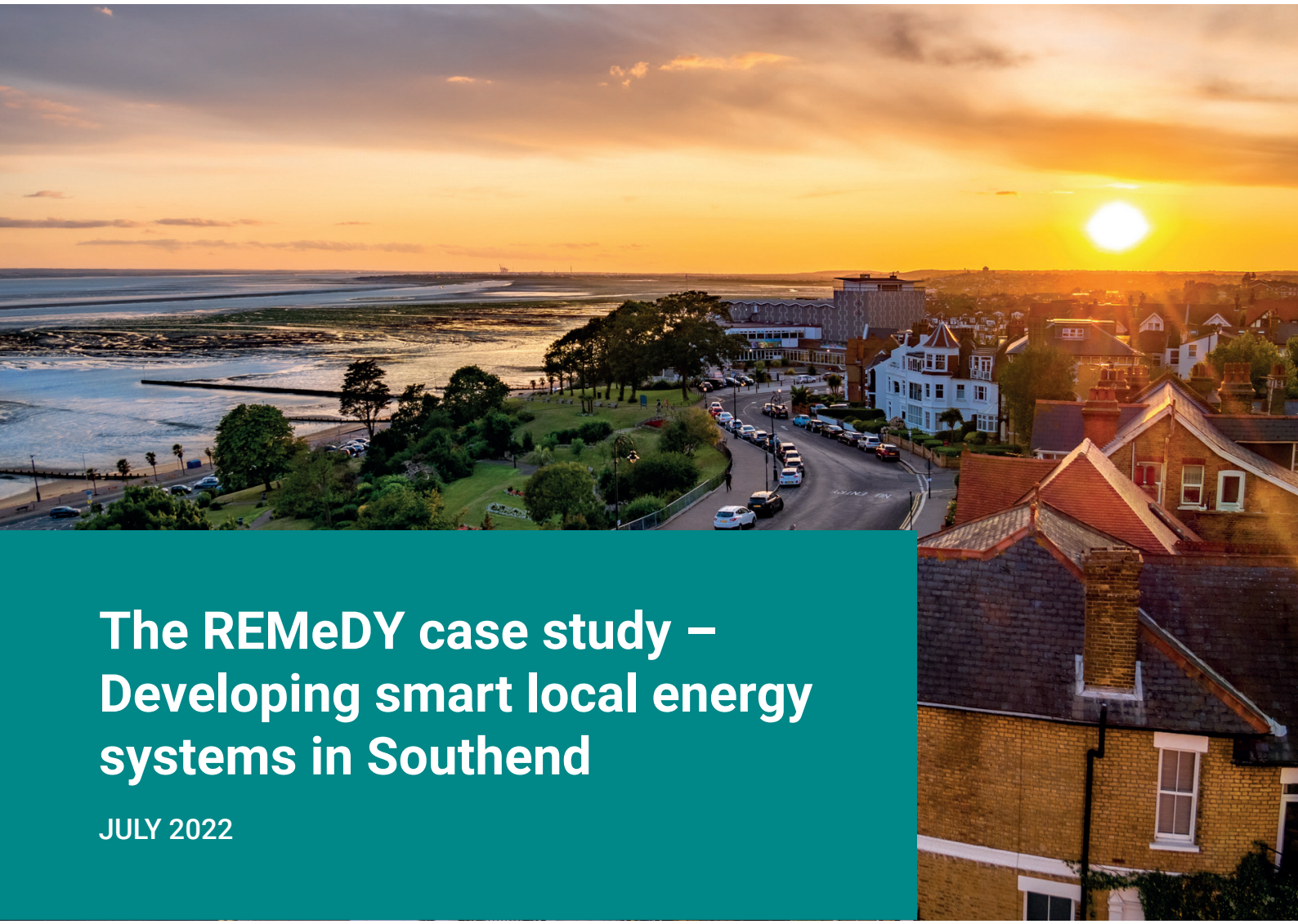

The REMeDY case study – Developing smart local energy systems in Southend

JULY 2022

This report was developed by EnergyUnlocked for Southend City Council as part of the REMeDY programme.

UK Research and Innovation

The REMeDY Partners:

southend onsea BOROUGH COUNCIL

SMS Leading the smart energy revolution

VITAL ENERGi

Imperial College London

UEA University of East Anglia

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How to use this report

This report sets out how the two-year REMeDY project developed technically and commercially viable 'smart local energy systems' in the UK, and considered how it could be applied in the City of Southend.

Part one introduces some of the key concepts in this field, explaining what smart local low energy carbon systems are, how our energy system works and the difference between heat pumps and heat networks. It introduces the REMeDY concept and how different low carbon heat solutions are suited to different types of residential housing.

Part two offers a brief overview of Southend. It describes the types of housing and energy demand in the city, plus a look at the different areas of Southend that might be suitable for a REMeDY solution. It also covers our community engagement work around attitudes to energy products and net zero, and the role of Southend City Council.

Part three looks at who is involved in making smart local energy systems happen and who influences the development of these solutions, from policymakers to developers and landowners. It also features our pipeline project case studies, highlighting the benefits and challenges of developing local energy systems.

Part four considers the benefits of smart local energy systems, such as REMeDY, but also some of the key challenges.

Part five summarises the project's key findings, emphasises the important role of local authorities and sets out the national and local actions that need to be taken to accelerate the development of smart local energy systems.

If you are …

A local policymaker you may be particularly interested in the deeper dives into Southend City's role in developing low carbon solutions, in parts two and five. You may also be interested in the roles and influences discussed in part three.

A national policymaker you may be interested in the sections of the benefits and challenges in parts four and five. We would also highlight the discussion on the power of the parties involved in part three.

A net zero campaigner or community worker you may be particularly interested in the section Developing a people-centred approach to the local energy transition in part two.

As a **project developer or property developer** we would highlight section four on the benefits of REMeDY type systems and why you should engage early in the project development to explore their possibilities.

Glossary

Term	Definition
Local Energy System Terms	
BESS	Battery Energy Storage System
D-TES	Distributed Thermal Energy Storage – this can be heat stores or improved building fabric that improves heat retention
DNO or DSO	Distribution Network Operator / Distribution System Operator – organisation responsible for the operation of the local energy grid
ESO	Electricity System Operator responsible for the national electricity system operation
EV	Electric Vehicle
EV CP	Electric Vehicle Charge Point
kW / MW	Kilo Watt (1000 Watts) or Mega Watt(1 million Watts) – a measure of electrical power – a kettle uses is about 3kiloWatts
Green Hydrogen	Hydrogen produced from renewable energy
Blue Hydrogen	Hydrogen produced from industrial sources or from hydrocarbon sources.
RES	REMeDY Energy System that excludes electricity supplies to domestic properties
ORES	Original REMeDY Energy System design that includes electricity supplies to domestic properties
SLES	Smart Local Energy System – an energy system in a local areas that uses digital technologies to manage generation, energy storage and controllable demand to reduce costs and infrastructure needs
PV	Photovoltaic generation / solar panels
Heating Terms	
CoP / COP	Coefficient of Performance – Heat pumps use less electrical energy than the heat they produce! The ratio between the heat produced and the electrical energy input is the Coefficient of Performance
Direct electric heating	Heating using electric storage heaters, Infrared panels or other radiant electric heaters
IR Panel	Infrared Panel – a form of direct electric heating that heats the building fabric rather than the air
Heat Networks - Low Temperature heat networks	Heat networks that operate at 25-30 degC. These need heat pumps in each property to provide high temperature hot water but cost less to build

Term	Definition
Heat Networks - High Temperature heat networks	Heat networks that operate at more than 60 degC. Usually only need a simple heat interface unit in each property
HP	Heat Pump
ASHP	Air source Heat Pump
GSHP	Ground Source Heat Pump
WSHP	Water Source Heat Pump
HVAC	Heating Ventilation and Air Conditioning
Carbon Footprint and Energy Efficiency Terms	
EPC	Energy Performance Certificate – an efficiency rating given to each property when sold or rented
LSOA	Lower-layer Super Output Areas are small geographical areas (a bit like post codes) used by national statistics that are designed to be of a similar population size, with an average of approximately 1,500 residents or 650 households.
tCO2 (e)	Tonnes of Carbon Dioxide (e=equivalent)
Energy Business Model Terms	
CES	Counterfactual Energy System – the alternative considered is usually individual heat pumps
CPO	Charge Point Operator
ESCo	Energy Supply Company
GB	Great Britain (England, Wales and Scotland)
LPA	Local Planning Authority
M&E	Mechanical and Electrical
MD	Master Developer
Fin Co	Investment finance company
O&M	Operations and Maintenance
OpCo	Operations Company
PPA	Power Purchase Agreement
SCC	Southend City Council
SMS	SMS plc – a REMeDY lead Partner

Summary

Local smart energy systems built around heat should play an important role in a decarbonised energy system. Future smart local energy systems will comprise of closely linked, interactive electricity and heat networks and this is what REMeDY has explored over the last three years.

REMeDY is a system that stores both heat and electricity to bring flexibility to low carbon heating and electric vehicle charging – and does it in a way that is seamless to the end customer.

Smart local energy systems built around heat offer a number of advantages:

For customers they:

- Have a user experience comparable to the current combi-boiler experience.
- Could be up to 10% less expensive to run than comparable low carbon air source heat pumps.
- Potential to reduce the upfront investment needed in individual low carbon solutions.
- No need for the space for indoor and outdoor heat pumps and heat stores, just a simple heat interface unit giving more space in homes.
- They move the complexity of smart optimisation, maintenance and renewal costs to expert system operators who can find all the value in the energy system.

For the wider energy system they:

- Create significant local energy storage in the form of heat and power. REMeDY solutions could save up to £1bn a year if deployed in 20% of Great Britain's housing least able to be thermally upgraded.
- Provide a single point of control to drive smart optimisation benefits rather reducing the need to harness and optimise thousands of individual consumers' systems.
- Can be made to work in many situations (dense or more distributed).

The REMeDY business model can also provide valuable alternative investment and financing options for developers and housing providers looking ways to fund efficient, smart and flexible low carbon heat systems.

Working with Southend City Council and the local community, REMeDY project partners explored smart local energy system on the ground and produced solutions that would work for three different kinds of developments:

- A high density new build development of apartments
- A mixed commercial/residential redevelopment
- A new build low density domestic housing development

The mix of developments in the Southend case study shows that the REMeDY concept should be widely applicable to new build developments. REMeDY type solutions may also be particularly suited to areas where the fabric of existing housing can only be cost effectively upgraded to a certain point.

Challenges

Being able to develop commercially viable offers requires early engagement between the smart energy provider and the developers so that the concept can be integrated into the development and the full benefits can be realised.

The benefits of low carbon solutions designed to meet the needs of a decarbonised system are often long term, and this creates challenges in developing commercially viable solutions which meet short-term imperatives for development, whether commercial imperatives for private developers or the urgent social need to invest capital in affordable housing.

In order for a REMeDY solution to be a developed, there has to be a business case for property developers (lower investment to meet requirements), landlords (lower operating costs and risks) and end users (affordable energy that meets their needs).

Low carbon solutions remain more expensive than gas heating, and smart flexible energy systems are a more costly and commercially complex solution to install than simple electrical heating. There is still not sufficient commercial motivation to for customers to consider low carbon retrofit options

Recommendations

Resolving these challenges needs further local and national action.

Local actions

Local authorities such as Southend can facilitate the development of REMeDY type smart local energy systems in three key ways:

- Planning and policy setting
- Placemaking through procurement and demonstration
- Partnering and communicating with the community to foster innovation

For Southend the key activities are

- Identifying opportunities and encouraging development through a well-evidenced local plan that supports Southend's increased new homes targets and net zero ambitions.
- Developing evidence to identify areas where local energy system development can support more cost-effective decarbonisation, using local area planning to identify areas where housing types and gas consumption make REMeDY a more effective solution – this could be as much as a third of Southend.
- Actively engaging on smart local energy solutions with the project teams leading on local authority-driven development and redevelopments.

National actions

Nationally, the capability and capacity to help local communities (including local authorities) understand where REMeDY solutions would be most beneficial needs to be developed. This includes local area energy planning that integrates with the national system so that the benefits of these solutions are recognised in policy and spatial planning.

Building the energy storage inherent in REMeDY systems would lead to a low carbon energy system at a lower cost. The long-term investment signals are not strong, but the investment in these systems is a long-term commitment. REMeDY was able to develop a case for commercial investment in new developments but regulatory changes to support longer term investment in these technologies, through zoning or mechanisms to reduce long term investment risk, might accelerate deployment.

REMeDY set out to explore a scalable commercial proposition. The full benefits of optimising domestic heat and power were not explored because the current regulatory framework, developed to address the power of large monopolies, limits the ability to develop a fully integrated solution. As heat regulation develops, new regulations that support integrated local heat and power at scale could unlock further value for customers.

Part 1: introducing low carbon energy systems and REMeDY

This case study describes the wider learning of the two-year REMeDY project to develop technically and commercially viable 'smart local energy systems' in the UK, with a focus on Southend City. The project was led by Southend City Council in partnership with SMS plc, Vital Energi, FutureGov, University of East Anglia and Imperial College London.

REMeDY is part funded by the government's Prospering from the Energy Revolution innovation competition, which aims to find scalable solutions to a lower cost, low carbon energy system.

The case study is designed to complement a separate commercial exploitation plan and so does not describe the commercial specifics developed by SMS and Vital Energi.

This section sets out some of the main concepts and challenges the partners explored during the REMeDY project.

What are smart cities?

Many definitions of smart cities have been developed by companies and communities. But while the details may vary, the key concept can be defined as:

> "by using digital information about how people use services and providing information to people about the city and its infrastructure, services can better meet people's needs, ideally at the lowest cost."

Examples of smart city solutions range from fully integrated infrastructure for heating, cooling and powering buildings through to mobile apps that let citizens navigate between trains, taxis or buses more easily.

What are smart local low carbon energy systems?

The main uses of energy in our cities are for heating and transport. In the UK, heating has been mainly provided by gas, and transport by petrol or diesel, all of which are 'high carbon intensity' compared to new sources of energy that are 'low carbon'.

Moving away from high carbon energy sources like natural gas and petrol/diesel will mean using more electricity. This involves updating and increasing the capacity of

local energy systems and the national systems that connect large remote sources of renewable energy to them.

The idea behind smart local energy systems is to coordinate local energy production with local energy storage and controllable demand. This means we can reduce the amount of additional infrastructure we need to build, both locally and nationally.

Today we have energy systems that were developed to supply electricity and gas from large central systems to our homes so that when we flick a switch our needs are met. These emerged from many smaller local energy systems developed in the late 1800s and early 1900s that supplied towns with gas and electricity, initially for lighting. As larger, more efficient systems to produce electricity from coal were developed, it was much better to locate these centrally near the coal, which was heavy and expensive to move, and connect the electricity to our homes.

Renewable electricity can be produced from a number of sources, most commonly from wind, solar radiation and the flow of water in rivers, as well as the power of waves and tides.

Wind and solar energy can be harvested anywhere, but we need diversity of supply as the wind does not always blow and solar panels only produce energy for around 12 hours a day. This means we will still need a large national grid system, to allow local production to be shared and supported by generation in windier or sunnier parts of the country.

Fossil fuels such as coal and gas can easily be stored in large quantities, but it is much harder to store large amounts of electricity. However, the variation in wind and solar energy make being able to store it more important.

One way in which large amounts of electricity can be 'stored' is by pumping water uphill into a reservoir and then allowing it to flow back through generators when needed. Relatively small amounts can also be stored in batteries, which is useful for short-term storage and managing the national grid. Using storage to be able to change our use of energy to match the production of wind and solar energy is often described as 'flexibility'. When energy systems get 'smarter' this means we are adding a layer of data analysis and the communication between all these technologies to make it possible to manage and coordinate them more easily and automatically.

REMeDY is a system that stores both heat and electricity to bring flexibility to low carbon heating and electric vehicle charging, which would otherwise require hundreds or thousands of individual customers' systems to be managed – and does it in a way that is seamless to the end customer.

How do heat pumps and heat networks fit into smart local energy systems?

Heat can be extracted from the earth, water or air efficiently using heat pumps (which we look at in more depth on p13 below). Heat pumps work in the same way as a fridge works, but instead of being used to take heat out of a space and then put the waste heat into the environment, we take heat out of the environment and put it into our buildings. Individual home heat pump systems need more space than a combi-boiler, typically requiring floor space outdoors and a hot water cylinder indoors.

We can use heat pumps individually, but we can also generate heat communally this way, storing it and sharing it between buildings through heat networks.

Interconnecting heat sources and users to create heat networks has potential benefits, such as sharing spare heat and spare heat storage, in the same way that interconnected electricity grids allow resources to be shared.

So, future local energy systems will comprise of closely linked, smart interactive electricity and heat networks and this is what REMeDY has explored over the last hree years.

How does our energy system work?

Today we have a single market for our energy. The pipes and cables of the grid systems are the transport system by which suppliers and consumers connect to 'one' central marketplace. Even if we have the ability to produce our own electricity through, say, rooftop solar panels, when we connect to the grid we sell to the same market we buy from through our energy suppliers. This is complicated in electricity because the energy system needs to balance consumption and production at all times, every second of every day.

Energy suppliers buy the electricity they think they need from generators, but this will always be slightly more or less than is actually consumed. They tell the Electricity System Operator (ESO) what they are expecting and then the ESO ensures the system is always in balance and correcting for the differences. The costs of this are then shared out across suppliers and generators depending on how good their forecasts were. This is done every half hour of every day. Ensuring all this is accurate is complicated and time consuming. A key benefit of smart meters will be to help make it faster and more accurate.

Electricity suppliers help manage this complexity and allow us to spread the costs of the energy we consume over the year. We can choose which supplier we buy from, but we cannot yet trade with each other, because of the need to manage this complexity.

The industry is organised so that there is equal access for all to the networks that enable the supply. This means that the ownership of networks from generation and supply is kept separate, especially when it comes to domestic customers.

What challenges does this create for local energy?

If you as an individual can produce and store energy on your premises you get the full benefit of it, but you have to pay the full cost of the solar panels and batteries.

It is much harder for a community to come together to do this and share the costs of solar panels and storage, especially if they live in separate homes.

Local v national energy markets

A single energy market aims to create the lowest cost overall solution for everyone. Transmission and distribution systems allow everyone to access the lower costs that usually come from building larger wind turbines or building large solar farms in easily accessed fields rather than on rooftops, and allow diverse energy sources to provide reliability and excess local capacity to be shared widely.

These 'economies of scale' mean that lots of self-sufficient local systems is not necessarily as low cost as a larger system, especially when large parts of that bigger system already exist. Today's energy system grew out of many smaller systems that were built in the early 1900s.

The economics of renewable energy are different to coal and gas given that wind and solar energy are available everywhere, but wind energy still benefits from economies of scale with ever larger wind turbines harvesting more energy more of the time. Reliable supplies also need renewable production to be spread geographically and the systems needs more separate storage so that energy is available on dark cold nights in winter.

Smart energy systems like REMeDY can help reduce the total costs, but energy grids that link local systems together and spread costs fairly between all their users will remain important.

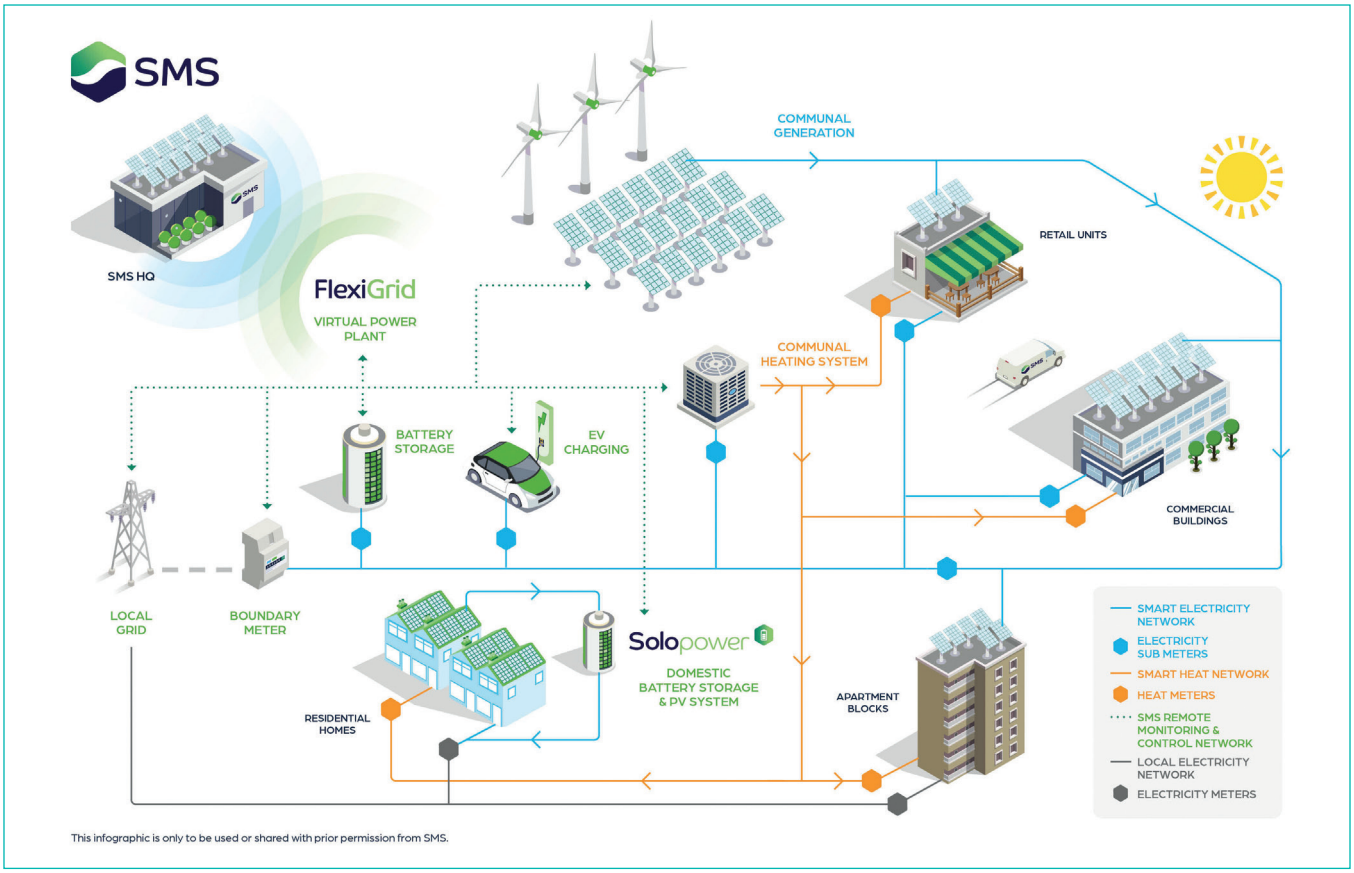
Introducing REMeDY: the concept

The original REMeDY concept envisaged using communal heat networks – a mix of communal and individual solar panels and battery storage and, possibly, communal wind – to create a smart optimised system to meet the community needs for low carbon heat, power and transport at the lowest cost.

As the REMeDY concept was developed, it became clear that it would not be possible to include domestic customers' electricity supplies and their individual solar panels and storage into the solution within today's regulations.

Current regulations are designed to give customers choice over their electricity and gas supplier and give every supplier the same access to customers. Because it is not economic to have multiple cables to every home, networks operate as sole providers of a service. This means you legally separate the ownership of generation and electricity and gas sales from networks that supply domestic homes, so there are no conflicts of interest. Energy companies are not allowed to own networks and supply energy to customers.

The final REMeDY concept



Heat services are more like networks and so heat networks run as small local monopolies.

The final REMeDY smart local energy system is therefore built around a communal heating system, combined with local generation, battery and heat energy storage, and potentially electric vehicle (EV) charging.

Domestic customers would still buy their electricity for lighting, cooking etc from normal electricity suppliers, but would get heat and, possibly, EV charging from the local smart energy system.

What low carbon heat technologies are available?

There are a few different low carbon heating technologies being discussed by businesses and government to meet net zero targets, as shown in the table below. Here we look at these in more detail, explore the benefits of heat networks over individual heat pumps, and consider the suitability of the different low carbon heat solutions.

Smart Local Energy System (SLES)

- Smart local enery system comprising heat generation from heat pump with integrated thermal storage, optimised with renewable generation and electrical energy storage potentially harnessing the opportunities of EV smart charging.
- Combines economies of scale with local carbon outcomes supported by investment and expert management.
- Needs scale for viability.

Communal low carbon heat pumps

- Communal heat pumps can offer alternative low carbon heat solutions.
- No optimisation of resources or communal heat storage – possibly needing.
- Maintenance and renewal costs remain with landlords or tenants through leasehold liabilities.
- Each building has its own solution.

Individual heat pumps

- Less efficient than larger communal heat pumps.
- Lose economies of scale – more assets needed eg. individual batteries, PV and thermal stores.
- More complex to integrate.
- Need fabric improvements to be efficient.

Dry electric systems

- Smart controls and scheduling can improve storage heating – potentially retrofittable.
- Need improved building fabric.

Gas central heating

- Remains the lowest cost solution.
- May be regulated out of new build but replacement remains challenging.
- Hydrogen or Biogas continue to be looked into.

Smart local energy systems

As we've already seen, smart local energy systems combine a range of energy technologies, including heat, electricity generation, energy storage and electric vehicle charging using smart digital technology in ways that allow for the benefits of integrated management of demand to be possible locally and nationally, rather than putting all the burden of adopting smart decarbonisation approaches on individual homes or businesses.

Heat pumps

Air source heat pumps extract heat from the air by compressing and expansion of a coolant, just like a fridge. They can be air to air or air to water with low and high water temperature versions. Under normal conditions they produce approximately 3kW of

heat for 1kW of energy input. Issues include icing and a significant drop in efficiency in cold weather. High temperature hot water systems that directly replace boilers are relatively large. Ideally, heat pumps are integrated with a sizable hot water store to allow most flexibility in operation. The most efficient heat pump systems are not a like for like replacement for typical gas heating systems, particularly combi boiler systems that produce instant hot water and have done away with hot water stores.

Ground source heat pumps work in the same way but extract heat from the ground. Ground temperatures are more constant than air temperatures, do not fall as far and there are no issues with icing.

Water source heat pumps work like ground source heat pumps but extract heat from larger bodies of water.

Water and ground source systems can use individual heat pumps but with shared ground or water loops.

Heat pumps can be integrated with gas heating to create hybrid systems that use carbon fuel only when needed. This does mean retaining the costs of two supporting infrastructure systems for the occasional use of the carbon fuel. Heat pumps can be used individually or to drive a communal system in a block of flats.

Electric heating

Storage heating: modern storage heating with smart controllers offers the opportunity for customised charging using smart tariffs. Controls can address the old problems of high heat in the mornings and cold at night resulting from overnight-only charging.

Infrared panel heaters: these can be installed on walls or ceilings and can be integrated into interior design as artwork or even mirrors. They work by directly heating the fabric of the building rather than heating the air, reducing issues such as condensation. Radiant heat can also feel warmer for occupants.

Low carbon gas

Hydrogen is sometime discussed as a potential replacement for natural gas and, in some instances, especially close to large industrial processes that will require a supply, this may be the right answer. Hydrogen is also one of the smallest and lightest gas molecules making it more prone to escaping, so significant work is going into the challenges of distributing it safely.

The ability to store it in large volumes for long periods also makes it an interesting fuel to provide energy security and resilience.

Hydrogen can be produced as green or blue flavours. Green hydrogen is usually produced from water by using a process called electrolysis, which uses electricity to break down water molecules. The main challenge is the efficiency of this process, which today is only close to 25%. Blue hydrogen is produced from fossil fuels such as natural gas and would require carbon capture and storage to be a truly low carbon fuel.

The inefficiency means that hydrogen might not be the ideal year-round fuel in most places.

What are the benefits of heat networks over individual heat pumps?

Heat networks have traditionally been based around boilers, Combined Heat and Power (CHP), using the heat from a gas engine and generator, but such systems have implications for air quality and are no longer favoured.

For example, Southend Hospital Trust operates combined heat and power and specialist heat networks on its site in the centre of Southend; Vital Energi runs heat network systems including those at Imperial College London.

The next generation of low carbon heat networks, such as those being developed for REMeDY, are more likely to use an electrically driven heat pump or heat recovered from an industrial process. So why not use individual heat pumps?

Individual heat pump systems often need significant changes to be suitable for efficient use. The most efficient heat pumps create lower temperature hot water and often benefit from significant heat storage capacity in the building fabric and through heat stores. Improving the fabric of buildings lowers the total energy needs but also creates 'thermal storage' so that electric heating can be better matched to the changes in renewable energy production.

High temperature heat pumps can also be much bigger than a combi-boiler and have both inside and outside elements, which requires much more space. Retrofitting individual heat pumps in every situation is not going to be straightforward.For new build properties it means compromises in design. In denser developments consideration has to be given to the space requirements of the external units and their visual and noise impact.

Heat networks can address some of these issues. Heat networks can also come in two variants:

High temperature heat networks use water at temperatures of 60-90°C and have compact 'heat interface' units in homes. They can provide instant hot water and use existing central heating systems. High temperature heat networks can use large efficient thermal stores to ensure efficient operation.

Low temperature heat networks circulate water at lower temperatures of 25-30°C and can be cheaper to build and maintain but need a form of heat pump and high temperature heat storage in each property.

High temp heat networks	Low temp heat networks
✓ Simple heat exchanger in each property	✓ Lower distribution losses
✓ Instant hot water – just like the combi boiler	✓ Cheaper pipework infrastructure
✓ Optimisation of communal demand	✓ Easier to integrate low grade heat sources
✗ Higher cost of heat distribution infrastructure	✗ Each property needs own heat pump and higher temp water storage – spaces needs and higher running costs

Heat networks can also be used to capture lower grade waste heat from other buildings, eg the output from air conditioning and heat from electricity transformers. They can be developed to link multiple heat generators together, starting to access the scale and synergies we've come to expect from our other energy networks.

Suitability of low carbon heat solutions

This table summarises the suitability of low carbon heating solutions for different types of residential housing.

	Individual heat pump	Individual direct electric	Communal heat pump run by management company	REMeDY smart local energy system
Flats – new build	Unsuited	Well suited	Suitable	Well suited
Flats – existing gas combi	Unsuited - need for water storage and space to install	Suitable – hot water store space potential issue	Suitable – depends on water loop temperature	Well suited
Terraced Housing	Suitable - hot water store space potential issue	Suitable - hot water store space potential issue	n/a	Suitable – depends on density of housing for network costs
Semi-detached housing	Suitable - hot water store space potential issue	Suitable - hot water store space potential issue	n/a	Suitable – depends on density of housing for network costs
Detached Housing	Well suited depending on fabric of building	Suitable	n/a	Suitable – depends on density of housing for network costs
Commercial	Suitable as part of air conditioning systems	Suitable depending on solutions	Suitable in new development If part of design	Suitable in new development If part of design

Complexity of low carbon heat solutions for social / mixed housing

This table provides further context for the complexity of introducing low carbon heating into social or mixed tenure housing.

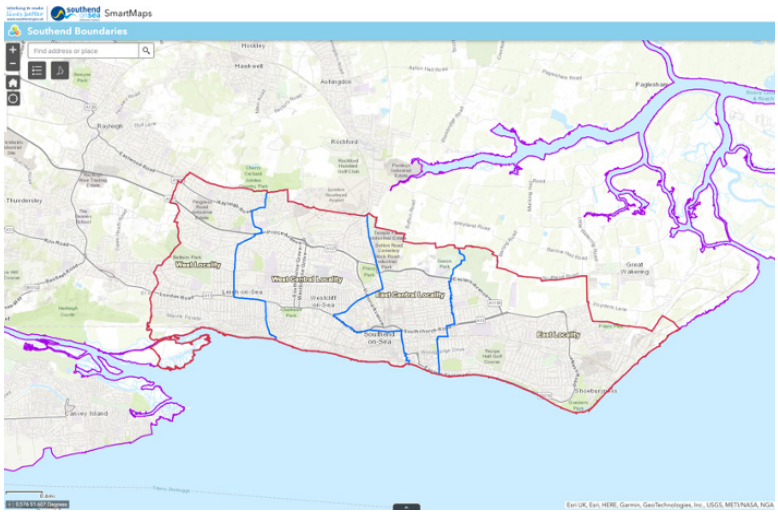
	Individual heat pump	Individual direct electric	Communal heat pump run by management company	REMeDY
Freeholder	Complex – siting and access	Simple – contained and responsibility of landlord / tenants	Complex additional systems	Complex agreements in place
Developer	Complex to design in efficient systems	Simple	Complex additional systems and contracts	Complex agreement but outsource complexity
Leaseholder	Complex access rights and responsibilities	Simple	Complex need to manage M&E contract – liabilities?	Long term responsibility with SLES provider
Landlord	Complex maintenance requirements	Simple – but may not be best for tenant – no cost risks	Complex relationship with tenant and management company	Simple – as with any other utility
Tenant	Needs heat stores and larger systems	Simple but potentially least efficient	Simple but liable for costs through maintenance charges	Simple heat interface unit and piping

New developments require a developer to choose and install a suitable heating system. Building standards usually drive the type of system selected. Electric heating is simple to install for developers but is likely to be the least efficient solution for residents, which may impact their bills later. Individual heat pumps are suitable for houses or small blocks, but communal heat pumps or REMeDY solutions are increasingly likely to be needed.

Landlords have different drivers, often linked to energy performance standards. This is particularly so for social landlords. In this instance, the cost effectiveness for tenants of heating solutions can be important. Low capital costs, maintenance and long-lasting equipment favour simple electric heat solutions. It is not common for landlords to supply heat and hot water. Regulations to protect customers limit the costs that can be included in charges for operational costs. Many landlords have also moved away from supplying energy as they do not want to take on additional debt risk. REMeDY solutions remove these risks from landlords.

Part 2: Southend and REMeDY – opportunities, engagement and net zero

The REMeDY project was invited by Southend City Council to explore the potential of smart local energy systems for the city. We looked at areas that might be suitable for REMeDY-style solutions and engaged with the local community around low carbon energy products and net zero more generally. Southend is a city of around 180,000 people on the northern side of the Thames Estuary in the county of Essex. Southend has, like many cities, strong ambitions relating to climate change, with its coastal locations increasing the relevance of many climate change impacts.

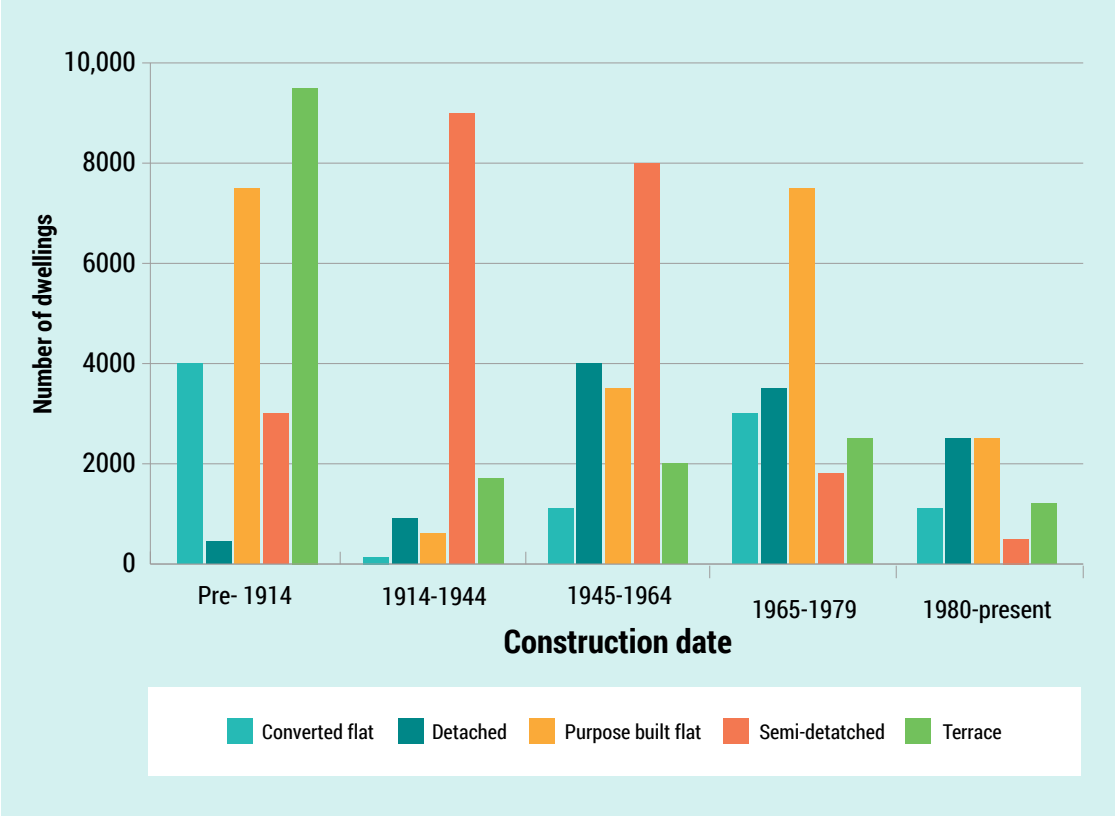


Population (http://www.visionofbritain.org.uk/unit/10056718/cube/TOT_POP)

Southend's housing stock

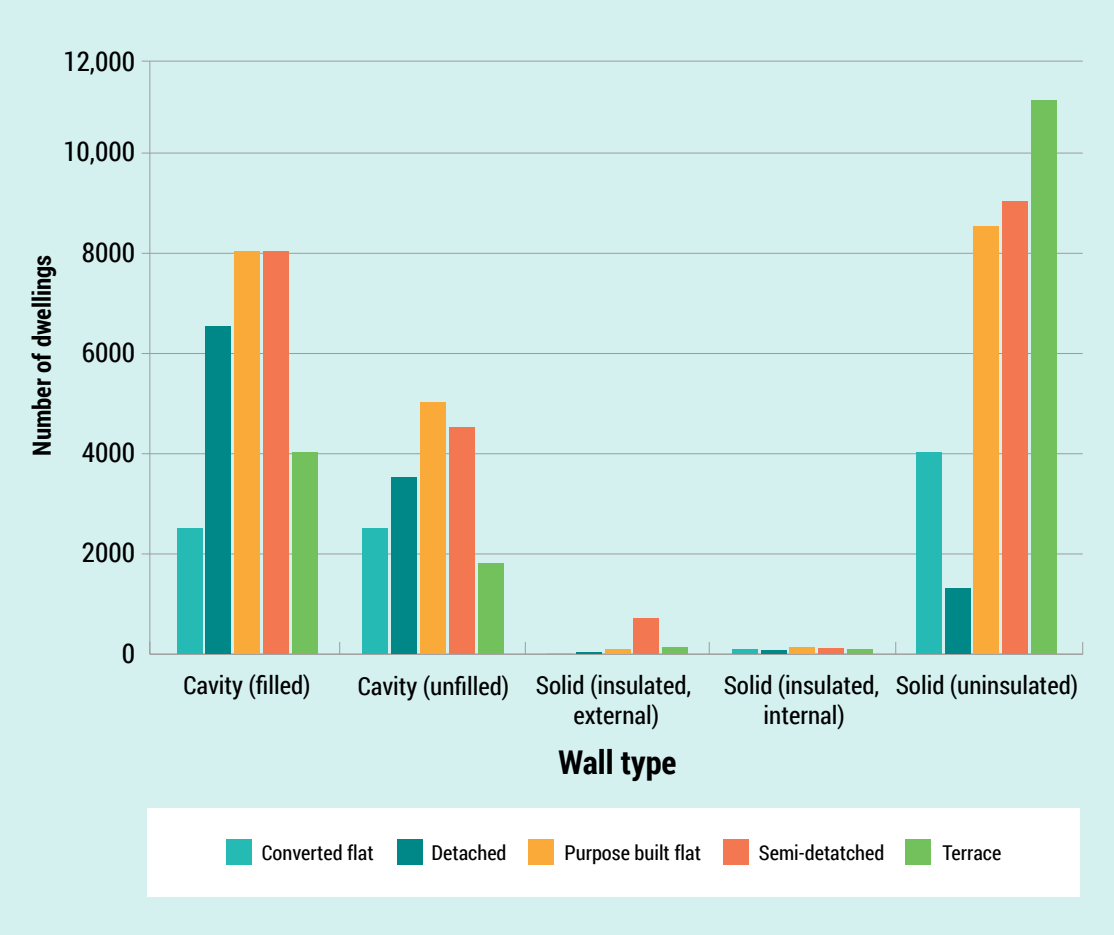
Railway arrived in Southend in 1856 and Shoeburyness in 1888 from London Fenchurch Street. The line to London Liverpool Street via Shenfield (and the link to the East Anglia main line) opened in 1889. The population grew rapidly after the railways linked Southend to London.

This has shaped the age and type of housing stock in Southend. Of the 80,000 of homes in Southend almost 70% are pre 1960 and only 10% built post 1980.



Source: Energy Systems Catapult Local Energy System Representation March 2020

This is important because the energy efficiency of housing has a significant impact on its energy needs, and the type of construction affects its energy efficiency, which affects the best low carbon heating solutions. In all climate mitigation scenarios, energy efficiency is a key component of ensuring societies can achieve their net zero targets.



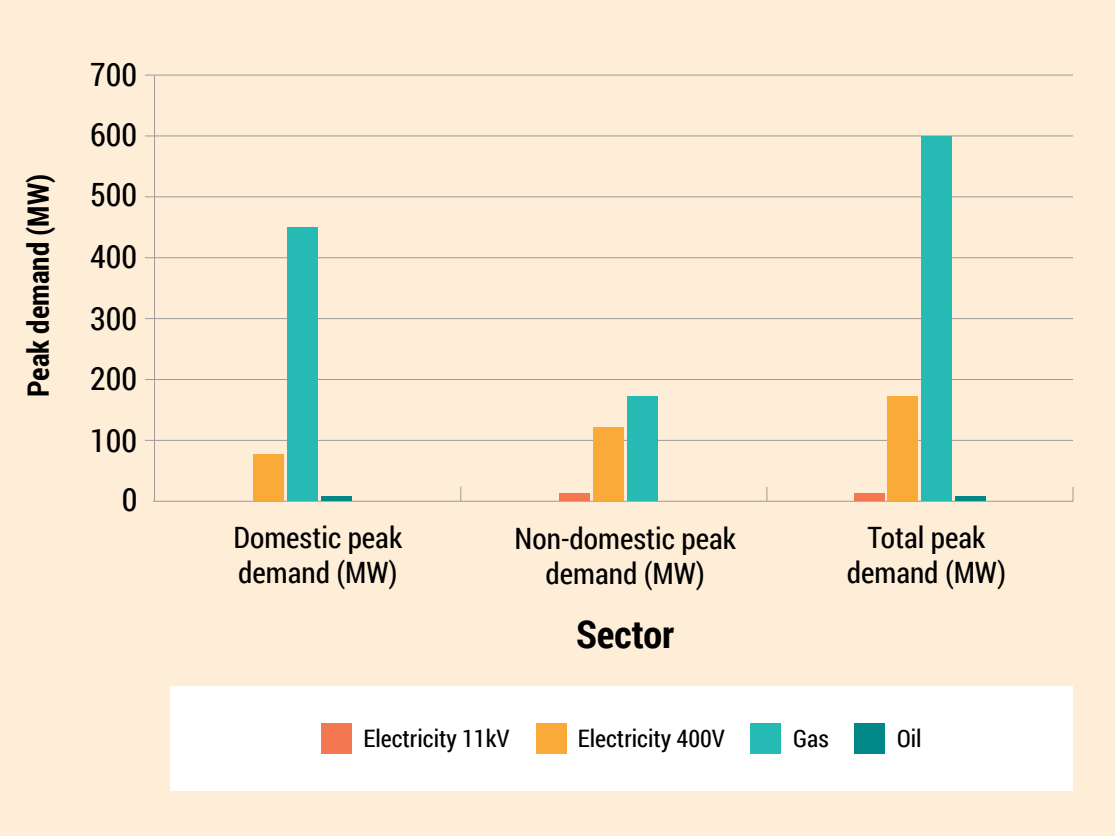
Source: Energy Systems Catapult Local Energy System Representation March 2020

The assessment of data available indicates that there are still significant numbers of properties with scope for improved insulation, although the vast majority of homes have double glazing. There are more than 40,000 uninsulated buildings in Southend, nearly half the total housing stock.

More than 90% of homes in Southend have gas central heating as their main heating system and almost 90% (173,000) of those are Energy Performance Certificate (EPC) D or worse, according to the data developed during the REMeDY project on the Southend carbon footprint. Of these, the EPC data indicates that around 50,000 do not have a potential EPC of C or better, making efficient upgrades to low carbon heat pump solutions challenging. However, REMeDY-style solutions may be well suited to providing flexible low carbon energy solutions in these areas, with their inherent energy storage offering some of the flexibility provided by thermal energy storage not able to be built into the fabric of these buildings.

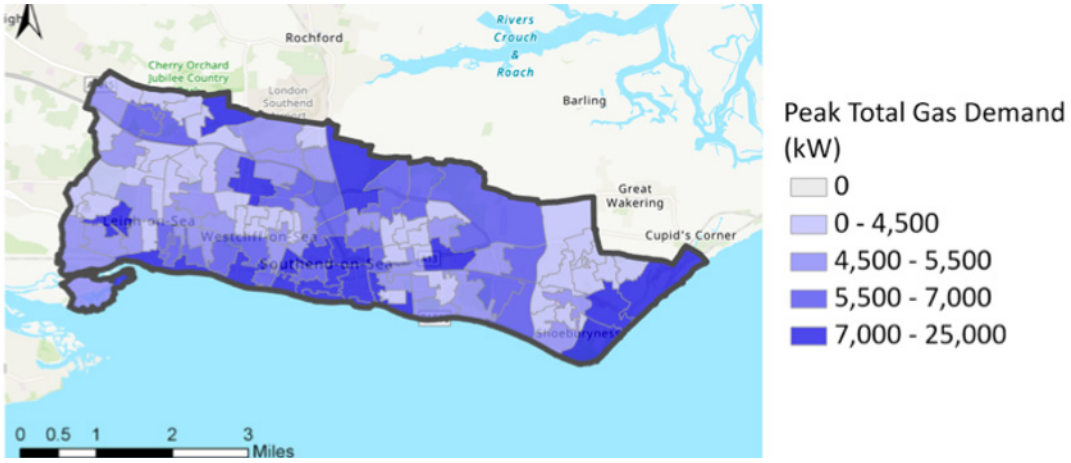
Southend has been given ambitious new housing growth targets, increasing from around 350 homes per annum to more than 1000 homes per annum in the next Local Plan, with 18,000 to 24,000 new homes over the next 20 years, together with an expected increase of 10,000 to 12,000 new jobs. Given the REMeDY project found that heat networks could be viable and suitable for new developments, the opportunity to apply REMeDY to these 24,000 homes is explored in later sections.

Southend's energy demand

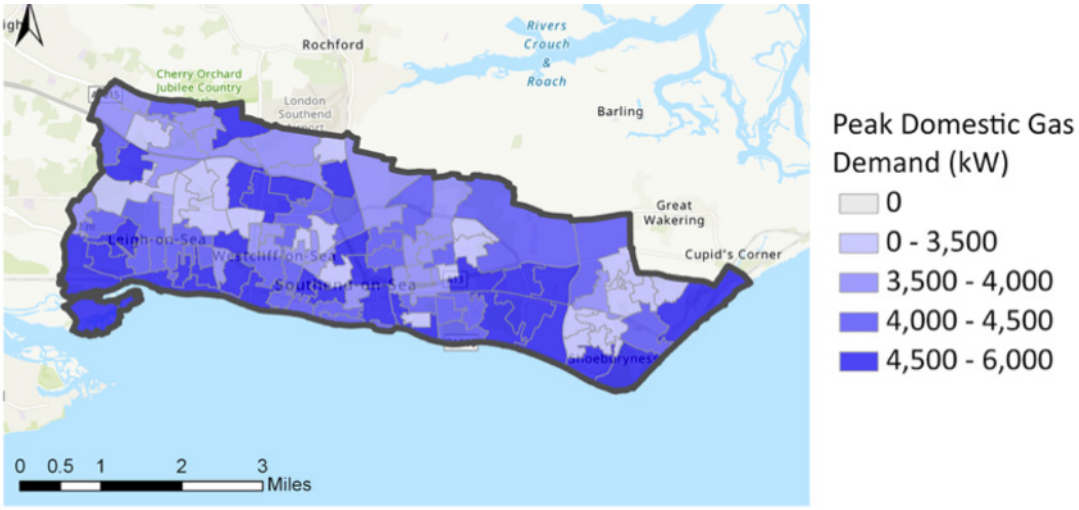


Source: Energy Systems Catapult Local Energy System Representation March 2020

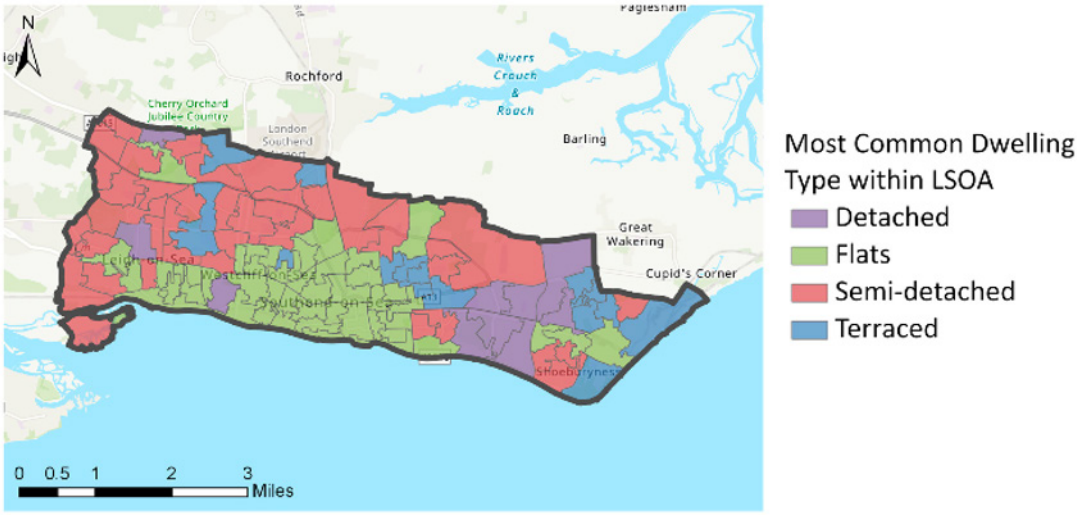
As with many places in the country, energy demand for gas is much higher than for electricity. Southend's peak energy demand from gas was determined to be around 600MW, compared to 170MW for its maximum electricity demand. Three quarters of this gas demand is from domestic consumers.



Source: Energy Systems Catapult Local Energy System Representation March 2020



Source: Energy Systems Catapult Local Energy System Representation March 2020

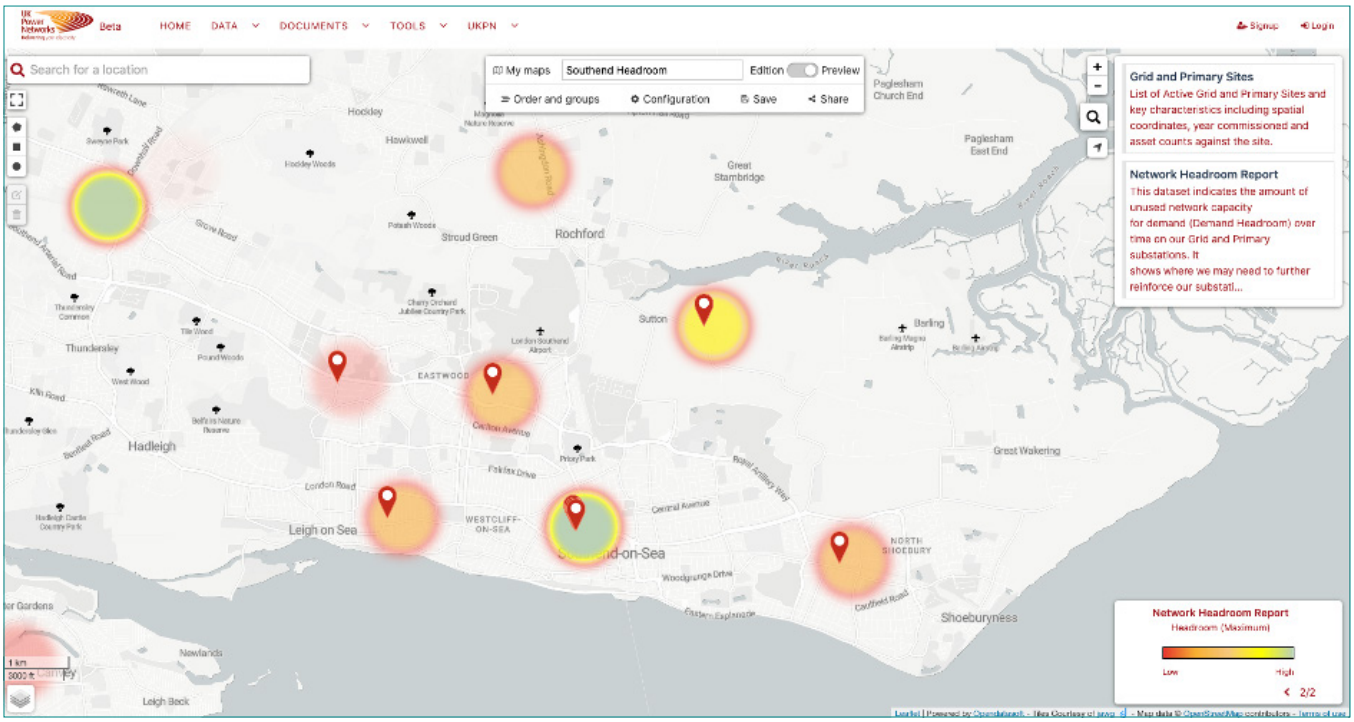


Source: Energy Systems Catapult Local Energy System Representation March 2020

While large detached housing is a significant contributor to demand, the assessments carried out by the REMeDY project for the carbon footprint indicated that flats account for up to 25% of residential gas emissions.

Southend's electricity supply

Southend's electricity supply system is owned and managed by UK Power Networks. Supplies are provided by five main supply substations within the city boundaries and one just outside.



Source: UK Power Networks Open Data Portal April 2022

Southend's maximum electricity demand is around 120MW with capacity in the main supply to accommodate further growth of around 70MW. The UK Power Networks headroom assessment indicates that by 2050 a further 50MW of capacity may be required in the higher demand growth scenarios.

These larger substations supply a further 500 smaller local substations that support supplies to most consumer premises. These local networks will require reinforcement to accommodate the conversion of an estimated 450MW of gas heating demand.

As part of the REMeDY project, Imperial College London has modelled the potential impact using assumptions in line with UK Power Networks forecasts. Its modelling suggests:

- Up to 50% of these substations may need reinforcement by 2035.
- Smart management of this demand could reduce the need for reinforcement by up to 70% by spreading out the demand over the day to maximise the use of the existing infrastructure.

Imperial College's analysis showed that using REMeDY type solutions produced savings against alternatives – and these increased with more widespread adoption – but the growth in electricity demand will be such that local grid upgrades will be needed.

The Imperial College modelling of the wider benefits of REMeDY local smart energy systems suggests that local grid capacity might enhance the ability of local flexible

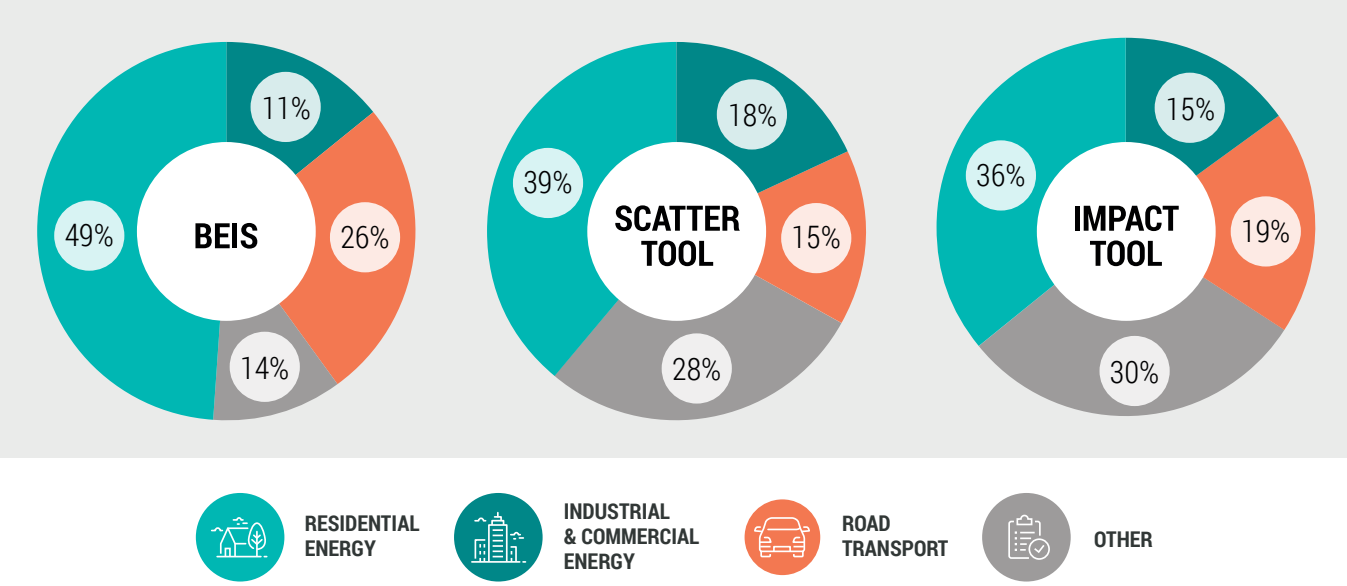
energy to use national intermittent resources, such as wind energy, more efficiently and that the wider benefits from a reduction in new renewable and energy storage capacity nationally may be more important than local benefits.

Instead of relying on coordinating thousands of individual heat pumps, the REMeDY concept takes the new demands away from existing infrastructure and centralises the smart management of the heat pumps with electricity and heat storage, so that customers continue to have on-demand heat and power without the complexities of smart control of their heating. Using REMeDY for new developments could provide the base demand for extending heat networks into adjacent areas where the housing is more suited to a heat network supply than individual heat pumps.

Southend's carbon footprint

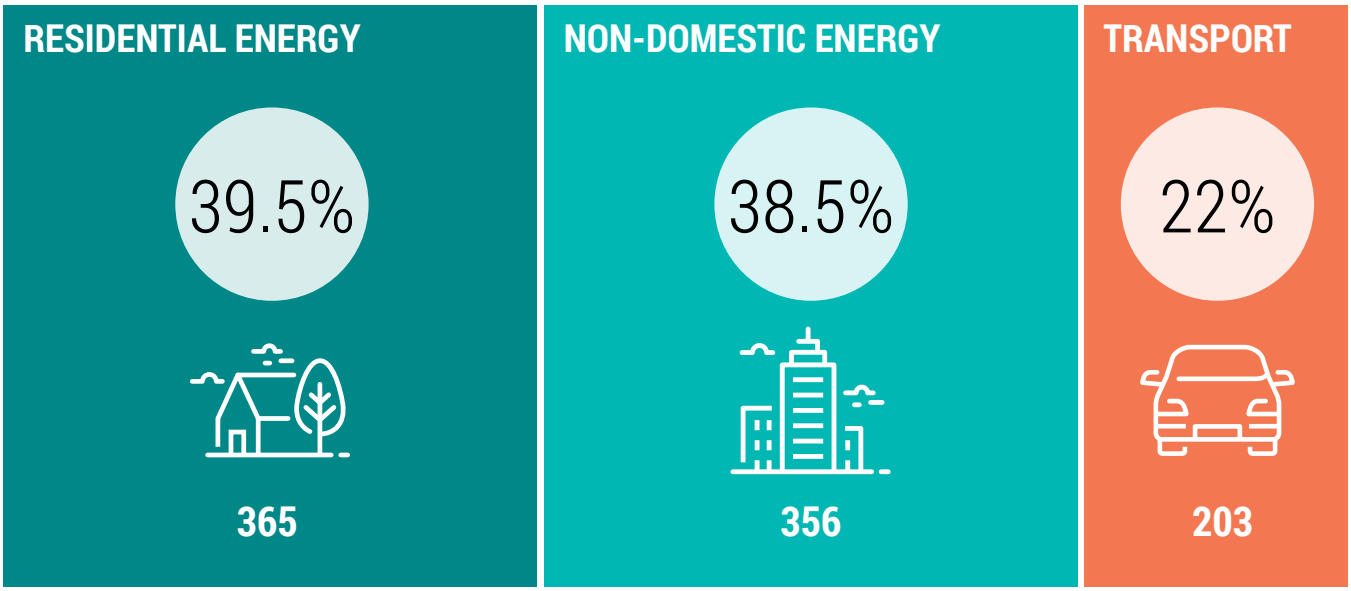
National estimates of Southend's carbon footprint (see figure below) indicate that around 50-60% of emissions come from residential and commercial energy usage.

Estimates of carbon emissions based on national data



As part of REMeDY, a more detailed bottom-up carbon footprint has been developed to provide a baseline for Southend's net zero ambitions and to help us understand where REMeDY smart local energy solutions might be most applicable. This was based on an extensive review of publicly available EPC data and transportation data. The data has been mapped and is already being used to understand where REMeDY is suitable and to plan retrofit strategies and pathways. More details on the methodology and detailed results can be found on Southend City Council's website.

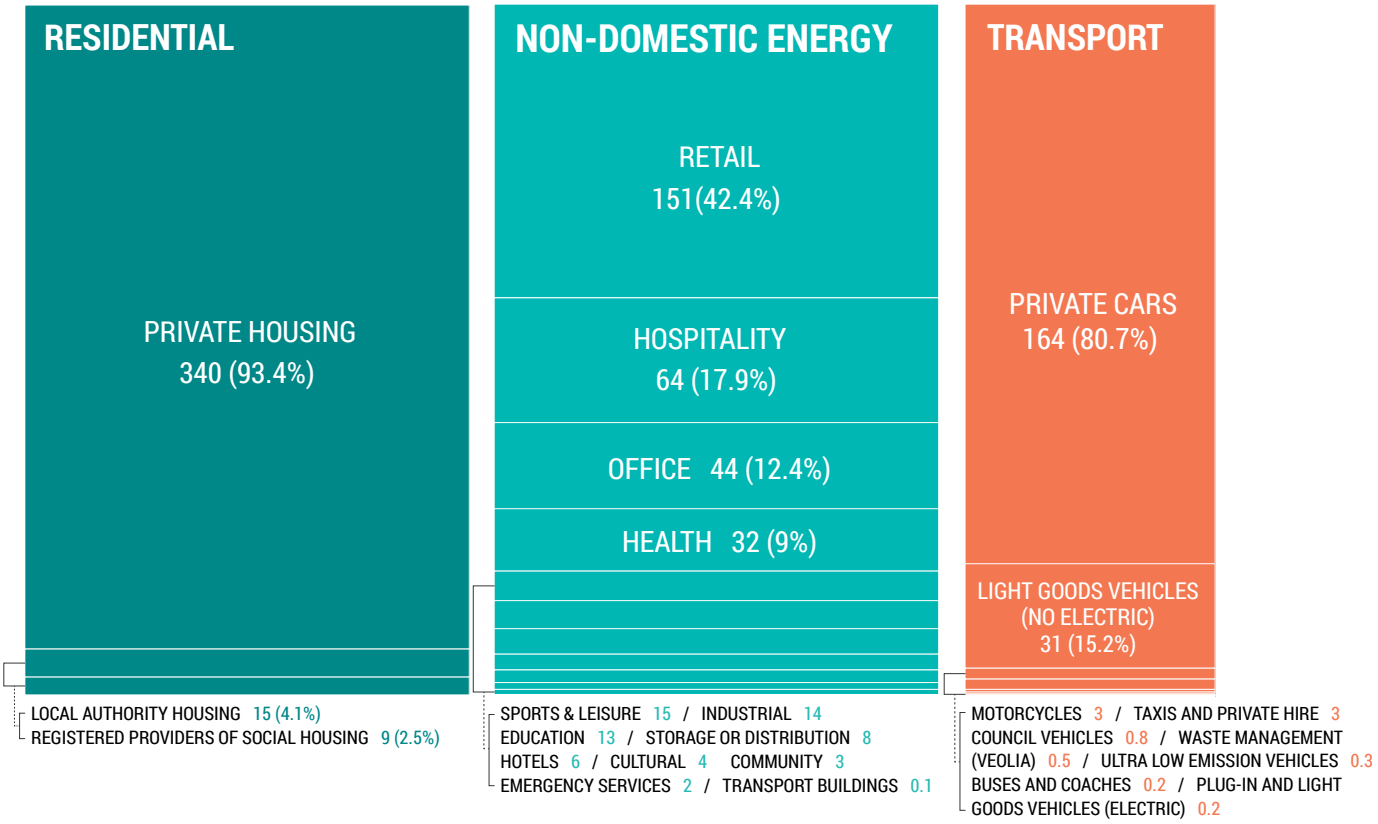
SOUTHEND ON SEA BOROUGH COUNCIL – EMISSIONS (000s tCO2)

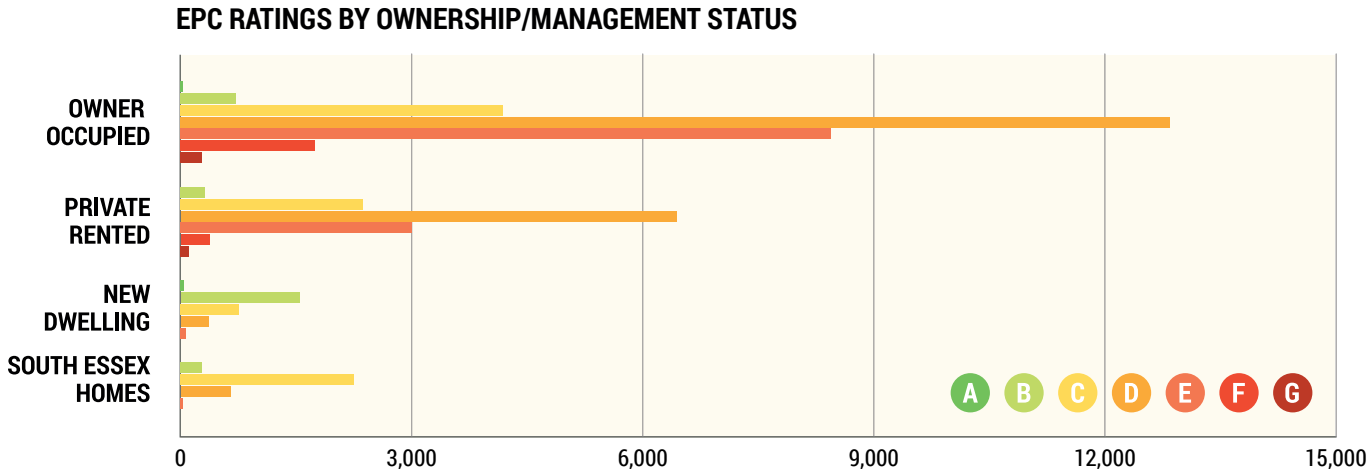


The bottom-up assessment estimates that residential and non-domestic emissions dominate, reflecting the service economy in the city. Residential and non-domestic emissions are more comparable in Southend, representing about 40% each of estimated emissions, with transport emissions representing the remaining impact.

Private housing represents one of the largest emissions areas. Around 75% of residential emissions were found to come from houses and bungalows, and 25% from flats.

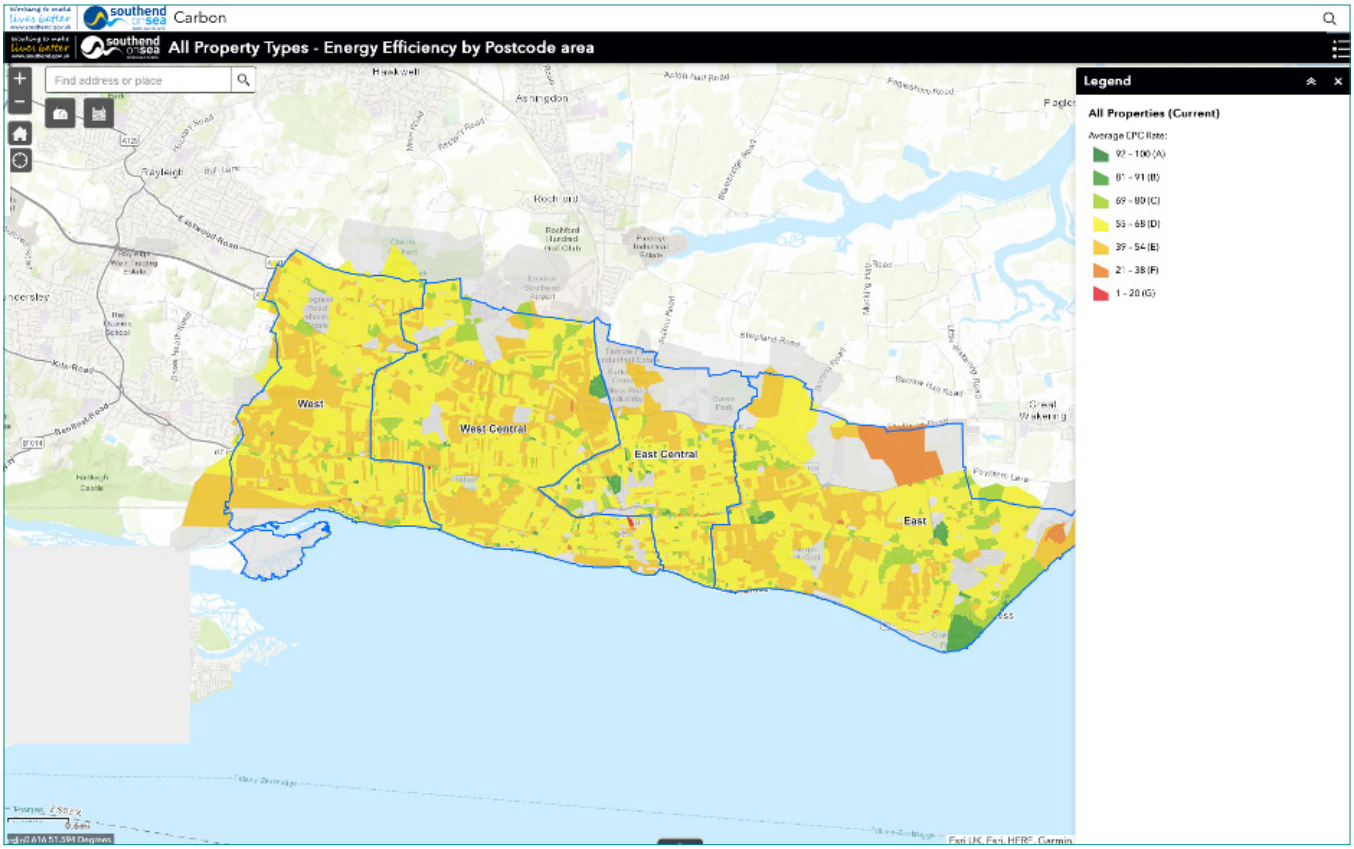
EMISSIONS (000s tCO2) SUBCATEGORIES



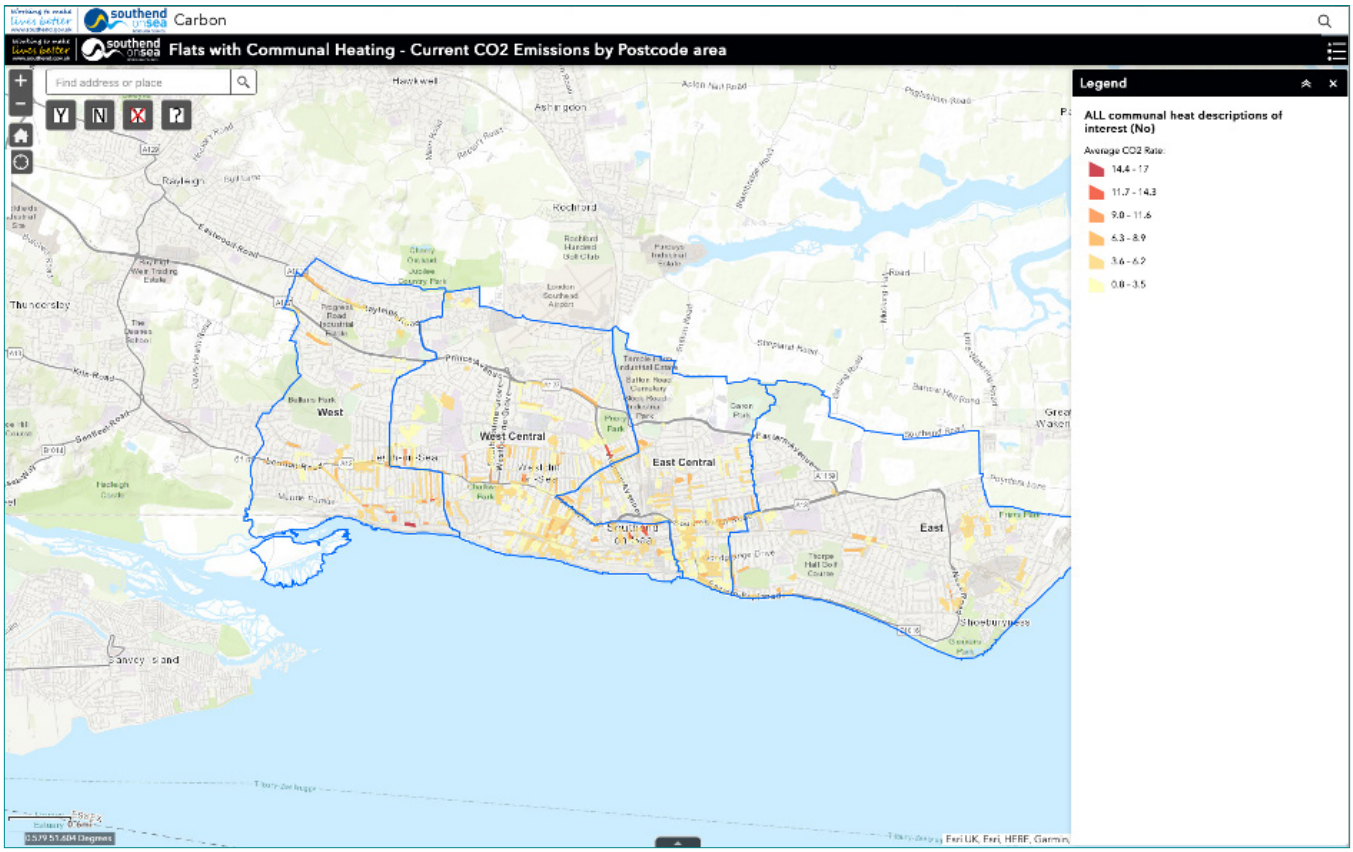


These estimates were developed from an analysis of the EPC data for the properties in Southend. This shows a significant number of EPC D, E and F rated properties especially among owner-occupied premises and significant numbers of D and E rated properties in private rented accommodation. As we described above, this does reflect the age and makeup of Southend's housing stock.

A detailed mapping programme has been undertaken with the help of Southend's digital team and these can be explored in depth on the Southend carbon website: https://carbon-southend.hub.arcgis.com/pages/residential-properties.



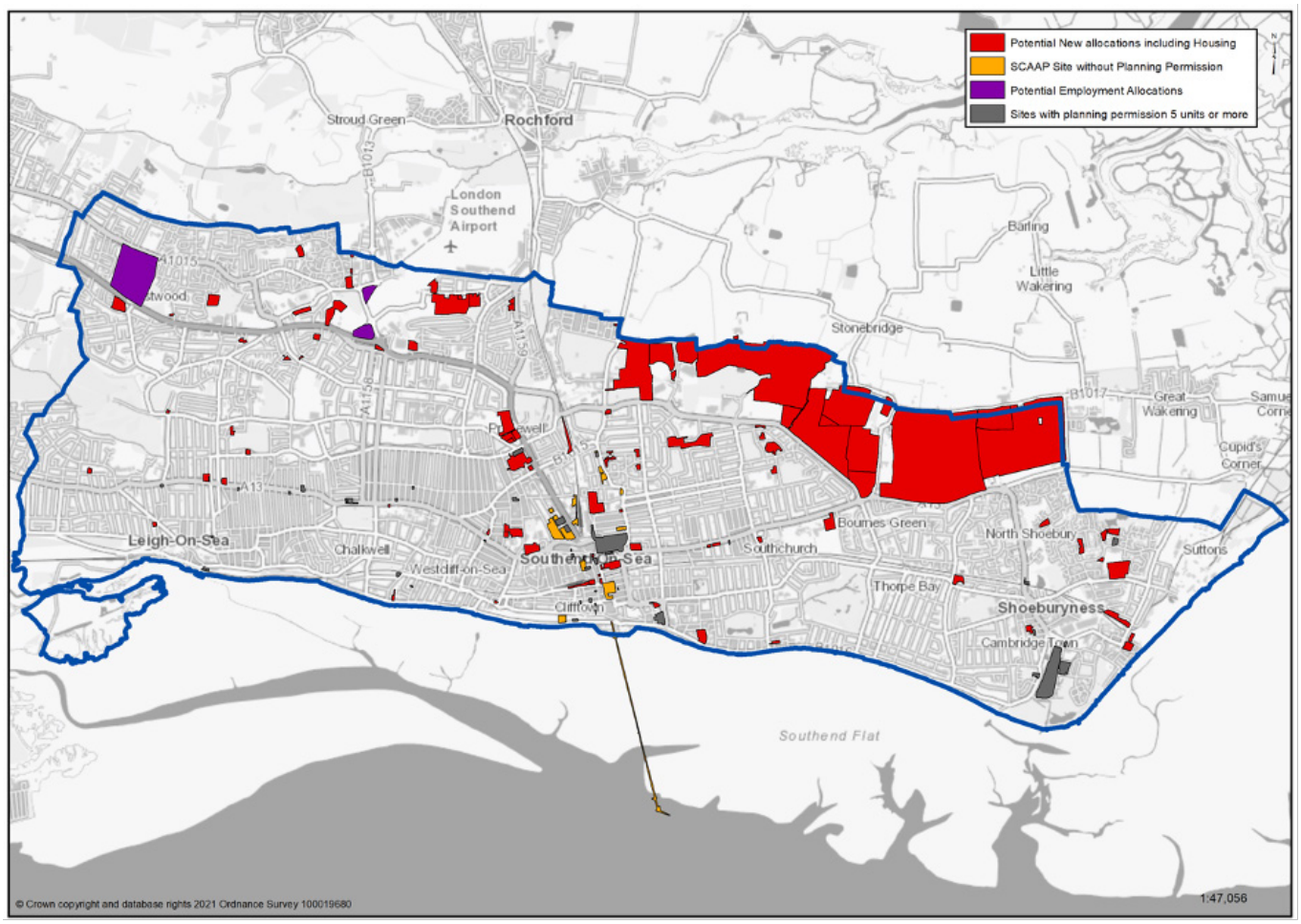
The carbon footprint exercise has identified a few areas, based on EPC data, where some form of communal heating is already in operation, possibly reflecting converted properties which contain multiple homes.



New development

Southend City Council is in the process of developing a new local plan at the time of writing.

Southend potential new housing and employment sites (five units or more)
https://localplan.southend.gov.uk/node/105 **Appendix 1**



The map of potential development sites shows the potential pressure for development along the northern boundary of Southend, which includes the Fossetts Farm site that has been considered as one of the REMeDY opportunity sites. Other areas of potential development are around the city centre and Shoeburyness areas, both also sites where the potential of REMeDY solutions has been investigated.

Areas of Southend that might be suitable for REMeDY-style solutions

REMeDY-style solutions are commercially viable to build in new developments today and could become the seeds of wider networks that bring together other large heat producers and consumers with their communities.

The identification of wider areas for heat networks needs the development of a local energy plan to complement the local development plan. This is a more complex task that needs to be undertaken with the input of infrastructure specialists, including electricity and heat specialists, and the communities affected.

As part of REMeDY, Imperial College London has carried out high-level assessments of the impact of adopting REMeDY type solutions. These show that a major benefit comes from the heat or thermal storage they include. This indicates that areas where there are properties that are not well suited to low carbon heating solutions that include thermal storage may be well suited to REMeDY type solutions. This includes areas with high densities of flats with gas heating (electrically heated flats will have some form of hot water tank).

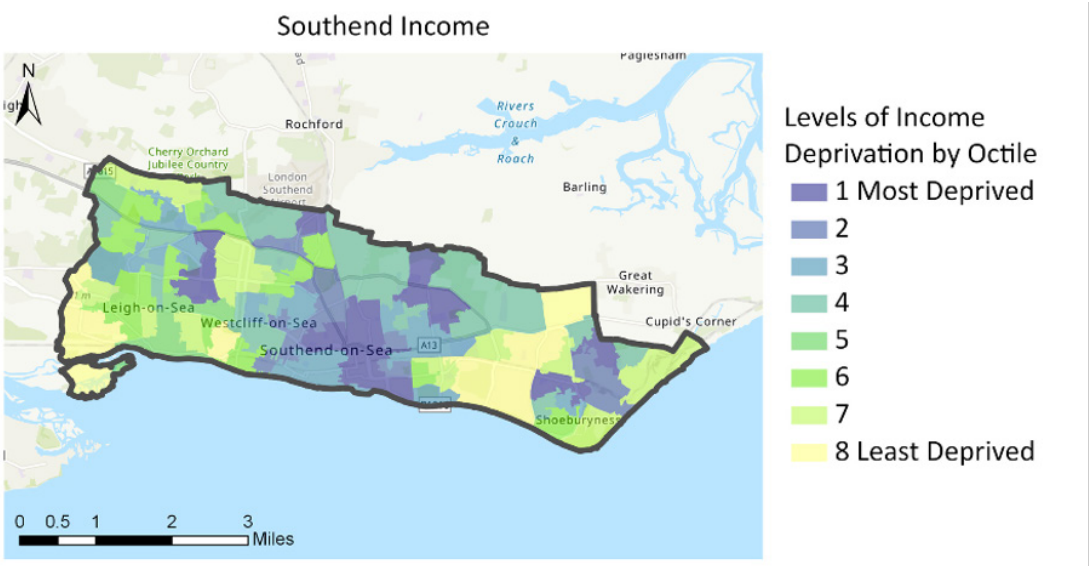
The map of potential development areas being consulted on for the next version of the Southend Local Plan shows two clear areas for consideration:

- The new developments along the north side of Southend between Southend and Shoeburyness
- Central Southend around the Better Queensway redevelopment areas

Central Southend and Westcliffe

The data discussed earlier highlights that the areas around the centre of Southend are mainly late 19th-century / early 20th-century properties converted to flats where there is still apparent high usage of gas for central heating, making it an area of high potential for a REMeDY type solution.

Westcliffe has the highest density housing in Southend at 45.7 homes per hectare, with Southend Central district being next highest at 36.8 homes per hectare. It is also an area of relatively high poverty, with the greatest number of low income households.



Source: Energy Systems Catapult Local Energy System Representation March 2020

REMeDY looked at two opportunities in central Southend, Better Queensway, a redevelopment site part owned by Southend City Council, and the Victoria Shopping Centre. The REMeDY project started too late to be included in the first phase of the Better Queensway development, but later phases of the Better Queensway development could consider a REMeDY type solution that could provide the basis of developing a heat-based smart local energy system.

Central Southend is also the location for the Southend Hospital which has large (albeit complex) heat needs and makes use of combined heat and power systems. The hospital has been identified in the Local Energy System Representation as one of the larger sources of emissions in Southend. The Victoria Shopping Centre retail units all had individual electric power supplies, which highlighted a number of commercial barriers to its use as an initial source of load around which to build a REMeDY-style solution.

Shoeburyness

Shoeburyness has areas of high gas usage for heating, a mix of older and mid 20th-century flats, including a significant number of homes owned by South Essex Homes (the arm's length management organisation that manages and maintains Southend's social housing stock). Shoeburyness also has a sizable school and leisure centre and is a significant industrial centre, but it has relatively low housing density compared to central Southend. It could therefore be another site suitable for the development of a heat network system, but would require significant planning and coordination, engagement with the community and development of the commercial and investment case.

REMeDY considered the social housing operated by South Essex Homes as one of the pipeline opportunities and identified that density, space for an energy centre and coordination with other major public institutions in the school and leisure centre were challenges that needed coordination and facilitation. Making a case for a REMeDY network would require detailed consideration of the timing of upgrades to the school and leisure centre's energy systems alongside the retrofit/upgrade or redevelopment of social housing to meet future needs, none of which are currently anticipated in the near future.

Developing a people-centred approach to the local energy transition

The decarbonisation journey, especially around energy, requires a framework for ongoing engagement. Many people suggest that a 'consumer-centric' approach to energy transitions is critical. As few people, either inside or outside Southend, are customers of a REMeDY solution, the project focused on a 'people-centred' approach, to understand attitudes to net zero transition overall.

The REMeDY project has engaged with communities around two aspects to develop an approach for ongoing engagement:

- Understanding consumer attitudes to energy products (undertaken by FutureGov).
- Understanding citizens' relationship to net zero and energy to inform the ongoing engagement on Southend's 2030 net zero target (undertaken by EnergyUnlocked for Southend City Council).

Research into consumer attitudes to energy products and services

The research carried out by FutureGov into energy products through REMeDY showed a wide range of needs and concerns shown below.

How do people choose between different energy providers and products today?

What motivates people to change their behaviours around energy use?

How do people respond to current SLES concepts?

1. People make choices based on domestic economics (spreading budgets and managing household use). However, most providers speak in market economic terms (kWh and tariffs) - at odds with how users see energy.
2. Second to budgeting, customer service & ease of use are essential criteria people use to choose between providers.
3. People have different needs and preferences at different life stages and want to be able to select the most suited option.
4. People are creatures of habit and comfort but can be open to change with the right prompts/incentives. When it comes to using energy, people are primarily motivated by cost and a sense duty to not be wasteful, rather than macro narratives around climate change.
5. While supportive of the idea of renewable energy, people have questions about the technical feasibility and cost of producing energy locally.
6. People appreciate smart technology's ability to automate certain tasks or present information, but are skeptical of blanket promises of automation.
7. Most people would be concerned when one company has an unchecked monopoly, especially if it's an unproven model.

Source: FutureGov

Our consumer research identified there is a real opportunity in designing services that meet consumer needs and build trust in energy services. Many smart energy systems emerge from technological solutions to building better energy low carbon energy systems, and there is an ongoing need to consider consumer needs and how these are met.

A significant challenge remains around engagement over the idea of a single supplier of an energy service; people remain unconvinced that a monopoly supplier would

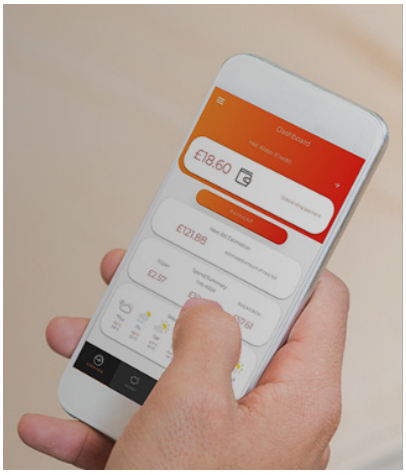
act in their best interests. Choice of energy supplier was found to be influenced by experience and recommendations from trusted parties such as friends and family. There were genuine concerns over how consumers would be protected given the lack of choice, especially in an unproven model. There are already 14,000 heat networks operating in the UK[1] and as greater familiarity and experience of heat networks is gained, attitudes will change. Ofgem has recently been appointed as the regulator for heat networks and we would expect more consistent standards and expectations to develop over time. REMeDY develops current best in class approaches to heat network provision.

People were not inclined to be wasteful with energy. However, there was some scepticism about the promises of automation and questions about the cost effectiveness of local energy production. REMeDY type solutions would integrate many of the automation issues for new low carbon demands in a way that would suit those not looking to manage complexity. It was only a small number of the people interviewed that were engaged and technically savvy enough to be interested in how they optimised their consumption.

Billing needs to give people control over their spending, either through direct debit, prepayment or the preference to pay for what they have used. It does not appear that a single energy service product is likely to be attractive. This is most likely to be an issue for retrofit solutions where customers are being persuaded to adopt the system as opposed to it being part of the property decision.

The REMeDY consortium partner Vital Energi already has smart flexible metering and billing systems[2] that integrate control of the heating when used with Vital heat interface unit.

Examples of Vital Energi's Glass app user interface



The original REMeDY solution would have integrated billing for heat and power, but this does not appear to be possible today in a way that allows the business model to scale widely.

These smart metering systems are important for social landlords in meeting their social obligations and if engaging resale of heat to tenants.

1 https://www.gov.uk/government/news/uk-government-announces-major-expansion-of-heat-networks-in-latest-step-to-power-homes-with-green-energy

2 https://www.vitalenergi.co.uk/glass-smart-app/

Engaging to understand how communities engage with net zero

Energy transition is a key part of achieving net zero, but technology adoption happens in the context of what residents and visitors (Southend is a major tourist destination with approximately seven million visitors per year) care about. Local energy systems like REMeDY need the engagement of their communities to be at their most effective and commercially viable.

We have seen through the projects assessed that they could provide a commercially viable alternative to individual low carbon heating solutions that addresses some of the challenges of individual solutions (space needs, upfront cost of change, ongoing maintenance, integration complexity to drive local benefits).

With a people-centred approach in mind, we carried out a wider engagement exercise to try to better understand where the communities in Southend are on the journey to net zero. The engagement started with internal city council workshops to prioritise the many ideas and suggested activities that could be undertaken by the city council. These ideas ranged from providing information in a dashboard to residents about carbon emissions impact in a 'town square,' through to job training, or providing digital carbon footprint apps. After sorting these ideas into strategies where the city council could either lead or support, a small number of engagement pilots were selected for further development.

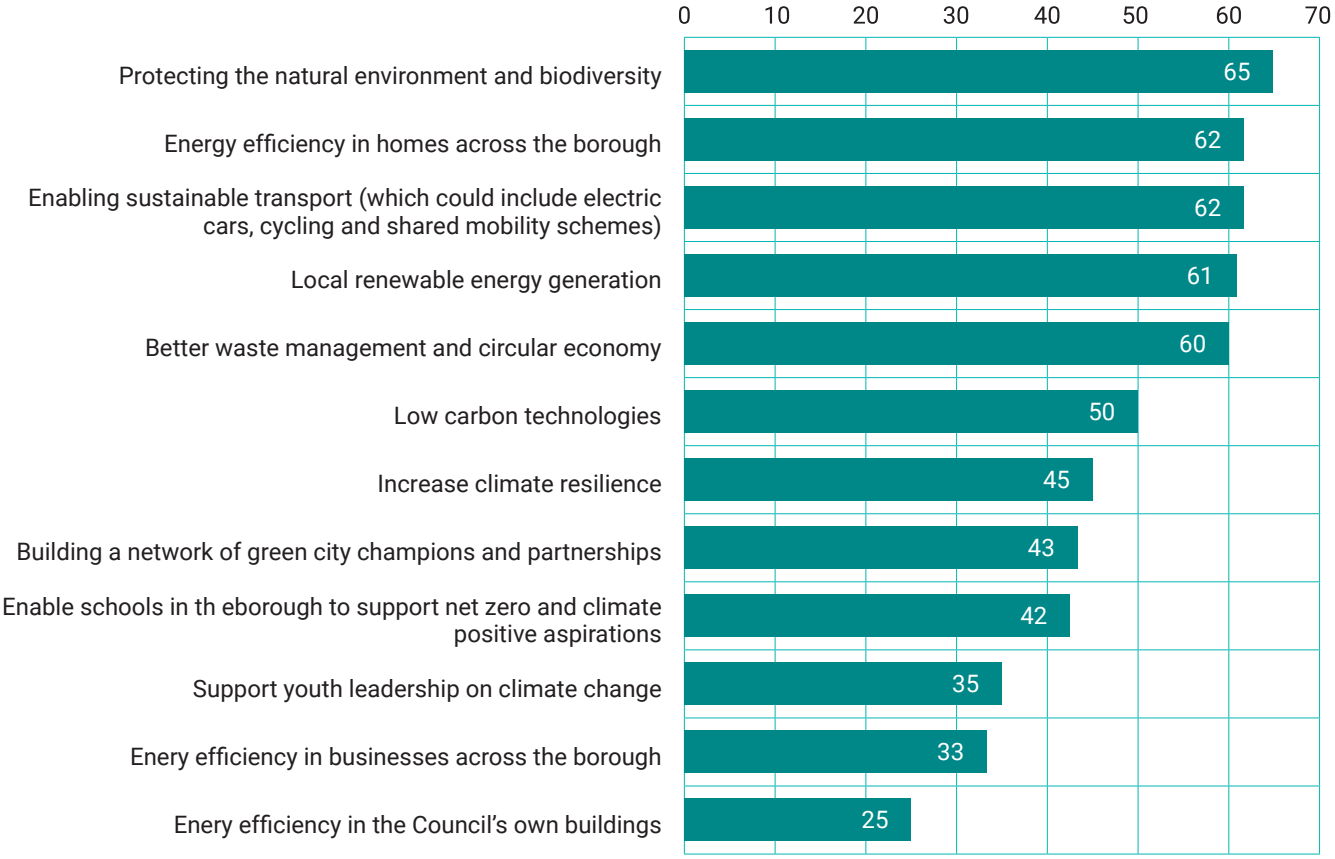
We also engaged with the voluntary sector to bring energy expertise into existing activities run by local organisations. By supporting organisations that are trusted in the community, the work done during REMeDY could have the potential to grow beyond the project. Finally, we ran pilot engagements that would provide evidence for the council to assess how to undertake people-centred engagement beyond the REMeDY project.

With this in mind, Southend City Council started an engagement process with residents of Southend-on-Sea, particularly concerning their views of climate change and smart local energy systems.

The questions in the survey were designed to reveal the respondent's general awareness and views on climate change, willingness to accept new technologies, ability to make changes to their homes, and invite further engagement with the council on the issue of climate.

In developing this survey, the team considered other local authority climate change surveys and the Department for Business, Energy and Industrial Strategy (BEIS) Public Attitude Survey questionnaire. Where BEIS questions were used, this was done in order to allow future comparisons with national results and potentially discover how the views of Southend residents and those across the UK change over time. The survey invited residents to participate and more than 100 people responded, but the sample was not representative, with those most interested replying.

Results showed that residents are concerned about energy but equally concerned about pollution and waste. The results of the survey provided one input into the design of the following pilot interventions: Ecodays, Net Zero Superheroes, Green Love Southend and Climate Hubs.



Ecodays

In partnership with local not for profit Trust Links, REMeDY hosted five energy and net zero related events with the public alongside a weekly programme of Ecodays events that included wider environmental themes ranging from food to fashion. During the course of the Ecodays, hundreds of residents were engaged on social media and a core group of 50 took part in the REMeDY project's Ecodays. The Ecodays highlighted that the complex information, opinions, experiences and rapid changes in technology and best practice have created a degree of confusion, uncertainty and anxiety for individuals and groups about the best approaches to reducing carbon footprints.

Trust Links have since gone on to find follow-on funding for Ecodays and will be able to continue to engage with the community as a result of the initial engagement with REMeDY.

Net Zero Superheroes

For 10 weeks in early 2022, a group of 30 residents participated in Net Zero Superheroes, where each week they had the option to spend 10 minutes to take action on net zero. Each week had a different theme, and two weeks were focused specifically on energy in the home and the electricity system. Residents were part of a WhatsApp group, website and social media engagement process that allowed them to take on mini 'missions'.

Each of these asked residents to do three things:

(1) Understand their current activities (what science would call a 'baseline').
(2) Take an action based on trusted advice from their peers or sources such as the Energy Savings Trust.
(3) Report back on their carbon impact.

A closing survey showed the majority would like to see the project continue.

Green Love Southend

In order to understand what residents expect from businesses and vice versa, and to provide businesses with a way to get involved in REMeDY, Green Love Southend was initially a two week process to provide expert guidance on waste and energy to the businesses, schools and voluntary sector organisations that signed up to participate. Twenty-three organisations participated. It showed that many were in the first stages of the journey to understanding their climate impact, with just a few already setting targets for reducing emissions. The businesses did not know that Southend had a net zero target and expressed interest in being part of a broader initiative that could support collaboration to achieve the council's goals. A subset of businesses elected to take part in energy workshops to understand their energy bills and the options they had for net zero and low carbon solutions. Ongoing work is providing detailed building modelling for 7-10 carefully selected buildings and what low carbon technologies will be applicable, which will inform the net zero strategy for Southend.

Climate Hub

Initiated during the REMeDY project, and continuing into the summer of 2022, the Southend Climate Hub is a physical space in Victoria Shopping Centre to provide a way for businesses, residents and voluntary organisations to convene and shape net zero action together. A programme is being developed where the City Council can run their own events, but they also can allow the community to use the space free of charge.

Several key insights emerged from the engagement about net zero.

Foster collaboration

Every actor in Southend has a role to play, and there is widespread interest in net zero. Businesses want to contribute and are finding ways to self-organise. The voluntary sector is creating discourse and community spaces. A lot of the simplest opportunities for impact have already been taken up.

Much of this activity is high quality, but it is not coordinated or centrally supported, so much of the effort being put into net zero is hard to measure in terms of quantified impact on CO2 emissions. Going further will require collaboration and coordination between multiple actors, often across sectors.

We have seen this challenge in the REMeDY pipeline too. Anyone trying to develop a smart local energy system must engage with local planning to understand the areas with development opportunities and with social housing, its contractors, developers, procurement teams to ensure that timely offers can be made. Complex coordination has a commercial cost, but also a societal one if complexity drives simple but poor choices.

Support trusted partners

We found community organisations were the most highly trusted on net zero issues. Some residents we engaged with were sceptical about the ability and willingness of authorities to implement the changes needed but would like to rely on a trusted authority for information and coordination.

Build capability in the community

Much more work is needed to help people develop the capability to understand the carbon impacts of choices they make in their lives.

Finding information and trusted sources was an important issue, with participants in the engagements often sharing tips and insights. There are important parallels with the research on energy products and the importance placed on personal experience and trusted relationships.

Support people to make change happen (agency)

Our engagements highlighted a concern that the right things might not be done even if they were well understood. Ensuring people have the support and opportunity to make changes they know will help is important.

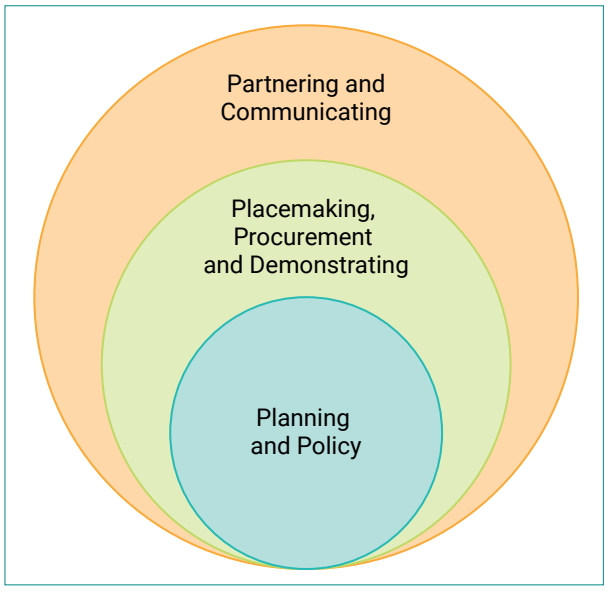
Southend City Council's role in future smart local energy systems development

Energy systems form a vital part of the complex infrastructure that underpins Southend and the changes needed to realise affordable energy for all require a wide range of organisations to act with common purpose, and each party to focus on what it can do best.

Local government strategies can fall into three main categories, illustrated below. First, they can direct their policy, planning and procurement decisions to take into account net zero targets.

Through projects like REMeDY, they can bring their own buildings into demonstration projects or providing physical spaces for people to meet and learn. Finally, they can join in with and enable the community through, for instance, partnerships or providing communications support to activities in the wider community.

Local authority strategy opportunities



Reducing barriers by reducing coordination costs

Early visibility and engagement is needed to lay the groundwork for REMeDY type solutions.

At Better Queensway, drivers to secure funding for the regeneration made adopting a REMeDY type solution impossible in the remaining timescales even though the merits were both evident and understood.

The existing role of spatial planning is clearly important in raising visibility of potential opportunities. The local spatial development plan could be developed to signpost opportunities.

Local Area Energy Planning may be needed to support evidence-based energy policy in local planning, but by identifying opportunities and then convening stakeholders, opportunities may emerge for collective action.

Southend City Council could enhance its role by adopting a convening role, through providing a point for businesses, property developers and energy developers in and around development areas to understand the wider opportunities and benefits before making their own decisions.

Actively convening organisations involved in Southend's development and energy transition could reduce perceived commercial conflicts of interest, identify short- and long-term opportunities, foster alignment and timing of investment, both accelerating and reducing the cost of change.

Supporting changes in attitudes

To support the engagement facilitation role above, the community must be engaged around the need to understand the energy challenge, the possible solutions and creating demand for the conversations.

This engagement doesn't need to be carried out by Southend City Council but, through its net zero mandate, it could create and support a singular area of focus.

Taking a lead

Having a Local Area Energy Plan could be a key element in being seen to take a leadership role and as a means of establishing an evidence base for informing the community about the options and choices. A Local Area Energy Plan needs to support the Local Plan and provide evidence for local policy choices, rather than being a development plan for specific infrastructure.

Southend does not have the capabilities to undertake this on its own and could work with adjacent local authorities and its energy system providers, as well as independent expert input. Southend does need to develop the capability to bring together the necessary multi-disciplinary technical, economic, social, policy, engagement and change expertise to support internal and external low carbon development.

Investing in heat networks requires careful consideration. These are significant investments, but REMeDY has demonstrated that they can, in new development and deep local regeneration, be attractive propositions for private investors. Southend has a pressing need to invest to provide social housing and it must balance its use of capital to provide the most community value.

REMeDY provides evidence to enable Southend to consider how it can create environmental, social and economic value for residents through attracting and stimulating investment in smart local energy systems by leveraging the opportunities that it explores at an early stage. The opportunity at Fossetts Farm was complex as the procurement process for the housing need had already progressed.

Southend also has an ongoing opportunity through the next phases of Better Queensway to actively consider a REMeDY solution and explore the opportunity in the wider area. These type of developments require significant investment, but REMeDY shows how it may be possible to reduce the investment requirements through bringing in specialist providers.

Part 3: how people and policy affect developing REMeDY smart local energy systems

Who is involved in making a smart local energy system happen?

We have identified a number of development personas that are important to understand as their drivers affect the development of projects.

Owner developer

The owner developer is seeking to develop property with long-term freehold ownership and operation of the property in mind.

Lifetime ownership costs are important as may the costs of services to tenants/ leaseholders, where they may be a part owner of assets such as combined heat and power systems.

One of the issues with landlords selling energy to tenants is that they can only recover the costs of energy in the resale costs (landlords resale regulations) making capital investment challenging for renewals and upgrades.

Commercial developer

Commercial developers are driven largely by financial drivers although within the constraints of planning requirements, building standards and client requirements.

Reduction in the amount of upfront investment is a key consideration. Independent network operators often part finance energy infrastructure on new developments. Developers want to maximise the opportunity for competition to drive down costs.

Freeholds are normally sold on to investors looking for stable returns driven by ground rents, underpinned by the freehold value and the leaseholds.

Operations and maintenance are usually made the responsibility of a corporate management company set up for the development.

Housing freeholder / investor

Freeholds are normally sold on to investors looking for stable returns driven by ground rents, underpinned by the freehold value and the leaseholds.

Simple commercial structures, where risks are understood and easily quantified are more likely to be preferable to commercial investors.

Operations and maintenance company

Contracts with these companies are established to manage common buildings and communal areas, funded by levies on tenants to cover the costs of operations (and potentially to provide a profit to the management company).

Housing operator / landlord - social housing

The social housing landlord provides 'social housing' to people who are eligible for affordable homes. They have a primary responsibility in addressing the ongoing shortage of affordable homes for those in most need. They do have an interest in ensuring tenants can acquire affordable energy, although most have stepped away from purchase and supply of energy for their tenants. They are investing in existing housing to improve the efficiency of homes where they have the funds to do so and meeting the Decent Homes Standard. Funding for energy and refurbishment is constrained by income, itself constrained by the need to provide affordable rents.

Housing operator / landlord – private housing

Many homes in Southend are owned privately and rented to tenants. They need a return on investment for the property they own, and would assess attractiveness of any REMeDY-style offer to prospective tenants based on cost to their operations and to tenants.

Smart local energy system developer / operators

Developing a smart local energy system needs significant upfront investment.

The energy project developer needs to be able to bring project management, delivery and ongoing operations into one organisation. The complexity of low carbon energy systems needs to be considered at the design stage, when the interplay between development costs and risks and ongoing costs, risks and benefits to owners and tenants needs to be balanced in the development of the business case.

The government has recently announced it intends to appoint Ofgem as the heat network regulator. This will lead to more consistent customer protections and service standards, but also bring experience of developing investment supportive commercial frameworks.

Local authority - planning

Local Development Plans and the consultation process establish local planning policies in line with national planning policy guidance.

Local authorities currently have no responsibilities and few powers regarding energy, but can include more specific policies on net zero requirements and environmental impact through suitably evidenced planning policies.

Southend City Council was interested in REMeDY because:

- As a developer and owner of property in the Victoria Shopping Centre and Better Queensway redevelopment, Southend could be a potential investor.
- As an owner and buyer of social housing through South Essex Homes it could be a customer of a REMeDY service.
- As the Local Planning Authority (LPA), it has a role in setting evidence-based planning policies affecting low carbon energy solutions.

These are three very different roles. A key output from the REMeDY project is learning about how the council can best use each of these roles to facilitate low carbon energy, and how to ensure that there is clarity about its role in its different engagements.

Local electricity utility

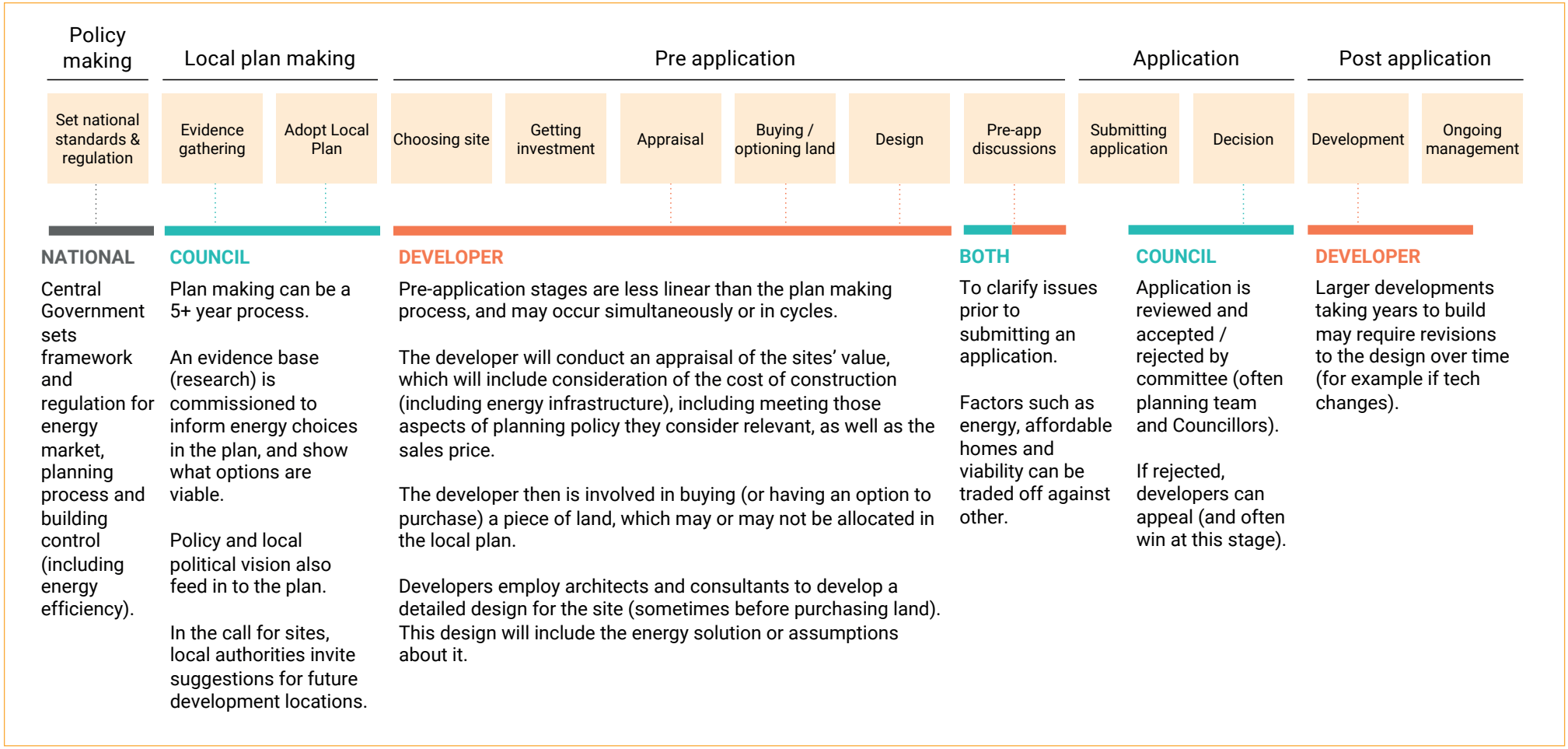
Local electricity network operators (either UK Power Networks or independent licenced network operators in new build developments) would provide connections. The REMeDY solutions could reduce the peak demands on electricity infrastructure and avoid potential reinforcement.

Where the control and flexibility offered by smart energy systems can help avoid or defer expenditure, there are emerging 'flexibility' markets that directly pass on some of the cost savings to those able to provide smart demand control.

However, if the development of REMeDY type systems just reduces the amount of investment needed in the energy system, there may be times where the developers of REMeDY systems are not directly rewarded by the local utilities or any of the energy markets, even though the total costs of the energy system end up lower.

The development journey

As part of the engagement work undertaken in REMeDY, the development journey for new construction was mapped as illustrated below:



Who influences the development of REMeDY solutions?

National policy

Energy issues in England, Scotland and Wales are managed by the UK government. National energy policy has many drivers including:

- Ensuring a resilient supply of energy.
- Ensuring the economic development of the British system to minimise costs to all (this is not necessarily the same as minimising individual or local costs).

Heat is an emerging energy policy area. There are around 14,000 small local heat networks operating in Great Britain.

Developing local heat networks will require more coordination and the government is considering how best to do this. There are strong synergies with local plan making, and also with the least cost development of local power infrastructure.

However, local area energy planning requires a wider range of skillsets not present in any one local body.

A number of areas of national policy are relevant:

- Energy market design and regulation affect how local smart energy systems can develop and, as they stand, limited REMeDY's ability to find synergies between domestic heat and electricity consumption in the optimisation of the local infrastructure.
- Heat policy will affect potential zoning for heat networks and licencing requirements which will define customer protection measures.
- Building standards drive energy efficiency of new buildings and the take up of low carbon systems.
- National legislation will ultimately affect the availability of gas to new build and eventually replacement heating systems.
- National Planning Policy Framework defines the limits of local planning requirements.

Local policy

Local authorities lead on planning matters and develop their local plans over extended periods of time. Local planning policy is guided by the National Planning Policy Framework, but local policies requiring the consideration of low carbon energy solutions and their contribution to wider net zero targets could be considered as part of local development plans. Development of specific local policies needs a strong local evidence base. REMeDY contributed to this by demonstrating that local REMeDY solutions could provide affordable and commercially viable approaches that should be considered by developers. The potential scale of economic provision across Southend need further detailed assessment as part of a Local Area Energy Plan exercise to support future local spatial development and transport plans.

Investors/owners

There are two funding phases to consider:

- Development: this has higher risks so is often funded by different organisations whose returns come from the sale of the finished buildings to their ultimate owners, which could be private freeholders, social housing associations, local authorities or even the residents.
- Ongoing ownership: commercial long-term ownership represents a lower risk investment that earns value through ground rent from leaseholders and increases in the value of the freehold. Operational costs are usually transferred to a management company that recovers costs from leaseholders.

Investors need to be familiar and comfortable with innovative solutions such as REMeDY. The attractiveness of REMeDY to potential ongoing investors is important. How REMeDY addresses risks is considered in the section on the benefits of REMeDY systems, but the development journeys explored also highlight that the additional complexity must be examined so that the developer and future owners will be comfortable with the arrangements.

It is worth noting that social housing can be owned or leased by the social housing landlord. If owned (or part owned) then social housing could play a significant role in adopting REMeDY solutions where they can help bring the benefits of complex smart energy systems to tenants who might be, or feel, less able to engage with smarter energy offerings.

Investors / owners of freeholds have significant power over the retrofit / refurbishment of energy systems

Property developers

For developers, understanding the development risks such as the impact on the timing of planning approval and construction timescales are important in ensuring they meet the expectations of those funding the development.

Energy solutions are largely driven by building standards and Standard Assessment Procedure (SAP) efficiency scores.

- SAP scores look at costs of running a property.
- Once individual gas is discounted, meeting SAP scores requires trade-offs between the physical building and the heating system.
- A more efficient heating system can be attractive if cheaper than engineering in fabric changes e.g. weight of triple glazing v double glazing has a cost in terms of the extra cost of the glass but also the weight that has to be engineered into the structure of the building – a more efficient heating system can offset these costs.
- Communal heat pump systems can be more efficient that individual systems and may become common as building standards improve.

Developers consider REMeDY against other options, including communal heat pump systems run by the building management company or direct electric heat and hot water.

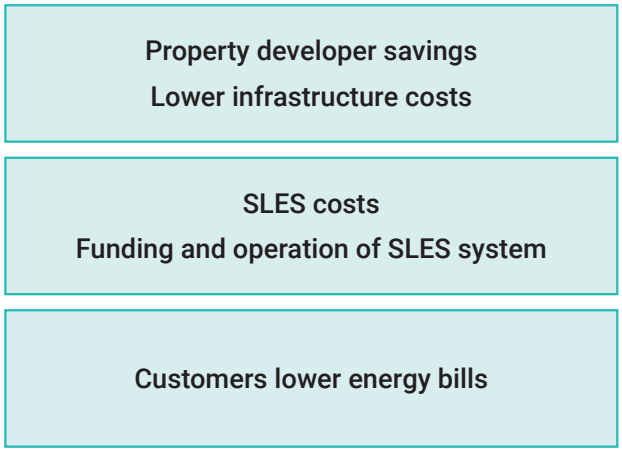
For a developer, a REMeDY solution could be seen to be:

- Simpler – a contract can be established with an expert who can manage the energy aspects of the development and provide long-term confidence to investors in freeholds and leaseholds.
- More complex – a different, more complex contractual framework is needed as there will be an energy system manager, a building management company and potentially a connection provider for domestic supplies to the local network (though this could be built by the energy system manager and transferred to the local network provider).
- Cheaper – if the energy system provider is funding or part funding the equipment this can reduce their upfront costs, depending on the solution they choose.
- More expensive – it is possible that less efficient solutions that meet regulatory requirements are cheaper to build/install even if more expensive to operate in the long term.

Developers have a high degree of power over the energy solution implemented in new developments.

Smart energy system developers

SMS and Vital Energy, which have devised the REMeDY approach, have developed a much greater understanding of the challenges of engaging and selling a solution and how to understand the value for each party in the development.



A key insight is that the value created has to be split three ways as shown below. The ability to make a proposal to developers that meet these objectives is key to making REMeDY systems commercially viable.

Leaseholders

The sale of leaseholds to individuals (directly or indirectly) or to social landlords is a major source of revenue for developers and is vital to their business case.

Energy solutions are only part of the decision but there needs to be confidence with the developer that the solution adopted can be sold.

The level of familiarity with smart energy solutions such as REMeDY could be a driver for their adoption or, alternatively, a lack of familiarity may make the adoption harder for a developer, even if they understand the benefits.

Larger 'anchor' leaseholders potentially have significant power over the solutions adopted, if they feel able to influence the design or solution.

Landlords

In most cases landlords are not engaged with providing energy to their tenants, although in one of the REMeDY opportunities energy with rent is part of the offering.

Landlords do have obligations to meet EPC ratings and therefore have more imperative to engage with the overall efficiency of housing than private leaseholders.

Solutions that involve collecting energy costs from tenants for energy are therefore unlikely to be attractive. REMeDY solutions where those risks are managed by the energy company are likely to be more attractive than ones where the liability could ultimately rest with the leaseholder rather than tenant.

Tenants

Tenants have limited power over their energy solutions. They may be accustomed to some degree of choice over supplier.

Providing energy to tenants has largely been avoided by landlords who want to avoid additional debt risk beyond rental debt. Energy resale regulations make funding energy investments through energy sales challenging.

Communities

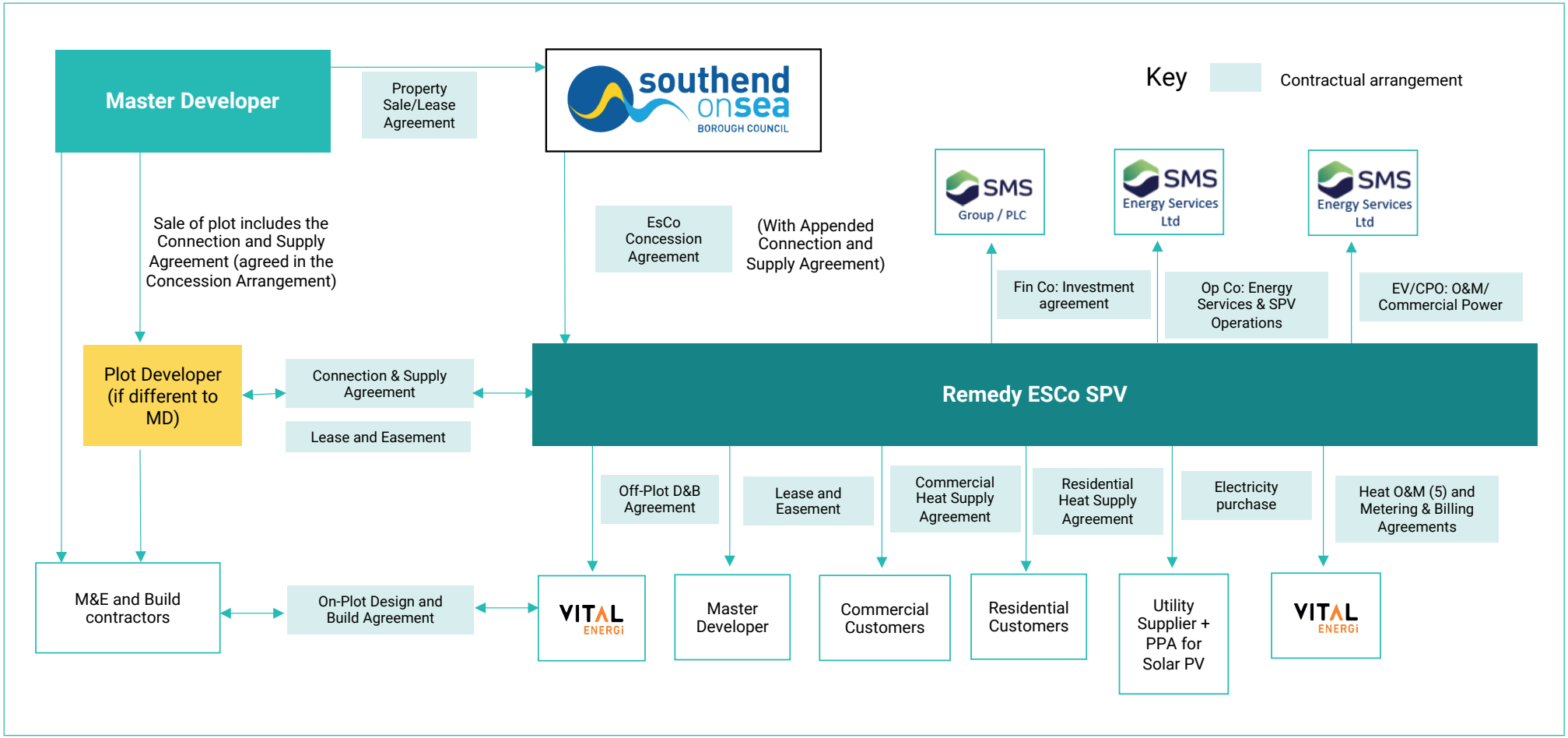
Communities have little direct influence over the development of energy in their local area and it currently forms a very limited part of local development plans. Network operators do carry out engagement as part of their planning and price controls, which is continually improving, but the development of heat networks does not readily fit within the governance of local communities.

Local Planning has little direct ability to mandate requirements and energy markets operate at a national level. Councils have variable levels of energy system expertise, but for most it is very limited.

The complexities of REMeDY

An issue with developers and their end clients may be the additional complexity of the commercial relationships in a REMeDY smart energy system. The complexity is illustrated in the following diagram:

Complexity of REMeDY contractual relationships



For the REMeDY consortium to have a concession to operate the heating system, agreements are needed with leaseholders, developers and building maintenance companies as well as the end users.

Agreements are needed with developers and construction partners during the development phase. These could be different agreements with different parties for different phases of the development.

The arrangements for the ongoing operation need to be included in all leasehold or freehold agreements that the developers make with those to whom they sell the development. These include agreements for any energy centres, heat and power distribution sites, cables and pipework.

The REMeDY energy supply company itself has agreements between the expert providers of different parts of the system including heat, electricity distribution, solar generation and electricity storage.

The REMeDY consortium then needs agreements with end customers for the provision of energy services, heat, commercial electricity and potentially other services including EV charging. There will also need to be contracts for the purchase and sale of energy with the wider grid system through an energy supplier.

REMeDY pipeline case studies

Our communities are all different and we wanted REMeDY to be as widely applicable as possible. In exploring real commercial possibilities we have developed a number of case studies or archetypes.

These case studies, summarised in this table and expanded below, allow us to consider the benefits and challenges of developing local energy systems.

Development type	Description	Pipeline projects
New build build housing owner/developer – high density	• New or replacement property built with long-term ownership/operation by one or more of the development partnership.	Better Queensway
New build housing commercial developer – high density	• New or replacement property. • Developer funds the development and development risk with cost recouped on completion through sale of leases and freehold. • Predominantly commercial investors.	Fossetts Farm
New build housing commercial developer – low density	• New or replacement property. • Developer funds the development and development risk with cost recouped on completion through sale of leases and freehold. • High proportion of Freehold to private buyers.	Banks Eggborough
Commercial development / redevelopment	• New or replacement property. • Developer funds the development and development risk with cost recouped on completion through sale of leases and freehold. • Predominantly commercial investors.	Victoria Shopping Centre PlaceFirst
Existing refurbish/ retrofit	• Replacing existing high carbon heating with low carbon solutions. • Might need to discuss other non-REMeDY options including: • Individual ASHP • GSHP shared heat loops • IR Panel heaters • Smart control of Storage Heaters and • Hot Water – can't be a treatise on low carbon heat	South Essex Homes, Shoeburyness, Places for People (Chorley Newcastle)

New build - housing

REMeDY solutions look commercially viable when compared to developments using other similarly efficient low carbon solutions and can be designed to offer lower cost solutions to the residents. Viable proposals have been made for the high density Fossetts Farm in Southend and lower density Placefirst development in Eggborough, indicating that REMeDY solutions could support many of Southend's new build needs.

The opportunity at Fossetts Farm was complex as the procurement process for the housing need had already progressed. This left the ultimate decisions on the technology adopted in the hands of the commercial developer with the leaseholders of the development, including Southend City Council, having no direct say in the solution presented to them. This may make simpler, less smart, direct electric heat solutions more attractive.

At Eggborough, the engagement was early enough that the benefits of incorporating a REMeDY style solution could be fully considered by the developer. There remain challenges over the provision and funding of a REMeDY solution where the demand growth is phased over many years and returns are good but cash flow takes many years to pay back the initial investment.

Refurbishment – commercial

The Victoria Shopping Centre in Southend, along with the Better Queensway residential developments, were considered as potential anchor developments as Southend Council had interests in both.

The complexities of the commercial relationships at Victoria Shopping Centre (which arose through individual commercial leaseholders having a mix of contractual arrangements, each retail unit having its own electricity supply and relatively low heat demand due to prevalence of electric air conditioning) made a REMeDY solution unviable to progress. This highlighted the complexity of engaging existing commercial leaseholders and also the different relationships that commercial leaseholders have with landlords compared to residential tenants.

The Placefirst project in Bolton contrasted in that it was a mixed, ground-up development with no existing leaseholders. In this situation it is possible to more easily integrate domestic and commercial heat demand into a REMeDY smart energy system.

Refurbishment – domestic

Residential refurbishment pipeline projects highlighted the need for strategic coordination and planning. REMeDY solutions need to be considered alongside alternative options for decarbonisation of heating suppliers. In this instance, the trade-offs between individual heat pump sizing and storage against smart energy system design can realistically be made, with landlords able to consider the impact of levels of building retrofit or redevelopment costs in the overall decision.

Bringing in wider community engagement in the process and sizing development of smart local energy systems to integrate with local electricity network development and other potential users needs planning and coordination.

Part 4: the benefits and challenges of developing REMeDY smart local energy systems

The benefits of REMeDY type solutions

The REMeDY solution addresses some of the key concerns with deploying smart local energy systems among potential developers and end users.

Our project research suggests one of these significant concerns is the reputational risk of a smart local energy system scheme not working effectively, especially for a social landlord. This would have an impact on tenants, and particularly in the case of local authority owned social housing, an impact on wider net zero credibility.

Other concerns and barriers to contracting these novel smart local energy system designs include:

- Who is responsible for designing and installing the equipment?
- What is the lifespan of the equipment, what happens at the end of its working life?
- Who maintains the plant and who will pay for this?
- Who guarantee plant performance/availability, and what happens if there's a fault?
- Who liaises with end users (tenants) if there is a problem or queries?
- Who carries the energy market risk if prices increase?
- Who carries the consumer debt risk if end-users fall into arrears?
- Who ensures the end users/tenants are getting a fair deal on their energy?

Risk		Design and build	Design, build + operate, maintain	Design, build + operate, maintain + lifecycle	Design, build, operate, maintain, lifecycle, ESCo
Design	Designer to meet developer requirements				
	Design works				
	Compliance with standards and regulations				
Build	Labour, material and sub-contractor costs				
	Construction cost				
	Build programme				
	System achieves performance specification				
Energy centre and network asset operations	Operationg labour				
	Cost and avialability of consumables				
	Compliance with emission targets				
Metering and billing	Consumption data collection				
	Credit billing				
	Payment collections				
	Debt management				
Planned preventative maintenance	Planned maintenance labour				
	Cost of parts for planned maintenance				
	Cost of specialist sub-contracts				
Reactive maintenance	Help desk / 1st response call out and diagnosis				
	Cost of labour and parts for reactive maintenance				
	Cost of specialist sub-contracts				
Life-cyle repair and replacement	Premature failure, repair costs				
	Replacement costs				
Performance	Plant efficiency				
	Network heat losses				
Energy price	Value of electricity export				
	Cost of electricity import				

Retained risks

Transferred risks

REMeDY

Shared

REMeDY type solutions, as with most larger energy systems, create advantages through:

- **Better integration:** rather than trying to integrate and optimise hundreds (if not thousands) of individual heaters and storage devices against individual usage patterns, a REMeDY smart local energy system creates centralised storage and control, and can integrate multiple heat technologies (eg the Eggbrorough case study has considered a mix of ground and air source heat).
- **Economies of scale:** larger more efficient heat pumps, improved storage systems with lower cost per unit.
- **Simpler offering**: while energy as a service offerings are possible there are significant complexities in smart energy solutions.
- **Reducing the risk** that smart synergies are not achieved from the integration of multiple individual systems.

	New Build	Retrofit
+	• Scale • Ability to design in space for energy centre • Less space taken in each property for air-source heat pump and heat storage • Savings possible against individual air-source heat pumps • Building Regs post 2025 making central systems more attractive - Particularly attractive if energy supply part of rental offering	• Heat interface units are small like boilers • No need to find space for hot water storage, batteries • Avoids space location issues for heat pumps and storage for individual properties in blocks / terraces • Lower maintenance than individual heat pump - Economies of scale – lower costs per kW and more efficient heat pump and storage systems
-	• More complex contractual framework needs early engagement • More capital intensive than direct electric heating (if potentially cheaper for residents) • Space for energy centre • Commercial energy contracts often at group level	• Space needed for energy centre • Scale and density needed to make commercial proposition for heat network development

It is possible, using modern technology, to control and manage a large number of individual devices to achieve similar ends to the REMeDY smart local energy system and, indeed, other projects have considered how such technology can be managed.

Potential cost savings of REMeDY solutions

Based on the potentially viable projects REMeDY considered, a solution would cost between £10-20 million to build and around £500,000 per annum to operate and maintain.

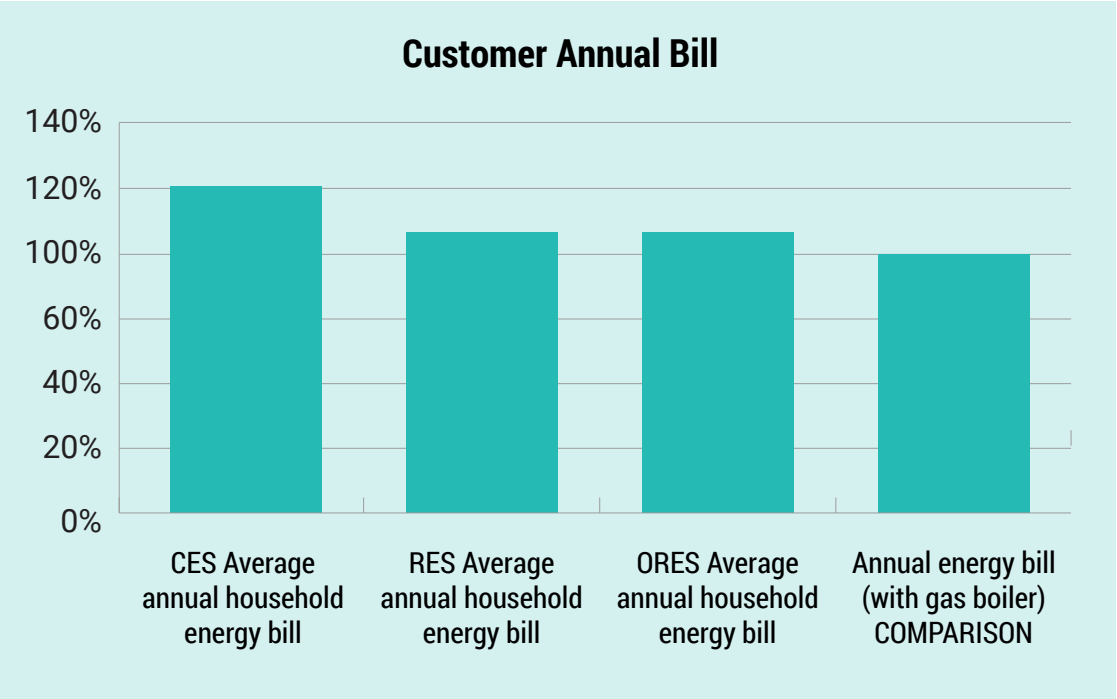
The pipeline has demonstrated that the upfront investment costs for a developer of a REMeDY solution can be comparable for a new development to the costs of air sourced heat pumps.

The pipeline projects were developed and designed to balance the benefits to users and developers.

The University of East Anglia worked with REMeDY to look at smarter ways to optimise the scale and operation of the combination of heat pump, thermal and battery storage.

Using historical 'normal' costs (based on 'normal'[3] prices between 2019 and 2021) for energy, it was estimated that, compared to a communal heat pump solution at Fossetts Farm, a saving of 11% on a customer's annual bill was possible with REMeDY solutions, although it would still be 10% more than the cost of gas (although there are other reasons gas would not be viable in a high density development).

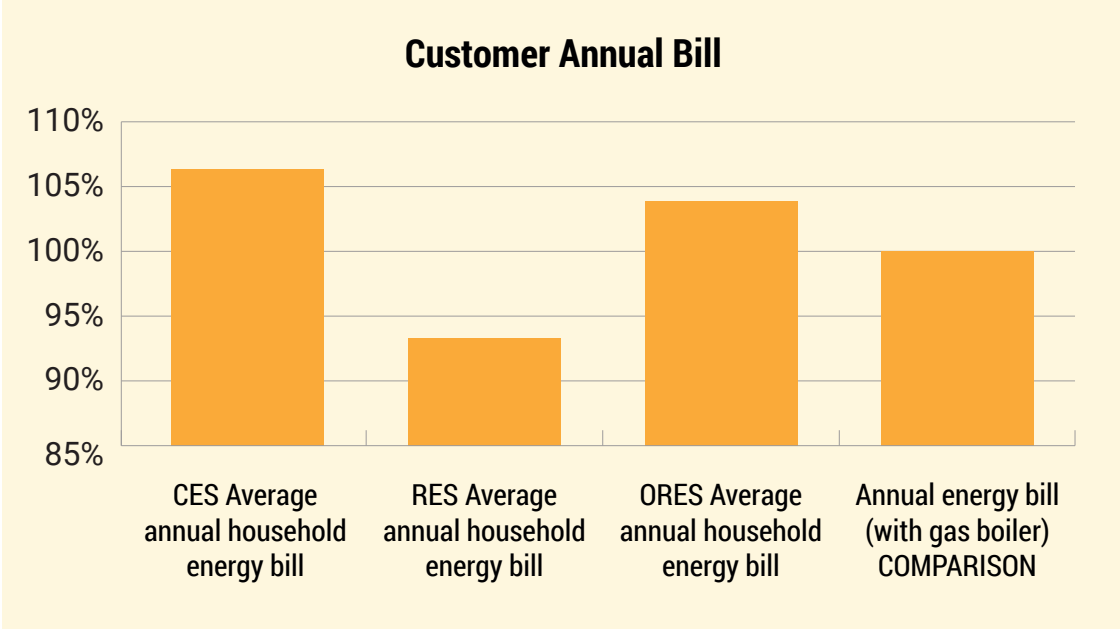
Customer costs comparison – Fossetts Farm 2019 /21 price assumptions



We modelled the impact of moving more decarbonisation costs to gas by shifting 5p/kWh from electricity to gas (approximately 25% of electricity costs at the time were attribtable to low carbon support mechanism)

3 During the latter part of 2021 and 2022 a surge in global gas prices was driving much higher electricity and gas prices. Increases in the price differential between electricity to drive low carbon systems and gas will only serve to make the justification to replace gas harder, but comparisons between low carbon systems will remain valid.

Customer cost simulation with decarbonisation costs moved to gas



This shows the potential for REMeDY solutions to be more cost effective than other comparable options.

The REMeDY model also provided the potential for a 30% saving for the developer compared to funding the costs of installing a heat pump system themselves.

The user experience

A core component of REMeDY innovation revolves around creating a user-centred design approach to design services customers want – low costs and no hassle.

Given that tenants will be receiving electricity from a licensed supplier, the key customer interaction point comes around the heat provision.

Vital Energi Glass app as primary customer billing platform shows the potential for this to be a seamless proposition.

Glass will act as primary interface between the end user and the REMeDY proposition, offering visibility of energy consumption and payments, with the flexibility to pay their bill or top-up anytime depending on their method of payment.

Customers are even able to predict future energy consumption using a built-in weather forecast. Energy efficiency measures are to be included to help vulnerable tenants avoid fuel poverty and assist smart local energy system balance grid costs.

Examples of Vital Energi's Glass app user interface can be seen on page 35.

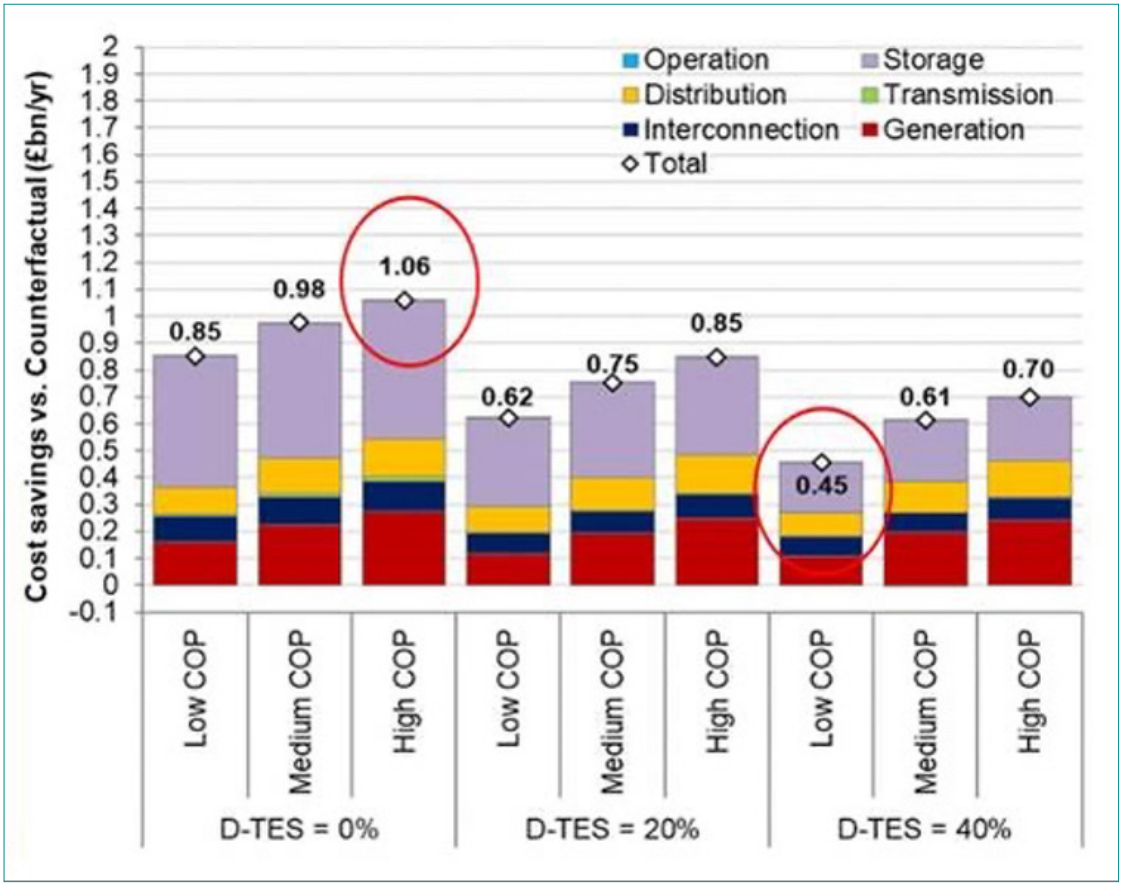
Modelling the wider impacts of adopting REMeDY solutions

Imperial College London has taken the technical findings of the project and modelled the impacts at a local and national level.

The assessment built on the initial design for the Fossetts Farm project, which was designed around an air source heat pump supplemented by an electric boiler and heat store, but further investigation and assessment of the capacity needs led to consideration of a heat pump only REMeDY solution.

The analysis shows that adopting REMedY solutions across the country to meet heat needs would provide a route to a lower cost energy system:

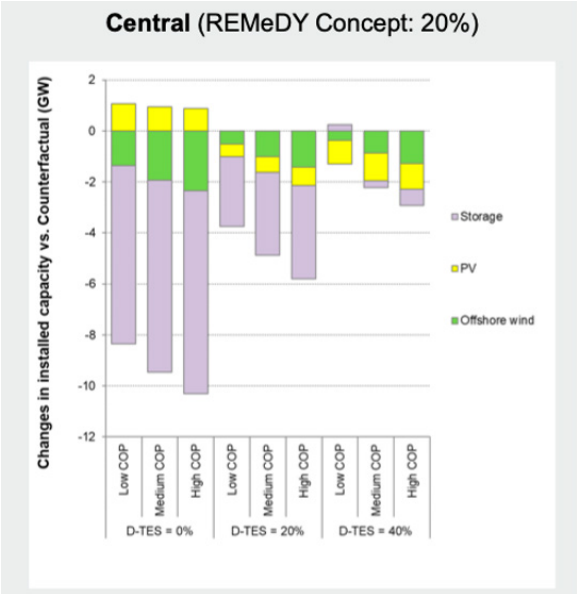
- They could reduce the amount of generation and storage needed on a national scale.
- They provide another storage medium and can help make best use of solar panels.



Source: Imperial College for REMeDY 2022

Savings depend on the amount of distributed thermal storage able to be deployed. Thermal storage can be specific thermal stores or fabric upgrades in buildings. The chart above shows the potential if REMeDY was adopted for 20% of heat needs and shows how beneficial it could be where increasing thermal storage in home is technically or financially too difficult. It shows that up to £1bn a year could be saved if REMeDY were to be adopted in areas where improving thermal storage in building fabric proves difficult.

The chart below shows that the biggest savings come from reductions in storage – up to 8GW less if there were low amounts of distributed thermal storage associated with the uptake of heat pumps. The uptake of thermal storage would have to be around 40% of properties to deliver the same impact as REMeDY type solutions.



Source: Imperial College for REMeDY 2022

This indicated that REMeDY style solutions are particularly suited where there is less opportunity for thermal storage built into individual properties:

- This could be because there is insufficient space eg in flats.
- The changes needed to fabric of buildings to improve their inherent thermal storage are not economically viable or technically limited.
- The value of the space occupied by individual thermal stores and heat pumps is considered more valuable for other uses. This has been one driver in the value consideration of a REMeDY solution by Bank's Property group in Eggborough.

In considering the make up of housing in Southend, there are a large number of early 1900s properties, including many that are multi-occupancy and still use gas as a primary fuel.

This analysis indicates that REMeDY local energy solutions may well be ideally suited to supporting the decarbonisation of areas like these where retrofit and refurbishment might not be able to create the modern levels of thermal storage and thus make heat pumps or electric heat systems more expensive to run and less flexible for the overall energy system.

Optimisation of the amount of storage and sizing of systems is important for the whole GB energy system. The work undertaken by Imperial College London shows that optimising thermal storage can produce significant savings in the total cost of the system.

Key challenges in developing REMeDY smart local energy systems

In this section we discuss the challenges encountered in developing commercially viable REMeDY projects.

Who has power over smart local energy development?

The table below describes the level of influence each of the organisations have over the development of low carbon energy solutions.

Power of key participants in the development of smart local energy systems

	Power to affect solutions	Impact of choice of solution
National government (policy)	High	Low
Local government (policy)	Low	Low
Investors	Medium	Low
Developers	High	Low
SLES developers	Medium	Low
Freeholders	Medium	Low
Landlords	Medium	Medium
Leaseholders (buyers)	Low - Medium	High
Tenants	Low	High
Communities	Low	Medium
Utilities	Medium	Medium

National government sets the underlying policy environment and legal requirements and through these has high power over the prevailing choices made by developers and investors. Local power can only be exercised within this framework, giving local government policy much lower power to affect outcomes.

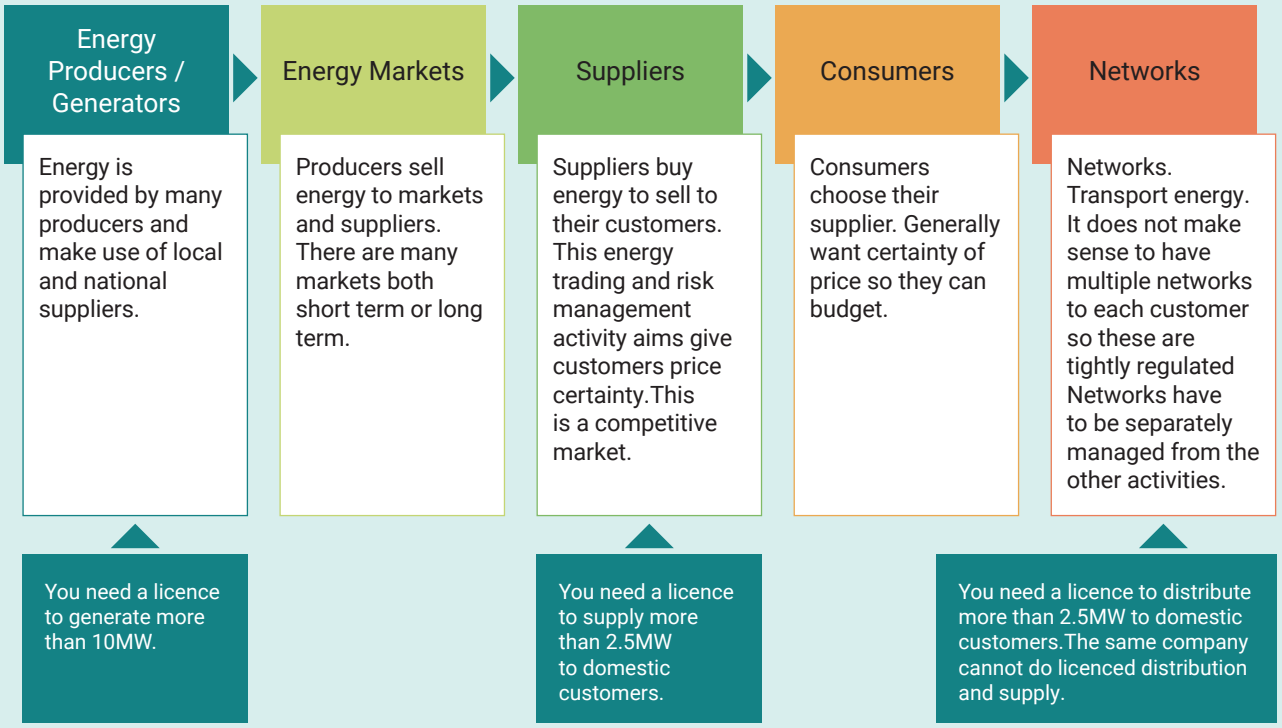
Developers and their investors have high power over the choices made. Their drivers are largely around compliance with legal requirements and financial costs, which can be important, especially in developing low-cost affordable homes.

Their customers, those who invest in the leaseholds or freeholds, have some power if they are willing to establish requirements for developers to meet, but can still have limited ability to influence the development.

Tenants and individual leaseholders are those who are most impacted by the choices made, having the long-term operating and maintenance costs determined by the solution adopted by the initial developer.

REMeDY explored these issues through its pipeline of real-world project opportunities. We have summarised the roles of different parties in enabling a smart local energy system to be developed.

Regulatory challenges



The requirements of the energy legislation are designed to promote competition in supply to customers. It was designed when markets were new and there were a few large utilities that did all these activities.

They don't stop small developments integrating heat, local generation and smart homes, but they limit the ability for companies to invest at scale and integrate the value.

Regulation was designed to promote competition, ensure energy markets operate properly and that domestic customers interests can be protected through the mechanisms that are included in licences. This means that licences are mandatory other than a few exceptions for small operations.

The legislation issue that affects REMeDY is that you cannot hold a supply licence and an electricity distribution licence if you supply more than 2.5 MW to domestic customers. This means that one company cannot operate a REMeDY system that includes electricity supplies to domestic customers.

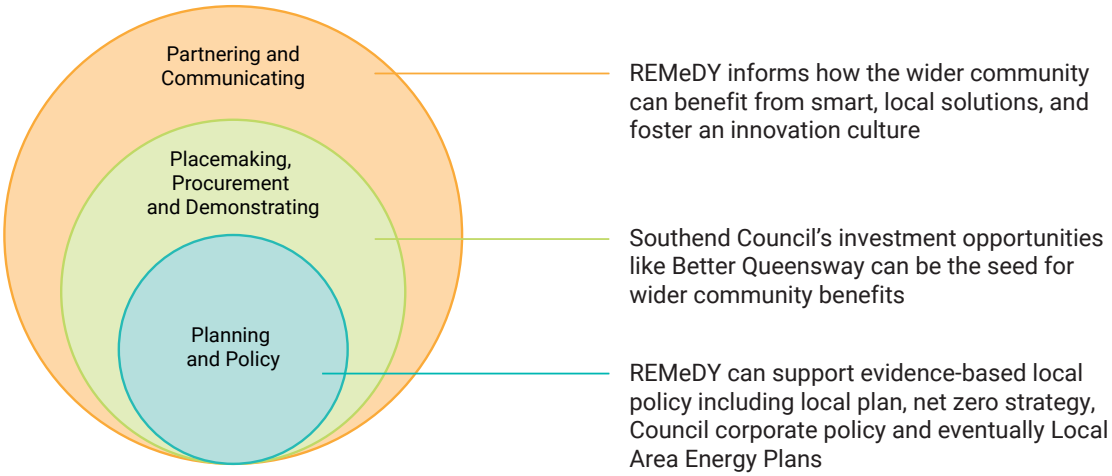
The REMeDY solution is to only supply heat to domestic customers, but it makes the overall solution less appealing to developers as you still need to provide domestic supplies separately and it also limits the energy of which the REMeDY operator can optimise the costs.

The role of local authorities

We have found the following ways a local authority could influence the development of REMeDY smart energy systems:

- As owners or developers of properties choosing to contract for a heat network.
- As buyers of property influencing the development through their contractual requirements or assessment of offers.

- Through the Local Area Plan development process including designation of zones under the forthcoming Zoning Regulations being consulted on by government.
- By facilitating awareness and engagement of alternative energy approaches early in the development cycle, enabling community input and engaging potential smart system providers with the developers, so that solutions emerge irrespective of the ownership.



Local authorities could initiate a REMeDY type solution through procurement when updating energy systems on property they own. Better Queensway in Southend is a key example where the local authority, as part owner, has a key role in the decisions taken about energy in the development.

As noted earlier, there is a real challenge in balancing the long-term energy cost/ benefits against the shorter term use of investment capital to procure much needed affordable housing and at affordable rents.

The appropriateness of investment solely in local REMeDY low carbon energy systems outside of larger regeneration developments discussed above, would be very situationally specific. There are possible roles as a long-term investor or as a co-investor with other public services such as hospitals, schools and leisure facilities, but these would need to be considered on their individual merits including wider societal impacts.

The ability of REMeDY system developers to be able to support the financing of systems where they might have higher costs than, say, direct electric heating will be of high importance in the development of the solution.

Local authorities and associated registered housing providers often procure housing as part of commercial developments they do not own, and in this case have lower power over the decision. It can be influenced if part of the initial procurement decision but, if not, then this becomes more difficult, as experienced at Fossetts Farm.

Early engagement by smart energy system developers with end customers of developments is essential in influencing procurement requirements that influence the developer's choice of energy solutions.

The development of Local Plans considers the development of land to meet local housing and economic development needs. While there is a mandate to consider wider energy planning energy, this is limited due to resource and skill challenges. In

the short term, land allocation, ensuring zoning is allowed for the development of energy centres will be important along with areas to be designated as heat network zones. Local Plan development would be enhanced by commissioning local area energy planning studies to identify the potential for heat networks, in conjunction with local infrastructure operators.

Local authorities could ensure land allocation in planning considers the needs of energy centre development supported by developing local area energy plans.

The role of the local electricity system operator

The role of the local electricity system operators will change in the coming years. At a national level the government has already signalled it will create a publicly owned independent body to oversee the planning and operation of the national electricity system and is now considering what is needed for local energy systems.

An independent planning body could support the development of local area energy plans, identifying where new smart local energy system developments such as REMeDY would be beneficial for customers and the wider system and provide a lower cost route to developing the additional capacity needed to support a low carbon economy.

Role of the smart energy system developer

We are at an early stage of the development of the smart energy system solutions envisaged by REMeDY.

- Energy system developers have a number of key roles:
- Engaging early and informing property developers of the benefits of SLES solutions so that they are designed into the development concepts.
- Engaging registered providers and wider consumers on the benefits of REMeDY-style solutions so that there is market pull for these solutions, and address concerns over monopoly provision.
- Providing a business case that works for developers and end consumers.

In Better Queensway, the initial engagement at the start of the project came too late to ensure key council stakeholders were comfortable with both smart local energy systems and the procurement of a REMeDY solution before key funding applications for phase 1 needed to be made.

Earlier engagement with Placefirst and Banks Property Group enabled the developers to understand and build in the wider benefits of the REMeDY type solution into their proposals.

Bridging gaps

In many scenarios, creating capacity to grow heat networks required bridging gaps between the early development demand and the end state of the heat network. All infrastructure grows in a ‘lumpy’ way where capacity is created, demand grows until more capacity is needed, more capacity gets built and this is repeated.

In larger infrastructures, such as electricity and gas, the costs of this get spread over very large user bases compared to emerging heat networks, yet securing the right

investment ahead of need and balancing the costs today against the needs of future customers remains a significant challenge.

This remains an issue for the Banks Property development, where the long-term development plan creates financing challenges, particularly when there is a long period of before customer revenues become larger than the money needing to be invested.

There are a number of possible approaches to address these issues:

- Allowing a guaranteed return on the invested capital as proposed for new nuclear generators. However, this make more sense for national assets where the costs are borne by all users of the system. It is not clear who would pay for local assets.
- Long-term licences to operate to attract investors with long term interests (eg independent network operators).
- Designated heat network zones with mandated connections
- Public investment (or guarantees) to support initial development period with divestment later to enable further investments. Such a model may need to be considered to support networks aiming for a customer base of existing properties rather than new build.

Aligning anchor projects through long-term planning

Government has started the process of developing a strategy[4] for identifying areas where heat networks may be the lowest cost low carbon solution. We hope that the experience from REMeDY provides useful insights and highlights the wider issues that need to be addressed so that long-term development opportunities are not lost in the near term.

Key large heat energy producers, particularly public sector operators such as hospitals, leisure centres and industrial processes should be encouraged to consider how their decarbonisation pathways can support wider community solutions.

REMeDY considered the decarbonisation of a social housing development owned by South Essex Homes near the local leisure centre and school. Several coordination issues emerged in exploring the opportunity:

- The initial assessment identified limited or no space around the mixed tenure housing development of small blocks of flats and houses for an energy centre as a key issue for a REMeDY solution.
- In exploring the local energy centre possibilities, it emerged that these are run by a private company for the council, with the centre leased from the local school which is an independent academy.

There appears to be limited opportunity to align the interests of these multiple actors:

- Each has its own drivers, even though part of the community.
- Each has different financial constraints.
- Each has different commercial arrangements in different timescales.

4 https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning

An independent long-term planning process that includes energy is needed to address this coordination and support the mix of local and national actors in making the right investments at the right time.

Integrating commercial demand

Domestic landlords continue to own and take responsibility for the standard of the property they let and through existing legislation already have obligations to meet energy efficiency and decent homes standards. This creates clear drivers to upgrade or procure more suitable property for which REMeDY solutions can provide a potential solution.

The commercial property market differs from this and was explored as part of the Victoria Shopping Centre opportunity in Southend.

Commercial properties are leased rather than rented. This means that the landlords do not retain responsibility for energy and have no power to drive commercial leaseholders to connect to smart energy systems like REMeDY. Many companies in buildings such as shopping centres have national energy contracts and local solutions are not attractive from an administration perspective, even if competitive on price.

Part 5: project findings

Overview of advantages and challenges of smart local energy systems

Smart local energy systems built around heat offer a number of advantages:

For customers they:

- Have a user experience comparable to the current combi-boiler experience.
- Could be up to 10% less expensive to run than comparable low carbon air source heat pumps.
- Potential to reduce the upfront investment needed in individual low carbon solutions.
- No need for the space for indoor and outdoor heat pumps and heat stores, just a simple heat interface unit giving more space in homes.
- They move the complexity of smart optimisation, maintenance and renewal costs to expert system operators who can find all the value in the energy system.

For the wider energy system they:

- Create significant local energy storage in the form of heat and power. REMeDY solutions could save up to £1bn a year if deployed in 20% of Great Britain's housing least able to be thermally upgraded.
- Provide a single point of control to drive smart optimisation benefits rather reducing the need to harness and optimise thousands of individual consumers' systems.
- Can be made to work in many situations (dense or more distributed).

There are a number of challenges to developing REMeDY style solutions:

- Growing heat networks is complex and needs long-term investment.
- There is a time lag between the upfront investment and achieving a sustainable level of revenue as customer base grows.
- Today, REMeDY smart local energy systems remain more suited to new build or deep regeneration schemes. These types of development consider all the benefits of fabric, space usage and energy in making a decision. A similar whole system approach to combined heat and power is needed for wider retrofit and refurbishment.

- Funding REMeDY systems through the growth phases of wider developments is a challenge and would be a key issue for establishing retrofit networks, while keeping costs low for end customers.
- Development and planning needs to identify space for energy centres.
- The wider value of developing smart local energy systems is complex and split across property developers, the wider energy system, customers and landlords.
- Consumer concerns remain about large companies with monopolies over energy provision and lack of choice.

REMeDY set out to create a commercially viable, replicable smart local energy system model. The project successfully developed a business model that could be applied in a variety of new build and extensive redevelopment situations.

Key findings are:

- REMeDY solutions look competitive when all the costs and risks of alternative solutions are considered.

- It is important that the cost effectiveness of REMeDY smart local energy system solutions are compared against equivalent smart energy systems and wider investment in developing the thermal storage needed to manage an efficient low carbon energy system. Low carbon solutions remain more expensive than gas heating in new developments, and smart flexible energy systems can be more costly and complex to install than simple electrical heating. This could change rapidly given the challenges of gas supply security.

- The business case for developing smart energy systems as an option in existing communities remains challenging. REMeDY has found opportunities that work commercially for new developments but has found it is much harder to apply commercially to existing developments.

- Investing in smart local energy systems is a long-term investment. REMeDY shows there is willingness and interest from private investors without the support mechanisms offered to other parts of the energy system. The REMeDY business model can provide valuable alternative investment and financing options for developers and housing providers looking ways to fund efficient, smart and flexible low carbon heat systems.

- However, the right support and regulatory frameworks could potentially reduce the costs of investment (ie the returns expected) and make REMeDY solutions cheaper for customers. An important issue is the funding and risk associated with development of heat-based smart local energy while the customer base grows.

- The work by Imperial College London has highlighted again the need to look at the energy system and the built environment together; that the costs and benefits of REMeDY solutions that provide thermal storage as well as heat to homes need to be compared to the costs of creating that thermal storage as part of building fabric and heating systems.

- REMeDY has explored pipeline projects over a two to three year period and has made viable proposals to developers for projects that might happen in the next 12 months. It is important that investment and pipeline development is accelerated and encourages developers to engage with smart energy system development. Well-evidenced local energy policy based on local area energy plans

that identify opportunities for developers to explore are needed to allow local authorities to ensure better solutions for their communities emerge through the development process.

- Property developers and future landlords need a business case to engage smart local energy systems at the time of development. Building standards and national energy efficiency standards remain the main drivers for low carbon energy adoption today. The key incentive for property developers is lower upfront costs. Long-term local and national energy system benefits are hard to translate into lower capital costs inputs.

- Lower capital costs are attractive but REMeDY type systems require contractually more complex concession agreements. The simplicity of low-cost direct electric heating, which is simple to install and contractually uncomplicated, remains attractive even if such solutions ultimately result in a more expensive overall energy system.

- Local policy development and local energy planning are needed to ensure that local developments adopt long-term solutions that support wider low-cost energy system decarbonisation.

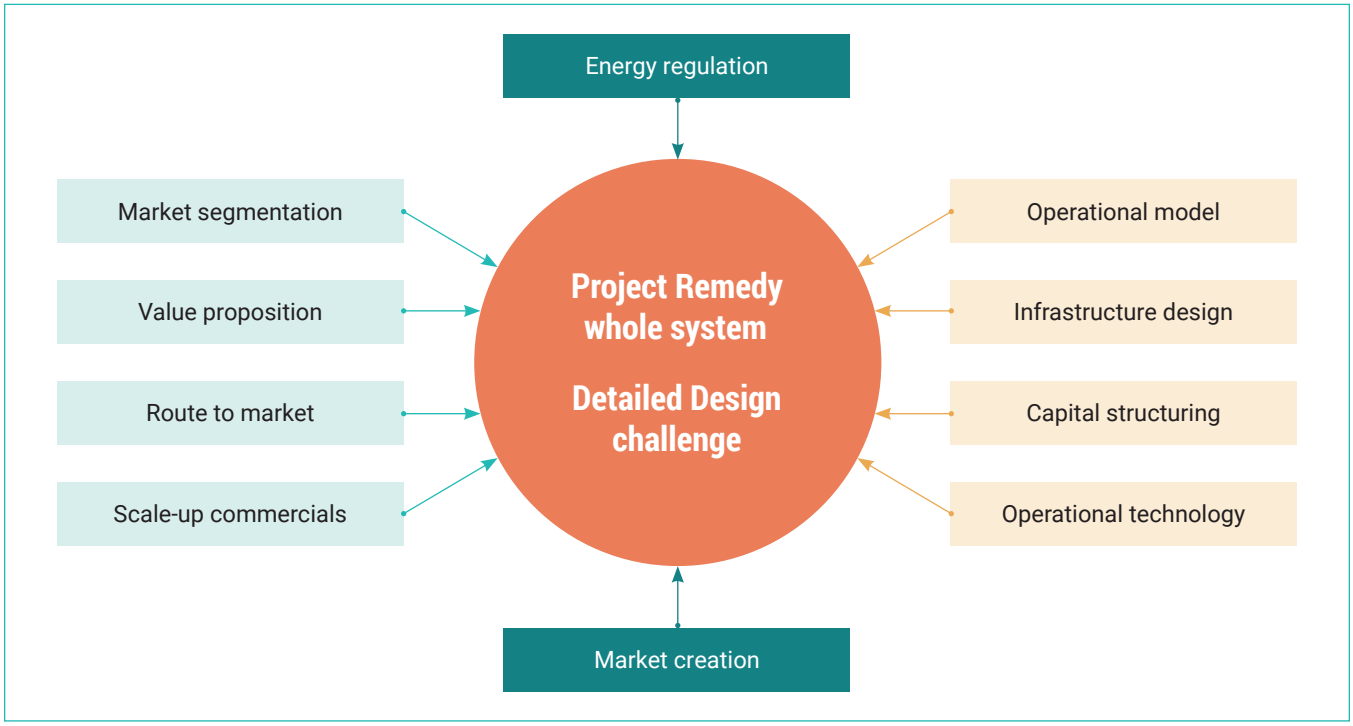
- Given the benefits smart local heat and energy systems could provide, a suitable regulatory framework is needed to allow local markets to reflect the full value, while offering customers suitable protection. It was not possible to explore the full benefits of optimisation of domestic electrical energy and heat because of the licencing and unbundling requirements.

- REMeDY type solutions place an expert in between the energy system and customers to help invest in technology and unlock value across the system by creating efficient local flexibility.

- The system-wide value of local thermal storage may not be fully valued today. The value of displaced future capacity is not necessarily reflected in today's markets, which reflect incurred costs or short-term operational costs.

How replicable is REMeDY?

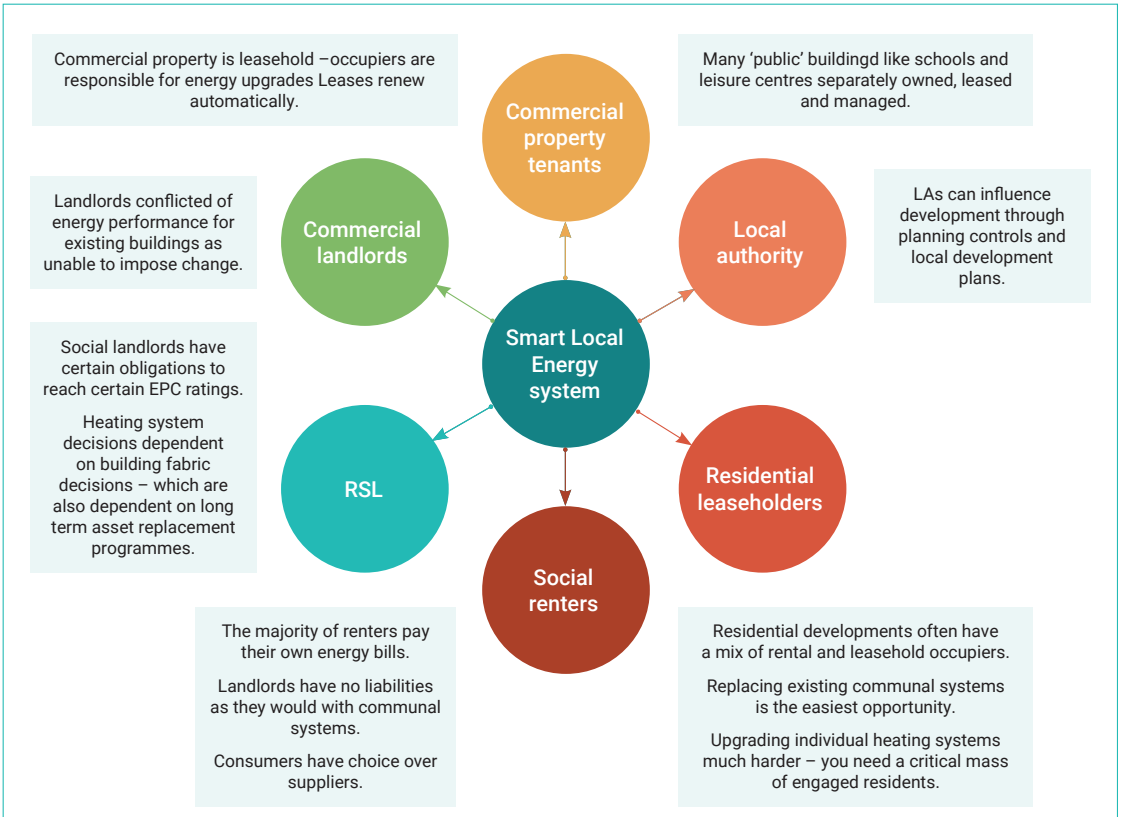
The project has considered a number of pipeline projects that show that the concept is technically and commercially replicable across a wide range of residential and commercial applications. However, every project has an almost unique blend of issues that must be considered.



REMeDY makes use of well-understood technology and can be optimised in ever more sophisticated ways as markets and the value of the technology to the wider system develops.

Commercial replicability is more complex. As we have discussed, there are a wide variety of issues that affect the possibility of developing REMeDY solutions.

Summary of actors in Smart Local Energy System Development



The need for local engagement / buy-in

REMeDY has demonstrated that early engagement and awareness of the possibilities is essential to ensure that planning, specification and procurement opportunities are all aligned with achieving low carbon, low cost solutions for the end user.

This requires a wider community engagement and local energy assessment of the benefits of developing REMeDY type local energy systems in specific areas.

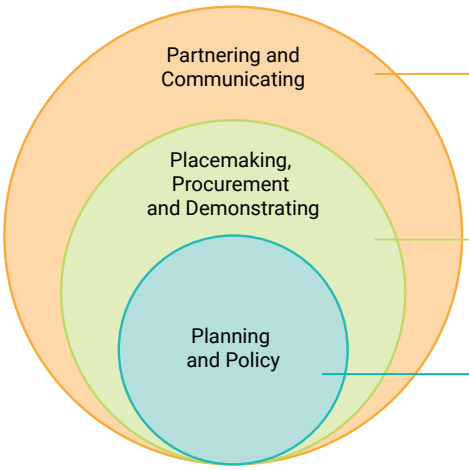
The engagement work on the wider net zero challenge undertaken as part of REMeDY has shown that there is a need for local coordination to unlock innovation

Government has started the process of developing a strategy[5] for identifying areas where heat networks may be the lowest cost low carbon solution. We hope that the experience from REMeDY provides useful insights and highlights the wider issues that need to be addressed so that long-term development opportunities are not lost in the near term.

5 https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning

Role of local authorities such as Southend City Council

Local authorities have a number of roles to play in achieving net zero, of which energy is a significant factor, although often seen as a national issue rather than a local one.



REMeDY informs how the wider community can benefit from smart, local solutions, and foster an innovation culture

Southend Council's investment opportunities like Better Queensway can be the seed for wider community benefits

REMeDY can support evidence-based local policy including local plan, net zero strategy, Council corporate policy and eventually Local Area Energy Plans

Planning and Policy - Local policy development and local plans

A core local authority role is in the development of local plans. Energy and infrastructure policies can be included in local plans with suitable evidence to support their inclusion.

Local plans consider transport and wider infrastructure including facilities such as schools, leisure and waste. Local plans have a wider range of policies including social, environmental, transport and infrastructure, giving local context to national plans. This local application of wider national direction on the development of energy approaches that support national decarbonisation goals will be important. A local area energy plan should be developed to provide evidence for policies supporting suitably smart local energy developments and zoning for energy centres in developments. These plans can also support the prioritisation of significant retrofit schemes that will be required in the coming decade.

REMeDY has identified that engagement and awareness raising through these processes is vitally important for setting the expectations of developers and other infrastructure providers around supporting the development of smart local energy systems.

As with the infrastructure delivery plans local authorities currently produce, this process would provide a catalyst for engaging residents about the choices and developing community support for integrated low carbon heat solutions.

Placemaking - Leading by example with net zero

Like many local authorities, Southend has set ambitious net zero targets that exceed those of national government.

Investing where appropriate may be seen as a way for Southend to generate return on its investment in REMeDY, following up on the potential in Better Queensway. Southend City Council will not be able solve the challenge alone.

Investing must be done while recognising that capital is limited and pressures for housing and social care may take precedence over energy, but REMeDY also highlights that it is possible for investors in smart local energy systems to offset upfront costs and address long term capital needs for renewal through long term contracts.

The need to identify opportunities early and take advantage of regeneration schemes is essential to effective investment.

Where the local authority cannot invest directly it has an important role in fostering innovation, both within the council and in the community. Energy is a very significant part of a wider net zero challenge. REMeDY has shown how complex the environment is, how the solutions to net zero must include many actors, some of whom will have conflicting interests and drivers, but where fostering innovation and reducing friction could reduce the costs of the net zero challenge to Southend.

REMeDY has highlighted the need for Southend City Council to build its capacity to support innovation towards net zero internally and externally.

Partnering and Communicating - creating capacity and momentum

Engagement with the community showed many businesses were at the start of their net zero journey, did not know about the net zero target, and were interested in being part of community scale activities that support their journey.

Southend City Council does not need to solve the issues itself. It can take a lead from the REMeDY process it has been part of and create a local innovation framework where low carbon innovators can be connected with the those in the community looking for low carbon solutions and vice-versa, fostering a low carbon innovation ecosystem in Southend.

The planning process should support a wider role for local authorities in creating capacity in the community:

- Bringing together other local public actors with regional infrastructure experts and smart systems expertise to inform planning.
- Enabling the debate – increasing local capacity to understand the options.
- Leading a local debate over heat zoning and wider non-financial benefits.

The local authority should be able to bring together the wider community's expertise in policy development, infrastructure development, economic planning and community engagement in a coordinated process.

This process should be integrated with wider net zero issues so that energy choices are made alongside other environmental and social issues.

What can be done to accelerate the development of smart local energy systems?

Well-evidenced local planning policy could be a useful driver to promote smart local energy system investment around new development and regeneration, through well evidenced local net zero policies that meet community ambitions.

Identifying areas where the combination of the thermal storage offered by REMeDY type solutions can best complement the built environment is a key need. A 'fabric first' approach to reduce total demand needs to be complemented by a heat strategy to ensure customers have access to the best overall cost choices.

The identification of suitable areas should be an important output of a whole systems local energy planning process, that can inform the development of local and national policy.

There are more than 300 local authorities in the UK so developing these expert skills in every corner of the country is challenging. The development of regional energy planning capability that can bridge the gap between the national Future System Operator that is being established and local policymaking is urgently needed if local low carbon systems are to develop in a timely way.

The engagement carried out in REMeDY shows that local authorities could support innovative businesses and community groups by creating frameworks to facilitate the engagement of low carbon / net zero solution providers and local customers.

Councils such as Southend City Council could harness the power of such a network to look forward and identify early the opportunities for it to act and help develop the business case and funding to make significant interventions.

Appendix 1 – Pipeline project insights

Details of pipeline projects, current status and potential next steps.

Project	Details	Developers / LA	End users (Tenants)	SLES developer and financiers	Outcome – next steps
Better Queensway Southend-on-Sea	New build, residential and commercial space 1,700 dwellings. Construction from 2022-2025.	REMeDY EsCo solution reduced CAPEX compared to the counterfactual evaluated. Cheaper CAPEX (less efficient) counterfactuals available on the market would present risk.	10% savings on total energy bill (including individual OPEX) for end users expected to be achieved immediately – potential for delta to grow with rising energy prices.	Reasonable investment returns present lower risk proposition to investor, quick building plan reduces cashflow risks as cumulative cashflow takes 4+ years to turn positive.	Although viable, project not taken forward in phase 1a due to external issues affecting the development timetable – REMeDY still being looked at for future phases.
Victoria Shopping Centre Southend-on-Sea	Retrofit of Council owned commercial property. 76 retail units and some office space = 26,000m^2.	Communal heating system judged to be uneconomical due to relatively low heat demand density and cost of retrofitting pipework. Private wire network similarly expensive to retrofit and physical separation of end-users (and landlord supplies) likely to increase costs.	Contract management needs considerable administrative effort due to the individual energy supplies already in place with different rates/end dates. Savings for customers were expected but hard to establish if 10% target could be met.	Rate of returns for investors difficult to calculate due to CAPEX points raised but overall risk profile was high unless some cost risk could be underwritten by SCC, which was assumed to be unlikely.	Deemed an unviable commercial venture and no further actions taken within REMeDY. However, scope to use Victoria shopping centre as a central heating network hub for surrounding area so a broader strategy question for SCC to consider.
South Essex Homes Shoeburyne Southend-on-Sea	Retrofit, social housing residential and local school. Multiple blocks with 346 dwellings (in total).	Limited space for centralised plant and adequate thermal storage around dwellings. Fabric of buildings of lower standard (than new build) meaning increased costs due to requirement for higher capacity heat pumps and thermal storage.	Hypothetical savings are possible for end users. Complex access for retrofit of communal heating loop would also increase costs and create significant disruption for tenants – other options are more practical.	Additional retrofit costs make it unviable as a standalone commercial proposition unless developer charged SCC/SHE. Some dwellings are privately owned creating complications to the investment/EsCo model.	Deemed an unviable commercial venture and no further actions taken within REMeDY, unless SCC were to take a wider strategic view on district heat and incorporate nearby school and other LA buildings – a lot of work to get to this point.
Fossetts Farm Southend-on-Sea	New build, Council owned residential-only (initially) 1,110 dwellings. Construction from late 2023-2026.	REMeDY EsCo solution reduced CAPEX compared to the counterfactual evaluated. Solution offers strong environmental performance and end user experience.	10% savings on total energy bill (including individual OPEX) for end users expected to be achieved immediately – potential for delta to grow with rising energy prices.	Reasonable investment returns present lower risk proposition to investor, quick building plan reduces cashflow risks as cumulative cashflow takes 4+ years to turn positive.	Project ongoing – proposal put forward to SCC and awaiting next steps regarding contracting and developing (post project). Approved for £2.5m private funding at SMS investment committee (pending further DD and tech review).

Project	Details	Developers / LA	End users (Tenants)	SLES developer and financiers	Outcome – next steps
Places for People, Astley Village, Chorley	Retrofit of Social housing estate, multiple blocks – 84 x 1 or 2 bed apartments (total).	Limited space for centralised plant and adequate thermal storage around dwellings. Fabric of buildings of lower standard (than new build) meaning increased costs due to requirement for higher capacity heat pumps and thermal storage.	Hypothetical savings are possible for end users. Complex access for retrofit of communal heating loop would also increase costs and create significant disruption for tenants – other options are more practical.	Additional retrofit costs make it unviable as a standalone commercial proposition unless developer charged PfP. Some dwellings are privately owned creating complications to the investment/EsCo model.	Deemed an unviable commercial venture and no further actions taken within REMeDY. Not judged feasible to provide centralised as the houses form a low heat demand density, capital cost of installing new pipework and system losses is more significant. SMS did find alternate energy saving measures.
Places for People, Hadrian Court, Newcastle	Retrofit of Social housing estate, multiple blocks (149 dwellings) – 62 x 1 Bed Flats, 74 x 2 Bed Flats, 13 x 3 Bed Houses.	Limited space for centralised plant and adequate thermal storage around dwellings. Fabric of buildings of lower standard (than new build) meaning increased costs due to requirement for higher capacity heat pumps and thermal storage.	Hypothetical savings are possible for end users. Complex access for retrofit of communal heating loop would also increase costs and create significant disruption for tenants – other options are more practical.	Additional retrofit costs make it unviable as a standalone commercial proposition unless developer charged PfP. Some dwellings are privately owned creating complications to the investment/EsCo model.	Deemed an unviable commercial venture and no further actions taken within REMeDY. Not judged feasible to provide centralised as the houses form a low heat demand density, capital cost of installing new pipework and system losses is more significant. SMS did find alternate energy saving measures.
Banks Property Group, Eggborough, Yorkshire	New build, private developer (low density) residential and commercial. 1,400 dwellings, Construction from 2024-2038.	REMeDY EsCo solution expected to be at cost parity with counterfactual evaluated (when taking EsCo contribution and GHNF). SLES reduces grid connection size also – costs TBC. Total new build development means that Remedy can be designed in from the beginning – this makes it a much simpler and cost-effective proposition compared to retrofit.	10% savings on total energy bill (including individual OPEX) for end users expected to be achieved immediately – potential for delta to grow with rising energy prices	First REMeDY project to utilise the GHNF in its business case. Lower investment returns compared with Fossetts Farm and Better Queensway which present higher risk proposition to investor, long building plan presents cashflow risks as cumulative cashflow takes 8+ years to turn positive. Need to unlock further market value for the to reward the benefit of the SLES on wider/ upstream energy system.	Project Ongoing – Banks Property very interested in the proposition and has signed a separate PCSA to undertake further developments. SMS and Vital committed to delivering the EsCo solution and further due diligence on the EsCo model underway and set to continue post project REMeDY conclusion.

Project	Details	Developers / LA	End users (Tenants)	SLES developer and financiers	Outcome – next steps
Placefirst - Central Street Bolton, Greater Manchester	Technically a retrofit, but was a renovation from old office units into new modern living domestic flats with one commercial unit. 158 dwellings. Construction from 2022.	EsCo provides private funding to help developer integrate low carbon tech and improve building performance. Total new building redevelopment means that SLES can be designed in from the beginning – this makes it a much simpler and cost-effective proposition compared to complete retrofit with tenants in situ.	Project modelling showed REMeDY system could provide cheaper overall energy costs for occupiers and allow a margin for Placefirst (who would administer via their service charge arrangement).	SMS proposed funding of solar PV and submetering to reduce developer CAPEX. ROI on funding was reasonable but overall upside (flexibility etc) was limited so doesn't hold as much strategic value. There remain challenges of domestic supply and billing in similar developments.	Project ongoing – the omission of district heat and centralised thermal storage meant the SLES doesn't offer the overall benefit envisage by the Remedy solution but did offer an interesting solution for the few privately rented properties (where energy is included in the rent). Lessons learnt from the regulatory review part of the project has meant SMS and Placefirst are realizing commercial benefits.