

# Low energy refurbishment – from case studies to national roll-out

2<sup>nd</sup> October 2010

Russell Smith, Parity Projects

Peter Rickaby, Rickaby Thompson Associates

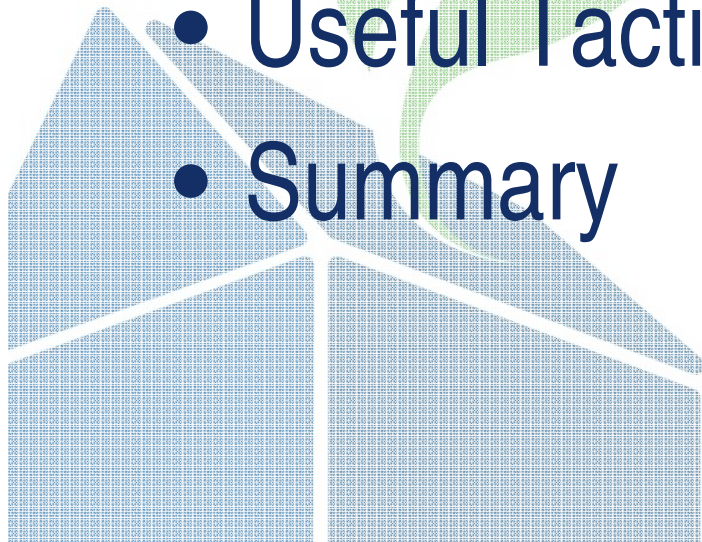
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# Agenda

- Introduction
- Strategy vs Tactics
- Strategy Options
- Useful Tactics
- Summary





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## Making your house an eco house

By William Mach  
Last Updated: 12:01am BST 18/06/2007

Have your say Read comments

Much of Britain's new housing stock is being made more environmentally friendly but what about older properties?

Can similar high standards and specifications be applied when renovating existing and older houses and flats?

The trouble is not many people have the know how or the inclination to take such projects on.

But turning a 19th Century end of terrace £200,000 house into an ecohome of the future was a labour of love for Russell Smith.



Russell Smith outside his Victorian eco-house in Sutton, Surrey. Making your house an eco house



TheObserver

# Ethical Awards 2008

In association with **ECOVER**  
Effective Cleaning - Ecologically

## Winners of Building Magazine's 2007 Award for Sustainable Refurbishment

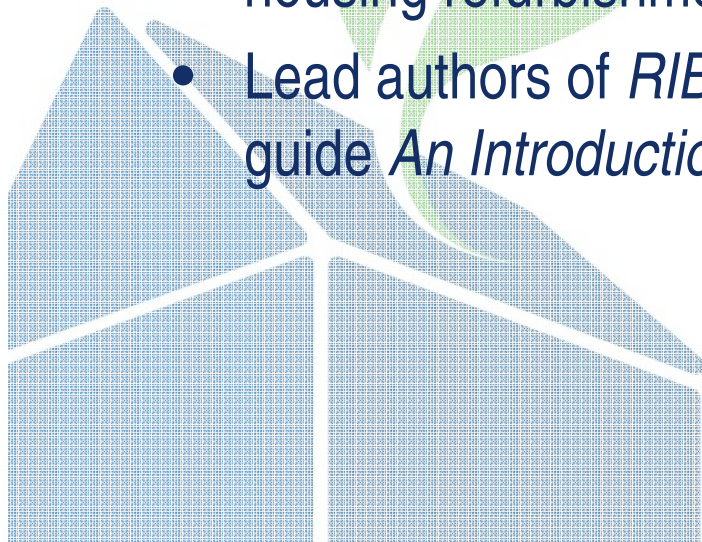


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# Rickaby Thompson Associates

- Energy and environmental consultancy since 1982
- Working for the housing and building industries across the UK and the EU
- Currently specialising in BREEAM-related work, and low carbon housing refurbishment
- Lead authors of *RIBA Climate Change Tools* and the CPA's guide *An Introduction to Low Carbon Housing Refurbishment*



# Strategy vs Tactics

- Strategy
  - a plan of action designed to achieve a particular goal
- Tactics
  - are concerned with the conduct of an engagement.
  - How a battle is fought is a matter of tactics: the terms and conditions that it is fought on.
- Strategy is concerned with how different engagements are linked and whether it should be fought at all.

# The Size of the Problem

- Statistics speak volumes
  - Kyoto Targets  
*(60% Reduction on 1990 levels of CO<sub>2</sub> by 2050)*
  - 27% of all UK Energy is Domestic
  - Rate of Change of Renewal  
*(24.8m homes – change/add 150,000 per year)*

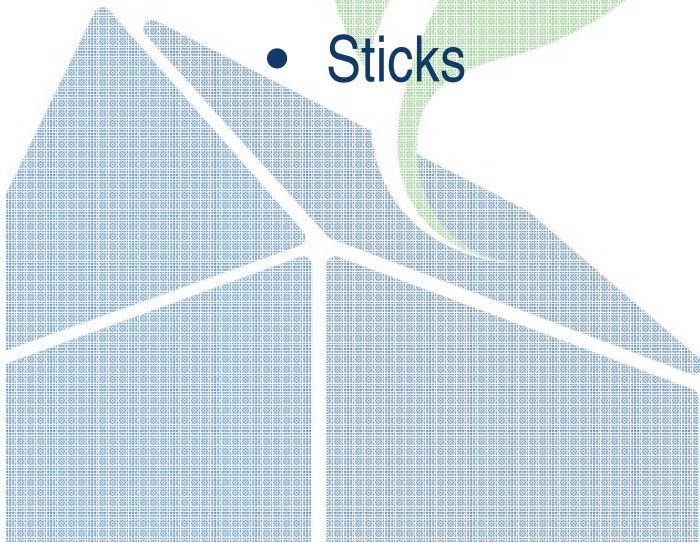
80%

**“75% of the houses that we have today will be here in 2050 so we need to remove barriers to their maintenance and upgrade now”**

Sustainable Development Commission, “Home Truths”, March 2006

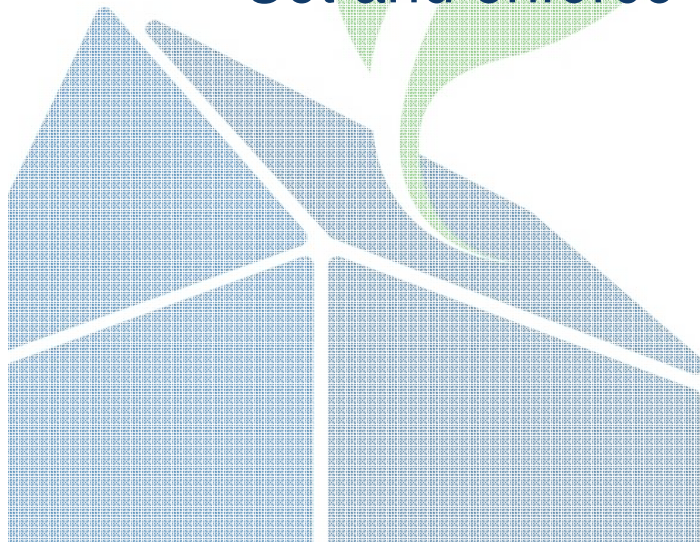
# The Ingredients of a National Strategy

- To reach the required CO<sub>2</sub> saving
- Realistic costs
- Tactics to ensure the most widespread adoption
  - Carrots
  - Sticks



# Key Principles

- Incentivise householders and landlords to improve
- Set a stable policy environment in which to invest
- Maximise use of EPC mechanism to plan for the future
- Set and enforce challenging but realistic standards





# The Ingredients of Ideal Tactics

- Maximum CO<sub>2</sub> saving
- To hurdle all barriers to change
  - Up front cost
  - Strong economic payback
  - Minimum hassle
  - Impartial, holistic advice or management
  - Useful standards
  - Training and Education

# Economic Payback

Reduce Costs

Initial Cost

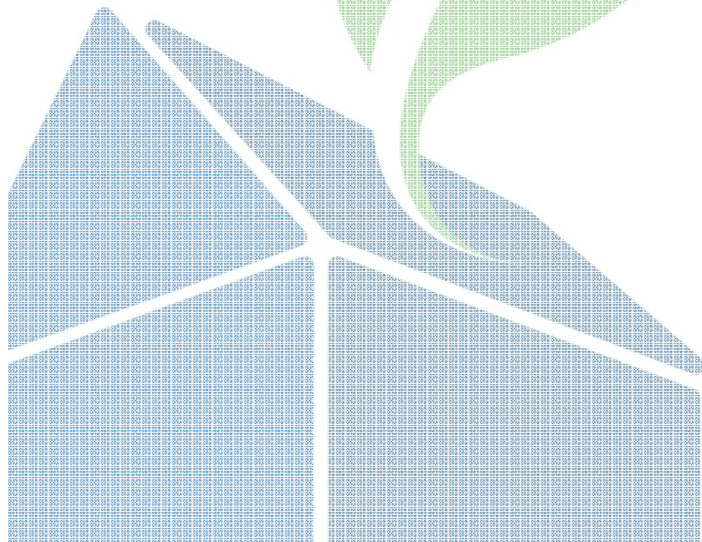
Economic Payback  
of Investment  
(years)

=

Annual Energy  
Saved (£)

Guarantee House  
Performance

Energy Prices Rise



## The UK Low Carbon Transition Plan

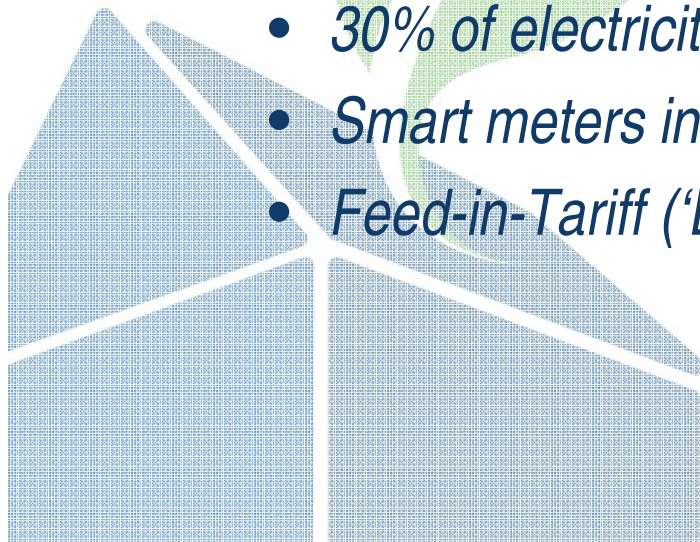
National strategy for climate and energy



Building Britain's Future 

# National Strategy

- The UK Low Carbon Transition Plan (15<sup>th</sup> July)
  - *EU commitment - reduce CO<sub>2</sub> emissions by 20% before 2020*
  - *UK commitment - >33% before 2020*
  - *40% of electricity from low carbon sources*
  - *30% of electricity from renewables*
  - *Smart meters in every home by end 2020*
  - *Feed-in-Tariff ('Energy Cash-back')*



# National Strategy

- Warm Homes Greener Homes
  - Cut CO<sub>2</sub> emissions from homes by 29% by 2020
  - Install loft and cavity wall insulation in every household where practical by 2015
  - 7 million homes to have more substantial improvements such as solid wall insulation or renewable energy generating technologies by 2020
  - Every home, should benefit from measures to improve energy efficiency in their homes by 2030



# National Tactics

- Individual programmes (not joined up)
  - CERT/CESP
  - Warm Front
  - LCBP
  - Random Local Authority Initiatives
  - FIT / RHI
- Building Regulations – follow don't lead
- The Green Deal
  - Access to £6,500 loan to spend on energy efficiency works
  - Payments to be taken as part of energy bills
  - Payments to be less than energy bill savings

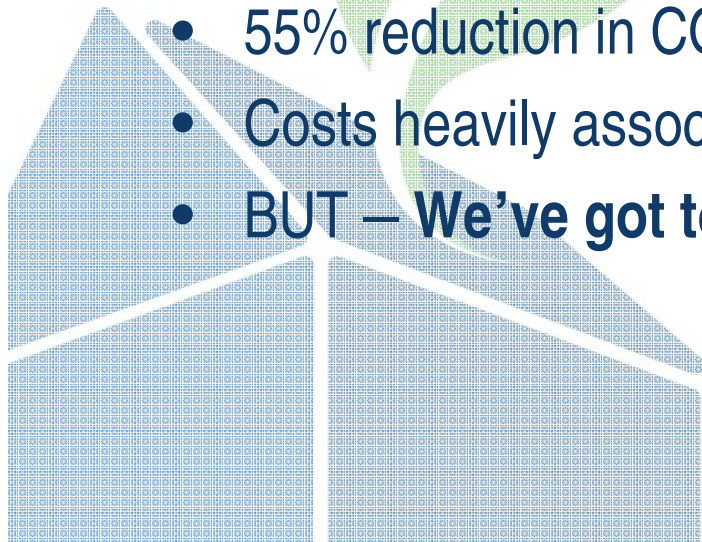
# Parity – Demonstration Project

- Victorian, Built 1870
- ‘Conventional’ Semi-Detached
- Solid Walled
- No south facing roofs
- No insulation
- 6 different window types
- High Ground Levels
- Damp



# Key Outcomes

- Eco measures are 15% of total refurbishment cost (£85,000 total, £12,750 'eco')
- Approx 5% of floor area has been lost
- Economic pay-back is 7-8 years on average.
- CO<sub>2</sub> reduction of 72% per m<sup>2</sup>
- 55% reduction in CO<sub>2</sub> from draughtproofing and insulation
- Costs heavily associated with logistics and ease of install
- **BUT – We've got to do the lot!**



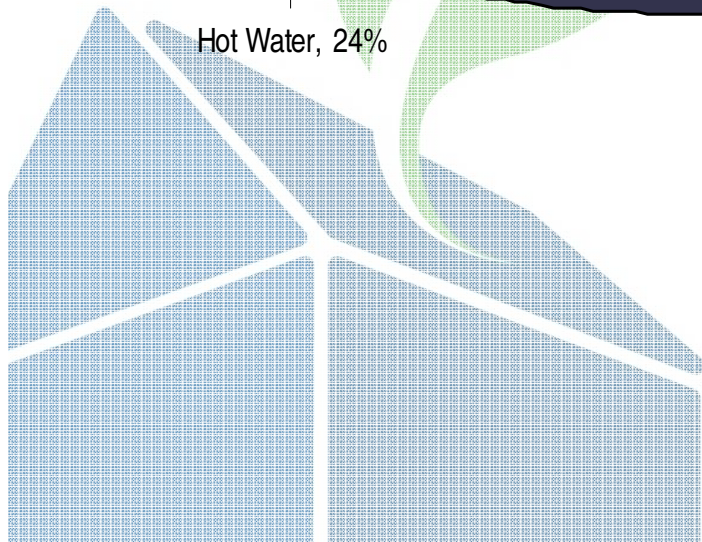
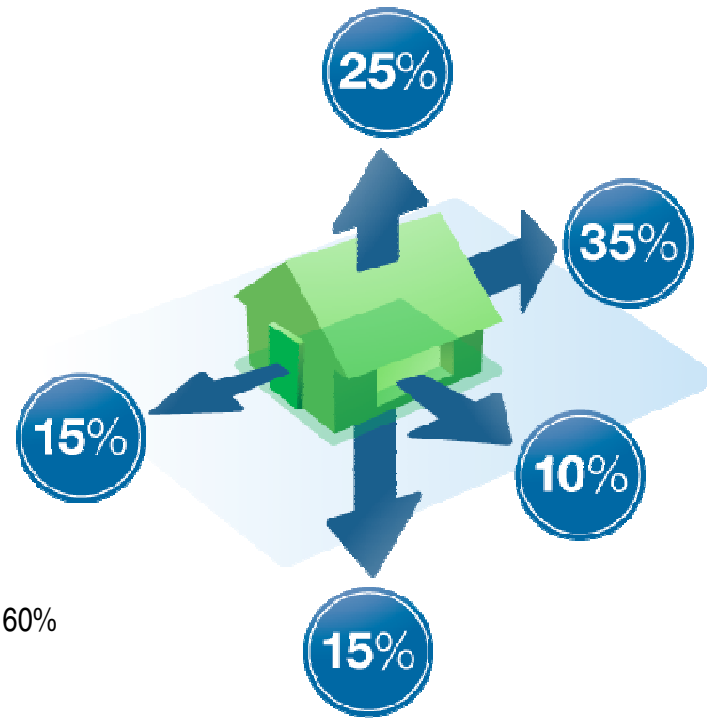
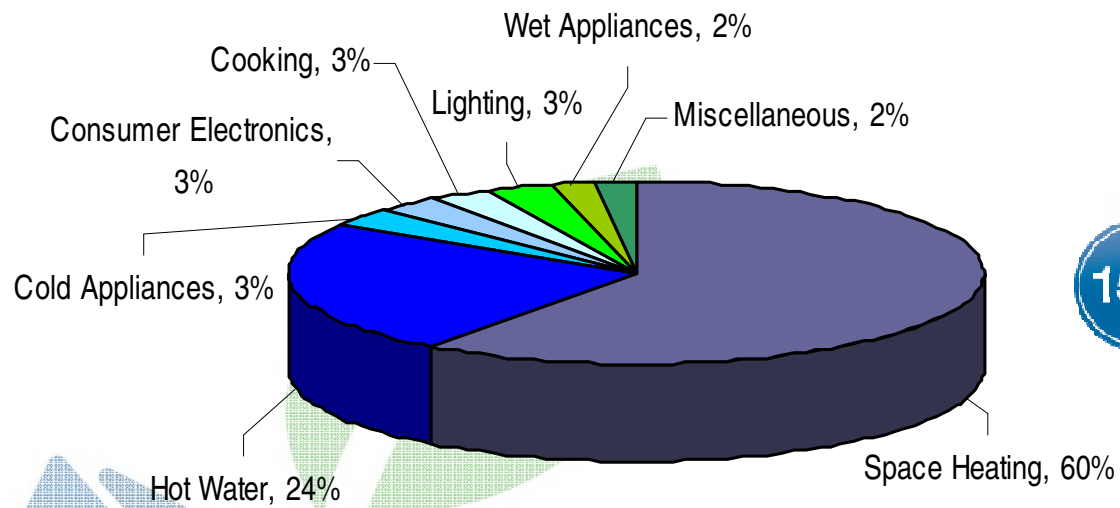
# Every House is Different

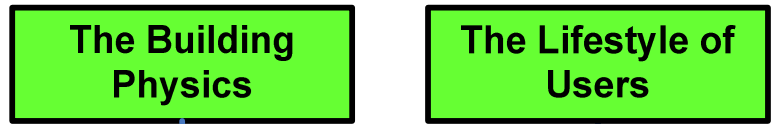


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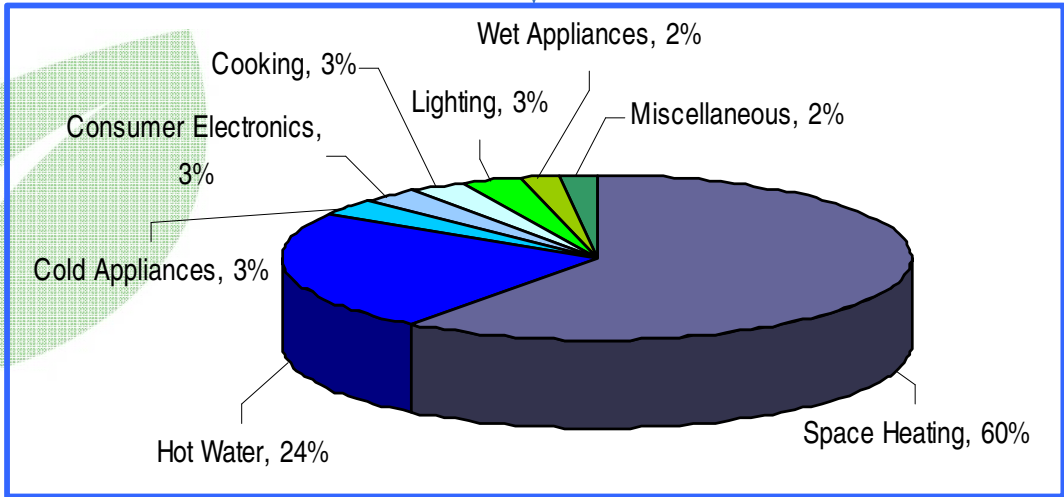
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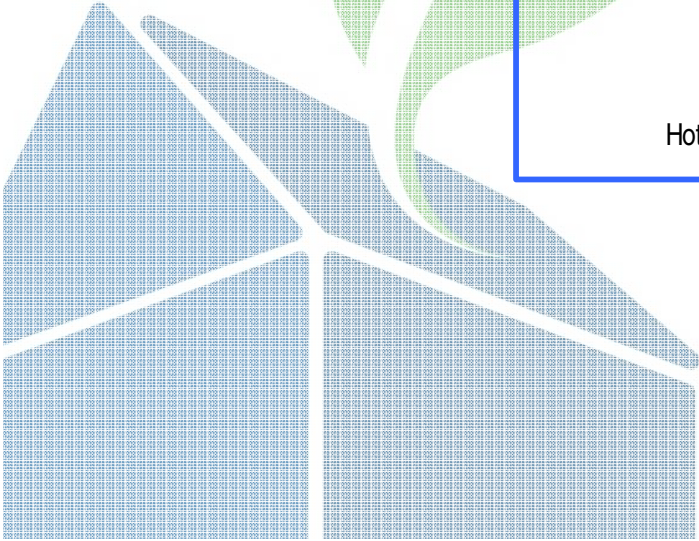




**Weather**



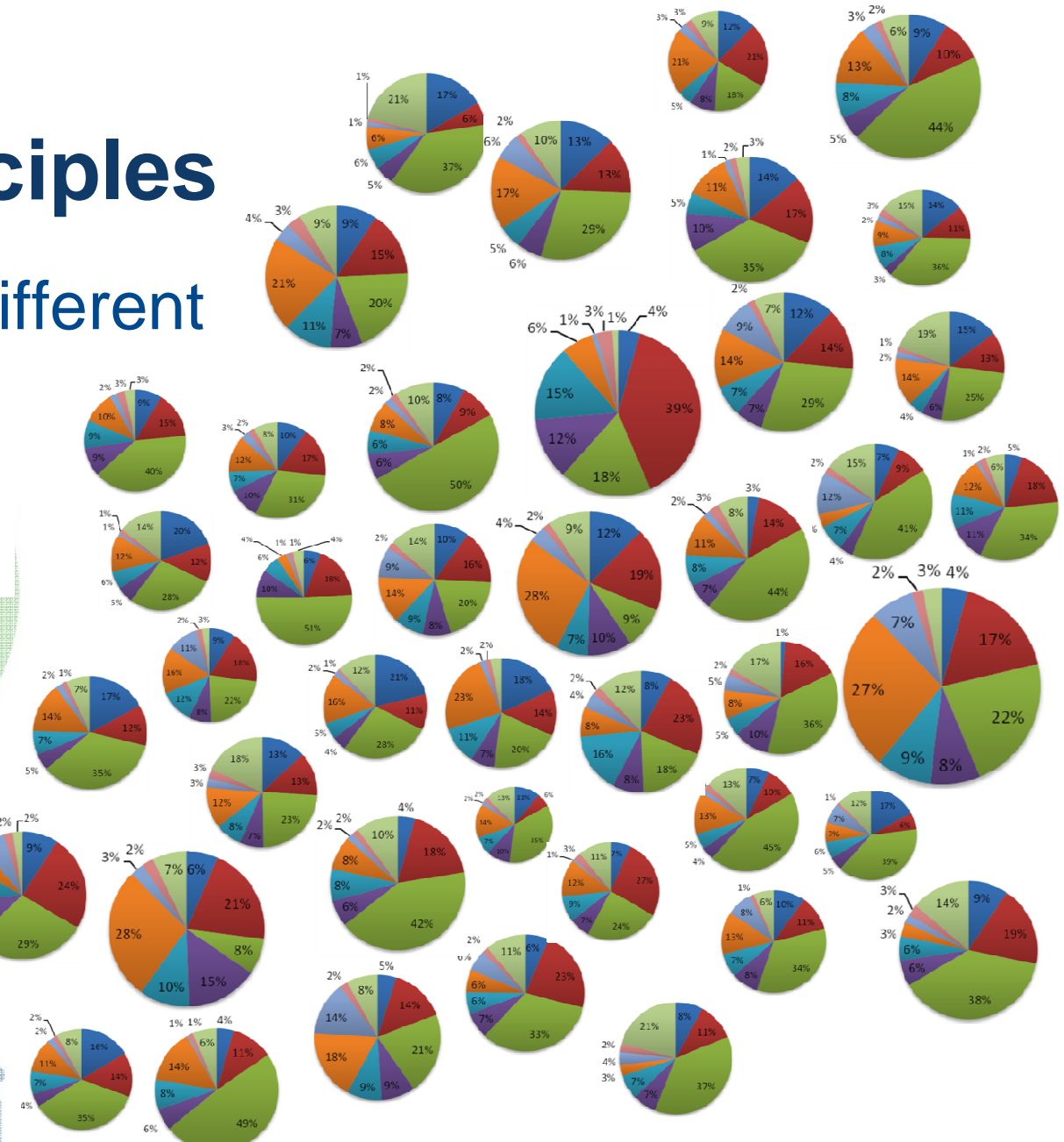
**Energy Consumption**



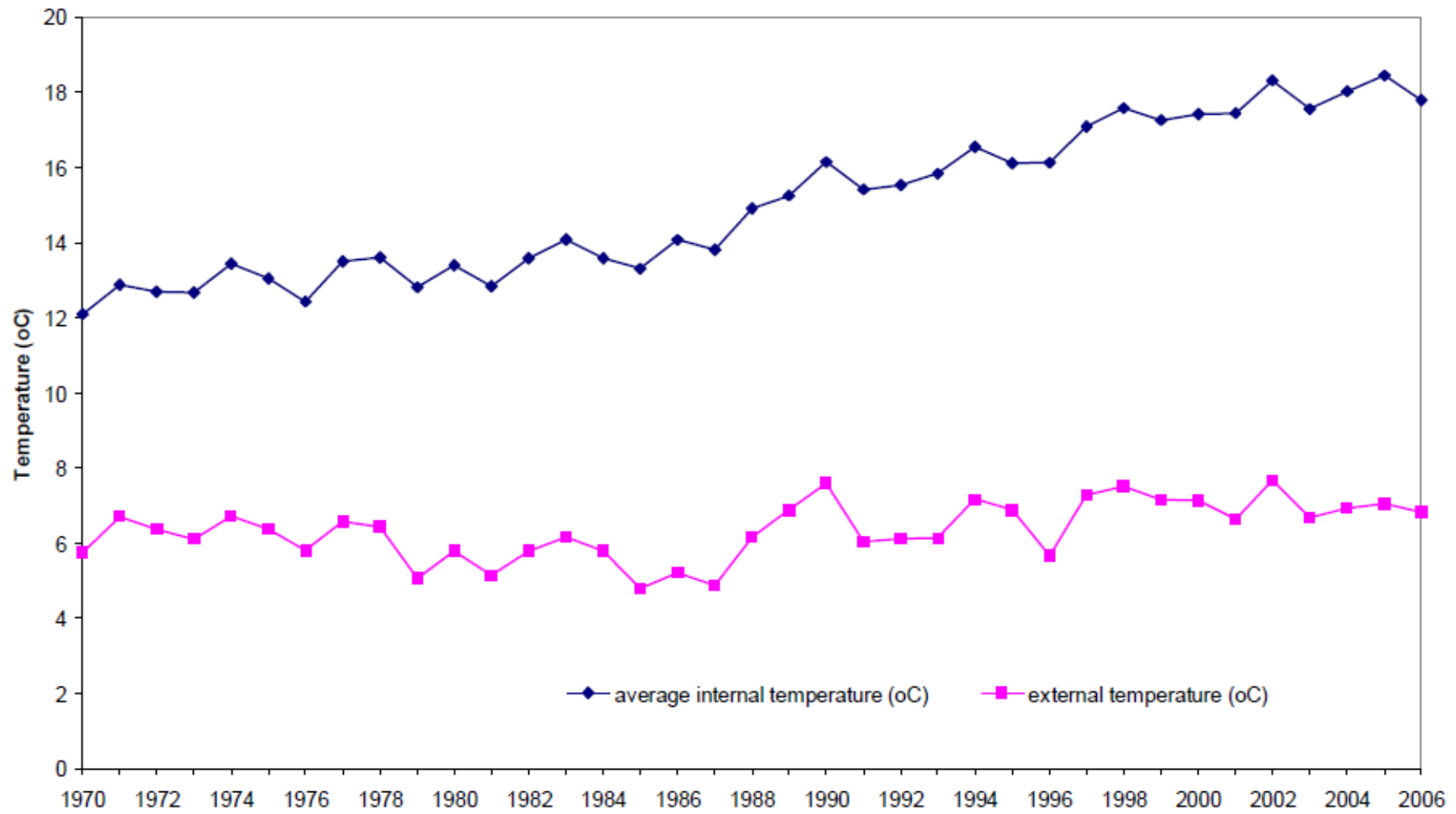
# Parity - principles

## Every home is different

- Windows/Doors
- Heating inefficiency
- Roof
- Floor
- Lights
- Hot Water
- Walls
- Appliances
- Draughts



Standards of comfort - mean internal temperature and average winter external temperature

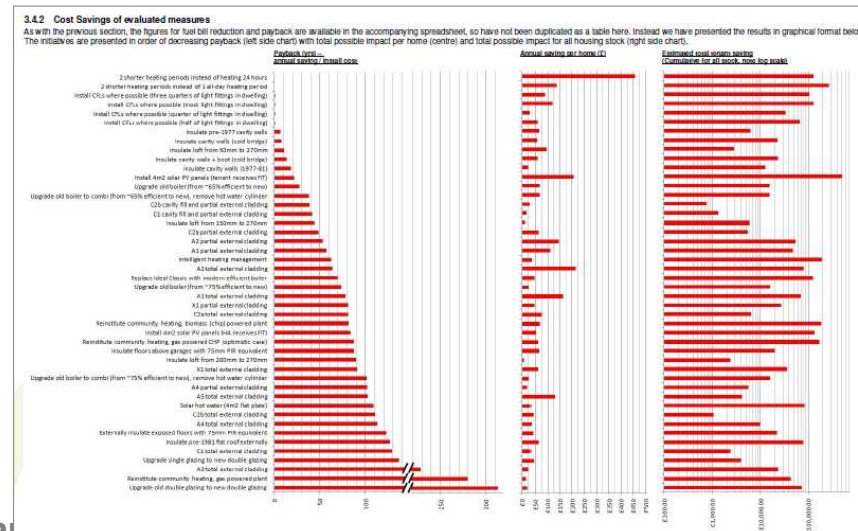
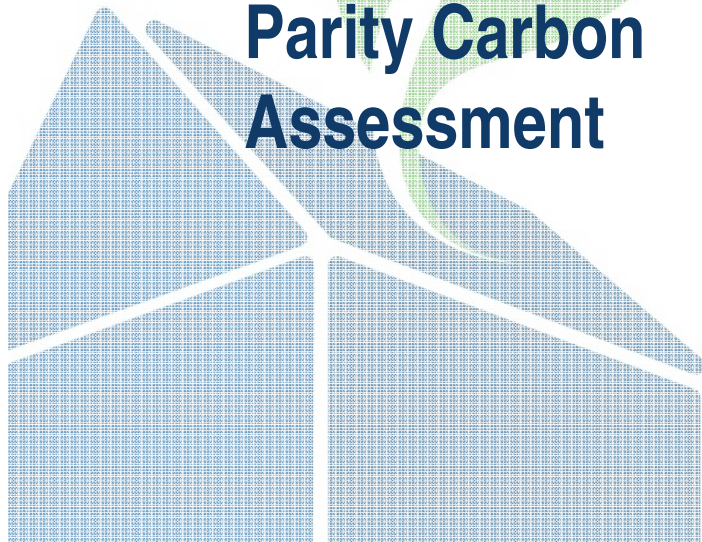


# Parity information and analysis

- Individual Homes Home Energy Masterplan



- Housing stock Parity Carbon Assessment



# Parity – modelling engine

An exploded view diagram of a mechanical assembly, likely a gun or a similar device, with various components numbered from 1 to 44. The diagram is rendered in a light gray, semi-transparent style, serving as a background for the text. The components are arranged in a way that shows their relative positions and how they fit together. The numbers are placed near the corresponding parts, with thin lines pointing to them.

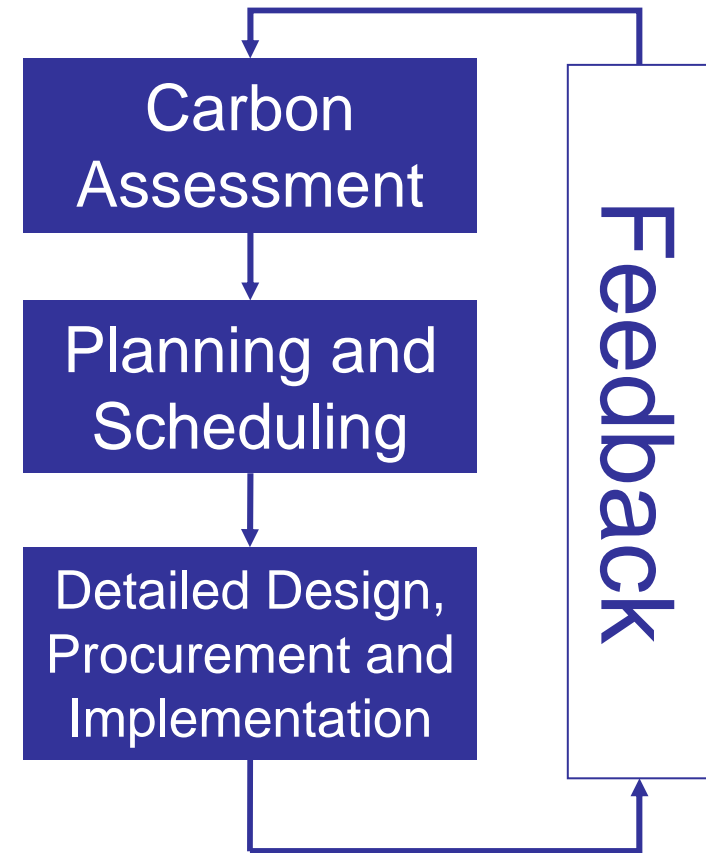
## A detailed advice tool

- NOT a benchmarking tool
- Based on BREDEM, compatible with SAP
- Allows for:
  - Regional variations (temperature, sunlight, etc)
  - Behavioural variations (heating temp, pattern)
  - Appliances and lights
  - Floors
  - etc

# A process for low energy retrofit:



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## How To Use This Plan



Quickly read through the report to understand its layout. Then come back to this page and move onto the below.

### UNDERSTAND YOUR HOME

Go to ● Section 2 to understand how your home is currently performing and where the energy to heat and run it is being used

### UNDERSTAND YOUR OPTIONS

Read through ● Section 3 to understand the different elements of your home and the options that are available for each area.

### SEE WHAT WE RECOMMEND

Go through the bespoke recommendations in ● Section 4 and look at the total costs, savings, paybacks and potential CO<sub>2</sub> reductions.

### GET THE RED PEN OUT

Work through the Appendix Tables in ● Section 6 with a red pen and circle items that you are interested in. Those included in the bespoke suites of recommendations are marked but you may find others that you prefer.

### MAKE A PLAN OF ACTION

Work out a plan of action for installing your chosen solutions taking care to do things in an order that doesn't make things harder down the line – see ● Section 5 for some guidance on things to think about. Parity Projects is available to help with project managing larger works.

parity home energy masterplan

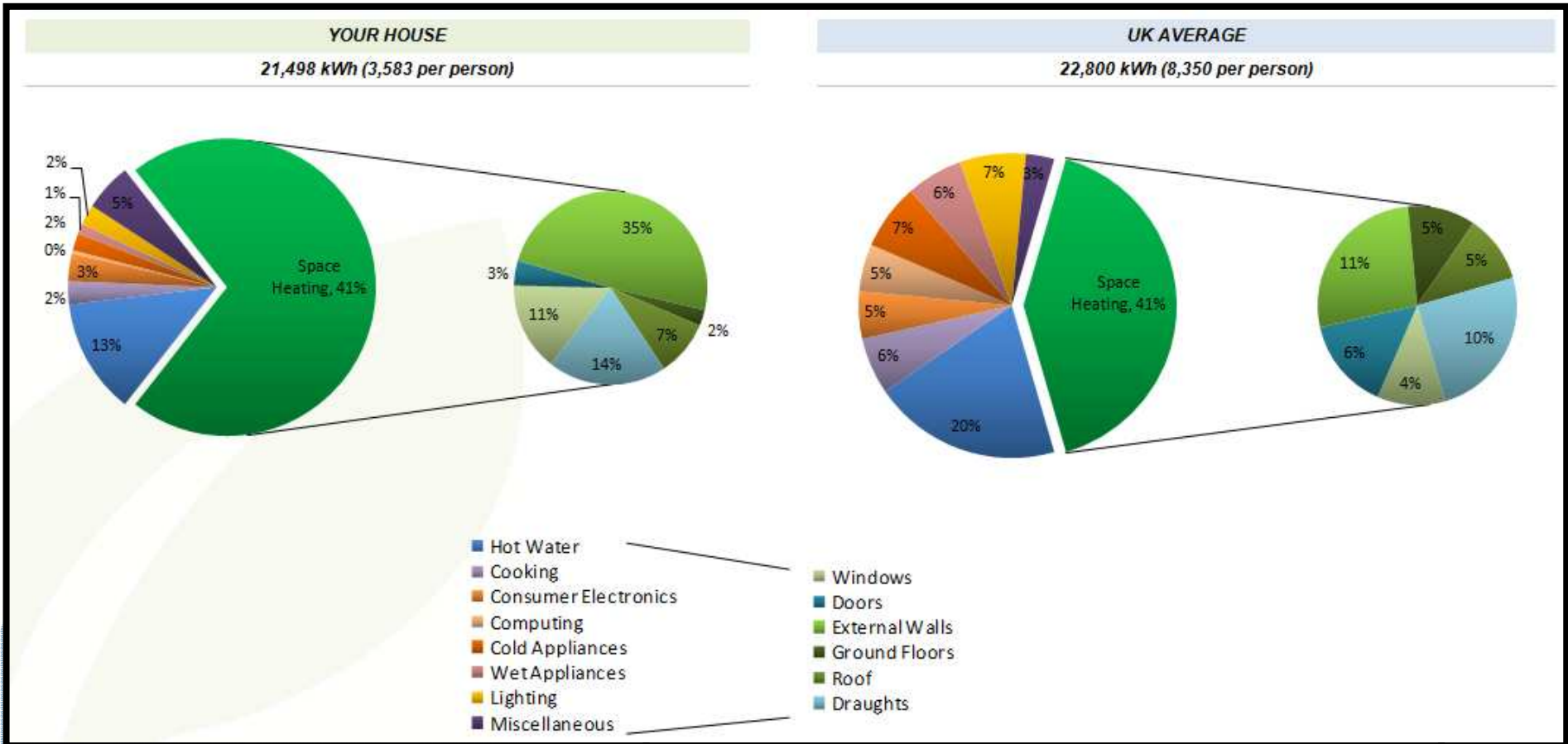
MS SALLY MORTON, 23 ROSECROFT GARDENS, HAMPSTEAD, NW15 3AT

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EPC ANNUAL FUEL COSTS		
FUEL COSTS	YOUR HOUSE	UK AVERAGE
ANNUAL	£2,550	£1,345



## RANKED BY CO<sub>2</sub> SAVINGS

INITIATIVE AREA	DETAILS	ANNUAL CO <sub>2</sub> SAVING (kg CO <sub>2</sub> )	DIY (£ per kg CO <sub>2</sub> )	PROFESSIONAL (£ per kg CO <sub>2</sub> )
FLOOR INSULATION	Insulate solid ground floor with 100mm PIR insulation or equivalent and install water based underfloor heating and highly efficient condensing boiler	3,246	N/A	£1.65
HEATING	Install a modern highly efficient condensing boiler	2,961	N/A	£0.84
WALL INSULATION	Internally insulate all solid external walls with 100mm PIR insulation or equivalent	2,125	£2.10	£2.63
WALL INSULATION	Internally insulate all solid external walls with 50mm PIR insulation or equivalent	1,952	£1.48	£1.85
WALL INSULATION	Externally insulate side and back walls with 100mm PIR or equivalent	1,705	N/A	£7.21
HEATING	Turn down thermostat by 1 degree	971	£0.00	N/A
WINDOWS	Upgrade windows to Building Regulations for replacement windows	722	N/A	£14.13
HEATING	Install a wood burning stove in the downstairs chimney and use regularly in the heating period	702	N/A	£4.27
ELECTRICITY	Systematically replace all remaining inefficient lamps with compact fluorescent lamps	666	£0.11	N/A
WINDOWS	Upgrade windows to top specification argon filled, low emissivity coated double glazed windows	648	N/A	£26.24
WINDOWS	Add secondary glazing to all vertical windows	636	£7.49	£10.03
HOT WATER	Install 8m2 flat plate solar panel facing West with its own solar pump	625	N/A	£8.56
HOT WATER	Install 4m2 evacuated tube facing West with its own solar pump	620	N/A	£5.07
DRAUGHTS	Seal floorboards and skirting boards	126	£2.85	£11.87
HOT WATER	Install Low Flow shower heads on all showers running off the mains hot water	110	£0.27	£2.74
DOORS	Upgrade all external doors to current Building Regulations	88	N/A	£27.18
APPLIANCES	Install new top energy rated washing machine and only use at 30 degrees	68	£4.42	N/A
APPLIANCES	Install new top energy rated oven	67	N/A	£7.41
APPLIANCES	Only wash clothes at 30 degrees	65	£0.00	N/A
APPLIANCES	Install new top energy rated dishwasher, only use it's eco-setting	56	£5.32	N/A
ROOF INSULATION	Add mineral wool or equivalent to the roof space up to 300mm	56	£14.28	N/A
WINDOWS	Replace all roof windows with top specification alternatives	35	N/A	£85.08
DRAUGHTS	Thoroughly draughtproof cellar door	25	£0.41	N/A
DRAUGHTS	Thoroughly draughtproof loft hatch	8	£1.26	N/A
DRAUGHTS	Install a heat recovery extractor fan in the kitchen	-5	-£51.83	-£72.56
DRAUGHTS	Install heat recovery extractor fans in the bathrooms	-13	-£37.87	-£53.02
DRAUGHTS	Unblock one chimney	-129	£0.00	N/A

## RANKED BY PAYBACK PERIOD

INITIATIVE AREA	DETAILS	ANNUAL FUEL COST SAVING	DIY INSTALL COST	PROF. INSTALL COST	DIY PAYBACK PERIOD (yrs)	PROF. PAYBACK PERIOD (yrs)
APPLIANCES	Only wash clothes at 30 degrees	£17	£0	N/A	0.0	N/A
HEATING	Turn down thermostat by 1 degree	£189	£0	N/A	0.0	N/A
HEATING	Zone the upstairs of the house using TRVs and set thermostat to be 1 degree lower than downstairs	£111	£0	N/A	0.0	N/A
HOT WATER	Add additional insulation to the hot water cylinder	£68	£20	N/A	0.3	N/A
ELECTRICITY	Systematically replace all remaining inefficient lamps with compact fluorescent lamps	£169	£70	N/A	0.4	N/A
HOT WATER	Install Low Flow shower heads on all showers running off the mains hot water	£32	£30	£300	0.9	9.3
DRAUGHTS	Thoroughly draughtproof cellar door	£5	£10	N/A	2.1	N/A
ROOF INSULATION	Add 50mm PIR or equivalent to the ceiling of the flat roof	£71	£254	£318	3.6	4.5
HEATING	Install a modern highly efficient condensing boiler	£575	N/A	£2,500	N/A	4.3
DRAUGHTS	Draughtproof all doors and windows	£34	£200	£5,100	5.8	148.5
DRAUGHTS	Thoroughly draughtproof loft hatch	£2	£10	N/A	6.5	N/A
APPLIANCES	Install two new top energy rated fridge freezers	£80	£600	N/A	7.5	N/A
WALL INSULATION	Internally insulate all solid external walls with 50mm PIR insulation or equivalent	£379	£2,894	£3,617	7.6	9.5
FLOOR INSULATION	Insulate solid ground floor with 100mm PIR insulation or equivalent and install water based underfloor heating and highly efficient condensing boiler	£630	N/A	£5,340	N/A	8.5
DRAUGHTS	Conduct an air tightness test with a blower door and smoke sticks and seal draught points that might be expected given the building fabric	£46	£400	£500	8.6	10.8
HOT WATER	Install 4m2 evacuated tube facing West with its own solar pump	£120	N/A	£3,700	N/A	30.7
HOT WATER	Install 4m2 flat plate solar panel facing West with its own solar pump	£119	N/A	£3,700	N/A	31.1
WALL INSULATION	Externally insulate side and back walls with 100mm PIR or equivalent	£331	N/A	£12,292	N/A	37.1
WINDOWS	Add secondary glazing to all vertical windows	£123	£4,760	£6,375	38.6	51.7
HOT WATER	Install 8m2 flat plate solar panel facing West with its own solar pump	£121	N/A	£5,350	N/A	44.1
ELECTRICITY	Solar PV panels - a six panel array (~8m2) facing East	£95	N/A	£4,800	N/A	50.4
ELECTRICITY	Solar PV panels - a three panel array (~4m2) facing East	£48	N/A	£3,150	N/A	66.2
WINDOWS	Upgrade windows to Building Regulations for replacement windows	£140	N/A	£10,200	N/A	72.8
ROOF INSULATION	Add mineral wool or equivalent to the roof space up to 300mm	£11	£795	N/A	73.6	N/A
WINDOWS	Upgrade windows to top specification argon filled, low emissivity coated double glazed windows	£126	N/A	£17,000	N/A	135.1
DOORS	Upgrade all external doors to current Building Regulations	£17	N/A	£2,400	N/A	140.0
WINDOWS	Replace all roof windows with top specification alternatives	£7	N/A	£3,000	N/A	438.2



## 4.5 SOME CONSIDERATION

For this Masterplan the 'some consideration' threshold for individual measures has been set at 20 years. *It is assumed that all 'no brainer' measures are also carried out.*

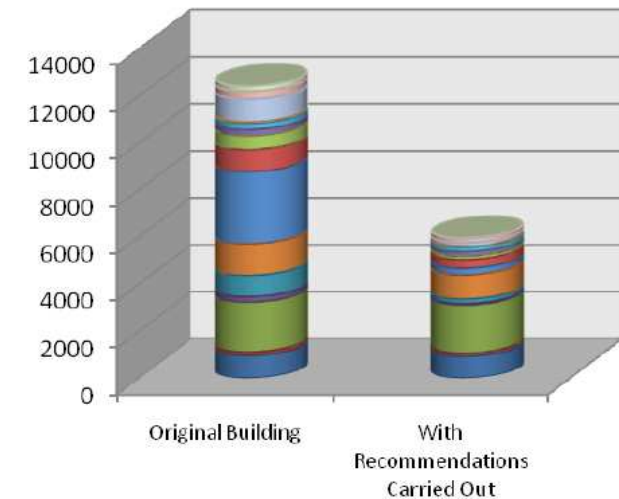
### RECOMMENDED MEASURES

	DIY	Professional
Install two new top energy rated fridge freezers	●	
Install new top energy rated washing machine and only use at 30 degrees	●	
Install a heat recovery extractor fan in the kitchen		●
Install heat recovery extractor fans in the bathrooms		●
Conduct an air tightness test with a blower door and smoke sticks and seal draught points that might be expected given the building fabric		●
Insulate solid ground floor with 100mm PIR insulation or equivalent and install water based underfloor heating and highly efficient condensing boiler		●
Installing 8m <sup>2</sup> Solar Photovoltaic Panels (PV) with 36.5p Feed-in-Tariff		●

### STATISTICS

Estimated annual saving	<b>£1,600</b>
Estimated cost of measures (include 'no brainer')	<b>£15,750</b>
Estimated annual CO <sub>2</sub> saving	<b>52% - 6.5 tonnes</b>
Estimated annual energy reduction	<b>50%</b>
Estimated Payback Period	<b>9.9 years</b>

### ANNUAL CO<sub>2</sub> – BEFORE AND AFTER

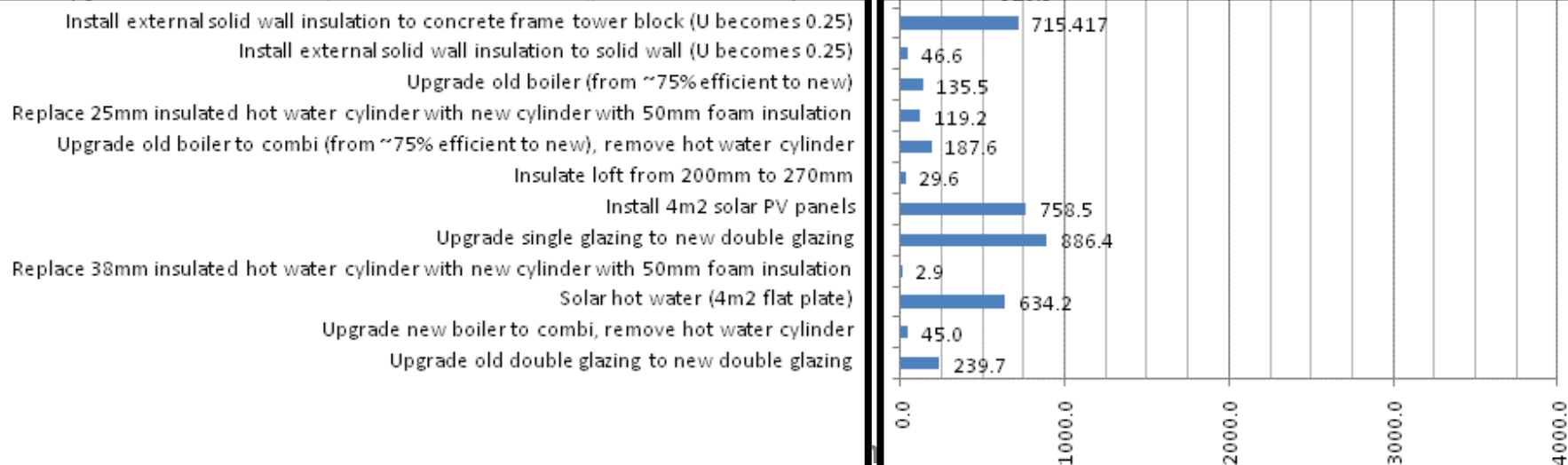
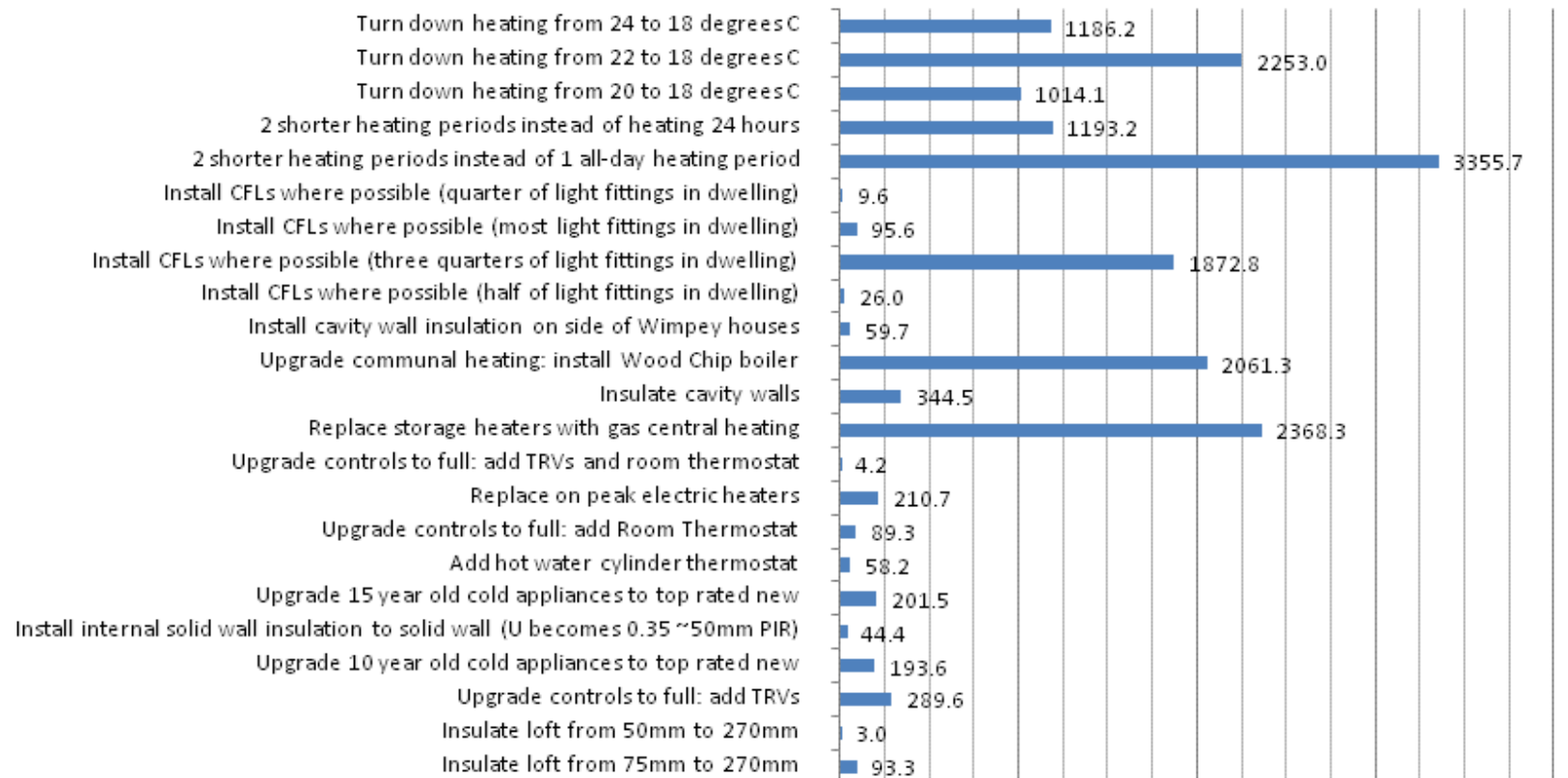


# Total CO<sub>2</sub> saved per initiative across stock



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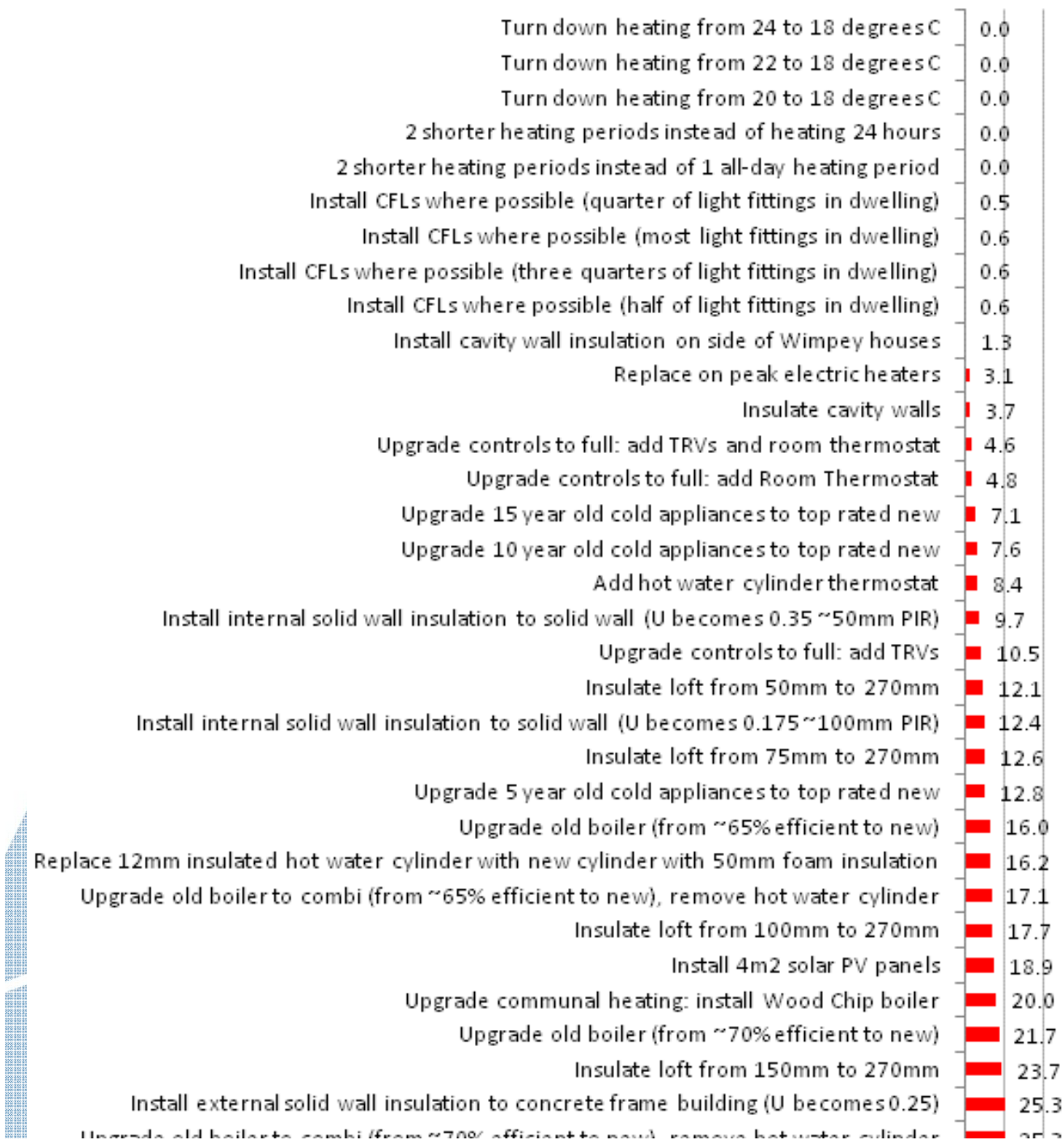


# Economic Payback



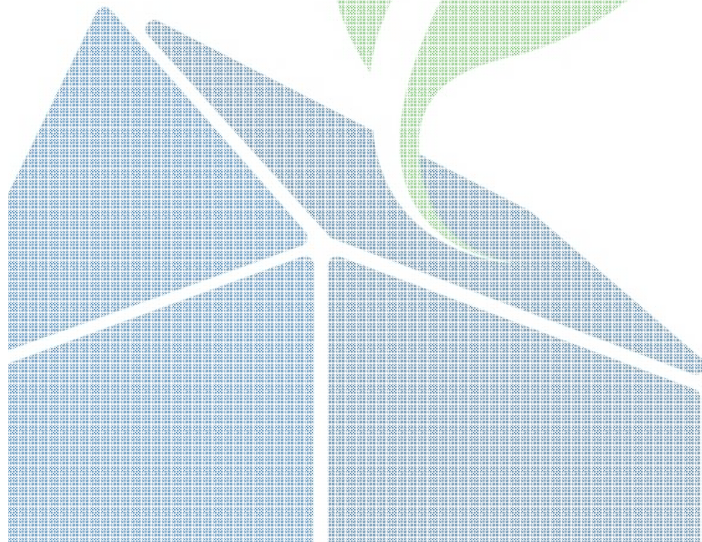
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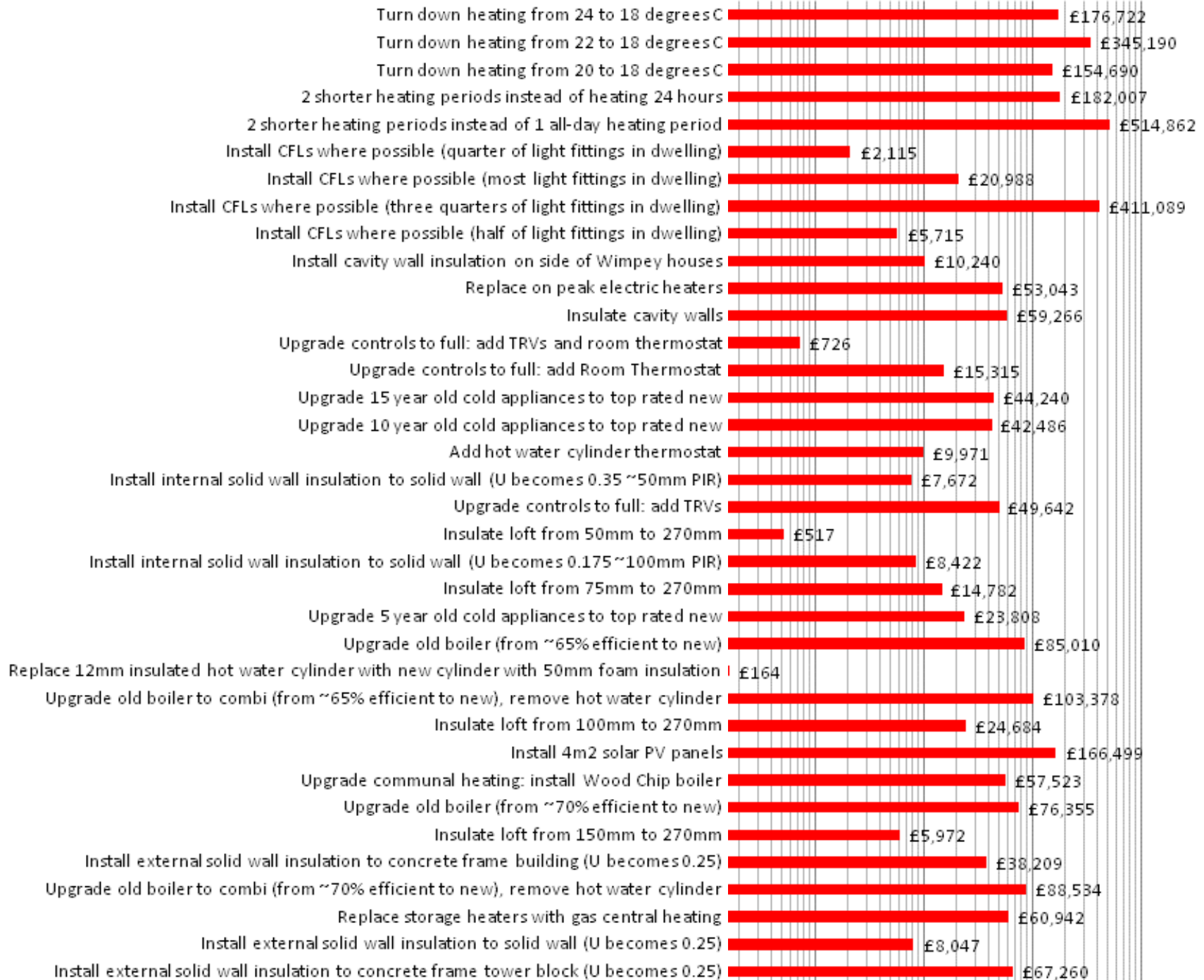


# Total Tenants Savings



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# Average Investment to Increase SAP by one point per dwelling



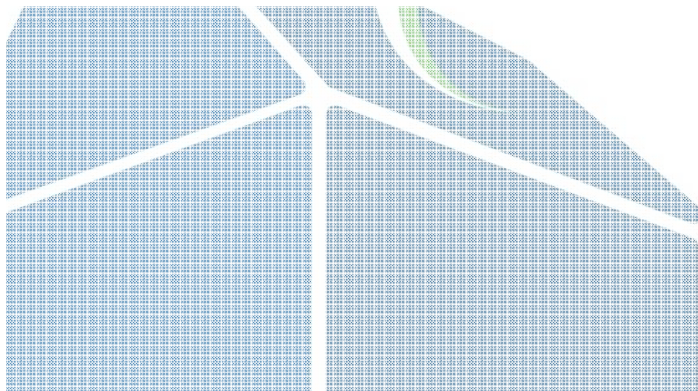
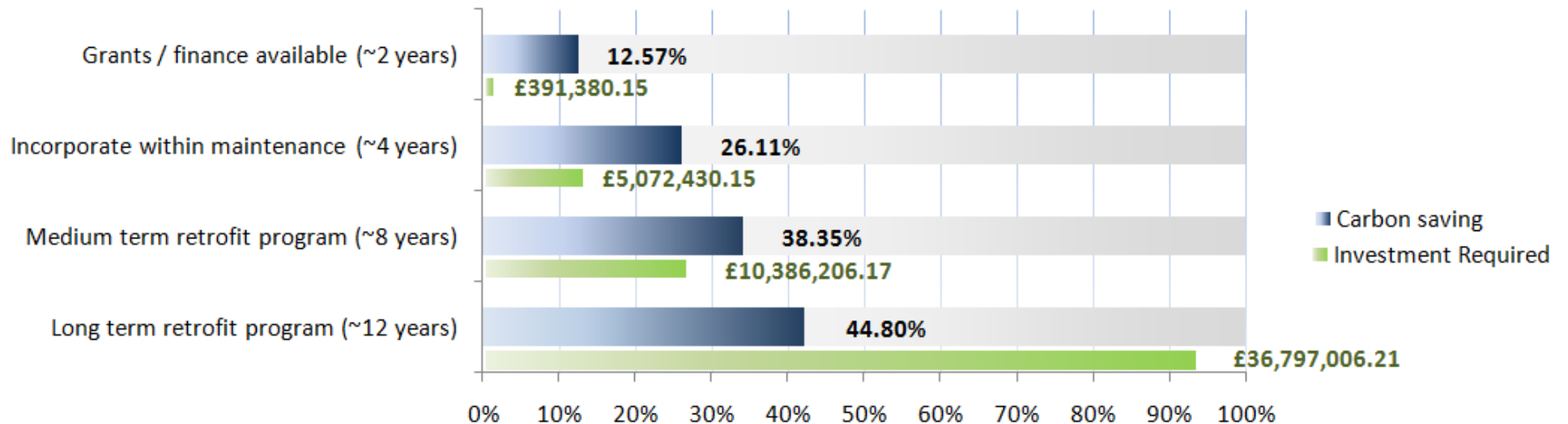
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# Carbon Assessment

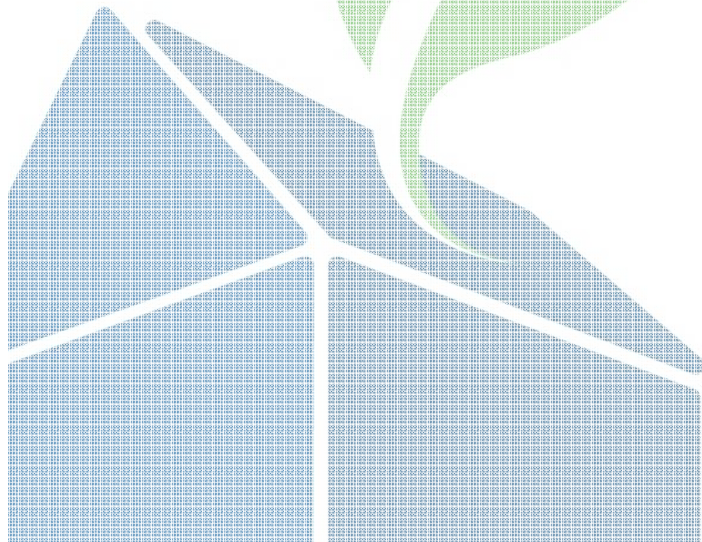
## Stage 4: Example recommendations



# 'Deep and Wide' CO<sub>2</sub> Reduction

- Renovate all houses to the most stringent standards?
  - Would we realistically achieve this? Will householders be convinced? Can we afford it? Do we have enough time? Skills and knowledge? Capacity?
- Renovate a proportion of houses to very high standards and the remainder as is practicable
  - Who decides which houses can get away with a lower standard? Can we rely on lifestyle changes?
- Assume that technology will save the day and the grid will be decarbonised?
  - When will technology arrive? Will it perform? Will it be as widespread as we would wish it to be?

# Cost vs CO<sub>2</sub>

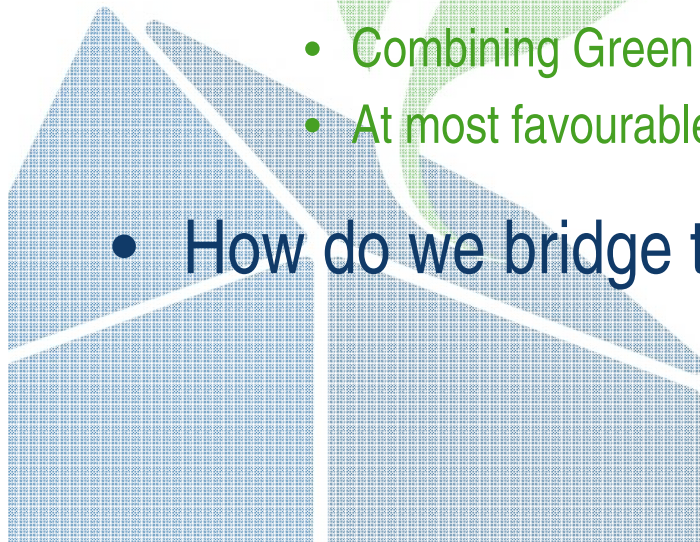


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# Constraints

- *Retrofit for the Future* suggests
  - £85,000 for one-off 80% CO<sub>2</sub> emissions reduction
    - *At current emissions factors*
  - Possibly reduce to £50,000 by economies of scale?
- CAMCO modelling for EEPH *et al* suggests
  - Maximum £12,500 per dwelling
    - *Combining Green Deal (PAYS), CERT, FiT and RHI funding*
    - *At most favourable interest rates*
- How do we bridge the gap?





# Carbon Footprint v Emission



MostUsed | IC\_BaseCarbon | IC\_Carb

67	SUITE - No Brainer	
77	SUITE - Some Consideration	£
87	SUITE - Green Halo	£1
85	SUITE - No Brainer	
86	SUITE - Some Consideration	£



740.5
1279.8
479.1
569.1
2874.9
1351.1
1386.6
18037.3
10425.6
14527.6
12935.7
1284.3
2664.3



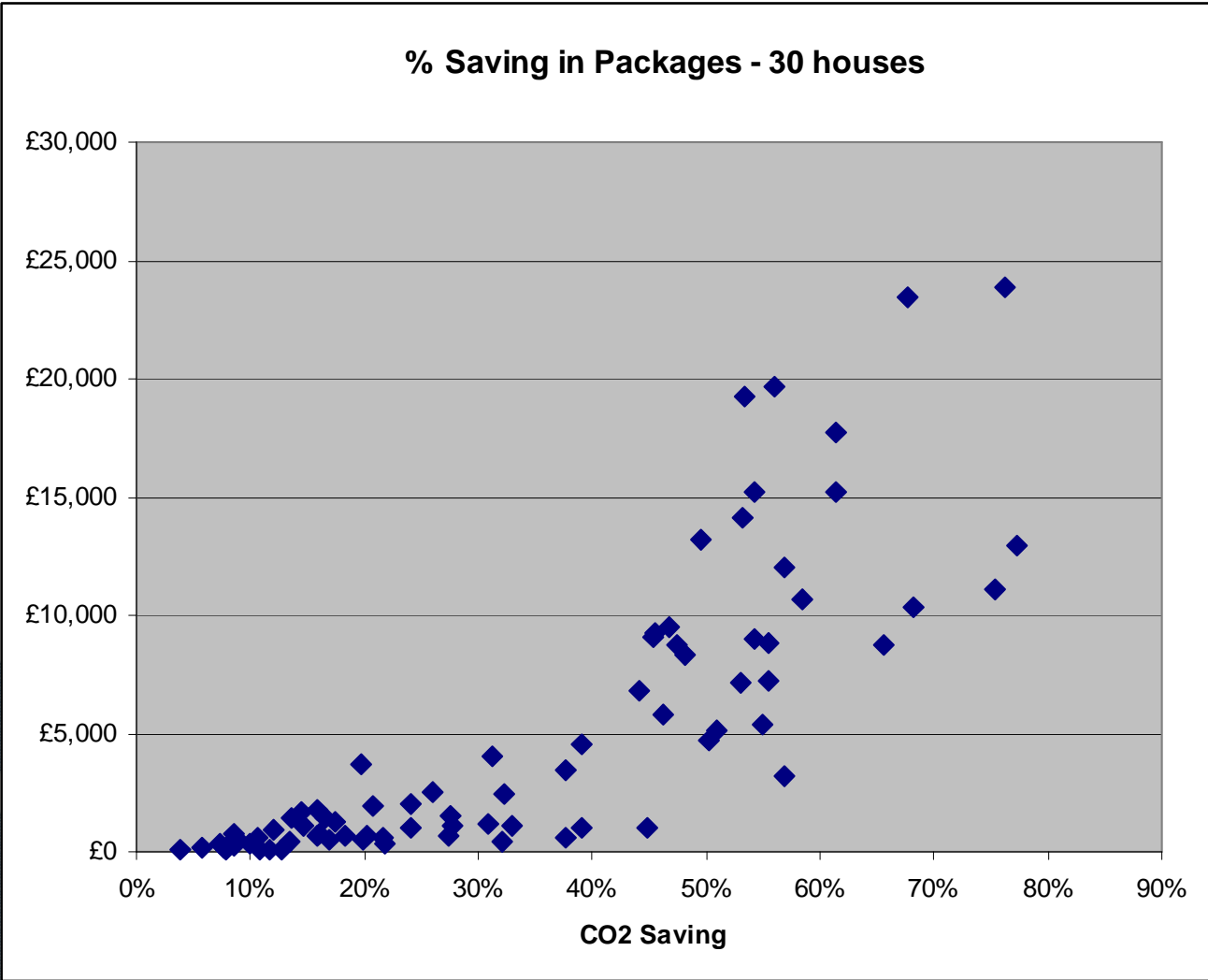
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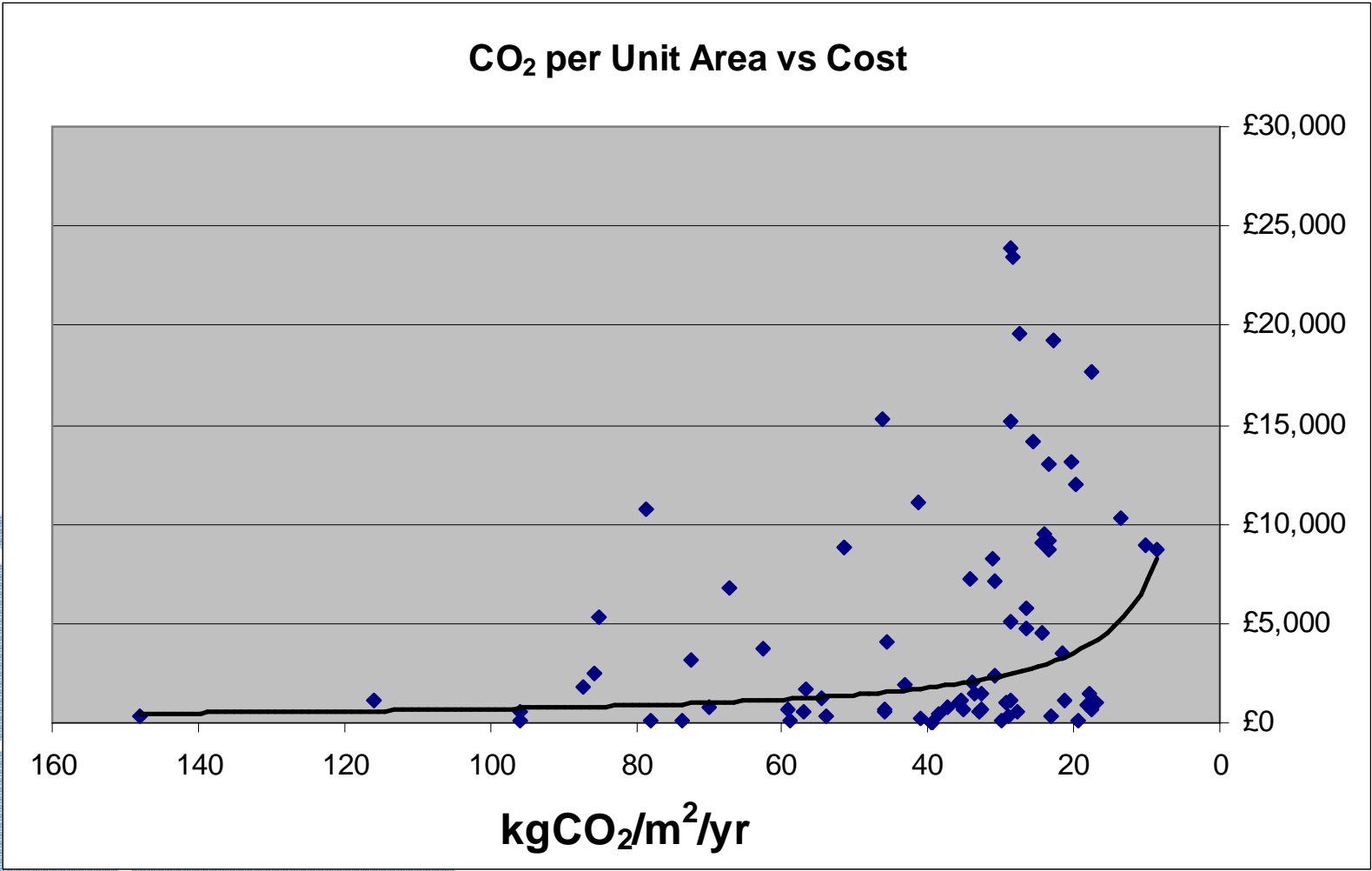
£13,178.29	9580.17	4751.0
£1,430.00	9580.17	1585.6
£4,566.73	9580.17	3741.2
£5,101.25	6631.14	3374.7
£612.00	6631.14	1437.1
£1,047.67	6631.14	2588.9
£4,028.00	14737.43	4590.0
£630.00	14737.43	1579.6
£1,648.00	14737.43	2131.6
£23,439.00	15792.33	10694.8
£120.00	15792.33	1842.2
£3,700.00	15792.33	3105.5

202.7	77.9	62.6	20%
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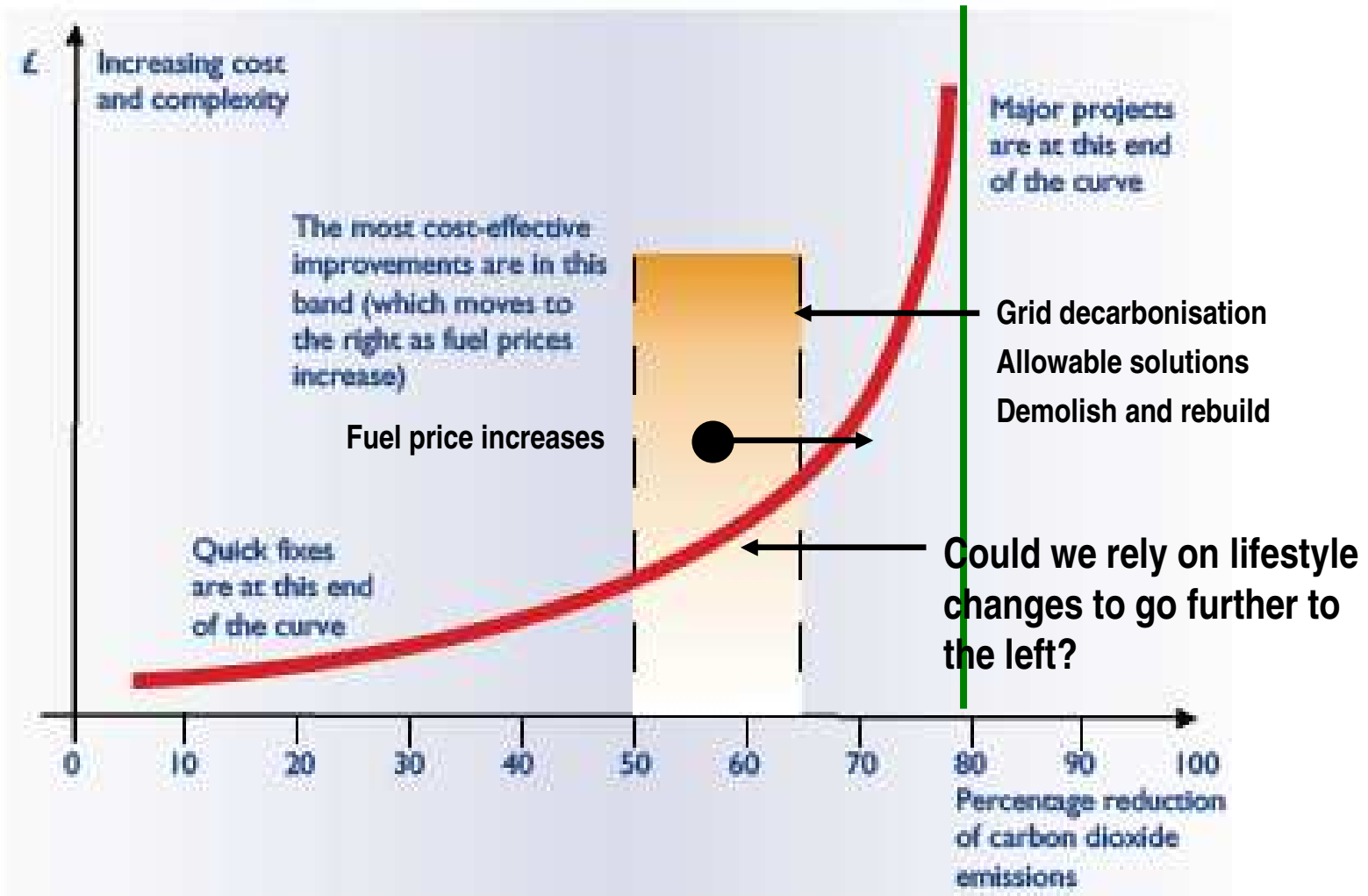
# Cost and Complexity v Emissions



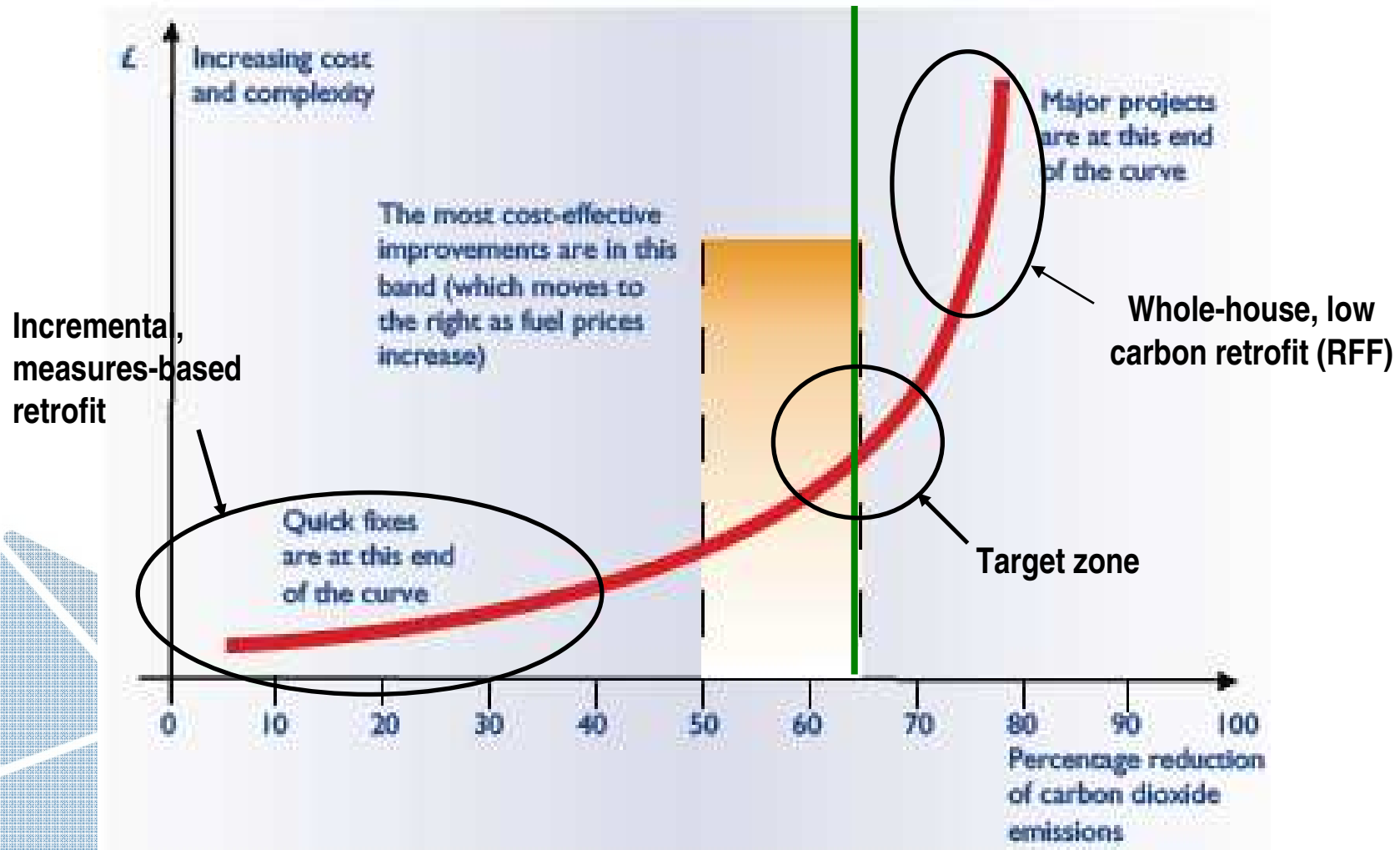
# Cost and Complexity v Emissions



# Cost and Complexity v Emissions

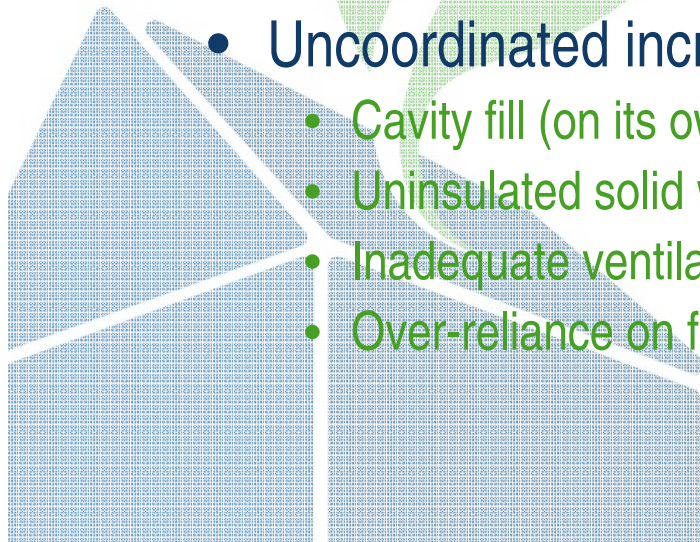


# Cost and Complexity v Emissions



# What's not in the target zone?

- Unaffordable and unnecessary?
  - PassivHaus *standard*, e.g.
    - Wall and floor U values  $\leq 0.15$  W/m<sup>2</sup>K
    - Air permeability  $< 1$  m<sup>3</sup>/m<sup>2</sup>h @ 50 Pa
    - Aerogel insulation board
    - Vacuum insulation
    - Exhaust air heat pumps
- Not good enough
  - Uncoordinated incremental measures, e.g.
    - Cavity fill (on its own)
    - Uninsulated solid walls
    - Inadequate ventilation
    - Over-reliance on fossil fuels



# What is in the target zone?

## Three criteria for choosing improvement packages

### Capital cost

Capital cost band	Symbol
Up to £100	£
£100 - £1000	££
£1000 - £5000	£££
£5000 - £10,000	££££
Over £10,000	£££££

**Net cost (£)**  
 (capital minus fuel saving)  
 divided by  
**Whole-life carbon dioxide emissions reduction (tonne)**

### Disruption

Disruption	Band	Examples
Minimal	✘	Low energy lamps, energy efficient appliances
Low	✘ ✘	Heating controls, cavity wall insulation, draught-stripping, loft insulation
Moderate	✘ ✘ ✘	Replacement boiler, solar water heating
High	✘ ✘ ✘ ✘	Replacement windows, whole house ventilation, external wall insulation
Significant	✘ ✘ ✘ ✘ ✘	Ground floor insulation, internal wall insulation, new heating system

### Carbon cost effectiveness

Carbon cost effectiveness	Symbol
<b>Pays for itself</b>	😊😊😊😊😊
<b>0 - 10 £/tonne CO<sub>2</sub></b>	😊😊😊😊
<b>10 - 100 £/tonne CO<sub>2</sub></b>	😊😊😊
<b>100 - 500 £/tonne CO<sub>2</sub></b>	😊😊
<b>&gt; 500 £/tonne CO<sub>2</sub></b>	😊

# What is in the target zone?



UK average house

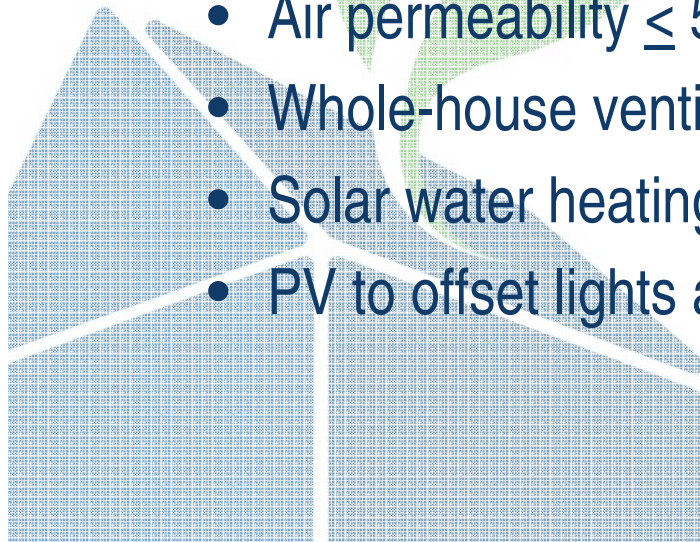
Capital cost,  
disruption and  
carbon cost  
effectiveness

Measure	Capital cost	Carbon cost effectiveness	Disruption
<b>Floors</b>			
Floor Insulation	££	☺☺☺☺☺	XXXXXX
<b>Walls</b>			
Internal wall Insulation	££££	☺☺☺☺	XXXXXX
Cavity wall Insulation	££	☺☺☺☺	XX
External wall Insulation	££££/£	☺☺☺☺☺	XXXX
<b>Roofs</b>			
Loft Insulation	££	☺☺☺☺☺	XX
Rafter Insulation (only when reroofing)	£££	☺☺	XXXX
<b>Windows and doors</b>			
Replacement windows and doors (U value 1.8)	£££	☺☺	XXXX
Replacement windows and doors (U value 0.8)	£££££	☺☺	XXXX
<b>Air tightness and ventilation</b>			
Draught-stripping	£	☺☺☺☺☺	XXXX
Major air-tightness measures	££	☺☺☺☺☺	XXXX
Air-tightness measures with MVHR	£££	☺☺	XXXXXX
<b>Lighting and appliances</b>			
Low energy lights	£	☺☺☺☺☺	XX
Low energy appliances (marginal cost of replacement)	£££	☺☺	XX
<b>Heating</b>			
Replacement gas boiler	£££	☺☺	XXXX
Upgrading heating controls	££	☺☺☺	XX
Micro CHP	££££	☺	XXXX
Ground source heat pump	£££££	☺	XXXXXX
Air source heat pump	££££	☺	XXXXXX
Wood pellet boiler	££££	☺☺	XXXX
<b>Renewable energy systems</b>			
Solar hot water heating	£££	☺	XX
1 kW solar photovoltaic panels	££££	☺	XX
Micro wind turbine	£££	☺	XX



# What is in the target zone?

- A long/medium-term plan for every house
  - Derived from SAP assessment, Passivhaus **strategy**
- Cost effective specification?
  - U values  $\leq$  Approved Document L1B (2010)
  - Solid wall insulation and ground floor insulation
  - Reduced thermal bridging
  - Air permeability  $\leq 5 \text{ m}^3/\text{m}^2\text{h @ 50 Pa}$
  - Whole-house ventilation (to recover internal gains)
  - Solar water heating (HW now biggest thermal load)
  - PV to offset lights and appliances (self-funded via FiT)

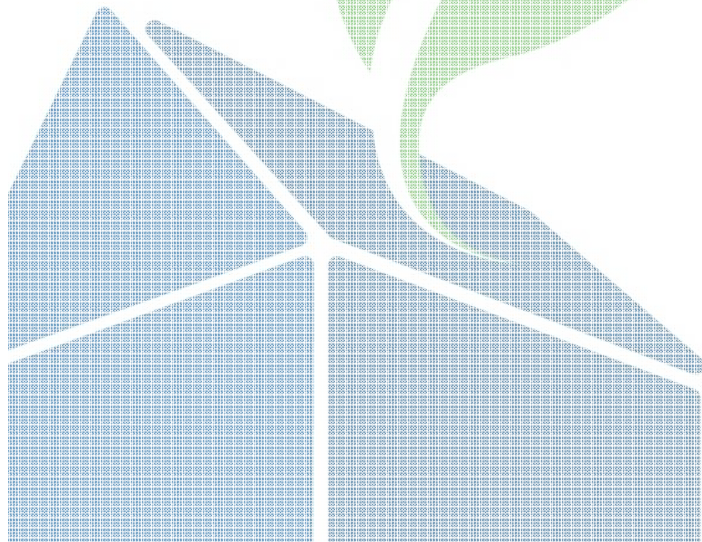


# Towards a Holistic Strategy

- 80% emissions reduction is not appropriate
  - At *current* emissions factors
- ~ 65% emissions reduction is more appropriate
  - Assuming decarbonisation of the grid, etc
- *RFF* measures are probably unaffordable
  - The funding gap is too big
- Select improvement packages on the basis of
  - Capital cost, disruption and carbon cost effectiveness
  - Specifications will vary by dwelling type
  - SWI, GFI, SWH and PV will be essential components

# Reducing Work Costs

- 'One Hit' costs
- Retrofit vs Eco-Renovation
- Marginal Costs
- Trigger Points



# Motivating Concurrent Working



A Whole House Plan

[www.parityprojects.com](http://www.parityprojects.com)

[www.rickabythompson.com](http://www.rickabythompson.com)

# Behavioural Measures

- 18°C



- 20°C



1.3x

- 22°C



1.6x

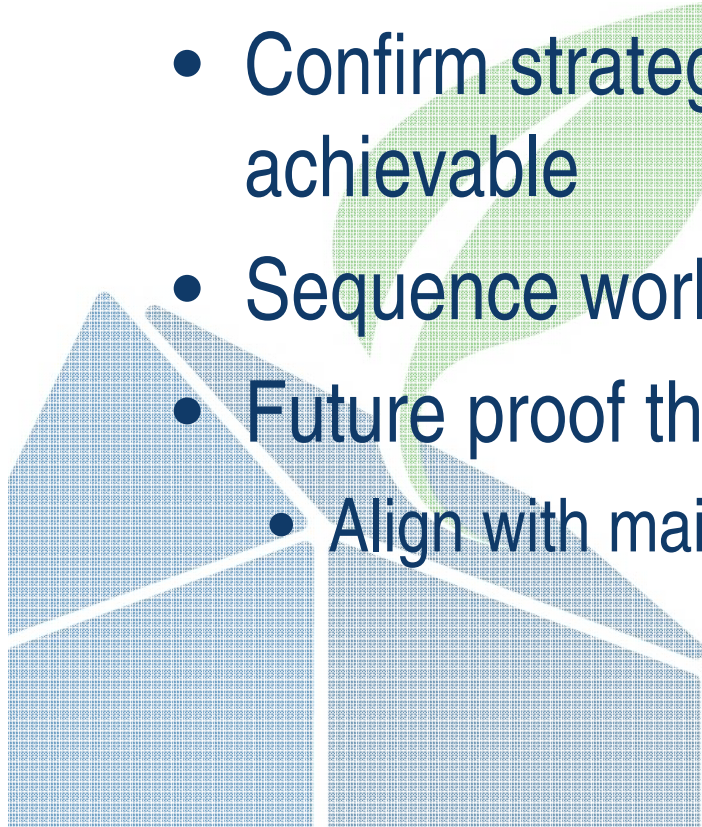
- 24°C



2.1x

# Planning and Scheduling: Tactical

- Fitting the recommended work items to existing works programmes.
- Confirm strategic targets are realistic and achievable
- Sequence works to maximise cost effectiveness
- Future proof the assets
  - Align with maintenance activities

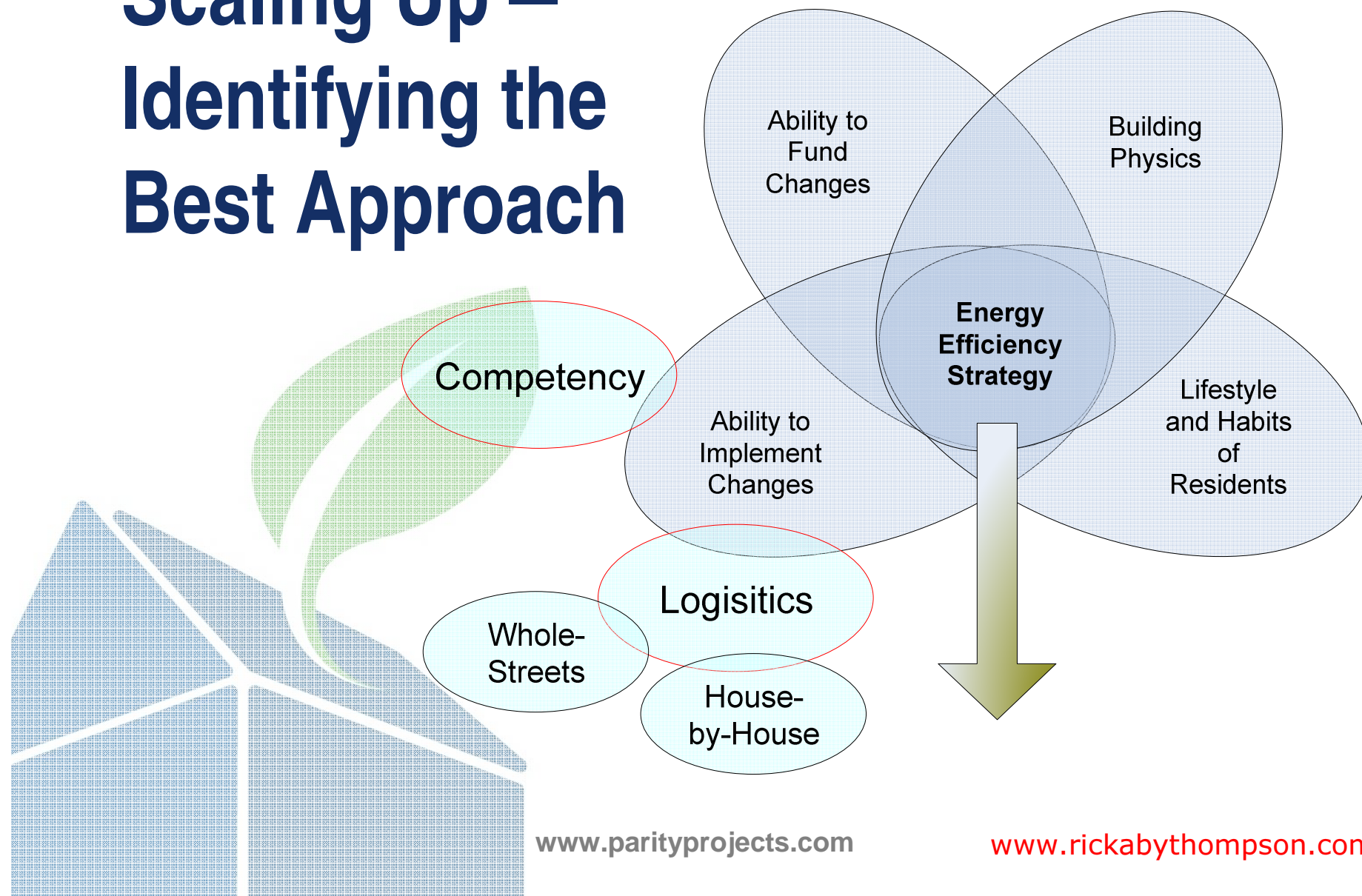


# What is already planned?

- Decent Homes
- Cyclical upgrade?
  - Boilers, Kitchens, Windows, Ventilation
- Maintenance
  - Servicing, Faults
- Voids
  - Everything!

**If you have no view of the end result, you'll not take advantage of every opportunity**

# Scaling Up – Identifying the Best Approach



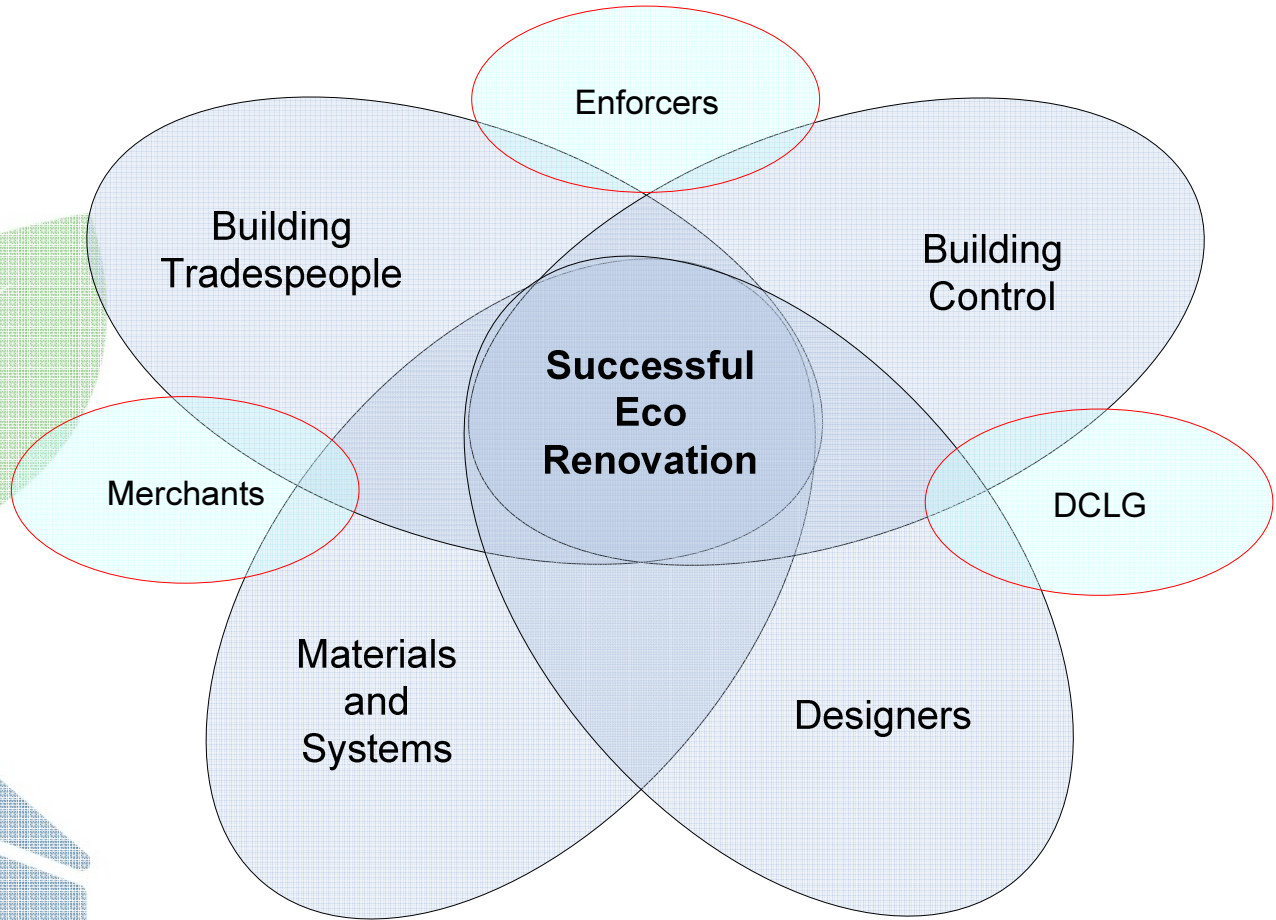
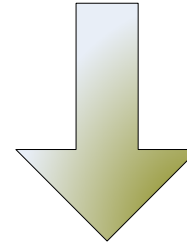


# Who Influences Change?

- Major Interventions

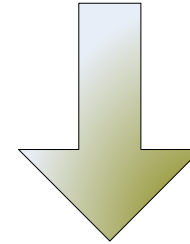
- Development
- Extensions
- Insurance Work

Motivated Client



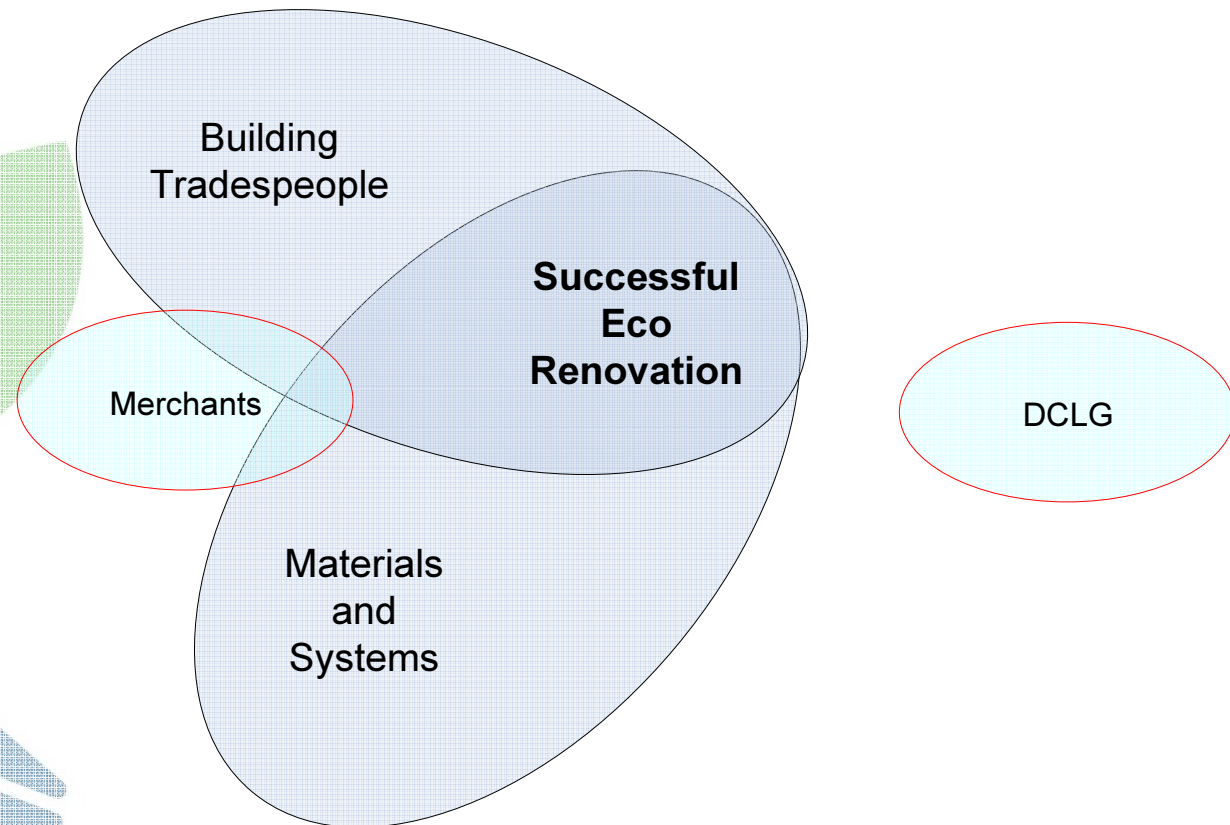
# Who Influences Change?

Motivated Client

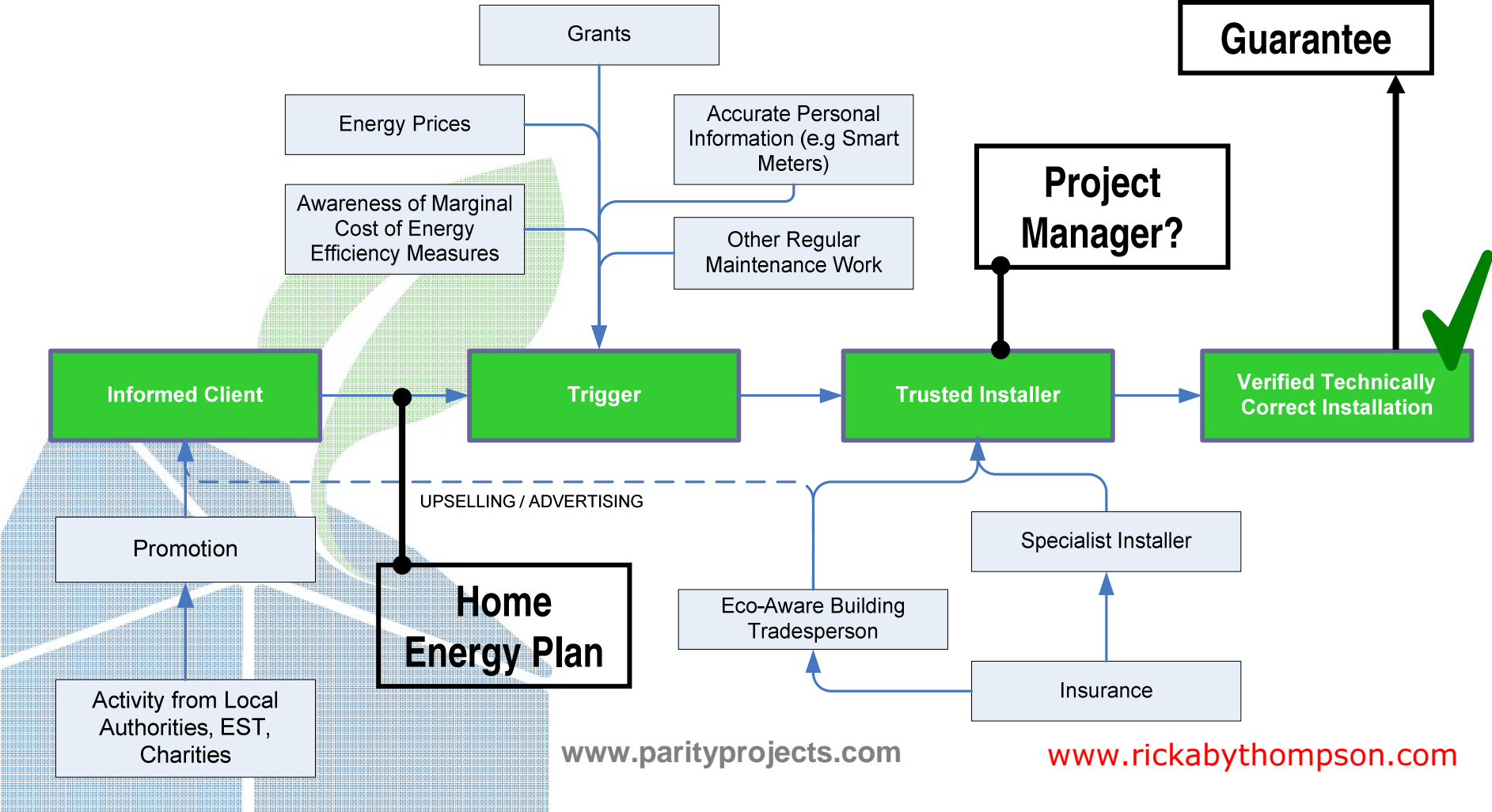


- **Minor Interventions**

- Faults, Repairs
- Redecoration
- Obsolescence
- Fashion



# What work will we be doing?



# Feedback

- Actual Installation costs
- Actual energy used in houses
- Feedback on the householder experience



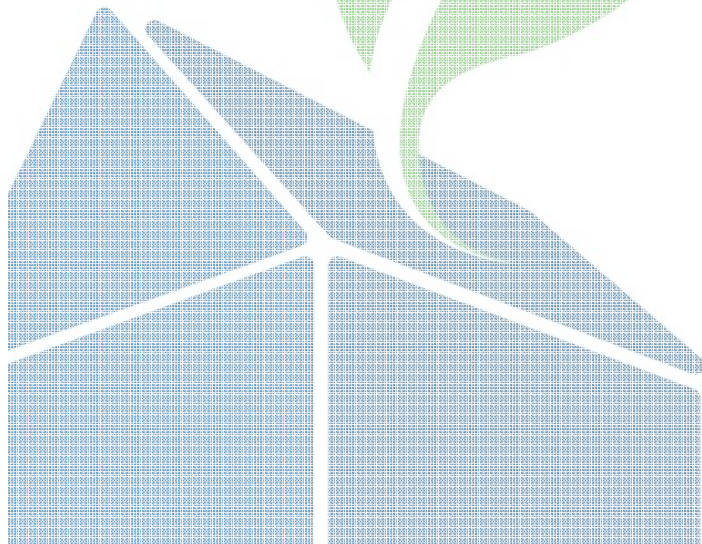
# Summary

- Passive House strategy – not standard
- Design is the easy bit – logistics is the key issue
- Give every possible measure a chance
- Make a life plan for the house (start at the end!)
- All work is an opportunity for energy saving
- Preserve opportunities you cannot do now
- Track the results and learn from them



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