Homes of today for tomorrow

Decarbonising Welsh Housing between 2020 and 2050

Stage 3: case studies and discussion

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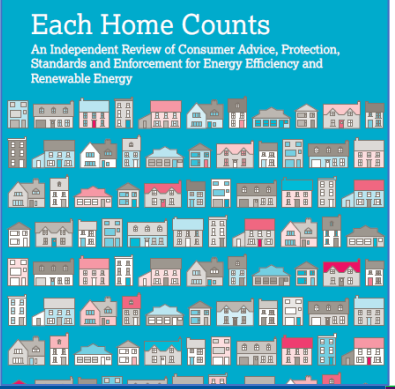
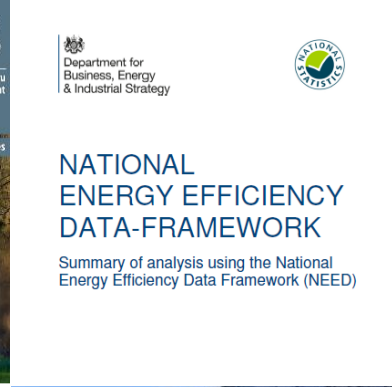
CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

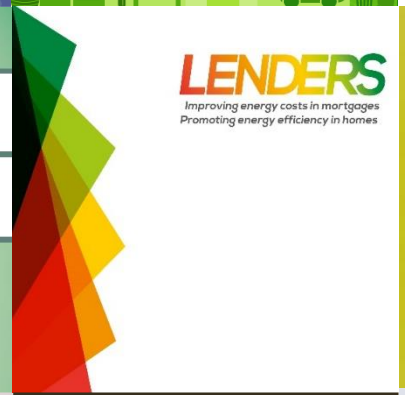
‘Welsh Government should urgently commence a 10-year programme to prioritise the retrofit of certain homes… [and]
…set a target of EPC Band A for homes in social ownership….’

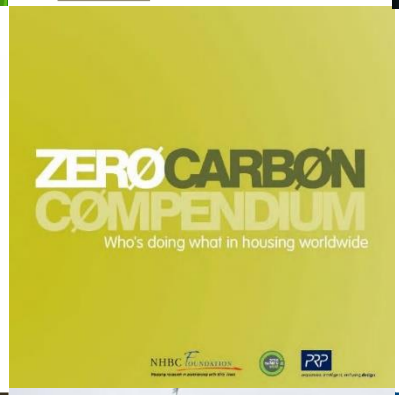
Independent Advisory Group report ‘Better Homes, Better Wales, Better World’

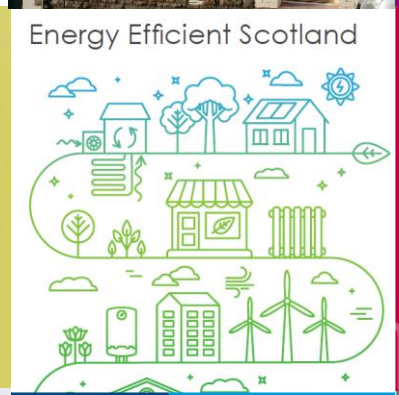
Stage 1:
What works



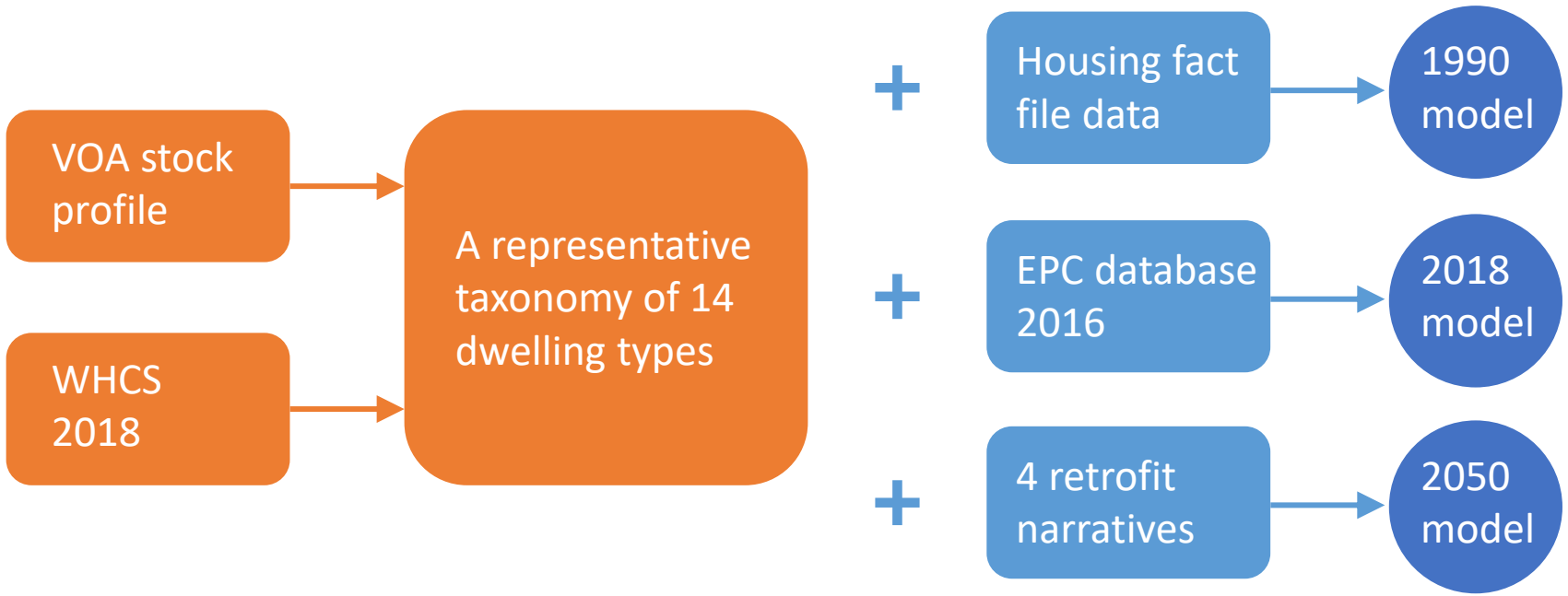








Stage 2:
the Welsh housing stock



Developing a taxonomy of dwelling types

Modelling the housing stock at three points in time

14 archetypes representing the Welsh housing stock:

	HOUSE End terrace	HOUSE Mid terrace	HOUSE Semi-detached	HOUSE Detached	FLAT (Purpose built)	Total
pre 1919	3%	9%	4%	7%		23%
1919-1944			5%			5%
1945-1964			10%			10%
1965 - 1990	4%	6%	10%	9%	4%	33%
post 1990			5%	7%	1%	13%
Total	7%	15%	33%	23%	6%	**84%**

Three energy supply scenarios:

Scenario 1
minor improvement

It is not tenable to deliver 90%+ decarbonisation with established retrofit methods.

40%

Scenario 2
significant improvement

90%+ decarbonisation is tenable, but requires a high standard of retrofit throughout the stock.

60%

Scenario 3
transformational change

Focus shifts from decarbonisation to demand reduction, to limit increases in energy costs and fuel poverty.

80%

Stage 2 recommendations:

- UK Government must be lobbied to ensure the national grid exceeds 60% clean energy by 2050.
- Action must be taken to protect vulnerable households, to ensure that increases in fuel costs or retrofit of new heating systems do not increase fuel poverty.
- The Welsh housing stock should, as a whole, be retrofitted to the equivalent of EPC ‘A’ rating.*
- Retrofit of some Welsh houses is constrained. However the justification for ‘acceptable fails’ must be carefully defined so as not to jeopardise decarbonisation targets.

* The Independent Review of Affordable Housing Supply (WG, 2019) recommended that “all new affordable homes be built to EPC ‘A’ using a fabric first approach from 2021”.

Stage 3: social housing

Stage 3 – key aims:

1. To test the assumptions and statistical modelling that underpin the independent steering group report's recommendations.

2. To learn as much as possible from social housing landlords in Wales about:

- The nature of their stock
- Their aspirations for the future and decision-making processes
- The cost and feasibility of retrofit (including learning from WHQS).

3. To identify challenges and benefits related to retrofit for decarbonisation.

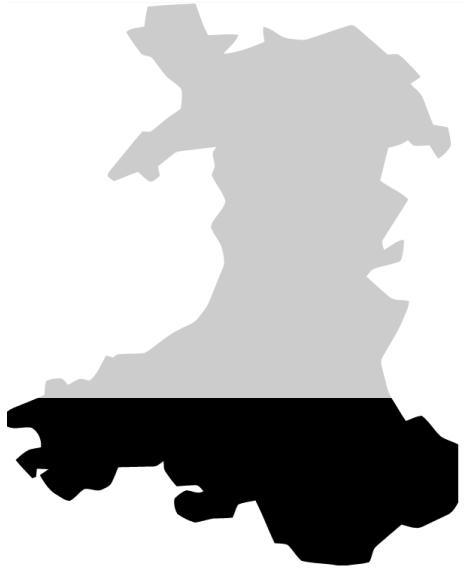
4. To develop tools that help with decision making.

10 archetypes representing the social housing stock:

	HOUSE End terrace	HOUSE Mid terrace	HOUSE Semi-detached	HOUSE Detached	FLAT (Purpose built)	Total
pre 1919	0%	2%	1%	0%	2%	5%
1919-1944	2%	3%	5%	0%	1%	11%
1945-1964	3%	5%	12%	0%	8%	29%
1965 - 1990	5%	7%	5%	0%	19%	36%
post 1990	1%	2%	6%	1%	9%	2%
Total	11%	20%	29%	1%	39%	**82%**

Social housing stock data:

- 49 social housing landlords
- 231,063 dwellings
- 2% listed in conservation areas
- 7.5% listed as off grid
- 94% provided with EPC/SAP ratings



background to Stage 3

Stage 2 identified a tension between decarbonising homes and reducing fuel bills for tenants.

The WHQS programme was successful and should be learnt from.

The social housing stock is not representative of the entire Welsh housing stock.

The participating landlords' stock represented the social housing stock.

This enables Stage 3 to focus on the social housing sector.

Prior work commissioned by WG has been 'top down' (strategic, based on a statistical overview).

Case studies are 'bottom up' (using real dwellings to establish *reasonable limits to retrofit*)

Case studies are not intended to be adopted as the 'correct' solution – they are worked examples.

Stage 3 case studies describe two scenarios:

Anticipated RMI describes ‘business as usual’ for the SHL – repair, maintenance and improvement.

The scope of anticipated RMI varies depending on dwelling condition and, typically, age.

The typical anticipated RMI includes providing a new mains gas combi boiler.

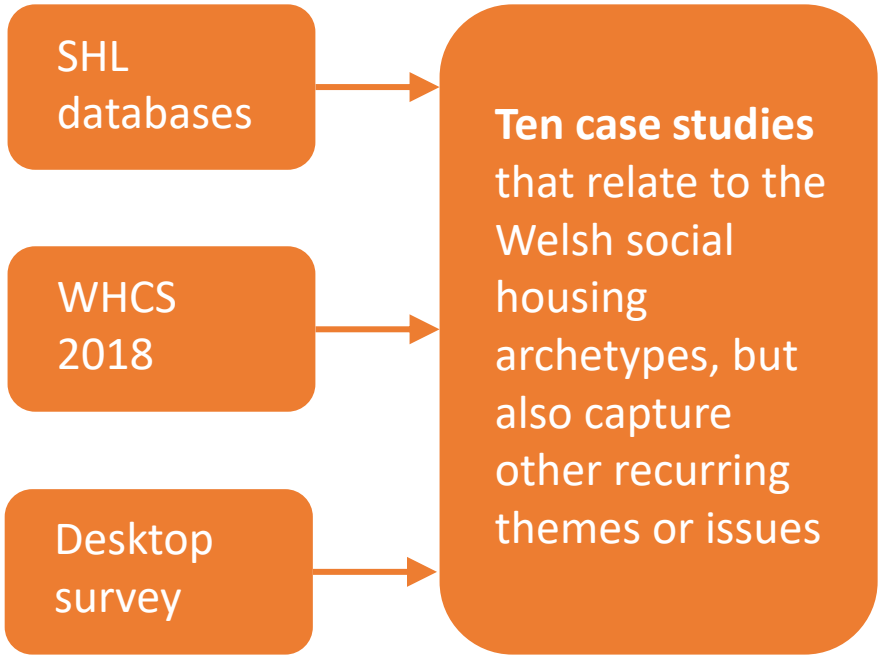
Typically, anticipated RMI does not include renewables.

Decarbonisation retrofit describes a current best practice that targets 95% decarbonisation* by:

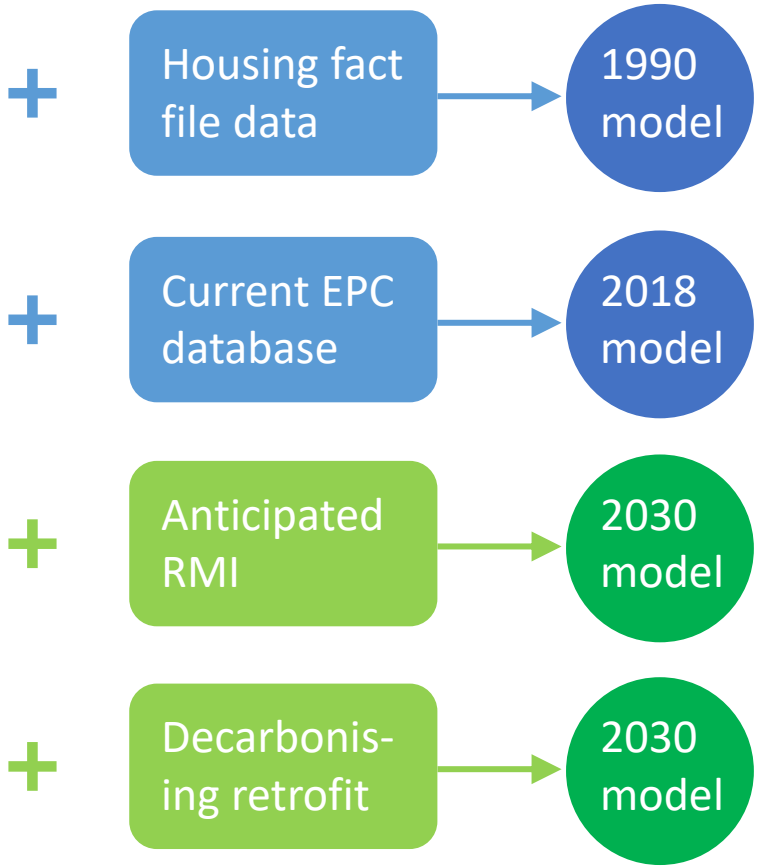
- Improving fabric such that switching to electric heat does not impact significantly on fuel costs.
- Replacing the existing heating and hot water system with heat from electricity.
- Installing PV as a renewable, to assess the benefit to the tenant (reduced fuel bills).

* relative to 1990 emissions levels, based on energy supply predictions for 2023 (source: NationalgridESO, 2019)

Stage 3: exploring the Welsh social housing stock



Identifying ten social housing case studies



Comparing RMI with retrofit for decarbonisation to explore the tension between capital cost, potential decarbonisation and impact on fuel bills

Social Housing Landlord	Identifier	Type	Age	Narratives	% of all social housing	% of all Welsh housing
Bron Afon	case study 01: Torfaen Terrace	End terrace	Pre 1919	**Retrofitting an older, poor quality void** Condensation in solid wall construction Smart metering	few	3%
Tai Tarian	case study 02: Ocean Way	Mid terrace	1945-64	**Non-traditional (no fines) construction** Upgrading existing EWI Including a battery in PV installation	5%	few
Carmarthenshire County Council	case study 03: Ael Y Bryn	Semi-detached	1945-64	**A poor quality off-gas house** Comparing oil and electric heat A motivated tenant	12%	10%
Carmarthenshire County Council	case study 04: Bryn Hyfryd	Semi-detached	1945-64	**A poor quality mains gas house** An holistic retrofit 'Clean slate' for a decarbonisation strategy	above	above
Tai Tarian	case study 05: Elmwood Road	Semi-detached	1965-90	**an older home that meets WHQS** old cavity walls with EWI Previously installed PV	5%	10%
North Wales Housing	case study 06: Cae Bold	Semi-detached	Post 1990	**Reasonable targets, recently built homes** Minimising aesthetic impact – IWI Estate-wide equality	6%	5%
Tai Tarian	case study 07: Cove Road	Flats	1945-64	**A retrofit package for the private sector** Non traditional construction ('Cornish') Removing gas from flats	8%	few
Carmarthenshire County Council	case study 08: Y Bwthyn	Flats	1965-90	**A poor quality flat needing significant work** Cavity failure "most satisfactory course of action"	19%	4%
North Wales Housing	case study 09: Cae Clyd	Flats	1965-90	**Integrating roof, systems and renewables** difficult flats on a desirable estate an estate-wide approach	above	above
North Wales Housing	case study 10: Gerddi Morfa	Flats	Post 1990	**When do you switch to electric heat?** (Recent boiler in 2016) difficult flats – older persons	9%	1%
				Total % of housing stock represented:	64%	

case study 03:

Semi-detached house, 1945-64

Carmarthenshire County Council

Headlines:

- **True cost of decarb, poor quality house**
- **An off-gas dwelling**
- **A motivated tenant**

Anticipated RMI

component:	specification	likely cost
Walls	External Wall Insulation 100mm	£2,957
roof	topped up to 300mm	£714
floor	No upgrade	
window, door	Standard high performance (upvc)	£3,664
Heating, hot water	Oil-fired boiler, wet central heating	£4,090
Airtightness, vent	Normal practice	
renewables	PV 4kWp	£7,000
Total cost		**£18,425**

Decarbonisation retrofit

component:	specification	likely cost
Walls	External Wall Insulation 150mm	£3,475
roof	topped up to 300mm	£714
floor	50mm over-floor insulation	£1,785
window, door	Triple Glazing composite (timber)	£7,328
Heating, hot water	Air Source Heat Pump	£8,180
Airtightness, vent	Best practice without MVHR	£739
renewables	PV 4kWp	£7,000
Total cost		**£29,221**

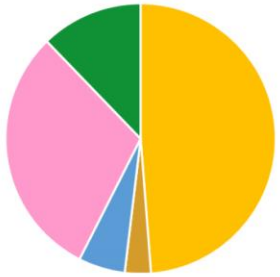
case study 03:

Semi-detached house, 1945-64

Results 1: **Anticipated retrofit**

Predicted incremental impact of retrofit:

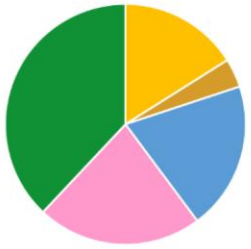
	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew
SAP	46	48	60	61		62	63		91
fuel bills (£)*	£1,062	£1,022	£792	£777		£748	£726		£173
Decarbon**	0%	26%	44%	45%		47%	56%		60%



Upgrading external walls and system are cost effective improvements. Upgrading glazing is more expensive, with a limited impact on emissions.

Installation of a traditional oil fired wet central heating system limits potential to decarbonise (60% overall), and annual fuel costs for tenants remain expensive.

PV is expensive but significantly reduces fuel costs.

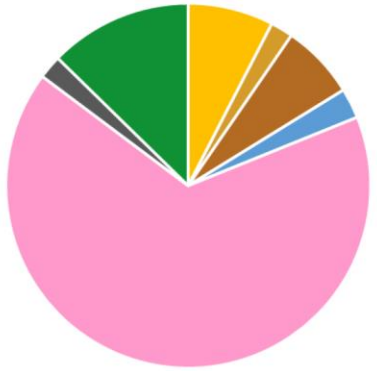


Comparison of decarbonising impact against capital costs for each component

Results 2: **Decarbonising retrofit**

Predicted incremental impact of retrofit:

	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew.
SAP	46	48	61	62	72	74	68	69	97
fuel bills (£)*	£1,062	£1,022	£770	£754	£557	£512	£639	£616	£62
Decarbon**	0%	26%	46%	47%	62%	66%	93%	94%	97%



Fabric first helps protect tenants from fuel poverty, reducing fuel bills by £500 per year.

The transition to electric heat is key to meeting decarbonisation targets (97% overall, with almost two thirds of the impact from heating).

Renewables make retrofit desirable for tenants, through a dramatic reduction in fuel bills of £550 per year.

Comparison of decarbonising impact against capital costs for each component

* energy costs are based on current cost per unit
** emissions relative to 1990, based on energy supply predictions for 2023 (source: NationalgridESO, 2019)

case study 06:

Semi-detached house, post 1990

North Wales Housing

Headlines:

- **Reasonable targets, recently built homes**
- **Minimising aesthetic impact – IWI**
- **estate-wide equality**

Anticipated RMI

component:	specification	likely cost
Walls	No upgrade	
roof	No upgrade expected	
floor	would be disruptive + costly	
window, door	Standard high performance (upvc)	£3,712
Heating, hot water	Mains gas combi boiler	£3,580
Airtightness, vent	Normal practice	
renewables	No upgrade	
Total cost		**£7,292**

Decarbonisation retrofit

component:	specification	likely cost
Walls	Internal Wall insulation 100mm	£2,196
roof	300mm insulation as existing	-
floor	50mm overfloor insulation	£2,040
window, door	Triple Glazing composite (timber)	£7,424
Heating, hot water	Air Source Heat Pump	£8,180
Airtightness, vent	Best practice without MVHR	£732
renewables	PV 4kWp	£7,000
Total cost		**£27,572**

case study 06:

Semi-detached house, post 1990

Results 1: **Anticipated retrofit**

Predicted incremental impact of retrofit:

	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew
SAP	60	67				68	70		
fuel bills (£)*	£865	£704				£700	£641		
Decarbon**	0%	54%				55%	60%		

Systems represent almost half of capital costs, which are modest (£7k overall).

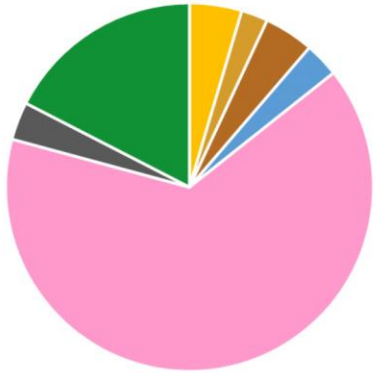
Installation of traditional mains gas wet central heating system limits potential to decarbonise (60% overall) but protects against fuel cost increases for tenants.

Comparison of decarbonising impact against capital costs for each component

Results 2: **Decarbonising retrofit**

Predicted incremental impact of retrofit:

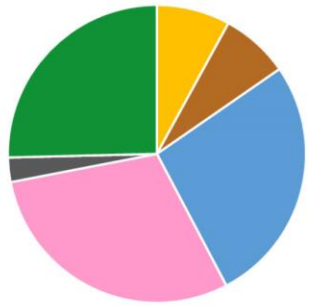
	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew.
SAP	60	67	70	0	72	72	67	69	94
fuel bills (£)*	£865	£704	£657	£0	£613	£599	£712	£681	£127
Decarbon**	0%	54%	59%	0%	63%	64%	89%	89%	95%



Fabric first helps protect tenants from fuel poverty, reducing fuel bills by >£120 per year.

Transition to electric heat is key to meeting decarbonisation targets (95% overall)

Renewables make retrofit desirable for tenants, through a dramatic reduction in fuel bills.



Comparison of decarbonising impact against capital costs for each component

* energy costs are based on current cost per unit
** emissions relative to 1990, based on energy supply predictions for 2023 (source: NationalgridESO, 2019)

case study 08:

Flats, 1965 - 1990

Carmarthenshire County Council

Headlines:

- **Poor quality flats needing significant work**
- **Cavity failure**
- **Most satisfactory course of action**

Anticipated RMI

component:	specification	likely cost
Walls	External Wall insulation 100mm	£2,640
roof	300mm insulation left as assumed	
floor	No upgrade	
window, door	Standard high performance (upvc)	£2,498
Heating, hot water	Mains gas combi boiler	£3,580
Airtightness, vent	Normal practice	
renewables	No upgrade	
Total cost		**£8,718**

Decarbonisation retrofit

component:	specification	likely cost
Walls	100mm external Wall insulation	£2,640
roof	300mm insulation left as assumed	
floor	No upgrade as party floor	
window, door	Triple Glazing composite (timber)	£4,996
Heating, hot water	Air Source Heat Pump	£8,180
Airtightness, vent	Best practice without MVHR	£410
renewables	PV 2kWp	£4,250
Total cost		**£20,476**

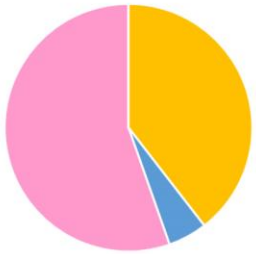
case study 08:

Flats, 1965 - 1990

Results 1: **Anticipated retrofit**

Predicted incremental impact of retrofit:

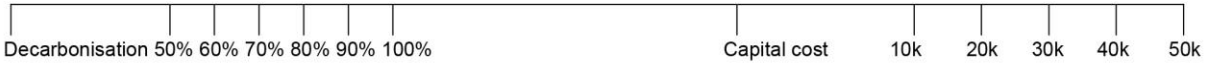
	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew
SAP	51	53	62			64	73		
fuel bills (£)*	£785	£754	£602			£582	£440		
Decarbon**	0%	36%	53%			55%	70%		



The upgrade of glazing represents a third of the costs, but with limited impact on emissions.

Installation of traditional mains gas wet central heating system limits potential to decarbonise (70% overall) but reduces fuel costs for tenants by £140 per year.

The impact of improvement of walls on fuel bills and decarbonisation is significant.

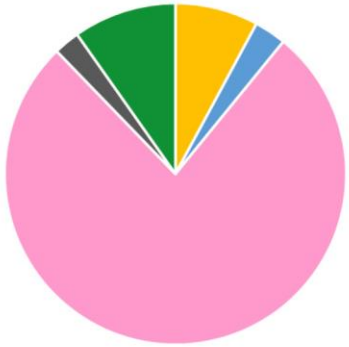


Comparison of decarbonising impact against capital costs for each component

Results 2: **Decarbonising retrofit**

Predicted incremental impact of retrofit:

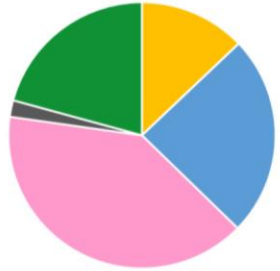
	1990	now	+wall	+roof	+floor	+glazing	+heat.	+vent.	+renew.
SAP	51	53	62			64	66	66	84
fuel bills (£)*	£785	£754	£602			£574	£553	£538	£261
Decarbon**	0%	36%	53%			55%	90%	90%	94%



Fabric improvements help protect tenants from fuel poverty, reducing fuel bills by >£150 per year.

Transition to electric heat is key to meeting decarbon-isation targets (94% overall).

Modest (2kWp) PV represent a quarter of costs but make retrofit desirable for tenants, by reducing fuel bills.



Comparison of decarbonising impact against capital costs for each component

* energy costs are based on current cost per unit
** emissions relative to 1990, based on energy supply predictions for 2023 (source: NationalgridESO, 2019)

				anticipated RMI							decarbonisation retrofit						
				SAP		Decarb		Fuel bills		Cost	SAP		Decarb		Fuel bills		Cost
Social Housing Landlord	**Identifier**	**Type**	**age**	now	after	now	after	now	after		now	after	now	after	now	After	
Bron Afon	case study 01: Torfaen Terrace	End terrace	Pre 1919	62	91	61%	70%	£1066	£249	£22k	62	92	61%	96%	£1066	£231	£33k
Tai Tarian	case study 02: Ocean Way	Mid terrace	1945-64	60	93	57%	71%	£844	£141	£19k	60	96	57%	97%	£844	£93	£31k
Carmarthenshire County Council	case study 03: Ael Y Bryn	Semi-detached	1945-64	48	91	26%	60%	£1022	£173	£18k	48	97	26%	97%	£1022	£62	£29k
Carmarthenshire County Council	case study 04: Bryn Hyfryd	Semi-detached	1945-64	42	67	33%	67%	£1277	£726	£12k	42	93	33%	96%	£1277	£148	£31k
Tai Tarian	case study 05: Elmwood Road	Semi-detached	1965-90	84	91	61%	71%	£373	£194	£10k	84	94	61%	96%	£373	£135	£27k
North Wales Housing	case study 06: Cae Bold	Semi-detached	Post ’90	67	70	54%	60%	£704	£641	£7k	67	94	54%	95%	£704	£127	£28k
Tai Tarian	case study 07: Cove Road	Flats	1945-64	58	65	51%	62%	£773	£643	£8k	58	96	51%	96%	£773	£66	£25k
Carmarthenshire County Council	case study 08: Y Bwthyn	Flats	1965-90	53	73	36%	70%	£754	£440	£8k	53	84	36%	94%	£754	£261	£19k
North Wales Housing	case study 09: Cae Clyd	Flats	1965-90	56	71	41%	67%	£794	£512	£8k	56	84	41%	94%	£794	£284	£22k
North Wales Housing	case study 10: Gerddi Morfa	Flats	Post ‘90	69	69	77%	78%	£453	£451	£2k	69	85	77%	96%	£453	£214	£19k
Average				60	79	51%	69%	£802	£410		60	90	51%	96%	£802	£189	

Findings

Most of the case studies currently fall into EPC ‘C’ or ‘D’ bands. Existing condition is very varied.

This is partly because of age, and partly because of prior retrofit (typically undertaken for WHQS and/or e.e. programmes).

The impact of *anticipated RMI* on SAP varies considerably, because the scope of the proposed works is very varied.

Anticipated RMI impact on emissions is limited to between 60% and 78% decarbonised.

Costs are varied because the condition of existing dwellings is very varied, and the proposed works are equally varied.

The impact of proposed *decarbonisation retrofit* on SAP is somewhat consistent (SAP range 84 to 96)

The impact on decarbonisation is very consistent (range 94% to 97%)

Costs vary mostly by dwelling type (due to overall size and constraints on fabric retrofit for flats).

SAP ratings predict energy efficiency and fuel costs, but cannot be used as the sole basis to judge whether retrofit will meet decarbonisation targets.

Successful decarbonisation is more complex and challenging than the WHQS programme (2004 – 2014) and requires more holistic understanding and actions.

Further findings – houses

				anticipated RMI							decarbonisation retrofit						
				SAP		Decarb		Fuel bills		Cost	SAP		Decarb		Fuel bills		Cost
Social Housing Landlord	**Identifier**	**Type**	**age**	now	after	now	after	now	after		now	after	now	after	now	After	
Bron Afon	case study 01: Torfaen Terrace	End terrace	Pre 1919	62	91	61%	70%	£1066	£249	£22k	62	92	61%	96%	£1066	£231	£33k
Tai Tarian	case study 02: Ocean Way	Mid terrace	1945-64	60	93	57%	71%	£844	£141	£19k	60	96	57%	97%	£844	£93	£31k
Carmarthenshire County Council	case study 03: Ael Y Bryn	Semi-detached	1945-64	46	91	26%	60%	£1022	£173	£18k	46	97	26%	97%	£1022	£62	£29k
Carmarthenshire County Council	case study 04: Bryn Hyfryd	Semi-detached	1945-64	42	67	33%	67%	£1277	£726	£12k	42	93	33%	96%	£1277	£148	£31k
Tai Tarian	case study 05: Elmwood Road	Semi-detached	1965-90	84	91	61%	71%	£373	£194	£10k	84	94	61%	96%	£373	£135	£27k
North Wales Housing	case study 06: Cae Bold	Semi-detached	Post ’90	67	70	54%	60%	£704	£641	£7k	67	94	54%	95%	£704	£127	£28k

Fabric retrofit is expensive, particularly for old / poor quality houses, but without it decarbonisation could dramatically increase fuel bills.

Retaining mains gas central heating constrains decarbonisation to around 70% (range 60% to 71%).

Switching to heat from electricity dramatically increases decarbonisation levels, from 70%+ to 90%+.

Installing renewables has a moderate effect on decarbonisation. More critically, it reduces heating bills by more than £500 per year.

The predicted cost of decarbonising houses is consistently around £30k (range £27k to £33k)

Achieving decarbonisation targets for houses requires SAP>92 AND a transition to heat from low carbon sources.

Further findings – flats

				anticipated RMI							decarbonisation retrofit						
				SAP		Decarb		Fuel bills		Cost	SAP		Decarb		Fuel bills		Cost
Social Housing Landlord	**Identifier**	**Type**	**age**	now	after	now	after	now	after		now	after	now	after	now	After	
Tai Tarian	case study 07: Cove Road	Flats	1945-64	58	65	51%	62%	£773	£643	£8k	58	96	51%	96%	£773	£66	£25k
Carmarthenshire County Council	case study 08: Y Bwthyn	Flats	1965-90	53	73	36%	70%	£754	£440	£8k	53	84	36%	94%	£754	£261	£19k
North Wales Housing	case study 09: Cae Clyd	Flats	1965-90	56	71	41%	67%	£794	£512	£8k	56	84	41%	94%	£794	£284	£22k
North Wales Housing	case study 10: Gerddi Morfa	Flats	Post ‘90	69	69	77%	78%	£453	£451	£2k	69	85	77%	96%	£453	£214	£19k

Fabric improvements are typically less expensive, but also less effective, making it more difficult to decarbonise flats to target levels.

Flat retrofits are more complicated – party walls also limit effectiveness, and shared ownership is a recurring issue.

The size of smaller flats makes space-consuming measures such as IWI problematic.

In some cases SHLs are reviewing whether demolition and new build is preferable.

Successful retrofit of flats requires greater coordination and may require a more creative response – e.g. district heating.

The predicted cost of decarbonising flats is consistently around £22k (range £19k to £25k).

Achieving decarbonisation targets requires fabric retrofit, transition to low carbon heat, and a significant renewable component.

Renewables (PV) are essential if tenants are to see retrofit as desirable. Benefits for tenants are still typically less than for houses.

Making retrofit work for social housing landlords

There is a presumption that a transition from mains gas to low carbon (e.g. electric) heat will be expensive for tenants.

However, if the dwelling fabric is retrofitted to an enhanced standard, modelling of the case studies indicates only modest differences in fuel costs between a new mains gas combi boiler and electric heat via an air source heat pump.

The best-fit enhanced standard will vary from project to project, and is best understood through accurate modelling.

If the dwelling fabric is improved to an enhanced standard, retrofit of low carbon heating systems can be cost effective for the tenant, and could take the place of boiler replacement programmes.*

This requires an holistic approach to fabric performance, and is more difficult to achieve in flats (less to work with).

Currently photovoltaics (or another source of renewable energy) are a necessary part of meeting decarbonisation targets.

As energy supply becomes cleaner, renewables may cease to be necessary to meet decarbonisation targets.

However, as modelled, they consistently and dramatically reduce fuel bills for residents, making retrofit desirable.

*The retrofit strategy should always be modelled as accurately as possible prior to retrofit. For schemes where renewables are already in-situ, the transition to electric heat is more likely to result in an increase in fuel bills for tenants. This situation needs to be explored further, and understood better.

Making retrofit work for tenants

There are clear reasons for Welsh Government to drive decarbonisation, and for SHLs to deliver the changes needed.

The reasons for tenants to engage with this process are less clear.

However, evidence shows that **unengaged tenants can significantly reduce the effectiveness of housing retrofit.**

Case studies indicate that improving fabric to an enhanced standard can mitigate the impact of electric heat on fuel bills.

The inclusion of renewables (PV) dramatically offsets fuel bills, making retrofit desirable for tenants.

However, as a standalone action, switching from mains gas (typically) to electric heat is currently likely to increase fuel bills.

Accurate modelling and holistic retrofit are critical to decarbonisation being perceived positively by tenants.

There are potentially additional benefits such as increased space, improved quality.

However, it is also possible that retrofit will reduce space and increase the possibility of health risks such as condensation.

Tenants should receive training to understand why retrofit is needed, and how to run their home afterwards.

Stage 3 tools

TOOL 1 describes the interconnected relationship between data, fabric, systems and renewables. It discusses the order that successful retrofit for decarb should adopt.

TOOLS 2, 3 and 4 acknowledge that landlords and homeowners think about their stock in terms of component performance and replacement. They outline the decision-making process for successful decarb, by linking component-based thinking with holistic planning and action, as follows:

TOOL 2: Retrofit decision making – Improving fabric

TOOL 3: Retrofit decision making – Upgrading heating systems

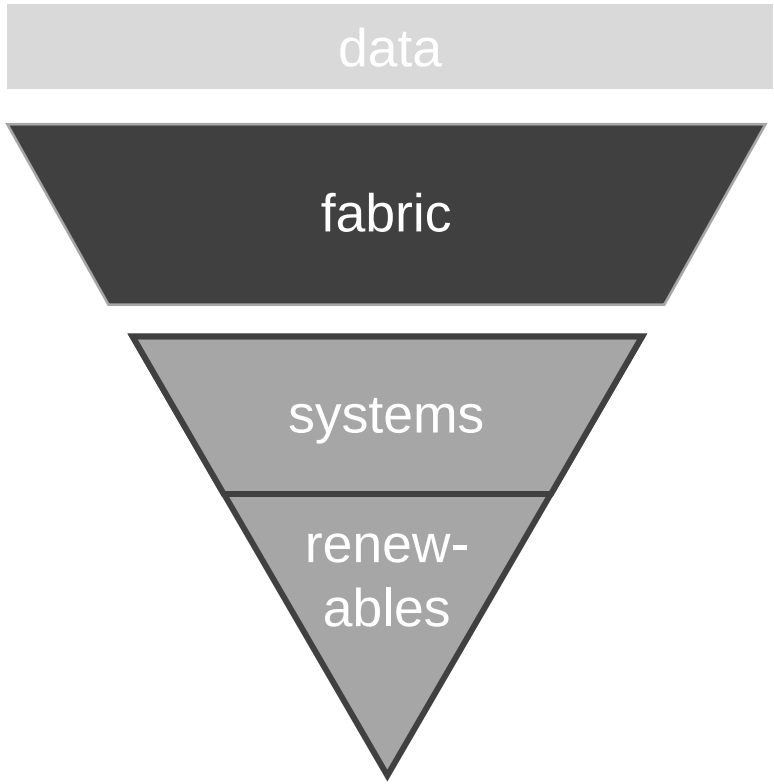
TOOL 4: Retrofit decision making – Providing renewables

Tool 1: **Understanding holistic retrofit**

SIMPLIFICATION

Reasons to retrofit:

- meeting decarbonisation targets
- providing affordable warmth
- Improving quality of homes



affordable decarbonisation

1. data:
Retrofit options must be modelled using accurate data.

2. fabric:
Fabric must be improved sufficiently that modelling of [3A] does not predict a negative impact on fuel bills.

3A. systems:
Replacement heating systems should provide heat from low carbon sources, but only after [1] and [2] are completed.

3B. renewables:
Renewables provide another means of reducing fuel bills for tenants, as well as reducing energy demand.

Tool 2: Retrofit decision-making: **Improving fabric**

SIMPLIFICATION

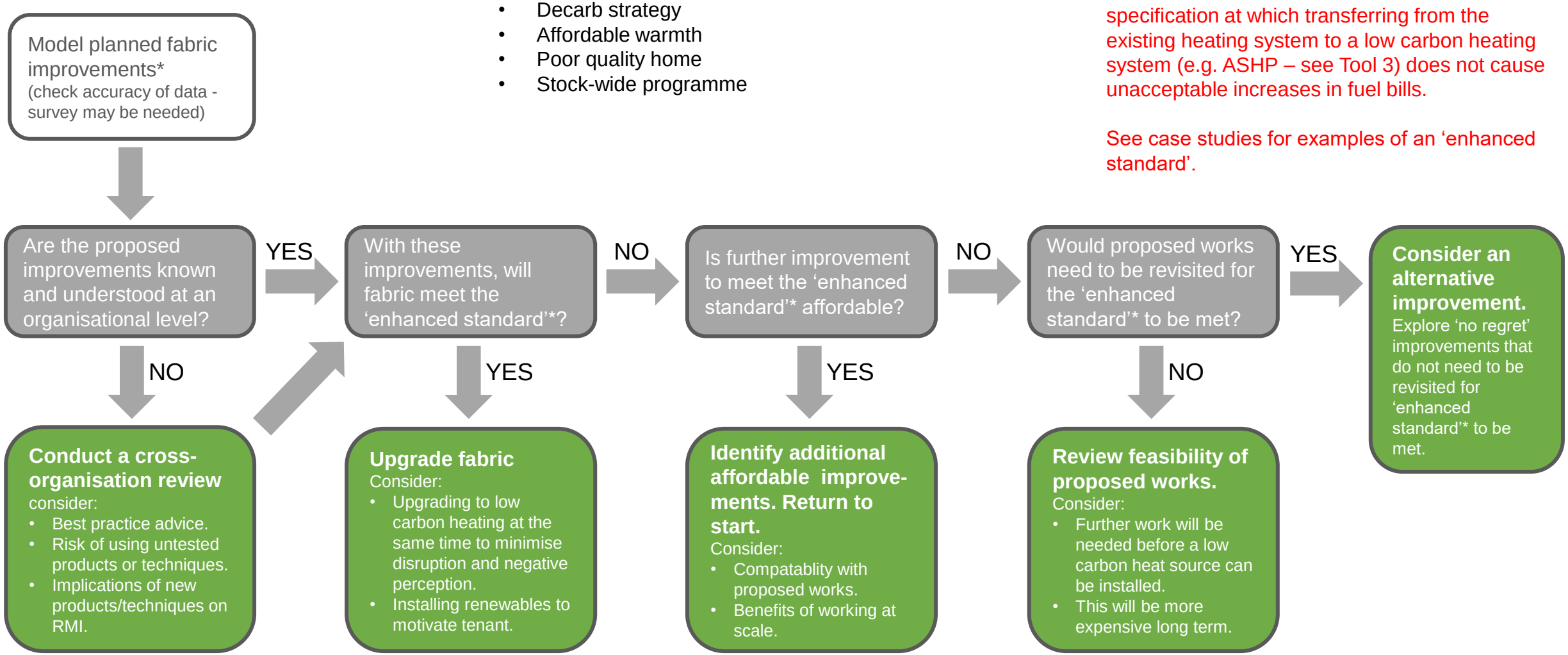
Reasons:

- Fabric failure or pre-existing problems
- Decarb strategy
- Affordable warmth
- Poor quality home
- Stock-wide programme

*'Enhanced standard' describes the fabric specification at which transferring from the existing heating system to a low carbon heating system (e.g. ASHP – see Tool 3) does not cause unacceptable increases in fuel bills.

See case studies for examples of an 'enhanced standard'.

Start here:



Tool 3: Retrofit decision-making: **Upgrading heating systems**

SIMPLIFICATION

Reasons:

- Boiler replacement cycle
- Boiler failure
- Decarb strategy
- Affordable warmth
- Poor quality home

*ASHP – For simplicity, air source heat pumps (ASHP) are assumed to be the decarb replacement heating system based on case studies. Other systems may offer greater benefit.

**PV – Photovolatics (PV) are assumed to be the preferred renewable based on case studies. Other options may be more effective / desirable.

Start here:

Model retrofit of ASHP*
(check accuracy of data - survey may be needed)

Is the impact of ASHP* on fuel bills acceptable?

YES → **Install ASHP***
consider:
- upgrading relevant fabric at the same time
- Installing renewables to motivate tenant

NO → Can fabric be upgraded to an 'enhanced standard'? (see tool 2)

YES → **Upgrade fabric then install ASHP***
Consider:
- Conducting work at the same time to minimise disruption and negative perception
- Installing renewables to motivate tenant

NO → Can PV** be used to make ASHP* affordable? (see tool 4)

YES → **Install renewables then install ASHP***
Consider:
- Conducting work at the same time to minimise disruption and negative perception
- upgrading relevant fabric at the same time

NO → Is it acceptable to delaying upgrade? (comfort and fuel bills)

YES → **Delay upgrade of heating system until situation changes**
Consider:
- No regrets work to fabric that will reduce fuel bills for tenant

NO → **Install conventional heating system to best practice**
consider:
- upgrading relevant fabric at the same time

All routes:
Ensure tenants receive training on any changes to their homes

Tool 4: Retrofit decision-making: **Providing renewables**

SIMPLIFICATION

Reasons:

- Decarb strategy
- Affordable warmth
- Difficult home to improve
- Off-grid location

Start here:

Conduct renewables assessment.
Consider:
- all proposed retrofit works.
- orientation, overshadowing and use patterns.

Is preferred renewable affordable, of suitable benefit to the tenant, and maintainable?

YES

Is storage desired as part of the renewable strategy?

NO

Is it viable to transfer to a low carbon heating system at the same time?

NO

Is it desirable to carry out any other RMI or retrofit work at the same time?

NO

Install renewables

NO

Postpone provision of renewables until situation changes.

Explore appropriate timing to review again in the future.

YES

Model the implications of storage using a suitable tool
Consider:
- Capital cost
- Space
- Related benefits

YES

Install low carbon heating (see tool 3)
Consider:
- Installing heating and renewables at the same time to minimise disruption and avoid negative tenant perception.

YES

Upgrade dwelling fabric (see tool 1)
Consider:
- Upgrading fabric and installing renewables at the same time to reduce capital cost and minimise disruption.

All routes:
Ensure tenants receive training on any changes to their homes

Stage 3 in summary

Successful decarbonisation is more complex and challenging than the WHQS programme targets (2004-2014), and requires more holistic understanding and actions.

SAP ratings predict energy efficiency and fuel costs, but cannot be used as the sole basis to judge whether retrofit will meet decarbonisation targets. Decarbonisation requires transition to a low carbon heat source.

If the dwelling fabric is improved to an enhanced standard, retrofit of low carbon heating systems can be cost effective for tenants, and could take the place of boiler replacement programmes.*

Flats are more difficult to treat successfully than houses.

Renewables are effective in reducing fuel bills for tenants, and reduce pressure on the energy supply network.

Unengaged tenants can significantly reduce the effectiveness of housing retrofit.

Accurate modelling and holistic retrofit are critical to decarbonisation being perceived positively by tenants.

Without in-house skills and expertise it will be difficult for SHLs to develop and evolve decarbonisation strategies.

*The retrofit strategy should always be modelled as accurately as possible prior to retrofit. For schemes where renewables are already in-situ, the transition to electric heat is more likely to result in an increase in fuel bills for tenants. This situation needs to be explored further, and understood better.