

Site: Montrose

Location: UK

Sector: GMS Manufacturing

Project Type: Energy Kaizen

Date: May 2017

Kaizen Projects Identified

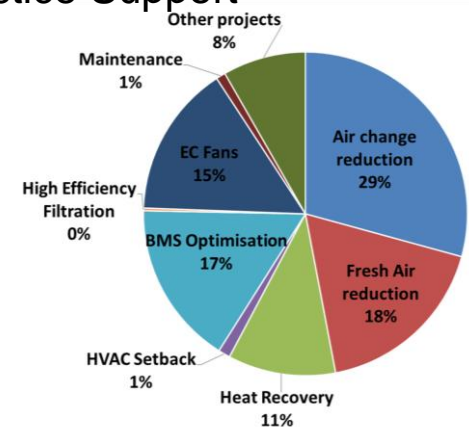
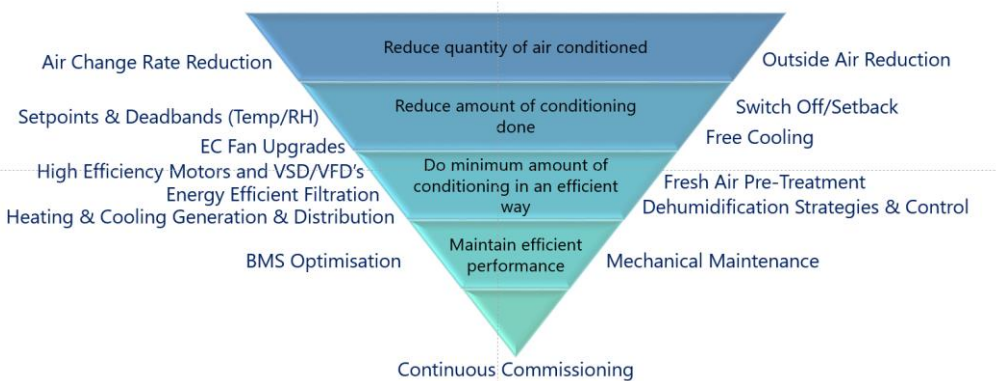


- 202 Saving Ideas generated
- 58 JDIs and Investigations will provide additional future benefit
- 27 Projects on the final project list, (4.6 years payback)
 - rejected projects recorded, all ideas recorded
- Key Focus Areas:-
 - HVAC
 - Chillers
 - CHP
 - M&T
- 36% CO₂ reduction opportunity from Kaizen projects

HVAC Savings Themes



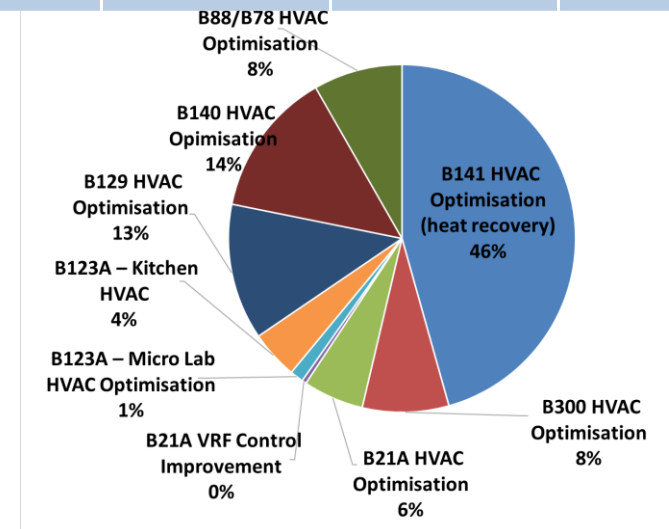
1. Air change Reduction - Manufacturing (B141, B152, B88, B78)
2. Air Change Reduction – GMP (B300, B123A)
3. Recirculation /FA reduction / Heat Recovery (B141,B140, B78, B88, B152)
4. BMS / Delta V Optimisation / Improvements (B300, B123A, B141, B152, B88, B78)
5. Set Back & Switch Off (B300, B141)
6. EC Fans (B141, B21A)
7. Maintenance for Energy (Belts, Pulleys, Filters, Leakage, Hot Water Coils) - Site
8. Best Practice AHU for New plant & Buildings – EECO2 Best Practice Support



HVAC Potential Savings - Projects



	Project	TOTAL Capital Cost (£)	Total Identified Savings (kWh)	Total Identified Saving (CO2)	Total Cost Saving (£)	Payback (years)
1	B141 HVAC Optimisation (heat recovery)	£ 418,348	2,084,048	671	£ 122,978	3.4
2	B300 HVAC Optimisation	£ 47,600	367,627	141	£ 28,132	1.7
3	B21A HVAC Optimisation	£ 70,005	257,910	107	£ 22,047	3.2
4	B21A VRF Control Improvement	£ 6,500	18,920	8	£ 1,617	4.0
5	B123A – Micro Lab HVAC Optimisation	£ 10,200	57,268	17	£ 2,971	3.4
6	B123A – Kitchen HVAC	£ 16,900	205,208	38	£ 3,871	4.4
7	B129 HVAC Optimisation	£ 62,600	578,274	163	£ 27,426	2.3
8	B140 HVAC Optimisation	£ 48,490	618,693	138	£ 18,740	2.6
9	B88/B78 HVAC Optimisation	£ 106,260	378,381	100	£ 15,861	6.7
	Totals	£ 786,903	4,566,329	1,382	£ 243,643	3.2



Expect HVAC projects to over deliver if delivered optimally

Capital £786k
ROI 3.2 Yrs

B141 HVAC Improvement Project



Current Status:

- 2 Main Supply systems. AHU 1 & 3 100% outside air systems. Running at higher ACPH rates. AHU's are in poor condition needing repair. Fan & heating controls basic

Project Plan:

- Reduce ACPH to 10 from Current 20 Off loading & 10 ACPH for Manufacturing
- Recirculation of Air with VOC sensing & Controls (AHU 3 & 4) / Or heat recovery.
- Review & improve distribution
- EC Fan replacement possible pending ATEX review.
- Low temperature Heating Coils installed for future
- Controls Improvements (Delta V)
- Switch Off AHU 5 Extract to be investigated
- Implement as part of capital planned AHU replacement

Note: 2 Versions of project considered with recirculation & Heat recovery

Feasibility & Impact Assessment:

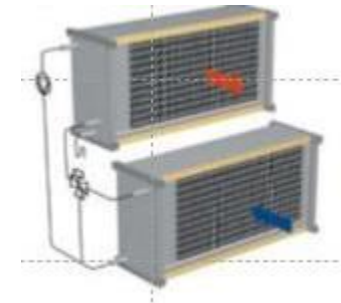
Major energy saving through heat recovery. Review of recirculation & VOC sensing vs Heat recovery. EHS & GMP support required

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B141 HVAC Opt	2,084	£122,978	671	418,348	3.4



EC Fan Wall



Heat Recovery



Jet Diffusers

B300 HVAC Optimisation



Current Status:

- New facility. Often completed but not optimised. ACPH's are greater than GSK requirements. BMS Not seasonally optimised. Facility will be idling during validation batches

Project Plan:

- Air change rate reduction (Grade C – 20 ACPH. Grade D – 12ACPH). Achieving classification no problem
- UDAF setback velocity to 0.15 m/s proved by EECO2 to provide classification
- Change Filters to HIFLO Bags from 30/30 - Opakfil
- BMS Controls optimized for energy & seasonally
- Setback strategy improvements during idling state.

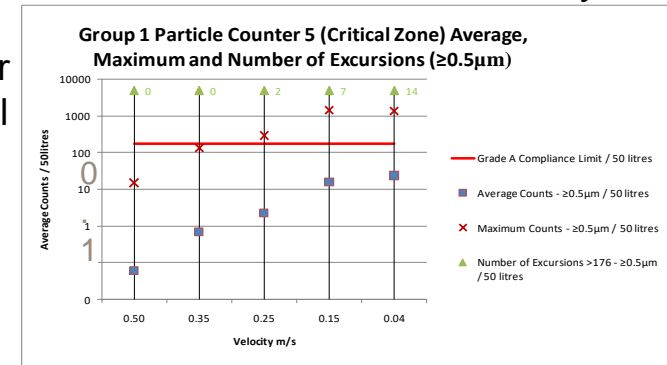
Feasibility & Impact Assessment:

- GMP review & change control required

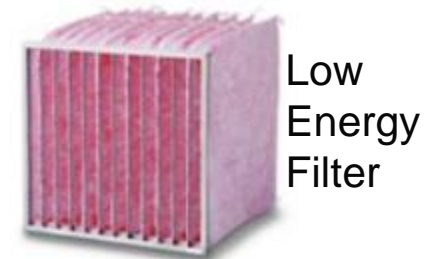
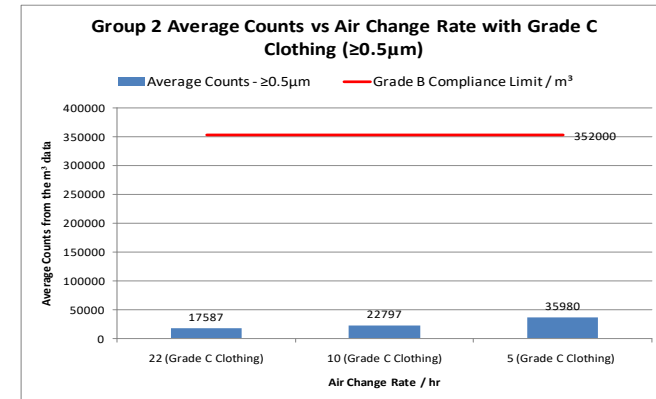
Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B300 HVAC Opt	367	£28,132	140	£47,600	1.7

Grade A Particle vs Velocity



ACPH vs GMP Classification



B21A HVAC Optimisation



Current Status:

Fresh air unit with heat recovery. Electric Reheat, Old Fan solution. Unsupported BMS. Poor intake & discharge locations

Project Plan:

- EC Fan Upgrade and low energy filters
- Heat pump replacement of Elec heaters. High efficiency
- BMS Controls (CO2 sensing, Fan speed control. adaptive temp)
- Switch off Electric Humidifier or replace with Ultrasonic

Feasibility & Impact Assessment:

No Risks

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B21A HVAC Opt	257	£22,047	107	£70,005	3.2



Air Quality Sensor



EC Fan Wall



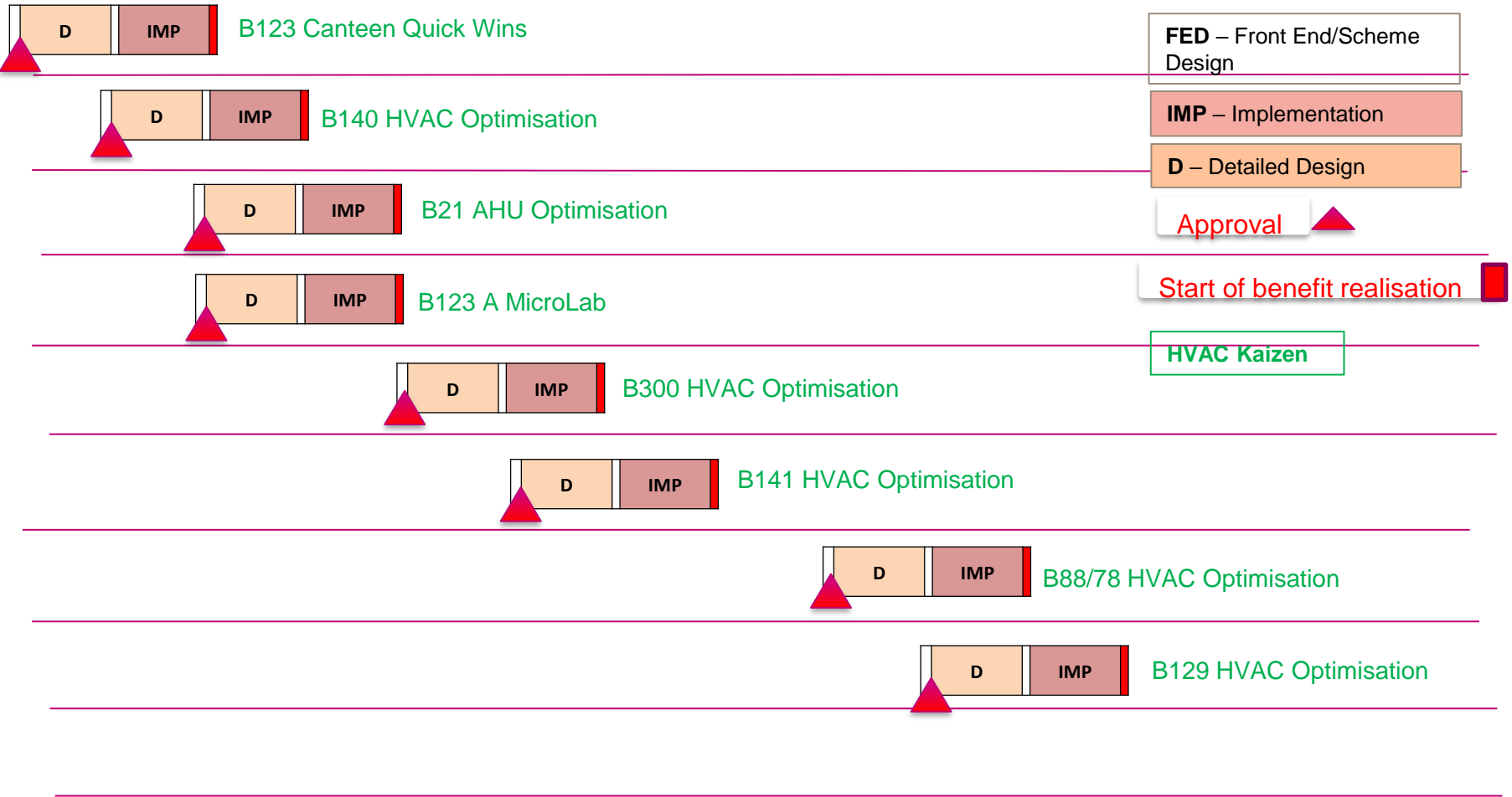
Blocked Fresh Air Intake



Hot Water Heat Pump

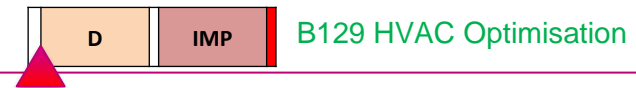
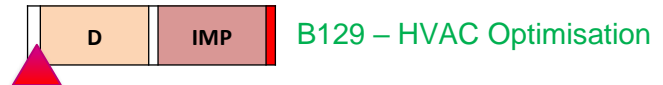
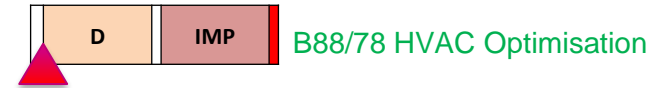
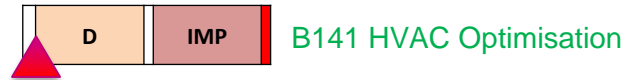
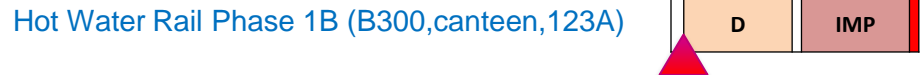
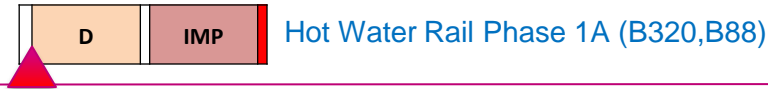
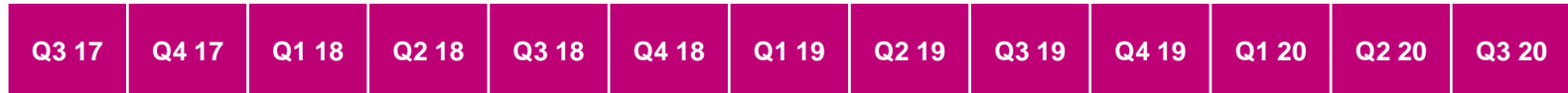
HVAC Projects Plan to 2020 – Kaizen Project Plan

Q3 17	Q4 17	Q1 18	Q2 18	Q3 18	Q4 18	Q1 19	Q2 19	Q3 19	Q4 19	Q1 20	Q2 20	Q3 20
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Capital £786k
ROI 3.2 Yrs

Projects Plan to 2020 – Hot Water Aligned Projects



FED – Front End/Scheme Design

IMP – Implementation

D – Detailed Design

Approval

Start of benefit realisation

HVAC Kaizen

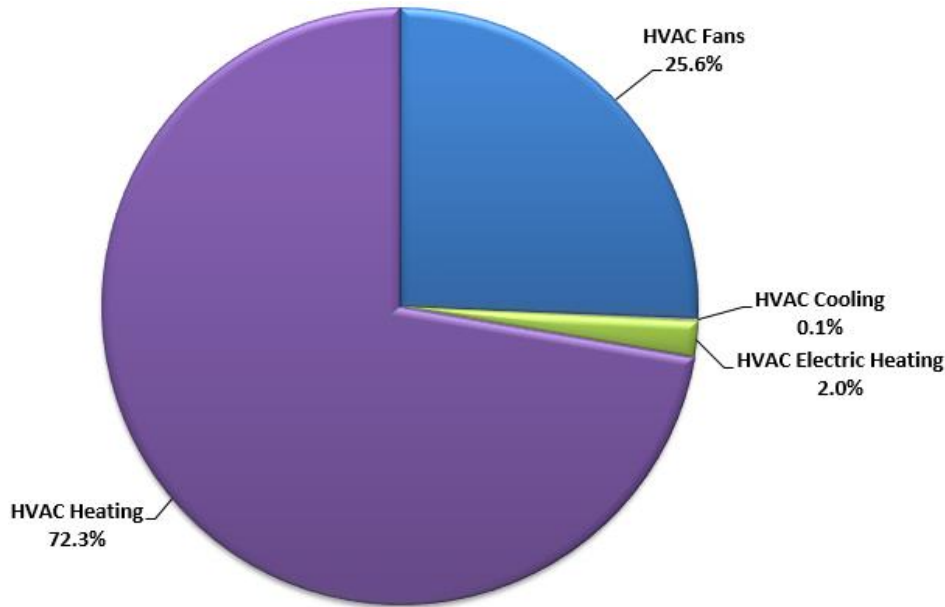
Hot Water Kaizen

Site Capital

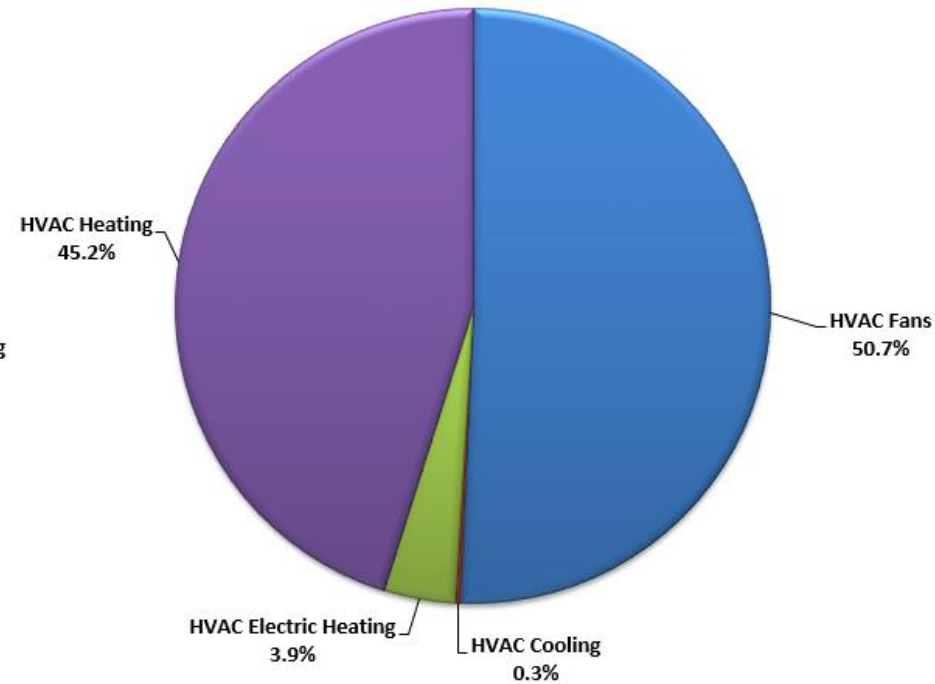
HVAC Consumption



HVAC Approx 25% Site Energy
(kWh) Inc losses



HVAC Approx 22% Site Cost



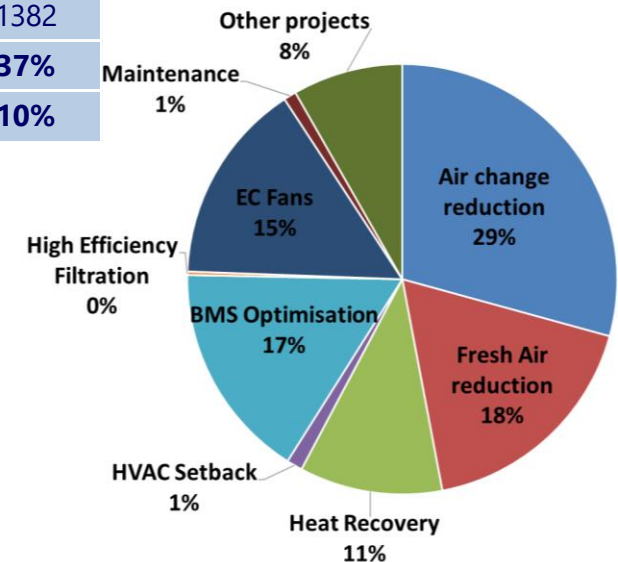
HVAC Map	kWh	t.CO2	% t.CO2
HVAC Fans	3,930,695	1,285	37.3%
HVAC Cooling	22,095	7	0.2%
HVAC Electric Heating	302,082	99	2.9%
HVAC Heating	11,093,451	2,050	59.6%
Totals	15,348,323	3,441	100%

HVAC Map	£	%
HVAC Fans	238,975	50.7%
HVAC Cooling	1,343	0.3%
HVAC Electric Heating	18,366	3.9%
HVAC Heating	212,937	45.2%
Totals	471,622	100%

HVAC Potential Savings



Description	Savings				
	Electricity	Gas	Total (kWh)	£	t. CO2e
Air change reduction	1,336,462	-	1,336,462	£ 114,245	552
Fresh Air reduction	3,798	806,487	810,285	£ 15,537	150
Heat Recovery	-	491,266	491,266	£ 9,267	90
HVAC Setback	54,415	-	54,415	£ 4,652	22
BMS Optimisation	138,581	607,694	746,275	£ 23,309	169
High Efficiency Filtration	12,350	-	12,350	£ 1,056	5
EC Fans	693,919	-	693,919	£ 59,318	287
Maintenance	43,013	-	43,013	£ 3,677	18
Other projects	81,740	296,604	378,344	£ 12,582	88
Totals	2,364,278	2,202,051	4,566,329	£ 243,643	1382
% of HVAC Totals			31%	43%	37%
% of Site Totals			7%	11%	10%



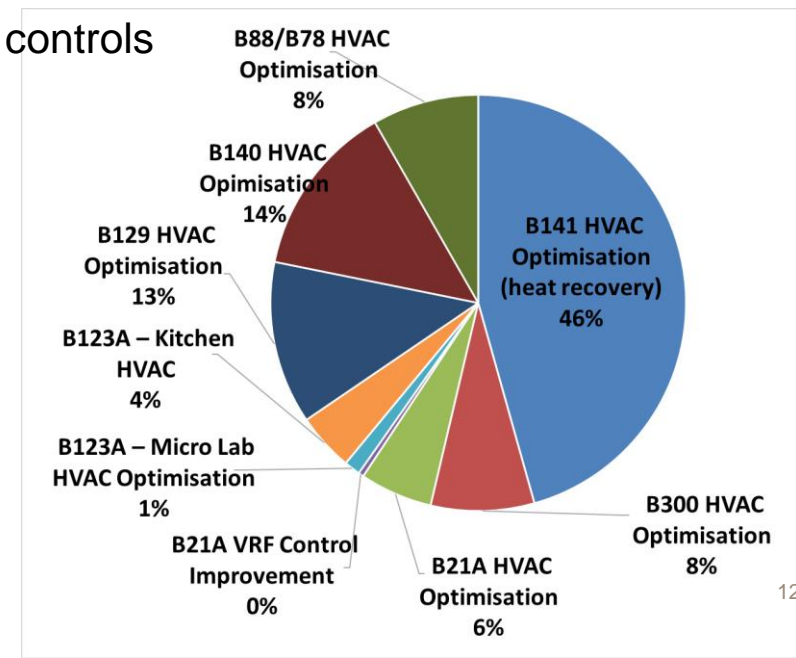
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ROI 3.2 Yrs

HVAC Saving Project Summary



1. B141 – ACPH reduction, Heat recovery / Recirculation, Temperature controls, EC fans
2. B300 – ACPH reduction, BMS optimisation & Setback strategy
3. B21A – Fresh Air system improvement, VRF control, Heat pump EC Fans.
4. B21A - AC improvements & Optimisation
5. B123A Micro lab – ACPH reduction, BMS optimisation
6. B129/B88/B78 – ACPH reduction, heat recovery, controls
7. B140 – AHU switch off strategy and recirculation



B21A VRF Control Improvement



Current Status:

VRF's & Cassettes do not have optimised controls. Some complaints regarding conditions and drafts

Project Plan:

- Controls improvements
- Adaptive set points, PIR's sensors, window contacts, compensated controls. ENOcean review
- Switch off to time clock

Feasibility & Impact Assessment:

Review current control system & improved controls with additional sensors

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B21A VRF Opt	19	£1,617	8	£6,500	4.0

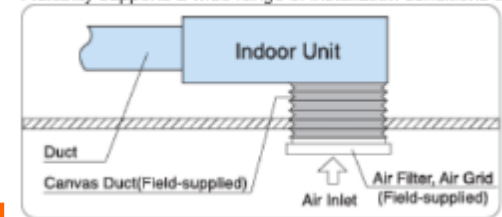


EnOcean AC Sensors



Hitachi AC Controller

Flexibility supports a wide range of installation conditions at site



DX above ceiling Fan coils

B123A – Micro Lab HVAC Optimisation



Current Status:

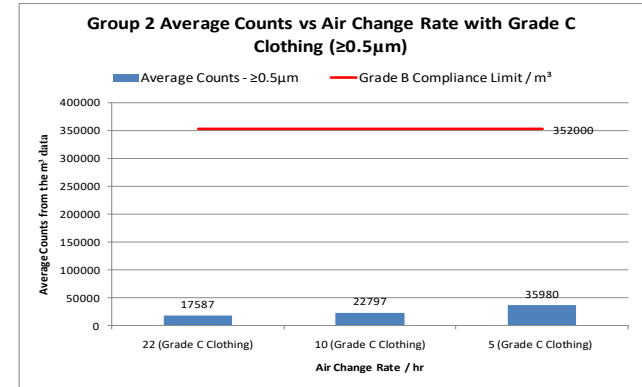
- New facility. ACPH's not optimised along with Controls

Project Plan:

- ACPH reduction to GSK standards
- Fresh air reduction , Set back , Filters upgrade
- BMS Optimisation

Feasibility & Impact Assessment:

Feasibility required. Project could be delivered during yearly re-measure.



ACPH vs GMP Classification



BMS Screen – Identify Issues

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B123A Micro Opt	57	£3,062	17	£2,971	3.4



Low Energy Filter

B123A – Kitchen HVAC Quick Fixes



Current Status:

Failed heating controls on AHU. Heating Controls on and windows open in canteen. Extraction Hoods on when not required.

Project Plan:

- AHU Heating Controls to be fixed
- Isolate Hot water Heating System seasonally - JDI
- Kitchen Hood controls to be reviewed for benefit (Can this be relocated to new kitchen?)

NOTE: New Capital Project planned. Short payback projects only.

Feasibility & Impact Assessment:

Simple maintenance projects with no risk

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B123A Kitchen Opt	205	£3,871	38	£16,900	4.4

B129/B88/B78 HVAC Optimisation



Current Status:

Manufacturing area AHU's operating with higher than required ACPH. 100% FA systems.

Project Plan:

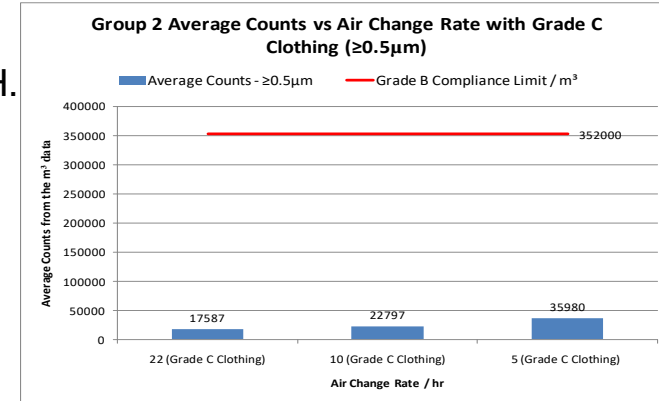
- ACPH reduction
- Recirculation & VOC sensing
- Optimise BMS Controls (Already on Delta V)
- Maintenance Savings (Leakage, pulleys & belts)

Feasibility & Impact Assessment:

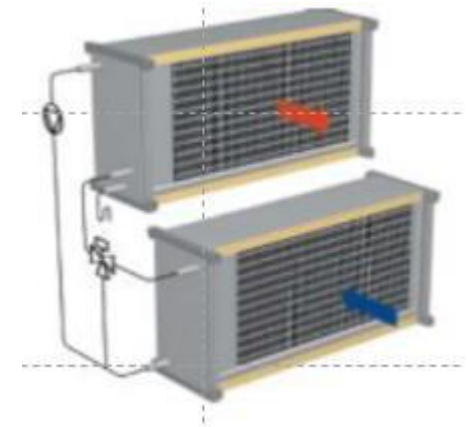
- Project requires shut down and GMP review. Heat recovery will not affect GMP

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B129/B88/B78	956,555	£45,943	262	£168,860	4.3



ACPH vs GMP Classification



Heat Recovery

B140 HVAC Optimisation



Current Status:

Building no longer used for original intention. Mostly stores. Currently 100% FA plan with poor control and failed heating valves

Project Plan:

- Repair Failed valves
- Swith off

Feasibility & Impact Assessment:

Simple project without risks

Financial Summary:

Description	Saving MWh/yr	Annual Savings £/yr	tons CO2/yr	Capital Cost, £	Simple Payback (yrs)
B140 HVAC Opt	618	£18,740	138	£48,490	2.6