# SUSTAINABLE TECH

## BMS3105

## 2026-11-25

DAMON HART-DAVIS

UNIVERSITY OF SURREY



SUSTAINABLE TECHNOLOGY INNOVATION

THIS?



# TOO EXPENSIVE TO SAVE OURSELVES?

> “No one's going to do anything about it. The planet won't be saved. It wouldn't be cost effective to do so.”

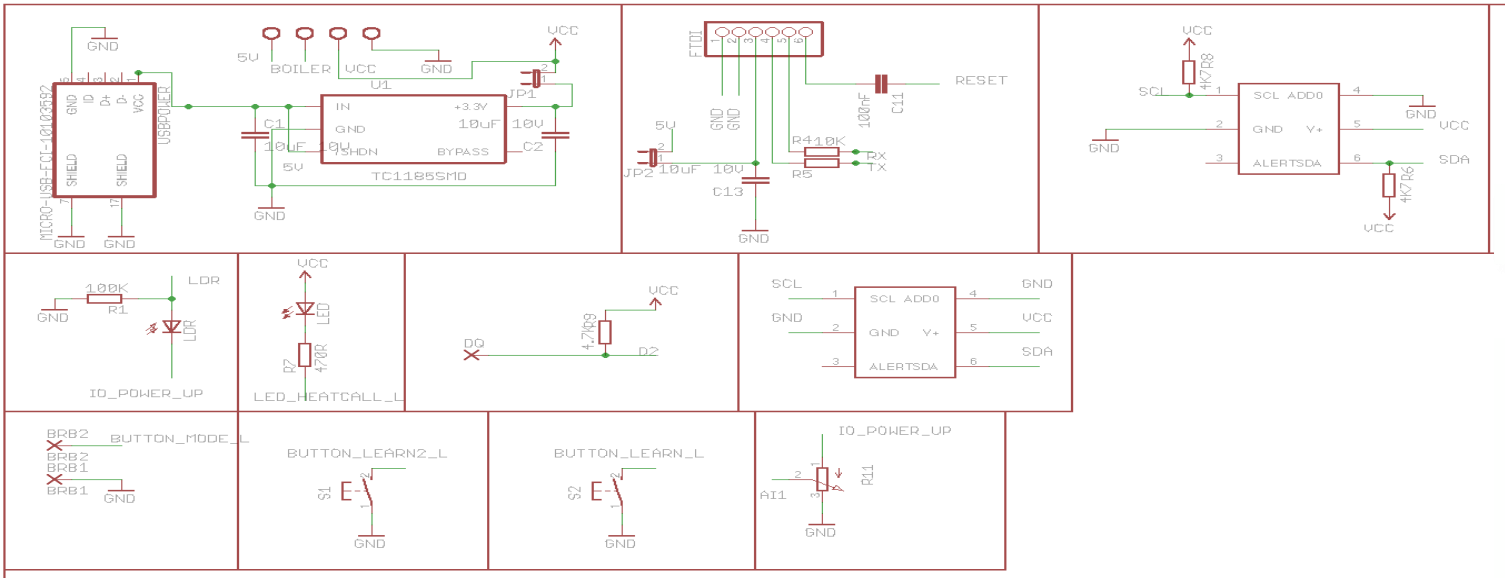
KURT VONNEGUT (1989)

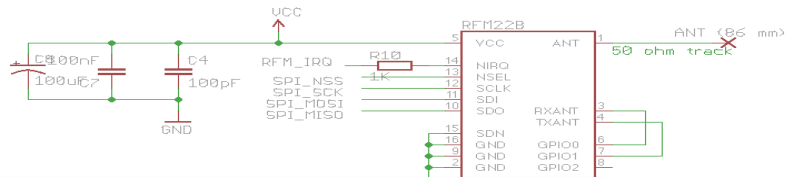
- Sustainable technologies and innovation
- *"… negative impacts of humans on the environment and ways to mitigate …"*
- **DISCUSS** points to help keep us all awake
- Stop me as I go with questions, existential or otherwise!

# WHAT IS "SUSTAINABLE TECHNOLOGY?"

- New (cancer cures, green revolution)?
- Essential, done better (EV, heating, insulation)?
- New, reducing demand elsewhere (Internet vs travel, physical paperwork, cashless payment)?
- Exotic, mega-scale (CCS, space umbrellas)?
- **DISCUSS**

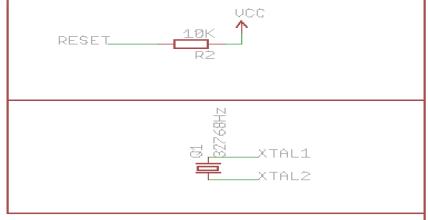
# DISCUSSION

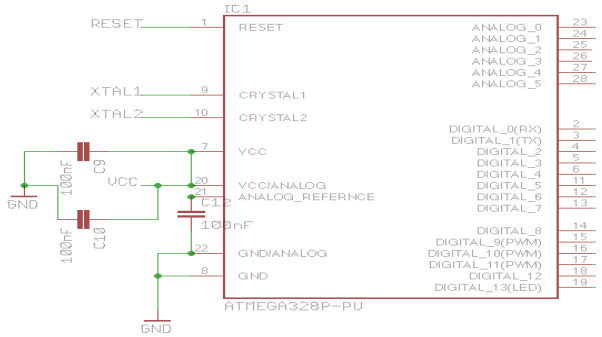



## WHAT IS SUSTECH?

In groups please pick one example each of tech new or old that is or is not "sustainable" and justify why...




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Author(s) / Copyright (s): Bo Herrmannsen 2013--2014, Damon Hart-Davis 2013--2014, Mike Stirling 2013

OpenTRV Wireless TRV Controller

| | |
|---|---|
| TITLE: V0p2_Main_PCB2 | |
| Document Number: | REV: 2 |
| Date: 28/03/2017 09:58 | Sheet: 1/1 |

# M E  M E  M E !

- Semi-retired serial entrepreneur, not quite as rich as Croesus or Musk
- Brought several technologies to market, probably good for the environment overall
- Run environmental and inventor groups
- Researching sustainability PhD
- Occasional raver!





# WAS MY TECH SUSTAINABLE?

- ExNet early UK **Internet** Service Provider (~1995)
- Entropay virtual VISA **payment** card (~2003)
- OpenTRV/Radbot **heating** control (~2020)
- PhD in decarbonising home **heating** (now)
- (Don’t talk about time in defence, oil, banking!)

# MOTIVATORS AFFECT SUSTAINABILITY?

- Getting rich?
- Making the world better?
- Doing interesting things?
- Retiring early (FIRE)?

P A U S E . . .

- Questions so far?



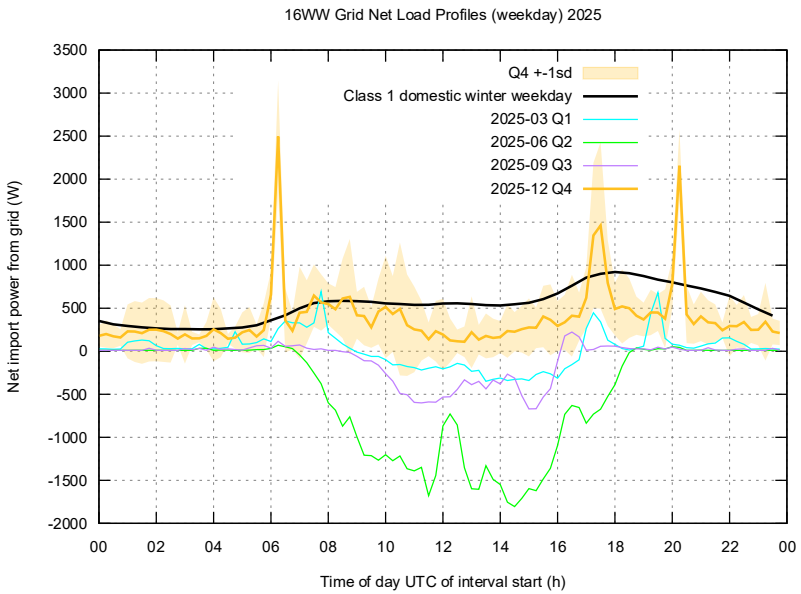
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# SOME SUSTAINABLE TECH HEADLINES

- Electrifying everything: heat, transport
- Heat: heat pumps, zoning, grid flex
- Repairability, efficiency: design in early
- AI (LLMs)

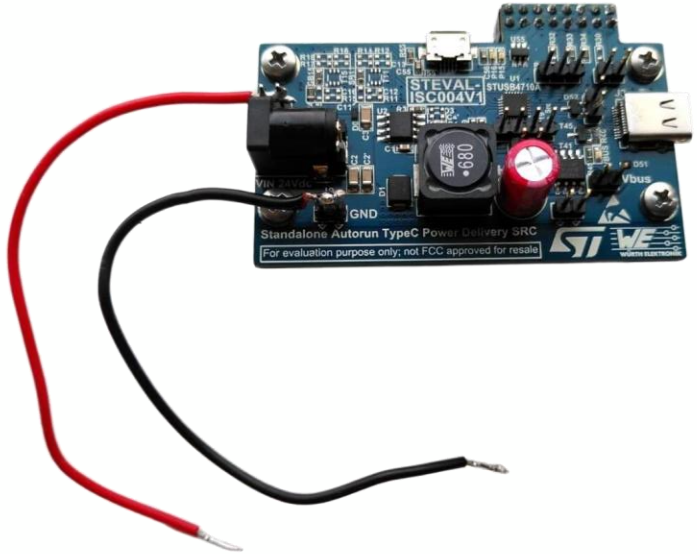
fairphone

REPAIR CAFE

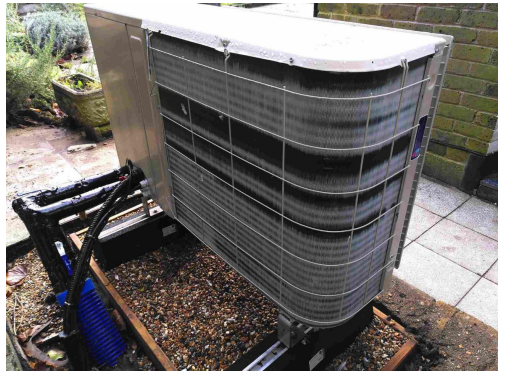


# AI LLM BROUHAHA!

- Any opinions on 'AI'?
- Energy/water consumption is a huge concern
- I used Claude and Gemini to help build a better off-grid power-supply for my laptop recently – is that ethical?
- **DISCUSS**



# HEAT: UK HOME HEATING DECARBONISATION



- Heat pumps are well over 100 years old!
- Vs fridges, not good at installing in homes
- I aim to fix this, and have householders understand heat pumps better than gas!
- ~20M UK home gas boilers need retrofitting with heat pumps by 2050
- Eliminate ~15% UK GHGs: very sustainable!

# HEAT: TRVS AND MICROZONING

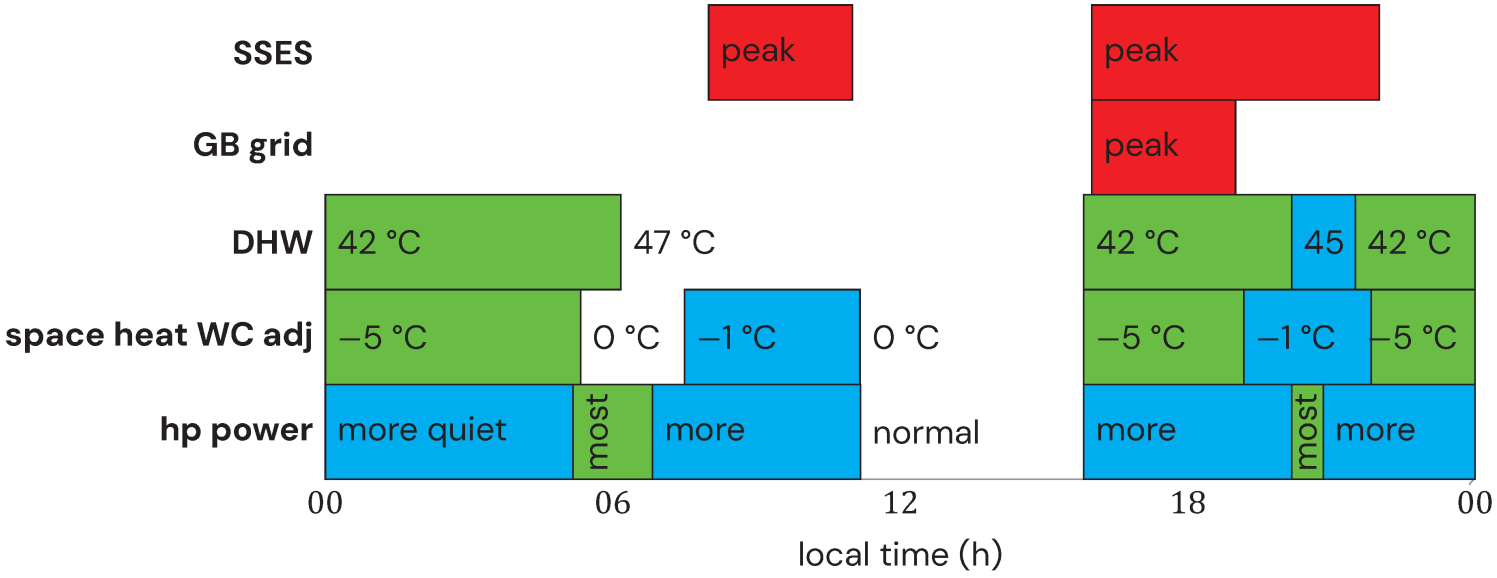
- One weird trick saves ~15% of carbon footprint (and heating costs) in home retrofits... [hart-davis2024zone]
- Have run an experiment in a whole house inside a lab in Salford to demonstrate [farmer2026TRV]
- Later in my research I hope to help people run their house heating with house music!



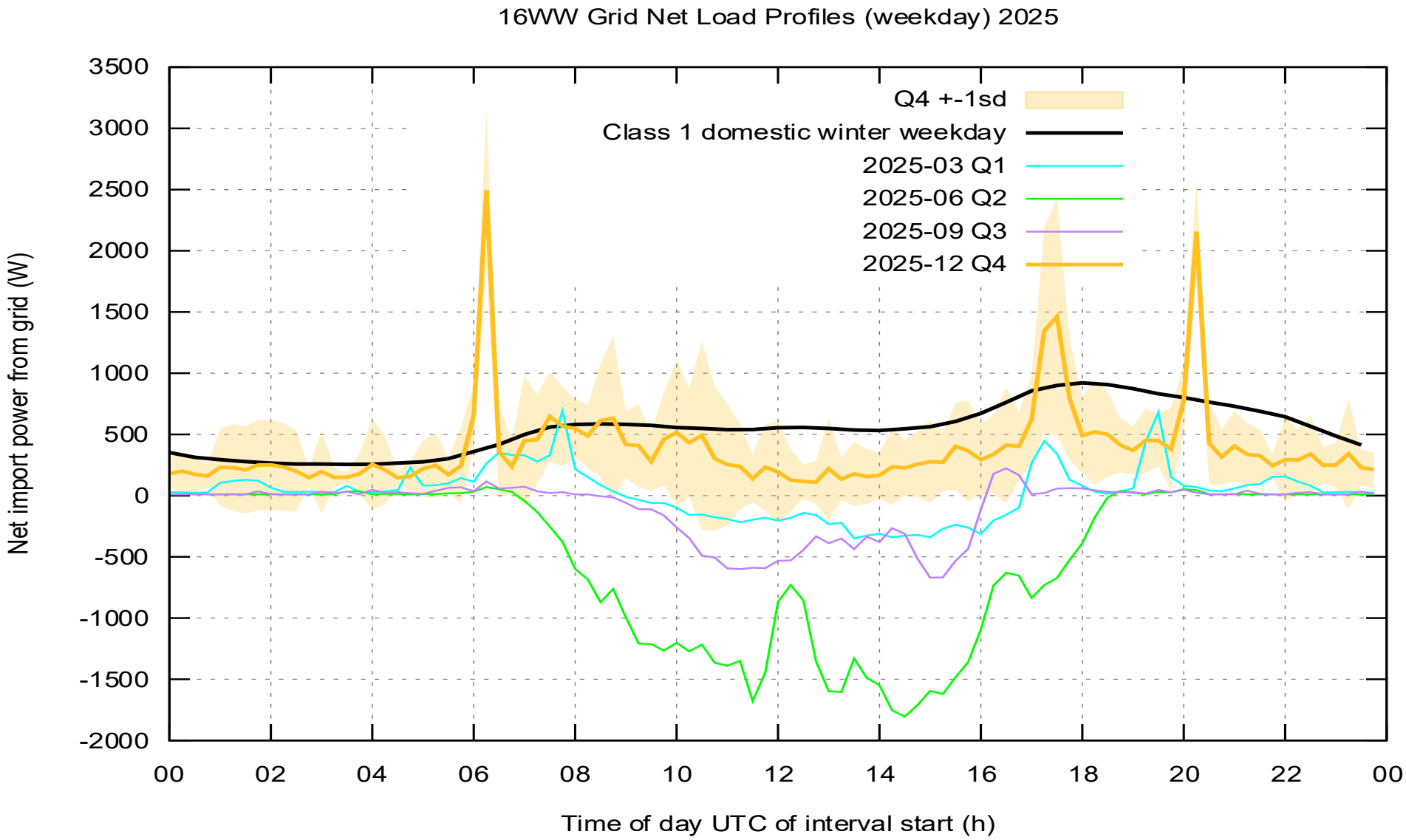
# HEAT: GRID FLEXIBILITY

- Heat and smart electrification! [hart-davis2026flex]
- Use less, and use at better times





# HEAT: GRID FLEXIBILITY



# HEAT: RADIATOR STICKERS

## Thermochromic Radiator sticker

Completed by Gillian Westley for ExNet

### Concept Comparison 2

#### A. Sticker

PVC, adhesive
13 x 25 mm Weight ~1g
Die-Cut

Binary. Turns red at 55°C and stays red as temp increases.



**Key Features**
Disposable
Low cost
No safety issues
High surface contact
Multi-Directional

#### B. Magnet backed

PVC coated, adhesive, 1 mm Ferrite-polymer blend magnet.
13 x 40mm Weight ~3g
Die-Cut

3 Binary, reversible Stickers Thermochromic Liquid Crystal (TLC). Amber < 55°C , Green @ 55° C , Red > 55°C



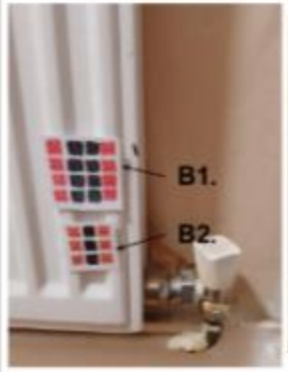

**Key Features**
Reusable
Lower production run
Longer Lasting
High surface contact (Direction Dependent)
Multi-Directional

#### B. Magnet backed evolved

PVC coated, adhesive, 1 mm Ferrite-polymer blend magnet.
Die-Cut



**B1.** 50 x 50mm comprised of 16 individual Microencapsulated thermochromic liquid crystal labels changing to red once the radiator surface has reach 55°C. Size had good surface contact on the two most common radiator styles. Minimised white space.
**B2.** 40 x 40mm comprised of 9 individual Microencapsulated thermochromic liquid crystal labels changing to red once the radiator surface has reach 55°C.






**Ferrite-polymer blend magnet.**
https://www.arnoldmagnetics.co.uk/flexible-magnets/

P A U S E . . .

- Questions so far?



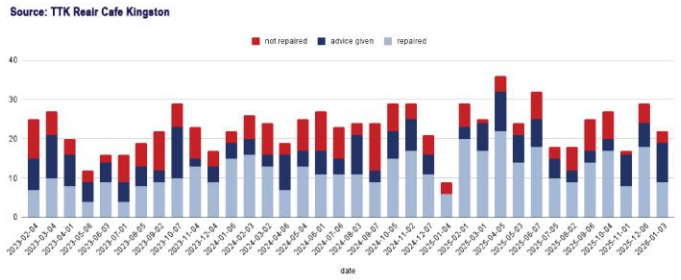
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# REPAIR CAFE KINGSTON: DATA ANALYSIS




**PER SESSION AVERAGES:**

**23 ITEMS** **15 REPAIRERS**




**TOTAL ITEMS 830** **REPAIRED 422** **51%** ✔

**76%**[1] of waste avoided or diverted approx **1.4t**[2] & **10t $CO_2$** emissions[3].

[1]by repair or providing a pathway to repair [2] Calculation based on Farnham Repair Cafe's assessment. [3]Calculation based on research by Steve Privett (SURREY).

### Knowledge Sharing Model

Proving repair is possible, changing the "Replace over Repair" paradigm.

Leveraging the mental health benefits of the cafe culture.

Upskilling the community in repair, maintenance and safety of products.

Influencing consumer choice

## ELECTRICAL & ELECTRONIC EQUIPMENT (EEE)

This category represents the major of Items presented at Repair Cafe Kingston and a pressing waste stream issue for the borough.

### Key Repair Barriers

**81% of End of Life**
Items designed without access for repair

No way to open product

**59% of Repairable**
Specific components needed for fix

New part required

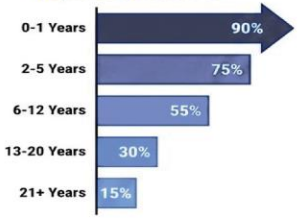
Source: Open Repair Alliance Dataset 2026.

### USER SURVEY Results

Most EEE items brought in to Kingston's for repair were due to multiple barriers to repair experienced by their users. **54%** reported two and **8%** face three distinct barriers. Access to and Knowledge of the product ranked as equal top barriers to repair.

based on a survey of 11 respondents at RCK.

### Product Age vs Repair Likelihood







**39% Fixed**
234 items successfully repaired

**32% End of Life**
192 items discarded

**29% Repairable**
173 items require further action

### In order of appearance

**Lamps**
Frequency: 55 items
Success Rate: 60% Fixed

**Vacuums**
Frequency: 43 items
Success Rate: 40% Fixed

**Radios**
Frequency: 42 items
Success Rate: 42% Fixed

**Toasters**
Frequency: 36 items
Success Rate: 30% Fixed

**Power Tools**
Frequency: 26 items
Success Rate: 53% Fixed

Repair Cafe Data Analysis by Gillian Westley, MSc Advanced Product Design, Engineering & Manufacturing, Kingston University London

# IN A STATE OF REPAIR

Repairability remains low, products feel unreapairable to experts and end-users. This is driven by a lack of documentation, standardised reversible fasteners and replaceable spare parts. Therefore a single failed component results in disposal of an entire product.




**Teardown Statistics:**

Main Material: Plastic
Brand: Russell & Hobbs
Made in: China
Power: 3000W

**Totals**
Parts: 55
Weight (g): 777.76
Tool/s Req: 7
No of Steps: 21

EU Repairability Index:
**C Average Repairability**

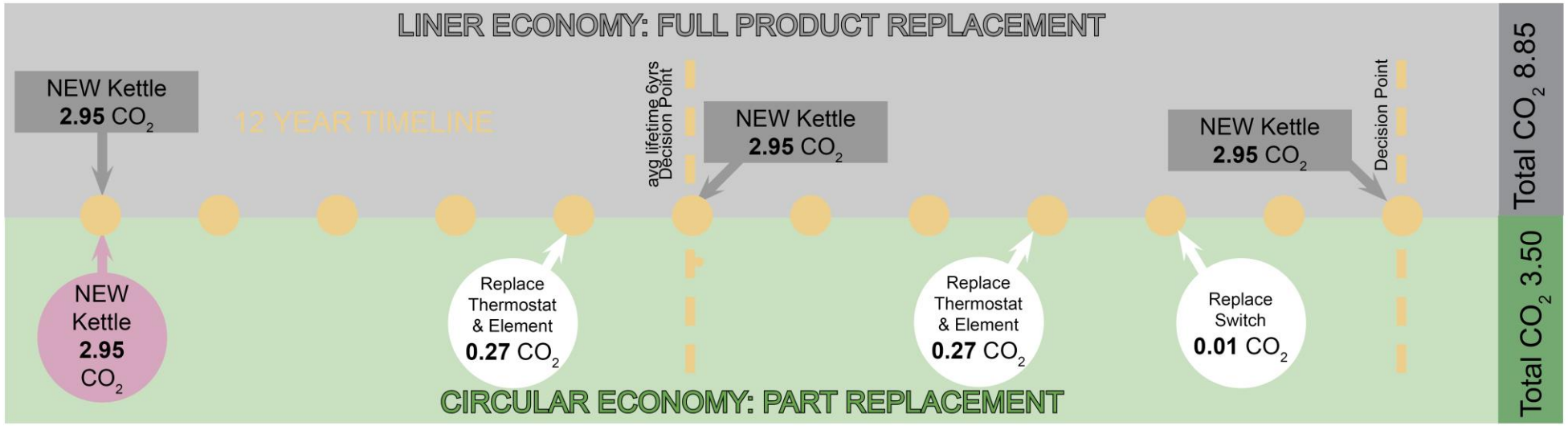
Carbon footprint per kg:
**2.59**

Disassembly Analysis and Teardown by Gillian Westley, MSc Advanced Product Design, Engineering & Manufacturing, Kingston University London

# Repairability does not cost more

**REPAIRABILITY SAVINGS**
**OVER A 12 YEAR LIFESPAN**
**5.35 $CO_2e$**

Cradle to Gate Streamlined Lifecycle Assessment of a typical domestic kettle.
Raw Material extraction and Processing Lifecycle Stages.




| Sub-Assemblies | Carbon Footprint ($CO_2$ e) | Avg Lifespan (Years) |
|---|---|---|
| Power Supply Base, Cable & Plug | 0.49 | 8 |
| Handle | 0.14 | 28 |
| Lid & Hinge Mechanism | 0.15 | 5 |
| Kettle Body | 1..88 | 5 |
| Heating Element | 0.12 | 6 |
| Thermostat | 0.17 | 3 |
| Switch | 0.01 | 10 |
| **Final Assembly** | **2.95** | **6** |

The components selected for replacement in the 12 year roadmap are based on an analysis of Failure Data provided at Repair events across the UK. The average lifespan of the product was also calculated from this dataset.

Extra material maybe required to engineer robust, reversible fasteners and components. However, this initial material investment is fully offset by long term durability gains and low-impact repair pathways. Replacing worn-out components preserves embodied carbon lock-in other functioning parts and potentially extending the lifespan to over years.

Streamlined Lifecycle & Failure Mode Analysis by Gillian Westley, MSc Advanced Product Design, Engineering & Manufacturing, Kingston University London

# Why prospective?

| Retrospective LCA | Prospective LCA |
|---|---|
| Process already fixed | Process still evolving |
| Reports impacts | Supports decisions |
| Limited scope for intervention | Enables optimisation |
| Used for validation | Used for design purposes |

**Environmental assessment should inform process development, not simply evaluate its outcomes**

P A U S E . . .

- Questions so far?



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# SUSTAINABLE WEALTH?

- ‘Wealth’ / happiness / healthspan can be decoupled from environmental damage
- We can probably deal with climate change, microplastics, biodiversity and peaking populations AND be happier, if wise
- (Sun-following Web servers?) [piantella2025harvesting]
- Tech AND behavioural change can enable this

# REPAIRABILITY / CIRCULARITY

- Who has used a Repair Café?
- What is the "circular economy"?
- Does "wealth" (GDP?) require "more stuff"?
- **DISCUSS**

# SUNSHIELDS IN SPACE VS SUFFICIENCY

- Do we have enough tech to fix the climate?
- Or sunshields, particulates, polar whitening...
- Or fewer flights, fewer cars, less stuff?
- My small home described by energy minister as 'modest' vs RIBA 'rabbit hutch' - but Net Zero! [mark2015homewise]
- Keep innovating, be frugal!
- **DISCUSS**



# DISCUSSION



**Enough?**

In groups please discuss and decide whether you think we already have all the tech we need to fix at least climate change...

# ALL DONE!

- Thank you!
- Questions?

These slides are available on my site [hart-davis2026sustech] and on SurreyLearn...

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# REFERENCES


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- [hart-davis2024zone] Hart-Davis, Damon and Liu, Lirong and Leach, Matthew *To Zone or Not to Zone When Upgrading a Wet Heating System from Gas to Heat Pump for Maximum Climate Impact: A UK View* 2024-05-31, *Sustainability*, volume 16, report/number 11, ISSN 2071-1050, doi:10.3390/su16114710
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- G Westley: "In a State of Repair" and Repair Café stats slides.
- M Gargaro: "Prospective LCA" slide.



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