

# The importance of hot water system design in the Passivhaus

Alan Clarke, Nick Grant.

[alan@arclarke.co.uk](mailto:alan@arclarke.co.uk)

[nick@elementalsolutions.co.uk](mailto:nick@elementalsolutions.co.uk)

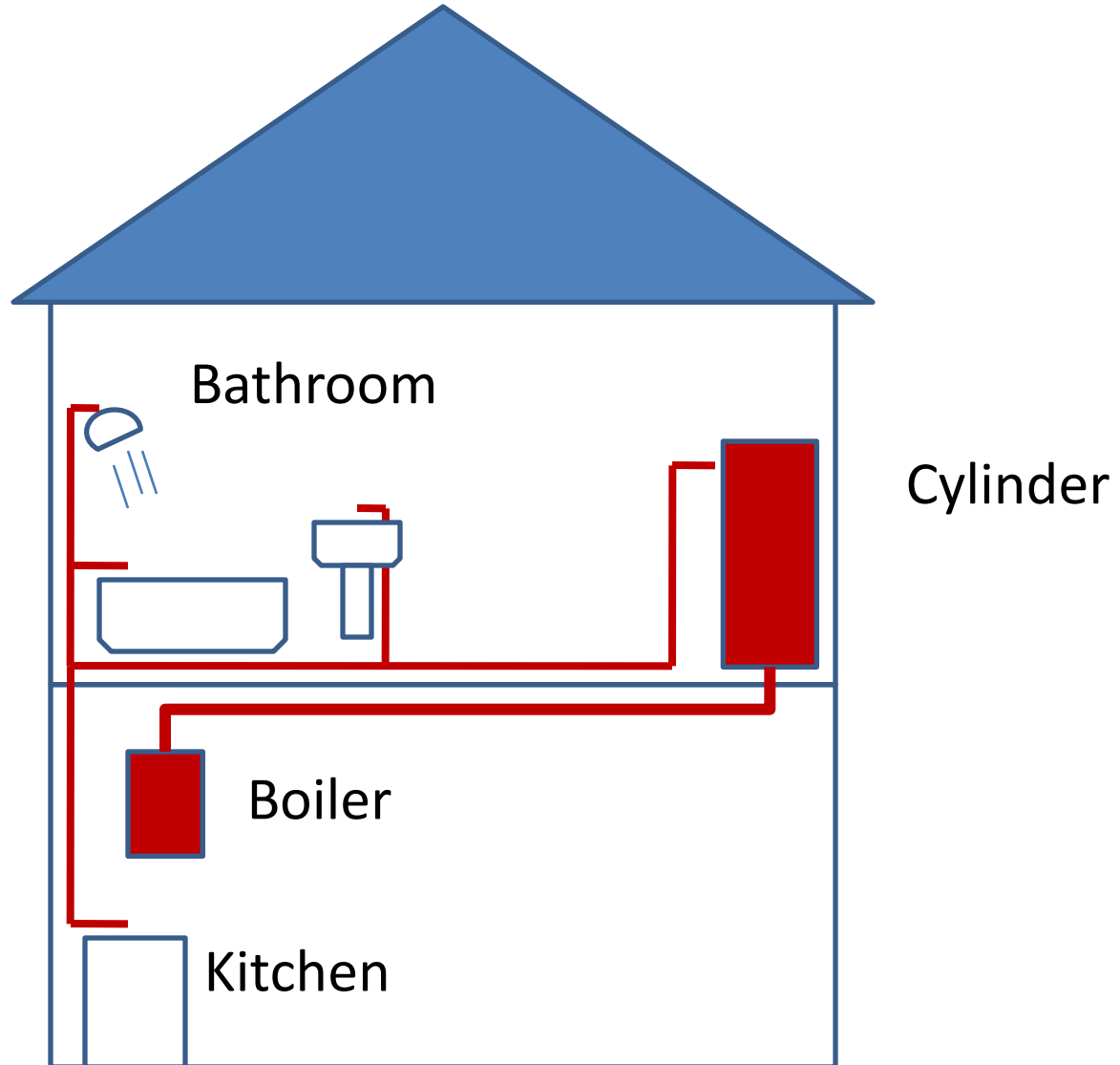
The Authors would like to thank the AECB and Passnet for their assistance towards presenting this paper.

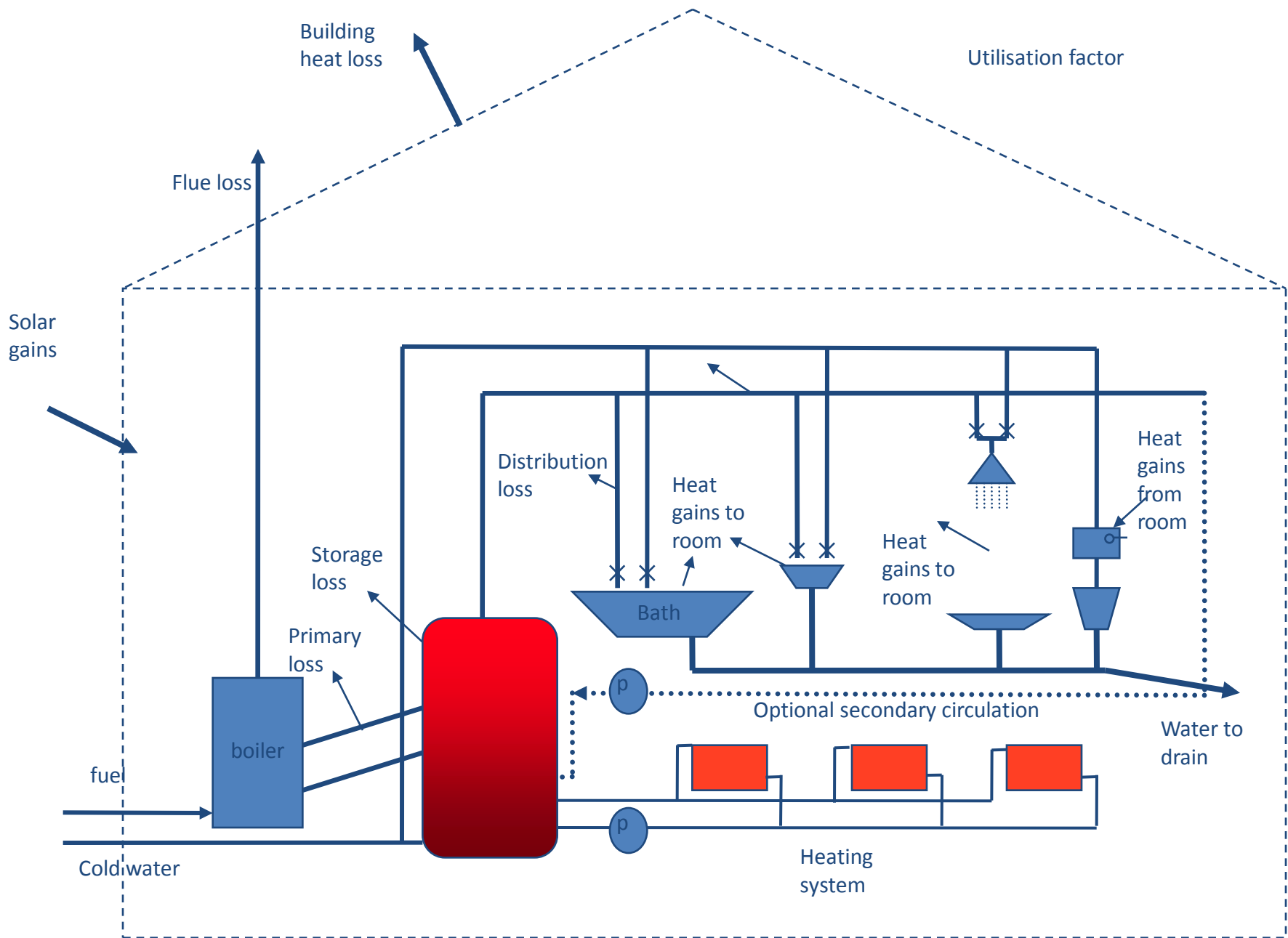


AECB

pass<sup>net</sup>

# UK hot water system



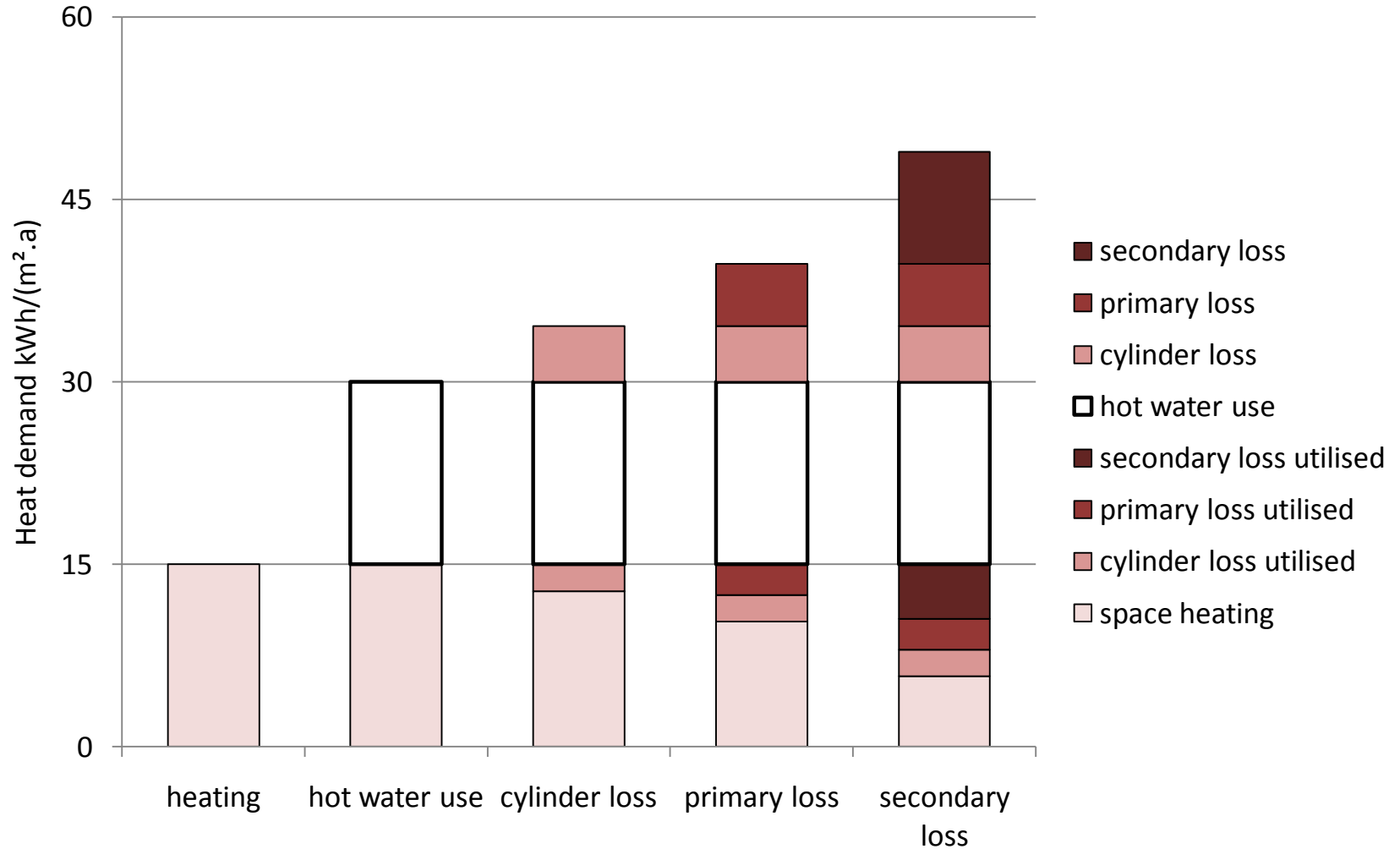


# Example of hot water system

- Hot water use is 25 litres/person/day
- Gas boiler
- Cylinder has 50mm insulation
- 7m from boiler to cylinder
- Secondary circulation
  - Insulated 12mm
  - Pumped 24 hours/day

So not best practice, but could be a Passivhaus

# The losses add up



Hot water losses > fabric losses

(if you're not careful)

# Behaviour

Same 12 litre/minute shower head,

Badden maybe average,

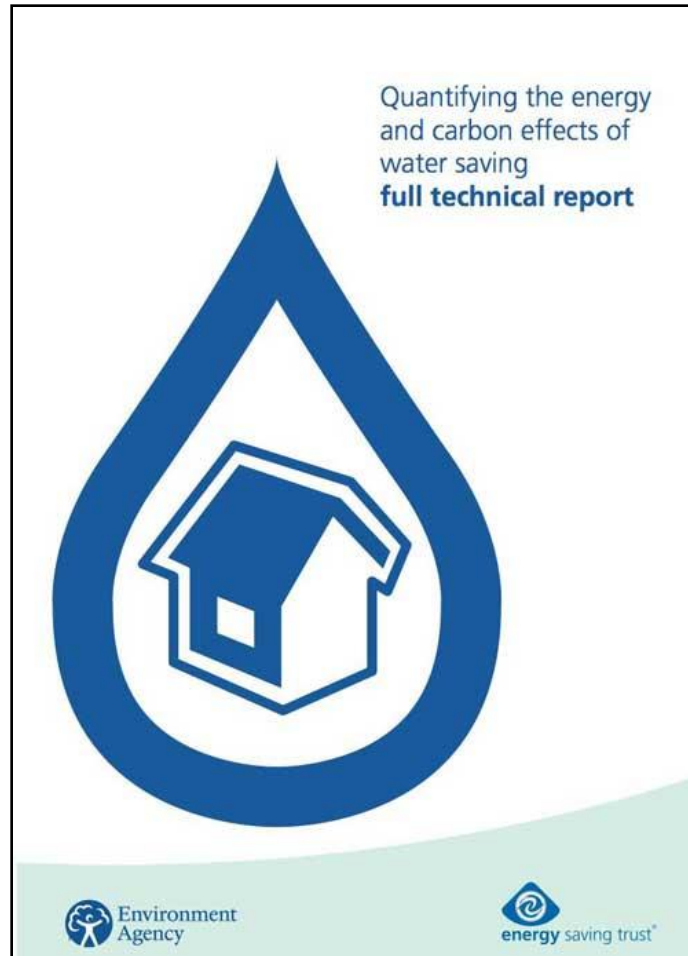
Blodwen doesn't like washing!

Branwen loves the shower

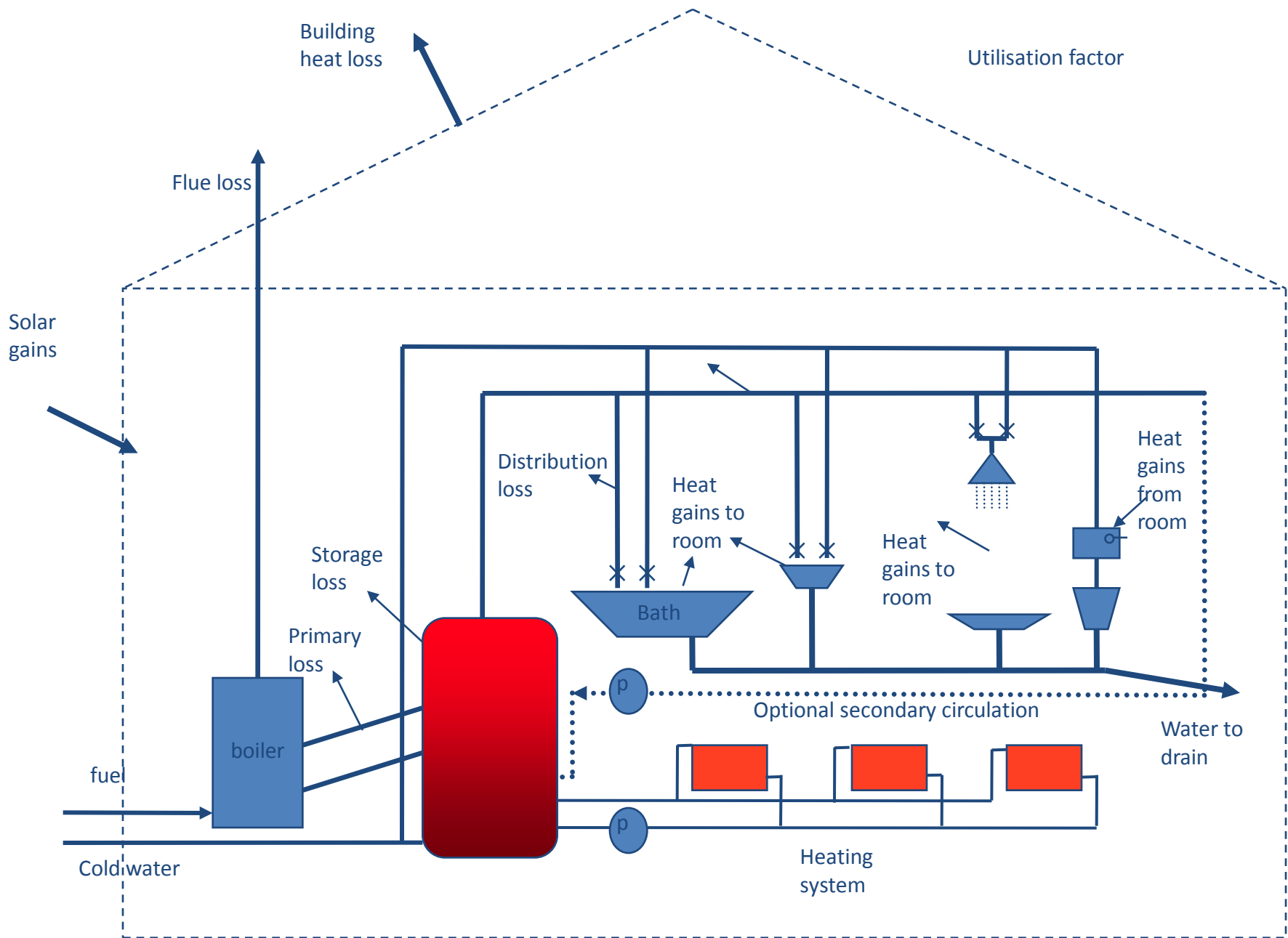
– and uses 20 times more hot water than Blodwen

Person	Flow (l/min)	Time (min)	Uses/ week	m <sup>3</sup> /y	kWh/y
Badden	12	7	7	31	1255
Blodwen	7	4	4	6	239
Branwen	12	15	14	131	5379

# Water energy model







# “micro-component”

- Usage figures for
  - Washing machine & dishwasher
  - WC
  - Basin
  - Bath
  - Shower
  - Kitchen sink
- Usage based on measurements in UK homes

# Energy Saving Trust Study

- Specifically measured hot water
- Average 122 litres/house/day
  - 40 litres/day + 28 litres/person/day
- Hot water delivery temperature 52°C
- Energy use for water used was 30% higher than PHPP assumption

# Principles of model

- Account all the heat flows
- See where the heat ends up
- System losses
  - Cylinder
  - Boiler and primary circuit
  - Pipes from cylinder to taps
- Gains from hot water in bathroom
- Losses to cold water in bathroom

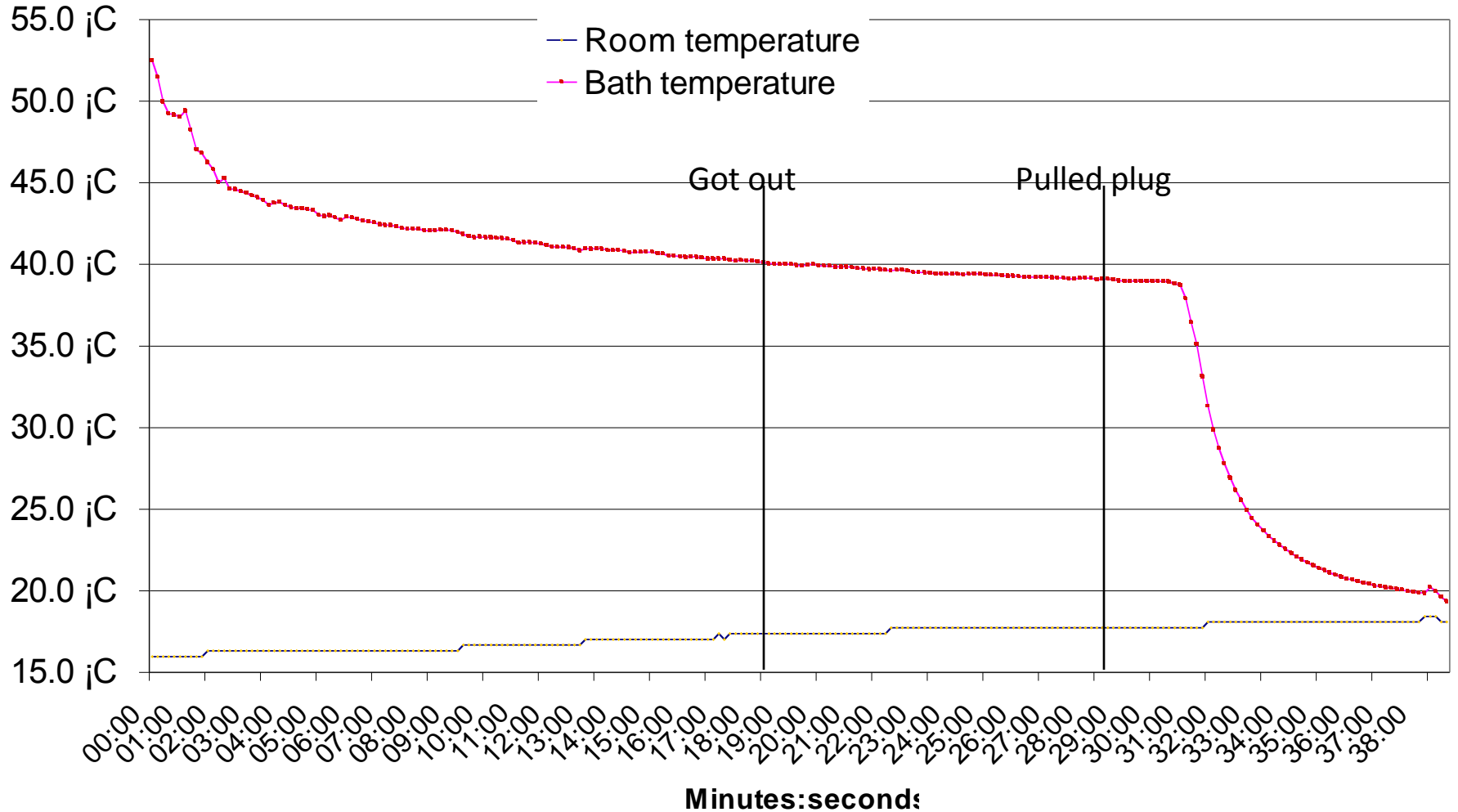
# Based on scientific measurement



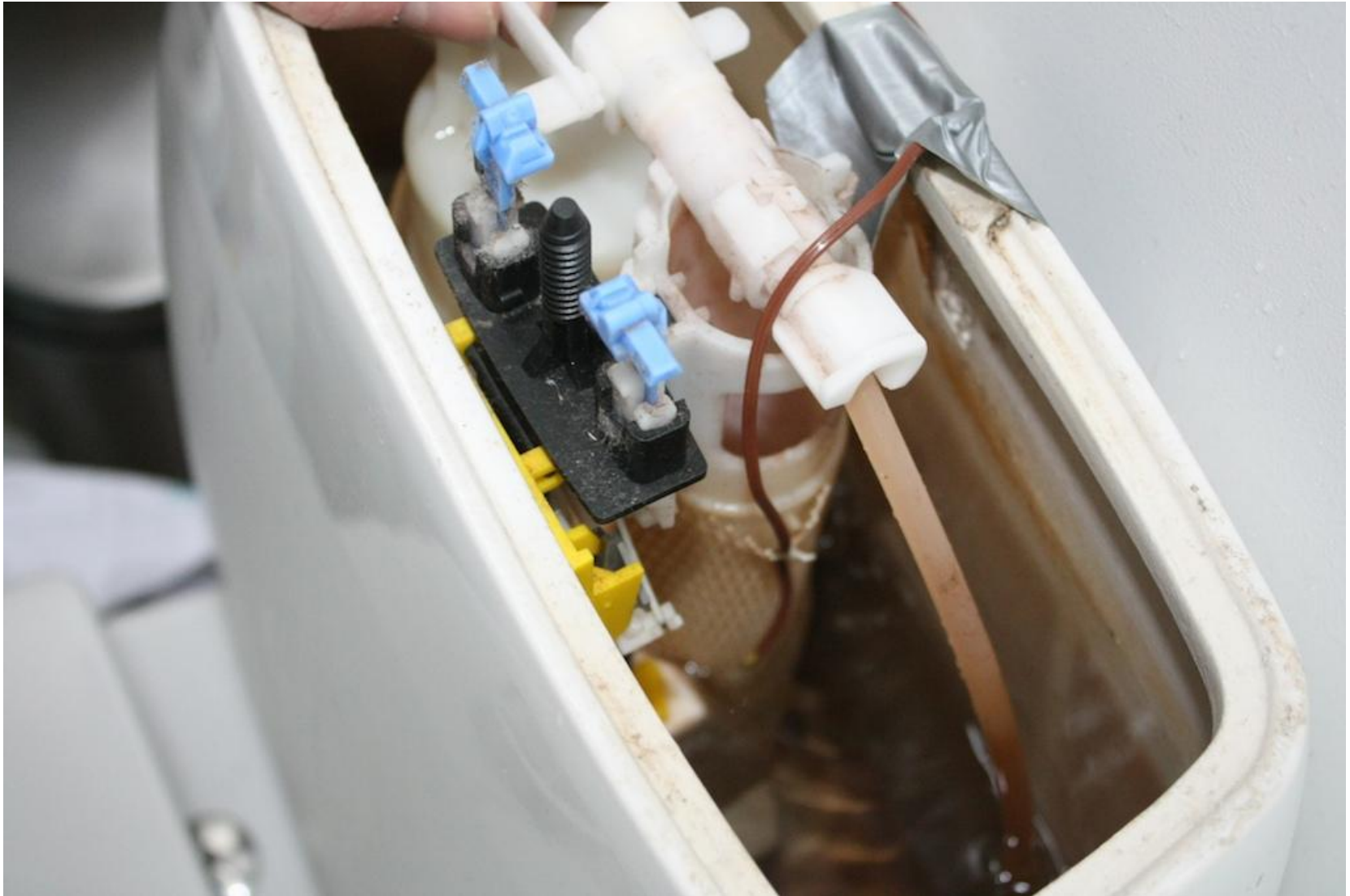
In the bath...

# Thermal gains

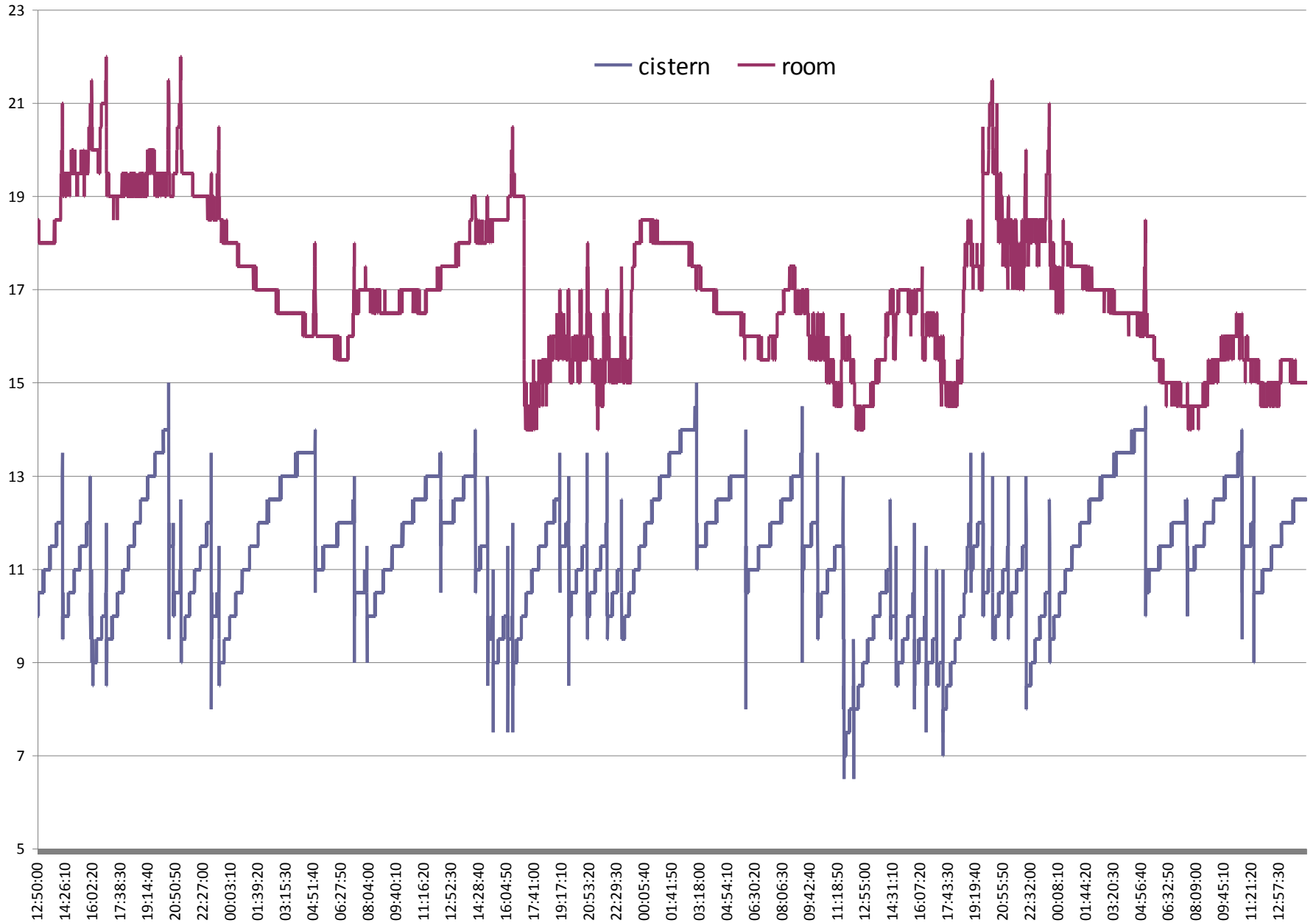
Bath Cooling curve



# And the WC cistern heat loss



WC and room temperatures 10 second sample





# The model: a big spreadsheet

Microsoft Excel - EST water model 1.0

File Edit View Insert Format Tools Data Window Help

Type a question for help

100% Verdana 10

AM16

Water use scenarios can be set up on the water data sheet and selected from the drop down menu. Values can be overridden by entering frequencies and volumes or daily household water use per fitting in the yellow cells below.

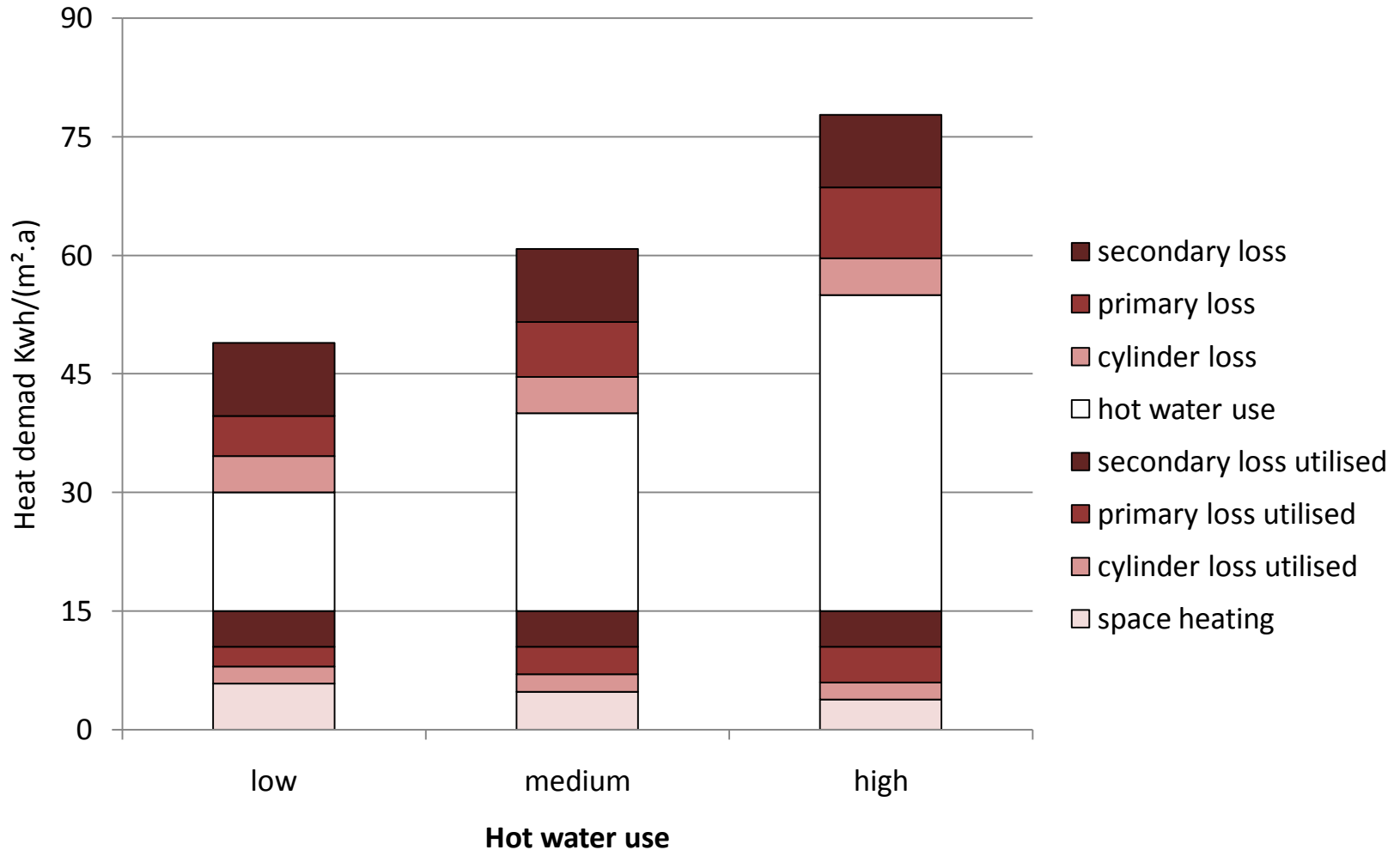
Scenario 1 usual stock	Fuel type	Gas	Cylinder volume	120	insulation	25	mm	Building insulation le		
		0.185 kgCO <sub>2</sub> /kWh								
	Combi or cylinder	Cylinder	Primary pipework	typical pipelength, good insulation				Utilisation of h		
Mains temperature	13.0		Boiler type	New A-rated	Plumbing type	normal UK				
Hot water temp.	53.0					Floor area metr				
Occupany	2.4	2.4	Boiler efficiency	90%	Pump loop insulation	typical (12mm)				
Mains water carbon	0.75	kgCO <sub>2</sub> /m <sup>3</sup>				Floor area per pers				
Use type		Freq./person	Volume/use	Household total	Water	Hot water	Total	Hot water	Heat	Electric
		user	scenario	user	scenario	user	scenario	user	scenario	user
Washing machine	kWh/use	0.64	0.34	50	40.8	Washing machine	14.9	107	118	
Dishwasher	kWh/use	1.10	0.29	21	14.8	Dishwasher	5.4	157	149	191
WC			4.66	9	105.1	WC	38.4	0	45	279
Basin	cold %	30%	0.00	0	42.0	Basin	15.3	64	74	38
Bath			0.21	70	35.3	Bath	12.9	90	93	42
Kitchen sink	cold %	41%	0.00	0	59.0	Kitchen sink	21.5	122	133	53.0
Outdoor use			0.00	0	5.0	Outdoor use	1.8		1	593
Shower	kw if elec		0.59	26	36.4	Shower	13.3	80	81	38
	duration		0.00		l/d total	338	cylinder loss		89	
	flow rate		0.00		l/d/person	141	deadlegs		58	
							pumped loop		0	
							primary/combi loss		69	
							Totals	124	620	911
										1729
										470

START HERE \ main calculation \ water data \ DHW \ Building data \ boiler \ fuel \ Hot water cooling \ cold water

Draw AutoShapes

Ready NUM

# Losses fairly independent of water use



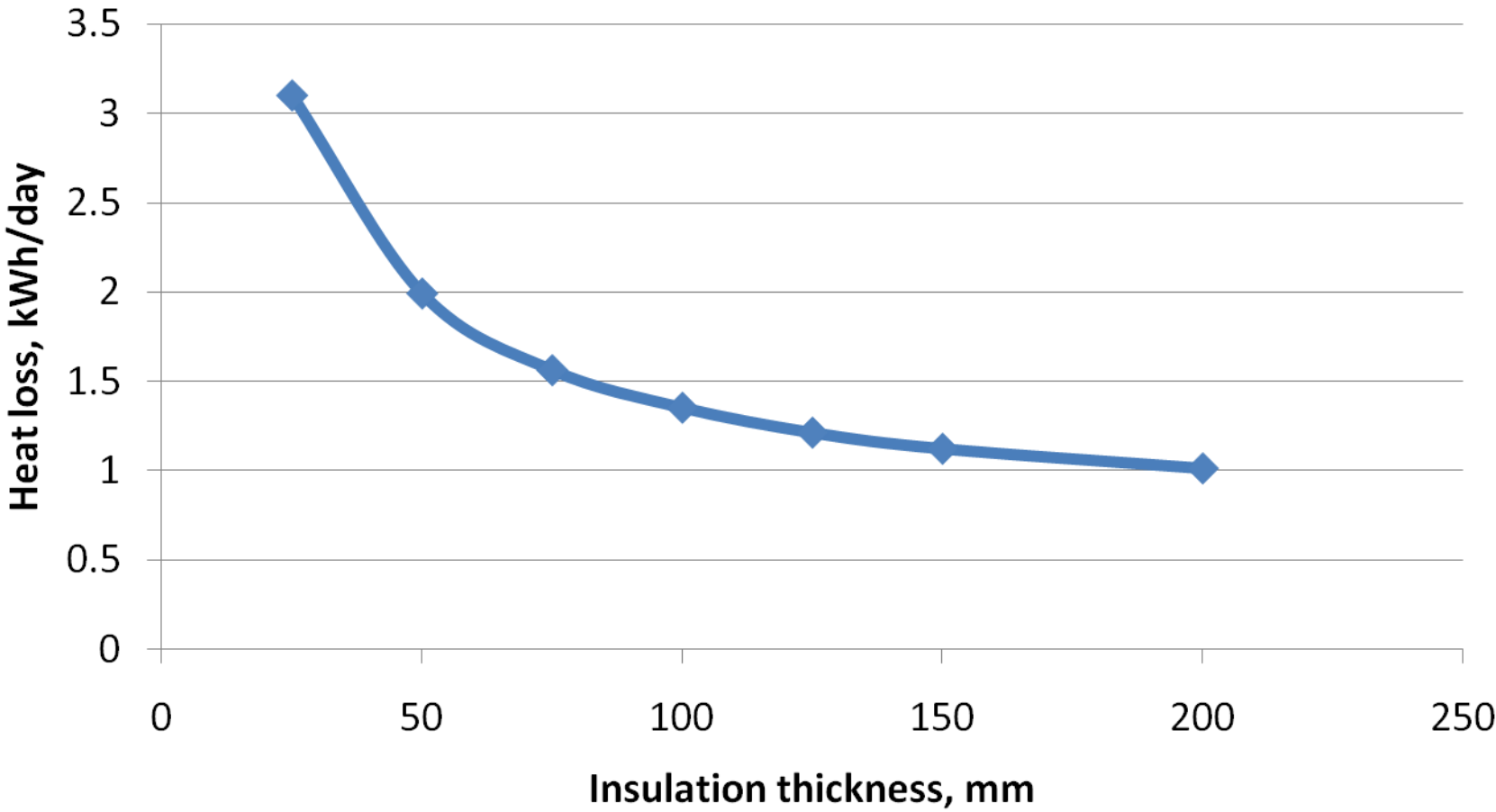
# Reducing losses

- Cylinder insulation
- Primary distribution
- Secondary distribution

# Solving the problems



# How much insulation?

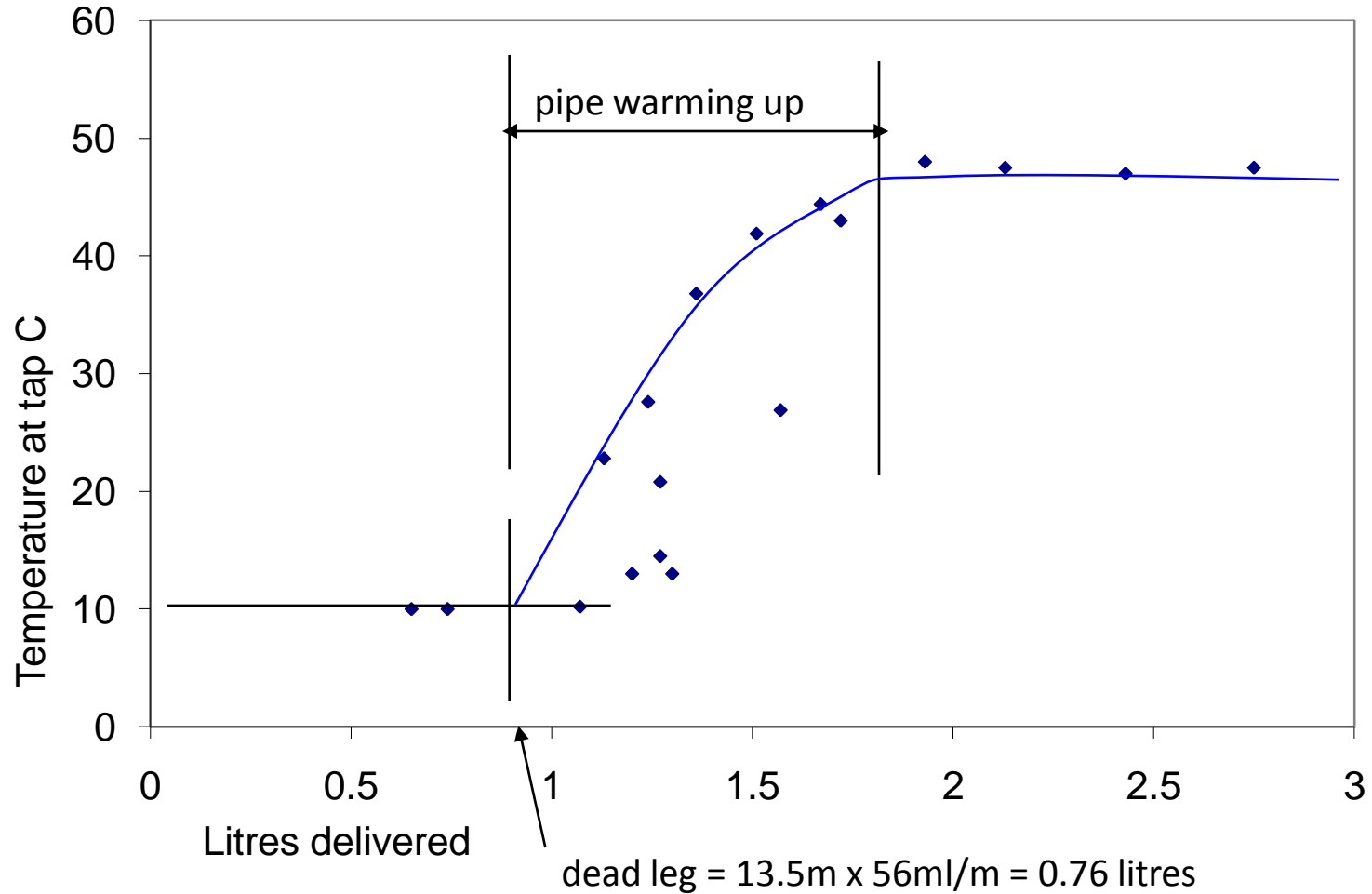


# Circulation loops



# Draw-off deadlegs

Measured results.



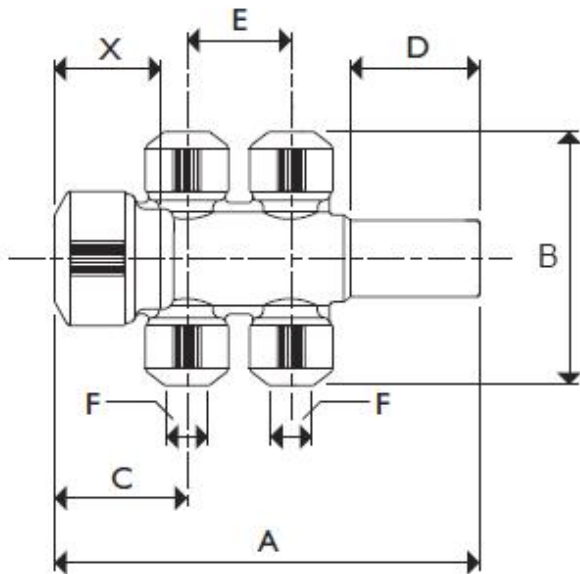
# Deadleg: pipe from cylinder to tap

- Draw-off lag
- Waste of water while waiting for hot
- Hot water left in pipe cools down
- Depends on volume = length x area



# Use simple microbore manifolds and flexible pipework

Four Port Manifold - Closed Spigot

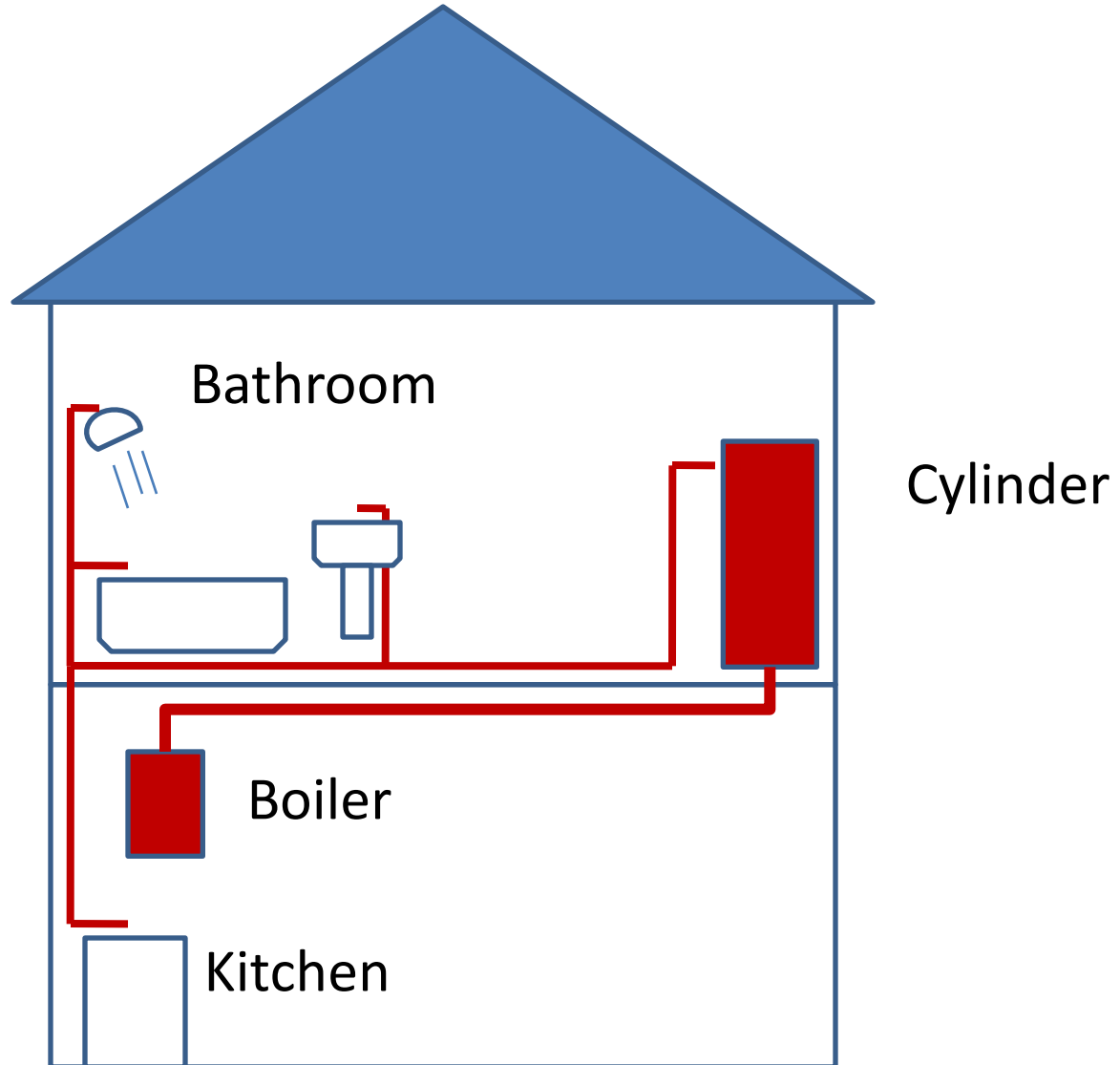


Code	Nominal Dia	A	B	C	D	E	F	X
HX94/22	22	123	74	39	40	30	10	31

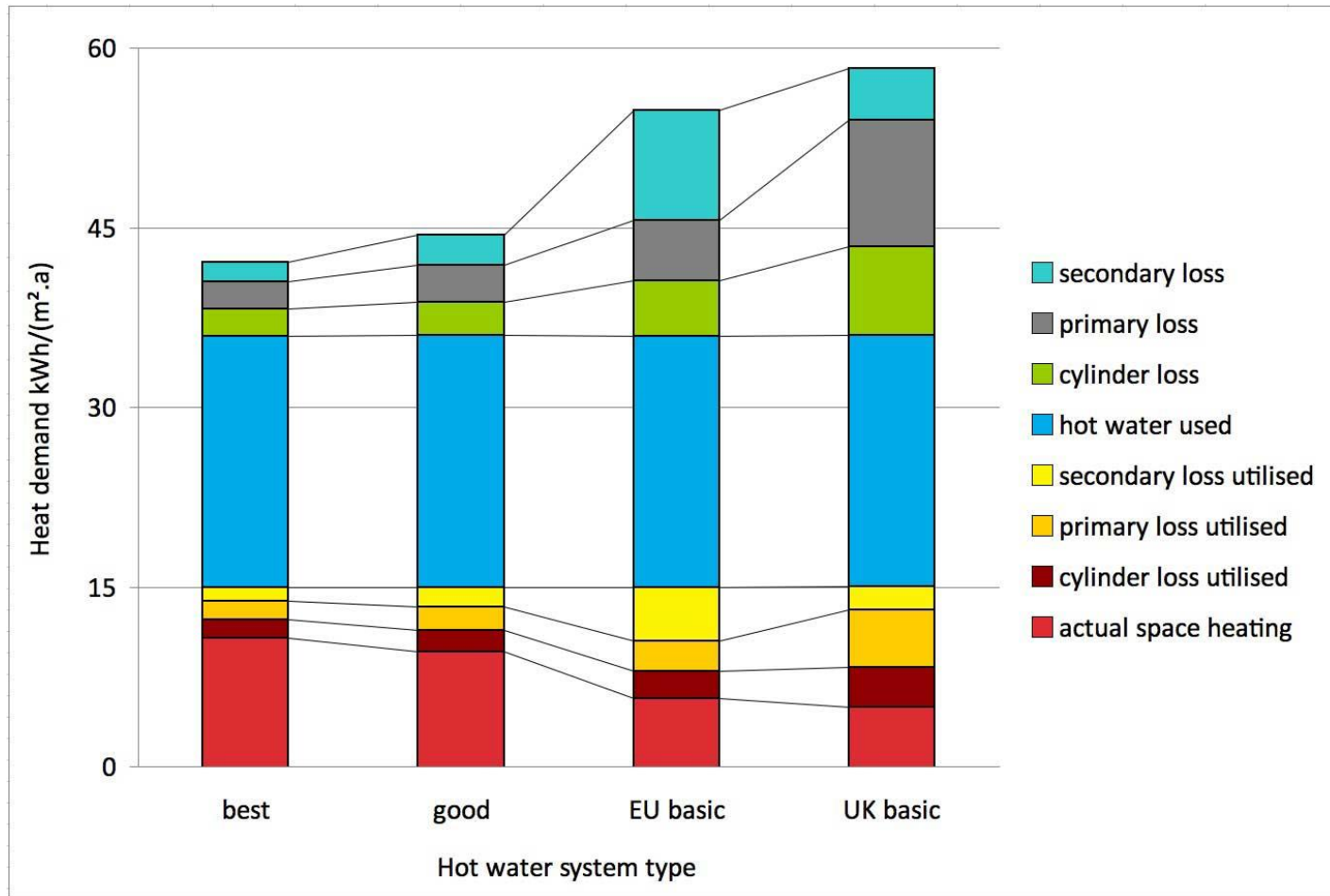
# Solutions

- Layout – less than 6m cylinder to kitchen sink
- Lower flow rates = smaller pipes
- Mains pressure hot water = smaller pipes
- Use manifold and radial piping, PEX or copper
- 10mm usually fine for basins, showers, sinks

# Boiler – cylinder length



# Improved systems



# Overall plan for UK houses

- 100mm+ insulation on cylinder
- Heat trap connections
- Microbore < 6m length
- No need to insulate the distribution
- Primary pipework < 3m
- Primary pipework 25mm insulation

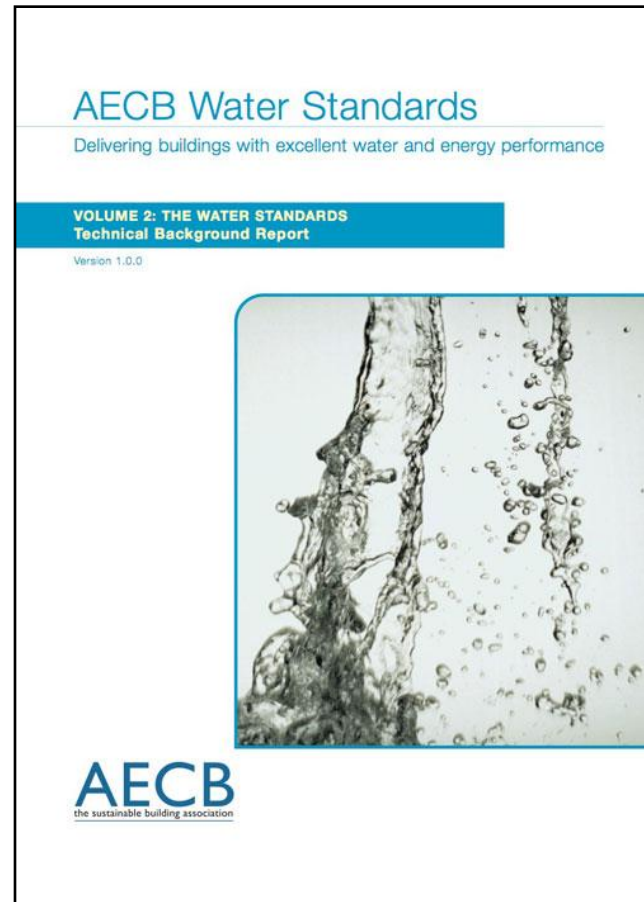
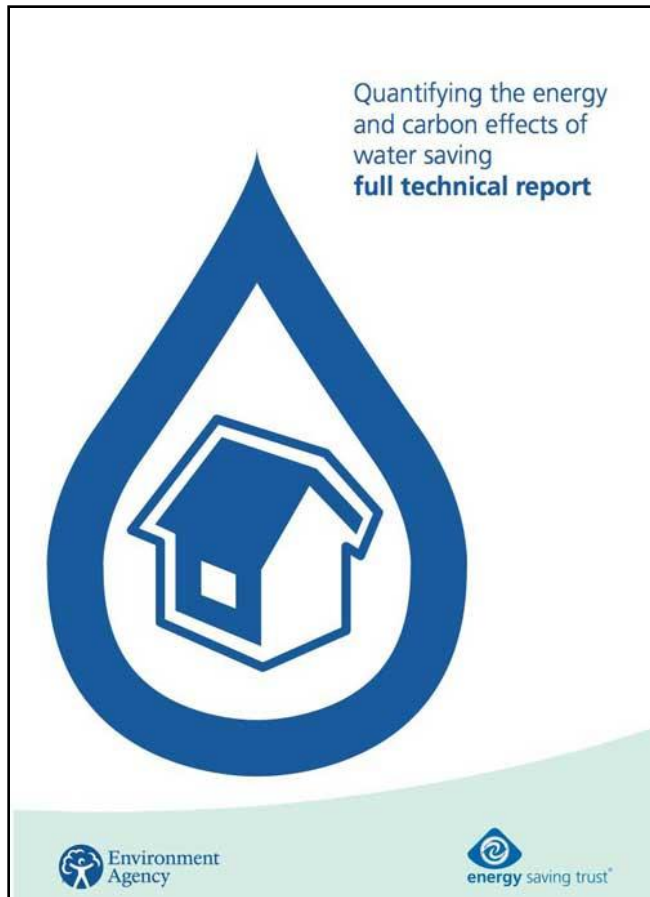
# Summary

- Designers limited in effect on hot water usage
- Designers can control hot water losses
- These losses are important
- We can reduce them with good design

# Conclusions

- For a domestic Passivhaus, DHW use is  $>$  space heating and losses can equal fabric losses
- Losses largely independent of water use but dependent on design.
- Losses can be reduced significantly

# Previous work



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