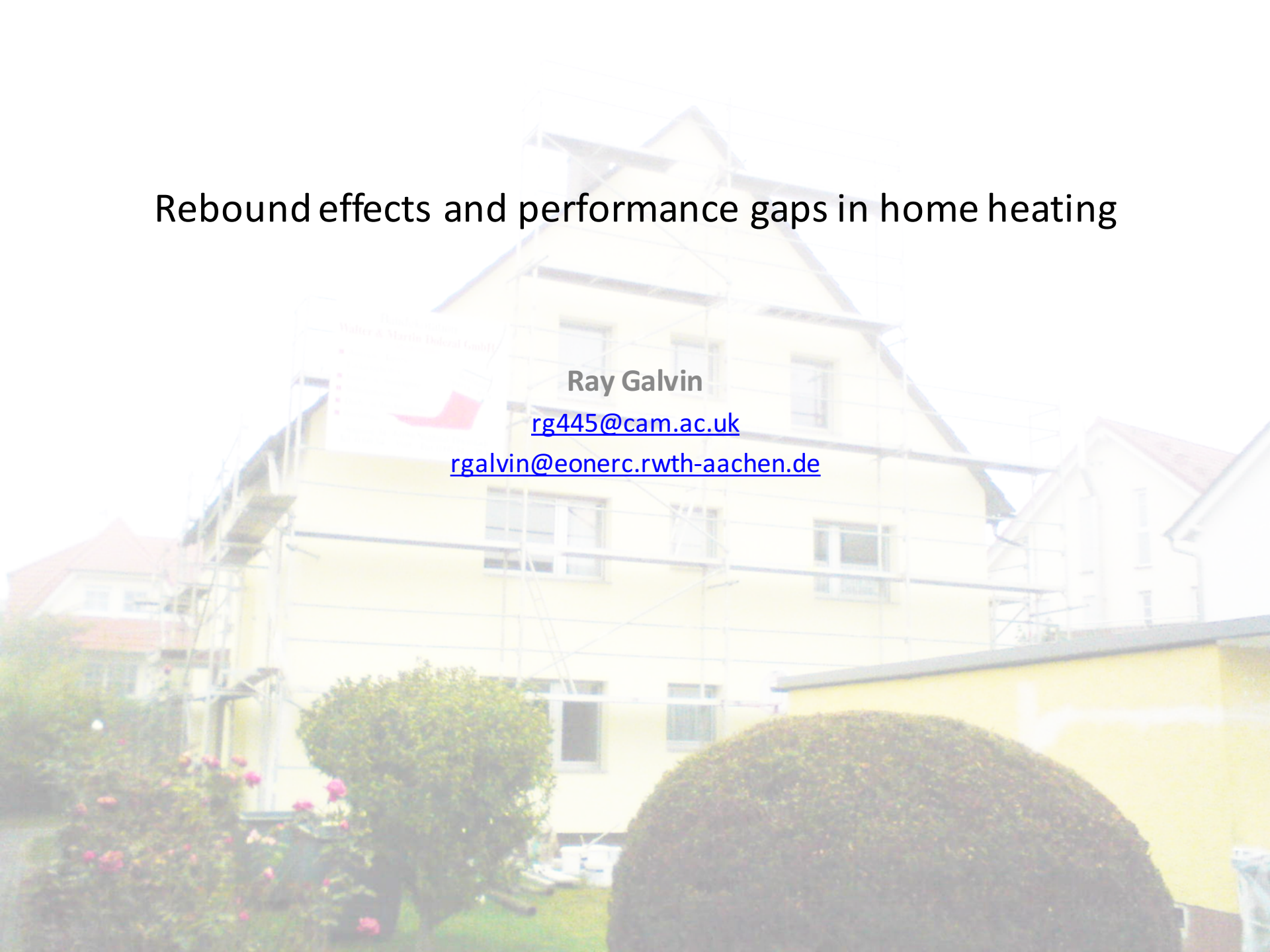
Rebound effects and performance gaps in home heating



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Outline and key literature

1. Defining the rebound effect – *history, definition, maths*
2. How the rebound effect happens in home heating – *description and causes*
3. The rebound effect is not always a bad thing
4. A framework of social theory for dealing with the rebound effect in home heating

Key works:

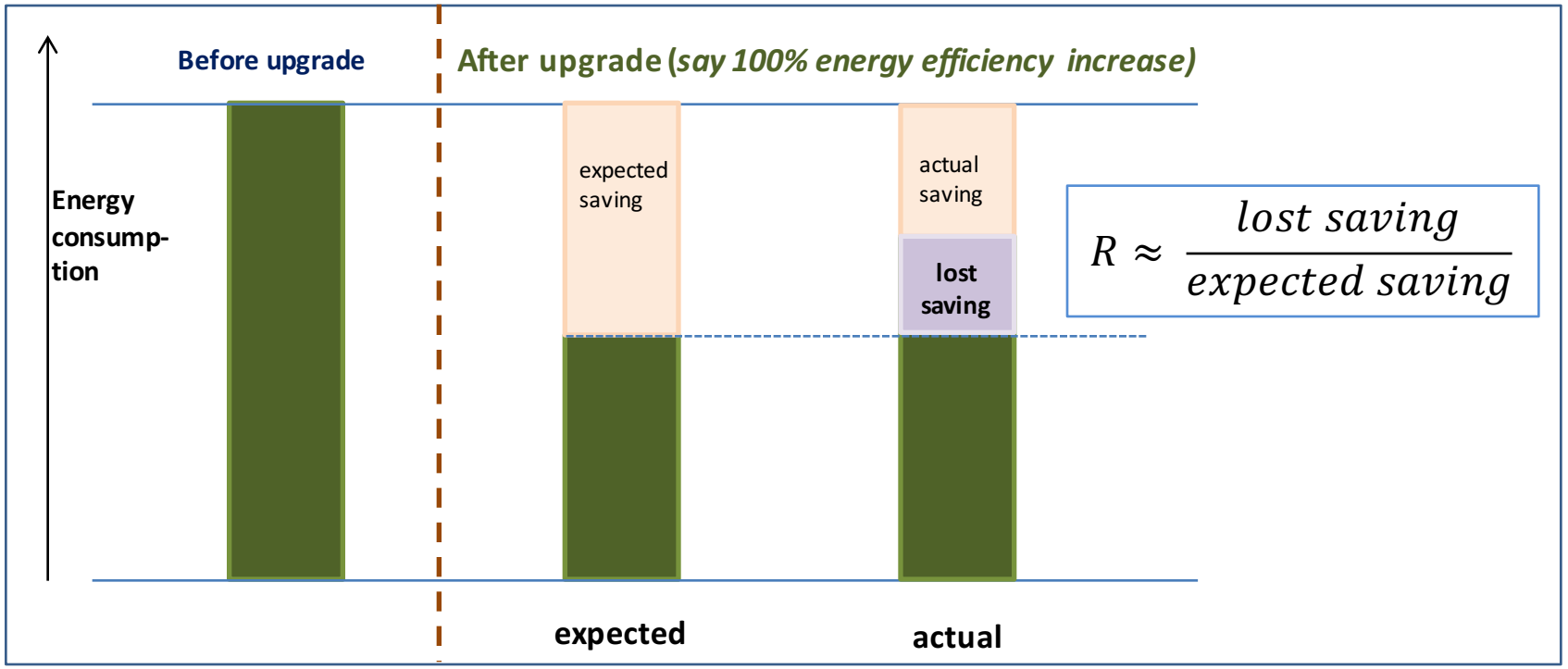
- Galvin R (2015) **The Rebound Effect in Home Heating: A guide for policymakers and practitioners**. Abingdon (UK): BRI-Earthscan-Routledge.
- Sunikka-Blank M, Galvin R (2012) **Introducing the Prebound Effect: the gap between performance and actual energy consumption.** Building Research and Information 40(3): 260-273.
- Galvin R, Sunikka-Blank M (2016) **Quantification of (p)rebound effects in retrofit policies e Why does it matter?** Energy 95: 415-424.

Other very relevant literature:

- Khazzoom J (1980) Economic implications of mandated efficiency in standards for household appliances. Energy Journal 1: 21–40.
- Berkhout P, Muskens J, Velthuijsen J (2000) Defining the rebound effect. Energy Policy 28 (6–7): 425–432.
- Sorrell S, Dimitropoulos J (2008) The rebound effect: Microeconomic definitions, limitations and extensions. Ecological Economics 65: 636-649.
- Saunders H (2000) A view from the macro side: rebound, backfire, and Khazzoom–Brookes. Energy Policy 28(6-7): 439–449.

1. Defining the rebound effect

- 1970s oil crisis *(Sept 1973-March 1974 oil price quadrupled, $3 → $12 per barrel)*
- → policy regulations to increase energy efficiency
- Late 1970s studies by Daniel Khazzoom and Leonard Brookes
- → The *actual* reductions in energy consumption were consistently less than the *expected* reductions



Interesting (and historically important) points:

- The rebound effect was identified/defined by economists
- They explained it in terms of *classical behavioural economics*
- i.e. *a behavioural response to cheaper energy services*
- They described it as an *elasticity*
- = the *"energy efficiency elasticity of energy services"*

expressed formally:

$$R = \frac{\frac{\partial S}{S}}{\frac{\partial \varepsilon}{\varepsilon}}$$

which resolves to:

$$R = 1 + \frac{\log(proportionate\ change\ in\ energy\ consumption)}{\log(proportionate\ change\ in\ energy\ efficiency)}$$

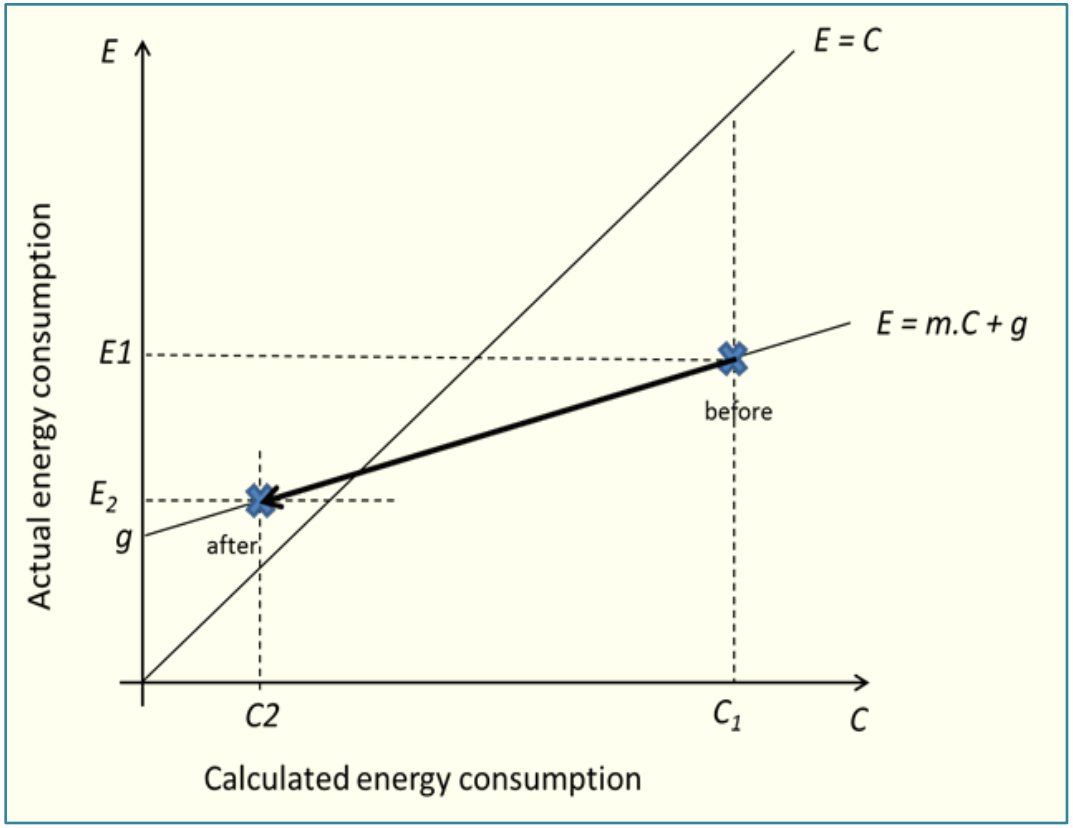
This is a good basis, but there are 2 important caveats:

1. Rebound effects aren't always bad
2. There's more going on than just a behavioural response to cheaper energy services

2. How the rebound effect happens in home heating

Typical structure of calculated and actual heating consumption pre- and post-retrofit

$$R = 1 + \frac{\log\left(\frac{E_2}{E_1}\right)}{\log\left(\frac{C_1}{C_2}\right)}$$



(- note that *C* is the reciprocal of energy efficiency *ε,* hence $\boldsymbol{\varepsilon_2 / \varepsilon_1 = C_1 / C_2}$)

Example:

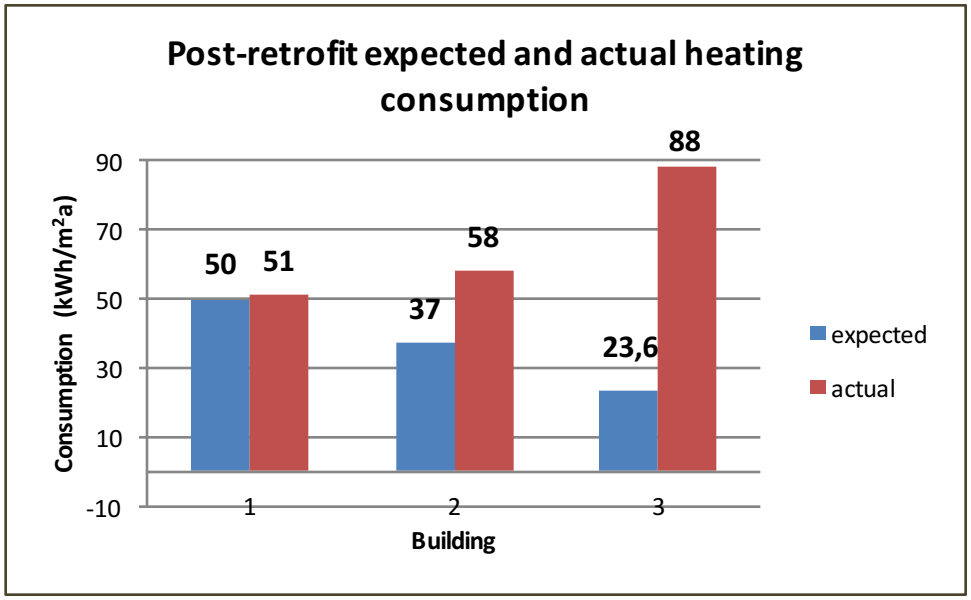
A retrofit project in southern Germany:

3 identical apartment blocks, each with 30 apartments.

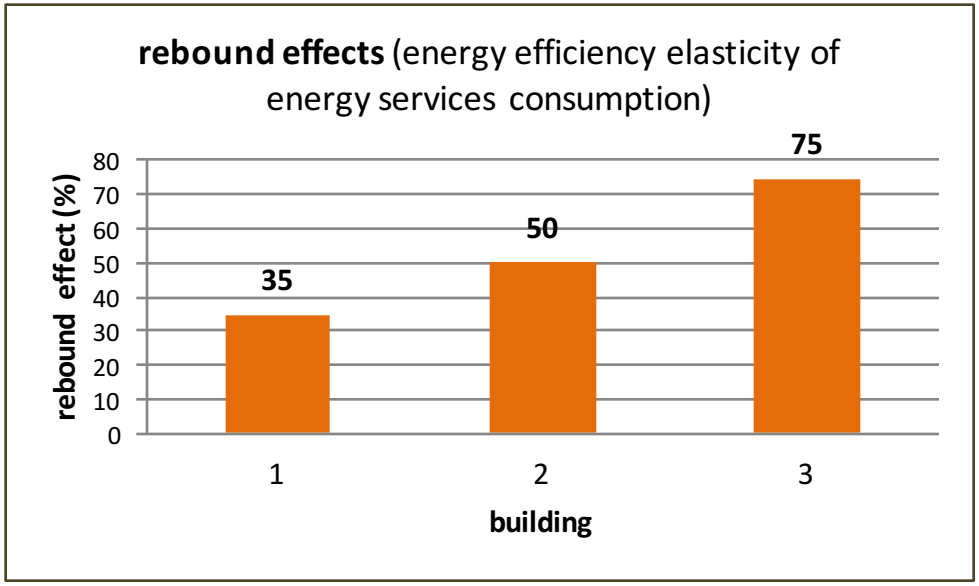
Pre-retrofit heating consumption:

expected: **320** kWh/m^{2}a

actual: **171** kWh/m^{2}a



This is an extreme but not unusual example.
Why do such rebound effects happen?



(Types of) reasons for rebound effects in home heating:

1. Household behaviour

- *classical behavioural economics*
- *changes in household practices*

2. Technical problems and mistakes

- *gaps in insulation and air-tightness*
- *boilers and/or radiators not optimally adjusted or unsuited to house*
- *thermostats in the wrong places*

3. Technology interfaces not well suited to human users

- *mysteriously unfathomable heating controls*
- *inward opening windows (bad for energy-efficient ventilation)*

4. Miscalculations of pre-retrofit U-values

- *Can give artificially high rebound figures (in some cases only!!)*

Each type might need a different type of solution:

- Technical fix / occupant training / policy change / cultural change /
- *(can you match which type of solution to which type of problem?)*

3. The rebound effect is not always a bad thing

A meta-study in 2012:

All datasets we could find, of expected and actual consumption, for homes in Germany, plus some from Belgium, Netherlands, France´& UK.

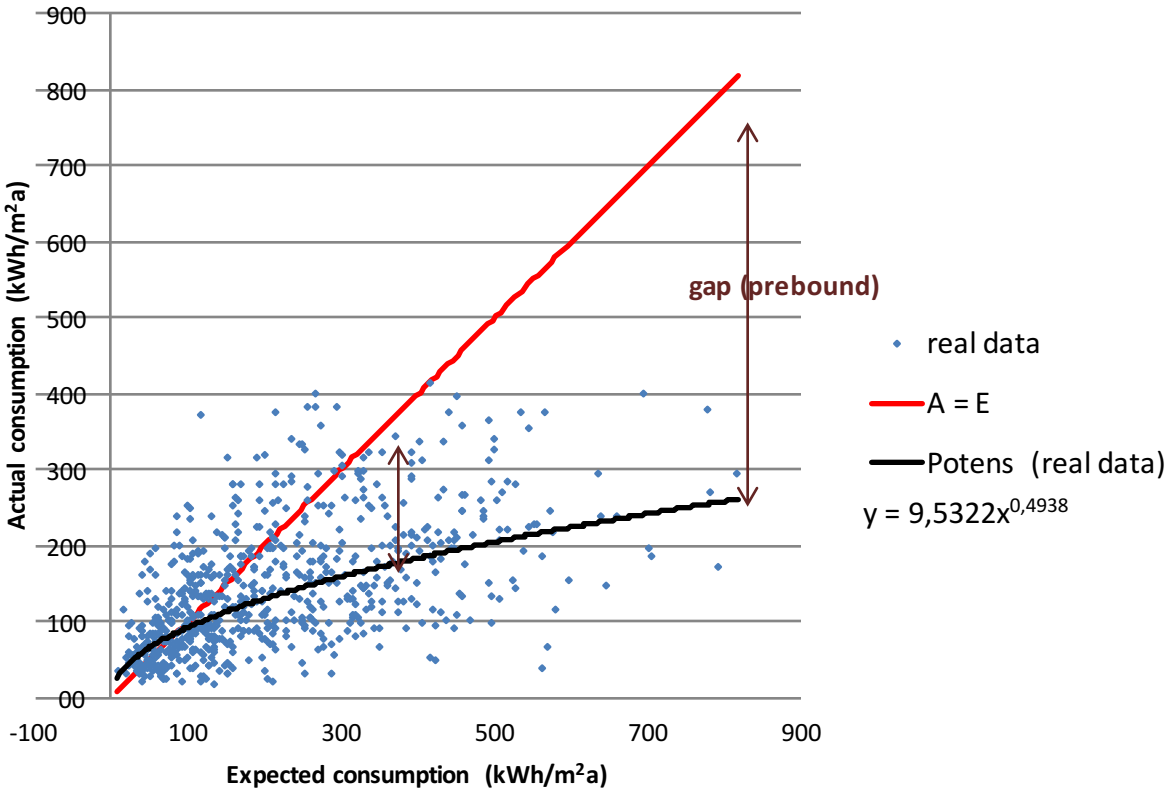
(Sunikka-Blank and Galvin, 2012)

In a later paper we showed the relationship between rebound and prebound effects.

- If the prebound effect is high, a retrofit needs to bring a high rebound effect to alleviate fuel poverty

(Galvin and Sunikka-Blank, 2016)

Example – random selection of 700 houses in France *(data courtesy of J-M Cayla, EDF)*



- *A high rebound effect can represent an **increase in welfare** for fuel-poor households.*
- *It gives them a choice of **more warmth for free**, or **lower fuel bills for the same heat**, or **a bit of both***

But this only applies to rebound effects caused by behavioural responses

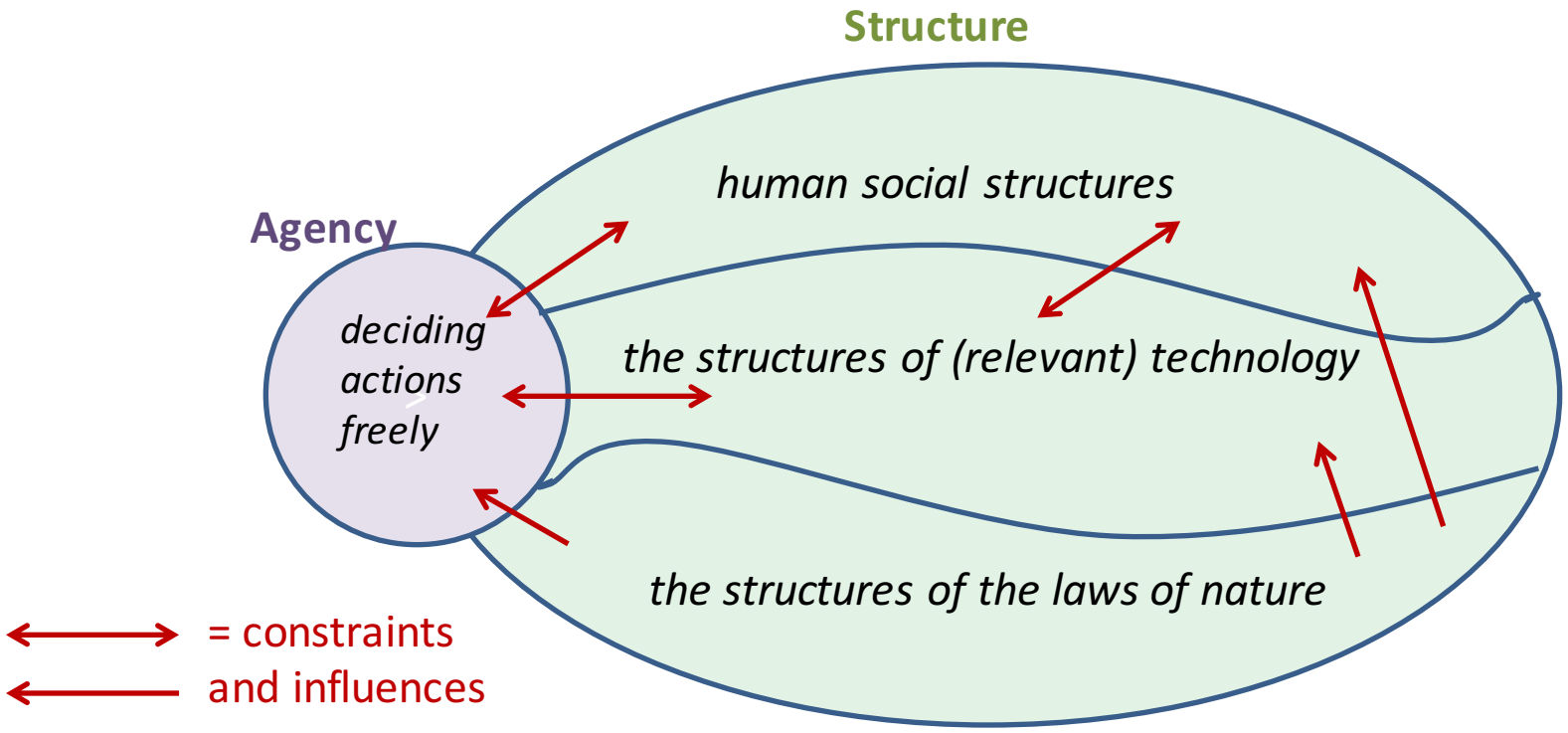
4. A framework of social theory for dealing with the rebound effect in home heating

- socio-technical systems theory?
- (social) practice theory?
- actor-network theory?

All have their roots in 20th century discussion of agency and structure

- *These are all useful, but it might be better to go back to basics*

→ *Revisit the discussion of agency and structure (will outline this tomorrow)*




Thanks for listening!
Your questions and ideas???