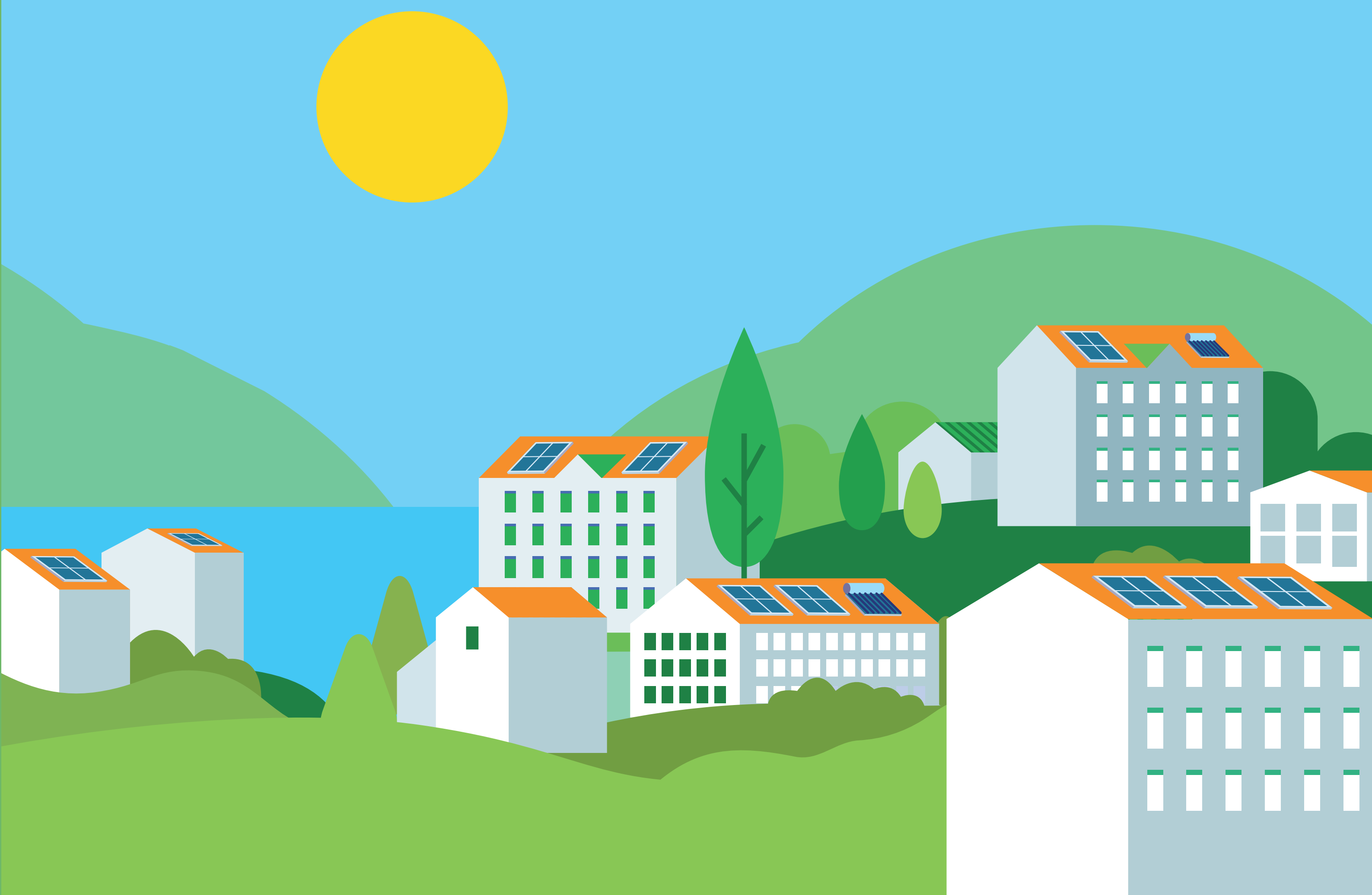
The Value of Solar Heat

The Role of Solar Heat Technologies in Meeting Scottish Net Zero Targets

Solar Energy Scotland



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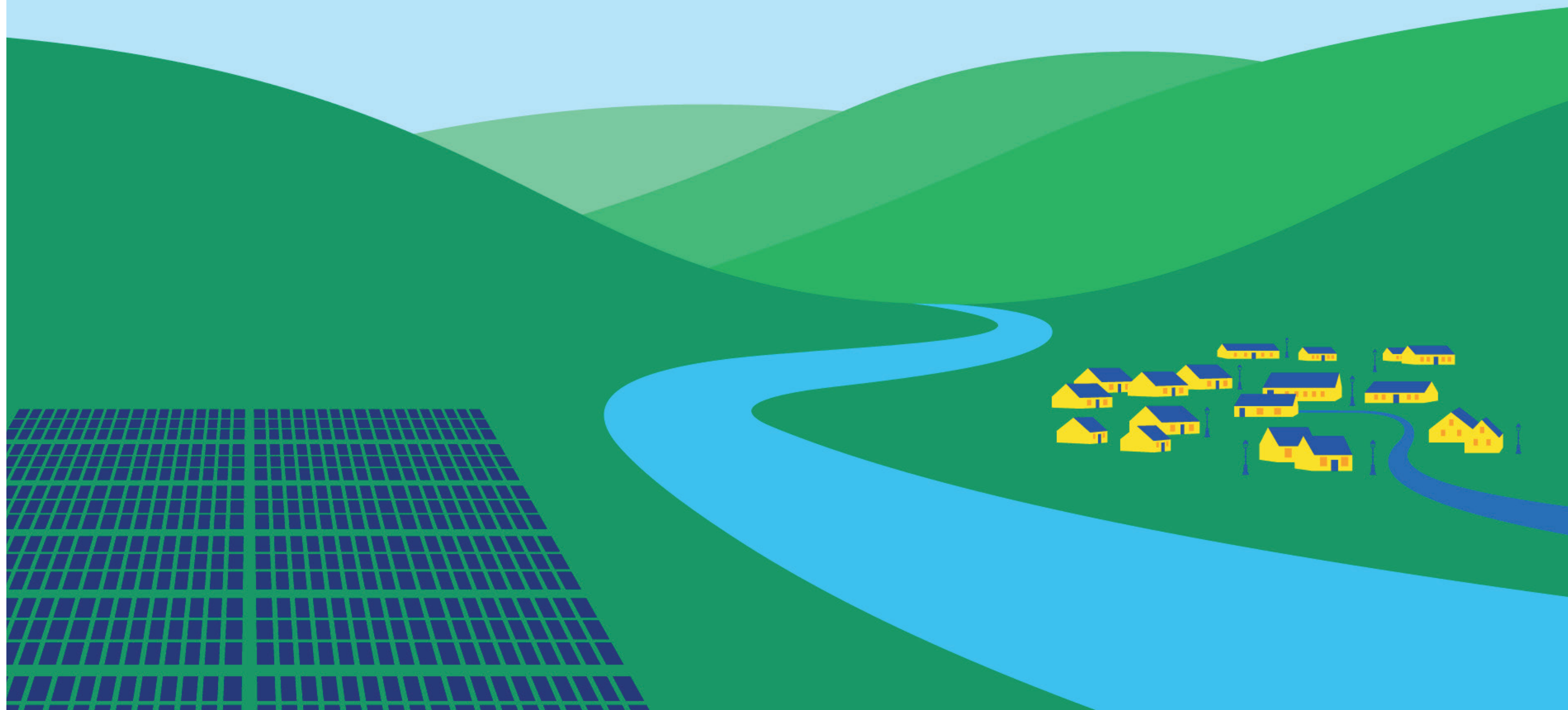
Solar Energy UK

About Us

As an established trade association working for and representing the entire solar and energy storage value chain, Solar Energy UK represents a thriving member-led community of over 300+ businesses and associates, including installers, manufacturers, distributors, large-scale developers, investors, and law firms.

Our underlying ethos has remained the same since our foundation in 1978 – to be a powerful voice for our members by catalysing their collective strengths to build a clean energy system for everyone's benefit. Our mission is to empower the UK solar transformation. Together with our members, we are paving the way for solar to deliver 40GW by 2030 by enabling a bigger and better solar industry.



Foreword

Richard Hauxwell-Baldwin, MCS

MCS Charitable Foundation is delighted to have been the principal funder for this important research by Solar Energy UK.

The research provides robust evidence on the significant contribution that solar heating technologies can make to the UK's net zero goals. The need to advance low carbon heating solutions has never been greater given the growing concern about the climate emergency and rising energy costs. This report clearly highlights that installing small-scale renewables provides a direct solution to these concerns.

As a charity, we work to decarbonise homes, heat and energy. The Value of Solar Heat report is yet another example of the excellent work Solar Energy UK has contributed towards achieving those goals.

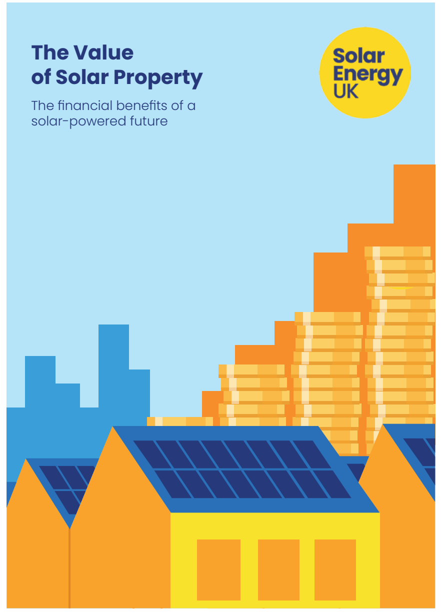
Report Context

This document fits into a broader suite of reports produced by Solar Energy UK to evidence the financial and system-wide benefits of residential solar and storage technologies. The previous reports are:

- Smart Solar Homes
- The Value of Solar Property
- The Value of Solar Heat

Together these reports show that residential solar is a hedge against the rising cost of living, promotes energy security and significantly contributes to the UK's net zero targets. This briefing is a supplementary document to our Value of Solar Heat report, which provides original evidence on the cost and carbon saving benefits solar heating technologies provide for consumers and the energy system. It explains solar's vital role in decarbonising heat in Scottish homes. This is crucial, given the colder temperatures in Scotland, and Scotland's more ambitious target of achieving a net zero economy by 2045.

The findings of this report have been produced by a comprehensive quantitative carbon and cost model. Further detail on the methodology is in the related annex.



Key findings

Solar is a crucial technology for consumers to utilise to drive the Scottish clean heat transition

For a typical gas-heated Scottish home, installing a solar heat system could reduce energy bills by £313 annually. Typically, this would mean a saving of 75.42 tonnes of carbon over the systems lifespan

In a typical heat pump-heated Scottish home, the installation of a solar system would mean heating bills would be reduced by £961 per year, saving 34.1 tonnes of carbon across the system's lifetime

In a best-case scenario, annual savings could reach more than £2,786 and 30.7 tonnes of carbon in total

These running cost savings will ensure an affordable consumer transition to clean heat, particularly with rising energy costs

Solar heat technologies are versatile and can be used across a wide range of Scottish building types, including commercial and industrial heat demands

The financial and carbon benefits of the four case studies presented in this report are shown below. Full details of eight case studies are included in the Annex, which accompanies this report.

Location	House type	Effective annual running cost savings (30 years)	Effective annual carbon savings
Northeast Scotland	Terraced	£84- £961	17.31 – 75.42
West Scotland	Detached	£2,603- £2,786	13.04 – 69.35
East Scotland	Semi-detached	£1,793- £2,385	9.98 – 35.64
Borders Scotland	Terrace	£948- £2,101 reduction in tenant electricity bills	8.29 – 37.31

Solar Energy UK Policy Recommendations

To encourage the deployment of solar for the decarbonisation of heating, Solar Energy Scotland recommends that the Scottish Government:

1. **Enable an affordable transition to low carbon heating for Scottish consumers by adding solar PV to the heat pump specification in the new building regulation.**
2. **Ensure that low and zero-emission heating system's include solar technologies as primary or secondary measures.**
3. **Support private homeowners by expanding incentives for onsite renewable heat technologies until at least 2030, including the Home Energy Scotland loan scheme and expanding criteria for Warmer Homes Scotland.**
4. **Incorporate Solar Energy Scotland's policy recommendations regarding fuel poverty and net zero targets in the long-term strategies currently being developed and consulted, including the Heat in Buildings Strategy[1] and the Scottish Building Regulations.[2]**

Introduction

Scottish homes currently contribute approximately 15% of Scotland's total greenhouse gas emissions[3]. The decarbonisation of Scottish homes is therefore essential for Scotland to reach its legally binding net zero commitments.1 The cost of gas and electricity has also increased so far and so fast that consumers are facing by far the highest bills in memory. This is a major component of the cost of living crisis which Scottish home owners and occupiers are facing.

To ensure that the Scottish Government achieves net zero and addresses and help keep consumer bills down, the rapid deployment of low and zero-emission heating systems powered by solar energy is crucial. For a typical gas-heated Scottish home, installing a solar system could reduce energy bills by £313 annually.

Increasing the affordability of homes by ensuring they can help generate their own heat must play a key part of the Scottish Government's target of reducing fuel poverty to 5% by 2040 [4].

In support of the deployment of solar heat technologies in Scotland, this briefing outlines the significant contribution solar can make to developing low-carbon heating systems. First, it outlines the many benefits of solar to the decarbonisation of heat. Then, it examines the impact that installing solar would have on the running cost of four different Scottish homes. Finally, the briefing summarises the importance of these findings.

The benefits of solar to the decarbonisation of heat

At present, Scotland's homes rely on gas for their heat. This means that when gas prices rise, consumers face increases in their bills. The impact of this can be severe. For example, one analysis by Shetland Island Council says that Shetlanders will need to earn more than £100,000 to avoid fuel poverty[5]. Transitioning away from gas and moving to cleaner sources of heat production for Scottish homes is in consumer and the national economic interest.

There is a consensus that electrifying heat is one of the most effective ways to decarbonise; this is consistent with the Scottish government's view, as noted in the Heat in Buildings Strategy[6]. However, as households move to electric heating systems such as heat pumps, there is a risk that the electrification of heat based on retail electricity prices will lead to significant rises in consumer bills. Scotland will need to maximise the deployment of onsite solar – PV as well as solar thermal, heat storage and emerging technologies, such as infrared - if it is to decarbonise its heat in an affordable manner.

Onsite technology such as PV enables power generation at a lower cost than grid electricity, helping to ensure the affordability of electric heating, while thermal technologies directly use the sun's thermal energy to provide space and water heating. Onsite generation technologies also reduce the need for investment in the broader energy system infrastructure, as the supply and demand of energy are in the same place and can be installed by existing networks of solar and storage technology businesses. These are expanding rapidly as part of the solar industry's broader growth.

There is no one size fits all solution to heat decarbonisation, which should be reflected in the support the Scottish government should provide to accelerate the uptake of solar heat and heat storage technologies. This must take place to enable homeowners to meet their needs in a way that delivers high volumes of decarbonised homes as quickly as possible. Solar is a key part of providing this. Solar technologies can be combined with other measures, such as heat pumps, direct electric heating, infrared and combi-boilers to make low carbon heating affordable for the consumer.

Case Studies

This section presents the financial and carbon benefits of installing a range of low-carbon technologies on four homes in Scotland. They are intended to represent a variety of carbon and financial performance, which could be expected depending on where the home is located, the financing used to pay for the system, and the property type and occupancy characteristics. The figures are produced from the carbon and running cost model developed for this research. Full details on eight case studies are presented in the Annex, which accompanies this report.

Each case study below presents the benefits for the same house that would be delivered by installing a solar system in combination with four different types of heating system (gas, direct electric heating, a heat pump, and infrared heating). The savings presented are in comparison with the base case scenario – in other words, the same house without any form of solar system.

Case study 1

NE Scotland; Mid-terrace

This case study represents the typical financial and carbon benefits that could be achieved by installing a solar PV system in a home in Scotland. It assesses the contribution that a solar PV system could make to several heating types.

The home is a Victorian mid-terraced building located in the Northeast of Scotland with no prior energy efficiency improvements. The home is fitted with a 2kWp solar PV array (around 5-6 panels) installed at a pitch of 45° degrees; the system faces a southeast/southwest direction. The house is in an area which receives lower-than-average levels of solar irradiation for the UK. The installation is funded using an unsecured loan with an interest charge of 5% and paid back over five years.

As the associated table shows, the installation of solar PV leads to substantial financial and carbon savings for a typical Scottish home. When paired with a gas-heated home, the annual savings are £313 across the system's lifespan. The system also delivers considerable environmental benefits, with 75.42 tonnes of carbon being saved across its lifespan. Similarly, the system provides an effective annual saving of £961 to homes heated by direct electric heating and a lifetime carbon saving of 34.11 tonnes.

Combining the PV system with a home storage battery would significantly improve the self-consumption rates (the percentage of the onsite generation used within the home). Adding an 8.2kW battery would increase the self-consumption rates to 91-94% and subsequently increase the energy savings to £738 - £873 a year.

Energy Tariffs		Electric 34p/kWh		Gas 10.3p/kWh	
Property and system details		1a	1b	1c	1d
Property characteristics	Heating fuel	Gas	Direct electric heating	Heat pump	Infrared
	Location	NE Scotland			
	Property type	Mid terrace			
	Energy efficiency	Baseline			
	Occupancy	Home half of the day			
	Property age	Before 1900 to 1966			
System characteristics	Onsite generation type	PV			
	Annual energy costs (before LCTs)	£2,450	£4,660	£2,900	£4,359
	Annual energy costs (after LCTs)	£2,045	£4,126	£2,389	£3,825
System costs	LCT Capex	£2,505	£2,505	£2,505	£2,505
	Annual Opex (yr1)	£521	£81	£586	£81
System financing	Type	Unsecured loan			
	Interest rate (%)	5%			
	Loan term (years)	5			
Financial benefits (running cost)	Annual revenue (year one)	-£704	-£125	-£3,222	-£125
	Annual revenue (year ten)	£188	£742	£315	£742
	Net present value (lifespan)	£9,405	£28,836	£2,531	£28,836
	Payback period (years)	18.6	5.6	29.2	5.6
	Effective annual saving (lifespan)	£313	£961	£84	£961
Lifetime emissions saved (TCO2)		75.42	34.11	17.31	31.57

Case study 2

West Scotland; Detached

This case study represents what may reasonably constitute a best-case scenario for the financial and carbon benefits of installing a solar and battery system in Scotland. This scenario demonstrates a more recently constructed detached property with prior improvements to its energy efficiency levels. The home is located in West Scotland, where daylight levels are nearly on par with the UK average. This detached house is fitted with a south-facing solar photovoltaic system and a home storage battery; the solar PV array is fitted at an angle of 30 degrees and generates 4,151kWh of electricity per year. The system is paid for with cash. The solar PV system has been maximised and paired with a larger battery, meaning the consumer can self-consume as much of the energy produced by the solar as possible.

Because the home is energy efficient, it has a relatively low heat demand, and reduced heat loss. This is ideal for low-temperature heating systems like heat pumps. As a result, the heat pump operates at a high efficiency resulting in lower energy demands for heating and hot water where this system is used. Overall, the system could be expected to save consumers of a heat pump heated home over £2,603 and 13.04 tonnes of carbon over its lifetime. Infrared heating also saves energy use with significantly less capital investment required for this form of heating. The solar PV and home battery systems also deliver high self-consumption rates for homes using electricity to meet the heating and hot water demand. This scenario's financial and carbon savings are impressive irrespective of the heating fuel used, with effective annual savings between £2,603 – £2,786 on running costs.

Energy Tariffs		Electric 34p/kWh		Gas 10.3p/kWh	
Property and system details		1a	1b	1c	1d
Property characteristics	Heating fuel	Gas	Direct electric heating	Heat pump	Infrared
	Location	West Scotland			
	Property type	Detached			
	Energy efficiency	EE4			
	Occupancy	Home all day			
	Property age	2003- 2006			
System characteristics	Onsite generation type	PV + battery			
	Annual energy costs (before LCTs)	£2,822	£4,992	£2,895	£4,724
	Annual energy costs (after LCTs)	£1,096	£3,368	£1,194	£3,101
System costs	LCT Capex	£13,078	£13,078	£13,078	£13,078
	Annual Opex (yr1)	£866	£751	£1,185	£914
System financing	Type	Cash buyer			
	Interest rate (%)	0%			
	Loan term (years)	0			
Financial benefits (running cost)	Annual revenue (year one)	£469	£917	£570	£917
	Annual revenue (year ten)	£1,901	£2,176	£1,951	£2,176
	Net present value (lifespan)	£77,586	£83,594	£78,089	£83,594
	Payback period (years)	11.0	9.1	10.6	9.1
	Effective annual saving (lifespan)	£2,586	£2,786	£2,603	£2,786
Lifetime emissions saved (TCO2)		69.35	30.72	13.04	28.47

Case study 3

East Scotland; Semi-detached

This case study represents the financial benefits of installing solar heat technologies in East Scotland. The semi-detached house, built between 1996-02, has some modest energy efficiency enhancements. The home buyer opts to install a solar thermal system, a solar photovoltaic system and a home storage battery at the point of purchase using a green mortgage, at a low interest charge of 2% over the 25yr mortgage term.

The home's orientation is not ideal (facing East/West), and daylight levels in Edinburgh are lower than in most other parts of the UK. The solar thermal system has an aperture of 6.25 m2, which offsets ~15% - 35% of the home's hot water demands. The 3kWp PV system generates 2,901 kWh/yr, and the 8kW battery facilitates a high self-consumption rate of 79% - 81%. Although this is not considered an optimised scenario, the combined low carbon technologies still generate significant savings in energy costs compared to the same home without any low carbon technologies.

In this scenario, the capital costs for any energy efficiency improvements are excluded since they come with the home as they were. Overall, this scenario shows that installing solar technologies is a sound financial decision. Every investment in a solar system returns an impressive net present value, even where a loan is used to buy the system. Of notable interest within this scenario are the payback periods, which remains under 2 years irrespective of the heating system used.

Energy Tariffs		Electric 34p/kWh		Gas 10.3p/kWh	
Property and system details		**1a**	**1b**	**1c**	**1d**
Property characteristics	Heating fuel	Gas	Direct electric heating	Heat pump	Infrared
	Location	East Scotland			
	Property type	Semi detached			
	Energy efficiency	EE7			
	Occupancy	Home all day			
	Property age	1996-2002			
System characteristics	Onsite generation type	PV + solar thermal + battery			
	Annual energy costs (before LCTs)	£2,194	£3,598	£2,542	£3,450
	Annual energy costs (after LCTs)	£852	£1,995	£1,085	£1,848
System costs	LCT Capex	£14,532	£14,532	£14,532	£14,532
	Annual Opex (yr1)	£451	£787	£753	£921
System financing	Type	Green mortgage			
	Interest rate (%)	2%			
	Loan term (years)	25			
Financial benefits (running cost)	Annual revenue (year one)	-£91	£170	£24	£170
	Annual revenue (year ten)	£856	£1,286	£1,050	£1,286
	Net present value (lifespan)	£53,802	£71,540	£61,707	£71,540
	Payback period (years)	2.8	<1yr	<1yr	<1yr
	Effective annual saving (lifespan)	£1,793	£2,385	£2,057	£2,385
Lifetime emissions saved (TCO2)		35.64	17.27	9.98	16.13

Case study 4

Scotland Borders; Social Landlord and Tenant

In this scenario, a housing association finances a solar thermal and PV system for a tenanted dwelling as part of its portfolio to improve the energy efficiency of its housing stock. The property is an end terrace home located in the Borders and fitted with a solar thermal and PV system.

This scenario provides an example of how costs and benefits can be split between a social landlord and their tenant, where the initial investment in the property is made by the housing association, which is assumed to own and manage it.

In this case, the tenant would not be liable for the capital cost of installing the system. However, the housing association could choose to recover all or some of the capital outlay through increased rent or a service charge. The tenant would receive the benefits of the reduction in electricity costs in total, while the housing association would receive any payment for exported electricity via the Smart Export Guarantee. The housing association would also be liable for any ongoing operational costs.

Though the housing association might not fully recover its costs, the tenant would benefit from highly reduced heating costs. Under a gas scenario, this would mean a year of £2,539 and a carbon savings of 37.31 tonnes a year. A heat pump home would benefit from £3, 865 year savings and 8.29 tonnes of carbon reduction.

Energy Tariffs		Electric 34p/kWh		Gas 10.3p/kWh	
Property and system details		1a	1b	1c	1d
Property characteristics	Heating fuel	Gas	Direct electric heating	Heat pump	Infrared
	Location	Scottish Border			
	Property type	End terrace			
	Energy efficiency	EE4			
	Occupancy	Home all day			
	Property age	1996-2002			
System characteristics	Onsite generation type	PV + solar thermal			
	Annual energy costs (before LCTs)	£2,047	£3,509	£2,189	£3,348
	Annual energy costs (after LCTs)	£1,323	£2,265	£1,151	£2,104
System costs	LCT Capex	£7,928	£7,928	£7,928	£7,928
	Annual Opex (yr1)	£241	£241	£241	£241
System financing	Type	Secured loan			
	Interest rate (%)	1.5%			
	Loan term (years)	3			
Financial benefits (loan finance)	Annual revenue (year one)	-£2,239	-£1,719	-£1,925	-£1,719
	Annual revenue (year ten)	£830	£1,650	£1,325	£1,650
	Net present value (lifespan)	£28,429	£63,039	£49,307	£63,039
	Payback period (years)	12.2	7.0	8.4	7.0
	Effective annual saving (lifespan)	£948	£2,101	£1,644	£2,101
Tenant benefit	Annual reduction in energy costs (yr1)	£655	£1,207	£996	£1,207
	Annual reduction in energy costs (yr10)	£2,539	£4,696	£3,865	£4,696
Housing Associations cost-benefits	Annual SEG payments (yr1)	£68	£37	£42	£37
	Annual SEG payments (end of life)	£262	£142	£162	£142
	Payback	>40yr	>40yr	>40yr	>40yr
Lifetime emissions saved (TCO2)		37.31	17.87	8.29	16.61

Conclusion

The cost-of-living crisis affects us all. An obvious way to minimise the impact of high energy prices – and decarbonise Scottish homes – is to maximise the use of domestic solar heat technologies.

As this briefing makes clear, there are significant carbon and cost benefits to installing a very wide range of solar energy technologies on residential property. These benefits must be incorporated into Scotland's public policy agenda.

By modelling the running costs of four Scottish homes, this research further reinforces the significant contribution solar heating technologies can make to individual households and Scotland's net-zero goals more broadly. The increased affordability of homes that generate their own heat, which can reduce fuel poverty at the community level, is especially clear under the nation's condition of crisis.

Our analysis provides evidence that the installation of solar heat technologies typically leads to savings of £313 - £961 on consumer's energy bills due to lower running costs, while achieving substantial carbon savings. Transitioning away from gas and moving towards cleaner sources of onsite heat production for Scottish homes is therefore in the national economic interest. The potential gains but be fulfilled through decisive policy action to maximise the deployment of onsite solar – PV as well as solar thermal, heat storage and emerging technologies, including infrared.

Onsite heat technologies generate power at a lower cost than grid electricity and reduce the need for investment in the broader energy system. Solar Energy Scotland calls on the Scottish government to accelerate the uptake of solar heat and heat storage technologies, based on the policy recommendations outlined in this briefing. Homeowners must be supported to take charge of their bills and reduce their carbon emissions by installing solar energy systems. This would help deliver a high volume of cost-effective and decarbonised homes as quickly as possible.

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