The importance of hot water system design in the Passivhaus

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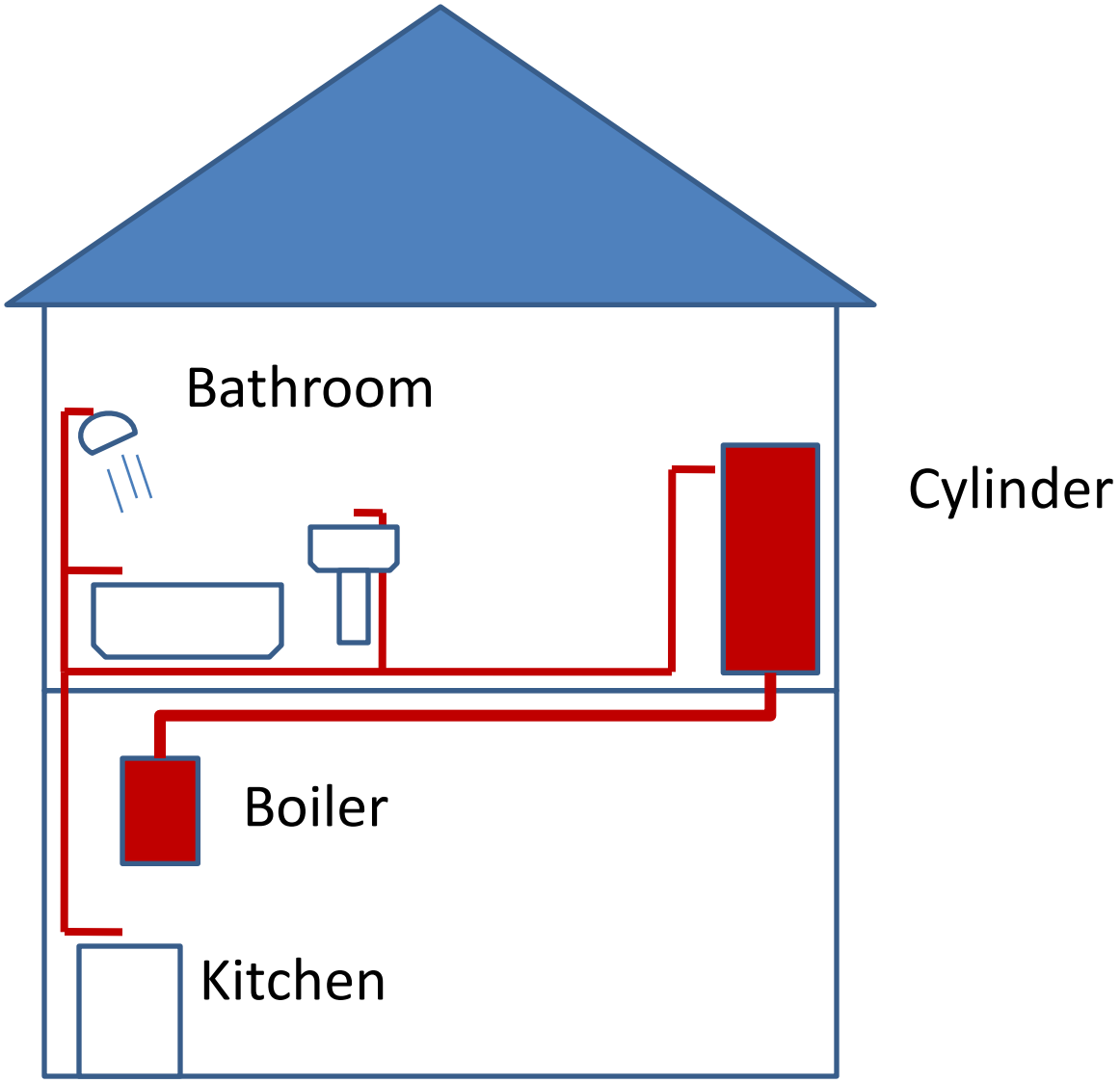
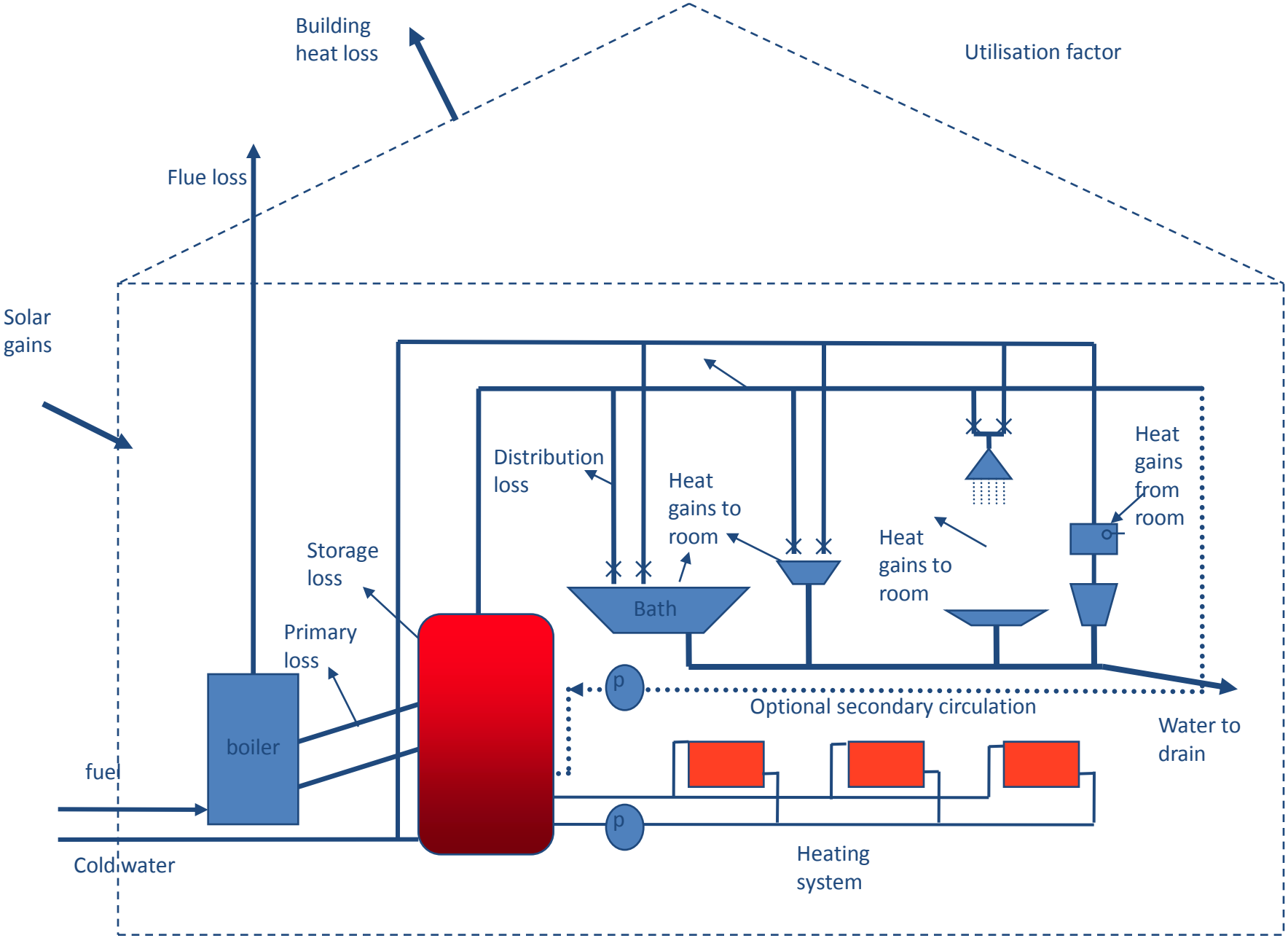
passivhaus trust

AECB

passnet

UK hot water system



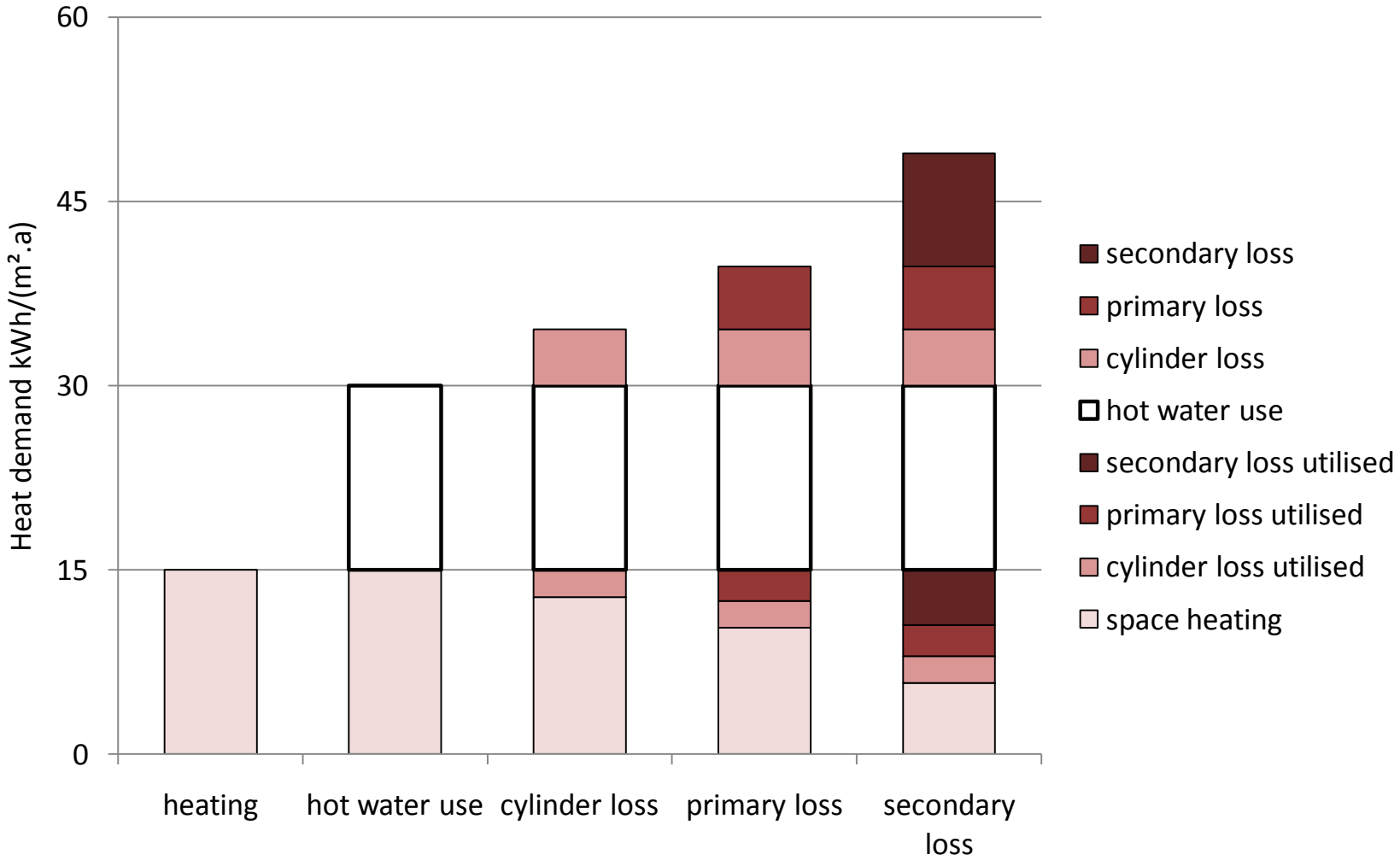

Building
heat loss
Utilisation factor
Flue loss
Solar
gains
Distribution
loss
Heat
gains to
room
Heat
gains
from
room
Heat
gains to
room
Storage
loss
Bath
Primary
loss
boiler
p
Optional secondary circulation
Water to
drain
fuel
p
Cold water
Heating
system

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

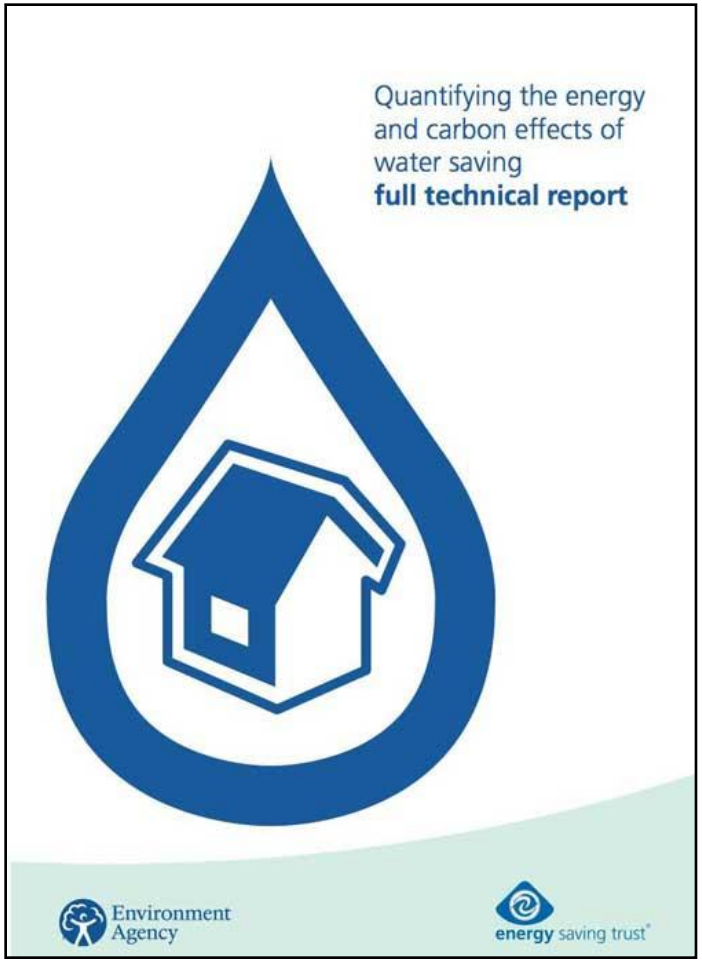
(if you’re not careful)

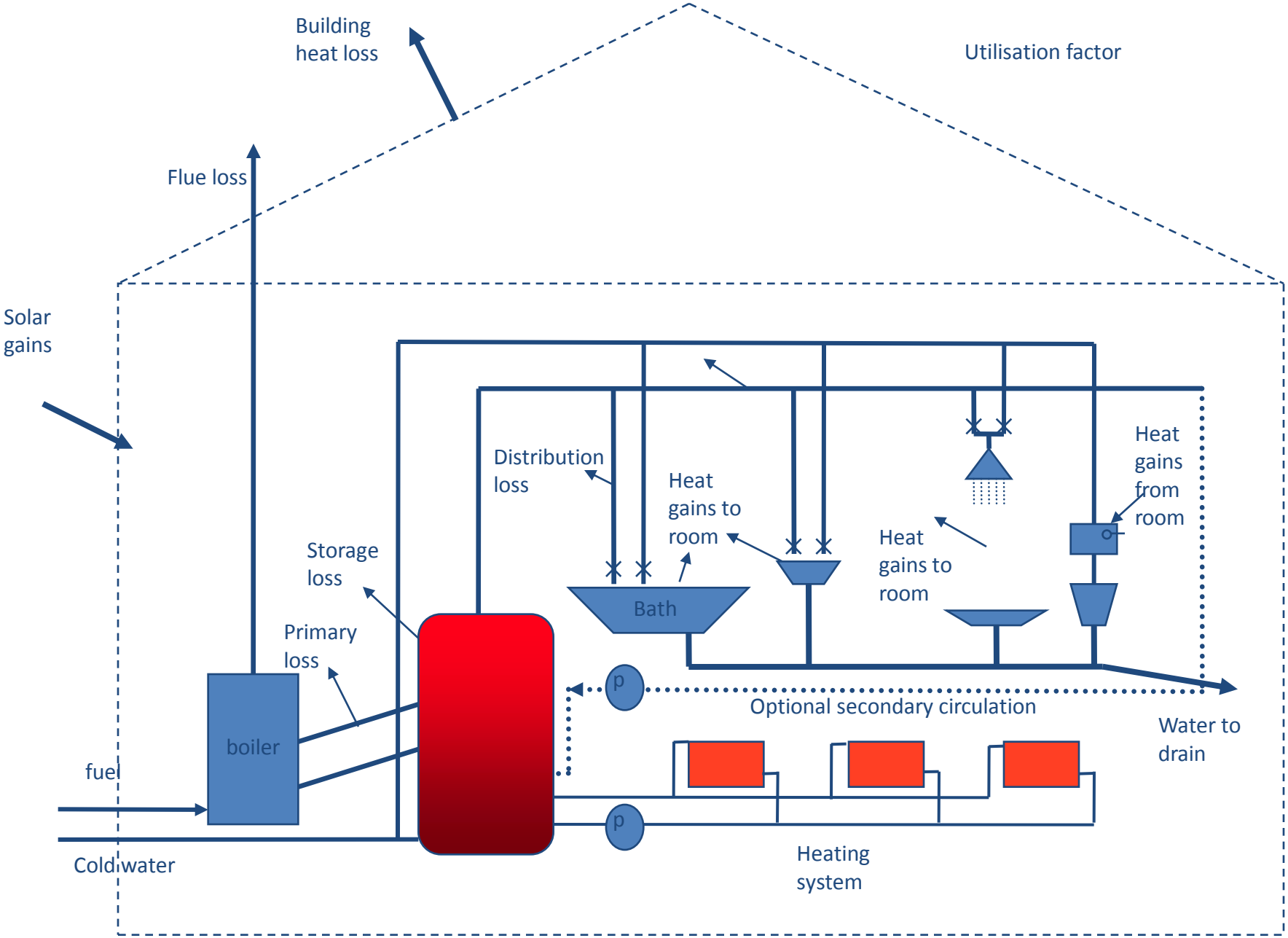
Behaviour

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^3/y	kWh/y
Badden	12	7	7	31	1255
Blodwen	7	4	4	6	239
Branwen	12	15	14	131	5379

Water energy model

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Optional secondary circulation
Water to
drain
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Cold water
Heating
system

“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

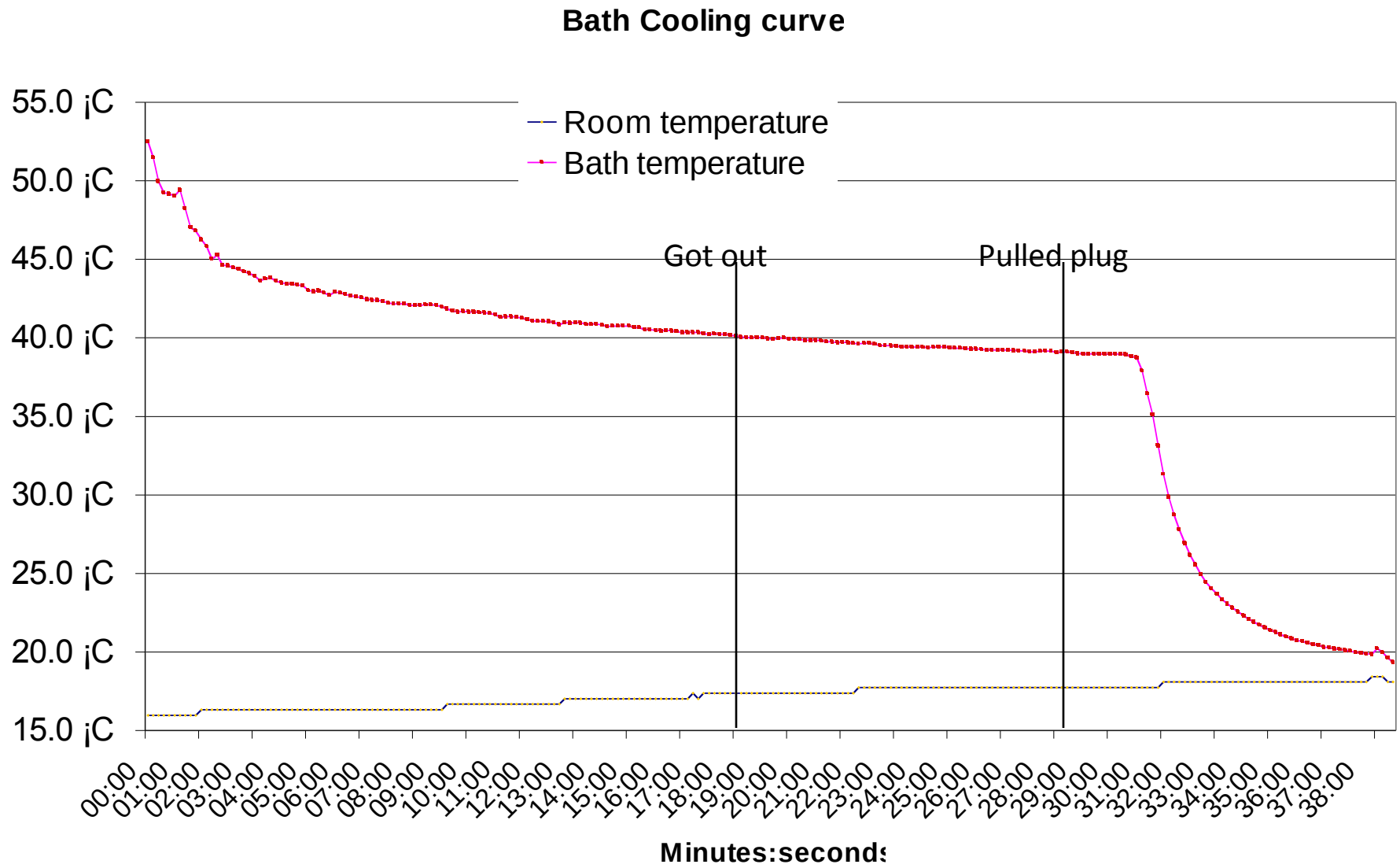
Principles of model

- 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

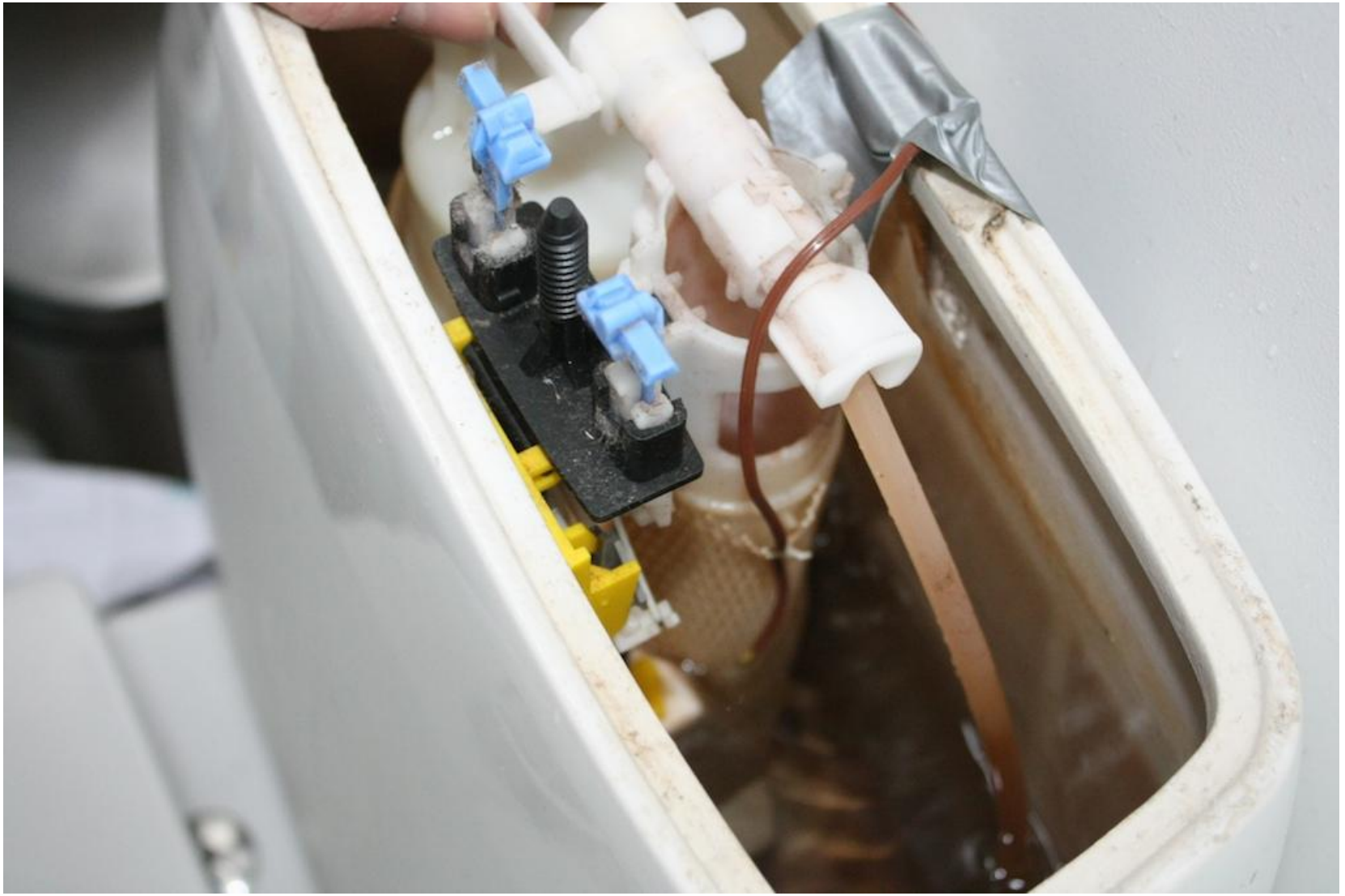
Based on scientific measurement

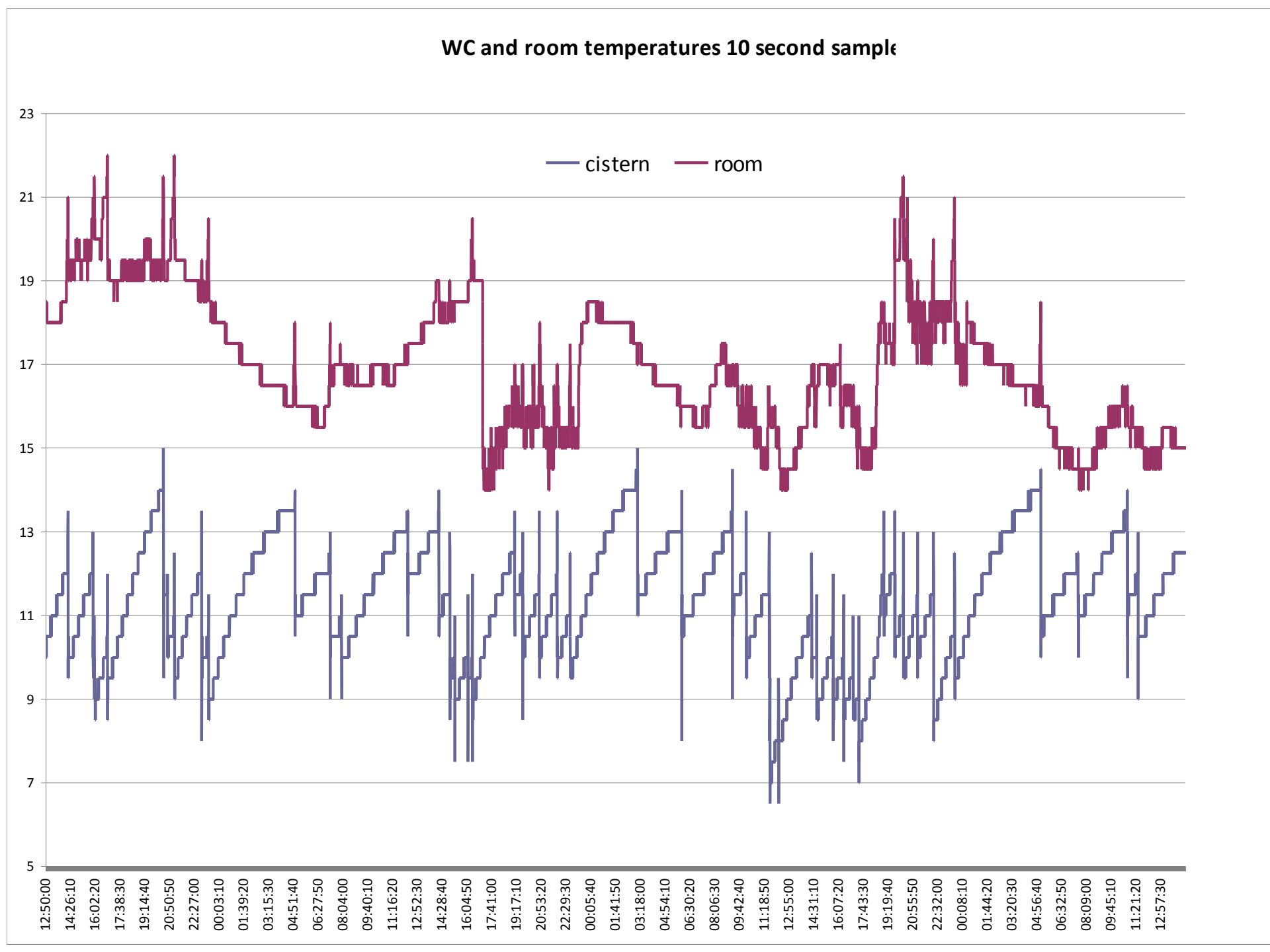
In the bath…

Thermal gains

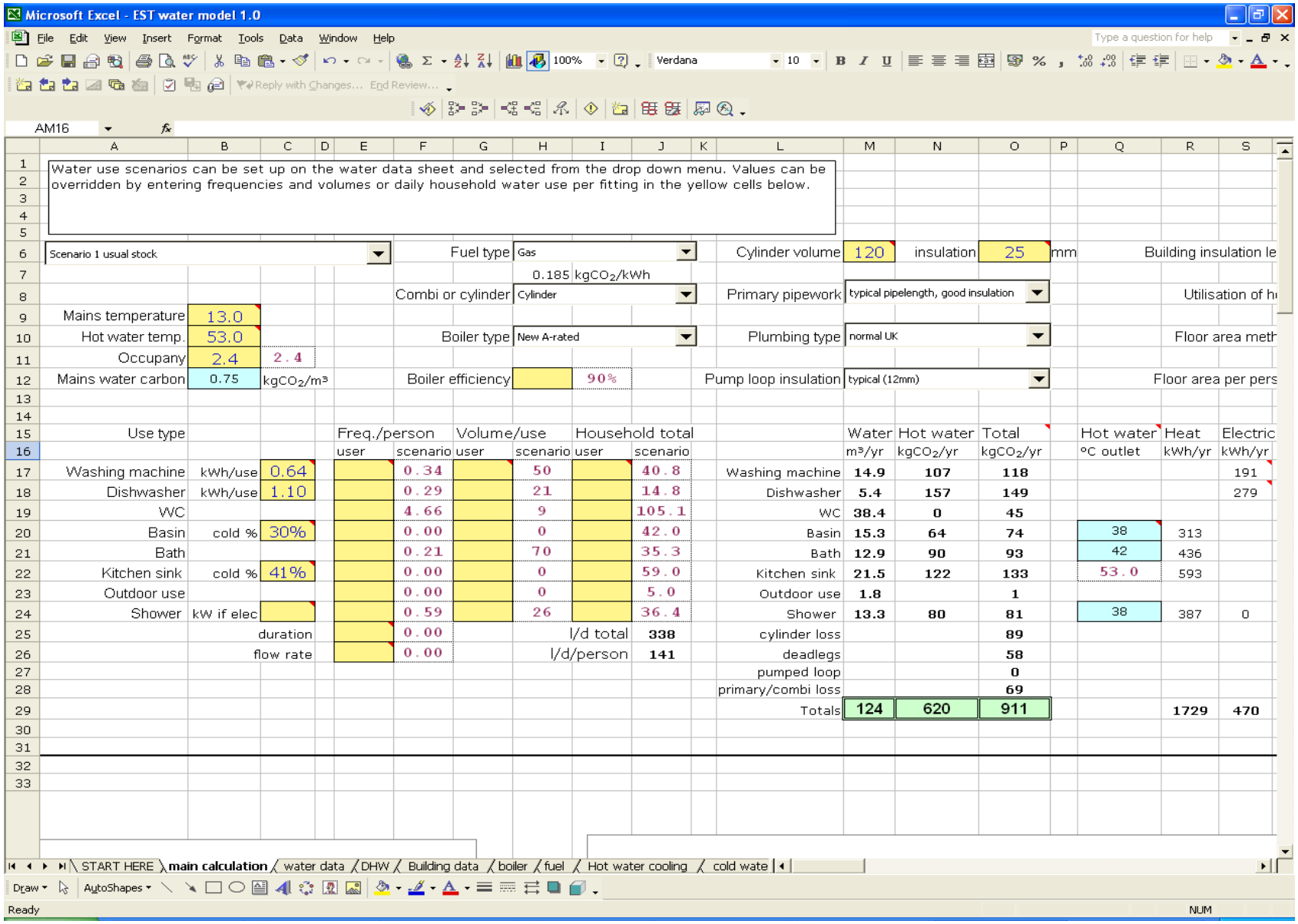


And the WC cistern heat loss

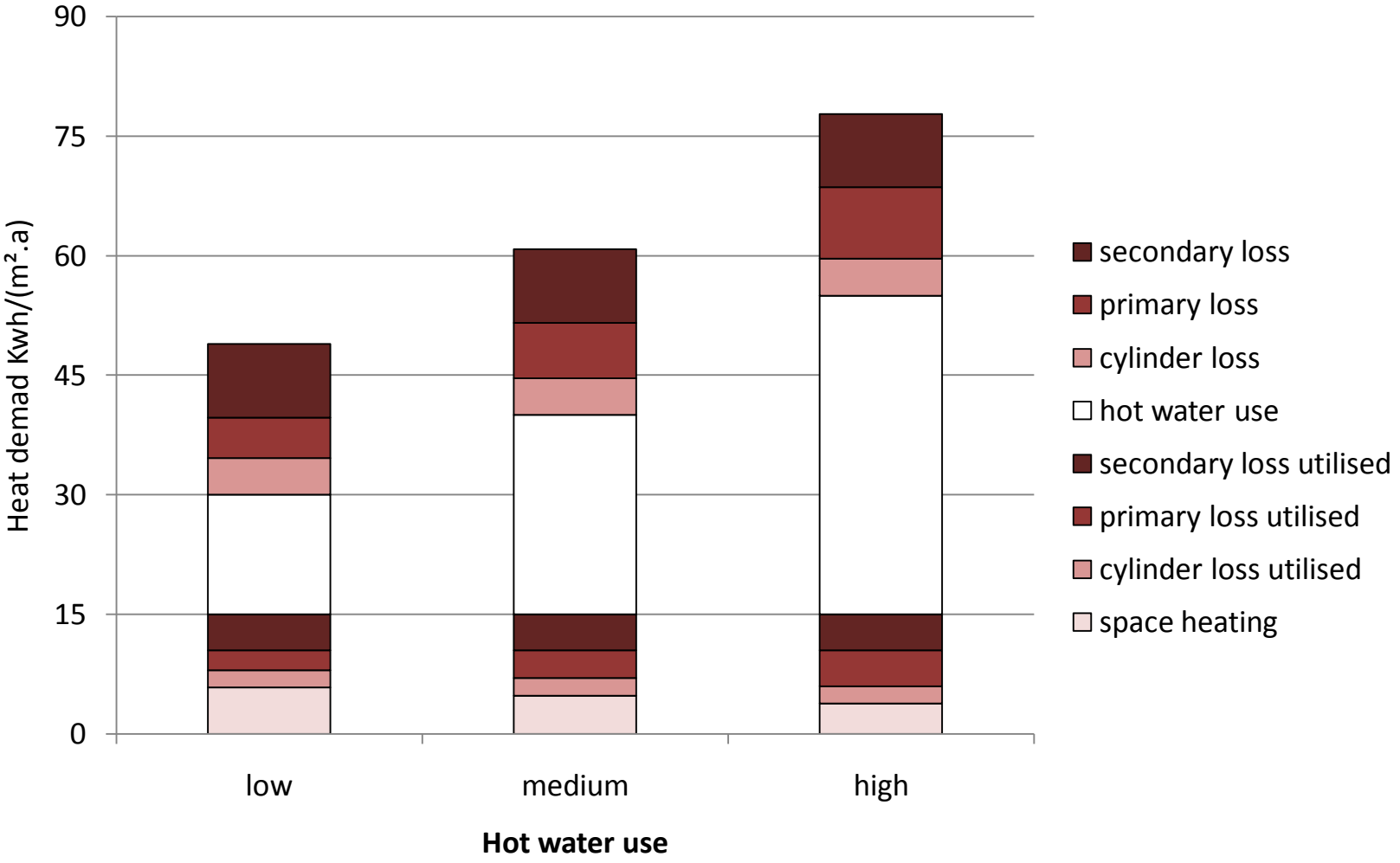



WC and room temperatures 10 second sample
cistern
room
23
21
19
17
15
13
11
9
7
5
12:50:00
14:26:10
16:02:20
17:38:30
19:14:40
20:50:50
22:27:00
00:03:10
01:39:20
03:15:30
04:51:40
06:27:50
08:04:00
09:40:10
11:16:20
12:52:30
14:28:40
16:04:50
17:41:00
19:17:10
20:53:20
22:29:30
00:05:40
01:41:50
03:18:00
04:54:10
06:30:20
08:06:30
09:42:40
11:18:50
12:55:00
14:31:10
16:07:20
17:43:30
19:19:40
20:55:50
22:32:00
00:08:10
01:44:20
03:20:30
04:56:40
06:32:50
08:09:00
09:45:10
11:21:20
12:57:30

The model: a big spreadsheet



Losses fairly independent of water use

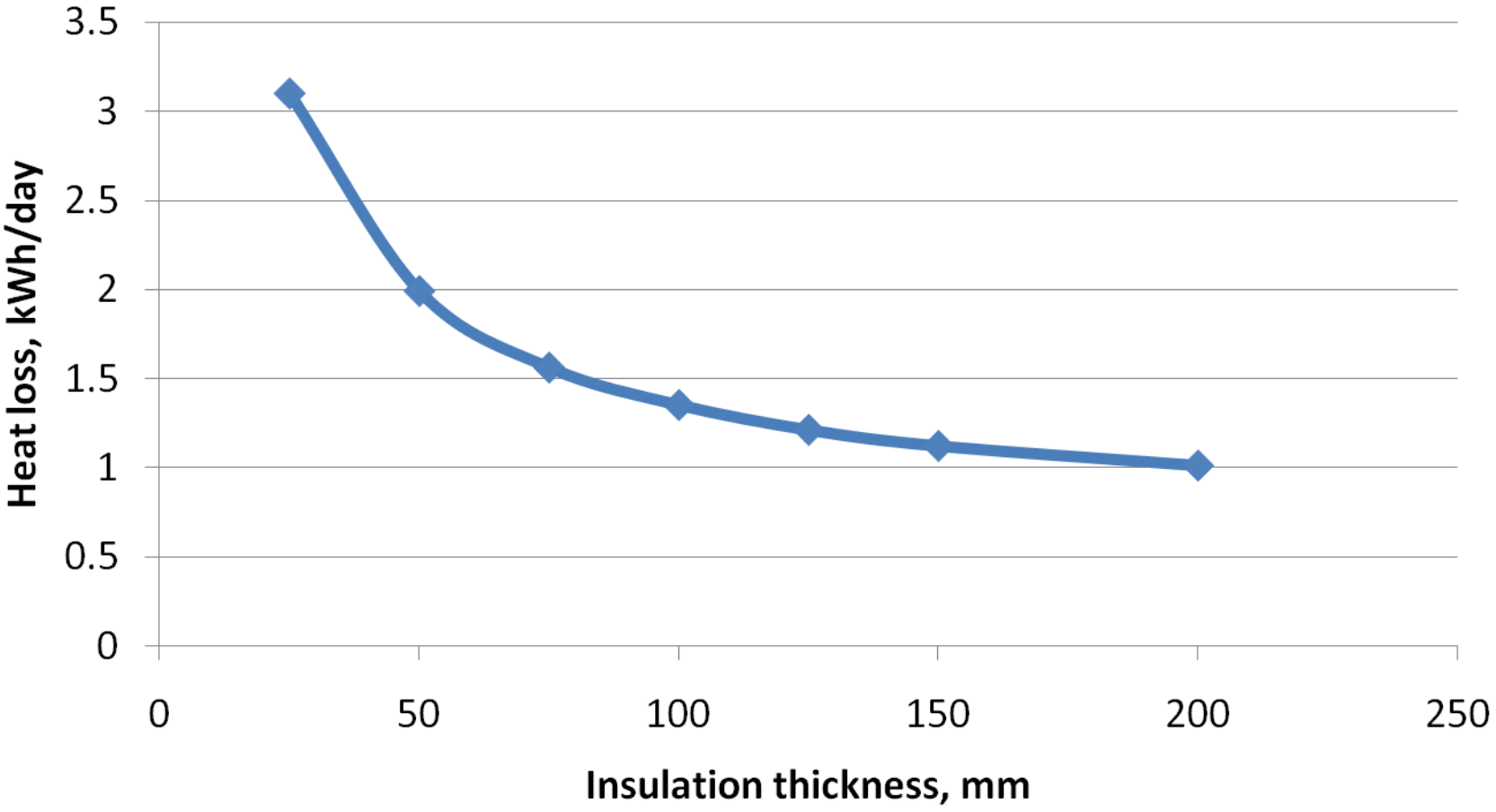


Reducing losses

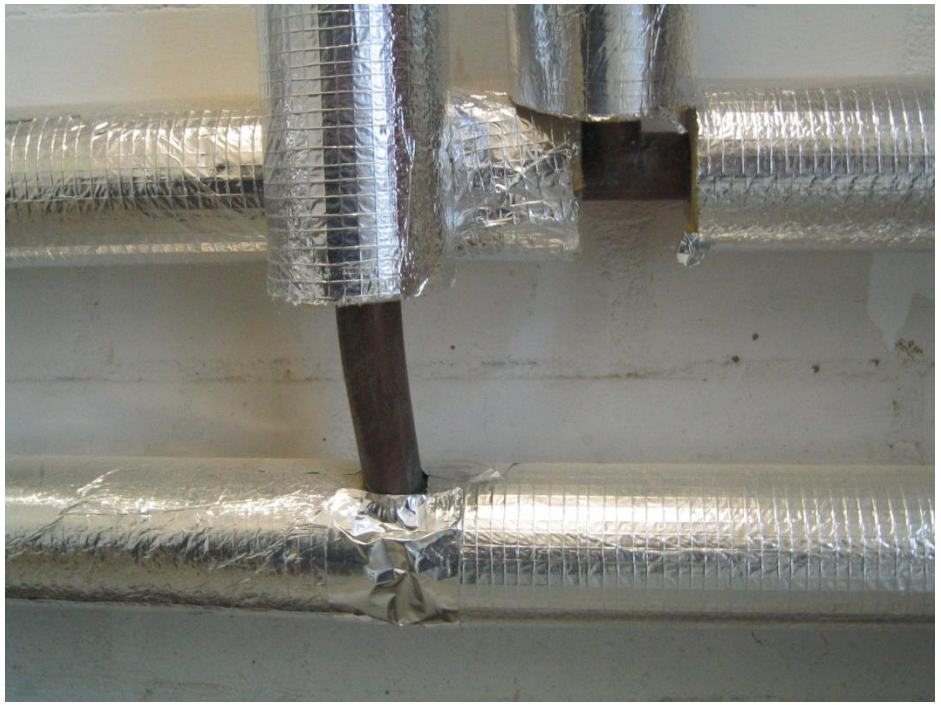
- Cylinder insulation
- Primary distribution
- Secondary distribution

Solving the problems

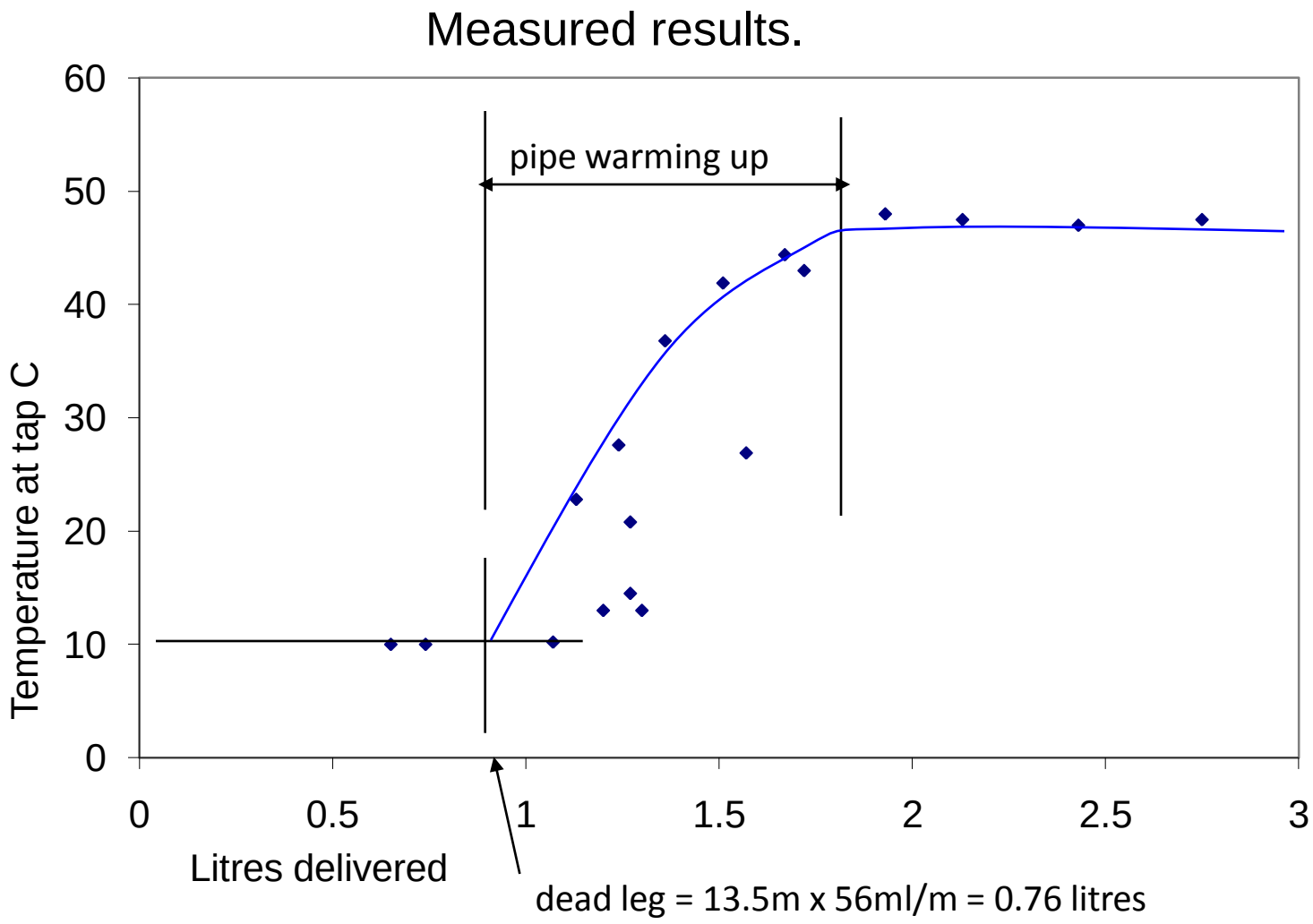
How much insulation?



Circulation loops



Draw-off deadlegs

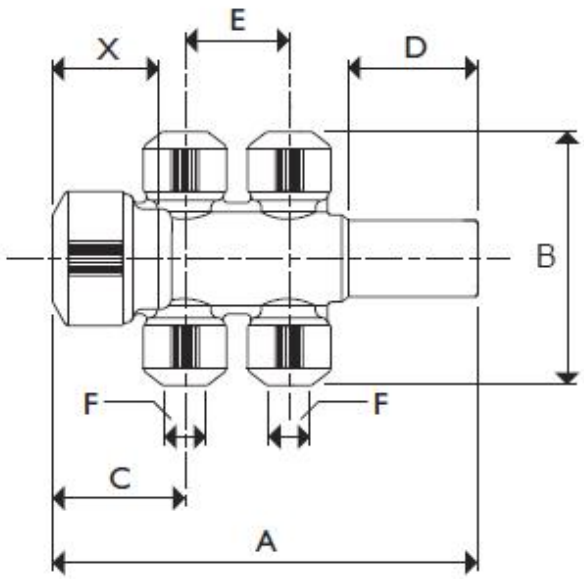


Deadleg: pipe from cylinder to tap

- 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

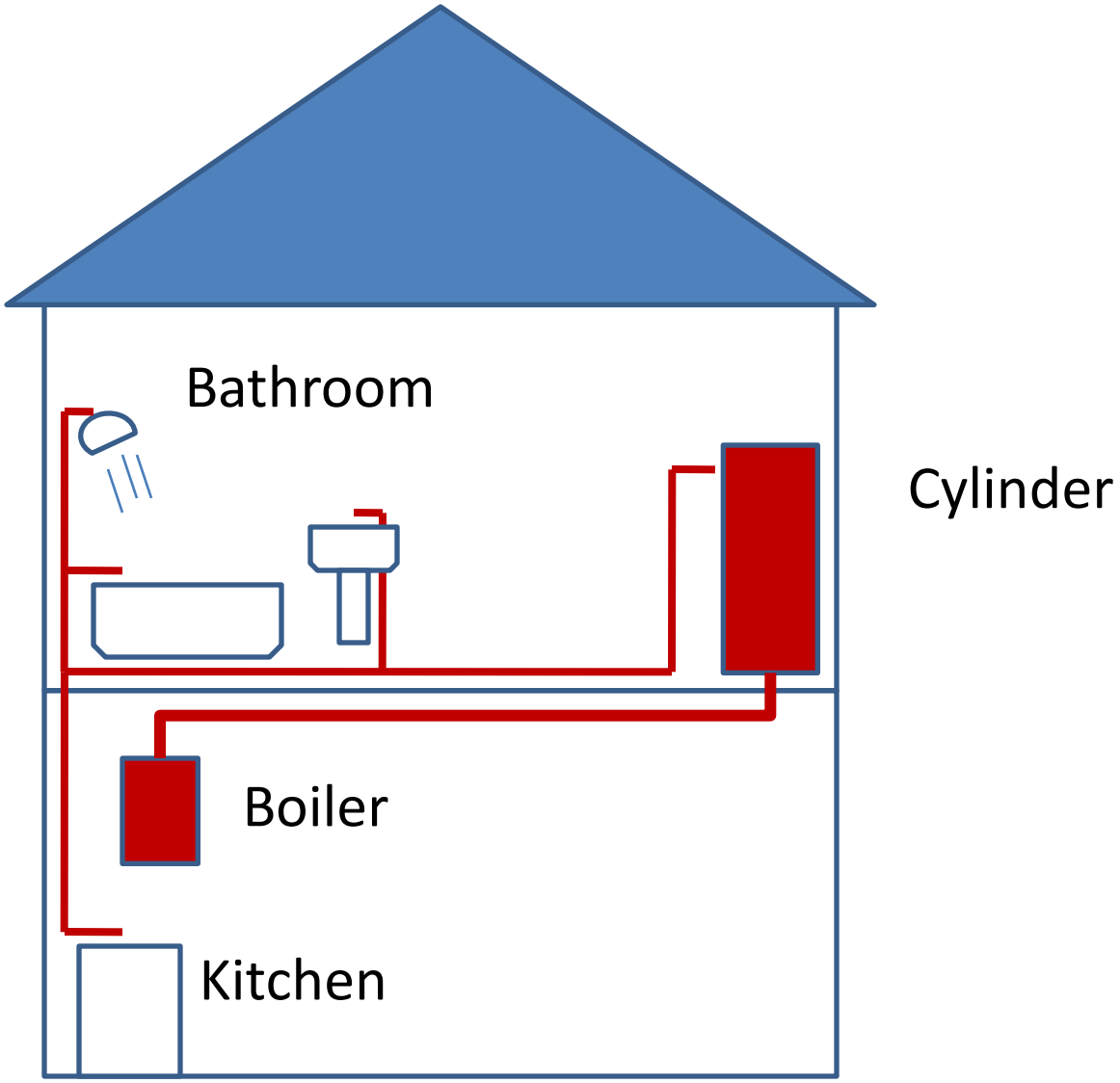


Code	Nominal Dia	A	B	C	D	E	F	X
HX94/22	22	123	74	39	40	30	10	31

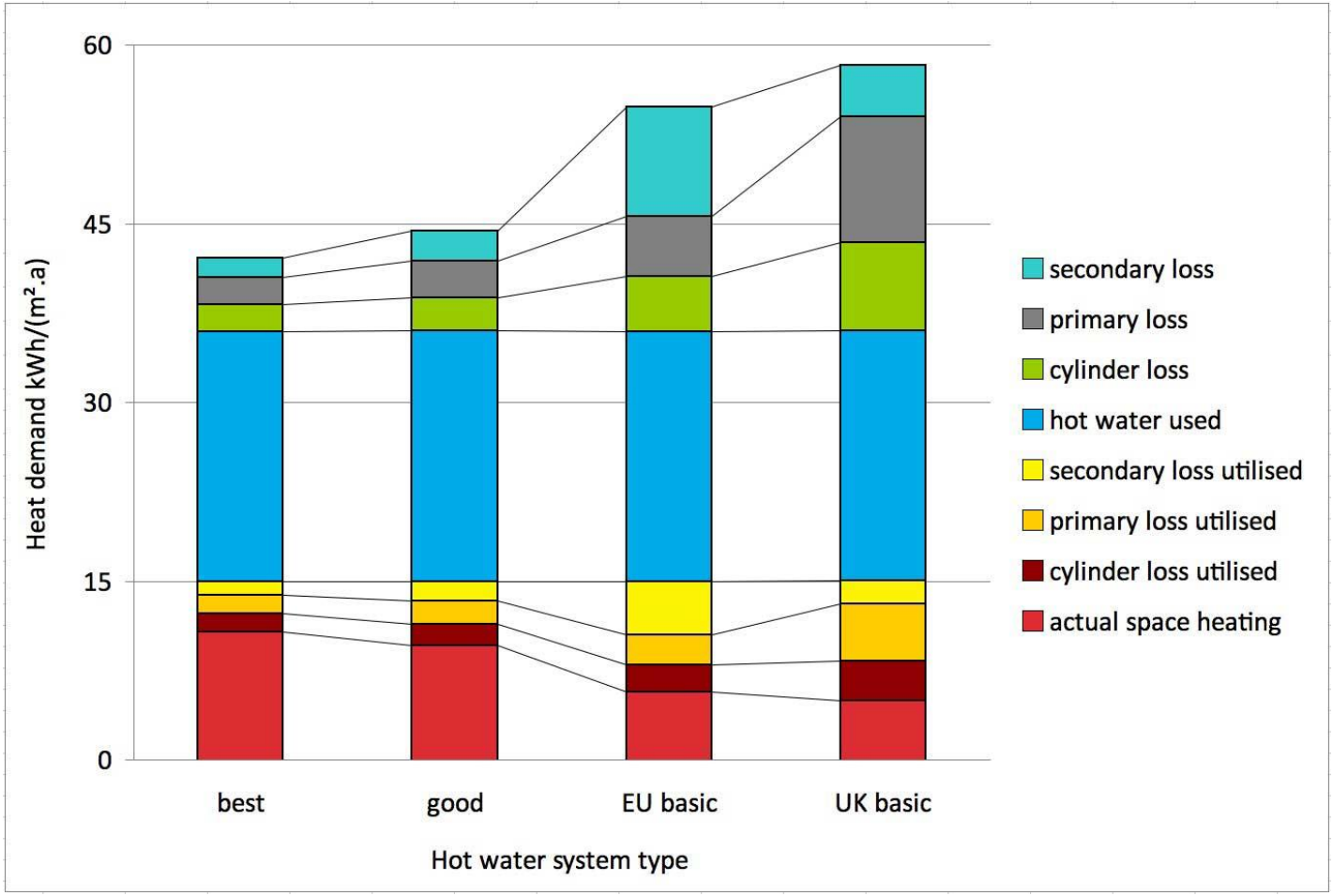
Solutions

- 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

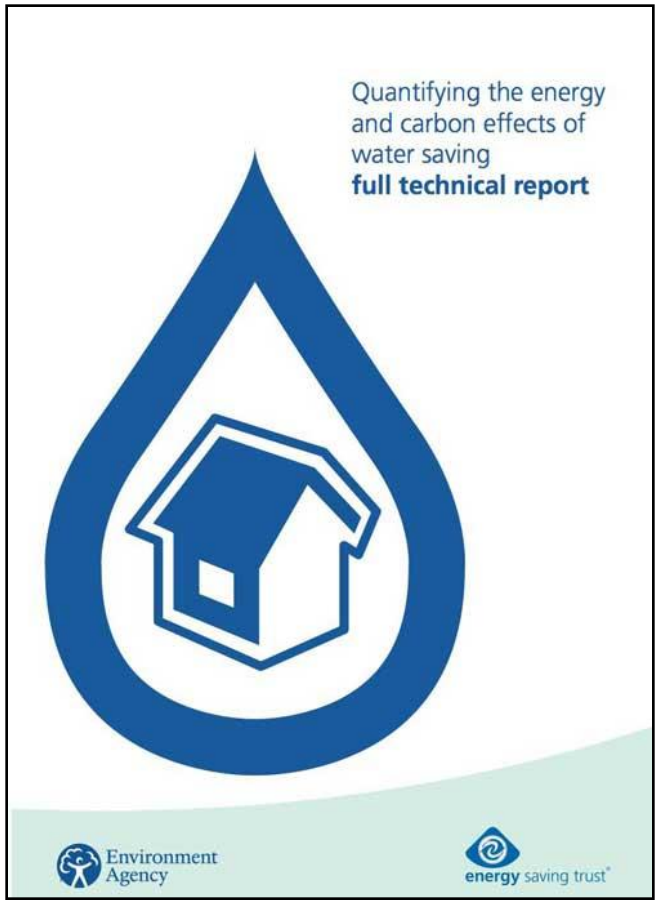
Summary

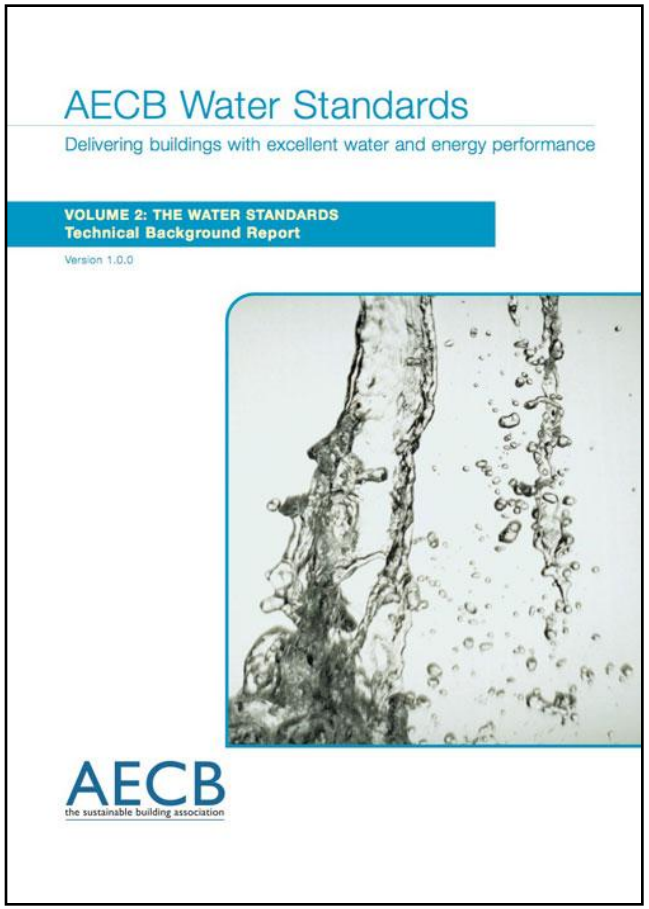
- Designers limited in effect on hot water usage
- Designers can control hot water losses
- These losses are important
- We can reduce them with good design

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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