AECB the sustainable building association

2009 Annual Conference

Building for a Sustainable Future

Policy | Research | Practice

Oxford Brookes University | 11-12 June 2009

Optional tours of local renovations: 13 June 2009

Organised by:

AECB the sustainable building association

Academic Partner:

OXFORD BROOKES UNIVERSITY

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KNAUF INSULATION it's time to save energy

Student Bursary Sponsor:

Greenbuilt building with people for people

ELEMENTAL SOLUTIONS

DESIGN FOR SUSTAINABLE WATER MANAGEMENT

an eco-minimal approach to water

AECB, Oxford 2009

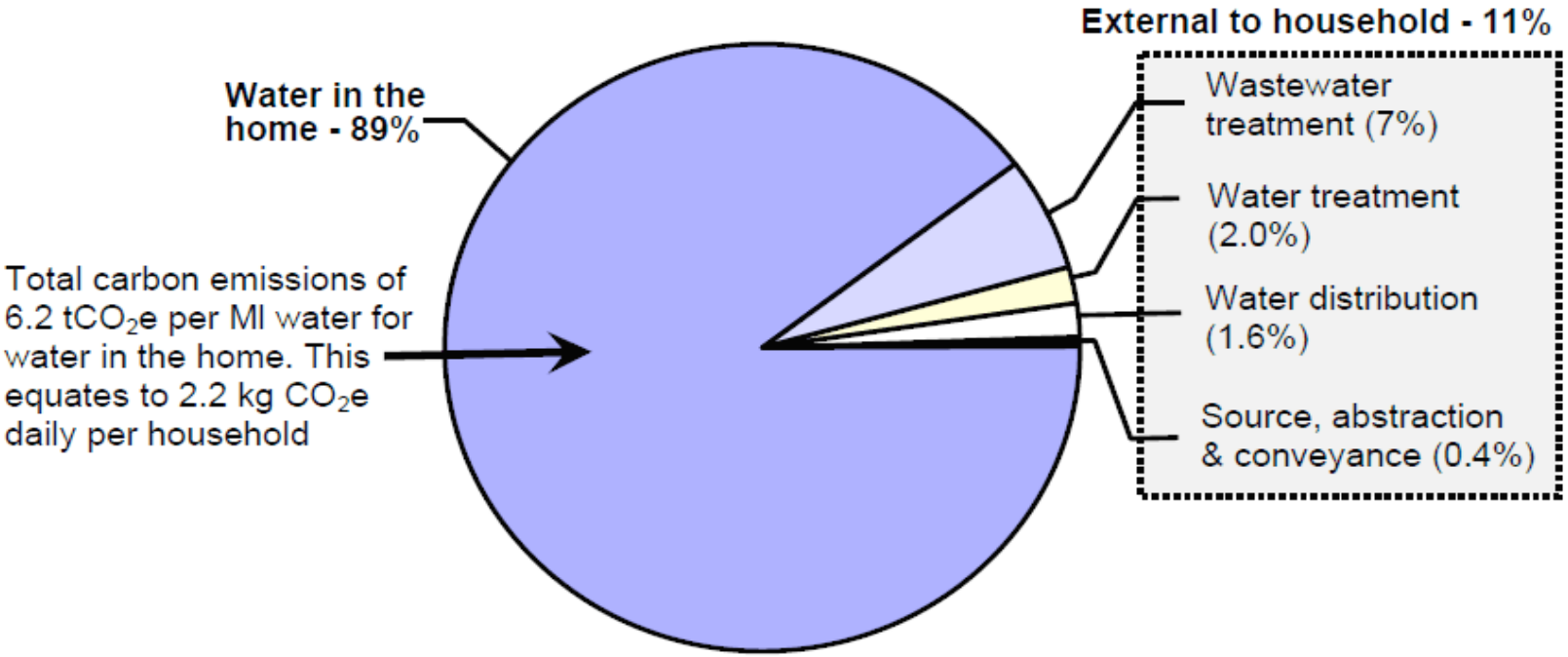
Nick Grant
www.elementalsolutions.co.uk

Domestic water and energy/CO_2 overview

"Science is the belief in the ignorance of experts"

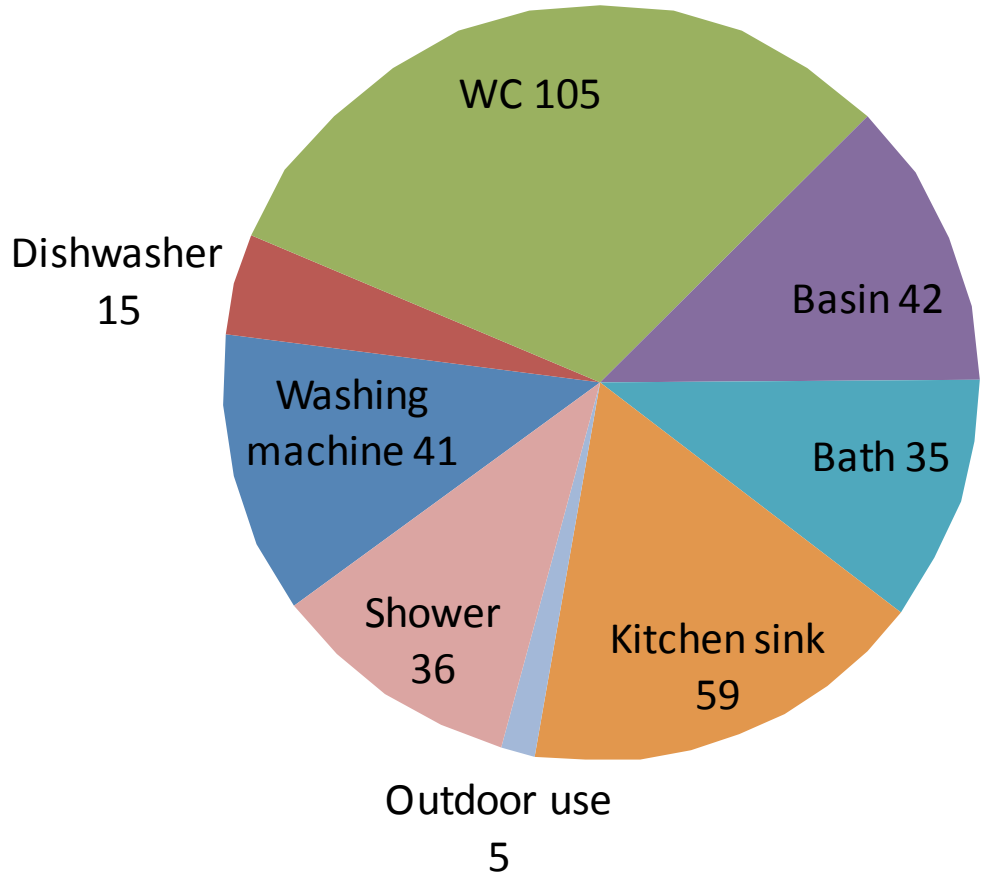
Richard Feynman

Carbon emissions;
Don’t blame the water company,
it’s all your fault…

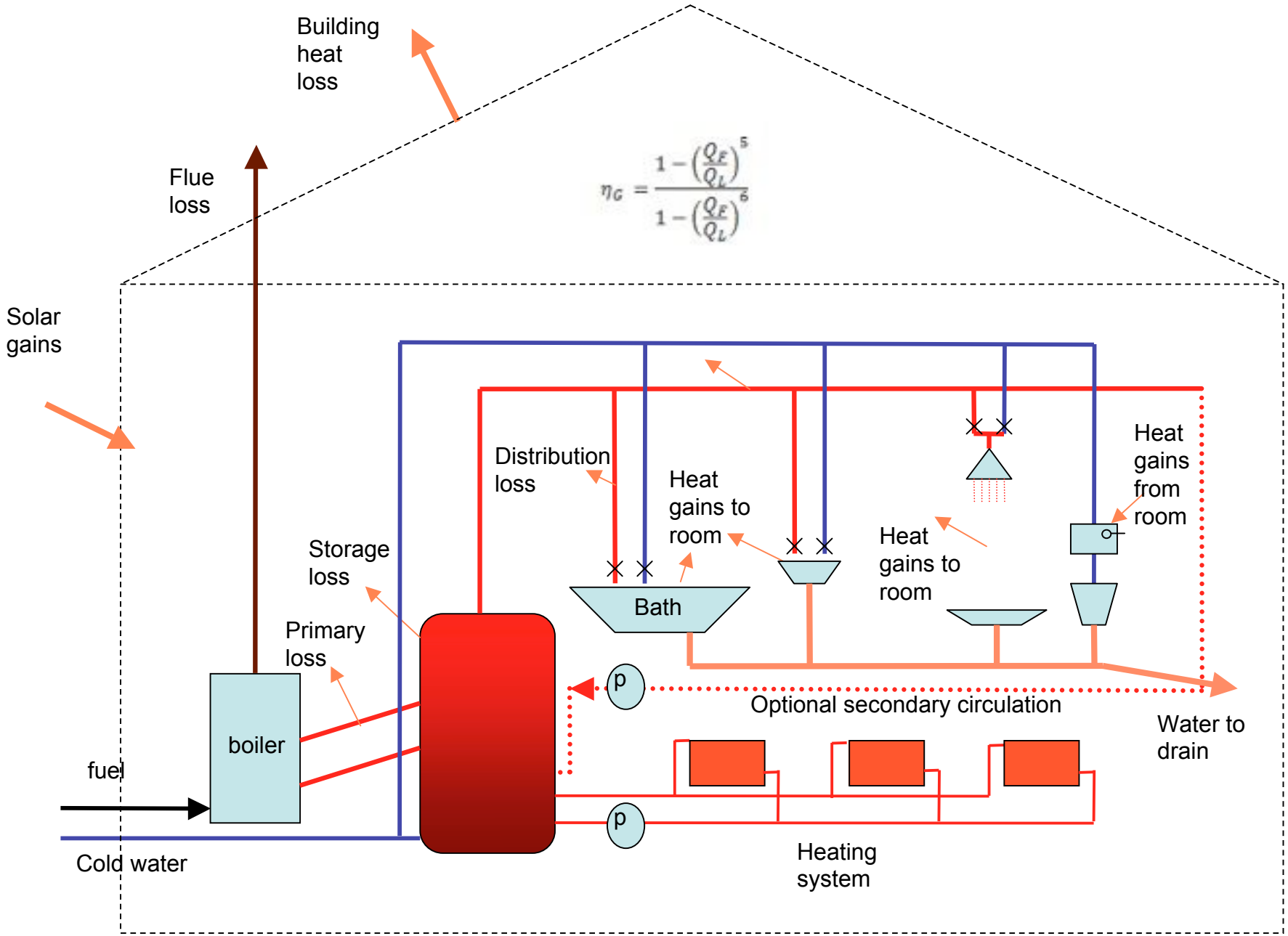


Environment Agency, 2008

Water use litres
Existing housing, 2.4 person occupancy

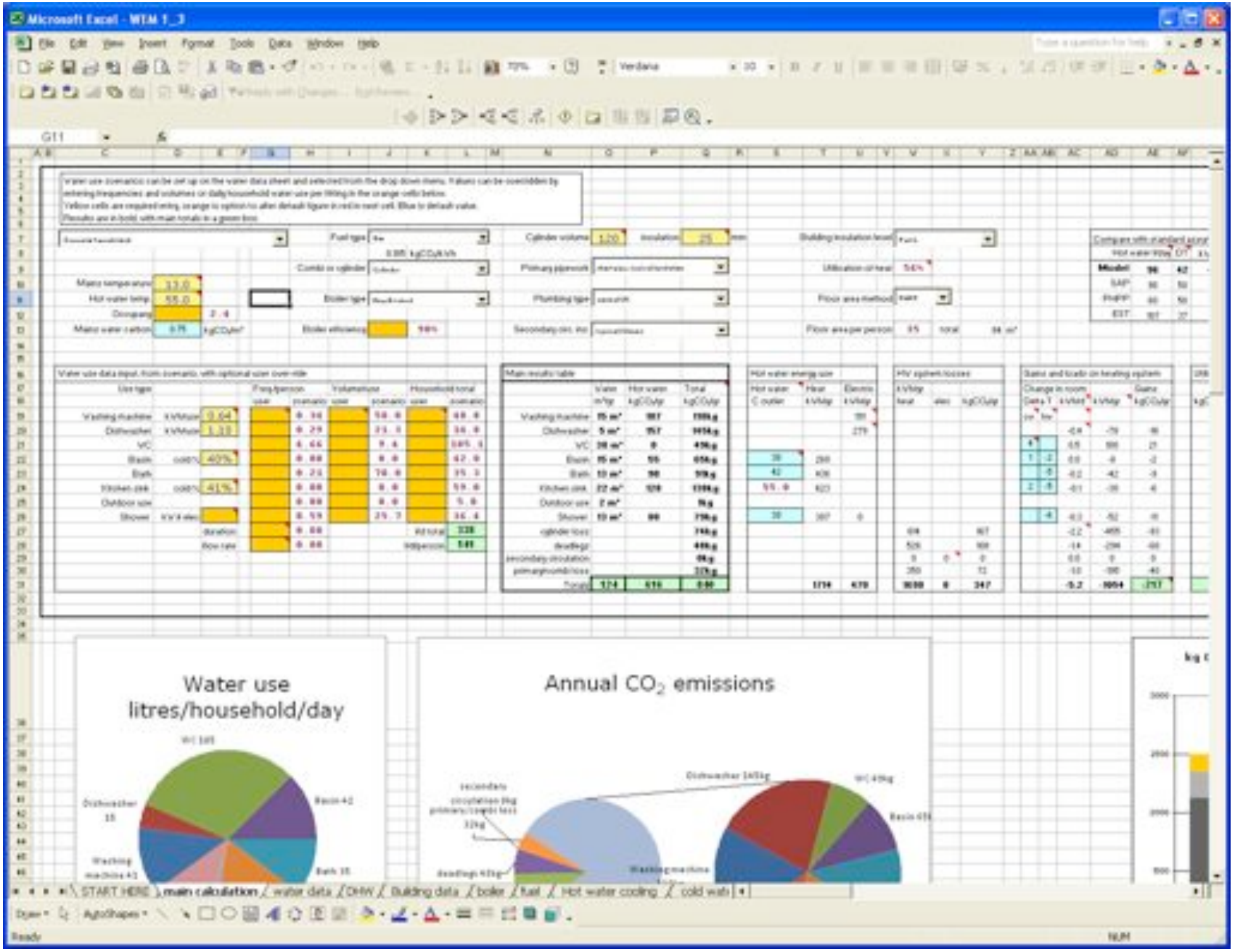


EST 2009; Clarke, Grant and Thornton



$$\eta_G = \frac{1-\left(\frac{Q_E}{Q_L}\right)^5}{1-\left(\frac{Q_E}{Q_L}\right)^6}$$

Elemental Solutions 2009



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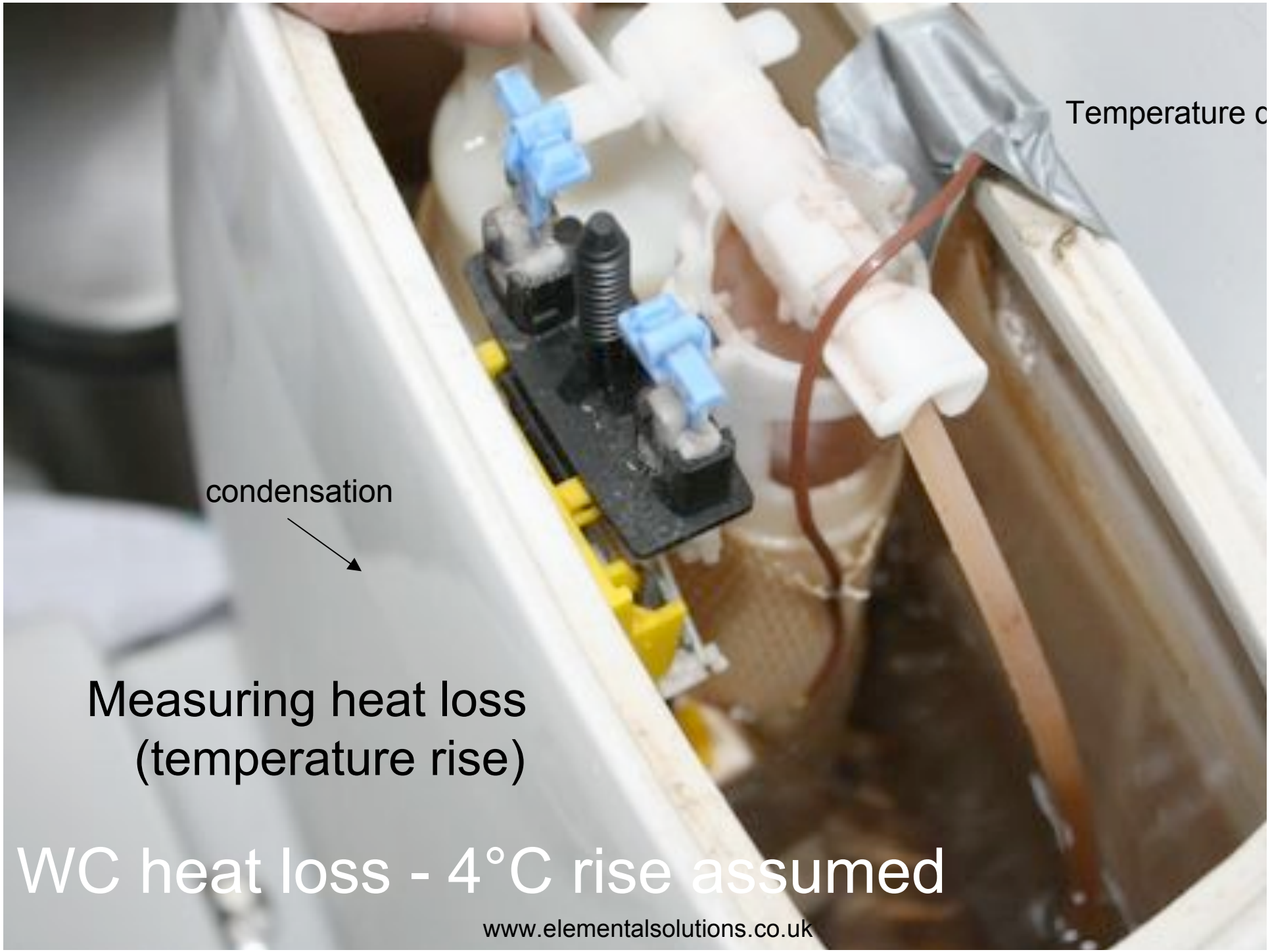
Main life cycle impact of a WC?

- Manufacture?
- Transport from China?
- Delivery transport within the UK?
- Water and sewage treatment?
- Toilet duck and loo blue?
- Final disposal?
- Anything else?

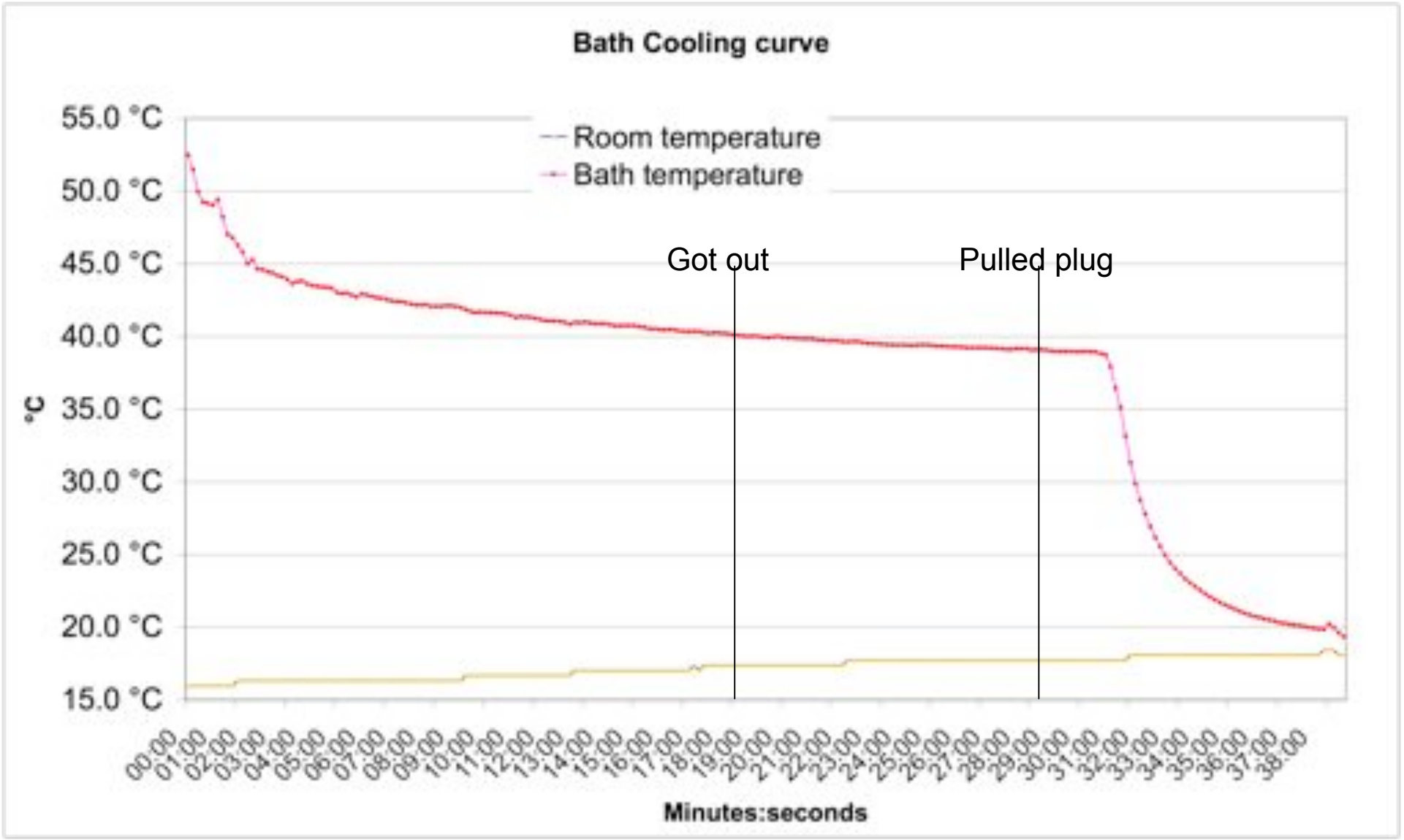
About 50:50 heat loss from building and water supply and sewage.



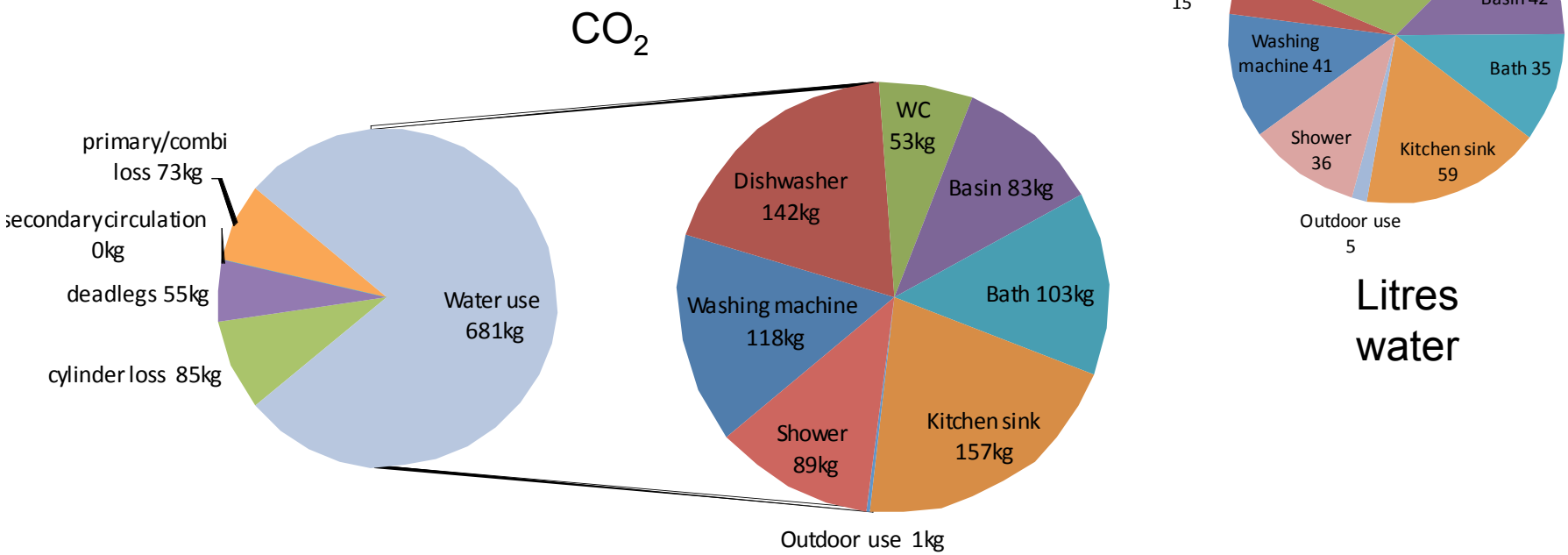
Measuring heat loss (temperature rise)

WC heat loss - 4°C rise assumed

Thermal gains - 5°C drop assumed



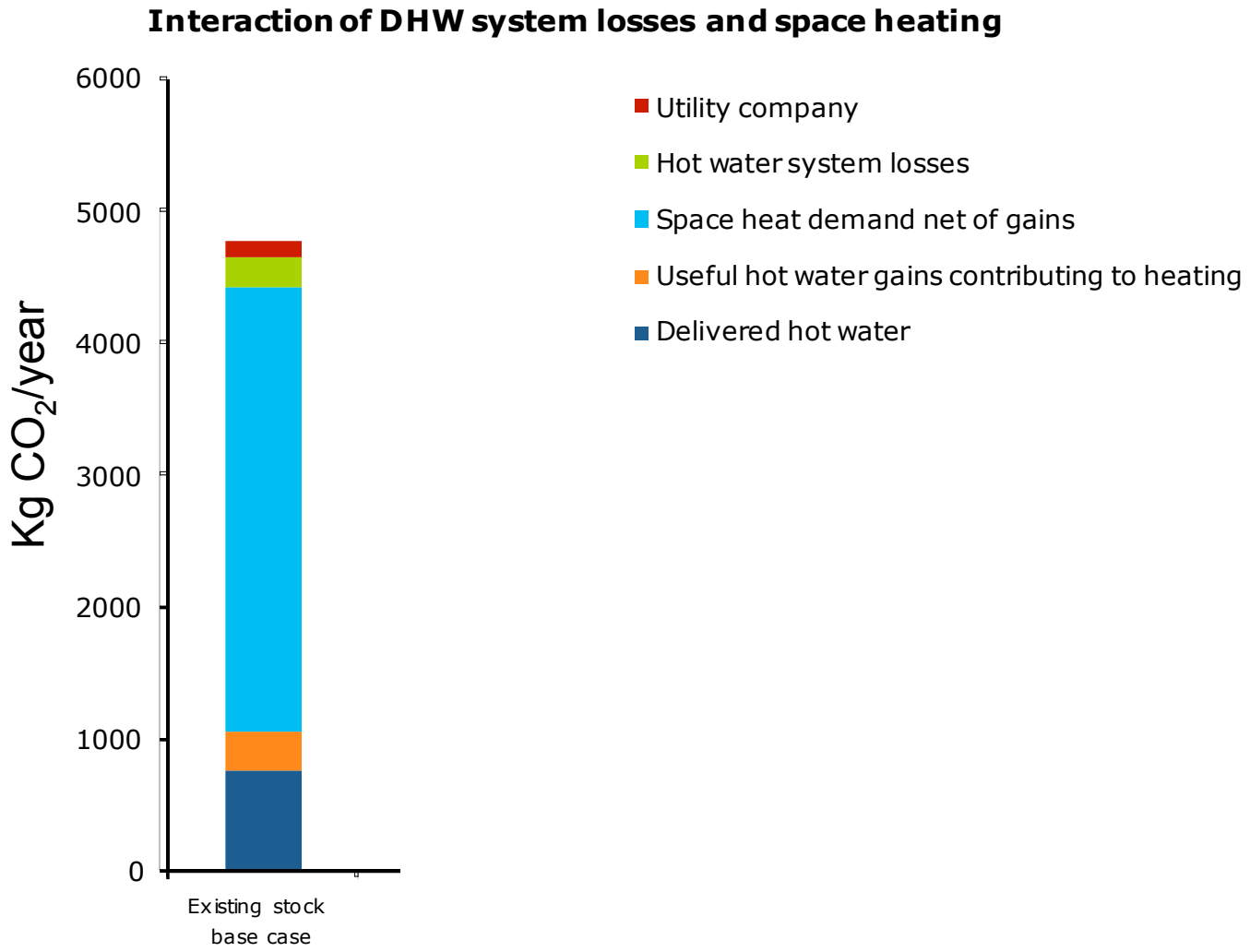
In more detail:



- Existing household
- occupancy 2.4
- gas system boiler (78% efficient).
- Figures in kg CO_2 equivalent/year

EST 2009; Clarke, Grant and Thornton

At what point does water heating CO_2 become higher than space heating CO_2?



EST 2009; Clarke, Grant and Thornton

Challenging some Clichés

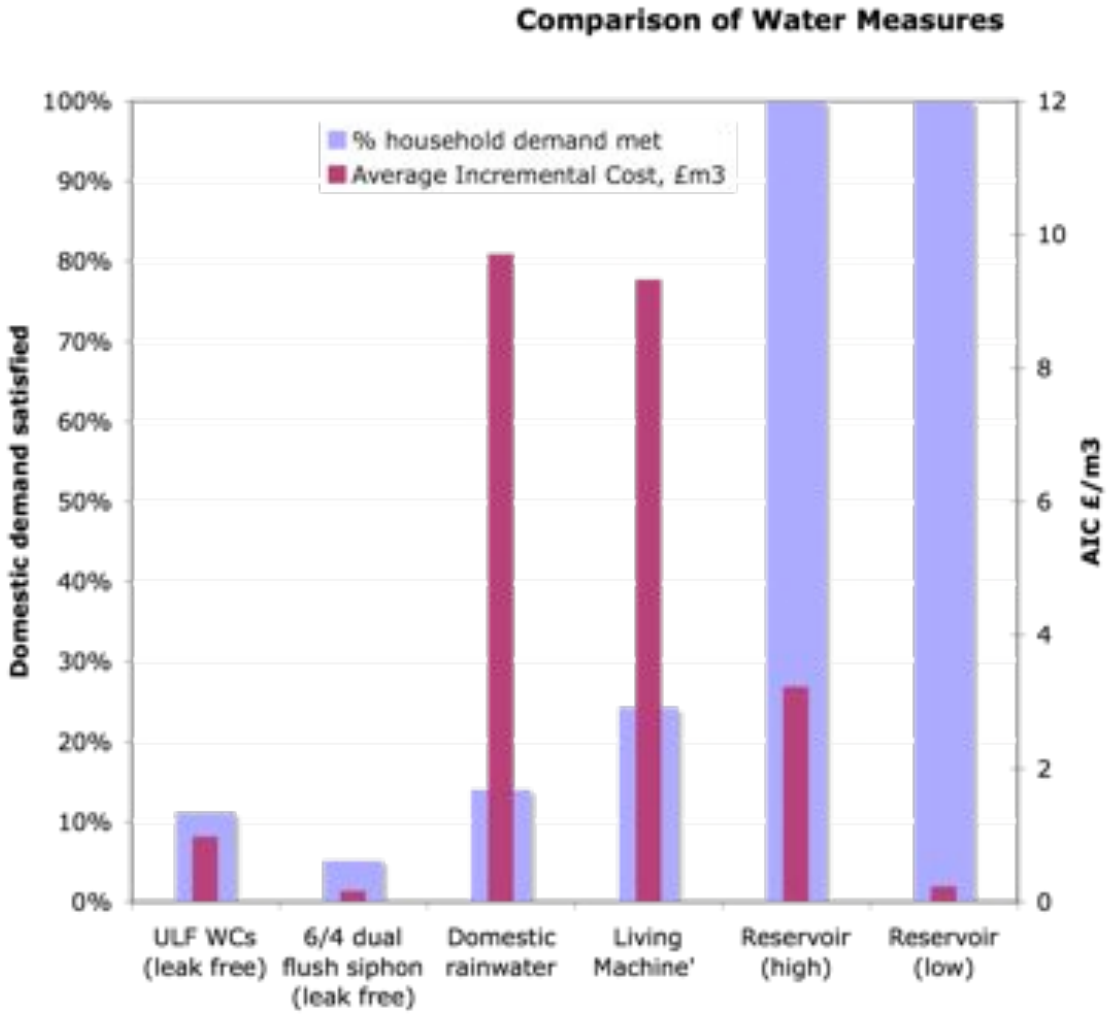

It’s ‘green’ but is it sustainable?
(now a paintball site and film set)

Key criteria

- Effectiveness
- Whole life cycle impact
- Consider user behaviour
- Cost effectiveness
  - *An eco-minimalist can do for a penny what any fool can do for a pound. (OK for 10p)*

Cost effectiveness for UK PLC;

Beyond payback period



$$AIC = \frac{C - S}{10.W}$$

AIC is Average Incremental Cost
C = discounted present sum of option cost (£)
S = discounted present sum of opex saving (£)
W = discounted present sum of water saved (megalitres)

All calculated over time horizon (e.g. 30 years)

Result in pence/m^3

Note
Data and assumptions for a specific project, 100 dwelling development in SE.

Effectiveness;

Domestic rainwater as encouraged by CSH:

Assumptions:

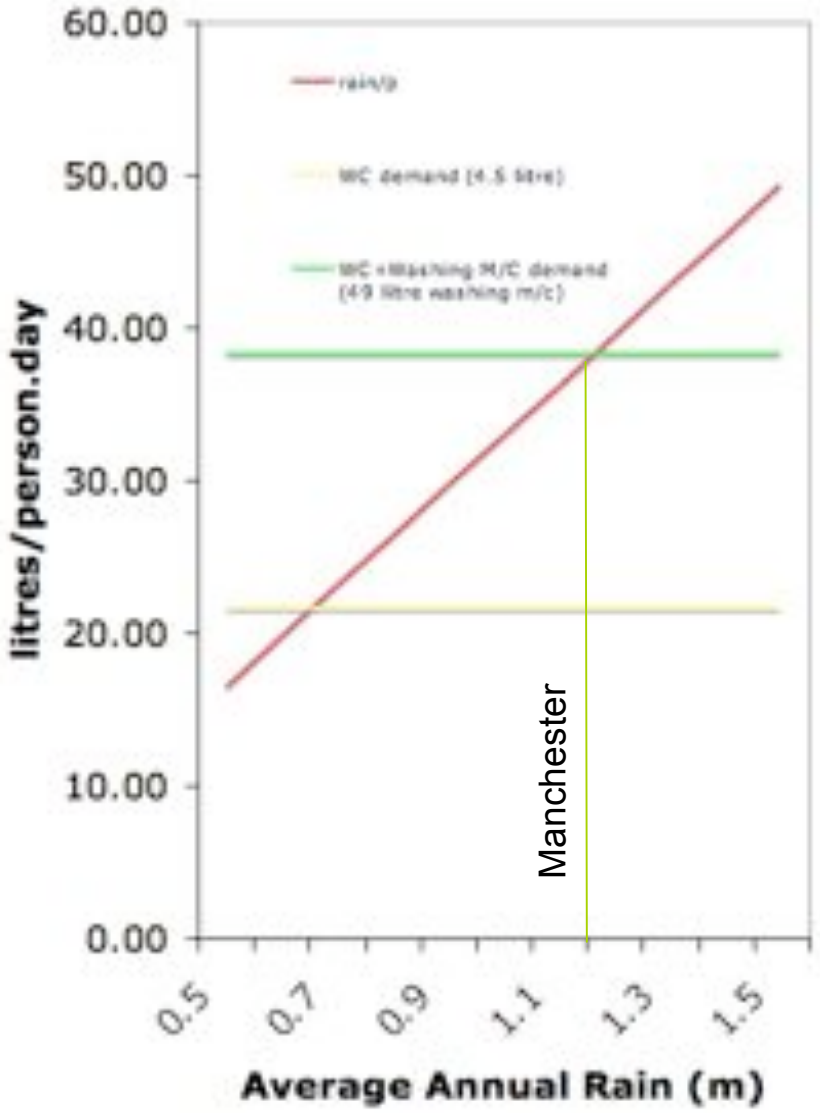
20m^2/person roof area (35m^2/person floor)

(80m^2 semi, thick walls, 2.3 people)

60% collection and use efficiency

Litres/person = 20m^2 X 0.6 X annual rain (mm)/365 days

Effectiveness



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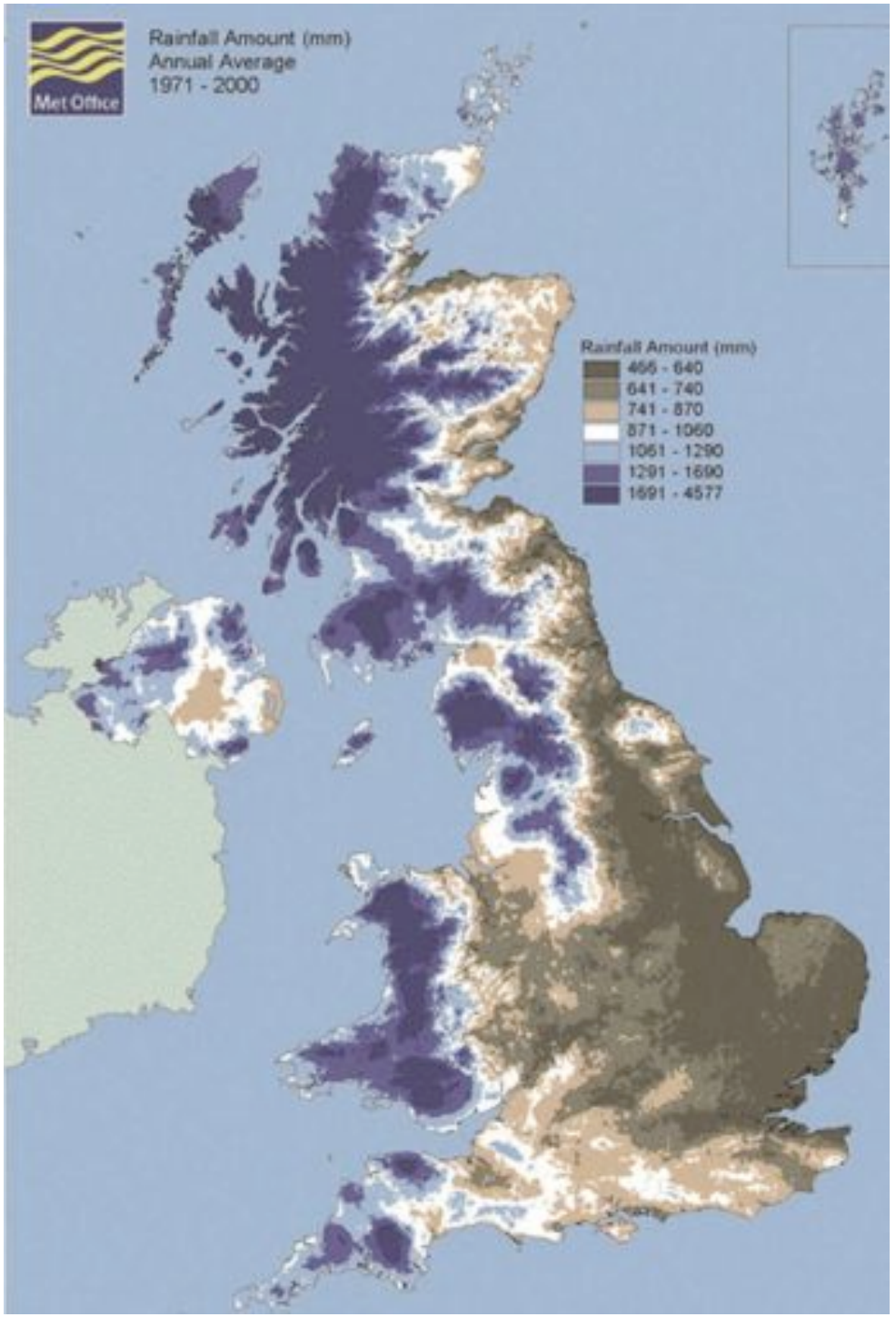


Effectiveness:

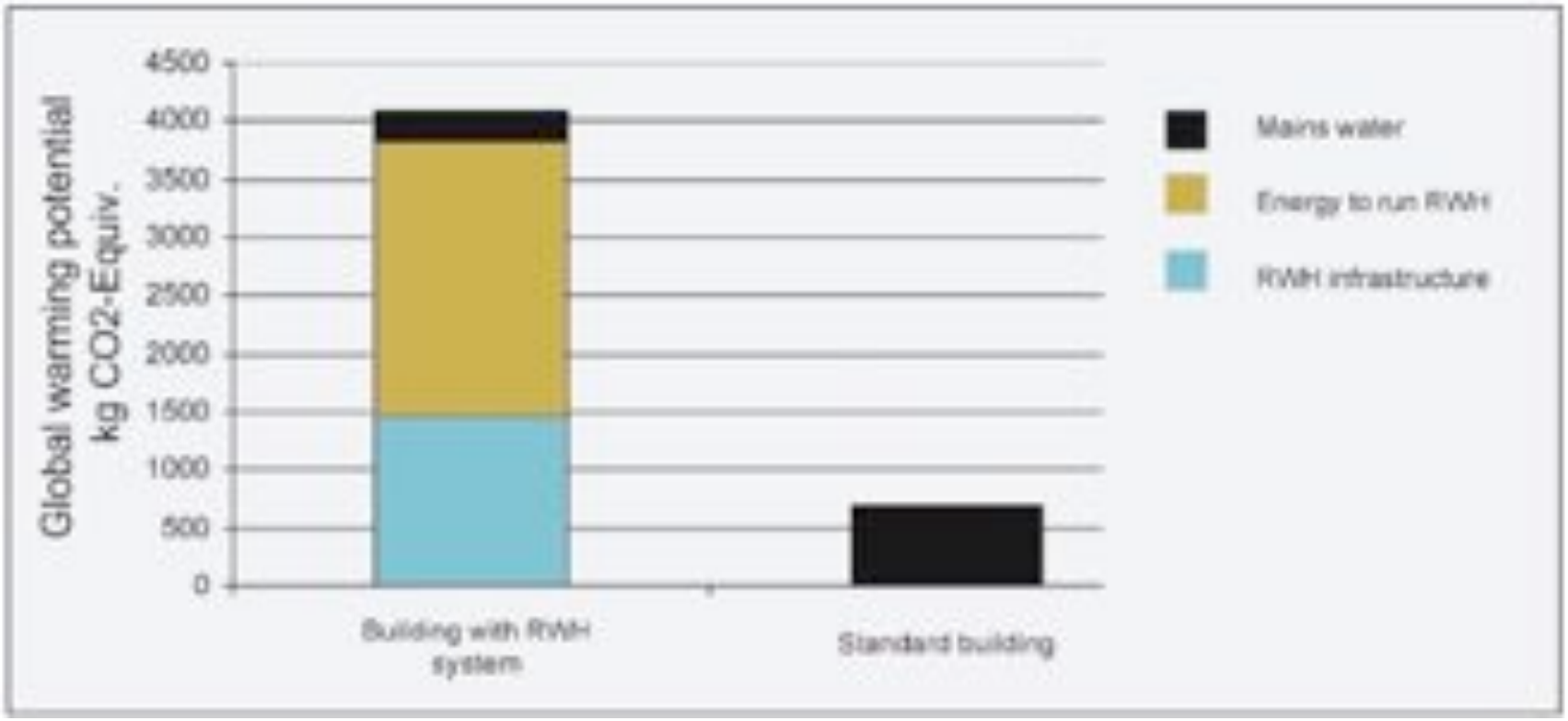
Don’t mix your eco-cliches:

Green roof + rainwater reuse at BRE Innovation Park

“But you can’t put a price on the planet!”

“What about all the chemicals, CO_2 and other environmental impacts of mains water?”

Life cycle impact;
Non-domestic rainwater system



Thornton (2008). Rainwater harvesting systems; are they a green solution to water shortages? Green Building Magazine, Spring 2008, p40-43.

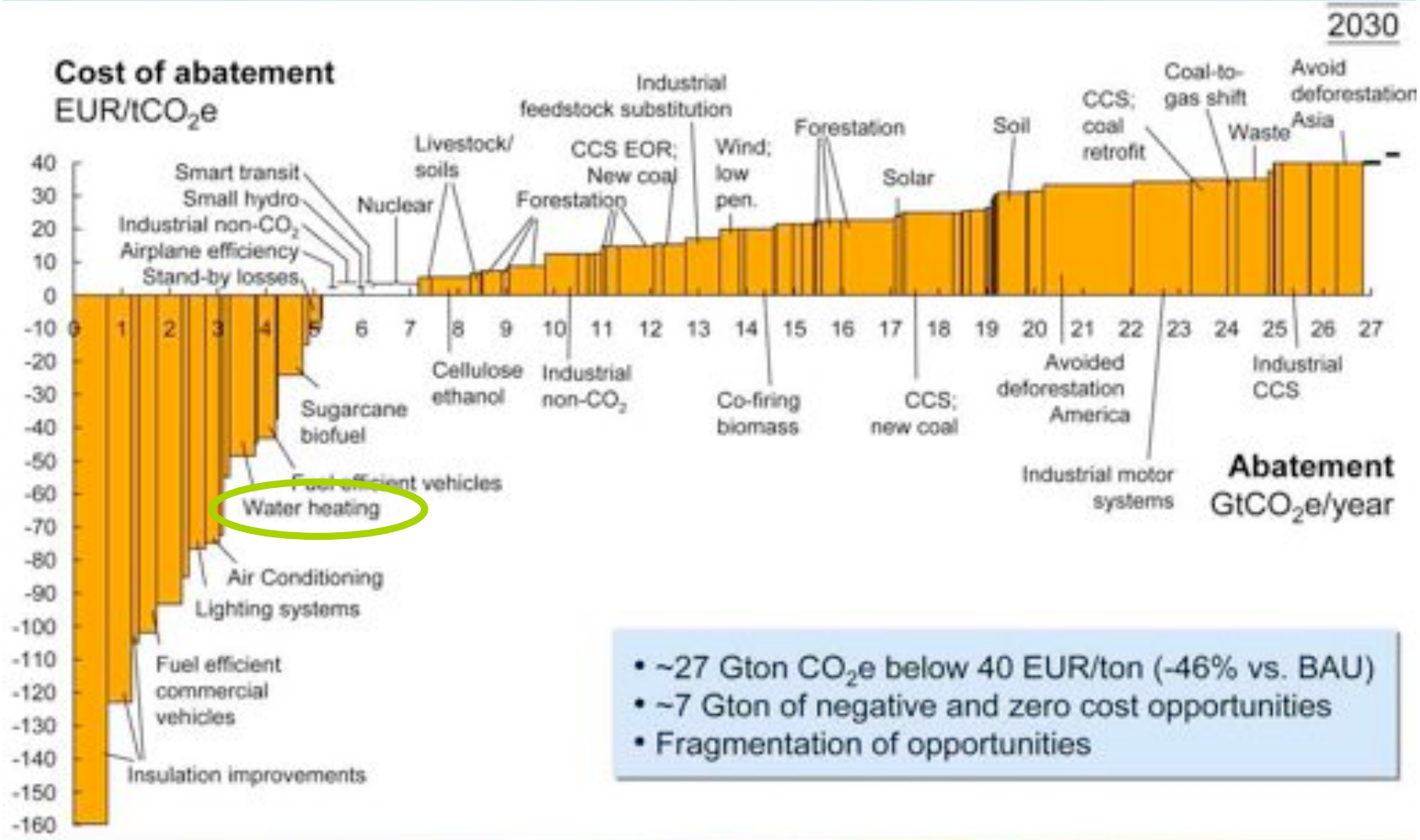
The last defence of eco bling;

“Ah but it’s not just about performance, cost effectiveness, reliability, low maintenance and life cycle impacts! What about the educational value? We should definitely use these technologies on schools.”

A genuine but compound quote

Cost effectiveness

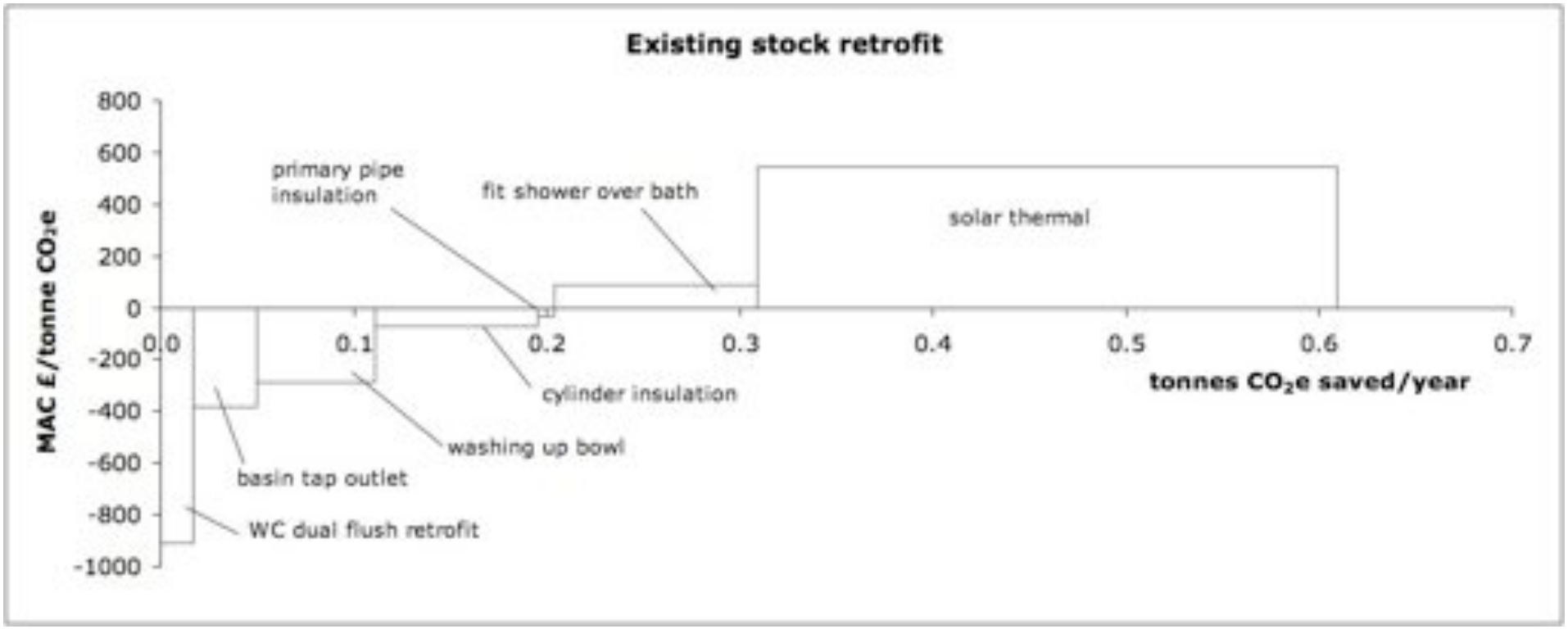
Global cost curve of GHG abatement opportunities beyond business as usual



- ~27 Gton CO_2e below 40 EUR/ton (-46% vs. BAU)
- ~7 Gton of negative and zero cost opportunities
- Fragmentation of opportunities

VATTENFALL

Water related CO_2 reduction:



Elemental Solutions 2009

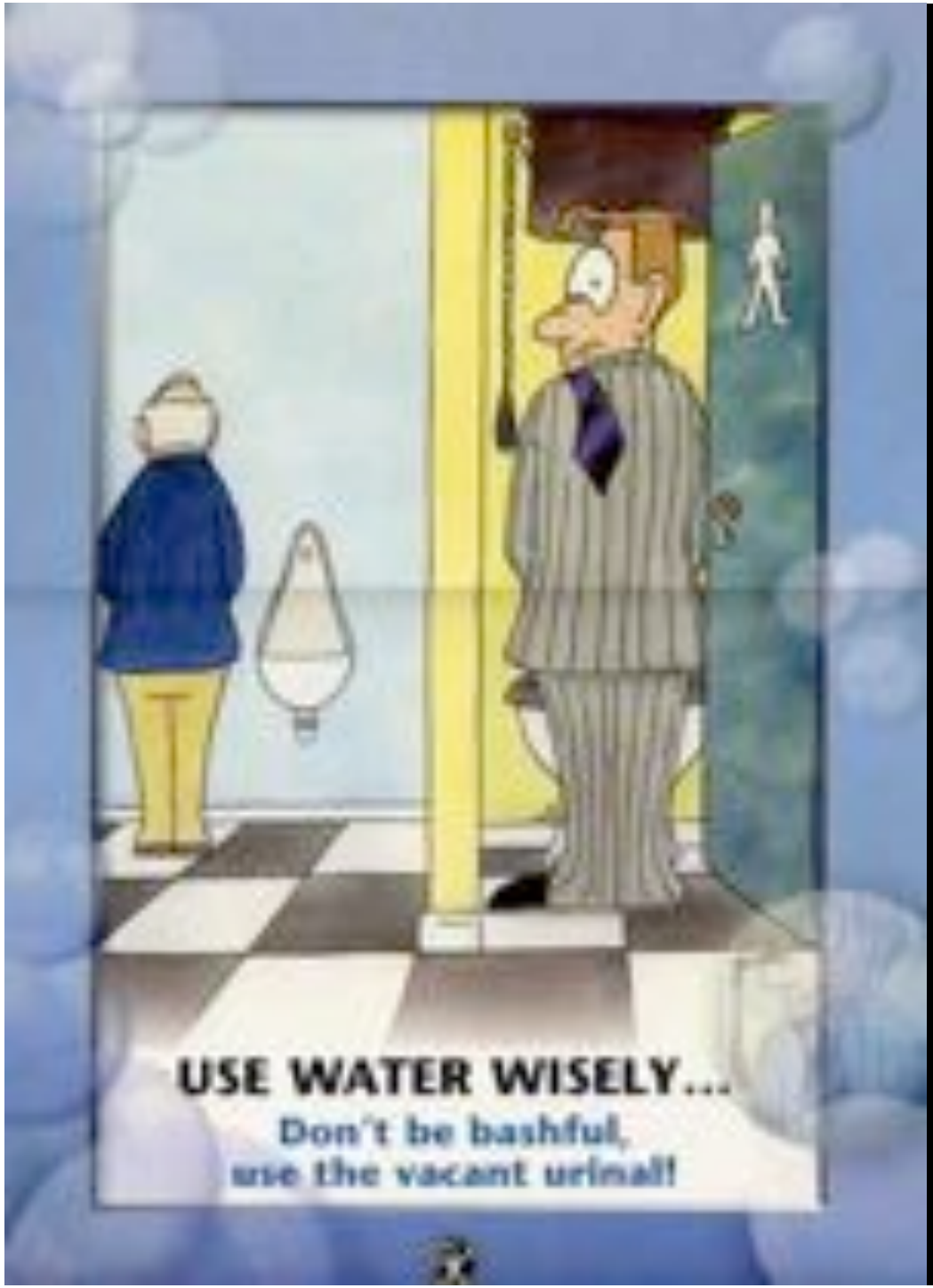
Behaviour & uncertainty

Same 12 litre per minute shower head - 3 different users

Person	Specified flow	Chosen flow	Duration	Showers/ week	m^3/year
A	12 l/minute	12	7 mins	7	30.6
B	12 l/minute	7	4 mins	4	5.8
C	12 l/minute	12	15 mins	14	131

23:1 ratio for same shower fitting without considering extreme behaviour

'Essentially, all models are wrong, but some are useful'
George Box



Design for behaviour; urinal spacing and dividers.


FOR HOT WATER PLEASE
RUN THE TAP FOR A MINUTE
OR TWO

AECB Water Standard

www.aecb.net

Dead Legs

AECB Good Practice

≤ 1.5 litre, all pipes insulated.

(≤ 0.5 litre with secondary circulation - controlled)

AECB Best Practice

≤ 0.85 litre.

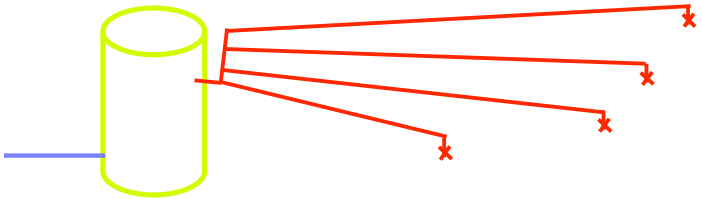
(≤ 0.25 litre with secondary circulation - controlled)

“Things should be as simple as possible – but no simpler”

Albert Einstein

As simple as possible:

Radial plumbing with short small-bore pipes.

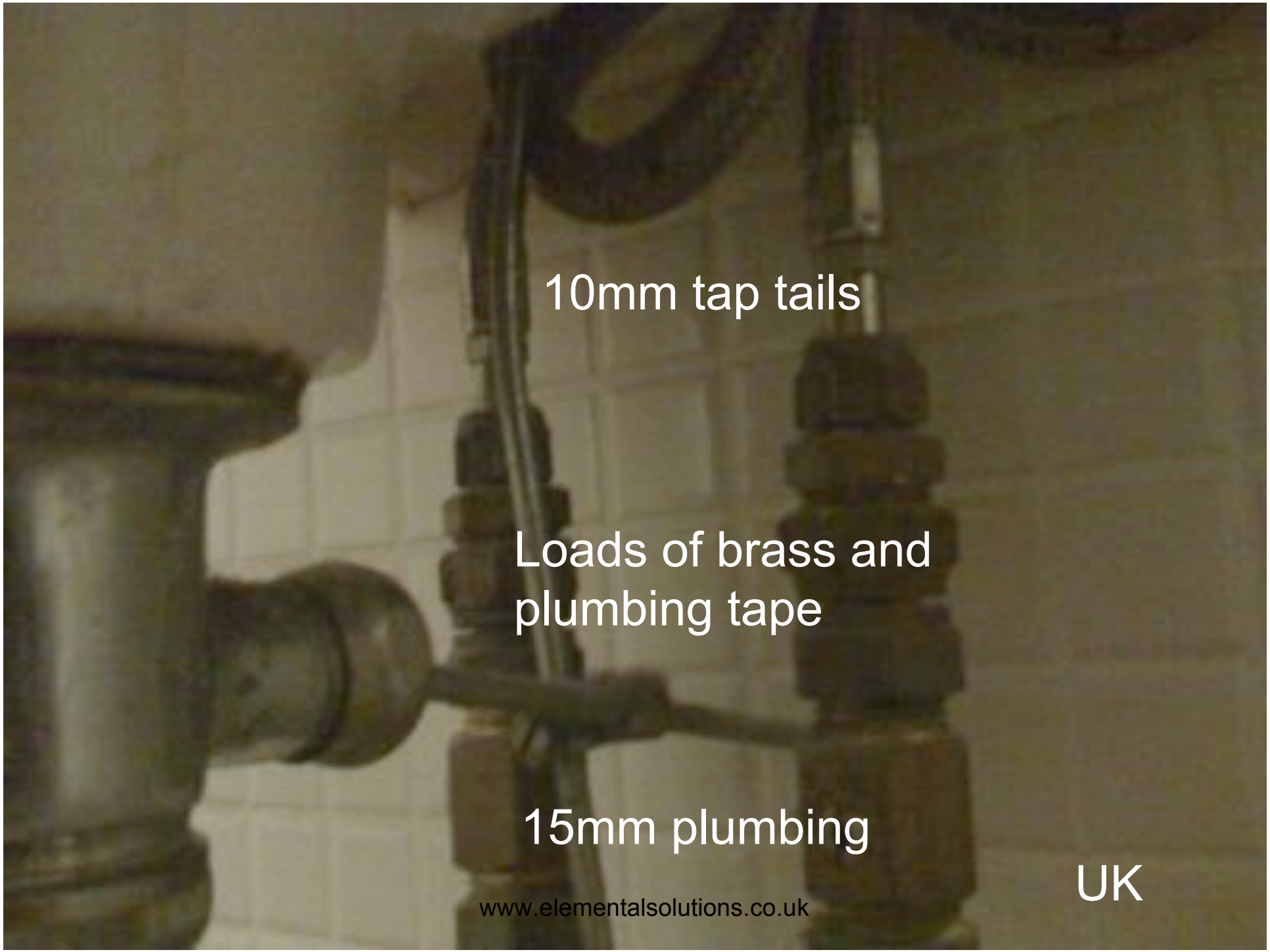


14m of 10mm PEX pipe = 0.5 litre (2 cups) dead leg

14m of 15mm PEX = 1.5 litres

Avoids cost, complexity and heat loss of secondary circulation (or trace heating) but requires compact layout and good water pressure.

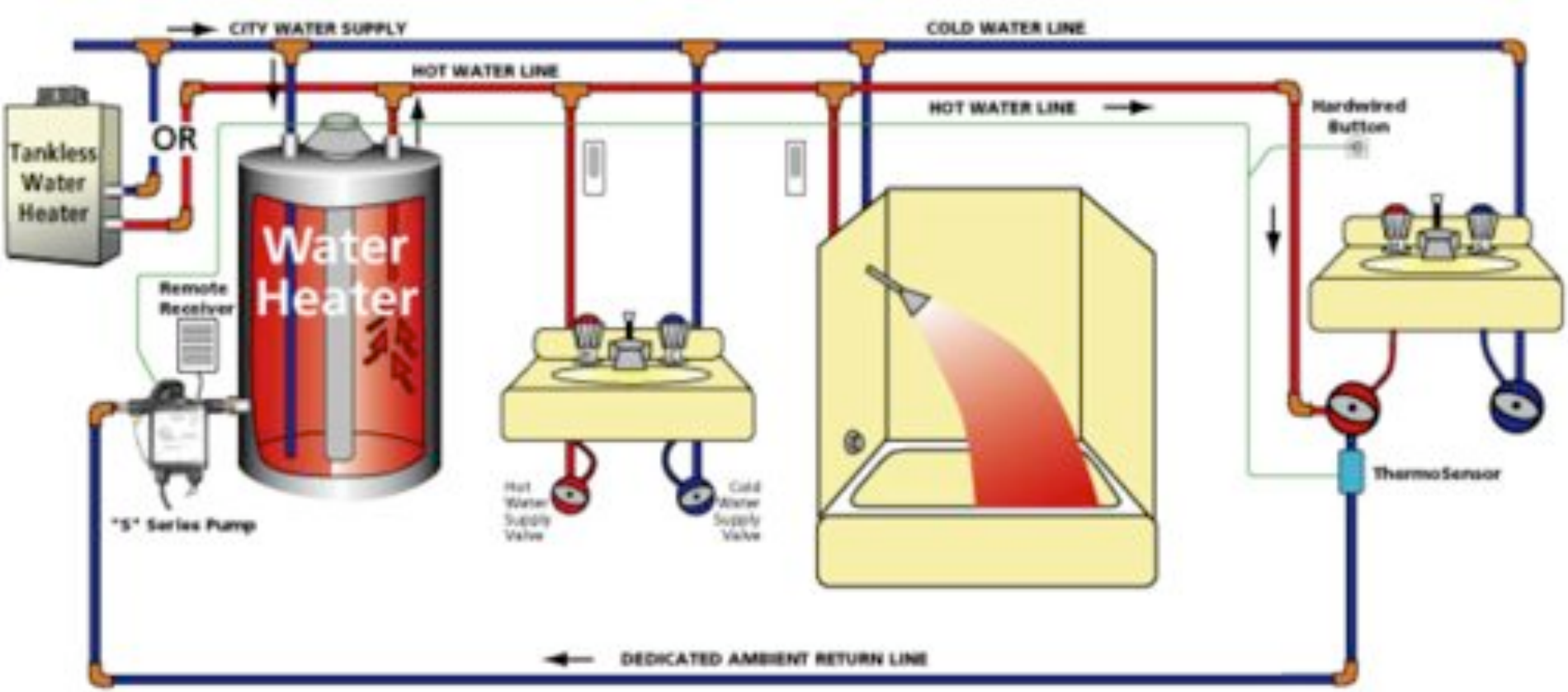

design details
10mm pipe
Germany


10mm tap tails
Loads of brass and plumbing tape
15mm plumbing
UK
www.elementalsolutions.co.uk

- but no simpler:

Structured plumbing ® for larger properties.

1-2 cups draw off before hot, minimal energy loss.



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Courtesy of Gary Klein


THE WATER PAVILION


design details


Airflush® urinals
Green Building Store


www.elementalsolutions.co.uk


One easy clean trap
www.elementalsolutions.co.uk

4 litre leak free WCs

Green Building Store

The non-eco-minimal bits:

One too hot, one cold!

Trace heating, 2 immersion heaters and solar panels feeding 3 spray taps!

Has never worked and used much more electricity than under basin electric heaters.

Eco-minimal sewage treatment (briefly)

Example;

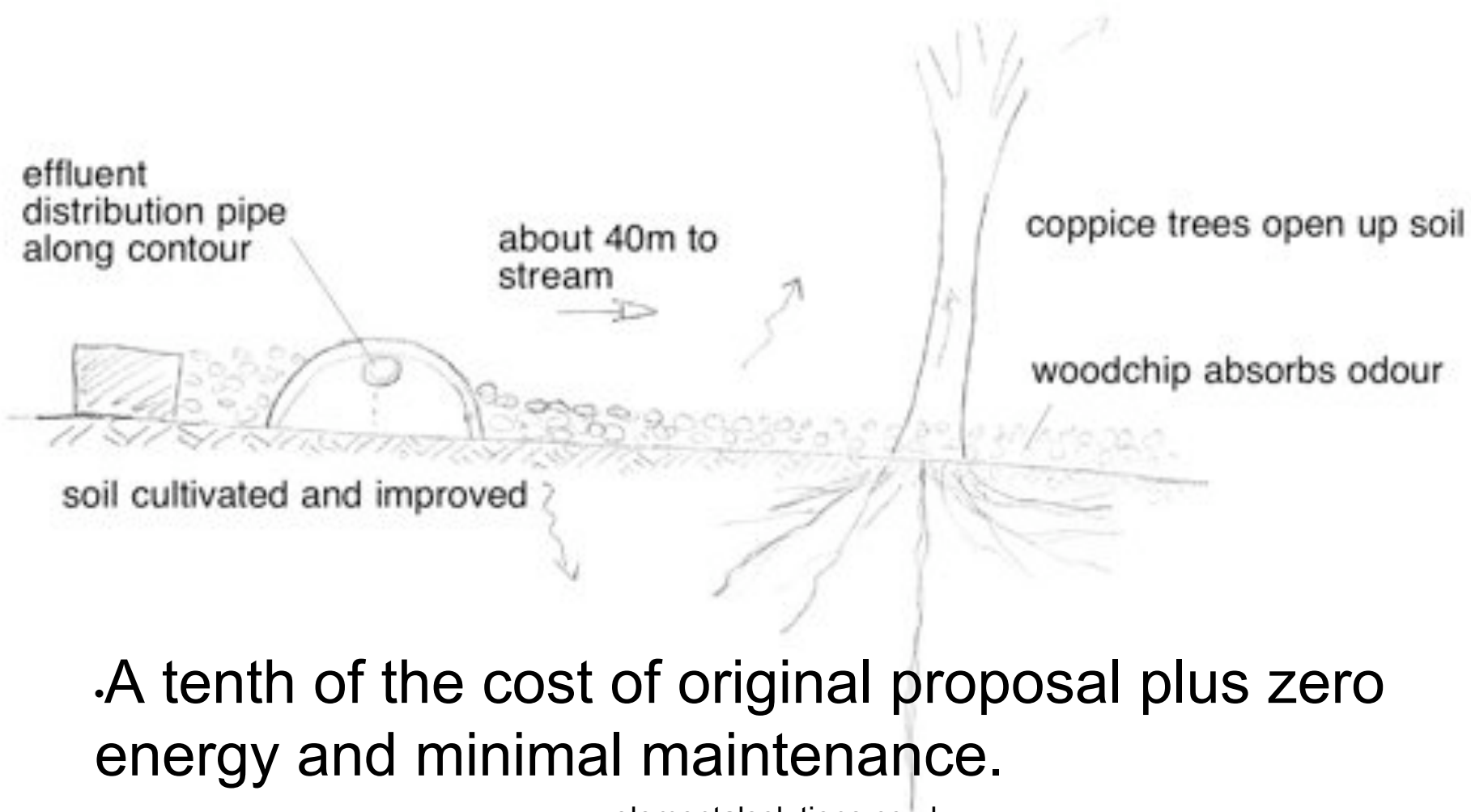
- New rural school for 320 kids
- Heavy clay soil
- Lots of space
- Small stream
- No capacity in village STP plus long distance

Conventional approach;

- Clay soil so soakaway assumed not suitable
- 320 kids x standard figure of 90 l/d = 29m^3/d
  - = High volume wrt small stream so strict consent from EA.
- Therefore solution is large high spec' powered treatment plant to meet very tight discharge consent, cost c.a. £300,000 plus ongoing maintenance and high energy consumption.

Eco-minimal approach;

- Challenge assumptions:
  - How much water do schools use? Data for 11,000 schools suggests about 15 litres/pupil.day.
  - 320 kids x 15 l/d = 4.8m^3/d (6 times less)
- Lower volume means less strict consent and smaller less expensive plant, perhaps £40,000 - but we can do better!



- A tenth of the cost of original proposal plus zero energy and minimal maintenance.

Section A-A @ 1:200

NOTES

Land drain above infiltration area to prevent surface water runnoff reaching the infiltration area.

	fall	level
Septic cover level		104.00
Septic inlet	0.60	103.40
Septic outlet	0.05	103.35
Dosing outlet	0.50	102.85
Temporary outlet (existing)	0.83	102.00
Proposed irrigation pipe	1.40	101.25

Plan @ 1:1000

ELEMENTAL SOLUTIONS

Project: HSA

Drawing: Sewage Schematic

Drawn: NJG Check:

No.: ESHSA 005

Rev: A

Scale: 1000 @ A3 Date: 1/9/08

T: 01981 540705
E: hello@elementalsolutions.co.uk
www.elementalsolutions.co.uk


www.elementalsolutions.co.uk


A year later
www.elementalsolutions.co.uk

Rules of thumb

- Keep it as simple as possible - but not too simple
- Efficiency first; reduce, reduce, reduce
- Impact in use is typically 90%+ of life cycle impact
- Sustainable can be cost-negative if designed in rather than added on
- Look for big savings first not incremental improvements
- Don’t forget behaviour, sometimes perverse.

“Making the simple complicated is commonplace; making the complicated simple, awesomely simple, that's creativity”

Charles Mingus.

More information

www.elementalsolutions.co.uk

For links to:
www.aecb.net - the AECB Water Standards

www.usablebuildings.co.uk

www.environment-agency.gov.uk/savewater