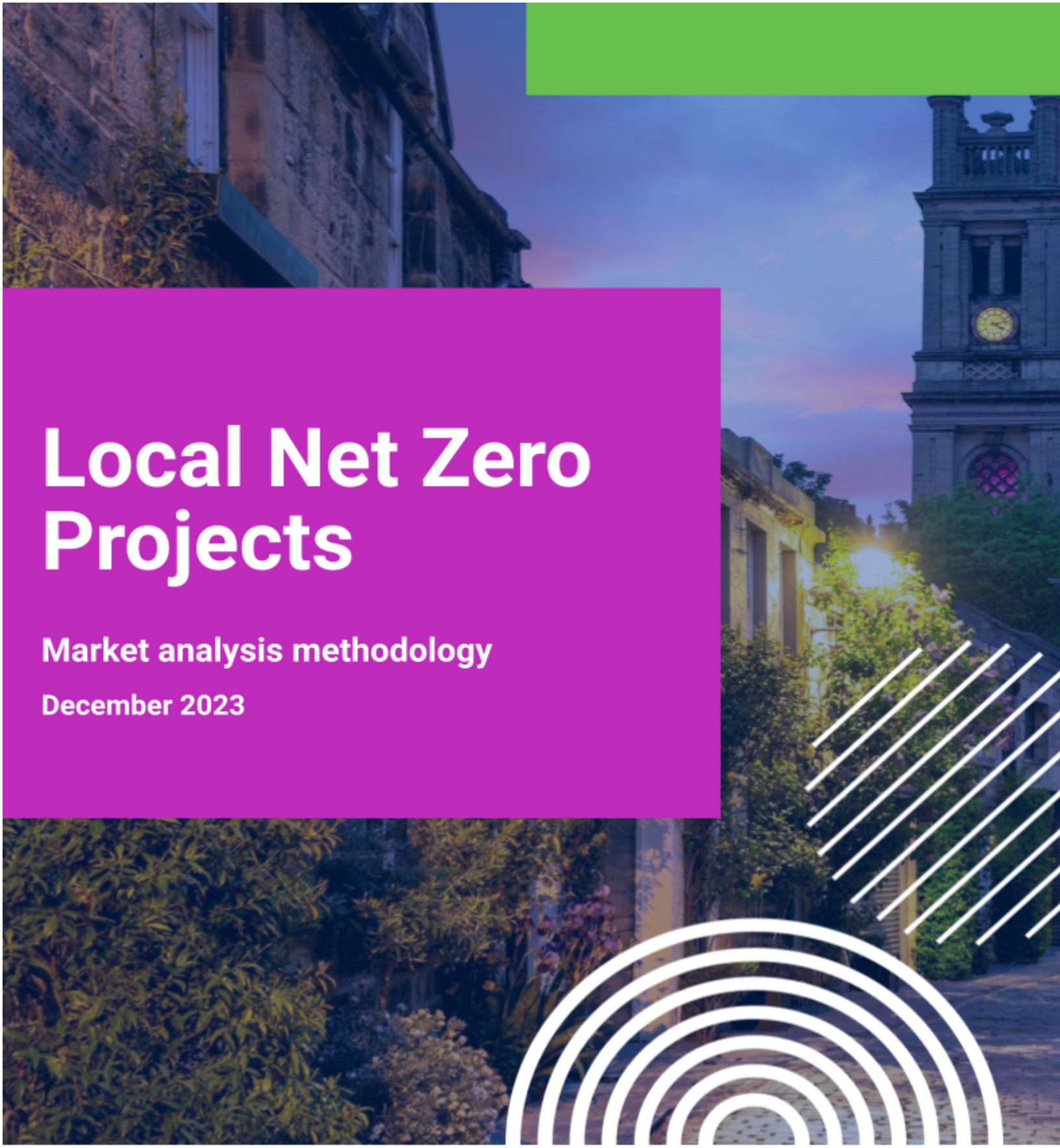


Local Net Zero Projects

Market analysis methodology

December 2023

Innovate UK

In association with:

pwc

Purpose of the research

As the energy system decentralises, a lot of capital investment will be required in towns, cities and other places on a scale that does not currently exist. This will include investment in local small or medium-scale generation and storage assets, EV charging infrastructure, buildings retrofits, as well as heat networks, private wires, energy centres and hydrogen infrastructure.

There are various analyses that quantify the UK investment required in the net zero transition under various scenarios, either overall or by sector. **However, there is no analysis that we are aware of that attempts to quantify the scale of investment required in these local assets**. This is important not just from an academic point of view but because these assets represent a market segment that is new, different and unfamiliar to most large infrastructure investors.

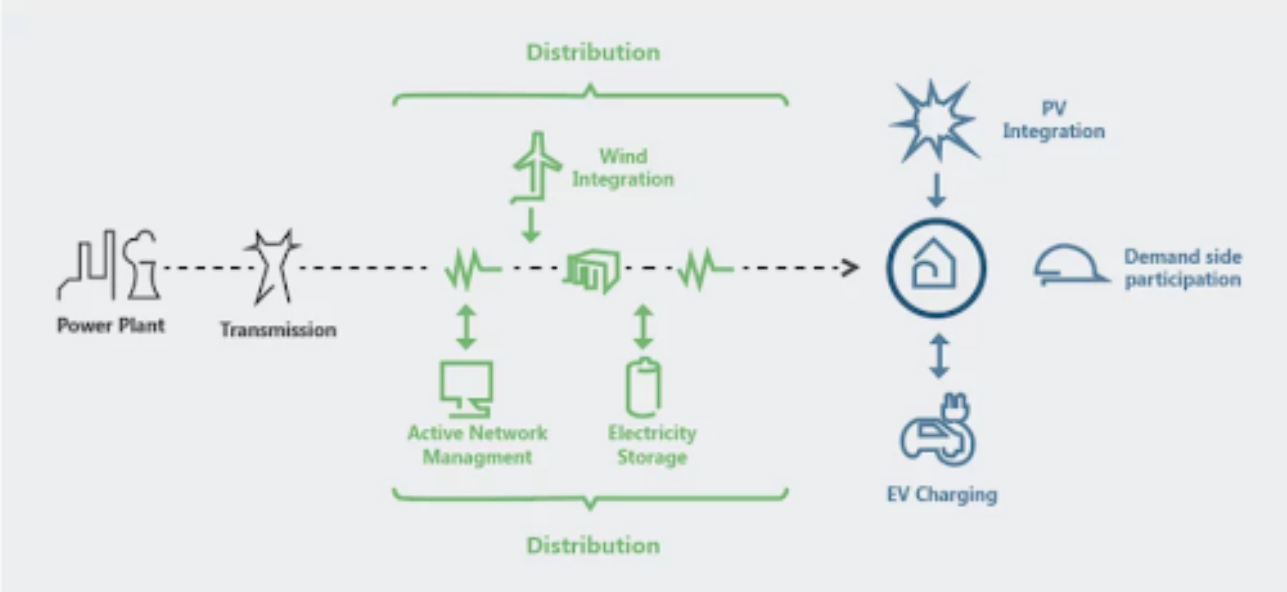
Context: The local energy sector is undergoing significant change

For the past half century, the UK's energy system has been linear and one-directional, as shown:

From the 1990s, a private, regulated electricity and gas market was developed, with roles for generation, transmission, distribution and retail split, and regulated. Each role (NGED, DNOs etc.) has long-term clarity around the investments it should make (substations, power lines) and a medium-term view on the levels of investment required, prices that can be charged and profits permitted via regulated frameworks such as RIIO.

All of this is paid for indirectly through levies on energy bills, creating a >£40bn a year market. This investment framework has been successful in crowding in private capital, with over 95% (IPA) of investment in the UK energy sector coming from private sources in recent decades. The use of Contracts for Difference (CfDs) over the past decade has continued this trend, resulting in large scale private investment in major renewable generation assets.

However, as shown on the next page, the future energy system will be more complex.



This represents a major shift from the current system, which creates a challenge for scaling investment. This is largely because the capex required is:

- In many **different types of assets**, each with its own technological and market risks, some of which **are not well understood** (e.g. the future role for H_2 and price and adoption curves for heat pumps and batteries).
- Many of these assets **are not traditionally part of the energy system**: the degree to which British homes are insulated could result in tens of billions of pounds a year more or less being spent on energy bills and invested in energy infrastructure, but insulation is not thought of as part of the energy system.
- In **many and smaller assets** which are too small scale for many investors, and are often owned by **many different counterparties**, which creates a distribution of risk that is difficult to quantify or assure.
- **Many revenue streams are difficult to capture** as most fall outside of the central energy market: a regulated market for flexibility services is developing but the equivalent does not exist for heat networks or demand reduction; small-scale generation is not eligible for CfDs, and the export fees paid to small-scale generators no longer incentivise participation.

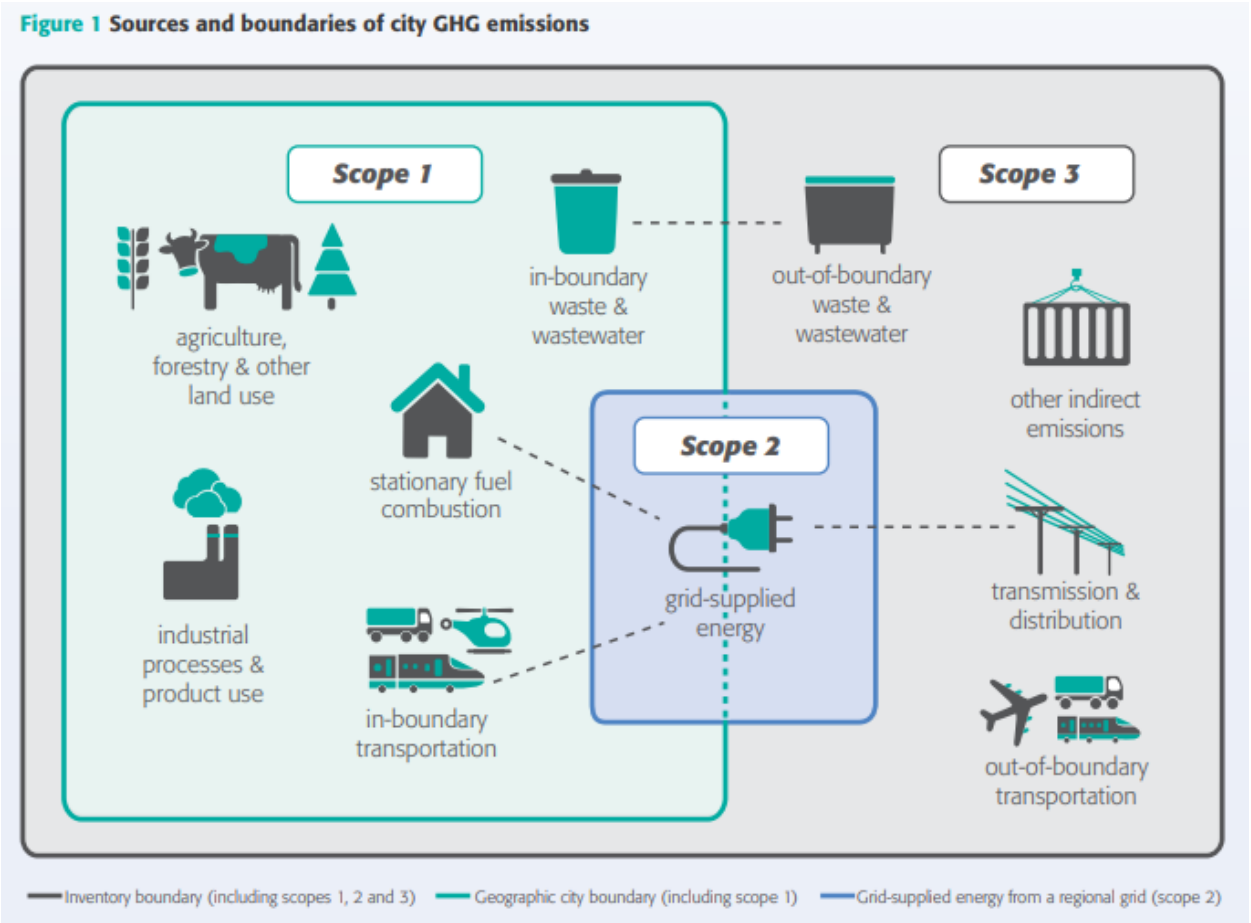
As a result, the market for these decentralised, decarbonised assets remains small and poorly understood, with most transactions happening via private contracts: private wires; residential heat networks. DESNZ and Ofgem are currently working across many strands of activity (e.g. REMA, the Winser Review; Local energy institutions and governance decision) to define the future energy system but **it is currently difficult to anticipate what this system will look like, who will pay for it, and how.**

Defining the 'local' market

The *Local Authority Guidance* and *Market Intelligence* reports produced during this project aim to build local authority capacity and educate investors about the same market. We define this market throughout both reports as **'local net zero projects'** - but what does this mean?

Everywhere, by definition, is 'local' and in theory the more 'local' you get, the less comparable two places are: local means, at the same time, the financial district in the city of London, the industrial cluster in Tees Valley, and the farms of Devon. In practice, though, 'local' is usually used to mean the places where people live and work - towns and cities. But even big cities have diverse industrial characteristics. The GHG Protocol for Cities defines urban emissions according to their scope. As shown below, this includes emissions from agriculture, industry and waste as well as aviation and shipping - i.e. flights taken by and goods ordered by citizens.

Figure 1 Sources and boundaries of city GHG emissions



Source: GHG Protocol for Cities

Throughout this research, we limit the local net zero project market to the buildings, surface transport and local energy sectors.

The rationale for this is that these sectors:

1. Are subject to the greatest degree of **local authority control**, through transport and land planning powers. As a result, projects in these sectors make up the vast majority of instances where a **local authority is likely to be the project sponsor.**
2. **Have a large degree of interdependence**, from:
    a. ***a project perspective***: many projects involve assets from across these sectors - for example retrofits with solar and EV charging, or new developments with cycle infrastructure.
    b. ***a placemaking perspective***: where people live is defined equally by the quality of transport and housing
    c. ***a net zero perspective***: a sparsely populated place will be more dependent on an EV-led decarbonisation strategy while denser places will be able to adopt more public and active transport
3. Are increasingly **treated as interdependent by central government policymakers**, as recognised in the Net Zero Strategy, Independent ('Skidmore') Review of Net Zero, Levelling Up White Paper and recent Devolution Deals.
4. **Require the most investment**
5. Account for the **vast majority of emissions**[1]
6. **Have the most impact** on people's day-to-day lives

In contrast, while sectors such as industry and agriculture may have large urban emission footprints, they have distinct decarbonisation strategies, as set out in the Net Zero Strategy and recognised in policies, funding and investment frameworks such as the Industrial Clusters Mission and Environmental Land Management Schemes (ELMS).

Similarly, our analysis excludes large scale national energy assets - power plants, transmission lines, including large-scale onshore wind assets. This is because these assets are also subject to existing investment frameworks, such as RIIO and CfDs, and so are unlikely to form part of a local net zero project.

We recognise that there may be local net zero projects that include aspects of some of these 'excluded sectors' and that the market may change over time. For example, some local net zero projects will involve green spaces and possibly small-scale urban food production.

Similarly, in the waste sector, we do include energy from waste (EfW) and biomass (food waste) but we do so under renewable energy. We don't cover recycling specifically as this wasn't seen as a priority for private investment by any of the LAs we spoke to. The UKIB points out in their recent strategy update: "*We do not yet see the scale of opportunities in the waste sector, though this may change when government policies on packaging (extended producer responsibility), consistent collections and recycling (deposit return scheme) are implemented*".

[1] It depends on the definition used but typically these sectors account for 60-75% of total emissions in UK cities. For example, 'Energy supply', 'Transport', 'Public' and 'Residential' sectors accounted for 62% of 2022 territorial emissions according to DESNZ

A detailed breakdown of each sub sector used in the investment analysis, can be seen in Annex 1.

Investment methodology overview

Against this backdrop, we set out to try and quantify what this future system might look like by answering the following questions:

1. What is the **total UK investment required in net zero assets** across the major supply and use sectors of energy, buildings and transport?
2. How much of this investment is likely to be in **'local' net zero projects?**
3. How much of this investment is likely to come from the **private sector** (including households) and how much will require **public funding?**

Given the uncertainties around the future of the energy market, we used government data and assumptions where available and industry sources and our own calculations to fill gaps.

We split our analysis into four sectors - electricity supply (including storage), residential buildings, non residential buildings, surface transport. Natural gas and hydrogen were both excluded. For each of these sectors we took the same general approach:

1. What is our assumed decarbonisation pathway for each sector?
2. How many of what type of assets in this sector will be required by 2050?[2]
3. How much total investment[3] will be required for each asset type?
4. How much of this investment should be classed as 'local'?
5. How much of this investment do we think is likely to come from the public versus the private sector?

Detailed investment methodology

1. **What is our assumed decarbonisation pathway for each sector?**

For all sectors, except for electricity storage, we used the CCC's Sixth Carbon Budget Balanced Pathway (6CB). This pathway was created in 2019, and some of the technologies and deployment assumptions are out of date though the total investment required is still in a similar ballpark to more recent estimates.

We considered instead using the government's Net Zero Strategy or our own modelling but both exhibit less cross-sector consistency: the fact that CCC have both detailed deployment and cost modelling, and that they are the government's independent experts on climate change pathways made the case for using CCC figures wherever possible.

[2] Non-investment measures such as behaviour change are a part of the 6CB but ignored for this analysis
[3] i.e. not just additional investment

2. **How many of what type of assets in this sector will be required by 2050?**

As above, we used the sectors from the 6CB. These are broken down into various assets and measures for each sector, as shown in full in the table in the annex, with the only exception being electricity storage, which we modelled independently.

3. **How much total investment will this require for each asset type?**

In most cases, we used the CCC's figures for investment for each measure. Exceptions were:

(1) **Surface transport**: CCC does not have costs for EV charging infrastructure, active/public travel infrastructure, or bicycle purchases, all of which we added using methodologies we used in the previous *Accelerating net zero delivery report (*UKRI /PwC 2022)

(2) **Electricity supply:** The 6CB provides a total investment figure (£457bn) for the sector but this is not broken down by technology. To create this breakdown:
   (a) We took CCC figures for TWh deployed by each technology in 2050
   (b) Then we used uptodate figures, from CfD auctions and other sources for the cost of energy per MW deployed
   (c) We multiplied these figures to create a weighted allocation of the total £457bn across each generation category based on its assumed contribution to supply in 2050, and its current relative price per MW. This approach is a good ballpark but assumes no future change in the total investment figure by 2050 the energy mix in 2050 or the relative cost of energy by generation type today.

(3) **Electricity storage**: neither projected storage capacity nor investment figures were available from Government sources, so we used a bespoke methodology based on industry sources and national targets (see note).

4. How much of this investment should be classed as 'local'?

We categorised the assets and measures set out by CCC as 0-100% 'local'. This allocation is shown in the table in the annex. In most cases we assigned either 0% local (offshore wind) or 100% local (retrofit), but there were exceptions:

- For onshore wind, we noted that there has been a resurgence of onshore wind in the latest CfD round and the average size of new onshore wind farms is over 50MW. However, there are still a lot of local projects, particularly in places like Orkney, which has >800 small sites, and small-scale onshore wind has been signalled by changes in planning policy. As a result we used a figure of **25% local.** For similar reasons, we assigned 33% of biomass as local, with 67% national.
- For EV chargers, recent government statistics show that of the 30,000 public chargers in the UK 82% are either on-street or at the destination (hotels, leisure centres, offices), with 18% either en-route (motorways) or 'other'. Most of the former should fall in the definition of local, so we have used this figure for all EV chargers, with the exception being HGVs where we think most charging will happen at motorways or out of town

depots. These figures exclude the ~300,000 home chargers, many of which will involve a simple extension lead.
- For electricity storage, we used our own methodology, described in the annex.

5. How much of this investment do we think is likely to come from the public versus the private sector?

This represents the most difficult part of the analysis. The analysis in steps 1-4 involves making assumptions about future energy use, efficiency, cost curves and technological progress. Over 30 years, all of these assumptions are uncertain, but can be forecast based on trends. However, step 5 involves making assumptions about political decisions - i.e. future government industrial strategy, regulation and fiscal stance, as well as the development of markets and commercial models that do not yet exist (growth in the offshore wind sector would not have been predicted in the early 2010s and a political decision to back CfDs were a major contributing factor). These factors are inherently more subjective, even among experts, with differing expectations about future governments and the support that will be afforded to different technologies.

The only similar research we are aware of that sought to answer this question was from the OBR in 2021 (see table in annex), but this data was not as granular enough for our purposes.

Our approach was to run a survey of informed practitioners. This allowed us to gain valid responses in a complex technical area while reducing individual bias. We asked representatives from government, academia and consultancies who work in local net zero to assign a figure of 0-100% to each asset type based on the percentage of future investment that they think will be required from the public sector. We intentionally did not add any statements about future policy such as '*based on current committed policies*' or '*to be in line with our net zero commitments*', since these factors underlie the assumptions we are trying to measure.

We received 20 survey responses. Question format and survey results are shown in the annex.

We cross checked our results against the OBR's higher-level categories and there was a strong degree of alignment, especially in the larger investment categories. See both tables in annex.

Results

Our final results are shown in the table below:

- Overall, **£1.15trillion** of investment will be needed across the built environment sectors
- Of this, **£544bn** will be required in local net zero investments
- And **£250bn** of this is likely to come from private sources

Sector	Total investment into energy, buildings and transport (£bn)	Total investment required in UK LNZPs (£bn)	Private investment required in UK LNZPs (£bn)	Public investment required	% total UK investment	% total UK LNZP investment
Residential buildings	254	249	116	133	22.1%	21.6%
Non-residential buildings	108	108	61	47	9.4%	9.4%
Surface transport	332	133	32	101	28.8%	11.6%
Electricity supply	457	54	41	13	39.7%	4.7%
TOTAL	**1,150**	**544**	**250**	**294**		

Annexes

1. List of Low Carbon Measures by sector
2. Storage methodology
3. Survey question format and results
4. OBR public share of costs analysis

Annex 1. List of Low Carbon Measures by sector and classification as 'local'

Residential buildings		Non-residential buildings		Surface transport		Electricity supply	
LCM	% Local?	LCM	% Local?	LCM	% Local?	LCM	% Local?
New homes with low carbon district heat	100%	Building scale heat	100%	**EV charging infrastructure, of which:**		Unabated gas	0%
New homes with heat pumps	100%	Catering and other	100%	BEVs cars	82%	H2GT	0%
New homes with gas, and heat pump retrofits	100%	District heat	100%	BEVs vans	82%	Gas CCS	0%
Cavity wall	100%	Energy efficiency and behaviour change	100%	BEVs HGV	20%	Biomass CCS	33%
Floor	100%			BEVs motorcycles	82%	Nuclear	0%
Other	100%			BEV buses	82%	Storage	33%
Roof	100%			**Electrification of public transport, of which:**		Offshore Wind	0%
Solid wall	100%			BEV buses	100%	Onshore Wind	25%
ASHP - Flexible SH + HW Storage	100%			H2FC REEV buses	100%	Other renewables	0%
ASHP - Inflexible SH + HW Storage	100%			**Active transport, of which:**		Used curtailment	0%
Communal GSHP - Flexible SH + HW Storage	100%			Bike lanes	100%	Interconnection	0%
Communal GSHP - Inflexible SH + HW Storage	100%			Bikes	100%	**Solar, of which:**	
Electric Resistive + Solar Thermal [HW/SH] - Flexible SH + HW Storage	100%			Bus lanes	100%	Utility	0%
Electric Resistive + Solar Thermal [HW/SH] - Inflexible SH + HW Storage	100%					Commercial	100%
Electric Resistive - Flexible SH + SH Storage + HW Storage	100%					Rooftop solar	100%
Electric Storage - Flexible SH + SHS + HWS	100%						
GSHP - Flexible SH + SH Storage + HW Storage	100%						
GSHP - Inflexible SH + HW Storage	100%						
Hybrid (ASHP + H2 Boiler) - Flexible SH	100%						
Hybrid (ASHP + H2 Boiler) - Flexible SH + HWS	100%						
Low carbon district heat	100%						
Hybrid (ASHP + Bio boiler) - Flexible SH + HW	100%						
Hybrid (ASHP + ER) - Flexible SH + SHS + HWS	100%						
Hybrid (ASHP + ER) - Inflexible SH + HWS	100%						
Communal ASHP - Inflexible SH + HW Storage	100%						
Hybrid (ASHP + Bio boiler) - Flexible SH	100%						
Communal ASHP - Flexible SH + HW Storage	100%						

Annex 2. Storage methodology

Battery and other storage technologies are subject to large uncertainties about technology types and relative importance in the future energy mix, all of which has changed significantly since the 6CB. As a result, for his analysis, we have used averages of various uptodate sources, as follows:

1. Deployment calculations

- Recent estimates exist for the storage requirements in 2050 for both the EU (600GW) and the US (200GW), which equates to 0.93GW per million people
- Based on UK 2050 population (74m), our assumed deployment is 69GW
- Current UK storage capacity is 5GW, so required investment by 2050 is 69-5= **64GW**

2. Checking deployment against other sources

- The 6CB Balanced Pathway assumes storage of 18GW by 2035
- National Grid estimates that the UK needs "more than 50GW" by 2050
- These figures justify using 64GW as a deployment assumption

3. Investment calculations

Three different industry sources were used to calculate the investment cost per GW installed

- Rystad say the UK capacity needs to reach 24GW (20GW new) and this will cost $20bn, which = £0.77bn / GW
- Timera estimate 30GW needed by 2035 at cost of £30-40bn (use £35bn) = £1.16bn/GW
- EurElectric estimate the EU will need to spend 'up to' EUR300bn to create 'upto' 486GW of storage in the EU, which = £1.4bn/GW
- The average of these = **£1.1bn / GW**
- [1.1 x 64] = **£71bn** required investment in storage by 2050

4. Local vs National estimates

- We could find only one source to estimate this. Regen showed that currently, 1 052MW of storage is located on the distribution network and 2 874MW on the transmission network, so 27% of storage is local
- Based on the future direction of the energy market towards local flexibility, we conservatively estimate that this will increase to 33%
- So [33% x £71bn] = £23bn of investment will be required in local storage assets by 2050

Annex 3. Survey question format and results

For the public-private investment survey, we used the following question format:

*"Please rate the level of public vs private investment required in local net zero projects for each of **the surface transport technologies below** based on the following scale:*

1 - Very high public investment and very low private investment
2 - High public investment and low private investment
3 - Similar levels of public and private investment
4 - Low public investment and high private investment
5 - Very low public investment and very high private investment"

The results are shown below:

Sector	Technology	Share of private investment	Share of public investment
Domestic buildings	Insulation	52.38%	47.62%
Domestic buildings	Low carbon heat	44.05%	55.95%
Domestic buildings	District heat	46.43%	53.57%
Non-domestic buildings	Energy efficiency	58.33%	41.67%
Non-domestic buildings	Low carbon heat	58.33%	41.67%
Non-domestic buildings	District heat	52.38%	47.62%
Transport	Car/motor EV charging	67.86%	32.14%
Transport	Van/HGV EV charging	73.81%	26.19%
Transport	Public transport EV charging	19.05%	80.95%
Transport	Public transport electrification	19.05%	80.95%
Transport	Bike lanes	5.95%	94.05%
Transport	Bus lanes	4.76%	95.24%
Transport	Bike infra	42.86%	57.14%
Electricity supply	Onshore wind	80.95%	19.05%
Electricity supply	Solar farms	76.19%	23.81%
Electricity supply	Rooftop solar	71.43%	28.57%

Note that the categories listed in the table above are not as granular as those used in the analysis in Annex 1. We used averages of these categories where necessary. For example, for the proportion of investment in storage assets that would be required from the public sector, we used the average of onshore wind, solar farms and rooftop solar = 24%.

Annex 4. OBR public share of costs analysis

Table 3.2: The share of costs borne by public spending

Whole economy cost/saving £ billion (2019 prices)		Public share of costs (per cent)									
		2020s			2030s			2040s			Total
		Low	Central	High	Low	Central	High	Low	Central	High	Central
Costs											
Vehicles											
Cars	213	11	11	20	3	3	13	3	3	3	6
Car infrastructure	35	20	29	70	20	20	60	20	20	50	21
Other vehicles	69	71	85	94	25	62	85	0	39	76	52
Other infrastructure	15	25	50	75	25	50	75	25	50	75	50
Total	332	16	18	28	11	21	38	6	18	33	19
Buildings											
Residential	254	7	44	65	7	44	82	7	44	89	44
Non-residential	142	28	43	47	27	42	53	25	43	59	42
Total	396	15	43	58	14	43	72	13	44	79	45
Power	481	4	7	10	0	5	10	0	5	10	6
Industry	46	24	54	89	21	42	77	19	31	66	38
Removals	101	85	89	93	69	75	81	50	59	67	64
Other	52	59	72	84	41	58	75	30	50	65	60
Total costs	1408	15	26	36	12	27	44	12	26	43	27
Savings											
Vehicles	-684	3	3	3	3	3	3	3	3	3	3
Buildings	-131	5	5	5	5	5	5	5	5	5	5
Other	-272	1	1	1	1	1	1	1	1	1	1
Total savings	-1086	2	2	2	3	3	3	3	3	3	3
Memo: Net cost (£ billion)	*321*	*46*	*84*	*115*	*58*	*138*	*228*	*45*	*113*	*195*	*344*

Source: Table 3.2 from the Office of Budget Responsibility's Fiscal Risks Report in July 2021

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