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MMS Membership number: 6807 Word count: 997

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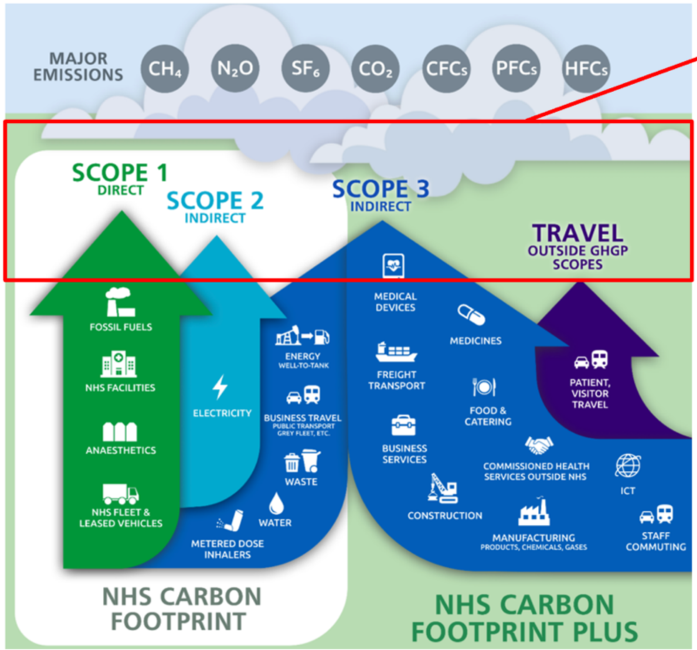
Sustainability in Medical Imaging: Reducing Environmental Footprint for Future Generations

Introduction

Global temperatures are forecast to rise by 2.5-2.9C by 2100 with current global policies[1]. The healthcare sector is a major driver of climate change, with NHS emissions equating to 4% of England's total carbon footprint[2].

Operation of medical imaging equipment accounts for 4% of yearly hospital energy consumption[3], contributing to healthcare service providers' direct and indirect carbon footprint through generation of scope 1-2 emissions [figure 1]. Equipment manufacturing & waste generation results in significant scope 3 associated supply-chain emissions [figure 1].



Radiology departments contribute significantly to **all** the NHS Greenhouse Gas Protocol Scopes

Scope 1 Direct	Emissions from fossil fuels, NHS facilities, anaesthetics, NHS fleets.
Scope 2 Indirect	Emissions from purchased electricity.
Scope 3 Indirect	Emissions from various activities including construction, waste & food.

Figure 1: Categorising the NHS carbon footprint according to the Greenhouse Gas Protocol Scopes

Radiology plays a crucial role in aligning practice with environmentally sustainable principles. This essay will discuss optimising power use, shifting towards a circular economy, and potential of artificial intelligence (AI) tools.

Optimising power use

CT and MRI scanners are high energy consumers due to use of powerful magnetic fields, cooling systems & x-ray generation, alongside a requirement for rapid data processing[3]. Annual operation of three CT scanners and four MRI scanners consumes as much energy as a town of 852 people[3].

CT and MRI scanners consume significant energy even in idle or system-off states. 2/3rd of CT scanner energy consumption takes place during idle states, with 1/3rd of energy consumption attributed to system-off states in MRI scanners[3]. Implementation of power-save modes or shutdown protocols are possible in departments where CT & MRI scanners are infrequently used out-of-hours. If MRI power save modes were implemented for 12 hours overnight in all outpatient US healthcare units, \$8.2–\$10.7 million, and 41,606.4–54,088.3 $MTCO_2eq$ could be saved annually[4].

Heating, Ventilation & Air Conditioning (HVAC) systems are required for climate control in Interventional Radiology (IR) suites[5]. HVAC usage represented the largest source of emissions in an IR department, 57% of which occurred outside scheduling working hours[5]. Standby modes and occupancy sensors may reduce power-use, and ultimately scope 2 emissions [figure 1], but implementation must not hinder clinical practice.

At an individual level, radiologists can contribute by shutting off workstations which consume significant power when idle[6]. Consistent automatic shutdown outside of core hours can reduce workstation energy consumption by 38%, eliminating 22.2 tons of CO_2 emissions in a hospital with 227 workstations[6]. Introduction of automated restart software may help reduce economic costs of downtime[6].

Transitioning towards a circular manufacturing economy

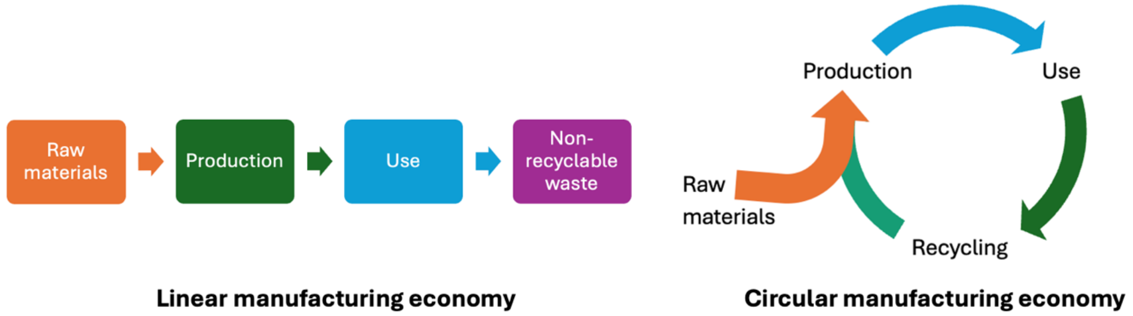


Figure 2: Linear vs. circular manufacturing economies

Circular economies aim to reduce waste by promoting continuous resource use, enhancing environmental sustainability by reducing carbon emissions linked to the production of new devices [figure 2][7]. Over 1.4% of NHS supply-chain emissions are directly linked to new device production[2]. Radiology departments play a role due to requirements for up-to-date imaging facilities and reliance on single-use products predominately within IR suites[5].

Imaging equipment lifetime can be extended through regular servicing, refurbishment, and technology updates[7]. Consistent service and maintenance ensures operational issues are identified early, improving energy efficiency and delaying the purchase of new equipment. Future integration of AI-based predictive maintenance models into routine servicing tools may detect future scanner malfunction[7]. Refurbishment of existing scanner equipment avoids carbon emissions whilst preserving finite resources and offers cost advantages over new models[7]. Manufacturers play a role in ensuring maintenance support and access to replacement parts. System capabilities of older scanner models can be extended through upgrades, providing new features without the need for new scanners[7].

Donation of imaging equipment to deprived areas is another strategy to reduce new device production whilst facilitating improved access to imaging. Adequate training & continued follow-up is essential as this strategy risks additional waste and travel-associated emissions[8].

Single-use surgical supplies are a significant source of IR-related emissions, accounting for 41% of emissions in one IR department[5]. The NHS needs to utilise its role as a large purchaser to encourage manufacturers to make multiple-use alternatives. This aligns with the NHS short-term target of achieving a 10% reduction in clinical single-use plastics[2]. Utilisation of alternative packaging, such as bio-based polymers, also reduces plastic reliance[2]. Implementing improved national waste disposal targets could help reduce scope 3 emissions by increasing the proportion of recycled waste [figure 1].

CT and MRI scanners rely on finite materials including helium, gadolinium and iodine[7]. Manufacturers play a role in reducing usage of finite materials and increasing their ability to be recycled or re-purposed. Helium-saving ‘BlueSeal’ technology within Phillips MRI scanners reportedly uses 0.41% of helium volume required for typical operation of a single conventional MRI magnet[9]. However, implementation is likely associated with significant upfront cost.

Artificial Intelligence (AI) to optimise practice

AI tools which directly reduce scanner energy consumption will likely have the greatest environmental benefit since CT and MRI scanners consume significant energy even when idle[3]. AI-driven intelligent scheduling may reduce scanner idle time & resultant non-productive energy consumption[10]. Optimisation of image acquisition times using AI can reduce energy use since active scan duration is proportional to energy consumption[10]. AI could also prevent unnecessary imaging through clinical decision support tools and advanced risk stratification[10].

Travel and transport account for 14% of total NHS emissions[2]. Utilisation of AI-driven scheduling tools in radiology could reduce patients’ carbon footprint and aid in teleradiology expansion, through grouping face-to-face appointments to reduce travel associated emissions [figure 1].

AI tools have potential in optimising sustainability, though they are an increasingly large contributor to radiology’s environmental footprint[10]. Development and deployment of AI tools have notable energy costs, requiring significant computational power and cooling resources[10]. Large purchasers of AI tools play a crucial role in fostering AI advancements whilst ensuring development does not compromise the environment.

Conclusion

Achieving environmental sustainability in radiology requires a multi-faceted approach, driven by key stakeholders. The true burden of decarbonisation lies with the NHS. By leveraging its role as a major purchaser of healthcare equipment and AI tools, it can action meaningful change. Optimisation of scanner power use is likely the single most important factor in reducing carbon footprint, though progression towards a circular manufacturing economy is essential for long term sustainability. The role of AI in enhancing environmental sustainability is currently unclear but carries huge potential.

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Figures:

Figure 1: NHS England. Delivering a 'Net Zero' National Health Service. London: NHS England and NHS Improvement; 2022. Available from: https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2022/07/B1728-delivering-a-net-zero-nhs-july-2022.pdf [Accessed 17/09/24]

Figure 2: own.