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From Service Call to System Insight: How Everyday Engineering Sustains Cancer Care — The Hidden Power of the Radiotherapy Engineer

In healthcare, sustainability often brings up images of recycling bins, green procurement, or digital strategies. Sustainability in healthcare is also built in the quiet unseen routines that keep complex medical systems running, reduce waste, and protect continuity. Radiotherapy engineers maintain high-precision machines that treat cancer and contribute directly to clinical sustainability. These engineers demonstrate through their daily decisions that maintenance is not merely upkeep but sustainability in action, supporting the NHS Green Plan, Net Zero ambitions and the resilience of modern cancer care. We often speak of sustainable technology but no technology is sustainable without the people who maintain, protect, and optimise it, namely the radiotherapy engineers in the case of cancer care. A silent test begins before the first beam is delivered, will the machine start? Every radiotherapy treatment begins with trust not only in clinicians but also in the technology. Engineers hold that trust together. Radiotherapy demands precision. The smallest mechanical drift, software freeze, or misread safety interlock can delay or distort care for patients already navigating cancer's challenges. Behind every beam of therapeutic radiation stands a network of systems and the engineers who sustain them. Too often overlooked, the hidden workforce of highly skilled radiotherapy engineers quietly builds sustainability, one intervention at a time.

In my role, I work with machines known as linear accelerators (LINACs), which deliver radiotherapy. These systems rely on synchronised motion, cooling, interlocks, and software, operating at sub-mm tolerances. Our task is not just to fix faults, but to prevent them and in doing so, support clinical safety and sustainability. One morning, a LINAC failed to start before a full clinic. A console fault cascaded into system errors. Our team rapidly isolated the issue, replaced damaged components and re-initialised key systems. Treatment was resumed within two hours. There was no announcement just quiet teamwork and trust preserved. It is the engineers not the policy or the machine who enable sustainability in real time, avoid wasted appointments, reduced

unnecessary patient journeys and prevent the hidden carbon cost of disruption.

Many interventions arise from proactive attention to quiet signs of wear. One afternoon, a cooling fan on a supervisor computer was quietly replaced. The task took under an hour but extended uptime by weeks delaying costly replacements and cutting the embedded carbon footprint of new parts. Such small, preventative actions are essential to NHS Net Zero goals, even if their impact is rarely visible. During autumn, a sequence of minor faults began to emerge, ending in a full abort during beam-on. None were fatal faults, but taken together, they indicated system drift. A review of our work order system indicated patterns of fault recurrence pointing to deeper issues. A targeted part replacement in the modulator resolved the problem before a complete outage occurred. This is where sustainability begins by pattern recognition, early action and preventing waste of time, materials, and patient confidence.

Some of the most critical engineering actions happen in spaces seen by few including the repair of cable runs for LINACs, inspecting airflows behind gantries or reviewing filter plans for air conditioning units. These are invisible actions which influence daily treatment quality, equipment reliability, and compliance with both radiation protection and infection prevention. Sustainability in cancer care is not a product of procurement alone, but a product of practice with engineers as its stewards.

On several occasions this year, I have joined meetings to understand context, namely what physicists are measuring, what radiographers are experiencing and what patients need during their care journey. True sustainability in engineering does not come from better parts alone but from better systems engineering thinking. Importantly, this work aligns directly with NHS Green Plan priorities:

- Extending asset life reduces environmental impacts from manufacture, shipping and disposal
- Preventing unplanned downtime limits the need for repeat journeys and rescheduling thereby reducing travel related emissions

- Digital work order systems enable data-informed decisions that support smarter, more sustainable care delivery

One small innovation which could begin immediately is a simple online Radiotherapy Engineering Fault Sharing Library hosted by IPEM or another professional body. Engineers across NHS trusts could post fault summaries, solutions and lessons learned. Such a platform could be as basic as a moderated discussion board, or as advanced as a searchable database over time. The aim would not be to replace formal service protocols, but to foster collective learning, reduce repeat errors and build a culture of shared insight. The recognition of engineering insight is a vital part of the healthcare system. True system insight begins with engineers recognising patterns, supported by structured data and shared learning and should not rely on AI alone. This work also supports workforce sustainability. Valuing engineering expertise, promoting shared learning and embedding insight into national systems can help support retention and pride among technical staff, critical at this time of workforce strain. Our work order records are filled with small wins, quiet interventions that do not make journals but represent engineering excellence in motion through Net Zero, but one intervention at a time. To secure the sustainable future of physics and engineering in healthcare, we must not only celebrate invention but also practices that keep systems running, protect patient care and minimise environmental impact. It is the radiotherapy engineer who transforms sustainability from a policy into a lived reality, one decision and one intervention at a time. Radiotherapy engineers must be elevated to a system thinkers, service and sustainability agents and not simply a fault fixers.

As IPEM and WCSIM look to inspire the next generation of healthcare professionals, I hope this essay demonstrates that true sustainability is built not only in what we create, but in what we protect, maintain, and quietly improve every day. I believe IPEM and WCSIM can lead the way in supporting such shared platforms, helping radiotherapy engineers across the NHS turn individual lessons into collective resilience.