EEDAL'06

INTERNATIONAL ENERGY EFFICIENCY IN DOMESTIC APPLIANCES & LIGHTING CONFERENCE '06

Estimating the size of the heat replacement effect and its implications for energy saving programmes

John Henderson

Market Transformation Programme, UK

What is the heat replacement effect?

- All electrical equipment produces heat when operating
- If used in an enclosed space that raises the temperature
- If the temperature is thermostatically controlled, the amount of heating or cooling will be adjusted automatically to correct for this

Therefore:

- Some of the energy saved by installing low energy appliances will be ‘replaced’ by extra heat from the heating system or will reduce the amount of cooling required

Why does this matter?

- Ignoring this effect in a heated building will lead to an overestimate of the benefits of efficient appliances
- Ignoring this effect in a cooled building will lead to an underestimate of the benefits of efficient appliances
- In other words, it will lead to wrong estimates of energy, cost and carbon savings in most cases

- Easy to forget when just thinking about the appliance in isolation

Sounds simple! But a few compliactions…

- Not all heat from appliances is replaced
- At times of year when no heating or cooling, no HRE
- Some people turn off their heating at night, so HRE is reduced (not zero because heat stored in building)
- Different appliances used at different times of day and year
- Often involves fuel switching

- Level of effect varies with climate, occupant choices, building characteristics and appliance type!

Sounds too difficult to consider!

- Possible to come up with average factors for a climatic region for a given appliance type
- Then can easily apply the factors to correct the savings

Example

- In the UK, on average, about half of the energy saved by reducing standby power will be replaced by the heating system over a year

  (Cooling still very rare in UK houses so not considered in this example)

Example – more detail

Heat replaced	Energy saved	Cost saved	Carbon saved
48%	31%	87%	68%

- If electric heating used, all factors would be the same
- Different in UK because most houses heated by gas central heating systems which are about 75% efficient
- Even if 100% efficient, cost and carbon factors would be different

How are these factors calculated?

- Initially estimated based on the coincidence between an appliance being on and the need for heating
- Later, detailed simulations of typical UK house used to improve estimate (taking account of heat storage)
- Simulations run with and without the source of gains to see how much of the heat is replaced
- From that we can calculate all the factors required for the appliance modelled

Factors developed so far for typical UK house

	Heat replacement factor	Beneficial saving factor		
		Energy	Cost	Carbon
Domestic				
Lighting	60.0%	14.3%	83.7%	59.8%
Fridges & freezers	46.9%	33.0%	87.3%	68.5%
Cooking (electric)	49.4%	29.4%	86.6%	66.9%
Cooking (gas)	49.4%	50.6%	50.6%	50.6%
Wet (washing machines, etc)	2.3%	96.7%	99.4%	98.5%
Consumer electronics	49.4%	29.4%	86.6%	66.9%
Standby power	48.4%	30.9%	86.9%	67.5%
Added heating (electric)	100.0%	-42.9%	72.9%	32.9%
Added heating (gas)	100.0%	0.0%	0.0%	0.0%
Commercial				
Motors	29.0%	58.6%	92.1%	80.5%
Office equipment	58.0%	17.1%	84.3%	61.1%
Lighting	63.0%	10.0%	82.9%	57.7%
Refrigeration	34.8%	50.3%	90.6%	76.7%
Air-conditioning	0.0%	100.0%	100.0%	100.0%

HRE in a hypothetical scheme

- Scheme to save carbon by stimulating the uptake of energy efficiency measures in homes
- Target : save 1MtC/yr by combination of 4 measures, split equally
- How many of each required to meet target?

	tC/yr	MtC/yr	millions		tC/yr	MtC/yr
	Saving per house	Carbon saving target	Number of installations required	HRE carbon factor	Corrected saving per house	Actual carbon saving
Wall insulation	0.7	0.25	**0.36**	100%	0.7	0.25
Roof insulation	0.5	0.25	**0.50**	100%	0.5	0.25
Low energy lights	0.1	0.25	**2.50**	60%	0.06	0.15
Low energy appliances	0.2	0.25	**1.25**	68%	0.14	0.17
Total		**1.00**				**0.82**

A real scheme where HRE factors used

- In the UK, the main driver of energy efficiency in housing is called the Energy Efficiency Commitment
- It requires energy supply companies to improve the energy efficiency of their customers homes
- They are set a target for energy savings and get credit according to how much energy each measure saves and how many they install
- HRE factors were applied to the appliance savings to improve the predictions of energy, cost and carbon saved

Conclusions

- Ignoring HRE in an energy saving programme could lead to incorrect expectations of benefits
- But it's very easy to take account of HRE once factors have been developed
- Factors developed for typical UK housing, but unlikely to apply anywhere else!
- So you may need to develop factors to suit your own circumstances