THE RETROFIT ACADEMY

RICKABY THOMPSON ASSOCIATES ENERGY + SUSTAINABILITY CONSULTANTS

The Retrofit Academy
Northern Ireland Housing Executive

Building Retrofit Into Housing Asset Management

Presented by

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Version A

Four Messages

1. Get your priorities right
   - Reduce fuel poverty
   - Reduce green house gas emissions
2. Know your stock
   - And know its potential
   - Housing Stock Energy Study
3. Use good tools and techniques
   - Affordable Warmth Matrix
   - Medium-term whole house retrofit plans
   - Fabric first | Concentrate on the interfaces
4. Manage the technical risks
   - Use best practice standards and specifications
   - Adopt a systematic approach to risk management

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Get Your Priorities Right

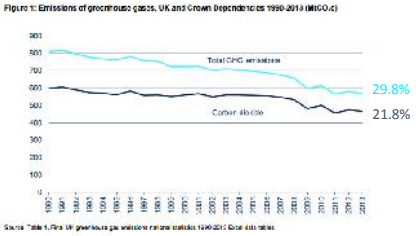
Two elephants in the room

Elephant 1 – Climate Change

- The most serious challenge facing us
- Features in very few corporate strategies
- Realistic response requires eye-watering investment
- Ignored by most asset management and investment plans

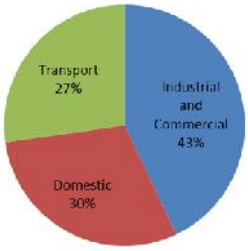
Climate Change

- UK statutory GHG emissions reduction targets
  - 34% by 2030 (against 1990 baseline)
  - 80% by 2050 (against 1990 baseline)

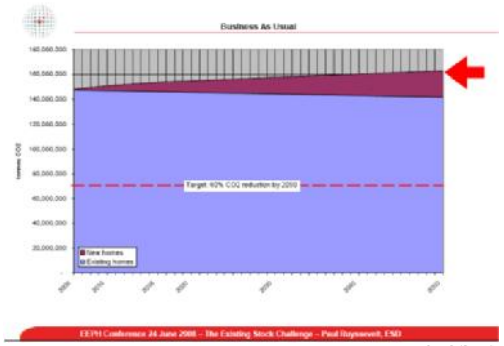


Emissions Associated with Domestic Energy Use - 2013

- 25%-30% of total
- 80% of existing dwellings still standing in 2050
- Emerging programme of low carbon retrofit



Housing Emissions to 2050



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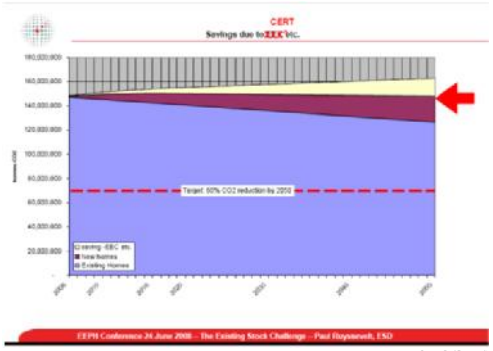
Housing Emissions to 2050



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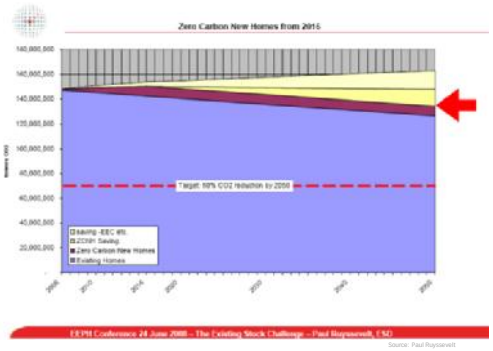
Housing Emissions to 2050



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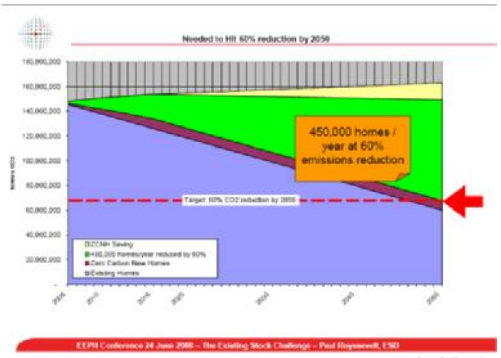
Housing Emissions to 2050



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Elephant 2 – Fuel Poverty

- Features in most housing organisations' corporate objectives
- Critical to health and well-being of residents
- Requires a long view
- Rarely features explicitly in asset management and investment plans

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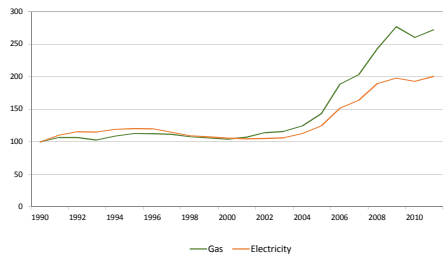
Rising Energy Costs



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Fuel Poverty in the UK

Scotland, Wales and Northern Ireland still use the >10% definition so UK estimates also still use this:

	No. of homes	Percentage
England	2.73 million	12%
Scotland	0.94 million	39%
Wales	0.4 million	30%
Northern Ireland	0.3 million	42%
Total	**4.5 million**	**17%**

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Fuel Poverty

- Highest percentages in households
  - on pre-payment meters
  - in solid wall homes
  - not on mains gas
- Typical response and consequences
  - Under-heating and under-ventilation
  - Condensation, mould growth
  - Unhealthy homes: respiratory illnesses, hypothermia
- The fuel poverty challenge
  - Protect residents from social impact of rising fuel prices
  - Ensure robust supplies of heat and power
  - Power accounts for 40-50% of fuel costs and emissions

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Questions from the Elephants

- What is the point of an investment plan that won't deliver affordable warmth in 2025 or 2030?
- What is the point of an investment plan that doesn't properly address fuel use, fuel costs, carbon dioxide emissions and overheating?
- What is the point of investment planning that ignore the two biggest liabilities?
  - And the most important stakeholder – the residents
- If housing professionals don't show leadership and rise to these challenges, who else will?

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The Retrofit Challenge

- Reduce average CO_2 emissions by 60%
  - Aim to get to 100% by 2050
  - Some homes will be unimprovable
  - Others will need deeper cuts to compensate
- Reduce fuel poverty
  - Aim to eliminate it wherever possible
  - Fuel prices will rise – invest for 2030 and beyond
  - Households who are cold are not interested in saving CO_2
- Invest an average of £25,000 per home by 2050
  - This allows for doing retrofit properly – and once!
  - Invest in skills and training in the supply chain
  - Adopt best practice standards for value for money

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Questions?

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2

Know Your Stock

And know its potential

If you can't measure it, you can't manage it

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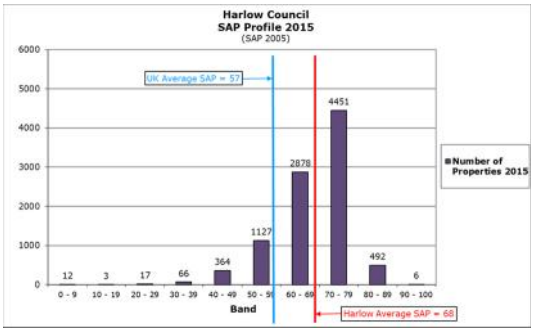
Housing Stock Energy Study

- Investigate the implications of proposed standards
  - Typically SAP 80 and 50% emissions reduction (C50)
- Assess the whole stock and establish KPIs
  - Stock profiles and averages updated to track investment
- Identify dwelling types and analyse them in detail
  - Costed, medium term retrofit plan for every type
- Scale up to the whole stock
  - Capital costs by dwelling type, measure and standard
  - Savings of fuel use, fuel costs and emissions
- Estimate the potential for external funding

The following slides present example output from Harlow Council's HSES

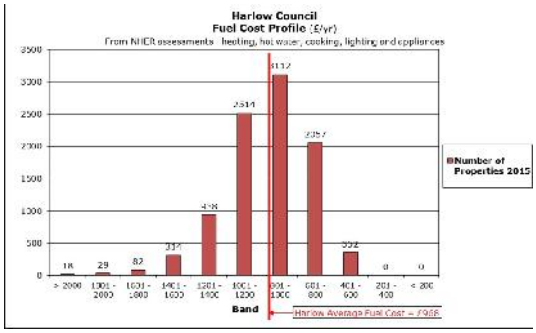
SAP Profile

Average SAP 68



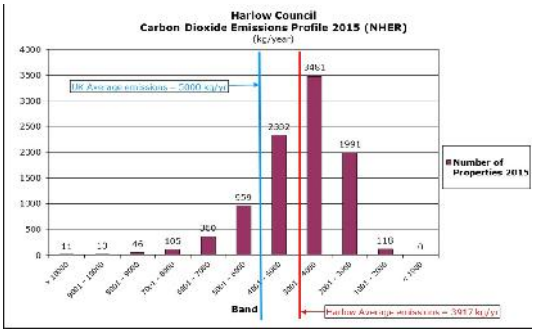
Fuel Costs

From NHER: average £968/yr



CO_2 Emissions

From NHER: average 3,917 kg/yr



Stock KPIs

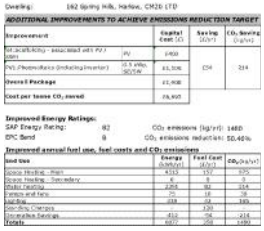
- Average SAP 68
  - Range <10 (12 dwellings) to >90 (6 dwellings)
- Average fuel cost (NHER) £968/yr
  - Range > £2,000/yr (18 dwellings) to <£600/yr (352)
- Average CO_2 emissions (NHER) 3,917 kg/yr
  - Range >10,000 (11 dwellings) to <2,000 (118)

Dwelling Types

- 28 dwelling types
  - 4 houses, 1 bungalow, 21 flats, 2 maisonettes
  - 3 variants of each flat, 2 variants of maisonette
  - Representing 9,416 dwellings
- Heating systems
  - All individual gas-fired systems except:
  - 6 types with communal heating, 7 with electric heating
- Detailed analyses
  - Made with *NHER Plan Assessor* v6.1 (SAP 2012)
  - As existing and with improvements to SAP 80 and C50
  - Assumed capital costs, multiple improvement options
  - 35 improvement packages evaluated altogether

Energy Analyses

Energy Analyses



- The analyses create a **medium-term low carbon improvement plan** for each dwelling type
- *NHER Plan Assessor* software and database can be used to evaluate other options

Scale-up to Stock Level

- Multiply costs and savings by number of dwellings
  - For each dwelling type and standard
- Improvement costs summary
  - Whole-stock tabulation by dwelling type and by measure
- Fuel cost reduction summary
  - Whole-stock tabulation by dwelling type and measure
- Carbon dioxide emissions reduction summary
  - Whole-stock tabulation by dwelling type and measure

The SAP 80 Fuel Poverty Standard

- Dwellings to improve: 8,918
  - 356 dwellings per year over 25 years
- Capital cost £113.4 million
  - Completed £4.8 m, programmed £5.8 m, balance £102.8 m
  - Average cost per dwelling: £12,712
  - £4.53 million per year over 25 years
- Fuel cost savings
  - Average £252/yr; total £2.25 million/yr when complete
- CO_2 emissions savings
  - Average 1.5 t/yr; total 13,337 t/yr when complete

The C50 Emissions Standard

- Additional improvements: 4,226 dwellings
  - 169 dwellings per year over 25 years
- Capital cost £120.6 million
  - Complete £4.8 m, programmed £5.8 m, balance £110.0 m
  - Average cost per dwelling: £14,419
  - £288,558 per year over 25 years
- Fuel cost savings
  - Average £300/yr; total £2.44 million/yr when complete
- CO_2 emissions savings
  - Average 1.68 t/yr; total 14,129 t/yr when complete

Questions?

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Use Good Tools and Techniques

Affordable Warmth Matrix
Whole-House Retrofit Plans
Fabric First | Concentrate on the Interfaces

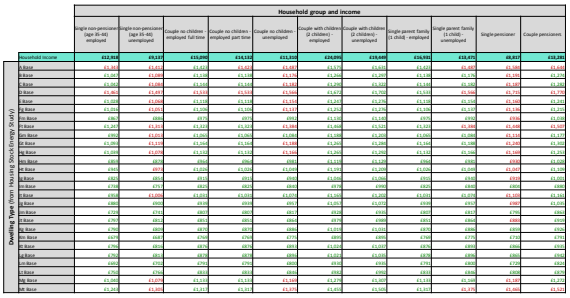
Affordable Warmth Matrix

- Fuel poverty results from a *combination* of
  - A dwelling with high fuel costs
  - A household with low income
- The Matrix tabulates household types against dwelling types using
  - LIHC or 10% definition
  - *Worst case* household income (from benefits)
  - Fuel costs under household type occupancy (from HSES)
  - Costs and benefits projected to 2020, 2025, 2030
- Display
  - Combinations in fuel poverty shown in **red**
  - Combinations at risk of fuel poverty shown in **amber**
  - Combinations with affordable warmth shown in **green**

Affordable Warmth Matrix

Unimproved Stock 2015 10% definition

Year	Income Inflation Rate	Fuel Cost Inflation Rate	UK Poverty Line	Median Fuel Cost
2015	0.00%	0.00%	£12,043.20	£1,369.00



Affordable Warmth Matrix

Unimproved Stock 2015 LIHC definition

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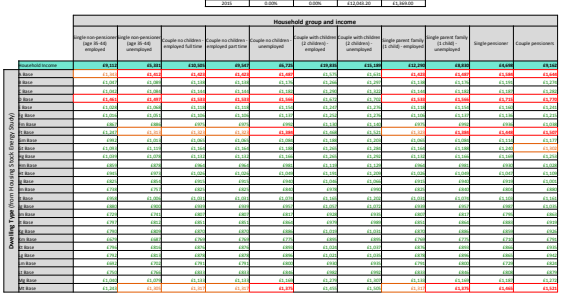
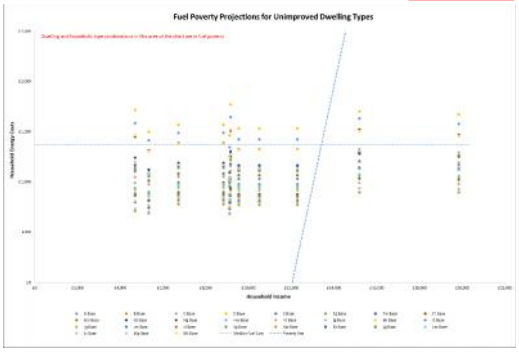


Affordable Warmth Gaps

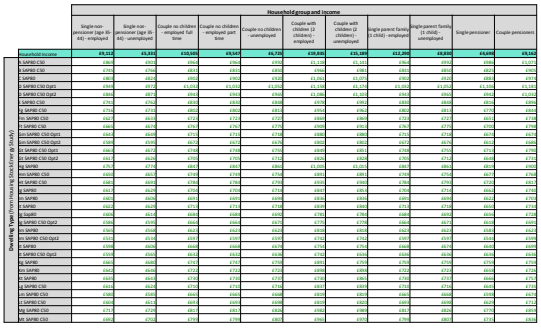
Unimproved Stock 2015 LIHC definition



Affordable Warmth Matrix

Improved to SAP 80 LIHC definition

Year	Income Inflation Rate	Fuel Cost Inflation Rate	UK Poverty Line	Median Fuel Cost
2015	0.00%	0.00%	£12,043.20	£1,369.00



Whole House Retrofit

- 50% - 60% emissions reduction requires
  - Insulation and air-tightness
    - Floors, walls, windows, roofs
  - Efficient and responsive building services
    - Ventilation, heating, hot water, lighting
  - Renewable / LZC technologies
    - Solar water heating, solar PV
- Typical whole house retrofit cost £25,000
  - Few householders or landlords can afford this
  - Other priorities intervene, e.g.
    - New kitchens and bathrooms
    - Repairs, redecoration, new floor finishes
    - Care for elderly relatives
    - Children's' college fees, etc.

Medium-Term Whole House Retrofit Plan

- A 20-30 year plan for retrofit
  - Based on detailed assessment
- Identifies applicable measures
  - 'Shopping list' of improvements
- Identifies priorities
  - Fabric first, quick wins
- Identifies combinations
  - External wall insulation with new windows
- Preserves opportunities for the future
  - Extend eaves for EWI when re-roofing
  - Install dual-coil HWC for future solar water heating
- Plan may be 'lodged' like an EPC

Retrofit Strategies

Fabric first

1. Improve the building fabric
   - To minimise heat losses and maximise air tightness
   - Insulation is relatively inexpensive and has a long life
2. Install efficient and responsive building services
   - To satisfy energy demand efficiently
   - Services have short lives and are replaced regularly
3. Use renewable energy technologies
   - To reduce emissions to the target level
   - Renewable systems are expensive and short-lived

Retrofit Strategies

Concentrate on the interfaces

- Between building elements
  - Corners, junctions, edges and around openings
  - Key risks: thermal bridging and air leakage
- Between building fabric and building services
  - Ventilation system compatible with air permeability
  - Heating system compatible with heat loss
- Between the building and the occupants
  - Functions of systems explained and understood
  - Controls user-friendly and understood
  - How to get the best performance explained

Questions?

4

Manage the Technical Risks

Use Best Practice Standards and Specifications
Adopt a Systematic Approach to Risk Management

Managing Retrofit Risk

- Why do retrofit projects rarely deliver the predicted cuts in fuel costs and emissions?
  - What contributes to the 'performance gap'?
- What are the risks of building-in defects?
  - How can we mitigate those risks?
- What are the key points to watch out for?
  - At each stage of the retrofit process
- Where are the risks?
  - Understand the retrofit process
- How do we mitigate them?
  - Modify and strengthen the process

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Where does retrofit go wrong?

- At the corners, junctions and edges
  - Where building elements meet and around openings
- At the interfaces between fabric and services
  - Matching systems to heat loss and air permeability
- At the interfaces between systems and people
  - Commissioning, handover, control, maintenance

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Managing Retrofit Risk

- Recognise the key risks
  - Fabric defects caused by inappropriate specifications
    - Thermal bridging, thermal bypass, air leakage, excess moisture
  - Poor IAQ caused by inadequate ventilation
  - Under-performance due to poor design and/or installation
- Avoid high-risk strategies and systems
  - Adopt the fabric first approach
  - Concentrate on the interfaces
- Develop simple, robust risk management
  - Identifying risks and mitigation processes
  - Applying appropriate tests, checks and monitoring

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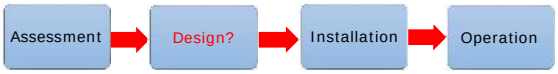
Retrofit Process



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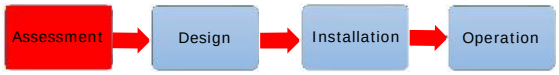
Retrofit Risks



Assessment Risks

- Wrong assessor
  - Vulnerable building
  - Specialist measures
- Inaccurate assessment
  - Dimensions | construction | services
- Wrong measures
  - Inappropriate | too expensive
- Optimistic fuel cost savings
  - Not realisable by occupants

Mitigation

- Triage assessment
  - Deploy vulnerable buildings assessors
  - Deploy specialist measures assessors
- Training and certification
  - Certification scheme QA checks
- Assessment software
  - Cross checks measures and costs
- Occupancy assessment
  - Lifestyle issues | affordability | in-use factors

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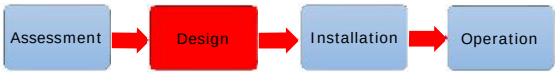
Retrofit Risks



Design Risks

- Poor retrofit strategy
  - Not fabric first, inappropriate services
  - No or poor ventilation strategy
  - Poor moisture control
  - Over-reliance on technology
  - Over-complicated systems/controls
- Poor integration of measures
  - Discontinuous insulation
  - Discontinuous air barrier
  - Poor matching of services with fabric
- Overheating
  - Inadequate shading and ventilation
- Poor communication
  - Occupants not engaged
  - Design intent and dependencies not clear

Mitigation

- Fabric first approach
  - Fabric | services | renewables
  - Consider winter and summer
  - Include climate change adaptation
  - Moisture control strategy
- Services
  - Ventilation strategy
    - Matched to fabric air permeability
    - Don't default to MVHR!
    - Consider supply, extract, heat recovery
  - Efficient and responsive heating
  - Simple user-friendly controls
  - Will the proposed systems fit?
- Communicate clearly
  - To occupants and installers (toolbox talks)
  - Specifications and construction details

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Retrofit Risks

Assessment → Design → Installation → Operation

Risks

- Poor integration
  - Multiple installers at different times
  - No coordination or overall responsibility
- Inappropriate substitution
  - Materials and products
- Poor installer design
  - Location of services and controls
  - Ventilation ductwork
- Poor commissioning
  - Systems not set up and tested

Mitigation

- Multi-skilled teams
  - Trades integrated into teams
  - Team briefing by designer/specifier
- Change management control
  - Mandatory reference to specifier
- Detailed design of services
  - Installer design forbidden
- Commissioning
  - All services together, not separately
  - Formal handover to occupant

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Retrofit Risks

Assessment → Design → Installation → Operation

Operational Consequences

- Condensation and mould
  - Surface and interstitial
  - Danger to occupants' health
  - Danger of long-term deterioration
- Controls not used correctly
  - Occupants do not understand
  - Controls too many / too complicated
- Systems disabled or overridden
  - Occupants dislike noise, draughts
- Poor energy performance
  - Predicted savings not realised
  - Summer overheating

Mitigation

- Handover procedure
  - Verbal and graphic
  - Explain systems and controls
  - Consequences of disabling systems
- Sample post-retrofit testing
  - Air tightness (pressure test)
  - Thermal bridging (thermography)
- Promote appropriate behaviour
  - Energy efficiency advice
  - How to mitigate overheating
  - Lifestyle changes to suit retrofit

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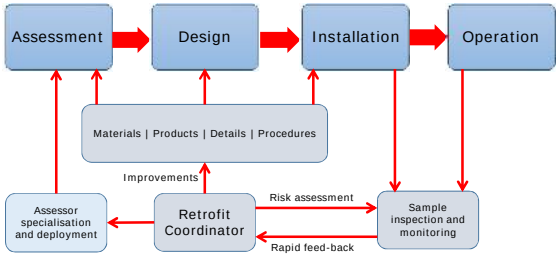
Retrofit Process *With integrated self-learning risk management*



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Questions?

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Summary

- Fuel poverty and climate change present significant investment challenges for housing organisations
  - Energy efficiency and affordable warmth are likely to become primary asset management drivers
- Assimilating affordable warmth and carbon dioxide emissions reduction into investment strategy requires a fresh approach and new tools
  - Housing stock energy studies
  - Affordable warmth matrices
- Retrofit has technical risks that can be managed
  - Adopt a robust strategies and a systematic approach
  - Use emerging best practice standards and specifications

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5

Case Study: Dealing with Condensation, Damp and Mould

The Peabody | Gallions Strategy at Thamesmead

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Thamesmead

- Built by GLC in 1960s and 1970s
  - Subsequent LSVT to Gallions HA
  - Recent Gallions-Peabody merger
- Over 4500 homes
  - High-rise tower blocks
  - Medium-rise deck access blocks
  - PC panel construction
- DH replaced by individual gas-fired CH systems by Gallions
  - Limited other investment
  - Backlog of repairs and maintenance
- Extensive fuel poverty
  - Under-heated and under-ventilated
  - Condensation, damp and mould

Thamesmead

- Crossrail terminus at Abbey Wood heralds regeneration
  - Increasing land values
- Peabody | Gallions £1 billion regeneration programme
  - Environmental improvements
  - Some demolition (worst homes)
  - Many new homes
  - Comprehensive refurbishment of existing homes
  - Some existing homes may not be replaced or improved over short-medium term

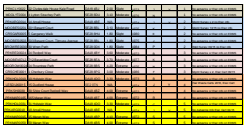
CDM Strategy

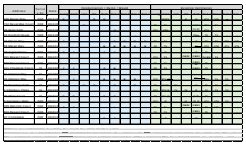
- Focus
  - Homes that will not be replaced or improved over short-medium term
- Objectives
  - Manage condensation and mould
  - Eliminate CDM where possible
  - Mitigate fuel poverty
- Budget
  - £2 million
- Programme
  - Three-year programme 2016-2019
  - Pilot complete in early 2017
  - Pilot and main programme monitored and evaluated

CDM Strategy

Key features

- Risk assessment of the stock
  - Stock condition and SAP/EPC data and occupancy information
  - Identifies homes with high, medium or low CDM risk scores
- Detailed surveys of high- and medium-risk homes
  - Confirms source and extent of CDM, and existing ventilation provision
- Three levels of intervention
  - Prioritised according to risk scores and survey findings

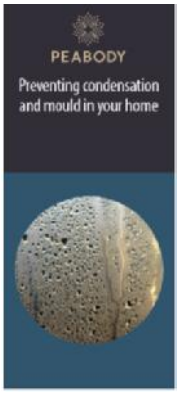




CDM Strategy

Levels of intervention

- Low risk homes
  - Energy and ventilation advice
    - Delivered to all homes by Peabody's in-house advice team
- Medium-risk homes
  - Energy and ventilation advice
  - *Switchee* smart heating controller
    - Monitors temperature, RH and heating
- High-risk homes
  - Energy and ventilation advice
  - *Switchee* smart heating controller
  - Demand controlled MEV
    - RH sensitive ventilation



CDM Strategy

Quality Assurance

- Risk assessments, ventilation specifications, survey method and installation QA developed in-house with consultant's assistance

Monitoring and Evaluation

- Pilot interventions (20 homes)
  - Formal monitoring and evaluation to confirm and refine the strategy
  - To be completedMarch2017
- Overall CDM strategy
  - Formal monitoring and evaluation to confirm effectiveness and inform roll-out to wider Peabody stock
  - To be shared with the industry

Summary

- The Thamesmead CDM strategy adopts a systematic, measured and evidence-based approach to the consequences of fuel poverty
- It makes use of the latest 'smart' heating controls and demand-controlled ventilation
- It is a ground-breaking initiative to improve on the 'just stick in a fan' approach that has been common in social housing
- The approach would apply equally well to any housing stock with extensive condensation, damp and mould

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Questions?

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The Retrofit Academy
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Presented by

Dr Peter Rickaby

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