



BUILDING A SUSTAINABLE FUTURE  
THROUGH COLLABORATIVE RESEARCH

# Building Performance Fabric, Impact and Implications

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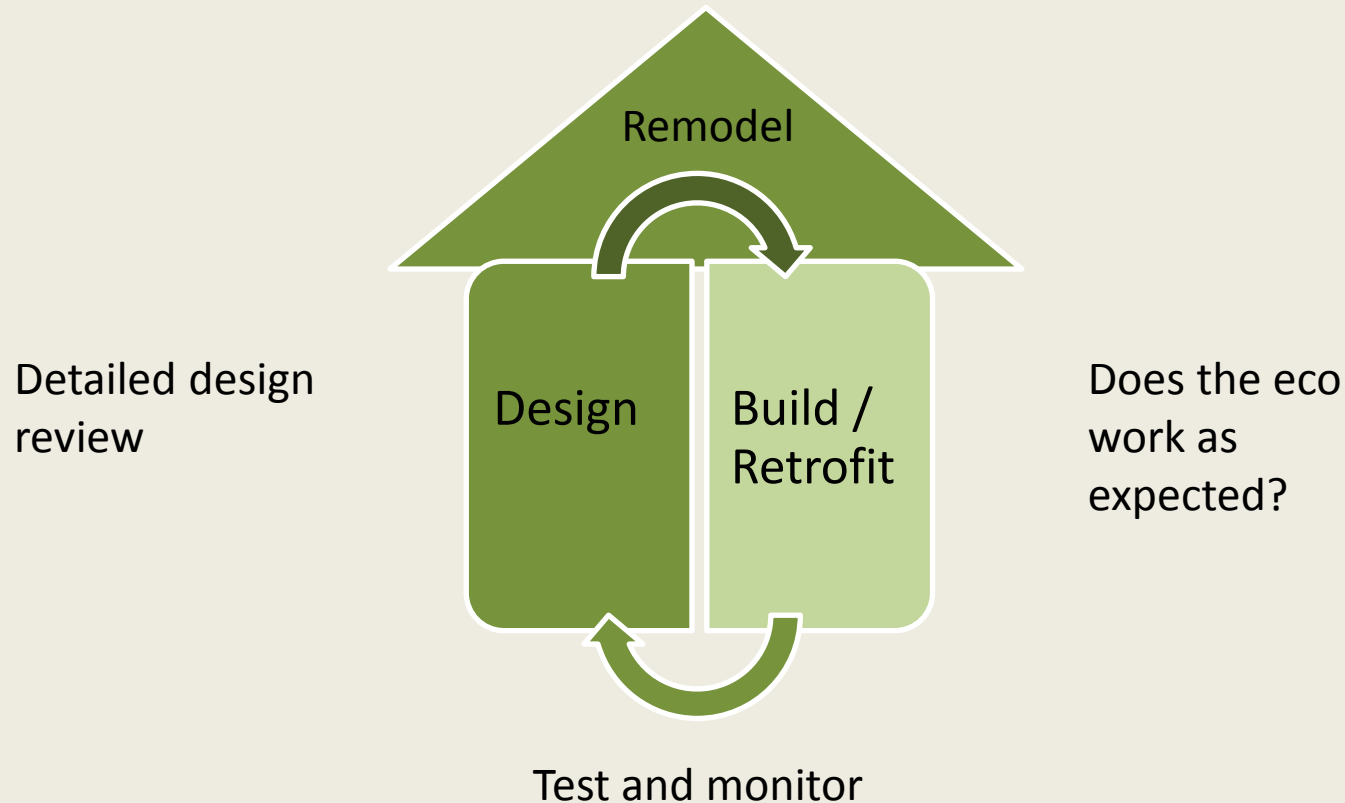


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# Do sustainable cities perform as expected?

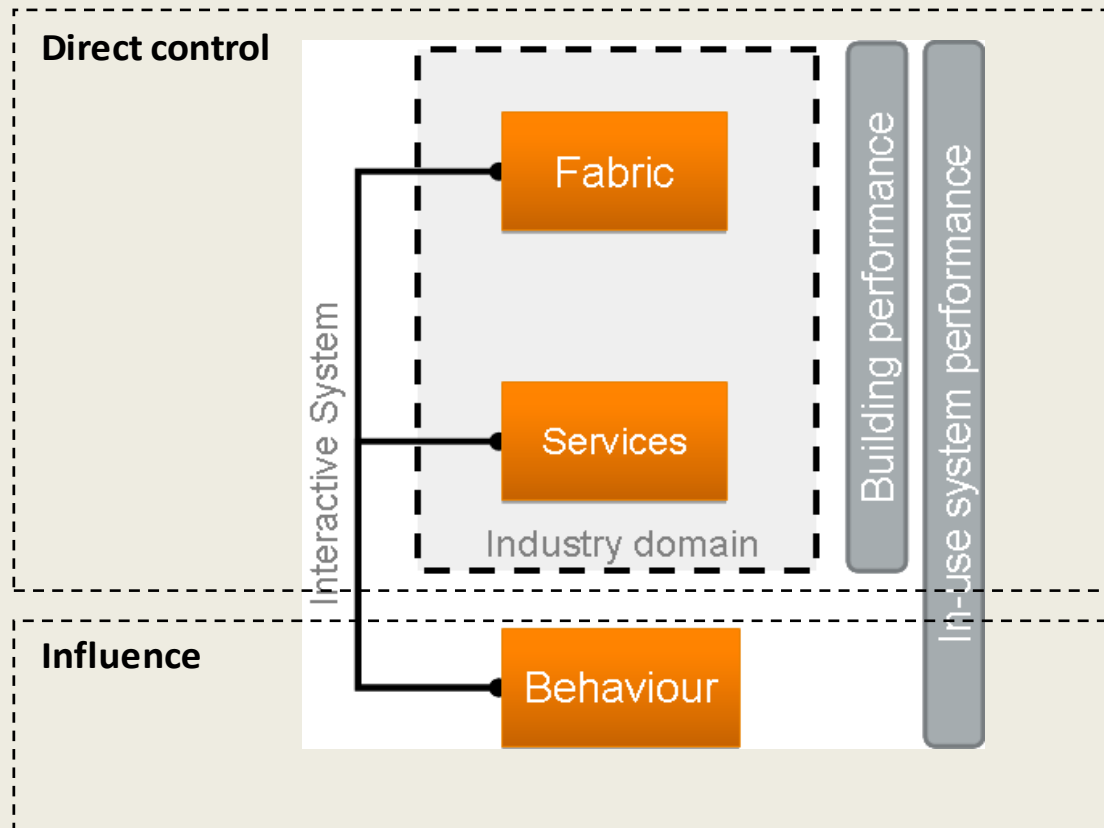


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# Eco-Control



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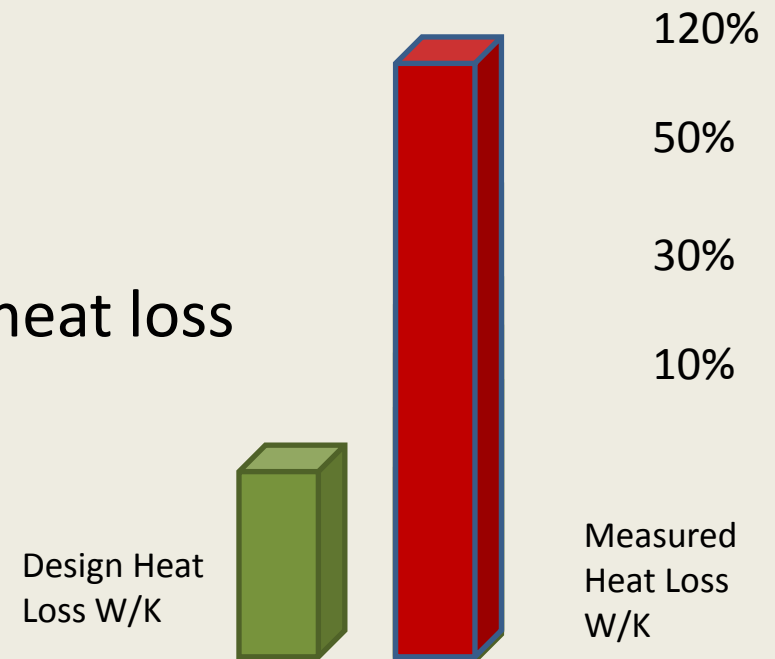
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# The Performance Gap

- The difference between
  - Design prediction
  - Measured values
- Measured whole building heat loss
- Solutions exist

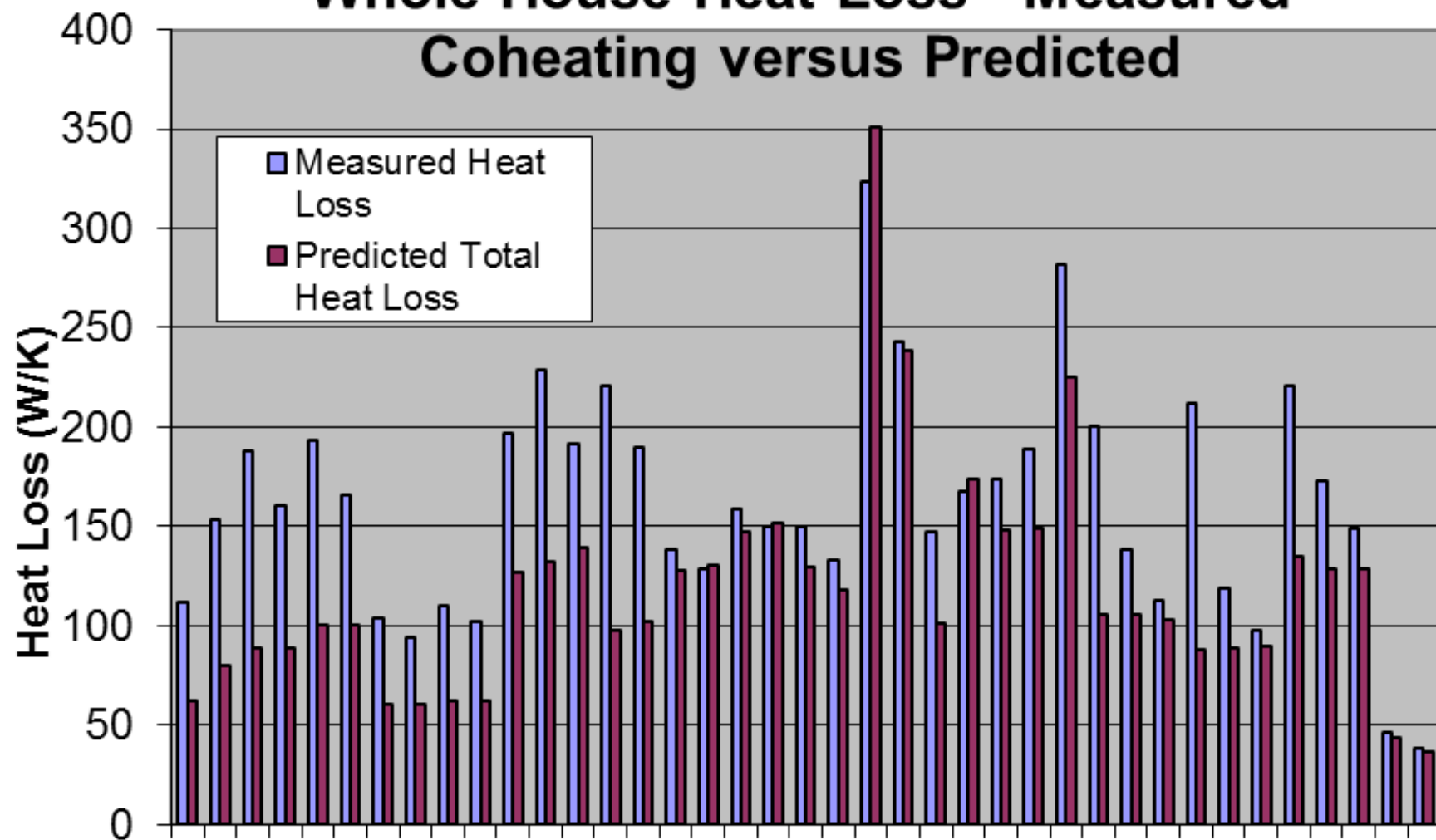


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# Whole House Heat Loss - Measured Coheating versus Predicted

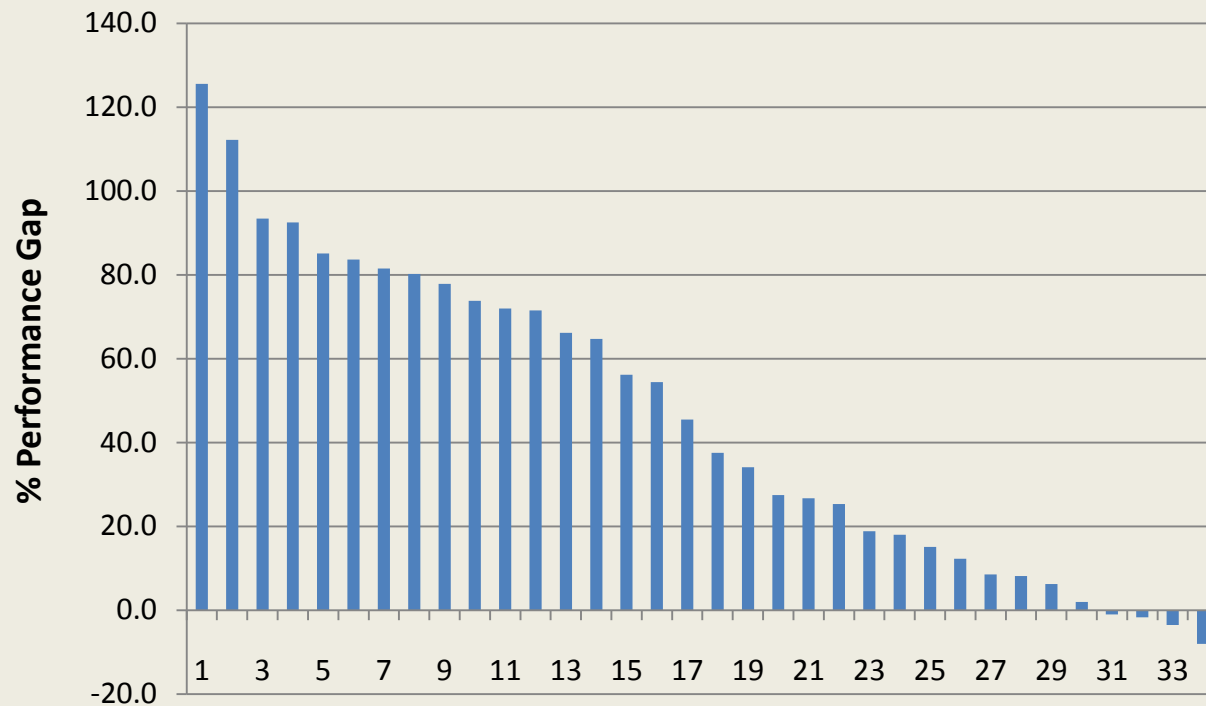


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# % Performance Gap: Tolerance



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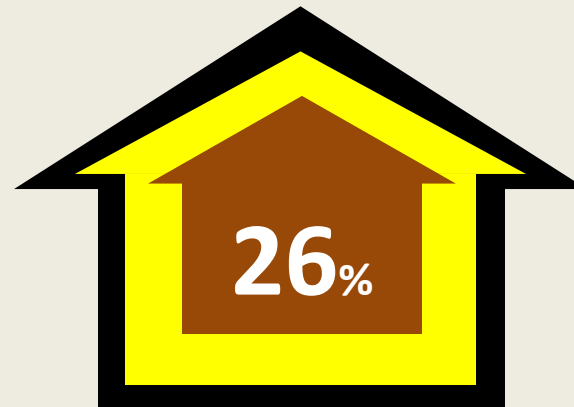
# Build with Confidence

- 120,000 – 200,000 new homes
- New homes need an upgrade
- 22 million homes need upgrading
  - (retrofit market £200 billion over 40 years?)



# Conservative estimates

- 120,000
- 50% not achieved (DECC)
- 26% average (LSI tests – fabric)
- 0.06mtCO<sub>2</sub>eq / annum
- £14 million or
- £115 per house





# Unintended Consequences

Solar

Water

Heat pumps

Build quality

Thermal performance

annual bill for their electricity and gas was £4,434. In the last 15 days they had spent £355 on electricity.

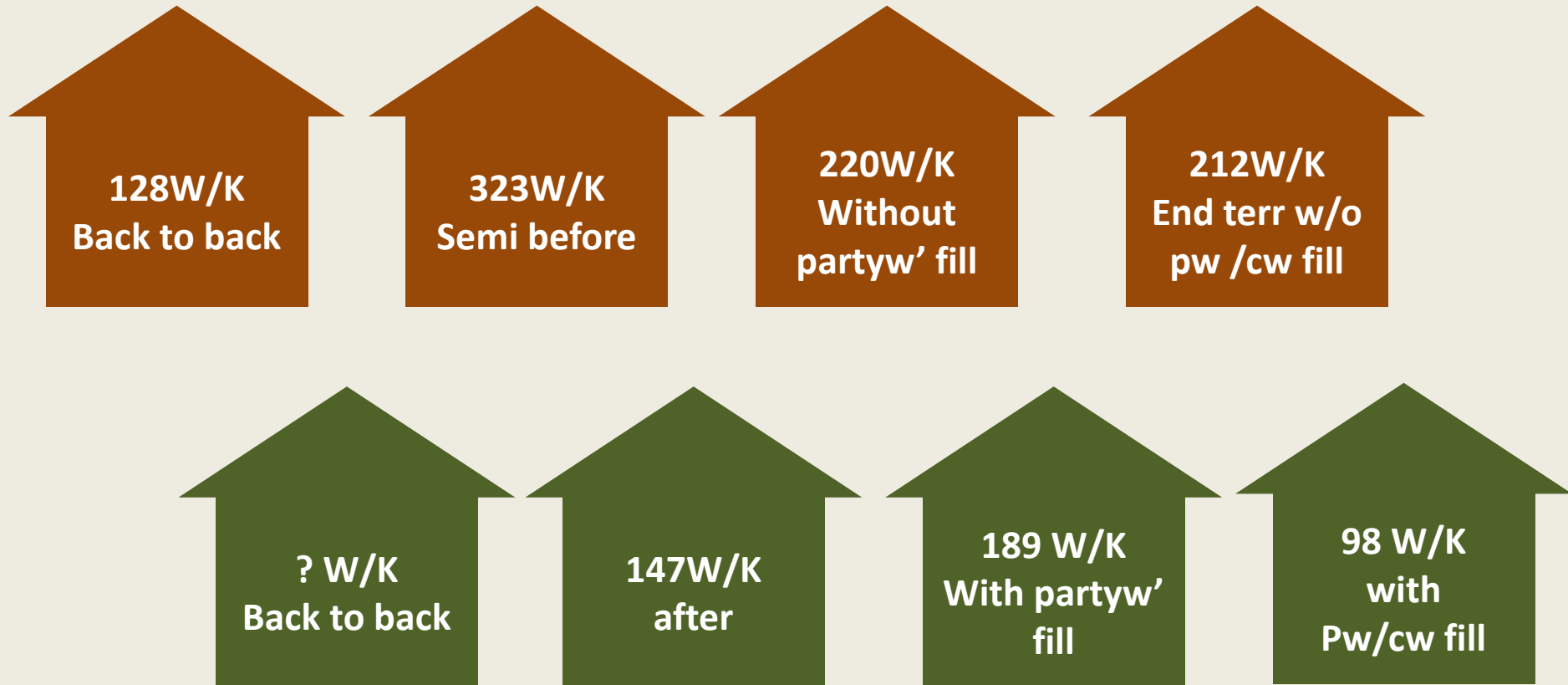
2 to 3 times national average



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# Establish Actual Change

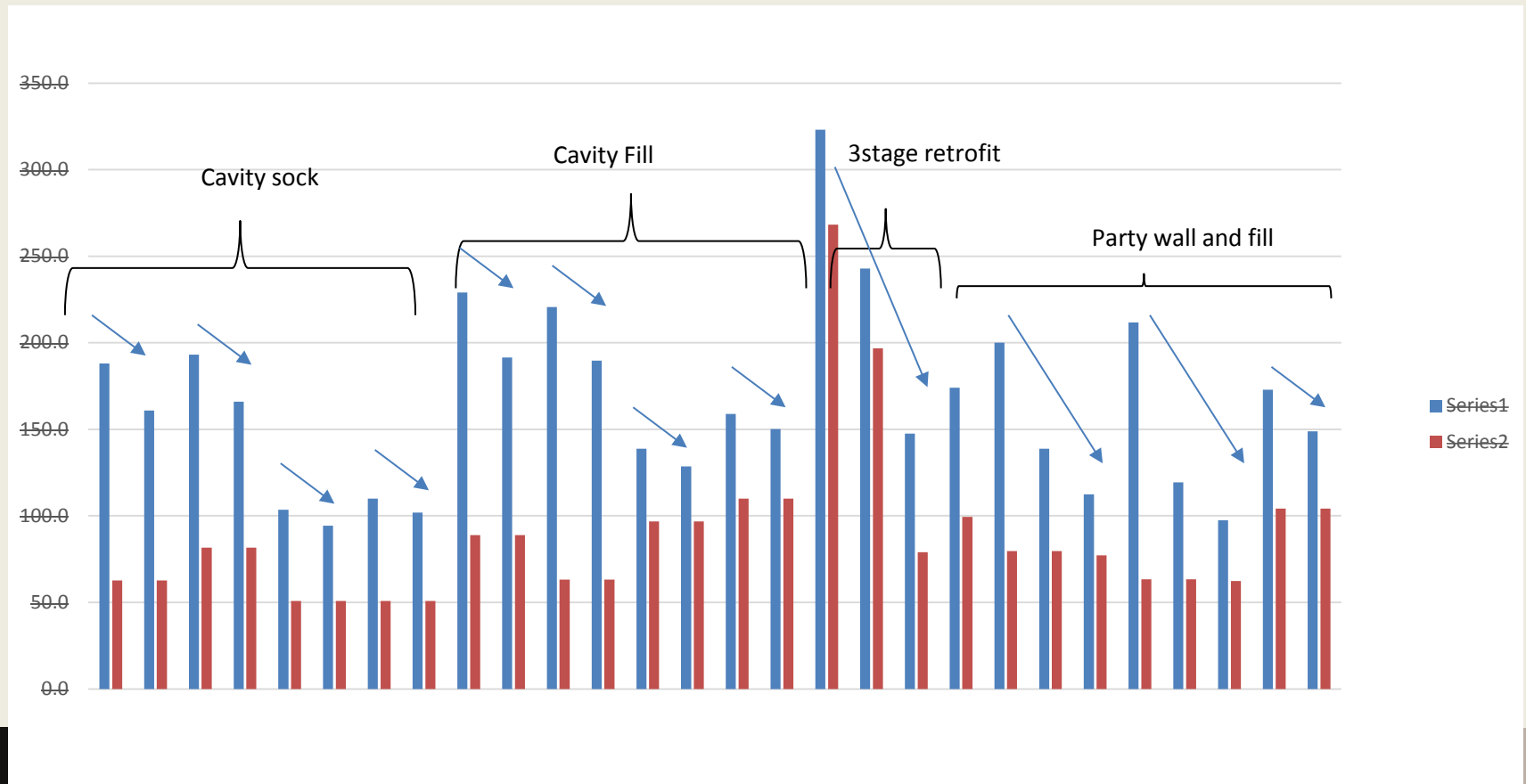


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# Retrofit – understanding the difference





# Base Line

- Design Review
- Performance Testing
  - Whole building and elemental heat loss
    - New build: design v's measured
    - Existing: before and after intervention
- Intensive and extensive monitoring
  - elec, gas, circuits, temp, humidity, weather stations
- Building survey, thermography
- Behaviour Studies

# Building Forensics



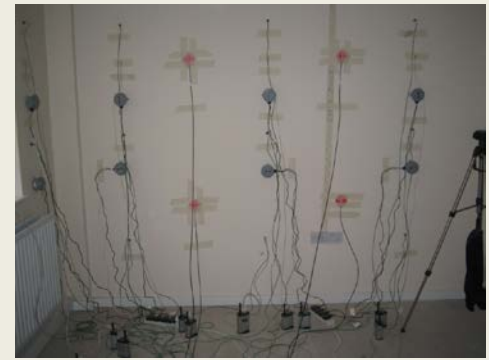
Pressurisation  
testing



Construction observations



Surface/cavity temperature  
measurement



Heat flux  
measurement



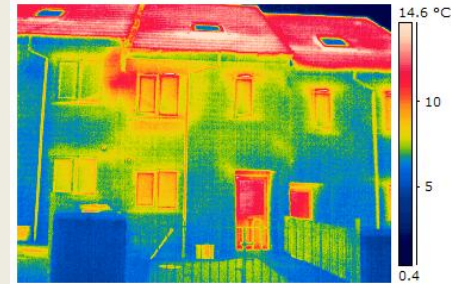
## Thermal Analysis

Tracer gas  
measurement



Leakage detection

Thermal imaging



Air flow  
measurements



Partial  
deconstruction

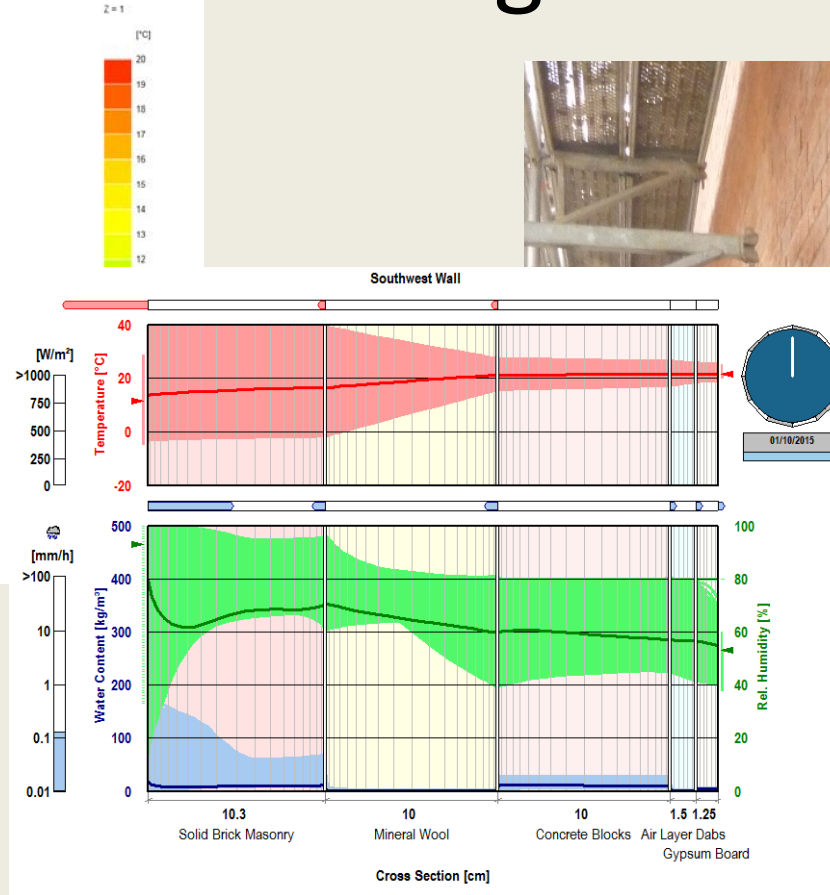
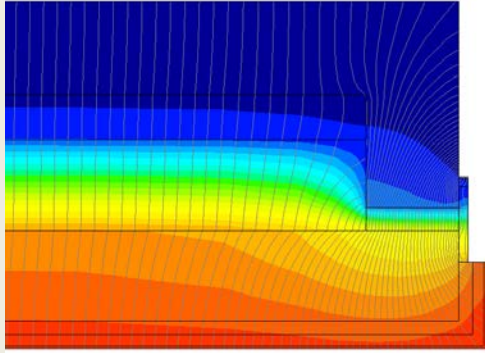


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# Hygrothermal and Thermal Modelling



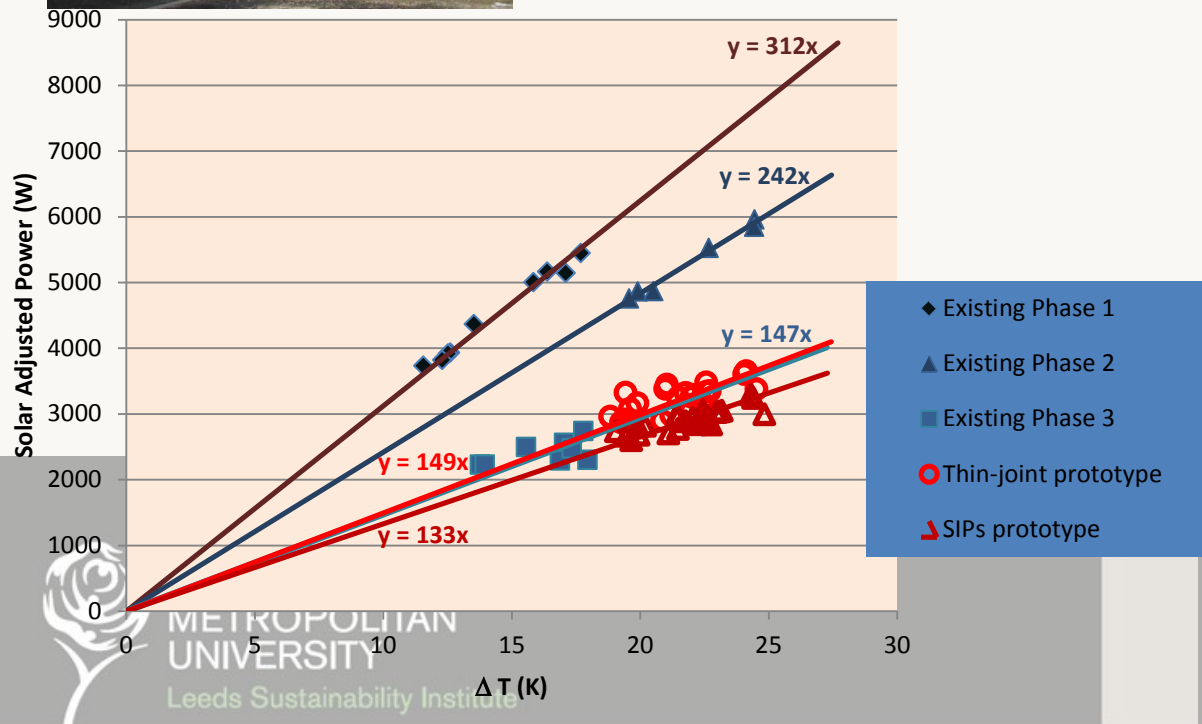
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# Temple Avenue Project



Prototype  
construction for  
Derwenthorpe  
SIPs  
Thin-Joint Masonry  
2-stage refurb. of  
existing home



# Consistent intervention?

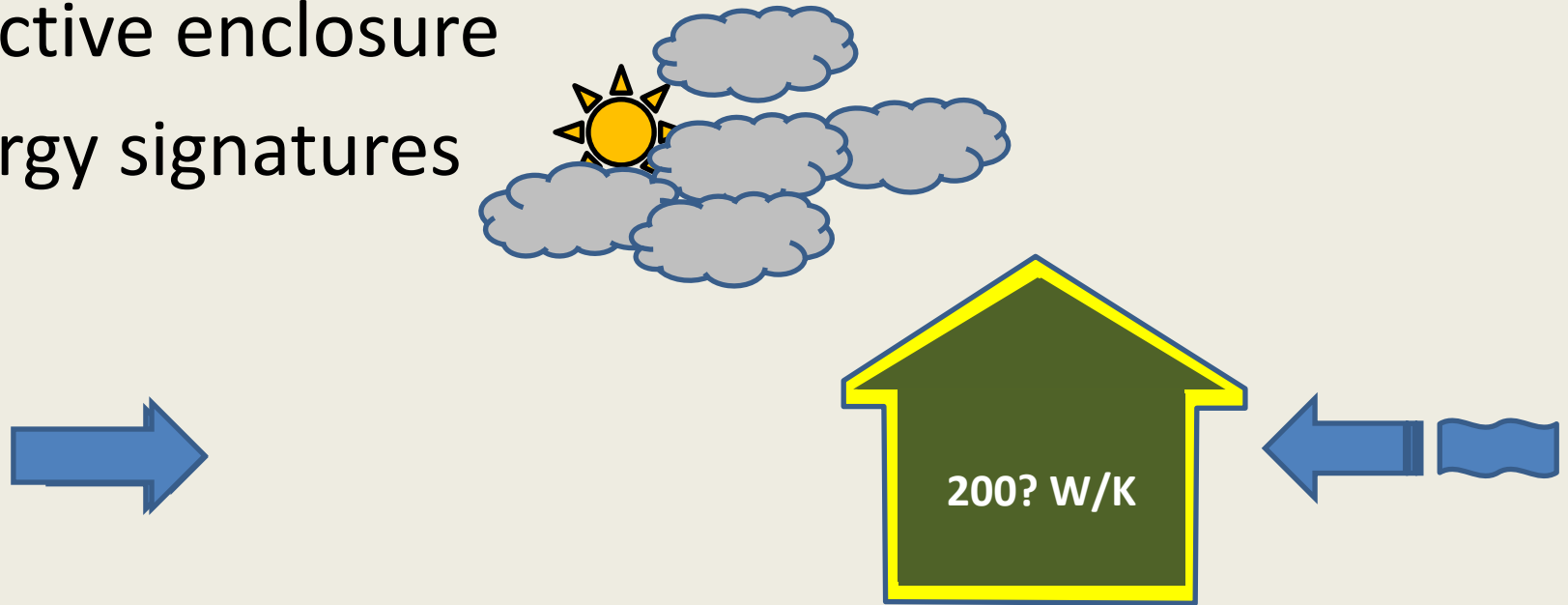




# Measurement

Effective enclosure

Energy signatures



- Integrated method for evaluating and controlling performance

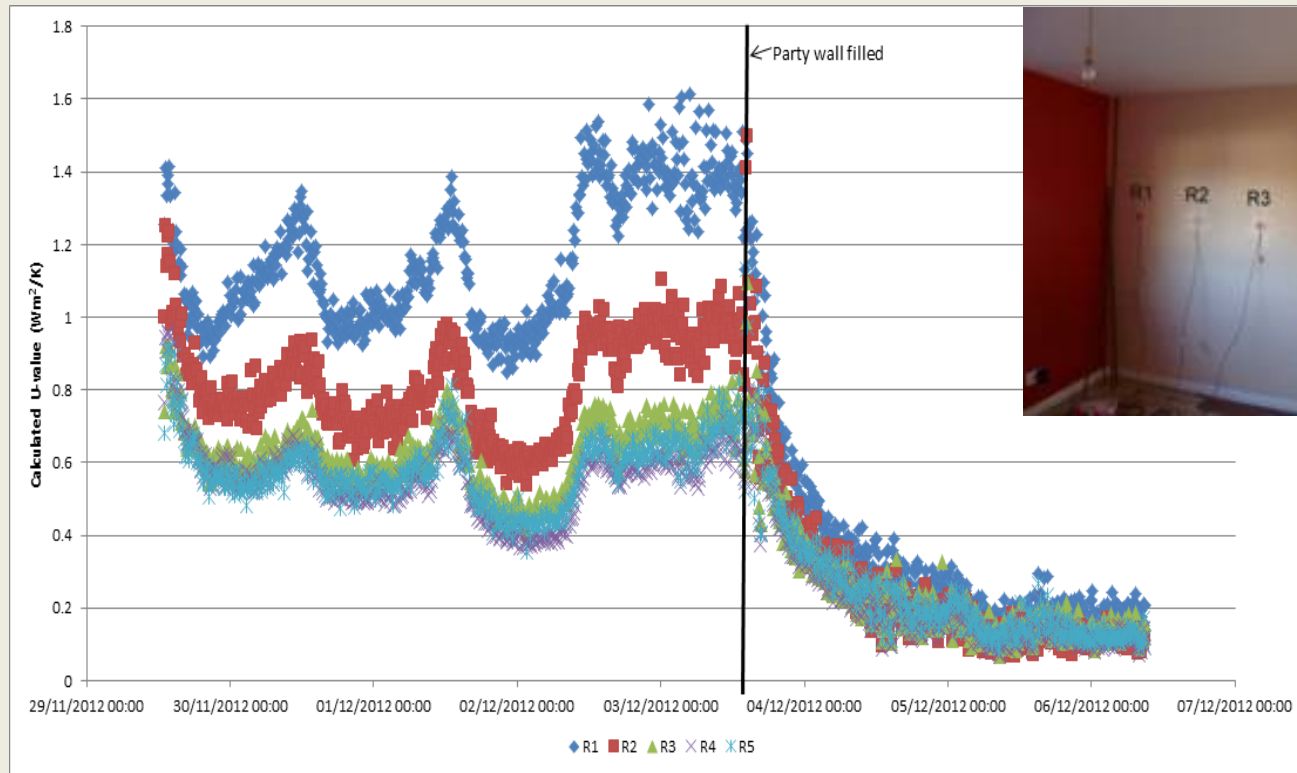


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# Consistency and Reliability





# Building better homes for the Customer: Future Groups April 2012

- “Concerns have been raised regarding the as-built energy performance of new homes in comparison to designed values. The evidence for this comes almost exclusively from the work of Leeds Metropolitan University who accumulated data from 16 homes between 2005 and 2009.”



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# Building better homes for the Customer: Future Groups April 2012

- This sample [Imu] relates to only 0.0064% of the housing stock constructed and therefore cannot be seen as being representative.
- Set against this data, The Futures Group has found growing evidence that the performance of newer homes is improving.

# Whole building testing

The co-heating test does not provide a practical or economic method for wide-scale measurement of as-built energy performance.

- **Expensive, Time consuming, Unoccupied and Winter test**
- **Energy signatures:**
  - steady state
  - dynamic
  - in-use and occupancy


**The Futures Group**  
The Best Homes "Think Tank"





REGULATED APPLIANCES THOROUGHLY TESTED, RELATIVE ENERGY RATING AWARDED ONCE THE KWh/YEAR EFFICIENCY IS KNOWN

- THE EUROPEAN COMMISSION DIRECTIVE (EUE-LEX 2012) AND RESULTING UK ENERGY CONSERVATION REGULATION (HMSO 2004) DICTATES THAT:
- **“6 (1) NO SUPPLIER SHALL PLACE ON THE COMMUNITY MARKET A REGULATED APPLIANCE UNLESS HE HAS ESTABLISHED TECHNICAL DOCUMENTATION SUFFICIENT TO ENABLE THE ACCURACY OF THE INFORMATION CONTAINED**



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graph TD; A[Understand, Develop Capability, Integrate, Build and Enhance] --- B[Research and Development]; A --- C[Educate and Train Knowledge and Skills]; A --- D[Methods for assessing, testing, monitoring and surveying]; A --- E[Build with integrity and confidence]
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**Understand,  
Develop Capability,  
Integrate, Build and Enhance**

**Research and  
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**Methods for  
assessing, testing ,  
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**Build with integrity  
and confidence**



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**Begin  
Anywhere**

John Cage

**Not knowing  
where to begin is a  
common form of  
paralysis.**

Silence 4:33



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**BUILDING PHYSICS AND PERFORMANCE:  
LESSONS LEARNED, RESEARCH AND  
INNOVATION**