**Sustainable Labs Steering Group**

**29th May 2017**

**Equipment Selection for Sustainability**

**(ongoing research process)**

# Description of paper

This paper summarises the results of desk-based research into the most efficient versions of different types of laboratory equipment. The equipment chosen for research was selected either due to known high energy/water consumption across the University of Edinburgh, or in response to requests from colleagues.

# Action requested

SLSG is asked to receive and provide feedback on, and (if appropriate) approve the findings and recommendations below.

# Recommendation

|  |  |  |
| --- | --- | --- |
| General conclusions | Issue | Recommendation |
| There appear to be more energy efficient CO2 incubators available | The manufacturers’ data may have been generated in unusually favourable conditions. | ESCO should be approached to request a trial of their incubators where we monitor them for in-use energy consumption. |
| Efficiency of glasswashers can be compared between Lancer models now | Further work is required for other manufacturers. | The above table should be used to guide purchase of Lancer models. |
| The results show that, in general, larger ovens are more efficient (if used at full capacity) | Lack of relevant data from Genlab.  Further work is required for other manufacturers. | Genlab and other models which appear to be efficient should be requested for in-use trials to compare performance. Further manufacturers should be investigated prior to units being selected for trial. |

# Background and context

The creation of the Sustainable Campus Fund and associated applications has prompted SRS and colleagues across the University of Edinburgh’s laboratories to try to identify Best Available Technology among commonly used equipment. The below research covered CO2 Incubators, Glassware washers, and Sterilising Ovens. Previous research has already been undertaken on drying ovens and ULT freezers.

# Findings

## CO2 Incubators

Colleagues in the Centre for Integrative Physiology at Hugh Robson Building (HRB) queried whether there were more energy efficient CO2 incubators available. Relatively comprehensive research was carried out, covering the following brands:

* Sanyo
* Panasonic
* VWR
* NuAire
* Thermo
* Esco
* RS Biotech
* Napco
* Haraeus

The data was gathered from three sources:

* Measured energy consumption of two CO2 incubators in HRB (old Sanyo and new Panasonic)
* Published manufacturers data
* Measured data gathered by lab efficiency counterparts in King’s College London (KCL).

The old Sanyo measured in HRB had a faulty heating element but still managed to achieve the required temperature of 37°C. This was initially compared to a new Panasonic CO2 incubator elsewhere in HRB with surprising results. The Panasonic consumed more electricity than the old (partially broken) unit. Both units were the same size and experienced the same usage. Looking at rating plates and published manufacturers data it seems that newer models are being produced with higher power. It is unclear why this would be the case unless they are expecting to operate in more challenging environmental conditions (i.e. colder room temperature or more frequent door openings).

This initial surprising result prompted desk-based research and contact with other lab sustainability professionals elsewhere to gather a greater body of evidence.

Below is a summary table. See appendix for full table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| name and model | volume (litres) | kWh/year | cost per year | annual cost/litre |
| Sanyo MCO-18AIC (UV) \* | 170 | 664 | £66.36 | £0.39 |
| Panasonic MCO19MPE \* | 170 | 790 | £78.96 | £0.46 |
| VWR Scientific 2300 | 184 | 2,219 | £221.90 | £1.21 |
| NuAire NU-5510E | 188 | 1,533 | £153.30 | £0.82 |
| THERMO SCIENTIFIC HERACELL 150I CO2 INCUBATORS | 150 | 701 | £70.08 | £0.47 |
| THERMO SCIENTIFIC WATER JACKET CO2 INCUBATORS | 184.1 | 883 | £88.32 | £0.48 |
| NuAire NU 5831 Hypoxic CO2 | 200 | 2,190 | £219.00 | £1.10 |
| ESCO CelCulture CCL-170 | 170 | 405 | £40.47 | £0.24 |
| ESCO CelCulture CCL-170 WJ | 170 | 405 | £40.47 | £0.24 |
| ESCO CelSafe CLS 170 | 170 | 361 | £36.09 | £0.21 |
| ESCO CelMate CLM 170B | 170 | 701 | £70.09 | £0.41 |
| Nuaire 5500E \*\* | 124.65 | 1109.6 | 110.96 | £0.89 |
| Sanyo - MCO-17AIC\*\* | 164 | 781.1 | 78.11 | £0.48 |
| RS Biotech (Pre-NBS)\*\* | 124.36 | 697.15 | 69.715 | £0.56 |
| RS Biotech (Pre-NBS)\*\* | 124.36 | 646.05 | 64.605 | £0.52 |
| Heracell 150\*\* | 150 | 701 | £70.08 | £0.47 |
| Napco 5415\*\* | 153.5 | 1,142 | £114.25 | £0.74 |
| Heraeus - Function Line BB16\*\* | 151 | 511 | £51.10 | £0.34 |
| Sanyo - MCO-18AIC\*\* | 170 | 799 | £79.94 | £0.47 |

\*Measured in Hugh Robson Building

\*\*Measured in King’s College London

Note that measured energy consumption of the HRB Sanyo is lower than the KCL Sanyo, likely because one fewer heating elements is operating.

Note also that the manufacturers’ data for the Thermo Heracell 150 is supported by the measured energy consumption in KCL.

Finally, it should be noted that the manufacturers’ data (describing running power at 37°C) from ESCO indicates that their models are substantially lower energy. This seems a little ‘too good to be true’ but perhaps should be investigated by running some ‘in-use’ testing.

## Glasswashers

A much less substantial body of evidence was gathered relating to glassware washers, with only 2 manufacturers covered; Lancer and Miele. This was due to lack of time – this study should be considered to still be in progress. The evidence was gathered purely through desk based research (manufacturers’ data)

Below is a summary table. See appendix for full table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Brand | Model | Capacity (litre) | Energy consumption per cycle | Energy consumption (kWh/year/litre) | Water consumption per cycle (litre) | Water consumption (litre per year per litre capacity) |
| Lancer | 810 LX | 139 | 0.70 | **6.29** | 12 | **2,079,117** |
| Lancer | 820 LX | 139 | 0.90 | **8.07** | 12 | **2,079,117** |
| Lancer | 910 LX | 148 | 0.90 | **7.54** | 13 | **2,411,994** |
| Lancer | 1300 LX | 254 | 1.00 | **4.93** | 15 | **4,754,652** |
| Lancer | 1400 LXP | 296 | 1.40 | **5.89** | 22.5 | **8,324,663** |
| Lancer | 1600 LXP | 494 | 1.74 | **4.41** | 32.5 | **20,066,396** |
| Lancer | 1800 LXA | 418 | 1.40 | **4.17** | 41 | **21,413,931** |
| Miele | G7883 | 134 | 2.12 | **19.80** | 51.6 | **8,650,212** |

## Sterilising Ovens

As with glasswashers, the number of manufacturers covered in the research for sterilising ovens was also reduced due to time constraints and this research should also be considered to still be in progress. For this research Thermo, Genlab and Binder were the manufacturers included. Again, all research was desk based and therefore relies upon manufacturers’ data.

Below is a table of the full dataset.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| name and model | volume (litres) | heat dissipation to env't at 150degC (room temp 25degC) (Watts) | heat dissipation per litre (W/l) | power rating (W) | heat up time from 25degC to 98% of 150degC (Minutes) | category |
| Thermo Heratherm OGS 60 | 60 | 194 | 3.23 | 1800 | 25 | general protocol |
| Thermo Heratherm OGS 100 | 100 | 261 | 2.61 | 3100 | 25 | general protocol |
| Thermo Heratherm OGS 180 | 180 | 320 | 1.78 | 3100 | 25 | general protocol |
| Thermo Heratherm OMS 60 | 60 | 291 | 4.85 | 1400 | 18 | general protocol |
| Thermo Heratherm OMS 100 | 100 | 426 | 4.26 | 3060 | 15 | general protocol |
| Thermo Heratherm OMS 180 | 180 | 473 | 2.63 | 3060 | 18 | general protocol |
| Thermo Heratherm OGS 400 | 400 | 520 | 1.30 | 2400 | 35 | general protocol |
| Thermo Heratherm OGS 750 | 750 | 795 | 1.06 | 300 | 60 | general protocol |
| Thermo Heratherm OGS 750-3P | 750 | 795 | 1.06 | 6350 | 60 | general protocol |
| Thermo Heratherm OGH 60 | 60 | 170 | 2.83 | 1810 | 22 | advanced protocol |
| Thermo Heratherm OGH100 | 100 | 210 | 2.10 | 3100 | 25 | advanced protocol |
| Thermo Heratherm OGH180 | 180 | 290 | 1.61 | 3100 | 25 | advanced protocol |
| Thermo Heratherm OGH-S 60 | 60 | 170 | 2.83 | 1810 | 22 | advanced protocol |
| Thermo Heratherm OGH-S 100 | 100 | 210 | 2.10 | 3100 | 25 | advanced protocol |
| Thermo Heratherm OGH-S 180 | 180 | 290 | 1.61 | 3100 | 25 | advanced protocol |
| Genlab HAS/100/SS/DIG | 100 |  | - | 1000 |  | N/A |
| Binder ED 115 | 114 | 250 | 2.19 | 1250 | 45 | Avante garde |
| Binder ED 260 | 255 | 370 | 1.45 | 2250 | 55 | Avante garde |

# Discussion

## CO2 Incubators

There are obvious difficulties around comparing 2 units in use, where one has a broken heating element. However, given that it seems to be meeting the two important criteria: serving the needs of the users; and not consuming excessive amounts of energy; it would seem appropriate to continue using the equipment until it fails in one of those two criteria.

The use of manufacturers’ data should always be undertaken with caution, and a degree of scepticism should be levelled towards the rather incredible claims from ESCO until further proof can be obtained.

## Glasswashers

The small number of manufacturers included in this research is an obvious weakness. Some initial conclusions can be drawn, especially in relation to Lancer models. If a decision has to be made between lower energy use and lower water use, lower energy use should be prioritised as the energy consumption associated with glasswashers is a far greater contributor to costs and carbon emissions (see table in appendix).

## Sterilising Ovens

Data was all derived from manufacturers’ publications, but not all manufacturers publish the useful measure of heat dissipation to environment. Notably the Genlab unit, which may be low energy as it has a relatively small power rating for its size (1kW for 100litres, as compared to 3.1kW from Thermo), does not describe its heat dissipation so cannot be compared on that measure.

# Resource implications

There are unlikely to be associated additional costs associated with this work. Possible (but unlikely) sources of additional costs are any costs associated with purchasing ‘test’ equipment – although this should be available for free on loan. Additional costs in relation to potentially higher purchase prices will be weighed up against associated savings from greater operational efficiency prior to any funds being allocated from the Sustainable Campus Fund.

# Risk Management

Low risk of small costs associated with purchasing ‘test’ equipment (see above).

# Equality & Diversity

No identified impact on Equality and Diversity.

# Next steps/implications

The SLSG response to this paper will guide next steps.

# Consultation

This paper has been reviewed by the SRS Head of Programmes

**Further information**Author and Presenter

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Paper written on 24th April 2017

# Freedom of Information

This is an open paper.

# Appendix

## CO2 Incubators

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| name and model | rated max energy consumption (Watts) | volume (litres) | rated max energy consumption per litre | typical kWh/week | measured kWh/week | Unit heat load (BTU/hour) | Unit heat load (kWh/hour) | weekly average operational hours | annual average operational hours | kWh/  year | cost per year | annual cost/  litre |
| Sanyo MCO-18AIC (UV) (\*\*broken heating element but still achieving 37°C) | 310 | 170 | 1.82 |  | 13.272 |  |  |  |  | 664 | £66.36 | £0.39 |
| Panasonic MCO19MPE | 382.3 | 170 | 2.25 |  | 15.792 |  |  |  |  | 790 | £78.96 | £0.46 |
| VWR Scientific 2300 | 264.2 | 184 | 1.44 | 44.38 |  |  |  |  |  | 2,219 | £221.90 | £1.21 |
| NU-5510E (running power) | 175 | 188 | 0.93 |  |  |  |  |  | 8760 | 1,533 | £153.30 | £0.82 |
| THERMO SCIENTIFIC HERACELL 150I CO2 INCUBATORS |  | 150 | - |  |  | 273 | 0.08 |  | 8760 | 701 | £70.08 | £0.47 |
| THERMO SCIENTIFIC WATER JACKET CO2 INCUBATORS |  | 184.1 | - |  |  | 344 | 0.10082 |  | 8760 | 883 | £88.32 | £0.48 |
| NuAire NU 5831 Hypoxic CO2 (running power) | 250 | 200 | 1.25 |  |  |  |  |  | 8760 | 2,190 | £219.00 | £1.10 |
| ESCO CelCulture CCL-170 (nominal running power at 37) | 46.2 | 170 | 0.27 |  |  |  |  |  | 8760 | 405 | £40.47 | £0.24 |
| ESCO CelCulture CCL-170 WJ (nominal running power at 37) | 46.2 | 170 | 0.27 |  |  |  |  |  | 8760 | 405 | £40.47 | £0.24 |
| ESCO CelSafe CLS 170 (nominal power at 37) | 41.2 | 170 | 0.24 |  |  |  |  |  | 8760 | 361 | £36.09 | £0.21 |
| ESCO CelMate CLM 170B | 80 | 170 | 0.47 |  |  |  |  |  | 8761 | 701 | £70.09 | £0.41 |
| Measured values (from KCL) |  |  |  |  |  |  |  |  |  |  |  |  |
| Nuaire 5500E |  | 124.65 |  |  |  |  |  |  |  | 1109.6 | 110.96 | £0.89 |
| Sanyo - MCO-17AIC |  | 164 |  |  |  |  |  |  |  | 781.1 | 78.11 | £0.48 |
| RS Biotech (Pre-NBS) |  | 124.36 |  |  |  |  |  |  |  | 697.15 | 69.715 | £0.56 |
| RS Biotech (Pre-NBS) |  | 124.36 |  |  |  |  |  |  |  | 646.05 | 64.605 | £0.52 |
| Heracell 150 |  | 150 |  |  |  |  |  |  |  | 701 | £70.08 | £0.47 |
| Napco 5415 |  | 153.5 |  |  |  |  |  |  |  | 1,142 | £114.25 | £0.74 |
| Heraeus - Function Line BB16 |  | 151 |  |  |  |  |  |  |  | 511 | £51.10 | £0.34 |
| Sanyo - MCO-18AIC |  | 170 |  |  |  |  |  |  |  | 799 | £79.94 | £0.47 |

## Glasswashers

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Brand | Model | Capacity (l) | Energy consumption per cycle | assumed kWh/year (based on 8 hours per day or 5 cycles per day) | estimated annual carbon from elec (tonnes CO2E) | estimated annual cost from elec | kWh/year/litre | water consumption per cycle (l) | assumed number of cycles per day | assumed number of cycles per year | water consumption per year (l) | estimated annual carbon from water (tonnes CO2E) | estimated annual cost from water | water consumption (litre per year per litre capacity) |
| Lancer | 810 LX | 139 | 0.70 | 871.89 | 0.39 | £ 87.19 | 6.29 | 12 | 5 | 1250 | 15,000 | 0.0158 | £ 30.37 | 2,079,117 |
| Lancer | 820 LX | 139 | 0.90 | 1,118.80 | 0.50 | £ 111.88 | 8.07 | 12 | 5 | 1250 | 15,000 | 0.0158 | £ 30.37 | 2,079,117 |
| Lancer | 910 LX | 148 | 0.90 | 1,118.80 | 0.50 | £ 111.88 | 7.54 | 13 | 5 | 1250 | 16,250 | 0.0171 | £ 32.90 | 2,411,994 |
| Lancer | 1300 LX | 254 | 1.00 | 1,249.22 | 0.56 | £ 124.92 | 4.93 | 15 | 5 | 1250 | 18,750 | 0.0197 | £ 37.96 | 4,754,652 |
| Lancer | 1400 LXP | 296 | 1.40 | 1,743.77 | 0.78 | £ 174.38 | 5.89 | 22.5 | 5 | 1250 | 28,125 | 0.0296 | £ 56.94 | 8,324,663 |
| Lancer | 1600 LXP | 494 | 1.74 | 2,179.72 | 0.98 | £ 217.97 | 4.41 | 32.5 | 5 | 1250 | 40,625 | 0.0427 | £ 82.25 | 20,066,396 |
| Lancer | 1800 LXA | 418 | 1.40 | 1,743.77 | 0.78 | £ 174.38 | 4.17 | 41 | 5 | 1250 | 51,250 | 0.0539 | £ 103.76 | 21,413,931 |
| Miele | G7883 | 134 | 2.12 | 2,652.78 | 1.19 | £ 265.28 | 19.80 | 51.6 | 5 | 1250 | 64,554 | 0.0679 | £ 130.69 | 8,650,212 |