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SUSQI PROJECT REPORT

Reducing energy usage in HHFT Theatres

Start date of Project: May 2025

Date of Report: September 2025

Team Members:

- Anja Templin: Clinical Matron Theatres
- Luke Hedges: Energy Manager

Background:

Operating theatres are among the most energy-intensive areas in the NHS, due to the need for highly specialised equipment and strict environmental controls that ensure patient and staff safety. This high energy demand, combined with ageing infrastructure and limited capital investment, creates significant challenges for estates teams. Theatres often rely on outdated systems that are inefficient and costly to maintain, contributing to the wider issue of backlog maintenance across the NHS. These infrastructure pressures not only affect operational efficiency and financial sustainability but also have a direct impact on patient care, particularly when failures lead to treatment delays. These challenges are explored below in further detail before introduction of our SusQI project which set out to explore these interconnected issues, energy management, maintenance, and patient outcomes, and identify practical steps to improve sustainability and resilience in surgical environments.

Poor energy management within theatres:

Theatres are the most energy intensive areas within the NHS alongside Sterile Services. They have features unlike any other areas which are required to keep patients and staff safe including ventilation that meets extensive requirements under the healthcare technical memorandum. However, the cost of replacing and upgrading equipment is extremely challenging and leads to repairs being completed on equipment that is decades old. These assets will be using fans that are powered by motors that are connected by belt drives which leads to the impacts of transmission loss. Belt drive imposes considerable efficiency loss. The efficiency depends on the calculation of the belt gear, type of belt and the complete gear adjustment. Normally an expected efficiency of a belt drive is 90% at medium power (3–15 kW), but it can easily slip to 60–70% if the gear adjustment is incorrect. The newly designed Air Handling Units (AHU) must avoid belt-driven fans and should always use direct driven fans, whose transmission efficiency is 100%.

Leaving on equipment and computers/monitors during theatre down time is also poor energy management. The Heating, Ventilation and Air Conditioning (HVAC) systems including the Air Handling Units (AHUs), Anaesthetic Gas Scavenging Systems (AGSS) run 24 hours a day, seven days a week, even when the theatres are not in use. Lighting and computers may also be left on when the theatres are not in use. Guidance from the Royal College of Surgeons and their Intercollegiate Green Theatre Checklist advise all equipment should be switched off when the theatre is empty, including HVAC and AGSS. The NHS Net Zero strategy, the need to save money to meet our financial plan and rising energy costs support action to switch off equipment to save energy and money wherever possible.

Backlog Maintenance:
For NHS staff, finances being in a difficult place is nothing new, and especially from an estates perspective tackling the substantial backlog maintenance issue remains a key priority. A report stated in June 2025 that the NHS is grappling with a £13.8 billion maintenance backlog, a crisis threatening patient safety, legal compliance, and financial stability across its estates. Rising costs, predicted to increase by 4.8% in 2025 according to the Building Costs Information Service, exacerbate the challenge. Delays in essential upkeep risk ward closures, cancelled treatments, and legal fines, while 33% of building maintenance professionals cite defending budget cuts as their top issue (Psychreg, 2025). Our trust is just a drop in the ocean compared to the bigger picture of the entire NHS but locally it is still a major issue. What this means is that as above, upkeep is missed and fines can be received when lack of maintenance is carried out. Whilst it requires capital investment to replace aging equipment, newer AHUs run more efficiently, can be better controlled and bring benefits including lower running costs and reduced maintenance costs. Switching the equipment off when not in use reduces the wear and tear on the AGSS pumps and AHU equipment, increasing their lifespan and also potentially saves on maintenance costs.

Patient outcome and financial implications:
Moving away from assets and finances to the real key piece of the puzzle and the main reason why most of us work for the NHS: our patients and specifically their experience and pathway through care during surgery.

The National Audit Office completed a report on the NHS and the findings are rather damning: on average, 5,400 clinical service incidents happened per year in the NHS between 2019/20 and 2023/24, due to property and infrastructure failures (Healthcare Leader News, 2025). The specific types of failures we are focusing on here are the estates' side such as the ventilation, medical gas supply, lighting, power supply and all other theatre specific assets.

Treatment delay is closely intertwined with mental health outcomes. Prolonged anticipation of treatment, coupled with the psychological burden of managing health concerns, can contribute to heightened stress and anxiety levels. The impact extends beyond the specific health condition, influencing broader aspects of mental well-being and potentially exacerbating pre-existing mental health conditions (Psychology Research and Reference, 2025).

Overall, with these three areas highlighted from where the basis of this project has started, it is one of the most important areas within healthcare to ensure operations are effective, energy consumption is reduced and patient wellbeing is kept as high as possible.

Specific Aims:

Our aim is to reduce energy consumption within the operating theatre, leading to measurable carbon and financial savings, while minimising theatre downtime and maintaining patient safety

Methods:

Scoping of SMART Theatres:

The SMART Theatre Project completed by St Georges Hospital was identified as a way to modernise existing operating theatres by integrating advanced technologies that enhance energy efficiency, asset performance, and patient care. Central to this transformation is the implementation of automated systems that shut down theatres when unoccupied, combined with intelligent lighting and socket controls. These features work in tandem with PIR sensor technology to detect occupancy and adjust environmental settings accordingly, ensuring energy is only used when necessary.

A key component of the project is the development of an integrated control strategy that continuously monitors energy usage and optimises consumption. This is supported by an upgraded Building Management System (BMS), which offers enhanced data integration to track performance and automate essential processes. Additionally, the project leverages artificial intelligence to optimise theatre assets, resulting in fewer breakdowns, improved operational efficiency, and a reduction in the need for engineer call-outs.

A site visit to St Georges Hospital was conducted by the Trust's Energy Manager, Theatre Manager and Theatre OSM to assess their SMART theatre install both from an estates and clinical perspective. This was beneficial as it gave us a good overview of the requirements needed to install a SMART theatre setup as well as how it would work day to day in theatre.

The anticipated benefits of the SMART Theatre Project are wide-ranging. Environmentally, it is expected to significantly reduce energy consumption and the carbon footprint. Operationally, SMART Theatres will improve patient experience and theatre productivity by increasing asset availability and reducing downtime. This ensures that theatres are consistently fit for use, enabling more procedures to be carried out each day.

From an Estates and Facilities Management perspective, SMART Theatres enhances productivity and efficiency through predictive maintenance and timely interventions. It also supports the creation of an auditable trail, which contributes to improved staff productivity and patient comfort. By reducing infection rates and shortening patient length of stay, the project helps free up beds and increases surgical throughput.

Looking ahead, the SMART Theatres project completed in St Georges lays the foundation for designing and building future theatres and healthcare facilities that are digitally enabled. It provides stakeholders with evidence-based insights to support the delivery of modern, sustainable infrastructure that aligns with NHS digital transformation and Net Zero goals.

A full Smart Theatre retrofit, estimated at £50,000 per theatre, was considered financially and logistically unfeasible for the duration of the project.

Changes planned:
As a result, the team agreed to concentrate on three practical and cost-effective energy-saving measures: switching to LED lighting to improve energy efficiency, powering down three computers and monitors when not in use, and turning off the Air Handling Units (AHU) and Anaesthetic Gas Scavenging System (AGSS) pumps when theatres were not in operation. These targeted actions were selected for their ease of implementation and potential to deliver measurable environmental benefits within the project timeframe.

The project was undertaken jointly by the estates and clinical teams. While there are many theatres in HHFT, the two Heathcote Theatres were chosen to launch the project as they were in use the least and could show the best return on investment in terms of reducing energy consumption: both theatres are not in use from 14.00 on Friday until 08.00 hours on Monday.

Prior to the project, theatre staff already carried out a routine theatre shutdown after each list that includes turning off all electrical equipment and lights. We surveyed Heathcote theatres over a 2-week period and found that theatre staff already followed the Green Theatre checklist and routinely switched off all electrical equipment except for computers and monitors. This was very positive to see staff already engaging in sustainable behaviours.

AHUs cannot be manually switched off by theatre staff. However, collaboration with the estates team has led to planned installation of direct drive fans and programmed inverters to align with desired schedules. Full replacement of the supply and extract ventilation system for Heathcote theatres is planned for early 2026, though funding for BMS components is still pending. The manager of the ventilation safety group has been directed to get costs together to replace the existing supply and extract ventilation that feeds the Heathcote theatres. These works are due to start in the New Year 2026. However, this is only one part of the project and there are no further funds for BMS components.

Next steps:
The switch to LED lights in theatres, the ‘switch off’ of PCs and monitors and a new AHU is being fitted for Heathcote Theatres at the beginning of 2026. The Estates team currently replaces theatre lighting with LED units on an as-needed basis, though a full conversion could offer greater energy efficiency and long-term savings. Auditing of Green Theatre checklist compliance is ongoing, with particular attention to ensuring PCs and monitors are powered down appropriately. Meanwhile, a SMART theatre business case has been developed and is under review by the Strategy Team. A funding bid has also been submitted to the Hampshire Hospital Charity to support a pilot SMART theatre project, which aims to enhance sustainability and operational efficiency within the trust.

Measurement

Patient outcomes:
As part of our ongoing efforts to improve patient flow and surgical efficiency, we have identified theatre downtime as a measurable indicator of delayed access to care. Theatre downtime refers to

periods when operating theatres are unavailable for patient procedures due to avoidable delays, inefficiencies, or resource constraints. To quantify this, we analysed patient and operational data provided by the Business Intelligence (BI) team.

At this stage, we do not anticipate any negative impacts on patient care or clinical outcomes as a result of making changes to reduce energy use in theatres. This data will be reviewed regularly to ensure that any changes do not compromise patient safety or experience. Where necessary, findings will be escalated to clinical governance teams and used to inform service improvement initiatives.

Environmental sustainability:
Electricity consumption data for the LED lighting switch, theatre systems (including AGSS and supply/extract AHUs), and computers was provided by the Energy Manager at HHFT. For the energy consumption calculations, it was assumed that three computers could be switched off for 48 hours each week. In the case of theatre energy usage, it was assumed that the AGSS and AHUs could be switched off for 103 hours per week (44 hours Monday to Thursday 7pm - 6am and 59 hour Friday 7pm to Monday 6am).

Electricity consumption was converted into GHG emissions using the emission factor for the UK electricity grid taken from the [2025 UK Government conversion factors for company reporting database].

Economic sustainability:
Energy cost data used in this analysis has been sourced directly from the Trust's energy provider invoices. The cost of electricity is calculated at £0.26 per (kWh), which represents an all-inclusive rate. This figure incorporates all commodity-related charges, meaning it reflects not only the base cost of electricity but also additional expenses such as transmission and distribution fees, environmental levies, and supplier administrative costs. By using this comprehensive rate, we ensure that all energy-related expenditures are accurately captured in our financial assessments and sustainability evaluations.

Social sustainability:
Impacts on staff have been considered through conversation with the theatres' team. We plan to collect more data following implementation of the changes. Impact on patients has been considered, but not directly discussed with patients. Theatre downtime and cancellations was used as a measure to indicate improved social sustainability for both patients and staff.

Results

Patient outcomes:
Using theatre utilisation and estates' data the following information on theatre downtime was extracted for 2025

- 27/01 – TC B – Heating Issue (Adjusted theatre time to 11:00 – 12:30)
- 24/03 – TC B - Temp 14C (Start 08:30 - 09:20) – Used time when the 1st pt was sent for
- 02/07 – NG 5 – Theatre temp too high – stopped list from 12:54 – 15:34
- Total theatre downtime = 222 minutes from 3 episodes in a 7 month period.

Reducing downtime reduces the risk of on-the-day cancellations. It also supports patients to be discharged without delay. Delays to patient surgery and discharge may mean that patients are nil by mouth for longer than necessary, and have increased anxiety about going to theatre. Preventing these issues is part of enhancing patient recovery.

Better ventilation reduces the chance of infection thus improving patient outcomes (Soagnolo et al 2013). Research from the Lancet does not support the use of laminar flow. (The Lancet).

Environmental sustainability:

Table 1: Savings for one theatre at Heathcote

	Annual savings	
Project	**Electricity (kWh)**	**GHG emissions (kgCO2e)**
Switching lights to LED	1,820	447
Switching off 3 x computers & monitors	250	61
Theatre room (AGSS pump & AHU)	48,204	11,829
Total	*50,274*	*12,337*

From the two theatres at Heathcote we are estimated to save 100,547 kWh of electricity and **24,674 kgCO2e** per year, equivalent to driving 72,592 miles in an average car.

Our project focused on the two operating theatres at Heathcote. However, there are seven additional theatres where similar changes to switch off ventilation and other equipment overnight and at weekends could also be introduced to deliver an additional saving of 86,359 kgCO2e per year. However, implementing changes in these areas is more complex. For example, shutting down one theatre would also affect the intensive care unit. Changes need to be made carefully in collaboration between clinical and estates teams.

Economic sustainability:

Table 1: Savings for one theatre at Heathcote

Project	**Annual financial savings (£)**
Switching lights to LED	473
Switching off 3 x computers & monitors	65
Theatre room (AGSS pump & AHU)	12,533
Total	*13,071*

From the two theatres at Heathcote we are estimated to save **£26,142** per year.

As above, there are seven additional theatres where the same changes could be introduced to save energy by switching off equipment overnight and at the weekends when the theatres are not in use. If implemented there could be additional savings of £91,498 per year.

In a 7 month period prior to the project, total theatre downtime was recorded at 222 minutes. Based on a conservative estimate of £20 per minute, covering staff costs and general operating expenses such as electricity and water, this equates to a potential cost saving of **£4,884**. These savings reflect the operational efficiency gained through improved asset availability and reduced interruptions to theatre use.

Social sustainability:
This project contributes to improved working conditions for staff by providing greater control over their working environment and reducing unnecessary downtime. These enhancements support better patient outcomes by ensuring theatres are consistently prepared and operational.

Efficient theatre management also improves the patient experience. Patients benefit from attending hospital only once for their procedure, reducing the need for multiple journeys and associated emissions. Additionally, theatre setup occurs only once, streamlining care delivery. Together, these changes foster a more patient-centred approach to surgical care.

Discussion:

This project has highlighted both the potential and the complexity of improving energy management within theatre environments. While the outcomes have been encouraging, there were several limitations that shaped the scope and approach of the work.

One of the main challenges was the lack of access to live energy data, particularly due to the absence of submetering for key assets such as the AHU and AGSS pump. To work around this, manufacturer data was used to estimate hourly consumption over a 24-hour period. This allowed for a reasonable understanding of energy use and the impact of programming these systems to be controlled via the surgeon's panel.

Time constraints also played a role. The competition period was short, and balancing this work alongside business-as-usual responsibilities made it difficult to access theatres consistently. As a result, not all theatres could be reviewed, and the project had to focus on a single theatre. This limited the ability to make direct comparisons, so external figures were used to support the analysis.

Working within a live theatre environment brought additional considerations, particularly around health and safety. There are numerous potential risks involved with manipulating heating, ventilation and air conditioning (HVAC) and medical gas systems in a theatre, such as no ventilation, no AGSS removal, too hot, too cold, failed operation, greater risk of infection and loss of revenue. Ensuring systems are managed and alarmed correctly the risks reduce over time. All reviewing of the ventilation had to be done externally or alongside the maintenance team replacing filters so that was a challenge to align all of the works. Fortunately, prior heat decarbonisation works had allowed a full and thorough asset list to be created so we were able to highlight and check condition of equipment provided by M&E experts.

Despite these limitations, the project has demonstrated clear opportunities for replication and wider impact. HVAC management is well-established in the commercial sector, but uptake in the NHS has been slow due to historic issues with installation, maintenance, and oversight. The approach used here could be applied to other areas with supply and extract ventilation or air conditioning systems. Within the trust, the model can be extended to other theatres by reviewing their standard operating periods and adjusting schedules accordingly. This represents a best practice that could be adopted more widely to improve energy efficiency and operational resilience across healthcare settings.

Conclusions:

This project has helped raise awareness across the wider team about the importance and impact of energy management. Success came from strong stakeholder engagement, a willingness to learn throughout, and making connections with other organisations who are implementing Smart Theatres (e.g. to attend site visits and learn from their experience).

One of the main lessons was recognising that change takes time. Challenges are part of the process, but they can be worked through, especially when financial savings are part of the solution.

To make sure the benefits last, all key learnings have been shared with the sustainability team, which is already part of a strong learning network within the trust. This helps ensure that knowledge is retained and built on. The trust is keen to take this work further, with plans to link energy efficiency improvements to all future theatre refurbishments. This will help embed sustainability into ongoing infrastructure upgrades and keep the momentum going.

References and Resources

Spagnolo AM, Ottria G, Amicizia D, Perdelli F, Cristina ML. Operating theatre quality and prevention of surgical site infections. J Prev Med Hyg. 2013 Sep;54(3):131-7. PMID: 24783890; PMCID: PMC4718372.

Effect of laminar airflow ventilation on surgical site infections: a systematic review and meta-analysis Bischoff, Peter et al. The Lancet Infectious Diseases, Volume 17, Issue 5, 553 - 561

Appendices

AGSS Data: [AGSS – Duplex]

Critical success factors

Please select one or two of the below factors that you believe were most essential to ensure the success of your project changes.

People	Process	Resources	Context
☐ Patient involvement and/or appropriate information for patients - to raise awareness and understanding of intervention ☐ Staff engagement ☐ MDT / Cross-department communication ☐ Skills and capability of staff ☐ Team/service agreement that there is a problem and changes are suitable to trial (Knowledge and understanding of the issue) X Support from senior organisational or system leaders	☐ clear guidance / evidence / policy to support the intervention. ☐ Incentivisation of the strategy – e.g., QOF in general practice ☐ systematic and coordinated approach ☐ clear, measurable targets ☐ long-term strategy for sustaining and embedding change developed in planning phase ☐ integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation	☐ Dedicated time ☐ QI training / information resources and organisation process / support ☐ Infrastructure capable of providing teams with information, data and equipment needed ☐ Research / evidence of change successfully implemented elsewhere ☐ Financial investment	☐ aims aligned with wider service, organisational or system goals. ☐ Links to patient benefits / clinical outcomes ☐ Links to staff benefits ☐ 'Permission' given through the organisational context, capacity and positive change culture.