technology and infrastructure lack the maturity to support change. Digital technologies to enable smart monitoring of manufacturing are not well established or scaled within the industry. In addition, regulators are slow to adapt to innovation in manufacturing, and delivery, meaning technologies that could generate carbon savings (e.g., continuous manufacturing) are not yet widely accommodated in regulatory standards, thereby reducing uptake.

The compliance culture within regulatory teams impacts a company's ability to identify opportunities to reduce emissions while maintaining regulatory standards. A culture of compliance is required within the regulatory affairs, manufacturing, and delivery teams within pharmaceutical companies to ensure there is compliance with the different regulations across multiple jurisdictions. However, it is a further barrier to change because there is often a failure to identify opportunities to reduce emissions.

Box 3: Air quality guidelines and energy efficiency

Regulators provide companies with recommendations on how many air changes an hour are required to achieve Good Manufacturing Practice (GMP) in terms of the cleanliness of manufacturing facilities. Regulators are concerned about the outcome (i.e., the cleanliness of the air), not the process (i.e., the number of air changes per hour) so companies have the opportunity to reduce the number of air changes (thereby substantially reducing energy use) while maintaining GMP as long as they are able to demonstrate air quality.

However, companies in general will adhere to the recommendations from the regulator strictly due to the potentially high cost of failing an inspection. Companies' strict adherence to the process guidelines on air changes per hour leads to a huge amount of wasted energy because of the large amounts required to do this in a large manufacturing facility. Technology like air quality sensors allow regulators to observe the GMP standard directly, giving companies more assurance that they can take control of the process without risking failing an inspection.

An energy efficiency review project at 10 manufacturing sites globally to improve energy efficiency generated annual savings of $6.4 million of energy cost (25% reduction), 18,600 tonnes of CO_2 (22% reduction) and 47 million gallons of water (22% reduction).

"We manufacture these products in clean rooms – enormous clean rooms – and they require air to be supplied through filtered air to keep the room clean. The more you change the air in the room, the more volume of air moving and the more you have to condition that air. 50% less air… is equivalent to an 80% reduction in energy… these are big numbers" Sustainability consultant

Source: Expert interviews & EECO2 environmental sustainability consultancy

Challenge 2: Pharmaceuticals are produced through complex, global supply chains

Pharmaceutical supply chains are complex and global. Each stage of the product lifecycle is typically carried out by different companies contracted by another company, often operating in different parts of the world. The main active pharmaceutical ingredient (API) manufacturers are based in China (13%) and India (48%), and products destined for use in the UK may be packaged within Europe (Raghavendran and Christian, 2022). Between each step of the supply chain, there are emissions associated with the distribution of intermediate goods from one supplier to another.

Many of the largest sources of emissions for a pharmaceutical company fall under scope 3 and are beyond the direct control of the company. Raw material extraction (i.e. processing of raw materials into ingredients and excipients), as well as API synthesis, are often outsourced by pharmaceutical companies to contract manufacturers and suppliers, thereby moving those high-emitting stages of the manufacturing process out of the direct control of pharmaceutical companies. The global footprint of manufacturing may be even more marked for generics which make up 81% of all drugs prescribed in primary care in England. Once patents expire, competition between producers leads to a race to the bottom in terms of costs. As a result, manufacturing is often outsourced to countries such as India and China, where environmental standards are not as high as they are in the UK.

All companies rely on fossil-fuel-dependent national infrastructure for their activities. Given the energy intensity of pharmaceuticals, national electricity and gas grids have a big impact on the environmental credentials of the manufacturing process. It is out of the control of companies to drive infrastructure changes needed to decarbonise national grids. After use, infrastructure for waste management is also lacking mechanisms to embed circularity as waste processing infrastructure for medical waste is largely not used in the UK or globally. Companies will not invest alone to establish

comprehensive recycling or circularity infrastructure within health systems and are currently not incentivised to do so in a meaningful, interoperable, and cross-product way.

Suppliers throughout the supply chain compete on cost, and a drive for lower-cost manufacturing has been a driver behind the complexity of pharmaceutical supply chains. The short-term cost incentive of using contract manufacturers in India and China is offset by a less resilient higher-risk supply chain where the risk of disruption and stockouts is likely to be high. The mitigation activities taken by companies, and health systems, to control the high risk associated with complex pharmaceutical supply chains increases costs and generates waste throughout the supply chain. For example, a substantial amount of inventory is held within the supply chain at every stage, which means excess emissions, products and product intermediates are generated than are needed to meet demand.

Challenge 3: There is a high waste-to-product ratio on both the supply and demand sides

Pharmaceuticals have a high level of waste across the whole value chain relative to other industries. Waste contributes directly to emissions because it means more emissions are generated than are necessary to meet the demand for a product.

On the supply side, waste is generated partly due to the need to hold inventory within the supply chain to offset the aforementioned supply risk. On the demand side, waste is generated when purchased products are not used or are used inappropriately. This may be due to patient or physician behaviour, such as low adherence or low-value prescriptions, which persist in the NHS despite waste reduction initiatives (Tomson, 2015). Overprescribing may be a particular source of waste in the NHS – it has been estimated that at least 10% of prescriptions in primary care need not have been issued (DHSE, 2022). Additionally, most health systems, including the NHS, generally do not manage stock well, with overstocking leading to a mismatch between internal supply and demand.

On the demand side, waste is generated because of poor matching between supply and demand. Pharmaceutical products are manufactured in large batches to meet global demand for months at a time. As a result, supply is not responsive to short-term changes in demand, so waste is generated through overproduction and subsequent expiry. Pharmacies within the NHS also choose to buy more medicines than they need in order to have buffer stock to protect against stockouts (Hazell and Robson, 2015).

Challenge 4: Pharmaceutical companies must continue to innovate

A significant amount of research and development (R&D) goes into producing a new medicine. Pharmaceutical R&D itself produces greenhouse gas emissions, albeit smaller amounts than other stages of the product lifecycle due to the lower scale of carbon-intensive steps such as manufacturing and sourcing of raw materials.

Around 90% of drugs in clinical development fail to reach the market (Dowden and Munro, 2019), and the clinical development success rate in oncology may be as low as 3.4% (Wong, Siah and Lo, 2019). Low success rates in pharmaceutical R&D mean there are greenhouse gas emissions associated with products that never reach the market, and given the high scientific complexity of drug development, emissions associated with unsuccessful development programmes cannot be eliminated.

Cumulatively, the emissions associated with all R&D activity are likely to be significant, particularly towards the later stages of development, such as phase III clinical trials. The average carbon footprint of getting one drug from phase II clinical trials to successful approval, including the failures along the way, may be as high as 23,363.2 tCO2e or 0.02 MtCO2e (Wong et al., 2019; Lyle et al.,

2009)[2], equivalent to 0.3% of the NHS Carbon Footprint (the measure that ignores patient and visitor travel and supply chain emissions). This estimate ignores preclinical and phase I trials which are only likely to make small contributions compared to phase II and phase III.

Reducing emissions in the pharmaceutical industry is a moving target because the technologies of the future will have a different environmental profile to traditional small molecule pharmaceuticals. The future of pharmaceuticals is moving towards highly innovative therapeutic modalities like advanced biologics and cell and gene therapies. Many of these technologies consume significantly higher quantities of energy per treatment produced than established processes for small molecules (Andrews et al., 2021; Murray and Livingston, 2021). The additional emissions are technically complex to overcome and present real trade-offs in terms of process efficiency and energy intensity of distribution. The environmental profile of biologics compared to small molecules will depend on the source of energy for the process; if the process relies on non-renewables, then the carbon impact of manufacturing will be very high in the future unless they can be mitigated.

Challenge 5: The market does not reward sustainability

There are no signals from the pharmaceuticals market that payers (such as the NHS) are willing to share the incremental cost of more sustainable products despite public support for greener healthcare (Cameron et al., 2021). Innovation to improve process efficiency has an upfront cost and leads to delays around launch and during the early stages of the patent's life. Companies are therefore hesitant to invest as they are unsure whether greater sustainability will be recognised and rewarded by the NHS.

Health systems see healthcare as a cost to be minimised rather than an investment that needs to be optimised for long-term outcomes in health and other areas of society, including environmental sustainability. Companies generally compete to manufacture their products at the lowest cost, meaning suppliers – those responsible for the highest emitting stages of the supply chain – are mainly incentivised to deliver on cost, not on sustainability.

Processes for appraising medicines embed a cost-based perspective even in value-based processes like health technology assessment (HTA) because they focus narrowly on health and on the short term. HTA often fails to take a pathway comparison approach to assessing cost-effectiveness, which has been shown to have an impact on emissions (Sustainable Healthcare Coalition, 2019; Nicolet et al., 2022). Actions that have important environmental (and social) implications, such as travel to the hospital and the additional environmental and societal benefits of curative or preventative treatments, are not considered. Measuring the environmental implications of medicines is not methodologically or conceptually impossible; however, there are currently no agreed methods for how total carbon emissions are measured and reported at a product level which would be a prerequisite for including an environmental perspective in HTA or other value assessment, processes.

Impact of each challenge on emissions and the ability of the pharmaceutical industry to act

Each of the five challenges has a different impact on the context for sustainability within the industry. Some of the challenges have a large direct impact on emissions, while some of them impact the ability of companies to make the required scale of changes at the speed needed to reach net zero targets. Figure 8 below summarises the impact of each challenge on both emissions and the industry's ability to act.

[2] *The average carbon footprint of a pragmatic randomised controlled trial involving hundreds of participants has been estimated to be 784 tCO_2e (Lyle et al., 2009). The average success rate from phase II to approval has been estimated to be 6.7% (Wong et al., 2019). At this success rate and from the standpoint of phase II, 14.9 attempts are needed to get one drug approved. Assuming each drug candidate has to undergo one phase II clinical and one phase III clinical trial and the average carbon footprint across these is equal to 784 tCO_2e, then the carbon footprint of getting one drug from phase II to approval is 14.9 x 2 x 784 = 23,363.2 tCO2e, or 0.02 MtCO2e.*

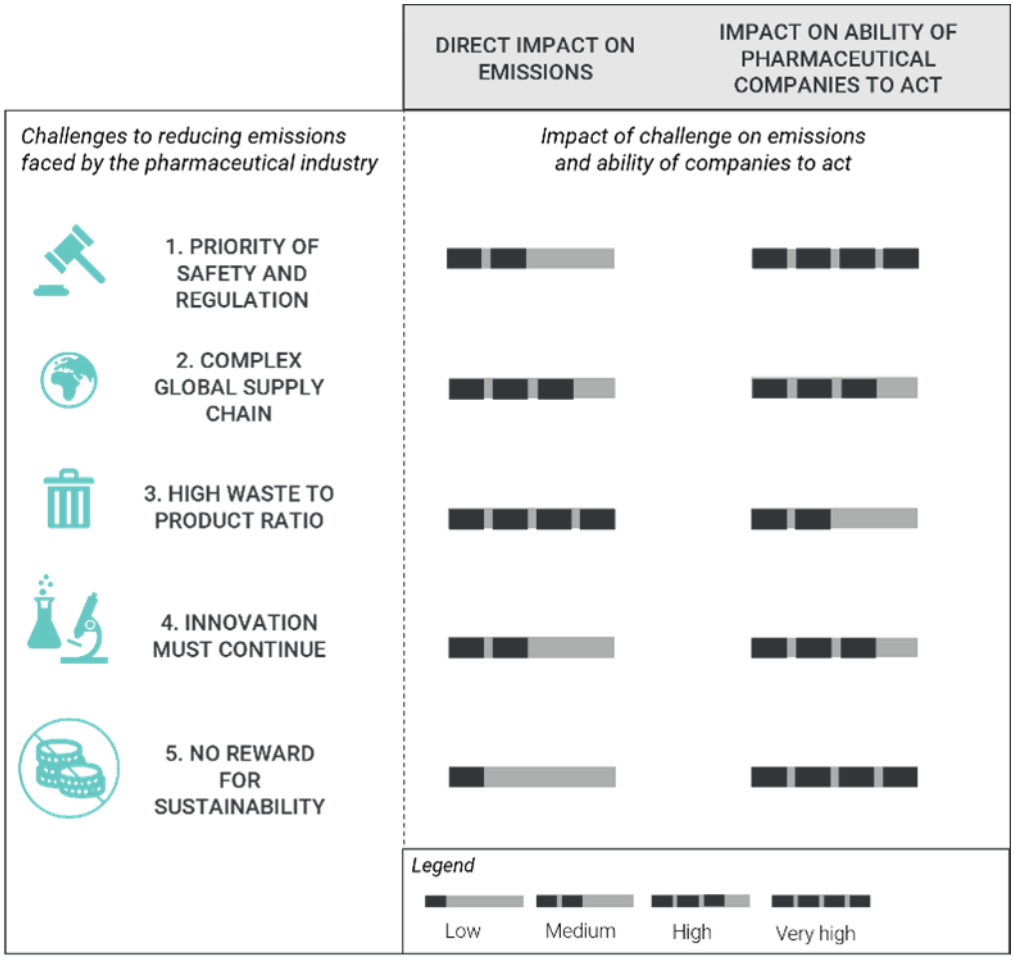

FIGURE 8: OVERVIEW OF THE IMPACT OF EACH CHALLENGE AREA ON DIRECT EMISSIONS AND ABILITY OF PHARMACEUTICAL COMPANIES TO ACT
Source: OHE expert interviews and roundtable

The scale of waste has the highest direct impact on emissions, while regulation and lack of reward for sustainability are the challenges which have the highest impact on the industry's ability to act at speed and scale. All the challenges are important, and all need to be targeted to achieve the kind of systematic change needed to meet net zero targets and ultimately embed sustainability in business as usual.

4 Recommendations for the UK government and the NHS to support greening within the industry

SECTION SUMMARY:
There are high-priority activities that the NHS, the UK government and industry should undertake to overcome the challenges set out in Chapter 3 and meet net zero targets:

RECOMMENDATIONS FOR THE UK GOVERNMENT

1. Invest in and develop strategy for grid decarbonisation
2. Lead international alignment on regulatory standards
3. Support the NHS's sustainability activities
4. Invest in implementation projects for carbon-reducing technologies
5. Invest in the people, skills and institutions required for green innovation

RECOMMENDATIONS FOR THE NHS

1. Implement an industry roadmap
2. Meaningfully build environmental sustainability into procurement decision-making
3. Implement models of circularity to align incentives to reduce waste
4. Partner with industry in green innovation
5. Engage in public-private partnerships for green infrastructure investment

RECOMMENDATIONS FOR THE INDUSTRY

1. Reporting and disclosure of sustainability metrics
2. Invest in product-level life cycle assessment (LCAs)
3. Partner with the NHS on waste management
4. Invest in improvements in energy efficiency
5. Engage in industry-wide collaboration on greening

The UK government, the NHS and industry all have a responsibility to act to overcome the challenges the industry faces in reaching net zero. This section explains the highest priority actions that could be taken by the UK government, the NHS and pharmaceutical companies to overcome the challenges outlined in the section above. Figure 9 below summarises how each recommendation addresses the challenges faced by industry in reducing emissions.

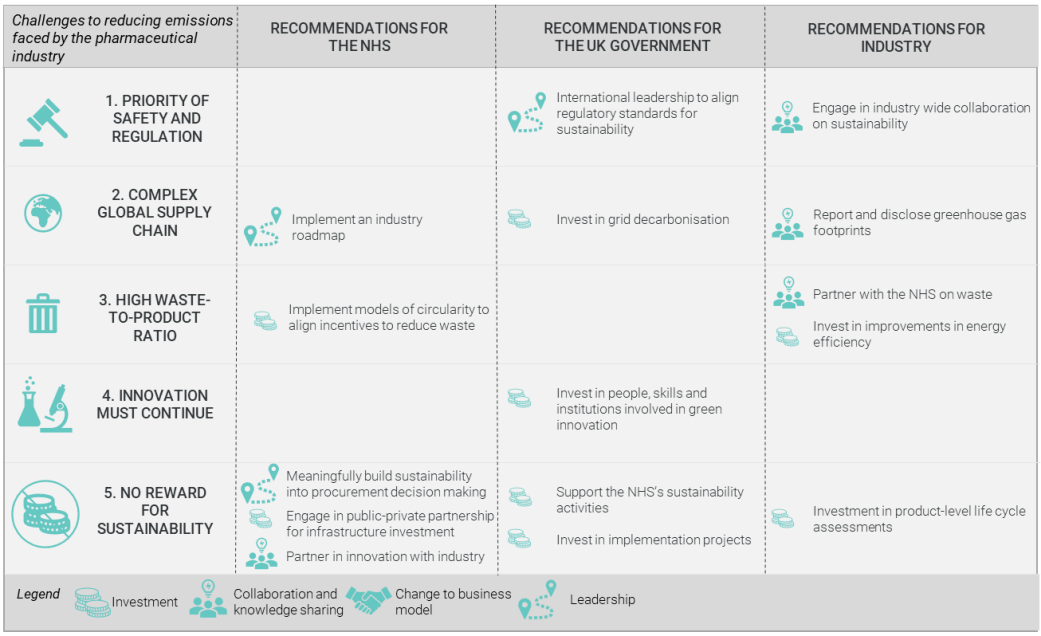

FIGURE 9: HOW RECOMMENDATIONS ALIGN WITH CHALLENGE AREAS
Source: expert interviews and roundtable

4.1 Recommendations for the UK government

Given the pharmaceutical industry is global with a minority of branded pharmaceutical companies having a footprint in the UK, there are two main mechanisms by which the UK government can generate change:

1. Undertaking activities to directly support companies with a footprint in the UK to reduce emissions on the road to net zero
2. Taking a leadership role internationally to seed global change through strategy and policy development

Supporting companies with a footprint in the UK to reach net zero

1. INVEST IN AND DEVELOP STRATEGY FOR GRID DECARBONISATION IN THE UK

The UK government should continue to invest in the decarbonisation of the national grid with a focus on replacing natural gas in heating. At the same time, the UK government should take action to encourage big exporters of pharmaceutical ingredients and final products to decarbonise their energy systems. Assuming that pharmaceutical supply chains remain highly global, the biggest gains will come from the decarbonisation of energy systems in India and China.

For the grid at home, the UK government should develop a long-term energy strategy for its transition away from fossil fuels and adapt the grid to support renewables and new forms of biogas. This includes bringing biomethane to the grid from waste sources and upgrading existing infrastructure to allow better transparency on the source of energy by the end user (i.e. differentiating between renewables and non-renewables at use). Investment in next-generation energy would be the most impactful intervention the government could engage with for all companies with footprints in the UK.

A long-term energy strategy should recognise that nuclear is not a viable energy source for the many companies who have signed up to renewables pledges such as RE100 (RE100, 2022). It should also

include detail on how infrastructure will be adapted over the following decades. This will allow industry to adapt their planning relating to retrofitting facilities to be able to use newly available renewable energy. Much of the success of Nordic countries (particularly Denmark and Sweden) in developing their green industries is due to the use of long-term energy strategies to guide investment for their transition to renewables.

A greener grid will support onshoring of companies committed to achieving net zero carbon, especially if they have ambitious commitments related to scope 2 emissions specifically. As the UK national grid becomes greener compared to other countries where a high proportion of manufacturing currently takes place (e.g., API manufacturing in India and China), the UK has the potential to attract inward investment not only from companies engaged in sustainability but also those looking to reduce supply chain risk, an issue brought to the fore by the global COVID-19 pandemic. While there are benefits of onshoring pharmaceutical manufacturing, there would likely be some loss in efficiency and a subsequent increase in costs and prices for health systems. A company's decision to onshore activities in the UK will depend on many factors such as the quality of physical infrastructure and the skills and knowledge of the workforce in the UK country and other potential inbound countries in Europe.

Although a greener grid might incentivise onshoring of some manufacturing, in the short term, most of the manufacturing in the industry will continue to be carried out in countries such as China and India. If this is the case, then decarbonisation of the UK grid alone will only have a small impact on the carbon footprint of industry and the UK as a whole. Therefore, the UK government should also take an active role in encouraging other countries to decarbonise their energy supplies through international mechanisms like the UN and through bilateral relationships with key countries like China and India.

Leading sustainable change in the global pharmaceutical industry

2. LEAD INTERNATIONAL ALIGNMENT ON REGULATORY STANDARDS

The UK government should take a lead role in convening representatives of different countries to generate common regulatory requirements and environmental reporting standards, particularly between the medicines regulators in the US and Europe. Many of the challenges pharmaceutical companies face in reducing emissions are underpinned by a regulatory constraint for medicines regulators, so consistency and clarity on regulations and reporting standards in relation to emissions and other sustainability metrics would support change.

Due to the global nature of climate change and pharmaceutical supply chains, all major markets would need to adopt consistent regulatory standards. There is a lack of leadership in regulatory alignment in areas relevant to emissions and sustainability. The UK could fill this void, especially given that the NHS in England is the first health system in the world to make an explicit net zero commitment.

The potential for the UK to lead in this space was demonstrated during the COP26 Conference in 2021, which resulted in an encouraging partnership between the NHS and the World Health Organization (WHO) on decarbonising health care systems globally. The aims of the Memorandum of Understanding are to share expertise among the fifty countries that have committed to the COP26 health initiative on sustainable low-carbon healthcare systems and to bring together healthcare systems to secure ambitious decarbonisation commitments and emissions reductions, while supporting regulatory and policy alignment.

Any form of alignment should include the development of international standards on how to label products as 'lower carbon' using robust life cycle assessment (LCA). Regulatory mechanisms for claiming sustainability should require accreditation and governance to avoid gaming and accusations of 'greenwashing', which detract from meaningful progress towards net zero.

3. SUPPORT THE NHS'S SUSTAINABILITY ACTIVITIES

The UK government should support the NHS directly to reach net zero both financially and with international leadership. The government should secure longer-term funding for NHS trusts to invest in the infrastructure needed to cut emissions. For example, it should maintain and expand the relatively short-term support for the reduction of heat and building emissions through the Public Sector Decarbonisation Scheme and the Public Sector Low Carbon Skills Fund. Beyond heat and building retrofitting, longer term investments could include the implementation of low-carbon waste and wastewater treatment solutions and electrification of the NHS fleet. Best practice activities could also be rapidly scaled nationally but only through bespoke funding.

Given that supply chain emissions make up a majority of the NHS's total carbon footprint, government support is needed to support greener practices outside of the NHS. Initiatives to support greener procurement, including leadership on international regulation and carbon labelling will accelerate the NHS's emissions reductions. The UK government should prioritise activities to support the NHS's net zero targets within its international agenda to have the biggest impact.

4. INVEST IN IMPLEMENTING AND SCALING CARBON-REDUCING TECHNOLOGIES

The UK government should continue investment in demonstration projects to de-risk carbon-reducing technologies for industry, particularly in pharmaceutical manufacturing. Expanding research and innovation funding in carbon capture technology could have a transformative impact globally. In addition, sustained funding for the High Value Manufacturing (HVM) Catapult and the Medicines Manufacturing Innovation Centre (MMIC) to expand their work on low-carbon innovation is also part of the solution. The HMV Catapult and the MMIC bring together industry and academia to investigate and scale industrial technologies across multiple industries. In the pharmaceutical space, the HVM Catapult is supporting the development of carbon-reducing oligonucleotide manufacturing techniques pharmaceutical industry (CPI, 2021).

5. INVEST IN PEOPLE, SKILLS AND INSTITUTIONS INVOLVED IN GREEN INNOVATION

The UK government should also continue the investment in the people, skills and institutions required for green manufacturing, innovation and technology development in the UK. Continued investment in the Catapults, UKRI, academic centres of excellence and translational education initiatives in engineering disciplines will have an impact beyond the UK. Continued investment in people and skills will ensure there is a strong knowledge pipeline, helping to position the UK as a hub for green innovation and an attractive destination for private investment. The UK Government should also encourage public research funders like UKRI and NIHR to fund research in environmental sustainability that can be helpful to industry.

4.2 Recommendations for the NHS

1. IMPLEMENT AN INDUSTRY ROADMAP

The NHS should implement its net zero supplier roadmap thoughtfully and with regular engagement with suppliers. Since publishing its net zero report, the NHS has also published a supplier roadmap which gives the main procurement milestones that it will require of its suppliers over the coming decade. Figure 10 illustrates these milestones. From April 2023, all suppliers for contracts above £5 million will be required to publish a carbon reduction plan for their scope 1 and 2 emissions.

On the road to net zero, the NHS should ensure that the roadmap is clear and actionable. This requires a sufficient level of detail and granularity and regular engagement with suppliers. It is also crucial that it addresses not just scope 1 and 2 emissions associated with each pharmaceutical product but also scope 3 as these often account for a majority of emissions. The roadmap also needs national alignment as trust-level standards would create too much fragmentation. The roadmap should also have a sufficiently long-term horizon to incorporate planning for changing demographics, care pathways and health technologies (e.g. advanced biologics).

The implementation of the roadmap needs to be detail-oriented with strong governance to prevent gaming (e.g. through cheap compensation and offsets). The plan should also reflect the different constraints facing branded and generic suppliers, with generics likely to face higher costs to reduce emissions.

FIGURE 10: NHS NET ZERO SUPPLIER ROADMAP Source: NHS England (2021)

2. MEANINGFULLY BUILD ENVIRONMENTAL SUSTAINABILITY INTO PROCUREMENT DECISION MAKING

The NHS, in partnership with the UK government, should develop a procurement weighting standard to incorporate environmental sustainability into procurement decision-making.

Firstly, the NHS needs to recognise that in order to achieve its long-term goals, there must be sufficient financial reward for suppliers to invest in their own sustainability. If cost remains the main procurement driver, then the NHS cannot expect to meet these goals. If there is sufficient long-term funding for the NHS and there are incentives for industry to develop net zero medicines (i.e. paying higher prices for products with a smaller environmental impact), then the health system will be able to substitute high-emitting products for lower emitting products while maintaining clinical efficacy. Substitutions for lower-emitting products are already being considered for metered dose inhalers and anaesthetic gases, but there are other products for which a similar approach could yield emissions savings. The underpinning principle must be appropriate clinical treatment – what must be incentivised first and foremost is the development of diagnostics and treatments which deliver clear clinical benefit, ideally at as low an environmental cost as possible.

Secondly, a robust methodology for evaluating the differences in environmental sustainability between two products needs to be developed. A 10% social-value weighting is being applied by the NHS from April 2022 through the Evergreen sustainable supplier assessment mechanism (NHS England, 2020). The threshold criteria of having a net zero target does not sufficiently incentivise progress towards emissions reduction. While the NHS's new Evergreen sustainable supplier assessment mechanism is an important first step, the development of more meaningful assessment criteria, including approaches making use of LCAs, are needed to reward companies who have better sustainability performance and to prevent gaming on the system and accusations of greenwashing. These need to be developed collaboratively and aligned to UK-wide and global initiatives – it cannot just be an NHS England initiative. A carbon reporting standard would also generate common expectations across the supply chain for data collection and reporting on emissions. The methodology could also make use of established sustainability certifications such as global B Corp accreditation (B Corporation, 2022).

Finally, environmental sustainability can and should be incorporated into the health technology assessment (HTA) methods applied by NICE. While NICE is not part of the NHS, it supports the NHS to adopt technologies that are cost-effective at meeting the NHS's aim to improve health. As environmental sustainability is now an explicit aim within the NHS sustainability needs to be embedded within procurement from market launch aided by the NICE process (Marsh et al., 2016a; b). New HTA methods should take a systems approach, by incorporating emissions associated with travel, stays in hospital, and ongoing prescriptions all of which have a small impact on health gains or cost of care to the NHS but a substantial impact on the carbon footprint of care. To capture the carbon footprint of the care pathway as a whole NICE would have to take a societal perspective, rather than a health system perspective, within its HTA process. As the methods are not developed to incorporate environmental sustainability into HTA, NICE should work with industry and sustainability experts to develop appropriate methods. NICE has begun work on this agenda (NICE, 2021), but it needs political support, resources and funding to accelerate progress.

3. IMPLEMENT MODELS OF CIRCULARITY TO ALIGN INCENTIVES TO REDUCE WASTE

Reduction of downstream waste is vitally important given the scale of carbon wastage at this stage of the supply chain. Hard-fought wins elsewhere will be squandered if the scale of waste continues. Linear models of service delivery used within healthcare mean that waste is inevitable as all resources are treated as disposable (van Boerdonk et al., 2021). Making waste partly the

responsibility of the supplying company will provide an additional incentive for industry to reduce waste through better supply management and to reduce disposal through high-value reuse and recycling processes. However, NHS organisations must take a collaborative approach, both with each other and with suppliers, in order to make meaningful progress on this challenge. Suppliers cannot achieve this in isolation, particularly as they rely on NHS and national infrastructure for waste management of their products.

There are a number of models for embedding circularity into the procurement of pharmaceutical products. Performance-based contracting has been proposed in the context of medical devices and could be applied to pharmaceuticals to move from a product-based to a service-based business model for delivering medicines (MacNeill et al., 2020). Extended producer responsibilities (EPRs) are a regulatory mechanism by which companies are legally responsible for the waste and recycling of their products after they are used in the system (OECD, 2006). There are a number of challenges to embedding circular economy principles in pharmaceuticals that can only be overcome through collaboration between the NHS and suppliers (Kandasamy et al., 2022).

4. BECOME A PARTNER IN GREEN INNOVATION

The NHS should partner with companies to supply a test bed for innovation to support environmental sustainability. Due to the structure of the system, the NHS can play an important role in scaling effective interventions, and this is crucial for progress (Pencheon, 2018). This may include building on the advanced therapy treatment centres model used to support the development of cell and gene therapies within the NHS (ATTC, 2020). By engaging with suppliers to test business models, proofs of concept and implementation of technologies and data collection, these centres can bring pilot projects to scale both within the NHS and internationally.

5. ENGAGE IN PUBLIC-PRIVATE PARTNERSHIPS FOR INFRASTRUCTURE INVESTMENT

The NHS could also partner with industry on key infrastructure projects to address shared challenges. The NHS already spends a significant amount of money every year (£50 million in 2012) on carbon permits that could be redeployed for meaningful investment (The King's Fund, 2022). Public-private partnerships could support shared power purchase agreements for purchasing renewable energy or the installation of co-located infrastructure like power points for charging electric vehicles. This approach would leverage private investment in areas where the NHS will eventually need to invest anyway to reach its net zero targets. As part of this collaboration, the NHS should clearly set out how and with which NHS organisations industry can partner.

4.3 Recommendations for industry

1. REPORT AND DISCLOSE SUSTAINABILITY METRICS

The industry should report and publicly disclose their emissions and progress towards sustainability targets using standardised metrics that allow robust interrogation of the rate of progress. It is vital that there is consensus on what data and metrics companies should be collecting and disclosing, and this requires cross-industry collaboration and engagement with the NHS and government. The industry has to agree on which data should be collected and disclosed, including detail on which metrics and reporting routes should be used.

A well-designed public disclosure mechanism based on rates of progress towards sustainability goals should be put in place that incentivises action without directly penalising companies at earlier stages of their decarbonisation journey. International organisations such as CDP can play an important role in helping companies disclose their environmental impacts (CDP, 2022).

2. INVESTMENT IN PRODUCT-LEVEL LIFE CYCLE ASSESSMENT (LCA)

Companies should invest in the development of LCAs of their products using consistent, science-based methods that allow the NHS to reliably incorporate sustainability into its procurement decision-making. Without detailed data on emissions and other environmental impacts at a product level, the NHS will be unable to act. LCAs will also help individual companies take targeted action to reduce their environmental impact by highlighting the products with the highest emissions and where those emissions are focused within the supply chain. Collaboration is again needed both across the industry and with international organisations such as CPD, as well as national governments, to develop a common set of metrics and reporting standards so that LCAs can be compared by health systems, such as the NHS, in their procurement decisions.

3. PARTNER WITH THE NHS ON WASTE MANAGEMENT

Industry needs to partner with the NHS to overcome the significant problem of waste. A large fraction of the units of pharmaceutical products produced is wasted within the health system due to issues such as poor stock management, overprescribing and poor adherence. While there are areas where the NHS can take unilateral action – overprescribing being a clear example – making meaningful progress on this challenge will require strong collaboration between the NHS and industry. Engagement on waste management should move beyond product-specific, small-scale pilot projects to develop interoperable and scalable circularity models that can be adopted internationally.

4. INVEST IN IMPROVEMENTS IN ENERGY EFFICIENCY

There are actions that companies can take today within existing structures of regulation and reimbursement to improve the energy efficiency of their sites and especially energy-intensive manufacturing facilities. The return on investment of such activities is quick, within 3-5 years, according to experts, and can significantly reduce emissions. While systematic change in regulatory frameworks allowing companies to engage in wider change to reduce emissions is taking place, more can be done by industry to reduce environmental impacts within existing regulatory frameworks and with existing technologies.

5. ENGAGE IN INDUSTRY-WIDE COLLABORATION

There is significant heterogeneity across pharmaceutical companies in their net zero targets and in progress towards these targets, which makes it difficult for health systems, such as the NHS, through mechanisms like HTA, to compare the environmental performance of different companies, and this has implications for the success of the NHS supplier roadmap.

Companies will need to share knowledge to accelerate progress and generate industry-wide solutions. Knowledge-sharing is particularly important given the significance of scope 3 emissions and the role that industry-wide action can play in shaping the behaviour of suppliers. The power of

collaboration is currently being demonstrated in the fight against antimicrobial resistance (AMR) (see Box 4 below).

Box 4: IFPMA AMR standards pledge

In 2016 IFPMA launched a voluntary programme for controlling discharge of antibiotics from API manufacturing plants (mainly in India and China) with 13 signatories including AstraZeneca, Roche, GlaxoSmithKline, Merck & Co., Novartis, Pfizer, and Sanofi.

The pledge has been implemented by the signatories who now have stricter compliance requirements for their suppliers on proving that effluent does not contain active antibiotics. Experts believe it is having an impact.

"There are API suppliers who are now investing in better effluent discharge equipment to capture antimicrobial content back and not letting it go in the waste stream because who they are supplying to has put more stringent requirements on that API supply." Global pharmaceutical supply chain expert

Source: Expert interviews

Many of the recommendations presented above are not novel. In many cases they suggest that to make a difference all stakeholders must invest to implement existing activities on a larger scale and at a quicker pace. These recommendations are similar to those presented in other reports in the healthcare sector, suggesting that there are shared barriers across pharmaceuticals, medical devices and health services to reducing emissions (Hopkinson et al., 2022; Health Care Without Harm, 2021). Those barriers are likely to be due to regulations for patient safety, lack of systems thinking and under investment in long-term initiatives.

5 Conclusions

The UK government, the NHS and the pharmaceutical industry need to act now to reduce greenhouse gas emissions. The recommendations we have presented highlight that collaboration is vital if stakeholders are to move from policy and strategy to implementation, scale and impact. The pharmaceutical industry is a significant contributor to national and health system carbon footprints and is, therefore, a key partner in the sustainability agenda.

Demographic change, the increasing prevalence of lifestyle diseases, and the health impacts of climate change mean our reliance on healthcare is only set to increase. Low-impact greening projects, lack of scaling of pilot schemes and marginal improvements in efficiency alone will not achieve the year-on-year carbon savings in healthcare needed to achieve net zero targets and avert the impacts of climate change.

Systematic change requires solutions to the systematic challenges to achieving decarbonisation that we have set out in this report. The pharmaceutical industry faces five key challenges to decarbonisation:

- Pharmaceutical products are highly regulated to protect the safety of the end-user
- Supply chains are complex and global
- There is a high waste-to-product ratio across the pharmaceutical value chain
- Companies must continue to innovate, which makes decarbonisation a moving target
- The market does not reward sustainability

The NHS, UK government and the pharmaceutical industry, therefore, have a role to play in overcoming these challenges. We recommend the following actions to be taken by the key stakeholders:

RECOMMENDATIONS FOR THE UK GOVERNMENT

1. Investment and strategy for grid decarbonisation
2. International leadership to align regulatory standards
3. Support the NHS's sustainability activities
4. Investment in implementation projects
5. Investment in people, skills and institutions involved in green innovation

RECOMMENDATIONS FOR THE NHS

1. Implement an industry roadmap
2. Meaningfully build environmental sustainability into procurement decision making
3. Implement models of circularity to align incentives to reduce waste
4. Partner in innovation
5. Engage in public-private partnerships for infrastructure investment

RECOMMENDATIONS FOR THE INDUSTRY

1. Reporting and disclosure
2. Investment in product level life cycle assessment
3. Partner with the NHS on waste management
4. Invest in improvements in energy efficiency
5. Engage in industry-wide collaboration.

The UK government, the NHS and the pharmaceutical industry need to collaborate and engage with a spirit of progress. Mechanisms that penalise companies who are lagging behind will not generate the industry-wide change needed, especially as many companies are still in the early stages of the long process of change. Importantly, investment is needed from all stakeholders - no one actor can be expected to foot the bill for the upfront and ongoing investment that is needed to decarbonise the processes and operations required to make, deliver and dispose of medicines.

Finally, any actions taken by the UK must be scaled internationally to be impactful in averting a climate crisis. The UK government and NHS England must take a leadership role on the global stage to share learnings from the Greener NHS project. Meaningful engagement, collaboration and action needs to be taken globally by governments, health systems and companies to build a green pharmaceutical industry and ultimately avert the catastrophic consequences of climate change.

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