

Passivhaus School Kitchens

16th International Passive House
Conference Hannover 2012

Alan Clarke & Nick Grant

Oak Meadow School



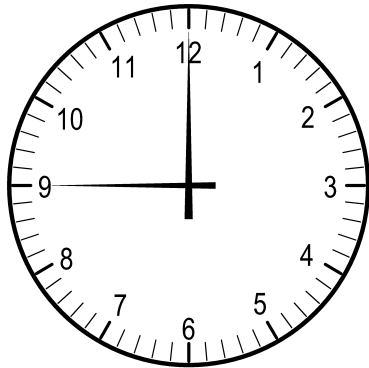
Architect: Architype

Bushbury School

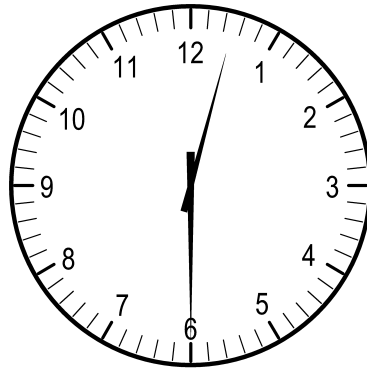


Architect: Architype

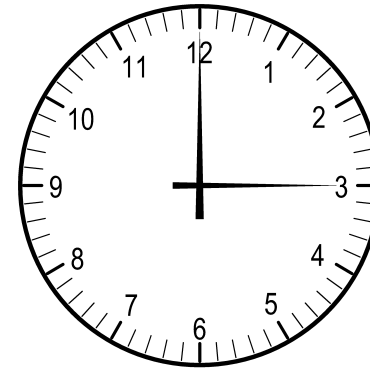
English school day



START



LUNCH



END

School dinners are important!

Wolverhampton Primary School Menu 2010 – 2011



Week 1 commences 1 September 2010

All meals freshly prepared daily by your dedicated catering team

WEEK 1

Monday

Sausages & Gravy
with Creamed Potatoes
Quorn Cottage Pie 🍷
Baked Beans
Garden Peas
Steamed Syrup Sponge
& Custard

Tuesday

Roast Turkey with Stuffing,
Roast Potatoes &
Creamed Potatoes
Vegetable Chickpea Curry
with Couscous 🍷
Julienne Carrots
Green Beans
Alien Crunch
& Custard

Wednesday

Chicken Casserole with
Creamed Potatoes
or
Chicken Curry with Brown Rice
Roasted Vegetable Pizza 🍷
Jacket Wedges
Mixed Salad
Carrot & Swede
Homemade Coleslaw
Raspberry Apple Delight

Thursday

Roast Beef with
Roast Potatoes &
Creamed Potatoes
Cheese & Potato Pie 🍷
Baked Beans
Parsnips &
Green Cabbage
Rice Pudding
& Jam

Friday

Fish Pie
Vegetable Bake 🍷
Chips
Sweet corn
Peas
Boston Brownie
with Custard

WEEK 2

Monday

Pasta Bolognese
or Lamb Balls with Pasta
Broccoli & Cauliflower Bake 🍷
Pitta Bread
Mixed Salad
Sweet corn
Green Beans
Toffee Apple Pudding
with Custard

Tuesday

Roast Pork & Apple Sauce
with Roast & Creamed Potatoes
Vegetable & Lentil Lasagne 🍷
Brown Roll
Mixed Salad
Carrot & Swede
Parsnips
Banana Muffin Tray Bake
with Custard

Wednesday

Beef Cottage Pie
Homemade Wholemeal Roll
Jacket Potato with
Cheese & Beans 🍷
Homemade Wholemeal Roll
Mixed Salad
Cauliflower
Broccoli
Chocolate Crunch with Custard

Thursday

Roast Chicken Roast &
Creamed Potatoes
Vegetable Pasta Bake 🍷
Mixed Salad
Green Cabbage
Julienne Carrots
Mandarin & Kiwi
Cheesecake

Friday

Cod & Salmon
Fish Finger & Chips
Quorn Sausages 🍷
& Chips
Peas
Sweet corn
Fruit Salad &
Vanilla Ice cream

Available Daily: bread, fresh fruit, assorted low fat yoghurts, cheese & biscuits, strawberry/banana milkshake. All meals £1.90

September 2010

Week	1	2	3	4	5
Mon	6	13	20	27	
Tue	7	14	21	28	
Wed	1	8	15	22	29
Thu	2	9	16	23	30
Fri	3	10	17	24	
Sat	4	11	18	25	
Sun	5	12	19	26	

October 2010

Week	1	2	3	4
Mon	4	11	18	25
Tue	5	12	19	26
Wed	6	13	20	27
Thu	7	14	21	28
Fri	1	8	15	22
Sat	2	9	16	23
Sun	3	10	17	24

November 2010

Week	1	2	3	4	5
Mon	1	8	15	22	29
Tue	2	9	16	23	30
Wed	3	10	17	24	
Thu	4	11	18	25	
Fri	5	12	19	26	
Sat	6	13	20	27	
Sun	7	14	21	28	

December 2010

Week	1	2	3
Mon	6	13	20
Tue	7	14	21
Wed	1	8	15
Thu	2	9	16
Fri	3	10	17
Sat	4	11	18
Sun	5	12	19

January 2011

Week	2	3	4	5	6
Mon	3	10	17	24	31
Tue	4	11	18	25	
Wed	5	12	19	26	
Thu	6	13	20	27	
Fri	7	14	21	28	
Sat	1	8	15	22	29
Sun	2	9	16	23	30

February 2011

Week	2	3	4	5	6
Mon	7	14	21	28	
Tue	1	8	15	22	
Wed	2	9	16	23	
Thu	3	10	17	24	
Fri	4	11	18	25	
Sat	5	12	19	26	
Sun	6	13	20	27	

March 2011

Week	1	2	3	4	5
Mon	7	14	21	28	
Tue	1	8	15	22	29
Wed	2	9	16	23	30
Thu	3	10	17	24	31
Fri	4	11	18	25	
Sat	5	12	19	26	
Sun	6	13	20	27	

April 2011

Week	1	2
Mon	4	11
Tue	5	12
Wed	6	13
Thu	7	14
Fri	1	8
Sat	2	9
Sun	3	10

Some schools may alter their menu, please check with your school



School kitchen

Kitchen ventilation

Initial design

- Bushbury: main MVHR: 5400 m³/h
- Kitchen ventilation: 3600 m³/h
- No heat recovery on kitchen system – grease

Engineer concerned this wasn't enough

– risk of overheating –

preferred kitchen rate of **4800** m³/h.

Impact on PHPP

- +20% ventilation
- Without heat recovery: +8 kWh/m².a

What is the extra energy for?

For heating the incoming fresh air to the kitchen

Why so much ventilation?

- Remove heat - radiant and convective
- Remove vapour & particulates - mainly water, also grease
- Supply combustion air for gas cooking
- Remove products of combustion

Low energy strategy

- Only provide as much air as needed to remove excess heat

This was not compatible with gas cooking

- Recover heat if possible

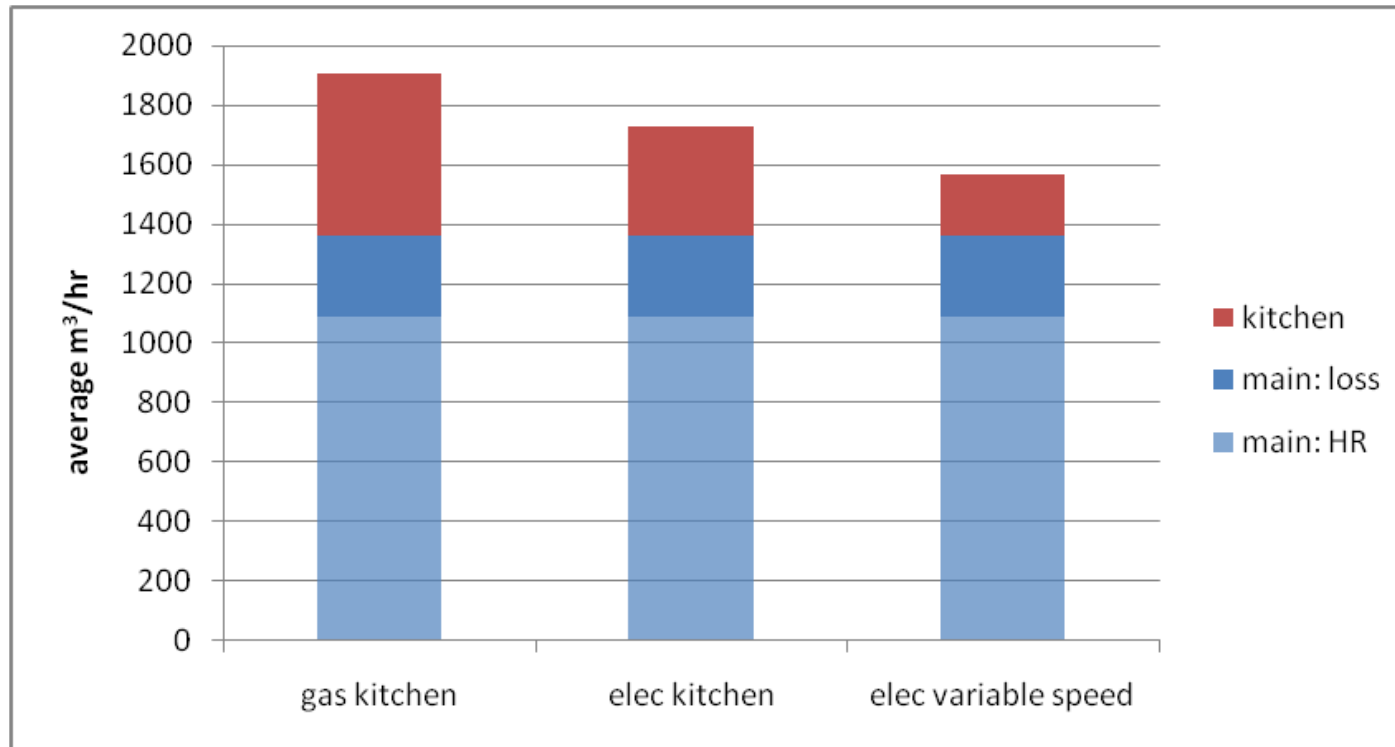
A robust heat exchanger possible if no frying

Reducing the vent rate

Less ventilation = less heat needed:

- Electric – no combustion products
- Induction hob – minimal excess heat
- Minimise hood area – just over oven and hob
- Passive dishwasher condensate hood

Ventilation rate options

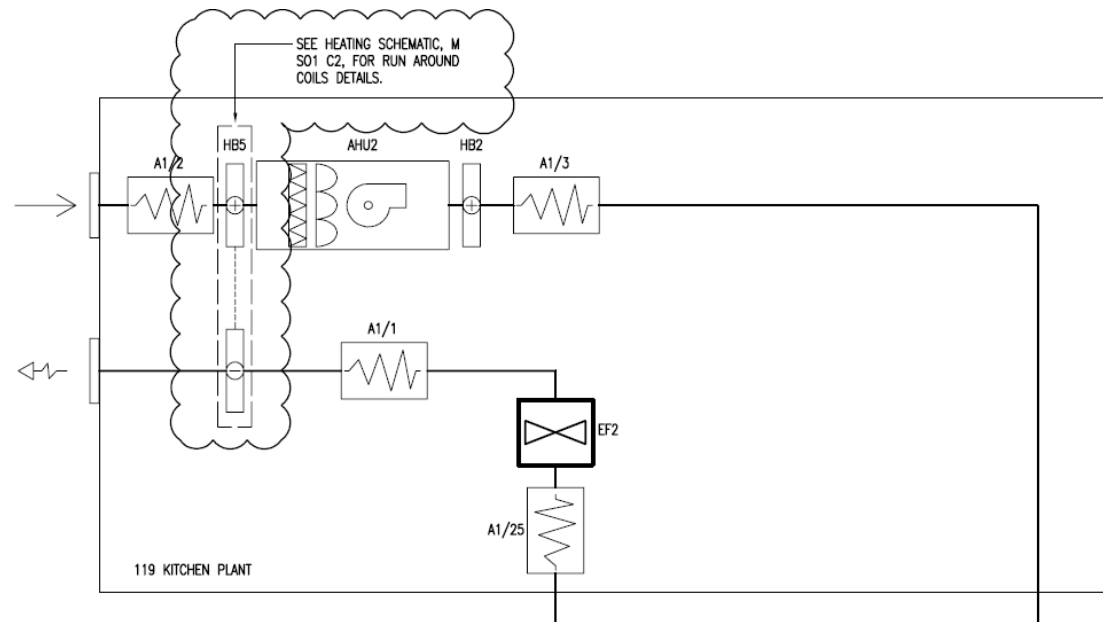


These are averaged over whole week (24x7 hours).

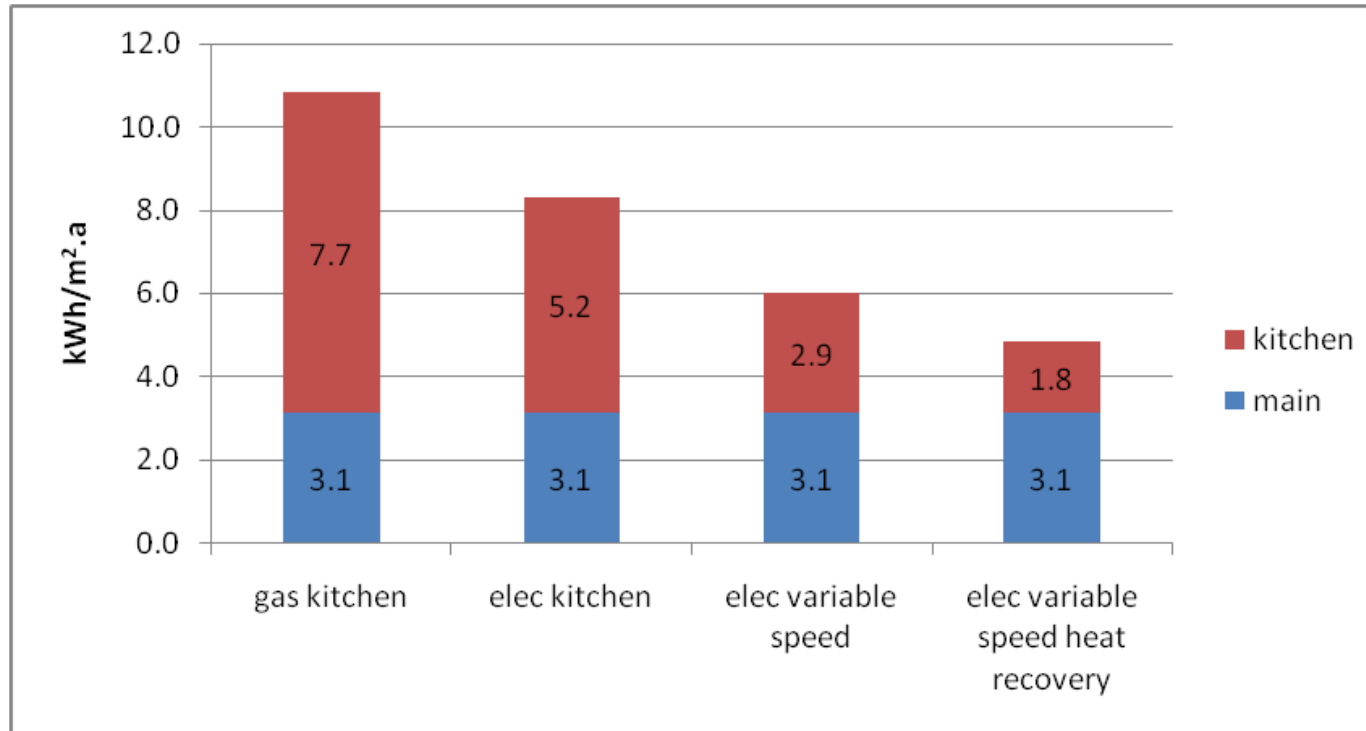
The main school uses 80% heat recovery

Heat recovery

- Run around coil – air-glycol heat exchangers in extract and supply with pumped fluid loop
- May be up to 50% efficient
- Robust



Energy impact in PHPP



With the 40% efficient heat recovery the impact of kitchen vent on the PHPP total was bearable

Can we do without fresh air heater?

- At start up: no heat gain from cooking
- So heater coil installed, and frost coil too
- But if air flow could be reduced to match cooling load we won't need to heat fresh air
- For comfort: minimum supply air temp 12C – we can do this with heat recovery in UK
- This was something to monitor...for next time

Low energy kitchen: how it looks

- Induction hob
- Steam combi ovens
- Central extract hood
- Hot serving counter
- Efficient refrigeration
- No fryers or grills



Induction hob



The cooks like it – pan handles are cool to touch!

Lower primary energy than gas hob



And no wasted heat = comfortable cooking

Ovens: energy efficient



Small hood, variable speed



Servery / hot cupboard



Dishwasher: condensate hood no air extract

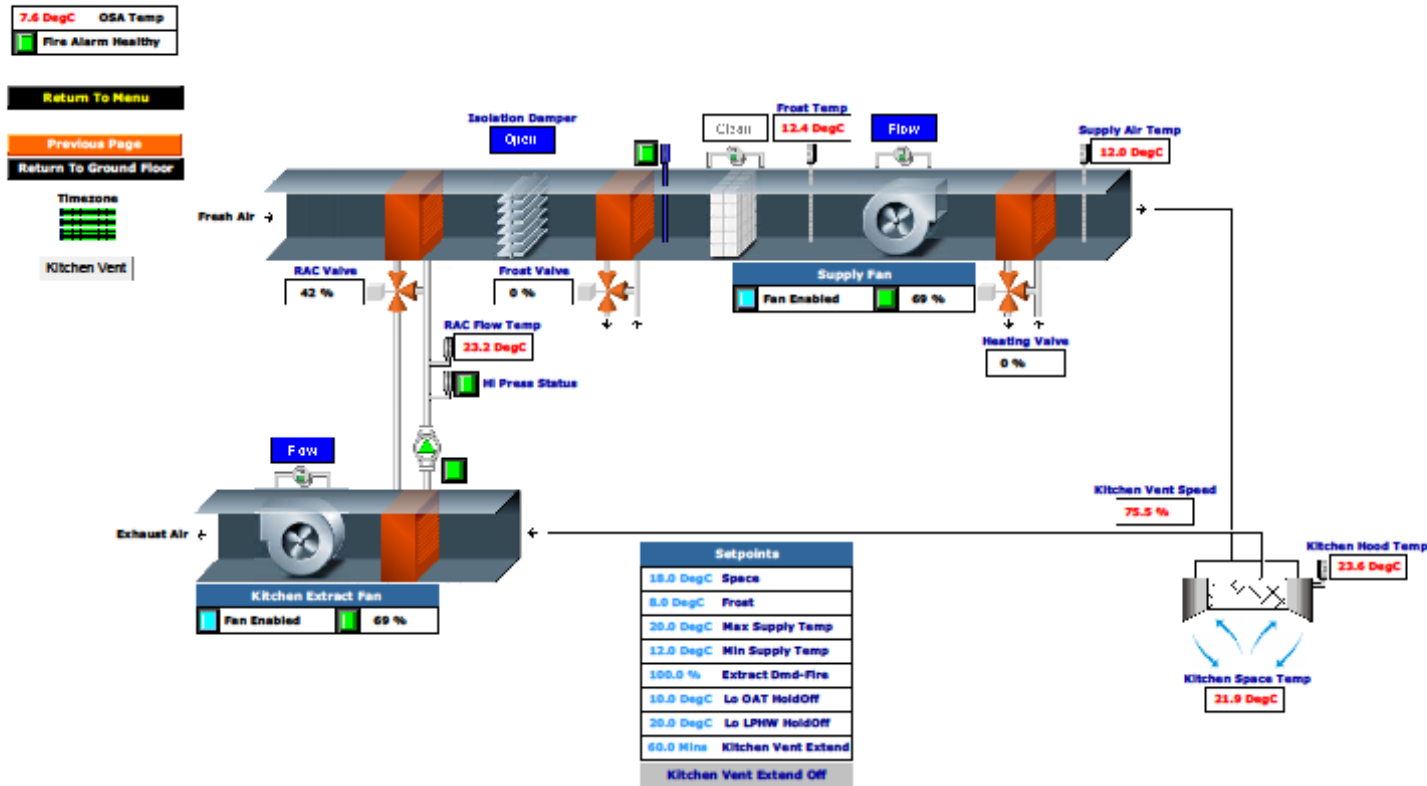


Refrigeration: low power



Ventilation system installed

Oakmeadow Primary School - AHU No3 Kitchen



- Mixing valve to vary the heat recovery
- Controlled on kitchen room temperature

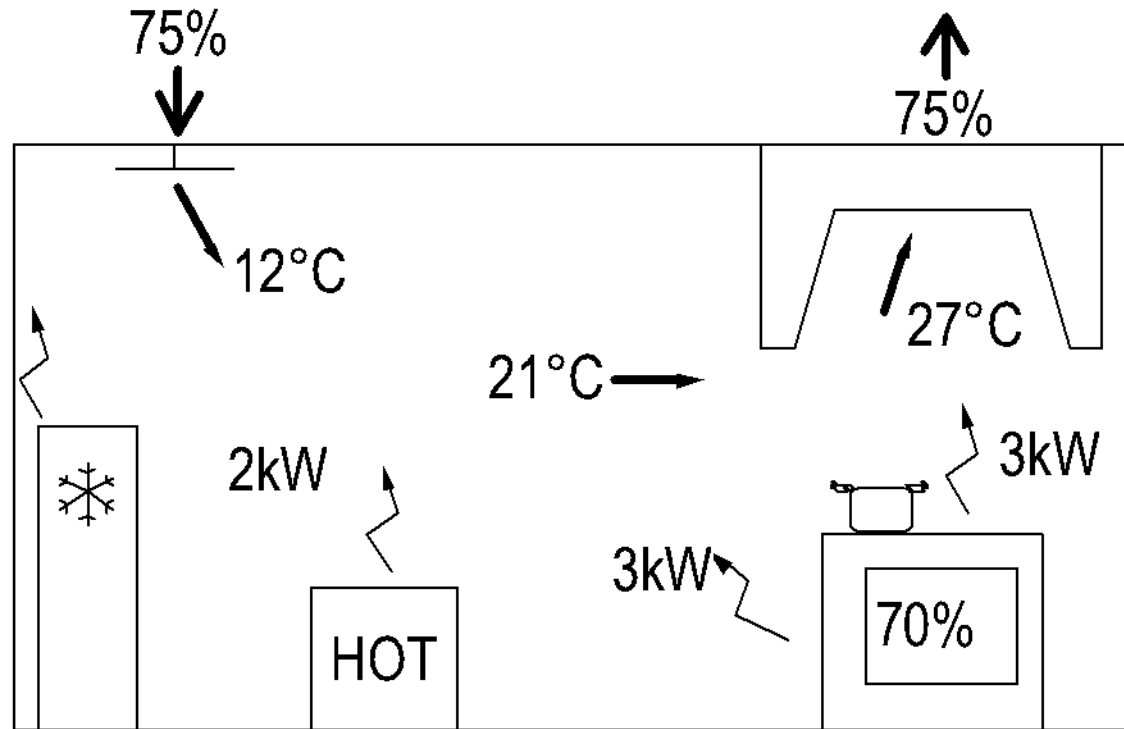
Energy balance

Heat flows analysed with measurements of:

- Supply temperature
- Room temperature
- Extract temperature
- Air flow rate
- Electrical consumption of cooking equipment

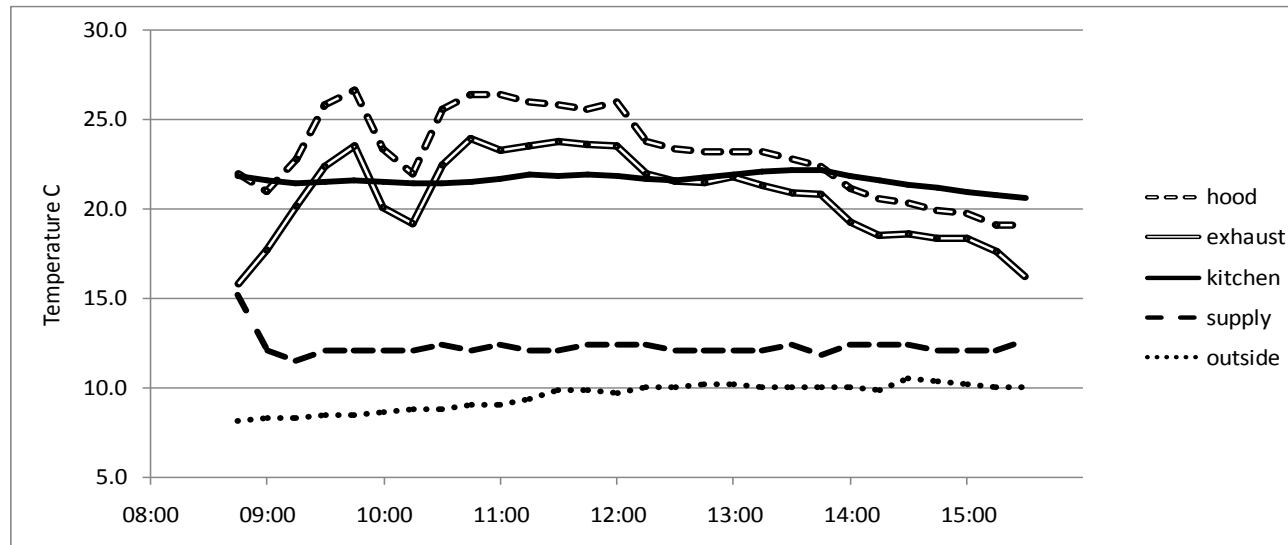
And model of radiant:convective balance for different cooking equipment

Full cooking – high airflow



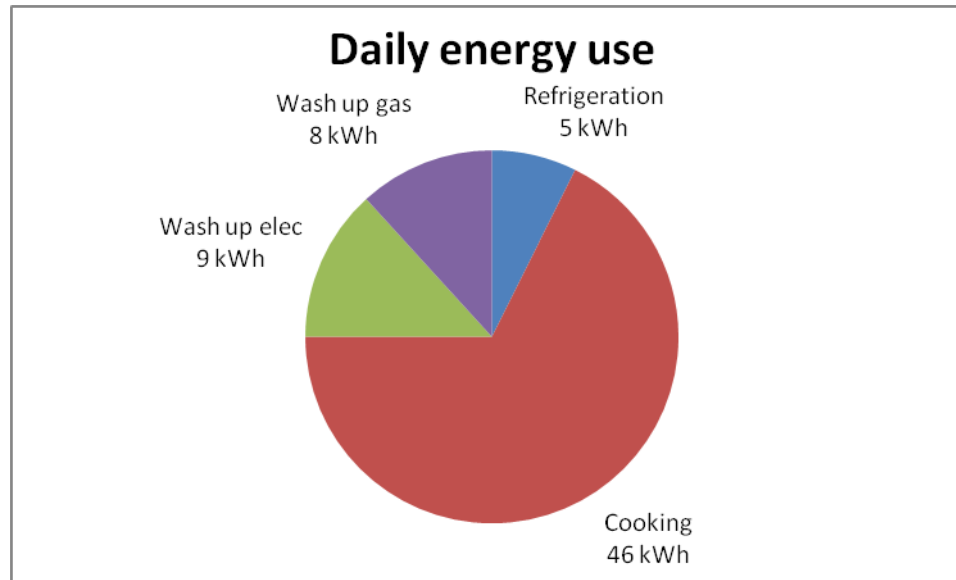
- Additional radiant gains from cooking
- High air flow
- Reduced heat recovery

Monitoring



- Batch cooking starts early
- Hood temperature quickly rises
- Heat recovery modulates to maintain supply temperature as extract rises

Cooking energy use



- 170 meals/day
- Cooking = 0.27 kWh/meal
- Dishwashing = 0.09 kWh/meal
- Data from just one school here – more needed

Key points

- No open gas combustion
- Induction hob – low heat gain & power use
- Efficient = comfortable
- Compact hood – small area for low air flow
- Variable speed air flow
- Heat recovery

Future

- Automate air flow-rate to maintain room temperature (without extra heating)
- Room-sealed gas combustion for ovens – lower Primary Energy, smaller hood
- Better insulated hot cupboard/server

Thank you

Alan Clarke & Nick Grant

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