

Measurement & Verification Report

Laboratory Drying Cabinets

Project Summary

In the Spring of 2021, 24 aging and inefficient laboratory drying cabinets were replaced with 24 new units, across 26 different laboratories, funded by the Salix Public Sector Decarbonisation Scheme (PSDS). The project saw a significant impact on the energy consumption of the cabinets themselves in addition to improvement in the heat loss into the buildings, therefore improving comfort levels and reducing the energy consumption of laboratory cooling. There were no planned changes to the baseline in terms of temperature settings or opening hours (compared to a pre-covid baseline).

This M&V Report is based on the principals of measurement and verification outlined in the International Performance Measurement and Verification Protocol (IMPVP) Volume 1, EVO 10000 –1:2012 as detailed in Table 1 below.

The replacement of these 24 drying cabinets has resulted in energy savings of 76,958.39 kWh per year (66.78%) with an annual cost saving of £11,697.68 and a payback period of 4.98 years. 17.94 tonnes CO₂e per year savings have also been calculated. These findings compare favourably with the estimations outlined in our original Salix application in terms of estimating the baseline consumption, however the retrofitted cabinets consume 18% less than predicted which has resulted in an additional 25,940 kWh saving per year.

Table 1: M&V Summary

Framework	
M&V plan	Project UoR149 Laboratory Drying Cabinet Upgrades M&V Plan (dated January 2021)
IPMVP Option	Option A (Retrofit Isolation)
Measurement	
Measurement Method	Measurable Energy (m.e) plug in energy monitoring platform

Measurement Boundary	Drying cabinets subject to the retrofit project
Monitoring Period	1 week for both baseline and verification activities
Analysis	
Savings Determination	Avoided demand
Basis of Routine Adjustments	None
Target Uncertainty	Total quantifiable accuracy of the savings +/- 7.00%
Reporting	
Reporting Schedule (if any major deviations from existing savings are predicted)	Year 0 Report – Immediately following ECM completion. Repeat measurements could be taken in subsequent years, however for a straightforward equipment replacement project, this is felt to be unnecessary, as results are unlikely to change.

1 Facility Consumption Summary

The following section presents the summary energy consumption data. Measured data were collected for the baseline/pre-retrofit over a period of 1 week between 1st March 2021 and 7th March 2021, which represents a full operational cycle of the ECM. The reporting period data were gathered, also for one week, between 12th March 2021 and 18th March 2021. There were no deviations from the M&V plan and no power outages or data gaps.

Data were gathered for 20.83% of the baseline population and 16.67% of the post-retrofit population. No baseline period adjustment was required; There are no independent variables as energy consumption of the pre-retrofit cabinets are unaffected by the drying load i.e., the volume of glass wear or samples placed into the cabinets, as they run constantly during normal operating hours, with no thermostatic control with respect to door openings or internal temperatures. Similarly, no adjustment for static factors was required as during spot checks on operational usage, the cabinets remained at the same settings and operating times throughout the monitoring periods (most are controlled by timers).

2 Baseline period adjustment data

A. Independent Variables/Routine Adjustments

No adjustment required.

B. Baseline Static Factors

No adjustment required.

C. Adjustments for Interactive Effects

Only the drying cabinets are measured, however, the retrofit has an interactive effect in terms of reducing the amount of excess heat leaked into the environment by the drying cabinets in the retrofitted areas. The reduction of space heat gain: a) increases the heating required in the winter, and b) decreases the cooling required in summer. These interactive effects only occur in the retrofitted spaces which are temperature controlled by the plant's heating and cooling system.

Calculation methodology for determining the adjustments required from changes to the heating and cooling of the laboratories are detailed in Section 5D of the associated M&V plan. These calculations are based on the heating and cooling months and the efficiencies of the heating and cooling systems, the results of which are detailed in Table 2 below. There was found to be no thermostatic control by room occupants, or room temperature sensors relating to any cooling system directly within any of laboratories, and therefore no savings attributed to any reduced cooling demand for these rooms. Where laboratories are connected to the district heating system (Wager building), the heating efficiency is reported at 55.73% for the combined heat and power (CHP) engine. However, it should be noted that this is not a full picture of the efficiency of the system as the power efficiency is 23.77% and the combined overall efficiency is 79.5%.

Table 2: Adjustments for interactive effects

Ref	Cabinet	Location	Heating efficiency (%)	Annual additional heating energy required (Δ kWh)
3	Leec Drying Cabinet Single	UoR/w070 - Russell/R131	84	309.5
4	Leec Drying Cabinet Single	UoR/w070 - Russell/201c	84	309.5
6	LTE Scientific Unitemp Drying Cabinet Double	UoR/w070 - Russell/Teaching Lab 1	84	523.68
7	LTE Scientific Unitemp Drying Cabinet Double	UoR/w070 - Russell/113	84	523.68

14	Corsair Manufacturing Drying Cabinet Bench Top	UoR/w005 - Wager/G5	55.73	197.14
20	Drying Cabinet Benchtop	UoR/w059 - Agriculture/2U42	78	347.30
23	Drying Cabinet Benchtop	UoR/w059 - Agriculture/1U36	78	523.68
Total				2,558.13

3 Energy Savings Calculations

Table 3 presents the methods for data adjustment according to changes in independent variables and static factors to determine the avoided demand.

Table 3: Method for baseline adjustment

Retained Option	Equation
Avoided demand (kWh)	Avoided Demand = Baseline demand (-) Reporting period energy (±) <u>Routine</u> adjustments to period conditions (±) <u>Non-routine</u> adjustments to period conditions

Table 4 provides a summary of the ECM in terms of energy, cost and emissions savings, without adjustment for interactive effects.

Table 4: ECM Summary

Location	Baseline Energy Use (kWh)	Reporting period	Energy Savings (kWh)	Energy Savings (%)	Cost Savings (£)	Emissions Savings (kgCO _{2e})
Total (weekly)	2,216.28	687.11	1,529.16	69.00	232.43	356.51
Total (annual)	115,246.33	35,729.81	79,516.52	69.00	12,086.51	18,538.48
Total (annual with adjustment for interactive effects)	115,246.33	38,287.94	76,958.39	66.78	11,697.68	17,942.08

Table 5 displays the full data from the measurements taken of both the baseline and reporting periods, alongside the consumption savings in terms of kWh, cost and kgCO_{2e}.

As per the M&V plan, electricity consumption costs used for savings calculation (baseline or reporting period) are based on rates effective during the reporting period and were established at 0.152 p/kWh including VAT for electric, and 0.038 p/kWh including VAT for gas. CO₂ equivalent (kgCO_{2e}) savings were calculated using the UK Government Department for Business, Energy and Industrial Strategy (BEIS) figures for 2020; 0.23314 kgCO_{2e} per kWh for grid electricity and 0.184 kgCO_{2e} per kWh for grid natural gas. This differs from the Salix Finance conversion factors which take into account persistence factors, however the BEIS nationally available figures is adopted here to ensure consistency with other reporting.

Table 5: Annual energy (kWh), cost (£) and emissions (kgCO_{2e}) savings

Location	Baseline Energy Use (kWh)	Reporting period	Reporting period (with interactive effects)	Energy Savings (kWh)	Energy Savings (%)	Cost Savings (£)	Emissions Savings (kgCO _{2e})
UoR/w059 - Agriculture	5,184.85	821.59	821.59	4,363.26	84.15	663.21	1,017.25
UoR/AMS Knight/G79	5,184.85	821.59	821.59	4,363.26	84.15	663.21	1,017.25
UoR/w070 - Russell/R131	5,008.12	821.59	1,131.10	3,877.02	77.41	589.31	903.89
UoR/w070 - Russell/201c	5,008.12	821.59	1,131.10	3,877.02	77.41	589.31	903.89
UoR/w047 - Food Biosciences/3.36	5,008.12	821.59	821.59	4,186.53	83.59	636.35	976.05
UoR/w070 - Russell/Teaching Lab 1	13,005.81	5,922.34	6,446.02	6,559.79	50.44	997.09	1,529.35
UoR/w070 - Russell/113	13,005.81	5,922.34	6,446.02	6,559.79	50.44	997.09	1,529.35
UoR/w047 - Food Biosciences/1.13 (Food Processing Hall)	5,184.85	2,900.09	2,900.09	2,284.76	44.07	347.28	532.67

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UoR/w047 - Food Biosciences/4.05	5,184.85	2,900.09	2,900.09	2,284.76	44.07	347.28	532.67
UoR/w047 - Food Biosciences/4.05 (might be HLS G10 replacing Knight unit)	5,184.85	2,900.09	2,900.09	2,284.76	44.07	347.28	532.67
UoR/w047 - Food Biosciences/3.12	5,184.85	2,900.09	2,900.09	2,284.76	44.07	347.28	532.67
UoR/w047 - Food Biosciences/3.31 - replacement to be set up in 1.29/1.27	5,184.85	2,900.09	2,900.09	2,284.76	44.07	347.28	532.67
UoR/w005 - Wager/G7	2,185.74	439.73	439.73	1,746.01	79.88	265.39	407.07
UoR/w005 - Wager/G5	2,185.74	439.73	636.87	1,548.87	70.86	235.43	361.10
UoR/w005 - Wager/108	849.20	439.73	439.73	409.47	48.22	62.24	95.46
UoR/w031 - Harborne/142	4,801.93	439.73	439.73	4,362.20	90.84	663.05	1,017.00
UoR/w005 - Wager/105	4,801.93	439.73	439.73	4,362.20	90.84	663.05	1,017.00

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UoR/w047 - Food Biosciences/3.39	849.20	439.73	439.73	409.47	48.22	62.24	95.46
UoR/w047 - Food Biosciences/3.34	849.20	439.73	439.73	409.47	48.22	62.24	95.46
UoR/w059 - Agriculture/2U42	4,801.93	439.73	787.03	4,014.90	83.61	610.26	936.03
UoR/ TOB 2	4,801.93	439.73	439.73	4,362.20	90.84	663.05	1,017.00
UoR/w059 - Agriculture/GU28	4,801.93	439.73	439.73	4,362.20	90.84	663.05	1,017.00
UoR/w059 - Agriculture/1U36	4,801.93	439.73	787.03	4,014.90	83.61	610.26	936.03
UoR/w047 - Food Biosciences/3.34	2,185.74	439.73	439.73	1,746.01	79.88	265.39	407.07
Total	115,246.33	35,729.81	38,287.94	76,958.39	66.78	11,697.68	17,942.08

4 Comparison of actual versus predicted savings

A summary of the energy savings predicted compared with the measured data is displayed in Table 6. The measured data compares very favourably with the predicted data set out in the original Salix grant application. Initial estimations of the annual kWh consumption of the drying cabinets vary by just 1% from the actual measured consumption. The retrofitted, new cabinets consume 18% less than their predicted consumption and this has resulted in 48% further savings, an additional 25,940 kWh saved verses what was predicted. A reduced, more favorable payback period of 4.98 years has been calculated compared with the 5.23 estimated in the original application.

The increased consumption due to interactive effects (increased heating requirements) are an unfortunate consequence to the very much reduced heat gains into each lab from the much more efficient equipment. Compared with the Salix application, measured energy savings attributed directly to the reduced oven kW are much greater than predicted, more than making up for any estimated cooling savings, which were not possible to verify. Consumption increases by 2,558 kWh per year due to the interactive heating requirements, compared with a reduction of 79,516.52 from the drying cabinets themselves, still yielding a net saving of 76,958.39 kWh per year.

Table 6: Energy conservation measure projected savings

Calculation	Original Salix Application	Updated Salix Application	Actual
Annual kWh Pre-Project	116,203	121,608	115,246.33
Annual kWh Post-Project	43,576	45,603	38,287.94
Annual Savings (kWh)	72,627	76,005	76,958.39
Annual Savings (% kWh)	63%	63%	66.78
Project Cost (£)	£51,600	£58,316	£58,316
Annual Financial Savings (£)	£8,090	£11,553	11,697.68
Payback (Years)	6.3	5.05	4.98

tCO₂e Pa	5.23	7.44	17.94
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