



SUSQI PROJECT REPORT: Switch Off

Reducing the CO₂e of Orthopaedic Surgery

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Background:

Operating theatres require vast amounts of energy to run, requiring 3-6 times more energy than other areas of the hospital environment (NHS Scotland, 2023). This is owing to electrical equipment, lighting, heating ventilation and air conditioning (HVAC) systems and anaesthetic gas scavenging systems (AGSS), which exist to safely remove anaesthetic gases from the environment and reduce staff exposure. Operating theatres HVAC systems account for 90% of operating theatre energy consumption (Macneill et al., 2017). NHS Scotland (2023) estimated each air handling unit to cost £132.84 per day and 114kgCO₂e, and noted potential annual savings of 6594 tCO₂e and £7,798,262 across 386 theatres in Scotland. The Greener Surgery Report (2023) anticipates that if this were rolled out across the UK, savings could be up to £90 million. It is commonly thought that HVAC systems should remain on to maintain cleanliness, however these are designed to reduce airborne contamination when there is a biological load, i.e. when there are people in the room (NHS Scotland, 2023). As there is no biological load when the theatre is not in use, the system can be switched off. AGSS accounts for the majority of anaesthetic related energy consumption and is not necessary to keep switched on out of hours or for strictly intravenous anaesthetic techniques (Green Surgery Report, 2023). The Green Surgery Report (2023) recommends switching off AGSS, HVAC and plug in devices when not in use through implementation of 'switch off' checklists alongside safety protocols for turning equipment back on when needed.

Methods:

We first engaged with stakeholders including IT, estates and energy managers. We liaised with estates and our energy manager to estimate our current energy usage and to seek information on our AGSS pumps and HVAC systems. We were advised that the AGSS pump in our main theatres also supplied our emergency theatre, and isolating this theatre would involve a lot of work to run safely out of hours and so these 5 theatres were excluded. Five theatres across other departments already had local control of their AGSS and were chosen to be included in the project, to be switched off at the end of the operating list and back on at the start of a list. Risk mitigation was considered. Our anaesthetic machines alert the user if the scavenging is switched off, also prompting them to turn scavenging on. This is also part of the Association of Anaesthetists for Great Britain and Ireland



(AAGBI, 2012) recommendations for checking an anaesthetic machine and is a well-established practice for ODPs, anaesthetic nurses and anaesthetists to check prior to use.

Our HVAC systems run off the building management system with one AHU per theatre. Our main theatres (excluding emergency theatre), womens' health and day surgery units are able to be switched off out of hours, and it was suggested that these would be scheduled to shut down at 20:00 to account for overrunning lists and be switched back on at 07:00, giving a downtime of 11 hours per day. One of our standalone theatres is unable to be turned off due to the AHU also supplying ICU. Our AHUs are run off inverters, and so are started up slowly, mitigating any concerns over robustness of the system to be switched on and off regularly. Our intentions were presented to clinical governance and infection control for approval.

We had hoped to gain an accurate baseline energy usage for plug in devices of our orthopaedic theatres via a submeter but this was not possible in the timeframe of the project. We felt that obtaining these baseline figures was of huge value in measuring the impact of change and so opted to delay the implementation of the project until we could accurately obtain this information. In the meantime, we audited our orthopaedic theatres at 21:00 to see which devices had been left switched on following a routine day. Plug in devices were then considered for what could be switched off and what needed to remain plugged in and charged. We then created a 'switch off' checklist (see appendix), with a QR code to record completion to implement when we are ready to go ahead.

Measurement:

Patient outcomes:

We anticipate no change to patient outcomes or experience based on previous data whereby set back ventilation mode is appropriate with no increased risk of surgical site infection when the theatre is not in use. Ventilation units will be turned back on automatically, therefore mitigating any concerns around infection control and patient safety through human error of not switching the systems back on. We could monitor incident reporting after implementation to ensure no change in surgical site infection. Patients will be unaffected by the shutdown of AGSS out of hours.

Environmental sustainability:

GHG emissions associated with energy consumption were calculated individually for ventilation and AGSS. Estates provided us with data on kWh for our air handling units (AHU) and AGSS pumps. To calculate emissions for the AGSS, we utilised the toolkit from the Anaesthetic Gas Scavenging System Project (2019) available from the Centre for Sustainable Healthcare. The kWh/pump was multiplied by the 2024UK electricity emissions factor and then multiplied by run hours per annum. Wasted kgCO₂e could then be calculated by looking at potential unoccupied run hours. To calculate daily unoccupied run hours, we calculated 3640 unoccupied hours during weekdays between 18:00-08:00 and 2496 unoccupied hours during weekends. This was then taken to give an average daily unoccupied run hours of 16.32. This was considered only for the pumps that could be switched off.

To calculate emissions for the ventilation system, we adapted the AGSS toolkit. The kWh/AHU was multiplied by the 2024 UK electricity emissions factor and then multiplied by run hours per annum. We then calculated potential savings by calculating the proposed scheduled downtime based on



switching off our non-emergency theatres at 20:00 and turning back on at 07:00 on weekdays and Saturdays, and turning off completely on Sundays. We calculated 3432 hours of downtime annually during weekdays and Saturdays and a further 1248 hours annually of downtime on Sundays. This was then taken to give an average downtime of 12.82 hours per day. This was only calculated for the AHUs in theatres where ventilation could be switched off.

Economic sustainability:

To estimate the financial benefit of switching off the ventilation for the orthopaedic theatres the assumption was made that they would be in use for 312 days of the year and used for 13 hours of these days. This allows the ventilation to be switched off overnight and on Sundays. We calculated costs using the kWh of the AHUs and cost per kWh of electricity obtained from our energy manager. Annual savings were then calculated based on the hours per year the systems would be turned off.

For the AGSS, we utilised the toolkit from the Anaesthetic Gas Scavenging System Project (2019), which multiplied the cost per kWh by kWh per annum to project overall costs for a year. We then calculated unoccupied running hours and averaged this over a year accounting for weekends and out of hours to project potential savings. Due to the lack of accurate usage data for our plug in devices, we have not calculated savings from these devices at this time, opting to wait for sub metre data. Implementation costs were requested from estates who would be completing any work required.

Social sustainability:

When planning this project, we aimed to reduce any negative impact on staff and clinicians by anticipating potential issues, for example overruns and the need to keep ventilation on during Saturdays for waiting lists. We also shared information around infection control to alleviate any anxiety. Estates have proposed scheduling ventilation downtime to happen automatically so that staff are not required to add additional tasks to their day. The AGSS will require manual switching on and off, however this is a simple task requiring minimal input, with risks mitigated.

Results:

Patient outcomes:

The ventilation will be switched back on using an automated scheduled system. This has yet to be implemented whilst waiting for estates to complete the works and so we have no results at the time of writing. Once this practice is established, we intend to retrospectively monitor incident reporting to review any changes in surgical site infection.

Environmental sustainability:

Table 3.1: Estimated carbon data from switching off 8 theatre AHU's at RHCH		
KgCO2e when AHU switched on 24hrs	KgCO2e when AHU switched on during occupied hours only	Potential KgCo2 savings if AHU switched off during unoccupied hours
92,684.30	46,322.17	46,362.13



The above data is based on the AHU's being switched off for 11 hours per day over night and all day on Sunday. After discussion with the estates team we were able to identify that with the current infrastructure we have the potential to switch off 8 AHU's at RHCH. For the purpose of this project, when the saving is applied only to the two orthopaedic theatres, there is a potential 11,590.53 KgCO2e saving.

Table 3.2: Estimated carbon data from switching off 5 AGSS pumps at RHCH		
KgCO2e when AGSS switched on 24hrs	KgCO2e when AGSS switched on during occupied hours only	Potential KgCo2 savings if AHU switched off during unoccupied hours
20,871.97	8,576.241	12,295.73

The above data is based on the AGSS pumps being switched of for 12 hours a day and at weekends. After discussion with estates, we identified 5 AGSS pumps that have the potential to be switched off at RHCH. Unfortunately, due to the current infrastructure, the AGSS pump that supplies the two orthopaedic theatres also runs our emergency theatre. The estates team has advised that it would not be possible to isolate individual theatres from the main pump, and therefore orthopaedics will not generate a saving from this.

Economic sustainability:

Table 4.1: Estimated financial savings from switching off theatres AHU's based on 8 units at RHCH.		
Financial cost when AHU's switched on 24hrs	Financial cost when AHU's switched on during occupied hours only	Potential financial saving if AHU's are switched off during unoccupied hours
£70,956	£45,687.78	£25,268.22

When the above information is applied to the two orthopaedic theatres for the purpose of this report, it gives us potential annual financial savings of £8,422, but these savings are significantly greater when applied to every theatre where switching off the ventilation is possible.

Table 4.2: Estimated financial savings from switching off theatre AGSS pumps based on 5 units at RHCH		
Financial cost/annum when AGSS switched on 24hrs	Financial cost/annum when AGSS switched on during occupied hour only	Potential financial saving/annum if AGSS switched off during unoccupied hours
£15,768	£6,832.80	£8,935.20



As mentioned previously, it is not possible to turn off the AGSS pumps in the two orthopaedic theatres due to the pump also supplying the emergency theatre. Looking at our potential savings, they are greater than the costs of running our AGSS during occupied hours, meaning currently we are unnecessarily wasting more than we are actually using.

Social sustainability:

Due to the delay in implementing the switch off protocol we were unable to record staff feedback. We plan to obtain this information through the QR audit too once implemented. Whilst there is a potential risk of exposure to anaesthetic gases if the AGSS was not turned back on, this risk is mitigated through alerts provided by the anaesthetic machines and visual prompts. We will re-audit compliance with the project after implementation to ensure this is being adhered to. Wider health benefits could be predicted through the impact of the reduction in carbon emission in the atmosphere as a result of this project.

Discussion:

Recently there has been an increase in the cost of energy and people are making an effort to live more consciously. This project will help to see those adaptations that people are making at home to save energy transferred to the workplace. It is hoped that this project will aid staff to apply these habits to the workplace resulting in both carbon and financial savings as well as a sense of 'doing good'. This practice has been a well documented advisory in recent influential healthcare papers mentioned in the report above. With the NHS under continued financial constraints, energy savings is an effective way to save money with a small initial financial outlay.

Buildings and infrastructure in some hospitals can be old and requires consideration when planning to implement this project. Switching off some AHU's and AGSS pumps was not possible in our trust due to the amount of theatres/departments they serve. Consideration was made as to if inverters were in place to aid the AHU's and AGSS's pumps to be switched on and off with no additional wear on the units. It was concluded that all units at the RHCH site had inverters in place but this would need to be investigated at the BNHH site.

The location of the switches that are used to turn on and off the AHU's and AGSS pump was something that needed to be considered and discussed with the estates team. The switches for all of our AHU's and some of our AGSS pumps are currently located in spaces that are not accessible to nursing staff. The current practice is to call the maintenance team to come and switch the units off if it is ever required. Engagement with our estates team enabled us to understand how the current system works in each area and to collaboratively come up with a solution. This inevitably involves a cost implication to install and we are still awaiting confirmation of costs incurred and for the work to be completed.

Conclusions:

Regarding implementation of our 'switch-off' checklist, we are in a position to implement the routine shutdown of plug-in devices and lights as soon as we have accurate pre-implementation data on energy usage, as we believe this will be invaluable in recording progress and aiding in sharing our learning. This project has taken much longer to navigate than anticipated, likely due to the need for vast amounts of advice and information needed from areas outside of our usual remit.



It is important that when this project is implemented that we have considered not only the savings but also the safety of our staff and patients, which we have considered at length along with colleagues from IPC and clinical governance. All of these things considered, we expect this to be a hugely worthwhile project with significant positive impacts on sustainable value in our department.

References

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Appendices

Appendix: Theatre shutdown QR tool

Theatre Shutdown Checklist

Operating Theatre

Switch off:

- Lights
- Computers/Nexus


Switch off and plug in:

- Infusion pumps
- Anaesthetic machines
- Anaesthetic monitor
- Stacks

Switch off and unplug:

- Diathermy
- Warming equipment

**Please complete the
online check via QR code**



Anaesthetic Room

Switch off:

- Lights

Switch off and plug in:

- Infusion pumps
- Anaesthetic machine
- Anaesthetic monitor

