

## HERITAGE UPGRADES, NET ZERO OUTCOMES A BLUEPRINT FOR ENERGY REDUCTION ACROSS THE TfNSW NETWORK

Degnan commissioned a comprehensive Net Zero investigation for Moss Vale station to identify practical energy reduction opportunities within a heritage-listed rail environment. The resulting evidence-based blueprint provides a scalable pathway for reducing operational energy consumption across similar heritage assets, supporting the TfNSW target of reducing operational emissions by 65% by 2030.

### The Challenge

Heritage-listed railway stations present a significant challenge for operational energy reduction due to the conflict between conservation requirements and the need to improve building performance. Constraints on modifying building fabric, combined with ageing infrastructure, often result in poor thermal efficiency and high ongoing energy consumption.

At Moss Vale Station, the two highest energy-consuming spaces were identified as the Station Services Equipment Room (SSER), which houses critical communications equipment, and the Station Master's room. Both are located within the station's heritage building fabric, characterised by limited insulation, ageing windows, and poor airtightness.

The Station Master's room was also heated by an unflued portable gas heater. In addition to its poor energy performance compared to modern reverse-cycle systems, this introduced carbon monoxide and nitrogen dioxide into an occupied workspace, creating a direct occupational health and safety risk for station staff.

To address these challenges, Degnan engaged Atelier Ten, SMEC, and the project sustainability team to undertake detailed energy modelling of both spaces. The analysis assessed existing performance, tested improvement options, and evaluated long-term resilience under future climate scenarios, establishing a robust evidence base for targeted operational energy reduction within a constrained heritage environment.








### Key Findings and Sustainability Benefits

The investigation identified practical, scalable measures to reduce operational energy consumption across heritage stations while maintaining heritage values and operational requirements.

For the Station Master's room, replacing the existing unflued gas heater with a high-efficiency reverse-cycle split system was identified as the most effective improvement, delivering up to 75% heating energy savings over a 30-year lifecycle. Combined with targeted airtightness improvements, this provides a low-cost pathway to reduce emissions, improve occupant comfort, and eliminate indoor air quality risks associated with unflued gas heating.

Within the Station Services Equipment Room (SSER), a Vertical Exhaust Duct (VED) system was identified as the preferred solution, delivering estimated energy savings of 37-45% while maintaining operational redundancy and preserving the heritage fabric through a fully reversible installation.

### MOSS VALE STATION AND STABLING YARD UPGRADE

MEASURE	OUTCOME	NETWORK BENEFIT
 Reverse-cycle split air conditioning	Up to 75% heating energy saving	Low-cost decarbonisation of heritage station offices
 Airtightness improvements	Reduced heating demand	Applicable across most heritage stations
 Vertical Exhaust Duct (VED) cooling system	37-45% energy saving	Retrofit solution for SSERs without service disruption
 Ceiling insulation (office spaces)	High ROI energy reduction	Suitable for occupied heritage spaces
 Evidence-based thermal modelling	Optimised solutions by room type	Avoids unnecessary capital expenditure

The study also demonstrated that energy reduction strategies must be tailored to each space. While insulation and airtightness improvements benefited occupied rooms, increased insulation within the SSER was found to be counterproductive in Moss Vale's cool climate, highlighting the value of evidence-based design.

### Direct Air Cooling (Economy Cycle)

The SSER requires continuous environmental control to maintain the operation of critical communications and server equipment that supports station functionality.

An additional energy reduction opportunity identified for this space is the use of direct outside air cooling (economy cycle) as an alternative to mechanical HVAC during cooler periods. The system would introduce variable-speed fan-assisted ventilation to supplement the existing 40 L/s pressurisation supply, automatically switching between outside air and mechanical cooling based on external temperature conditions.

Moss Vale's cool climate makes this approach particularly effective, with approximately 55% of annual hours below 14°C, enabling the system to displace mechanical cooling for a significant proportion of the year. However, implementation requires a large supply duct wall penetration that exceeds heritage approval constraints.

As a result, while the solution is technically feasible as a future retrofit, the design team considers it better suited to new or early-stage SSER fitouts across the network, where duct sizing and intake requirements can be incorporated without heritage limitations.

### Network wide Impact

The significance of this study extends well beyond Moss Vale station, providing a scalable methodology for reducing energy consumption across heritage rail assets. The model was calibrated for broad applicability, including the double-brick and timber construction types common throughout the NSW rail network, and tested against a range of infiltration rates typical of heritage buildings. Unit-rate CAPEX benchmarking enables asset managers to identify candidate stations and prioritise interventions before committing to detailed energy modelling.

The findings demonstrate that operational energy reductions of 30-45% can be achieved within heritage constraints through non-invasive, reversible, and progressively implementable measures aligned with asset renewal cycles. This provides a practical pathway towards achieving the TfNSW target of reducing operational emissions by 65% by 2030.

The Moss Vale Net Zero study was recognised under the TfNSW SDGv4 Innovation and Project Legacy criterion for its network-wide applicability and long-term contribution to emissions reduction. It demonstrates how a single project can generate value beyond its immediate scope, establishing a benchmark for the decarbonisation of heritage rail infrastructure across NSW.