greenfox community energy

Delivering Zero-Carbon Schools

A practical and innovative business model for the community energy sector

JANUARY 2022

power to change

NEXT GENERATION

COMMUNITY ENERGY EVOLUTION

Loughborough University

CATAPULT Energy Systems

Leicester City Council

ALT

COMMUNITY FUND

Contents

Images
Cover image and others throughout taken from Leicester school climate protests, 2021

1 Foreword

Climate change is one of the biggest challenges of our times. We are increasingly seeing and experiencing first-hand the impact it is having on our communities: extreme weather events, coastal erosion and biodiversity loss. While our political leaders have set targets to aspire to in the future – Net Zero by 2050 – we need to be taking radical actions now, because the risk of not acting soon enough is far too high.

At Power to Change, our mission is to strengthen community businesses to tackle this challenge and support them in developing locally-led solutions to the climate and nature crisis. The community energy sector was one of the great success stories of the UK in recent years, until the government withdrew financial support for renewable energy projects. The sector now needs to adapt, diversify and innovate. This means developing new, untested and potentially complex ways of helping the UK move towards a smarter and more decentralised energy system.

Through our Next Generation programme, Power to Change is supporting 11 different community groups to innovate, test and develop new business models that can deliver more holistic and integrated local energy services. Community businesses like these ones will be the cornerstones of a fairer, greener UK economy.

They are the leaders and risk-takers pioneering new approaches to energy and showing other communities what can be achieved with determination and a spirit of innovation. We applaud them and urge others to follow in their footsteps. And we call on local and national decision-makers, influencers and investors to support them.

> “Green Fox has produced a viable new community energy model that can inspire other groups across the country.”

The result of the work done by Green Fox Community Energy and set out in this report is one such example. Schools are at the heart of our communities, but they have neither the time nor resources to be energy managers. This report shows how the community energy sector is perfectly placed to help schools to become zero carbon; it can mobilise communities and bring people together to practically tackle climate change at a local level.

Green Fox’s pioneering model, developed with a team of experts in their fields, is the first of its kind in the UK to quantify the cost of retrofitting schools to create a zero-carbon outcome, and demonstrate how this could be funded by communities.

By showing what can be achieved with four primary schools in Leicester, Green Fox has produced a viable new community energy model that can inspire other groups across the country. After all, it is our children who will bear the consequences of climate change; their future is in our hands and change needs to start with them.

Vidhya Alakeson
Chief Executive, Power to Change

2 Executive Summary

For explanations of technical terms and acronyms please refer to the Glossary on page 27.

Community energy puts people at the heart of the energy system. It brings communities together to tackle climate change in a practical and democratic way by understanding, generating, owning, using and saving energy. It accelerates the transition to zero-carbon energy systems while increasing community resilience.

In England, Scotland and Wales there are over 420 community energy organisations, who have raised over a quarter of a billion pounds of investment through share offers and matched funding for low carbon projects and initiatives. Community-owned energy capacity in the UK currently totals 319 MW (2021 State of the Sector report). However, following the recent withdrawal of renewable energy subsidies the community energy sector needs a new business model.

Schools are at the heart of our local communities; they represent a quarter of public sector carbon emissions, so fully decarbonising their energy will be essential. While two-thirds of local authorities have declared a Climate Emergency, many do not have plans in place to tackle schools' emissions. Schools therefore present a powerful opportunity to develop a new business model for the community energy sector.

Leicester-based Green Fox Community Energy Co-operative (Green Fox) has been at the forefront of decarbonising heat in the community energy sector and has also launched successful projects at schools. We have developed this new business model for completely decarbonising the energy used by schools, to create zero-carbon schools, with expertise from the Energy Systems Catapult (ESC), Loughborough University, Leicester City Council, and the newly formed Attenborough Learning Trust (ALT), a multi-academy trust with four primary schools in the heart of Leicester. The project has been supported by the Next Generation Programme, funded by Power to Change.

Our new business model provides a practical and enlightened response to the urgent need to transition to a zero-carbon economy, focusing on primary schools and the role of communities.

Heating accounts for over a third of the UK's total carbon emissions, and decarbonising heat is the biggest challenge the UK faces in transforming to a future net zero energy system. Currently there is little alternative to gas heating and although there has been much talk about hydrogen replacing gas, it remains a long way off. The electrification of heat through heat pumps is a solution that is available now, and is supported by the government, so our new business model utilises this technology to achieve zero-carbon schools.

2021 State of the Sector report
https://communityenergyengland.org/files/document/523/1624438045_UKSOTSReport.pdf

Image
The 2014 launch of the UK's largest community owned renewable heating system in a Leicestershire school

The model takes a two-stage approach:

1 Base Model, which is already viable for community energy groups, and

2 Base Model Plus, which will require additional support.

The Base Model measures the schools' energy consumption and costs and then implements proven low-carbon technology to reduce these, including generating energy through solar PV.

The Base Model Plus achieves full electrification of the energy demand which totally decarbonises the schools by adding heat pump technology and newer energy-related products and emerging markets which can generate additional value.

Base Model
Previous community energy models in schools mainly focused on solar PV; our new Base Model takes this a step further to include energy efficiency and lower energy tariffs. These provide further financial value for both the school and the community energy organisation and greater carbon reduction. The key findings were:

1 Implementing energy efficiency measures and installing solar PV reduced CO_2 emissions by 21% ; switching to a new renewable energy tariff reduced these by a further 16%. Overall, the Base Model saved the four schools a combined total of 88 tonnes CO_2 per year equating to a cost of £115 per tonne of carbon saved over 20 years.

2 A new renewable energy tariff was more economical than any of the existing school tariffs. There is real scope for developing a national renewable energy tariff specifically tailored to decarbonising schools. There is also potential for renewable electricity to be supplied to schools through existing community energy generators which may discount prices to help the schools become zero carbon.

3 The energy savings are financially worthwhile as they are primarily reducing or replacing electricity consumption. The price of electricity is relatively high, even at the reduced rate of 13p/kWh, which allows a wide range of interventions to be cost effective, with LED lighting proving to be the most economic. The higher the electricity price the more financially attractive the Base Model becomes.

4 The Base Model enabled a 42% saving on the ALT's energy bill. This represents a simple payback period of just over 6 years. For a community energy group raising funds through a share offer the model provides a 3% return on investment over 20 years with capital repayments of 5% every year.

5 In financial terms the Base Model provides a total annual saving of £40,000 or £800,000 over 20 years. These savings can be offset against the costs of the Base Model Plus which provides electric heating via Air Source Heat Pumps (ASHPs) to create a zero-carbon school without increasing its overall energy bill.

Image
High Winds Community Energy Society

6 The capital cost to implement the Base Model across the four primary schools (ten buildings) within the ALT was £215,000, equating to approximately £54,000 per school. Scaling up to all 80 primary schools in Leicester would cost £4.3 million and throughout England with 16,800 primary schools, it would cost £907 million.

7 Having raised over £0.25 billion in finance, the community energy sector is well placed to provide some of the equity required to implement the Base Model in England.

"The Base Model saves 42% of the ALT's energy bill with a payback of just over 6 years"

Base Model Plus

To achieve overall zero-carbon schools is more challenging and would require a higher capital cost through the Base Model Plus. The key findings were:

1 To upgrade and decarbonise the heating system using ASHPs would cost an estimated £710,000. In addition to the £215,000 for the Base Model this equates to a total capital cost of £925,000 across four schools. With a simple payback of 18 years this effectively makes the community energy business model unviable.

2 Adding a capital grant of £525,000 (just over half the capital required) would improve the simple payback to 9 years. With the above average heat price at the ALT, the Base Model Plus community energy business model could work at primary schools that are off the mains gas network.

3 Base Model Plus could also work in primary schools with a better building fabric and where existing radiators and pipework can be utilised which would have a lower capital cost.

4 The Base Model Plus reduced CO_2 emissions by a further 63% and together with the Base Model totally decarbonises the ALT. The four zero-carbon schools would have a combined CO_2 reduction of 4,800 tonnes over 20 years. This equates to a cost of £193 per tonne of carbon saved over 20 years.

5 The lower the electricity price for heating the schools the more financially attractive the model becomes (because heat is cheaper than electricity).

6 Installing the maximum solar PV at each school would reduce the running costs of the ASHPs. At the ALT, the model calculated a 20% increase in self-consumption of electricity generated by PV which helped with the overall finances of the Base Model Plus.

7 We also looked at additional cost benefits from other interventions. Replacing the Smart Export Guarantee (SEG) with a Power Purchase Agreement (PPA) would add a further £2,000 per year. This could improve the simple payback to just over 5 years.

8 Theoretically battery storage and heat optimisation can provide further income and energy savings. However based on current market prices, the financial benefits were not attractive enough. The potential for both technologies to improve the business case is worth further exploration in the future.

9 The average cost to transform an ALT primary school to zero-carbon equates to £230,000 per school. To implement the Base Model Plus in all 80 primary schools in Leicester would cost over £18 million; throughout England with 16,800 primary schools it would cost £3.9 billion. The community energy sector could contribute significantly to the equity required but would need government support to make the Base Model Plus model work financially.

10 Modelling schools with the existing heat supplied by gas rather than the DHN increases fuel costs by approximately 34% due to the low price of gas in relation to electricity and extends the simple payback to 11 years. The increased fuel costs are offset by the savings delivered through the Base Model. This emphasises the importance of implementing both the Base Model and Base Model Plus scenarios together making decarbonising heat financially viable.

“The Base Model Plus totally decarbonises the ALT at a cost of £193 per tonne of carbon”

Image

Cllr Adam Clarke, Deputy City Mayor at Leicester City Council, responsible for Environment and Transportation, leads Leicester's Green Heart campaign during Climate Action Week 2021

3 Introduction

3.1 Power to Change: The Next Generation Programme

Green Fox Community Energy Co-operative (Green Fox) together with our project partners, received funding from the Next Generation Programme to develop a new innovative business model for the community energy sector.

The **Next Generation Programme** aims to create a step change in the development of genuinely sustainable, financially viable and innovative community businesses, helping to raise the profile of place-based community energy activity with policymakers and industry.

The initiative is funded by **Power to Change**, an independent trust that supports and develops community businesses in England. The Next Generation Program me worked with 11 organisations to develop and test new business models on behalf of the community energy sector in response to the withdrawal of the Feed in Tariff and the Renewable Heat Incentive subsidies.

Each project was provided with up to £100,000 of grant funding and the support of a consortium to develop their project ideas, test the real-world application of their business models, and share this learning to benefit the wider sector.

3.2 The partnership

Green Fox worked in partnership with Leicester City Council, the Attenborough Learning Trust, Energy Systems Catapult and Loughborough University to develop a new innovative business model for the community energy sector that would deliver zero-carbon primary schools and improved learning environments through innovation.

Green Fox Community Energy Co-operative

Green Fox was established in 2012 to facilitate community energy in Leicester and Leicestershire and is best known for delivering award winning projects which decarbonise heat. Green Fox has raised just under £1 million in community shares, enabling local renewable energy projects to be owned and operated by local people.

Energy Systems Catapult

Energy Systems Catapult (ESC) is an independent, not-for-profit centre of excellence that aims to unleash innovation and open new markets to capture the clean growth opportunity. The ESC brings together academics, government, and industry to realise opportunities and tackle barriers that will allow the UK to achieve Net Zero energy systems.

Attenborough Learning Trust

The Attenborough Learning Trust (ALT) is a multi-academy Trust in Leicester, established in April 2019. It comprises two primary and two infant schools near each other, supporting pupils from the urban centre of Leicester. The Trust has declared a climate emergency which builds upon its strong environmental ethos.

Next Generation Programme
https://www.next-generation.org.uk/

Power to Change
https://www.powertochange.org.uk/

Image
Attenborough Learning Trust pupils celebrate the launch of the Next Generation Programme

Loughborough University
The Centre for Renewable Energy Systems Technology (CREST) at Loughborough University has world-leading expertise in solar and wind power, thermal storage, and power systems. Researchers at CREST have developed a detailed understanding of electricity demand and the application of low carbon technologies such as solar PV, heat pumps, electric vehicles, and battery storage systems.

Leicester City Council
Leicester City Council (LCC) has declared a climate emergency and aims to make the city carbon neutral by 2030. In 2019 schools within the city accounted for up to 41% of the council's carbon emissions, equivalent to 15,200 tonnes of CO_2.

3.3 The role of the Community Energy Sector
Green Fox Community Energy Co-operative is one of over 400 community energy organisations which make up the community energy sector in England, Scotland and Wales. Community energy puts people at the heart of the energy system. It brings them together to take democratic climate action by understanding, generating, owning, using, and saving energy. Community energy can help underpin the more rapid role out of a decentralised energy supply system by giving local people a stake in the outcome.

The financial capital required for each initiative is usually funded through a public share offer, specifically aimed at local people. Share capital raised in this way is unique to co-operative and community benefit societies, enabling them to buy assets and hold them for the benefit of the community in perpetuity. They typically offer a target rate of return, membership, and participation in decision-making.

Community energy organisations are already at the forefront of energy innovation, accelerating the transition to a decentralised zero-carbon energy system while increasing social, economic and environmental benefits primarily at a local level but with a national significance for mitigating climate change, local prosperity and community cohesion.

Installing a multitude of low carbon technologies, the community energy sector has raised over a quarter of a billion pounds of investment through share offers and matched funding for low carbon projects and initiatives. In 2020 community owned energy capacity in the UK totalled 319 MW. Taking a community-based approach to delivering zero-carbon schools ensures that economic, social and environmental value is retained locally and local interests are championed in the transition to zero-carbon schools.

https://communityenergyengland.org/

https://communityenergyengland.org/news/state-of-sector-report-2020

Loughborough University

Leicester City Council

4 Project Objectives

1 Design a new innovative business model for the community energy sector which demonstrates how local communities can work with schools to participate in climate change mitigation and create zero-carbon schools.

2 Respond to the challenges of decarbonising heat through innovation, working with the four primary schools in the ALT as a case study.

3 Reduce the high capital costs and the potential increase in energy bills associated with the transition to low carbon heating.

4 Calculate the capital cost to retrofit all school buildings with low carbon energy technology to create zero-carbon schools. This capital cost will be based upon market prices and validated through industry benchmarks.

5 Provide a realistic benchmark of the cost to decarbonise a primary school in the UK.

6 Fund the schools' transition to zero carbon through community share investment and quantify the potential scale of investment required. Through generating different financial scenarios, the model aims to inform and demonstrate what is achievable from a financial viewpoint.

7 Document and quantify new financial benefits arising from the emerging energy market and use them within the new business model.

8 Identify barriers due to market conditions and the regulatory environment that inhibit the uptake of these community energy schemes.

9 Quantify the potential reduction in public spending and the relative price of carbon to deliver zero-carbon schools.

5 Context

5.1 Decarbonising heat at a national level
The Climate Change Act 2008 commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050. The Act also established the Committee on Climate Change to ensure that emissions targets are evidence-based and independently assessed.

More recently, in October 2021, the government's Net Zero Strategy committed to decarbonising the UK's electricity system by 2035 while it's Heat and Buildings Strategy seeks to move heating away from fossil fuels to electric powered heat pumps.

Energy used for heating accounts for over a third of the UK's greenhouse gas emissions. Decarbonising heat is the biggest challenge the UK faces in terms of the transition to a net zero energy future.

To meet its targets the UK will need to decarbonise nearly all heat in buildings. Most of our domestic, commercial and industrial heating is delivered by fossil fuels, predominantly natural gas.

5.2 Decarbonising heat in schools
There are approximately 24,000 schools in England representing a quarter of public sector carbon emissions; while primary schools represent 33% of the education sector.

Decarbonising primary schools is essential to help the UK deliver on its 2050 net zero target. Heating and hot water account for 76% of a school's energy use with gas being the main energy source (70%).

16,800 primary schools
3,500 secondary schools
2,000 independent schools
1,000 special schools
400 nurseries
300 pupil referral units

Source: BESA

Leicester has approximately 80 primary schools and 20 secondary schools and colleges which account for 41% of the council's carbon emissions. These schools are mainly heated using gas boilers.

Currently there is no national strategy which will practically deliver zero-carbon schools. Substantial and sustained investment will be required to implement a national roll out and this is a major barrier to implementation. This is exacerbated at a local government level where Local Authorities declare climate emergencies, but often do not have the plans or funding in place to effectively deliver the carbon reductions in their own school estates. Schools are focused on education, they neither have the funding or expertise to decarbonise their buildings. They also often pay more for their energy through high tariffs, and energy efficiency is low on the list of school's priorities.

Implementing decarbonisation measures can seem daunting, and for each school or academy trust to develop and manage their own decarbonisation process will be time consuming and costly. This will only increase as the energy market develops and new income streams can be realised through the management of school assets.

To complicate the process further there is no 'one size fits all' methodology for decarbonising a school through retrofitting low carbon technology. Schools differ vastly in design, age, construction and supporting infrastructure. An understanding of local issues and constraints will be important in decarbonising schools cost-effectively.

Climate Change Act 2008
https://www.theccc.org.uk/uk-action-on-climate-change/reaching-net-zero-in-the-uk/

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf

BESA
https://www.besa.org.uk/key-uk-education-statistics/

https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

5.3 Schools – a focal point for climate change action

Schools are often the hubs of communities, bringing local people together. Recently pupils have been the catalyst to unite local people around the issues of climate change mitigation and are leading the way in asking for change from local and national government.

Young people have been striking from school on Fridays since Swedish teenage activist Greta Thunberg began her “School Strike for Climate” in August 2018 sitting outside the Swedish parliament. School children across the world then followed her lead, with monthly protests in the UK beginning in February 2019. By September 2019 Greta Thunberg led the largest climate strike in history, with organisers reporting that over 4 million people participated in strikes worldwide.

Decarbonising schools provides the opportunity to engage communities and particularly school children in the transition to net zero.

5.4 The need for innovation within the community energy sector

Most community energy initiatives have relied on government subsidies such as the Feed in Tariff or the Renewable Heat Incentive for the financial models to work. In addition to providing members an annual interest payment for their investment, many business models created a community benefit fund for further local environmental work. With policy changes and the end of subsidies this model is no longer viable.

5.5 The role of Salix Finance

Salix Finance provided Government funding to the public sector to improve energy efficiency, reduce carbon emissions and lower energy bills. Salix is a non-departmental public body, owned wholly by Government.

Until April 2021 schools could apply to Salix for an interest-free loan to install low carbon technology with the predicted energy savings enough to repay the loan, which must be done within eight years. The Salix loan was available to all grant-maintained schools all year round, and to academies annually.

Although the loan scheme targeted energy reduction and decarbonisation, it did not support low carbon heat technologies such as ASHPs as the repayment period would exceed the eight-year threshold. Similarly, double/triple glazing and many insulation measures fall outside the loan criteria making it impossible to access this source of funding for creating zero-carbon schools.

5.6 Public Sector Decarbonisation Scheme (PSDS)

During the development of this new business model, the Department for Business, Energy and Industrial Strategy (BEIS) closed the Salix loan programme and replaced it with the £1 billion Public Sector Decarbonisation Scheme (PSDS) offering grants to fight coronavirus, support business, and tackle climate change. Delivered by Salix Finance, the scheme is available for capital energy efficiency and heat decarbonisation projects within public sector non-domestic buildings supporting the Government’s net-zero and clean growth goals.

In April 2021 Salix Finance announced Phase 2 of the PSDS with sharpened focus on heat decarbonisation and a further £75 million of grant funding. This second grant funding scheme was designed to ensure that UK Government policy delivers on the agenda for the decarbonisation of heat, enabling the public sector to be at the forefront of decarbonising buildings.

https://www.salixfinance.co.uk/PSDS

https://www.salixfinance.co.uk/Phase_2_PSDS

5.7 National and local government regulation

In most cases when a community energy organisation works with a grant-maintained school or academy the school need to seek permission from the Education Skills Funding Agency (ESFA) and the Secretary of State. The ESFA is an executive agency of the UK government, sponsored by the Department for Education. Its remit is to provide assurance that public funds are properly spent; achieve value for money for the taxpayer; and deliver the policies and priorities set by the Secretary of State. In relation to the installation of low carbon technologies by community energy organisations this usually refers to legal and financial agreements.

In a more local context, notwithstanding the status of the school, the land is often owned by the local authority and their permission as landlord can be required to install low carbon technologies. The governing body of the school for whatever reason can also block the transition to a zero-carbon school.

5.8 Upskilling the supply chain

One of the issues facing the UK's transition to net zero is making sure that the supply chain has the right skills and knowledge to match the ambition. A zero-carbon school will need a range of experts in surveying, retrofit co-ordination, insulation, heat pumps and finance.

Using data from the Climate Change Committee, a recent report by the CITB cited a shortage of skills when it comes to decarbonisation work.

It suggests that an additional 350,000 full-time workers will be needed by 2028, to be mainly involved in delivering improvements to existing buildings that will reduce energy demand. That represents an increase of around 13% on the current size of the workforce, based on current technologies and ways of working. This has the potential to give thousands of people a valuable new career opportunity as we emerge from a time of national crisis.

5.9 The price of gas and electricity

When considering the transition to zero-carbon schools, costs are obviously a major consideration; not only the capital costs of building improvements and low carbon technology, but also the longer-term running costs. The price of energy is a major factor in making the business case stack up. For public sector energy users, the Government estimates the average price of electricity at 13.9p per kWh and 2.9p per kWh for gas. This is based on 2020 data, the most recent available at the time of this report – prices have risen sharply since then.

The differential between electricity and gas prices for each unit of heat creates a disadvantage for low carbon heating that will primarily be fuelled by electricity. A further discrepancy arises as over 20% of a non-domestic electricity bill can be made up of environmental levies. This includes policies like Contracts for Difference, the Renewables Obligation and Feed in Tariffs. Gas in the non-domestic sector does not have the same levies applied.

In the future this may change, with organisations like the Climate Change Committee, Frontier Economics and ESC promoting a rethink on renewable subsidies and carbon pricing. Although not unique to schools, a more level playing field on fuel pricing would help the zero-carbon business case.

Although the Smart Export Guarantee (SEG) has replaced the Feed-in Tariff, the way it is designed places the community energy sector at a disadvantage. The SEG provides no minimum export price, and no long-term certainty beyond 12 months, whereas larger renewable energy projects can receive long-term certainty from Contracts for Difference.

https://ashden.org/news/the-uks-dire-green-skills-shortage-must-be-tackled/

https://www.citb.co.uk/media/vnfoegub/b06414_net_zero_report_v12.pdf

https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

https://www.sseenergysolutions.co.uk/business-energy

https://www.ft.com/content/54b437ad-4683-434e-89aa-e26772092b31

6 Green Fox & Attenborough Learning Trust Case Study

The business model has been developed using the ALT and Green Fox as a case study. It is intended that the methodology could be extended to schools more generally.

Recognising that every primary school is different in terms of their energy requirements, the model focussed on the Attenborough Learning Trust (ALT) which comprises four primary schools across ten sites:

- Sparkenhoe Primary School
- Highfield Primary School
- Uplands Infant School
- Green Lane Infant School

Typical of many schools, the building stock is varied. It includes a Victorian building, others constructed between 1970 and 1990, two mobile classrooms and a purpose-built theatre opened in 2005. The buildings are heated in different ways including district heating, electrical heaters, and conventional gas boilers. This provided the opportunity to utilise real time energy data and understand the various technological challenges of retrofitting existing schools.

At the centre of the business model is Green Fox who would act as an energy service provider to the ALT. Green Fox assumes responsibility for managing the school's total energy bill through a suitable Energy Services Company (ESCo) and works with the school to reduce its carbon emissions with financial incentives.

The value of the ALT's energy bill is transferred to Green Fox on an annual basis on the understanding that Green Fox then pays the energy bill.

The value of the school energy bill is calculated at the start of the model and increases by inflation each year. This provides the school with an energy bill no higher in real terms than it was originally and, importantly, enables the school to decarbonise at no additional cost, because measures are funded through the savings on its bill.

Green Fox achieves the reduction in the school's energy bills through monetising efficiencies in the purchasing of energy, reduced energy usage, energy generation, and maximising innovation within the energy markets by implementing optimised energy solutions. This gives rise to the revenues in the model.

The capital costs of purchasing and installing the low carbon technology were verified through a competitive tendering process and validated further through benchmarking. These quantifiable capital costs will be financed through a community share offer.

In order to be commercially viable the community energy business model must provide a minimum rate of return for investors, at a suitable level of risk while having no negative impact on the school's current energy costs.

The new business model comprises two stages: Base Model and Base Model Plus.

Image
Purpose built theatre at Sparkenhoe Primary School

The Base Model uses proven low carbon technology which reduces the overall cost of energy and can generate income. It starts the decarbonisation process and lays a sound financial foundation for the overall business model.

The Base Model Plus enables complete energy decarbonisation of the primary schools through the installation of ASHPs and assesses emerging energy markets where extra value can be generated.

7 The Base Model

The Base Model builds a picture of the current energy usage and the cost of energy for the schools in the ALT. It then implements several proven low-carbon demand reduction measures to reduce the overall cost in four key areas:

- Lower cost tariffs and the potential removal of additional supply charges
- Installation of energy efficiency measures
- Installation of solar PV
- Income generation through the Smart Export Guarantee

The resulting cost savings in energy bills provide a quantifiable income to Green Fox which can be utilised within the business model to pay for the low carbon measures.

7.1 Establishing the existing energy usage and billing

Understanding the schools' current energy usage is fundamental to the business model. Triangulating three sources of data provides a robust basis:

1 Energy bills
2 Salix reports
3 Half hourly energy data

The schools' energy bills
The first source of accessible data was the schools' gas and electricity bills. The ALT provided access to the energy usage data, the billing and the subsequent total cost of energy over a three-year period. Although this billing data was accurate where meter readings had been taken, some of the monthly readings were missing and others appear to have used estimated values.

An internal energy management system within the schools turned out to be unreliable.

Salix Finance reports
As an economic and consistent way of estimating the current energy usage in each school, Salix Finance assessors were commissioned to deliver a Salix report. This assessment uses the well-established methodology and standardised report structure already developed by Salix Finance for public-sector decarbonisation loans and is well known by schools. This provided an estimated energy usage at each school site, together with an estimated cost of energy.

Energy monitoring data
Half hour energy usage data was provided by the ALT's energy suppliers and used for all the modelling. This records the energy usage of electricity, gas and from the heat network, measured at the incoming supply points. When compared to the energy bills, the half hour energy usage data seemed the most reliable, though there were periods for which the data was missing. The existing energy demand was therefore estimated using a combination of the billing data and the monitoring data. The total energy usage across the estate was an estimated 1,350 MWh which equated to a cost of £95,000 per year.

Additional energy costs including standing charges, capacity charges and the climate change levy amounted to £10,000.

Therefore the ALT's overall energy bill was £105,000.

7.2 Establishing the existing energy tariffs and charges
Through the existing energy bills the electricity tariffs were identified:

- The daytime tariff ranged between 13p/kWh and 25p/kWh
- The night tariff ranged from 11p/kWh to 17p/kWh
- The weekend tariff ranged between 15p/kWh to 25p/kWh

Tariffs varied between energy suppliers, but we also found that tariffs from the same supplier differed between sites.

The heat tariffs were:

- District heating network average of 5.3p per kWh for space and water heating
- Gas mains between 1.6p per kWh and 2.7p per kWh.

7.3 Securing a new energy tariff and reduction in charges
Green Fox negotiated a new flat rate renewable electricity tariff of 13p per kWh for daytime (equivalent to the lowest daytime tariff for any of the schools involved) and 10p per kWh for the night-time tariff.

While there is still some debate as to the extent to which green tariffs confer additionality in the actual generation of renewable energy, a growing number of smaller suppliers are working with local generators to offer new and innovative renewable energy tariffs which should be supported.

It could be argued that switching to a renewable electricity tariff achieves a zero-carbon outcome without implementing other measures. However, installing energy efficiency measures and solar PV not only reduces consumption but also saves costs which is important for funding the Base Model Plus which includes air source heat pumps which increase electricity demand.

These lower electricity tariffs resulted in an overall projected saving on energy bills of £5,000 per year. The reduction in fixed charges added a further saving of £3,000, 30% of the overall charges. Most of these savings arose from the Climate Change Levy that the ALT was paying. Multi-academy trusts are defined as charities, so they are exempt from this charge.

7.4 Installation of energy efficiency measures
We invited competitive tenders to identify the energy savings measures and the maximum solar PV that could be installed at each building. These mainly related to electricity usage but also highlighted some small-scale opportunities to reduce heat demand. These included:

- Replacing fluorescent or incandescent lights with LED bulbs.
- Fitting lighting controls and sensors so lights are switched off in rooms that are not occupied. This creates savings mainly at the start and end of the day, but also during the day for areas that are used intermittently.
- Time clocks for IT equipment and hot water heaters, so they are automatically switched off when they are not needed.
- Replacing resistive heaters with air source heat pumps for mobile classrooms. A small air source heat pump can provide the same thermal output as an electric resistance heater but with typically 3.5 times less electrical input due to their much greater co-efficient of performance (COP).
- Automatic destratification fans to help circulate heat more efficiently, creating a more even temperature across a large space such as a hall as well as reducing energy consumption.
- Pipe and valve insulation provide a small but cost-effective way to reduce heat demand.
- Locked thermostatic radiator valves (TRV). While TRVs allow heating control of individual rooms, they are often used as 'on/off' switches which can result in local overheating and opening windows which wastes heat. By limiting the TRV to a temperature between 19-21oC in teaching spaces and around 16oC in circulation spaces, substantial energy savings can be achieved without affecting comfort.

These energy efficiency interventions had the potential to reduce the energy bill by £20,000 (21%). LED lighting and controls made up most of the savings, but significant contributions were made from the destratification fans and the air source heat pumps units in the mobile classrooms.

Image
Leicestershire school students admire their new LED lights

https://www.gov.uk/government/publications/excise-notice-ccl13-climate-change-levy-reliefs-and-special-treatments-for-taxable-commodities/excise-notice-ccl13-climate-change-levy-reliefs-and-special-treatments-for-taxable-commodities#section2

7.5 Installation of solar PV
Solar PV has an important part to play as it generates renewable electricity on site which can effectively replace electricity supplied to the schools through the grid. This self-consumption is generally restricted to the daytime and term time, but still adds significant value to the model as the price of electricity is relatively high in relation to the overall cost of energy. Modelling the installation of solar PV reduced the energy bill by £12,000 per year, equivalent to 13%.

Excess electricity, such as that generated during summer holidays, can be exported to the grid, earning additional revenue from the Smart Export Guarantee (SEG). The Department for Business, Energy and Industrial Strategy (BEIS) introduced the SEG in January 2020 which requires some electricity suppliers to pay small-scale generators for the low-carbon electricity which they export to the grid. This means that all the electricity generated through PV has a financial value.

However the SEG differs from previous schemes such as the Feed in Tariff. Contracts usually run for 12 months, there is no fixed price a supplier must pay, and prices are subject to change each year. This uncertainty makes long-term modelling difficult.

Nevertheless our model estimates the SEG will generate £4,000 per year, assuming an export price of 4p per kWh.

7.6 Identifying the capital cost through competitive tendering

Three companies were invited to tender for the energy efficiency measures and solar PV to identify the costs. The most competitive price for the energy efficiency measures was £75,000. With projected energy efficiency savings of £20,000 this provided a simple payback of under 4 years.

The most competitive price to purchase and install 177 kWp of solar PV was £140,000. The projected cost savings were £12,000 providing a simple payback of under 12 years.

7.7 Impact on carbon emissions

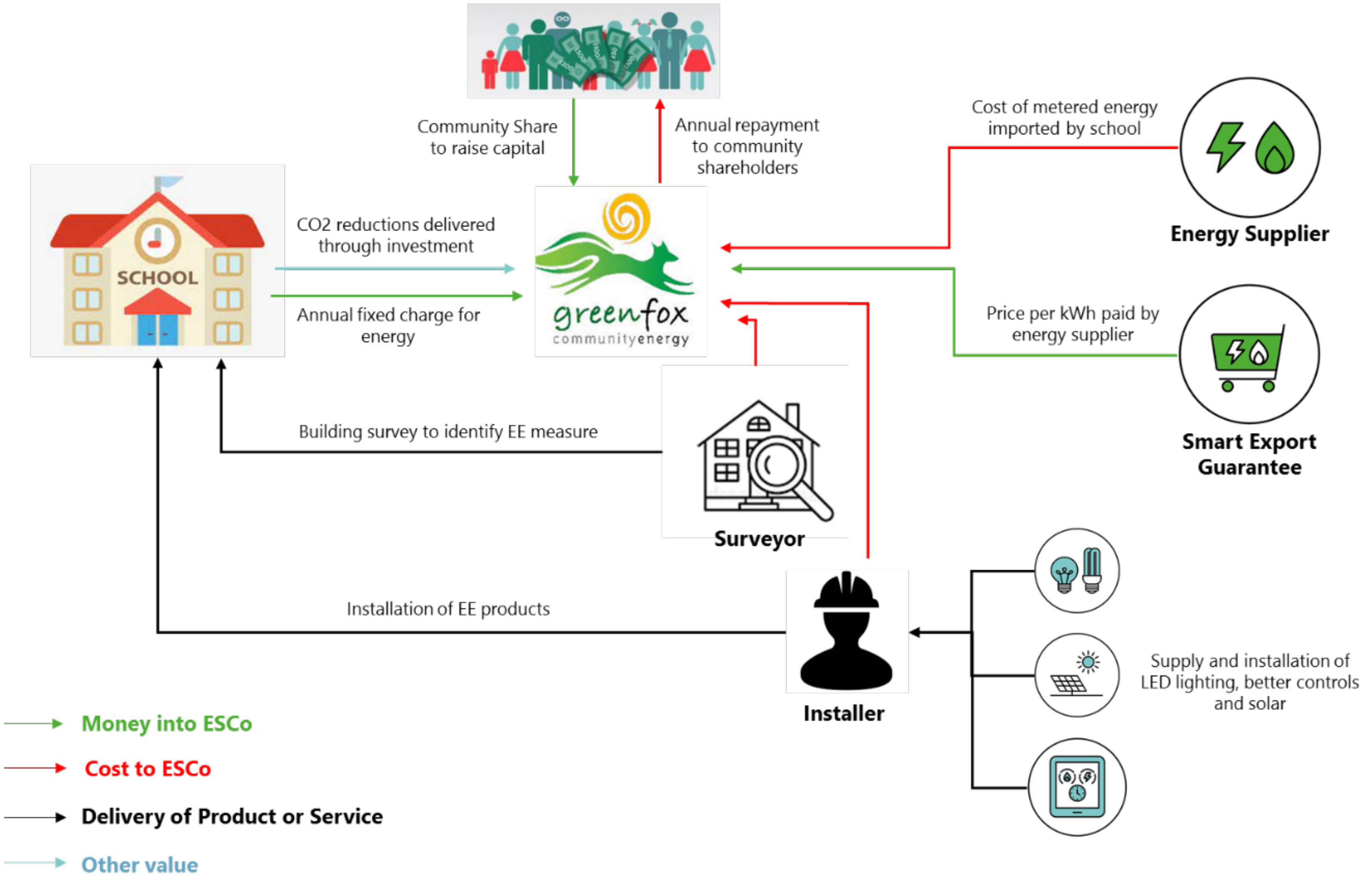
The existing school energy demand of 1,300 MWh has associated emissions of 240 tonnes of CO_2 per year, with 63% from heating and 37% from electricity.

Implementing the energy efficiency measures and installing PV could reduce CO_2 emissions by 21%. Switching to a renewable electricity tariff could achieve a further 16% reduction.

Overall the four schools could save a combined total of 88 tonnes of CO_2 per year through the Base Model, equating to 1,760 tonnes of CO_2 over 20 years. The cost of carbon reduction can be measured as £115 per tonne of CO_2 over 20 years.

Figure 1 demonstrates the financial transactions between the different organisations and the way in which the interventions work within the model.

Figure 1: Base Model - inter-relationships



7.8 Behaviour Change

The Salix surveys forecast up to 5% of savings from changes in staff in pupil behaviour, particularly from better management of heat. These savings have not been accounted for in the Base Model or Base Model Plus because they are hard to measure or verify. However behavioural change could provide further cost savings and could be part of financially incentivising schools to further reduce their energy bills.

7.9 Conclusions

The Base Model works well as a community energy business model without the need for financial subsidy. It highlights that solar PV, energy efficiency and tariff reduction combined provide a significant cost reduction and new income streams to make a community share approach viable without subsidy.

Although the base model alone would not deliver a zero-carbon school, it can provide a massive step in the right direction and the foundation for the Base Model Plus which aims to provide the zero-carbon outcome.

The main reason the Base Model works so well is that it is primarily reducing or replacing electricity consumption. The price of electricity is relatively high – and has risen further since the modelling work was completed – even at the reduced tariffs, which allows a wide range of interventions to be cost effective.

Figure 2: List of interventions, installation costs and financial savings

Intervention	Savings	Capital Expenditure
Reduction in Energy Supply Tariffs	£5,000	–
Reduction in Energy Bill Charges	£3,000	–
Energy Efficiency	£20,000	£75,000
PV	£12,000	£140,000
Value of Savings – Sub Total	**£40,000**	**£215,000**
SEG Income	£4,000	–
Total	**£44,000**	**£215,000**

The Base Model provided a simple payback period of just over 6 years with the following assumptions:

- Other than inflation there is no increase in the ALTs energy bills
- The capital cost of £215,000 for the installation of the energy efficiency measures and solar PV would be raised through a share offer
- It would offer investors (who become members) an annual 3% return on investment over 20 years, with capital repayments at 5% per year over 20 years
- The savings created by the Base Model would provide a community energy organisation with an annual operational income of £14,000

Although the Smart Export Guarantee has replaced the Feed-in Tariff, for the community energy sector it is flawed because it provides no minimum export price, and no long-term certainty. It puts the community energy sector at a disadvantage to larger renewable energy projects which may receive long-term certainty from Contracts for Difference. Alternatively a Power Purchase Agreement could be arranged which would improve the financials – this is examined in the Base Model Plus.

It is worth noting that the new renewable energy tariff proposed was more economical than most of all the existing school tariffs.

Many community energy organisations are already engaged with schools through providing solar PV. The model shows these organisations could also work with these schools further on energy efficiency and tariff reduction. The energy efficiency measures provide a shorter payback than PV and could easily be implemented without any subsidy support. This could work even better with a share offer which aggregates the risks over several schools.

Image
Uplands Junior School

8 The Base Model Plus

The main difference between the Base Model and Base Model Plus is the transition to low carbon heating. Modelling estimates the ALT uses 74% of its energy for heating compared to the national average of 76% (source: BEES report). It is a vital to address this if we want to achieve zero carbon schools.

Retrofitting low carbon heating, especially in older buildings, is currently difficult. The UK's policy on decarbonising heating is unclear and gas remains a cheap and reliable solution for most of the country. Low carbon solutions can be expensive and limited by the UK's supply chain. Nevertheless, the market is changing rapidly.

The Base Model Plus looks at three key areas:

- The viability of delivering decarbonised heating in schools through ASHP technology. Ground source heat pumps were not considered for this case study due to building density in the area.
- Investigating opportunities for additional value from energy to make low carbon heating more viable
- Future products and services that make it more economically attractive

8.1 Air Source Heat Pumps (ASHP)
Although there are many options being explored for decarbonising heat, including greening the existing gas network with biogas or hydrogen, the only viable option right now is the installation of heat pumps. There are two types of heat pump: ground source and air source.

Heat pumps work like a fridge or air conditioning in reverse. They take latent heat from the air, and compress a gas known as refrigerant which drastically increases the temperature. That heat is then exchanged with the central heating system and pumped round the building as any normal boiler would. This process is three times more efficient than using standard electrical heating and is classified as a low carbon technology due to its high efficiency.

Heat pumps in schools are still an emerging concept, especially retrofitting. There are a handful of case studies such as St Andrews Primary School in the Cotswolds which replaced oil as its primary fuel and retrofitted heat pumps at a cost of £120,000 through the Public Sector Decarbonisation Scheme.

When installing a heat pump, consideration should be given to local constraints, such as planning permission if located near a residential property or limitations of the local power infrastructure. An installation for a primary school would require consultation and approval from the Distribution Network Operator. It is very likely that upgrades would be needed to service cables, local mains or transformers. This will vary from site to site.

However, heat pumps are more typically incorporated in new builds or extensions. Careful design, sizing and heat loss calculations are essential to ensure that the heat pump operates efficiently. A badly designed heat pump or one fitted in the wrong conditions can be expensive and uncomfortable for the end user.

Results of installing ASHPs
The high capital cost of ASHPs in the Base Model Plus would not work for a community energy business without external capital such as a grant.

Installing ASHPs is estimated to cost £710,000, based on the initial Salix survey, a quote from a heat pump installer and other construction industry benchmark prices. Combined with the Base Model capital costs, this equates to £925,000 for the four primary schools, an average of just over £230,000 per school.

However, costs will vary greatly depending on individual schools' circumstances. We estimate 33% of the total costs would be in upgrading the heat distribution system and minor improvements to the building fabric. Any major change to building fabric like external wall insulation has not been factored in. Every building is different, and it is difficult to price a heat pump without a detailed survey of the existing heating system and heat loss calculations across the buildings.

Results will vary from school to school; modelling four primary schools demonstrated the differences, allowing us to balance the overall results. Highfields Primary school was built in the 1990s and has cavity wall insulation, double glazing, and radiators capable of running at low temperatures. The school could transition to a heat pump without excessive remedial costs on improving the building and heating system. By contrast Sparkenhoe Community Primary school is a much more complex site. The three buildings on site are a mix of new build and older properties with uninsulated solid walls.

BEES report
https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

https://les.mitsubishielectric.co.uk/case-studies/st-andrews-school-chedworth

The ALT has a higher cost of heating due to the higher cost of the District Heat Network (DHN) relative to gas. The differential between the current cost of heat (5.3p per kWh) supplied by the DHN and the electricity price (13p per kWh) to operate the ASHPs is less than the same differential using gas as the primary fuel.

Initial conclusions from the Base Model Plus:

- Including ASHP provides a simple payback in 18 years which is not financially viable for a community energy group
- It ensures no effective increase to the ALT's energy bills
- It provides a 100% reduction in CO_2 emissions equating to 4,800 tonnes of CO_2 over 20 years
- The model requires £925,000 of capital investment
- It would offer investors (who become Members) an annual 3% return on investment over 20 years with capital repayments at 5% per year over 20 years
- The savings generated from implementing the Base Model would provide a community energy organisation with an annual operational income of £15,000

As the Base Model Plus was unviable, the modelling continued to investigate which parameters could be changed to make it work. The Base Model worked well with a capital expenditure of £215,000, and provided a simple payback period of just over 6 years. So we looked at reducing the capital cost through a grant.

Reducing capital expenditure with grants
We modelled different scenarios with capital grants allowing the overall capital required by a community share offer to be lowered. The recent introduction of the Public Sector Decarbonisation Scheme by BEIS offers significant capital grants of over £1 billion to decarbonise public estates and could be the catalyst to make the model work. A capital grant of £525,000, just over half of the total capital required, would provide a simple payback of 9 years. Our modelling suggests a capital cost ceiling for a community energy share offer in the region of £400,000 i.e. £100,000 per school. With the higher heat price associated with the ALT this would work for four primary schools off the gas network.

Although this means the new model isn't viable without some grant funding support it would reduce the overall cost to the public purse. The model would provide excellent value for money to BEIS: the community energy sector would contribute £100,000 per school with a capital grant of £130,000 from BEIS which would provide the £230,000 required to create a zero-carbon school.

Since we started working on this report, Leicester City Council was awarded over £24 million from PSDS for three applications to upgrade 93 buildings, including 55 primary schools. This will include replacing natural gas heating with ASHPs, installing LED lighting and solar panels, and improving insulation through the installation of double glazing, cavity brick wall insulation, roof insulation and fitting replacement roofs.

This is a step in the right direction; to implement the Base Model Plus in all 80 primary schools in Leicester would cost over £18 million according to our model.

Base Model Plus in schools heated by gas
As 70% of schools are heated by gas, we also investigated the viability of an ASHP community energy business model working with these schools.

This tested the sensitivity of the model to differences in the existing costs and sources of the energy used for heating, using the same parameters including the £525,000 capital grant.

The model was then modified to represent an alternative scenario in which the heat provided to the schools by the district heating network (DHN) was replaced by the gas supply. Rather than using the specific gas tariffs available to the ALT, this model used a more generic tariff of 2.9p/kWh based on the National Government Green Book pricing.

In the modelling the ASHPs have a coefficient of performance of 3.0 (one kWh of electricity provides 3 kWh of heat energy) so that an electricity price of 13p is equivalent to a heat price of 4.3p. Conversely, the gas boiler operates with 90% efficiency and so a gas price of 2.9p per kWh is equivalent to a heat price of 3.2p.

On this basis, converting from gas to heat pumps will increase fuel costs by approximately 34% although some improvement can be gained if the heat pump is timed to operate at lower night-time tariffs. These increased fuel costs would be offset by the savings delivered through the Base Model.

These savings provided a 42% reduction in energy bills.

If the four schools were to use gas heating in place of the DHN, fuel costs would be approximately £8,000 lower. This would be partially offset by a £3,000 increase in additional standing charges for the gas supplied.

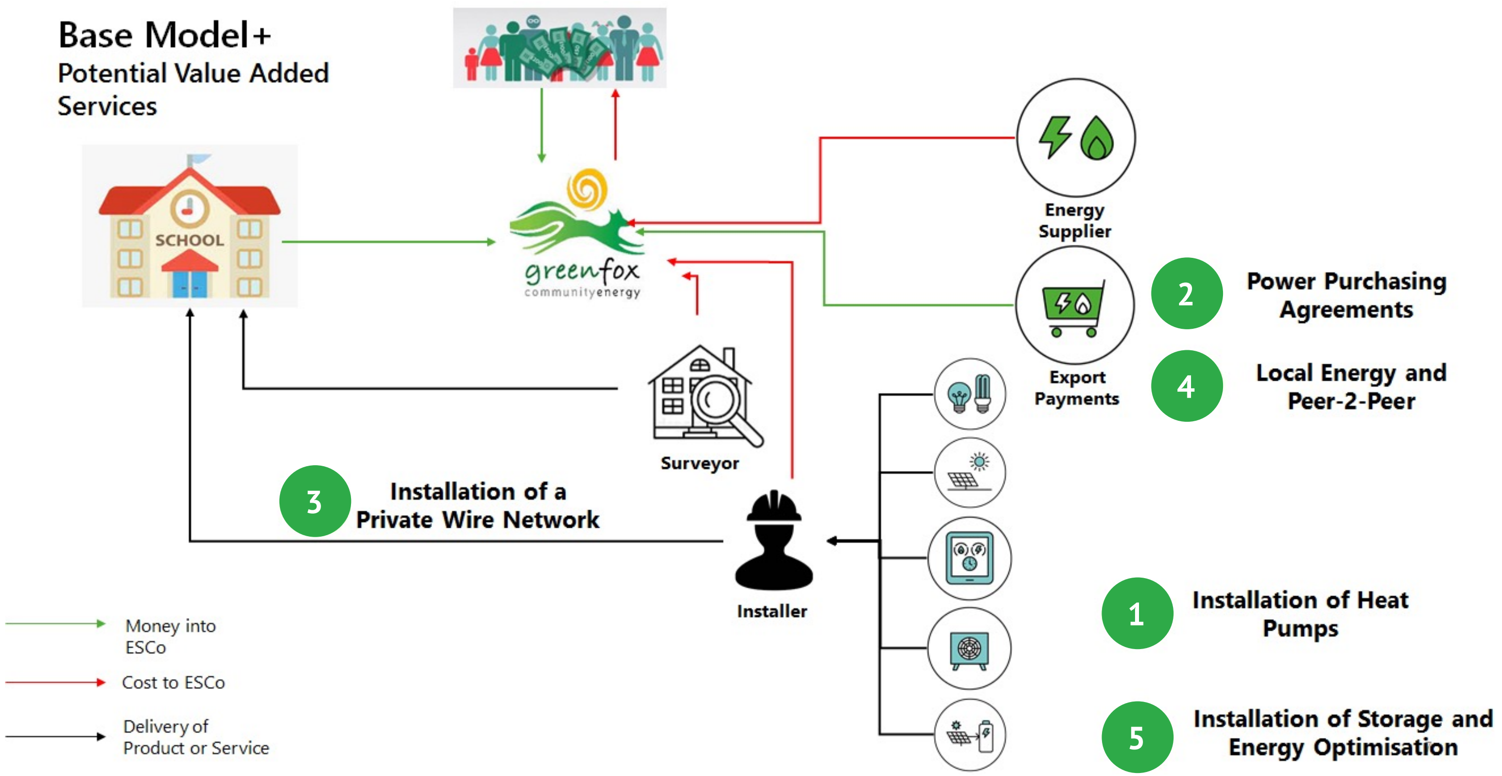
On the basis that the business model maintains the existing energy costs to the schools, the potential income to the scheme would also be reduced by £5,000. The capital costs of installing and running heat pumps would remain the same and so the annual operating margins would also be lower by £5,000.

With a capital grant of £525,000, replacing gas (rather than district heating) extends the simple payback period from 10 to 11 years. Despite the differences in the price of the DHN and gas, the viability of the Base Model Plus approach is not greatly affected in this modelling.

To construct a more favourable financial model, it would be necessary for the gas price to increase in relation to the electricity price and the capital costs of ASHP installations to fall.

The Base Model Plus investigated five further scenarios that could provide additional revenue streams. Where there is a financial benefit to the model, it has been included within the Base Model Plus.

Figure 3: The Base Model Plus – potential value from added services



8.2 Power Purchase Agreements (PPA)
A Power Purchase Agreement (PPA) is negotiated between a generator of energy and a buyer (or off taker), who will purchase power over an agreed time and at an agreed price. In most cases a licensed energy supplier is required to facilitate this; either the supplier buying directly to sell onto their customers or helping arrange a purchase with a local buyer.

PPAs can take many forms, but the types that were examined included:

a) **Direct PPA** – where the school would enter into an agreement with a licensed energy supplier to buy any energy exported from the school. This power can then be resold by the energy supplier to its customers. There is usually a small uplift in the price for the generator depending on where and when the power is available.

b) **Sleeving** – where a licensed supplier would help facilitate the matching of power generated from the school to a single local buyer. This is especially relevant where the generator (in this case the school) has several local sites that they want to benefit from the cheaper, green energy being generated. Although the power is not directly supplied to site, an energy supplier will help "virtually" balance the power across all the local sites. When the sun is shining and solar is generating power, there is a decrease in price for the buyer and uplift in price for the generator. When it isn't, they revert to standard prices.

PPAs provide a small extra level of effort to negotiate pricing each year, so some extra admin costs may need to be taken into consideration.

Creating revenue from a Power Purchase Agreement
The base model assumes any additional energy exported by the schools is covered by the Smart Export Guarantee. However, based on the location and time of export it is possible to negotiate a Power Purchasing Agreement with an energy supplier and get a higher rate.

To obtain a quote, there are a few requirements for the school:

- half-hourly metering, including export data
- a forecast of annual demand and export over the last 12 months
- a postcode for each site so that location can be factored into the pricing

A PPA's value is primarily based on the wholesale price for electricity. Uplift is possible where the time or location is right for the energy supplier setting up the PPA. We contacted a number of different energy suppliers to obtain quotes for the ALT, which were around 6p per kWh which approximately equates to £2,000 per year. Quoted contracts were 12 months but it is possible to negotiate a longer deal, potentially at a price reduction.

It is worth noting that PPAs don't have the same level of transparency as buying energy, and it is important to shop around to understand what a good price would be for an individual set of circumstances. Tying the PPA to a standard energy supply contract is also likely to provide a better price.

8.3 Private Wire and Micro Grids
A private wire is a direct link is between an energy generator and a local user. Unlike the PPAs described previously this is a physical electrical connection between two locations. Any additional energy not consumed on site by the school could be fed to the local buyer, at a much-reduced price to what they would pay for a standard electricity tariff.

The private wire could be a direct link between two buildings owned by the same organisation (but separately metered), or it could be a link between two different organisations. Where there are multiple parties generating and sharing electricity, without using the main electricity network, this is often referred to as a micro grid.

The value is potentially high, as the energy never has to use the main electricity grid network, thereby avoiding grid, environmental and regulatory charges. For example, even with a low unit cost of 13p per kWh, 8.5p per kWh is additional charges from network companies, government and suppliers.

The key to a successful private wire arrangement is:

- Making sure there is enough excess energy to justify the additional costs required
- Making sure that excess energy is well matched to the buyer's energy demand
- The costs are not so high that local sharing becomes economically unviable

Local factors play a major part in whether a private wire arrangement is viable. It requires the two sites to be in close enough proximity with a safe and effective way to route power between the two sites.

Creating revenue from Private Wire and Microgrids
The model considered three scenarios for sharing excess power with other sites and buildings in the local area. These depend on individual situations and may not be suitable for every school, but consuming more power locally is highly advantageous from an efficiency, value, and CO_2 perspective.

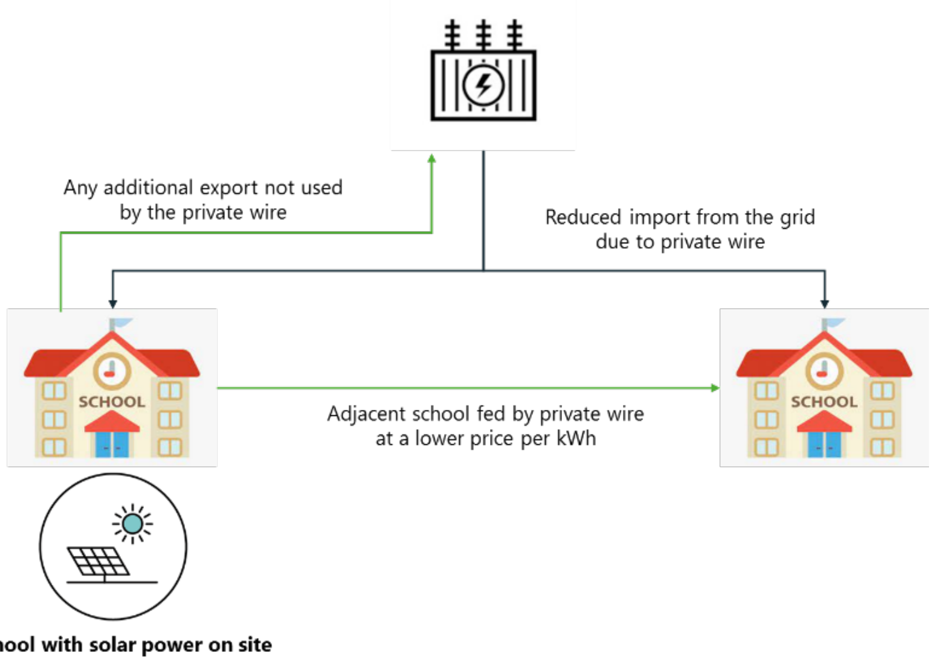
a) **Moving the solar connection point**
In some cases the school has multiple buildings that are separately metered (e.g. Uplands Primary School). In Uplands' case, the building most suitable for solar does not have the highest demand and by re-routing generated energy to a different building the school can increase the amount of solar power it uses locally. The revenue uplift from this arrangement is estimated at £765 a year.

b) **Moving the grid connection point**
Within the ALT there are several instances where buildings in the same school have separate grid connections. This means solar installed on one building will not be consumed at another building in the same school. If this arrangement is modified such that both buildings share the same grid connection, the generation output from the solar PV can be utilised more efficiently across the school. Separate grid connections exist at Uplands, Green Lane Infants and Sparkenhoe Community Primary. The revenue uplift from this arrangement is estimated at £842 a year.

c) **Sharing generation with other nearby customers**
Uplands Primary is also adjacent to a Junior School. Although the demand is not known at the Junior School it could be safe to assume that a proportion of exported solar could be utilised on site through a private wire arrangement. This is assumed to be a similar situation to sharing solar across the two Uplands Primary buildings.

Clearly any evaluation of the benefits of private wire arrangements would need to include the costs of additional cables and the impact of any increase in capacity charges relating to the grid connection. The relative merits are likely to be highly site-specific but are worth considering, particularly if there are adjacent buildings with different daily demand profiles or where there could be higher demand at weekends or during holidays.

Figure 4: Private Wire and potential for further income



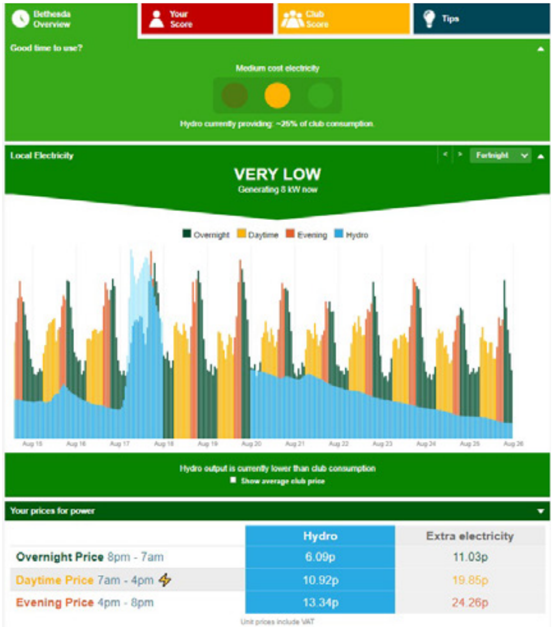
8.4 Local Energy and Peer-to-Peer (P2P) models

A P2P network is a more sophisticated form of power purchasing agreement that is facilitated across a local area. The logic of a P2P network is that you aggregate all the demand of homes and businesses that want to take part, and then try and match that to whatever local generation is available.

This is a much more flexible arrangement than the PPA and private wire scenarios, as balancing demand and supply is much easier when there are several buyers with different energy demand profiles. It is also more valuable to those taking part, with the price received by the generator and the price paid by the buyer being roughly the same. This would mean being paid circa 8p-9p / kWh instead of 5p-6p/kWh for a direct PPA. There are regulatory and political challenges for P2P schemes that are currently being addressed within the community energy sector. This arises since local energy trading at these prices avoids payment of some levies and charges relating to use of the electricity distribution system. The regulatory environment must balance the desire to incentivise local investment in community energy with the need for fairness to customers outside of the schemes who could then bear a disproportionate share of the costs.

P2P is still an emerging concept and requires a platform or facilitator to make it happen. There are not many P2P platforms in operation in the UK at the moment, but two examples have been investigated for this project; one targeted specifically at community energy (Energy Local) and one targeted at local businesses (QEenergy).

Figure 5: Example of an Energy Local dashboard



Energy Local is a Community Interest Company that helps set up Energy Local Clubs, or Co-ops. The club will be a mix of households and local generators within a defined area. Members will then effectively have two tariffs – a matched tariff when local generation is available which is at a discounted price, and a normal tariff for when they are importing from the grid. If there is sufficient local generation this should work out cheaper for the homes and gives the generator a better deal than they could get from a standard PPA.

It does require a community energy group to set up the club and administer it, but Energy Local provides an advisory service and software tools (e.g. their Energy Club Dashboard) to help manage that. Energy Local also takes responsibility for the supply side, working with suppliers to ensure local balancing, settlements and tariffs are all in place. Currently this is supported by Octopus Energy. Energy Local charges a small fee per month for its service.

Another example is QEnergy, an energy broker and technology company that sells to small and medium sized businesses. Its Energy Local Club is a new concept that would bring together local businesses and local generators into a virtual network that is equally beneficial for buyers and generators. The QEnergy platform generates a local energy tariff, by carrying out balancing and optimisation among its customers and generators utilising battery storage and demand flexibility, while buying additional energy from the wholesale market using green energy partners.

Creating revenue from Local Energy and Peer-to-Peer initiatives

There is a simpler scenario to consider where Green Fox and the ALT become only a generator into a local energy club and receive an uplift on any export. Although the price uplift for the school's export is known (circa. 8p-9p per kWh) it is very difficult to determine how often the school's export would match local demand without more complex modelling.

There are several factors to consider in the Local Energy scenario. Export from the school alone would be insufficient to setup the club, so extra local generation would be required that Green Fox would own or must procure. The definition of local is usually defined by where they sit on the electricity network, not by city or postcode. The schools and local club members would need to sit on the same primary substation. The match tariff is also reliant on what's happening in the market, and energy suppliers supporting it.

8.5 Battery storage and optimisation

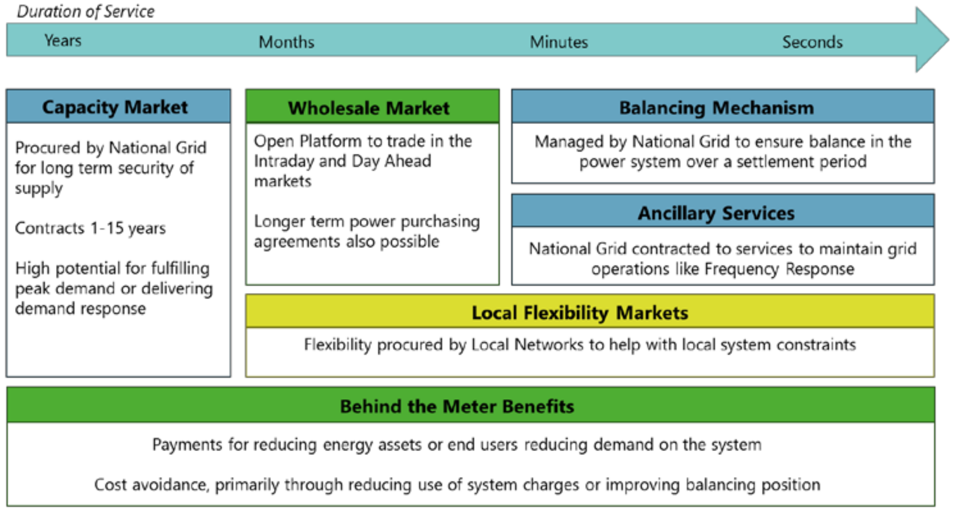
Development in battery and other storage technology means there is an emerging market for schools to store excess electricity and use it at times of higher demand. There are many ways to store energy, but for this project we focus on the opportunity from power storage and in particular the use of lithium-ion batteries, and to a lesser extent thermal storage and optimisation.

The technology functions in the same way any battery does. You can either charge or discharge the battery depending on what you're trying to achieve. A battery could be optimised for cost savings, CO_2 savings or revenue opportunities. The benefits of battery storage are:

- Reducing imported energy thereby maximising the use of solar energy generated at the school
- Reducing imported energy at certain times of the day when energy is more expensive (peak cost avoidance)
- Using the battery capacity for trading in flexibility and energy markets for revenue opportunities

Battery storage will vary in cost but as an example a 30kW battery system would cost £25,000 for the product alone. For the business case to stack up all three value streams (reduce import, optimise import and trading) would need to be managed. This requires intelligence in the control of the battery and forecasting different market prices. A third-party service provider is needed to help a school realise the benefits of battery storage.

Figure 6: Potential for battery storage revenue



Source Aurora Energy Research

Creating revenue from battery storage and optimisation
Two options have been explored for the ALT. Pricing is commercially sensitive to both companies so this is an illustration of how the model could work. For any future net zero school project pricing will vary depending on the school's energy demand, profile and location.

a) **The Shared Revenue Model**
Social Energy is a technology provider and licensed energy supplier formed in 2017. Its model is based on shared savings. Social Energy will manage the battery on behalf of the schools and typically can earn 6.5p for every kWh utilised. This is done through contracts with National Grid on services like Firm Frequency Response, and energy trading in wholesale markets. With new markets coming online from local networks and the National Grid (e.g., Dynamic Containment), Social Energy expects to increase that figure to as high as 8p for every kWh utilised.

For providing this service, Social Energy takes a 20% share in any additional revenue generated. The cost of the battery would have to be fronted by the Community ESCo in this model. It is worth noting that lithium-ion batteries have a useful life of about 10 years depending on how they are used. The replacement of the battery over the lifetime of the Community ESCo contract needs to be factored into any business case.

b) **The Rental Model**
F&S energy is a renewable energy supplier founded in 2011 in Chelmsford. The company supports several different models for battery storage, but for a customer like a school it recommends a rental model. This would mean F&S both owns and operates the battery independently for the school. As part of the service the Community ESCo and schools would benefit from a rental fee paid for the year.

F&S gets its value back in much the same way. The capacity of the battery, and the power it provides, is "stacked" into different energy markets like wholesale trading, the balancing mechanism, and ancillary services. F&S, as the licensed supplier would manage all interactions with the market and the school should see little if any change to the service they receive.

8.6 Thermal storage and heat optimisation
Another technology that could help improve the zero-carbon business case is heat storage and the optimisation of heat. With the move to heat pumps, a school will be increasing the amount of power used especially in the early mornings and on cold days. Electricity is much more variable in price then gas, so if there is a way to optimise when the heat pump is running at times when energy prices are low (and carbon intensity is low too), then this could bring added benefit to the Community ESCo.

Stemey Energy is an example of a new wave of technology companies in the energy market that can support community energy and the transition to net zero. It is an energy service provider and software developer based in Spain and London. Its core product is SPLODER, an intelligent energy management and optimisation platform that has been used by community energy groups, businesses, and homes.

In Spain, Stemey has been working with community energy groups to deliver optimised district heating for homes and businesses. The platform can integrate with several electrical appliances, including heat pumps, in a building and monitor usage over time. Once usage patterns are understood, they then look at how demand can be managed up or down at certain periods of the day. This management of demand (Demand Side Response or DSR for short) can then be traded in the ancillary services market with the National Grid.

There are equally big developments in heat storage that should be considered at the design phase of a zero-carbon school as the technology advances. A thermal store or new innovations like Sunamp and Caldera are possibilities for utilising lower cost power, improving the performance of the heat pump and increasing the comfort of the staff and pupils.

8.7 Conclusions from the Base Model Plus
The Base Model Plus enables the ALT to reduce the remaining 63% of CO_2 emissions and together with the Base Model totally decarbonises its energy. The four schools would save a combined total of 152 tonnes of CO_2 per year (4,800 tonnes of CO_2 over 20 years) for a carbon cost of £193 per tonne over 20 years.

The four primary schools consist of ten buildings that are all significantly different, therefore the Base Model Plus concludes that the average primary school would cost £230,000 to totally decarbonise in terms of its energy consumption and use.

However the high total capital costs of the Base Model Plus, £925,000, would not be viable as a community energy model without additional grant funding. The recent introduction of BEIS Public Sector Decarbonisation Scheme could be the catalyst that is needed to make it work.

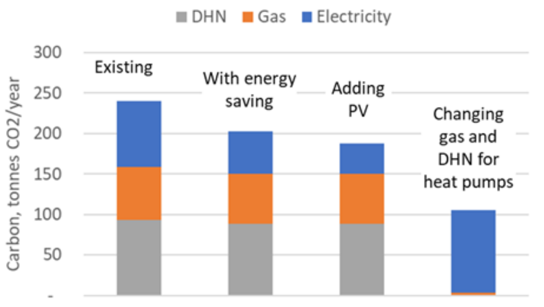
It would reduce the overall cost to the public purse. The model would provide value for money to BEIS as effectively the community energy sector could be contributing an estimated £100,000 per school and together with a capital grant of £130,000 from BEIS it would provide the £230,000 required to create a zero-carbon school.

Primary schools with a better building fabric may require less intervention to upgrade the central heating system, which would potentially reduce the capital costs and improve the viability of the model. Targeting more recently built schools would provide an opportunity to test the model.

The price of heat

While the Base Model benefits financially from a high electricity price when installing energy efficiency and PV, the Base Model Plus would benefit from a lower electricity price as it incorporates the ASHP heating technology. This differential in price effectively means that the different models would benefit from different pricing mechanisms.

Figure 7: Impact of Base Model and Base Model Plus on carbon emissions



However, the two models are interwoven, as ideally the Base Model interventions generate the financial savings required whilst the Base Model Plus effectively creates the zero-carbon school. One of the potential solutions to the problem would be to raise the price of gas which is the fuel that heats 70% of schools. A reduction in electricity prices would negatively affect the finances of the Base Model.

In the case of the ALT this price difference is not so acute, as the heat is supplied by the DHN at a price of 5.3p per kWh and the electricity is supplied at a price of up to 13p per kWh. However even with this higher price for heat, as previously stated the model is not viable.

The creation of new income streams

The Base Model Plus set out to investigate the opportunities for additional revenues from emerging and innovative technologies.

Installing the maximum solar PV at each school reduced the running costs of an ASHP. At the ALT, the model calculated a 20% increase in self-consumption of electricity generated by solar PV which helped with the overall finances of the Base Model Plus.

Replacing the SEG with a PPA would provide a further £2,000 per year. This is included within the modelling of the Base Model Plus.

A Local Energy Club represents a potentially valuable opportunity for Green Fox, the ALT and the local community. It could improve the business case for more local renewable generation and help lower bills for local households. It also keeps a cyclical flow of money within the local community, with investors, generators, and customers potentially all being in the same household.

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9 Glossary and Definition of Terms

ALT Attenborough Learning Trust

ASHP Air Source Heat Pump

BEES Building Energy Efficiency Survey

BEIS Government Department for Business, Energy & Industrial Strategy

CCL Climate Change Levy

COP Coefficient of performance

CO_2 Carbon Dioxide

DfE Department for Education

DHN District Heat Network

ESC Energy Systems Catapult

ESCo Energy Service Company

ESFA Education and Skills Funding Agency

ESPO Eastern Shires Purchasing Organisation – public sector professional buying organisation

Green Fox Green Fox Community Energy Co-operative

IRR Internal Rate of Return

LED Light Emitting Diode

LCC Leicester City Council

PPA Power Purchase Agreement

PV Photovoltaics

P2P Peer to Peer

SEG Smart Export Guarantee

SME Small Medium Enterprise

TRV Thermostatic Radiator Valves

kW One kilowatt of power

kWh One kilowatt hour or 'unit' of energy

kWp Rated peak power of a PV system

MWh 1 megawatt hour or 1,000 kilowatt hours