energy saving trust

Community and locally owned energy in Scotland

2022 report

31 March 2023

Report produced on behalf of the Scottish Government

energy saving trust

Executive summary

1. An estimated 908 MW of community and locally owned renewable energy capacity from 26,290 installations was operational in Scotland at the end of December 2022.[1] This is estimated to produce 1,933 GWh of renewable energy annually.
2. This means the Scottish Government has progressed 45% towards their 2030 target of having 2 GW of operational renewable energy capacity in community and local ownership.
3. There was 37 MW of operational capacity newly identified by Energy Saving Trust this reporting year.[2] Approximately 20 MW of this capacity became operational in the 2022 reporting year, with the remaining 17 MW attributed to previous reporting years.[3]
4. The greatest share of operational capacity of community and locally owned energy by:
    1) Ownership category is farm and estate (41%, 370 MW), followed by local authority (17%, 157 MW) and local business (13%, 117 MW).
    2) Technology is wind (37%, 338 MW), followed by biomass (30%, 277 MW).
    3) Local authority area is Aberdeenshire (25%, 226 MW), followed by Highland (12%, 110 MW).
5. The greatest share of operational number of installations of community and locally owned energy by:
    1) Ownership category is housing association (46%, 12,050), followed by local authority (43%, 11,340).
    2) Technology is solar photovoltaic (PV) (44%, 11,570), followed by heat pump (34%, 8,870).
    3) Local authority area is Stirling (9%, 2,420), followed by South Lanarkshire (9%, 2,250).
6. In addition to the 908 MW of operational capacity, there is an estimated 1,505 MW in various stages of development. [4]
7. There are 550 installations recorded in the database which include an element of shared ownership, 440 of which were operational and accounted for 74 MW (8%) of the total reported capacity.
8. At the end of December 2022, there was an estimated 10 MWh of operational energy storage capacity in community and local ownership in Scotland with a further 2 MWh in development.[5,6]

[1] Numbers of installations have been rounded to the nearest ten throughout this report.
[2] The 37 MW is the net gain including operating records newly known to us minus records confirmed to be decommissioned and other records removed as a result of data improvement.
[3] Summed figures may not precisely equal reported totals due to rounding.
[4] We anticipate that a proportion of the in-development capacity has either already become operational or is no longer going ahead but we are unable to confirm this.
[5] Capacity for energy storage technologies is measured in MWh (megawatt hours) rather than MW (megawatts) because storage technologies are measured by the amount of energy that can be stored.
[6] Energy storage technologies are not counted towards the 2 GW target because they do not generate energy, but only store it for later use.

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1. Introduction

The Scottish Government has set a target of 2 GW of renewable energy to be community or locally owned by 2030.[7] Renewable energy technologies are defined as those which generate electricity, heat or both from natural sources that are replenished at a higher rate than they are consumed.[8] Common sources of renewable energy include solar energy, wind energy, hydropower and bioenergy. See Appendix C for the full list of technologies included within the report.

Energy Saving Trust was asked in 2011 by the Scottish Government to produce a database of all community and locally owned renewable energy installations in Scotland. This database is used to monitor progress towards the Scottish Government's target and progress is reported on annually. This database has been updated each year since 2011 and includes, as far as possible, all installations known to be operating, under construction, or in earlier stages of development as of 31 December 2022.

As energy storage technologies have become more common, findings on the capacity and type of community and locally owned energy storage systems have been included in this report since 2016. As energy storage systems do not generate renewable energy, the capacities of energy storage technologies are not included in the progress towards the 2 GW target but are presented to provide additional information on the growth of community and locally owned energy storage systems.

It is important to be aware that we have updated aspects of the time series as part of our continual improvement of the data and reporting method which means historic figures published in this report will differ from previous reports in the series. Details of the changes are set out in Chapter 2. There remain several methodological limitations which are also important to be aware of to have the best understanding of the presented results. Please refer to Appendix B4 for more details.

[7] https://www.gov.scot/publications/local-energy-policy-statement/pages/4/
[8] https://www.un.org/en/climatechange/what-is-renewable-energy

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With thanks to

The report draws on various sources of data from Energy Saving Trust and other organisations and has been compiled with thanks to:

- Local Energy Scotland, who deliver the Community and Renewable Energy Scheme (CARES)
- Scottish Federation of Housing Associations (SFHA)
- The housing associations who responded to our survey
- The local authorities who responded to our survey
- NHS Scotland
- Eunomia, who prepare the Renewable Energy Planning Database (REPD)
- Scottish Forestry (previous Forestry Commission Scotland)
- Scottish Water
- UK Department of Business, Energy and Industrial Strategy (BEIS)
- Community Energy Scotland, who with Community Energy England and Community Energy Wales publish the Community Energy: State of the Sector report[9]

We would also like to extend our thanks to the many other organisations and individuals who helped with time or information.

For any questions or comments relating to the Community and Locally Owned renewable energy database, or accompanying analysis and report, please contact RenewableReporting@est.org.uk.

[9] https://communityenergyscotland.org.uk/wp-content/uploads/2021/06/UK-SOTS-Full-Report-reduced-file-size.pdf

2. Changes to reporting 2022

There were two significant changes to our reporting in 2022 compared to previous reports.

The first change is that we have created a revised time series going back to 2010. The updated time series is the result of continual improvement to the existing data and backdating new installations that are known to be operating prior to 2022 to their correct historic reporting year. Typical improvements to the data include reviewing and updating installation operating dates which can move operational capacity from one year in the series to another. We have also better included decommissioned installations as well as installations which begin or end being community or locally owned during the time series so that they are included only in the years in which they are operational and considered community or locally owned.

In previous reports, we mainly commented on the change in capacity in comparison to the figures published in the previous year. Such an approach is limited because some of the growth seen between reports was historic and could be confused with the growth seen within the latest reporting year. Therefore, we have moved to updating the time series each year and using this to provide updated results and trends for historic years. These improvements will better identify the growth in each reporting year and allows commentary on more realistic trends in the sector. As the latest report in the series will now be the most up to date and accurate reflection of growth and trends in the sector, only the latest report should be referred to.

The second significant change to this year's reporting is that we have excluded the social let Energy Performance Certificate (EPC) analysis from the revised time series. The social let EPC analysis involves cross checking installations held within our own database with renewable installations found in the domestic EPC register of Scotland for properties with social rented tenure status. This analysis was introduced for the 2020 and 2021 reporting years, but as we recently explored extending this analysis for earlier years, we found a raised risk of double counting that requires further investigation. We have therefore excluded the 'undetermined social housing' category due to the risk of double counting. This means in the current report we are underestimating the true capacity and number of installations in community and local ownership but to an unknown extent. We will seek to address this in future reporting.

Please refer to Appendix A for more details.

3. Progress towards the 2 GW target

At the end of December 2022 an estimated 908 MW of community and locally owned renewable energy capacity was operational in Scotland. This means that at the end of 2022, the Scottish Government has progressed 45% towards their target of having 2 GW of operational community and locally owned renewable energy capacity by 2030, see Figure 1. For ease of comparison with capacity figures reported in MW, we refer to the 2 GW target as the equivalent 2,000 MW throughout the report. The capacity in operation is from a total of 26,290 individual renewable energy installations.

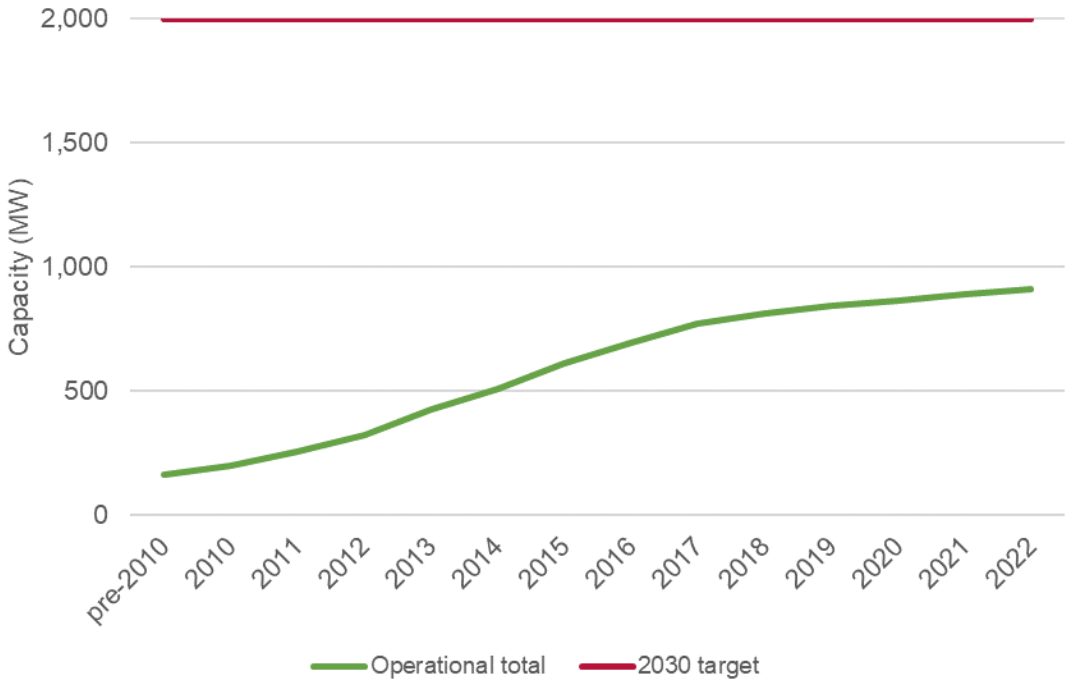

Figure 1. Total operational capacity and the 2030 2,000 MW (2 GW) target

3.1. Operational capacity and number of installations 2022

Results by community and local ownership category

A breakdown of operational capacity and number of installations by community and local ownership category is given in Table 1 and illustrated in Figure 2 and Figure 3.

Table 1. Operational capacity and number of installations by ownership category, 2022

Ownership category	Operational capacity (MW)	Percentage of operational capacity	Number of installations	Percentage of installations
Farm and estate	370	41%	930	4%
Local authority	157	17%	11,340	43%
Local business	117	13%	780	3%
Community	101	11%	660	2%
Public sector and charity	85	9%	540	2%
Housing association	78	9%	12,050	46%
Total	**908**	**100%**	**26,290**	**100%**

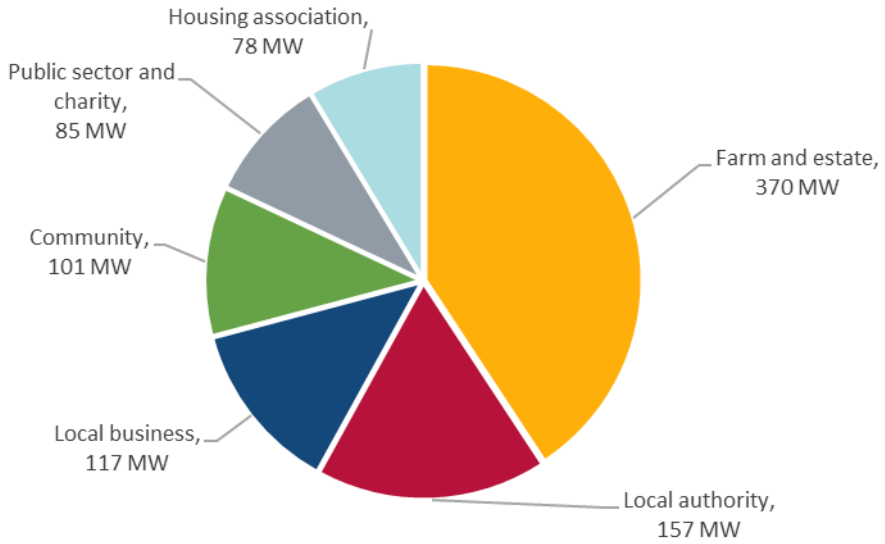

Figure 2. Operational capacity by community and local ownership category, 2022

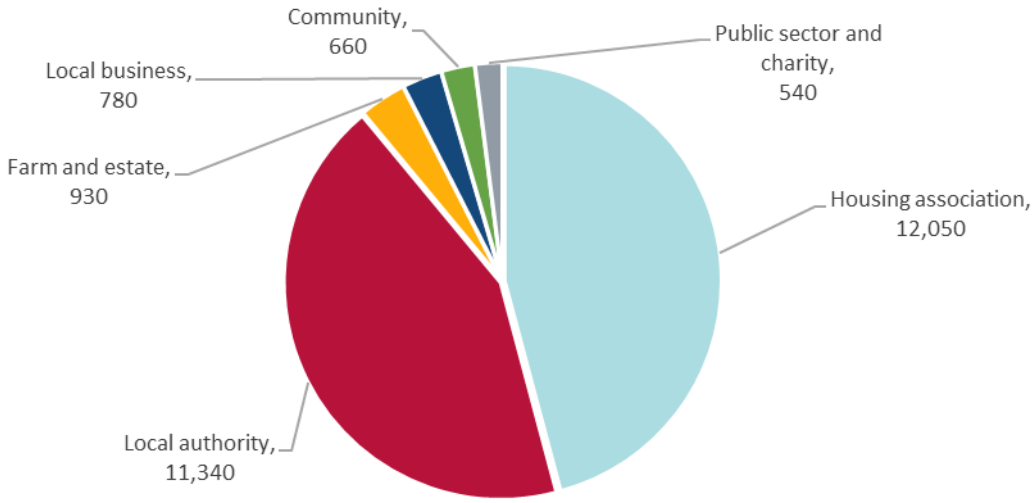

Figure 3. Number of operational installations by community and local ownership category, 2022

The largest proportion of operational capacity was on Scottish farms and estates (41%) despite making up a small proportion (4%) of the total number of installations. Local authorities have the next largest share of total capacity (17%) but also own a considerable share of the total number of installations (43%). Housing associations have the largest share of the total number of installations (46%) but a relatively low share of the total capacity (9%).

Results by technology

A breakdown of operational capacity and number of installations by technology is given in Table 2 and illustrated in Figure 4 and Figure 5.

Table 2. Operational capacity and number of installations by technology, 2022

Technology	Operational capacity (MW)	Percentage of operational capacity	Number of installations	Percentage of installations
Wind	338	37%	740	3%
Biomass	277	30%	1,240	5%
Heat pump	90	10%	8,870	34%
Solar PV	80	9%	11,570	44%
Biogas	56	6%	50	<1%
Hydroelectric	45	5%	190	<1%
Solar thermal	17	2%	3,640	14%
Waste	6	1%	<10	<1%
Total	**908**	**100%**	**26,290**	**100%**

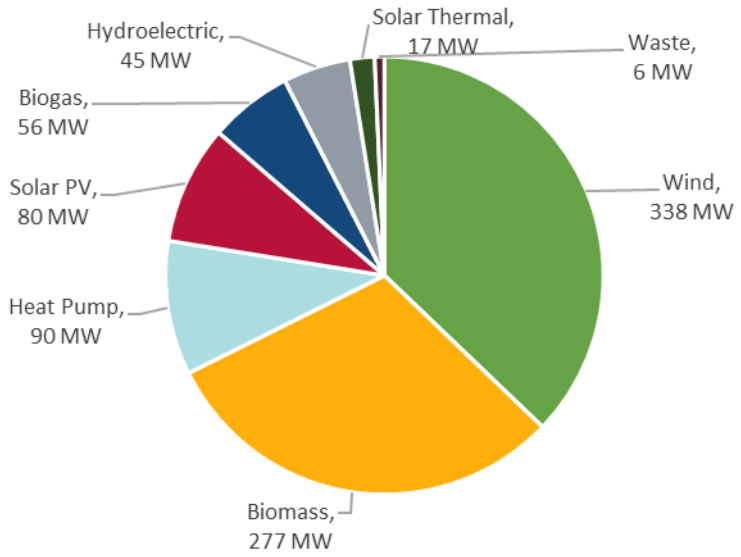

Figure 4. Operational capacity by technology, 2022

Table 2 shows that wind installations are responsible for the greatest share of reported operational capacity (37%) followed by biomass (30%). However, both technologies are responsible for relatively small shares of the total reported number of operational installations, at 3% and 5% respectively.

In comparison, the technologies comprising the greatest percentages of the number of installations are solar PV (44%) and heat pumps (34%) However, these make up relatively small percentages of the total capacity, at 9% and 10% respectively.

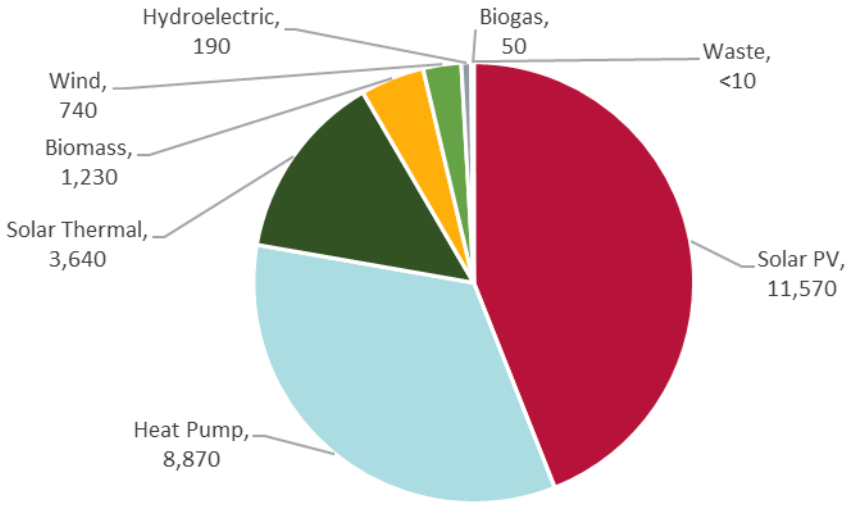

Figure 5. Number of operational installations by technology, 2022

Results by local authority area

Figure 6 and Figure 7 show the distribution of operational community and locally owned renewable energy capacity and number of installations respectively for the local authority areas of Scotland as at the end of December 2022.[10]

Figure 6 shows that the majority of community and locally owned renewable energy capacity is found in the more rural local authorities. Rural local authorities may host higher capacities because they are more likely to have abundant natural resources to generate renewable electricity or heat, such as wind or wood. This is explored more in detail in the patterns between ownership category and technology section. The local authority areas which are contributing the most capacity are Aberdeenshire and Highland.

Figure 7 shows that most of the community and locally owned renewable energy installations are found in the local authorities that are a mixture of urban and rural according to the Scottish Government's 8-fold urban rural classification.[11] The local authority areas which are contributing the most installations are Stirling, South Lanarkshire and Fife. The installations in the local authorities which have the greatest number of installations are mostly in local authority and housing association ownership. The local authority areas with the greatest number of installations are thus not necessarily tied to geography but to which areas are known to have had large renewable installations programmes for social housing. To some extent the geographic distribution of installations may also be methodological and a reflection of which local authorities and housing associations have responded to our surveys; see Appendix B4 for more information on methodological limitations. If regional gaps in domestic renewable energy installations exist, an analysis of the EPC register may help to fill them in; see Appendix A for more information on our future reporting plans.

[10] Please note that these maps show more than 99% of the reported total capacity and number of installations. A small percentage has been omitted because we cannot allocate it to specific local authority areas.
[11] https://www.gov.scot/publications/scottish-government-urban-rural-classification-2020/

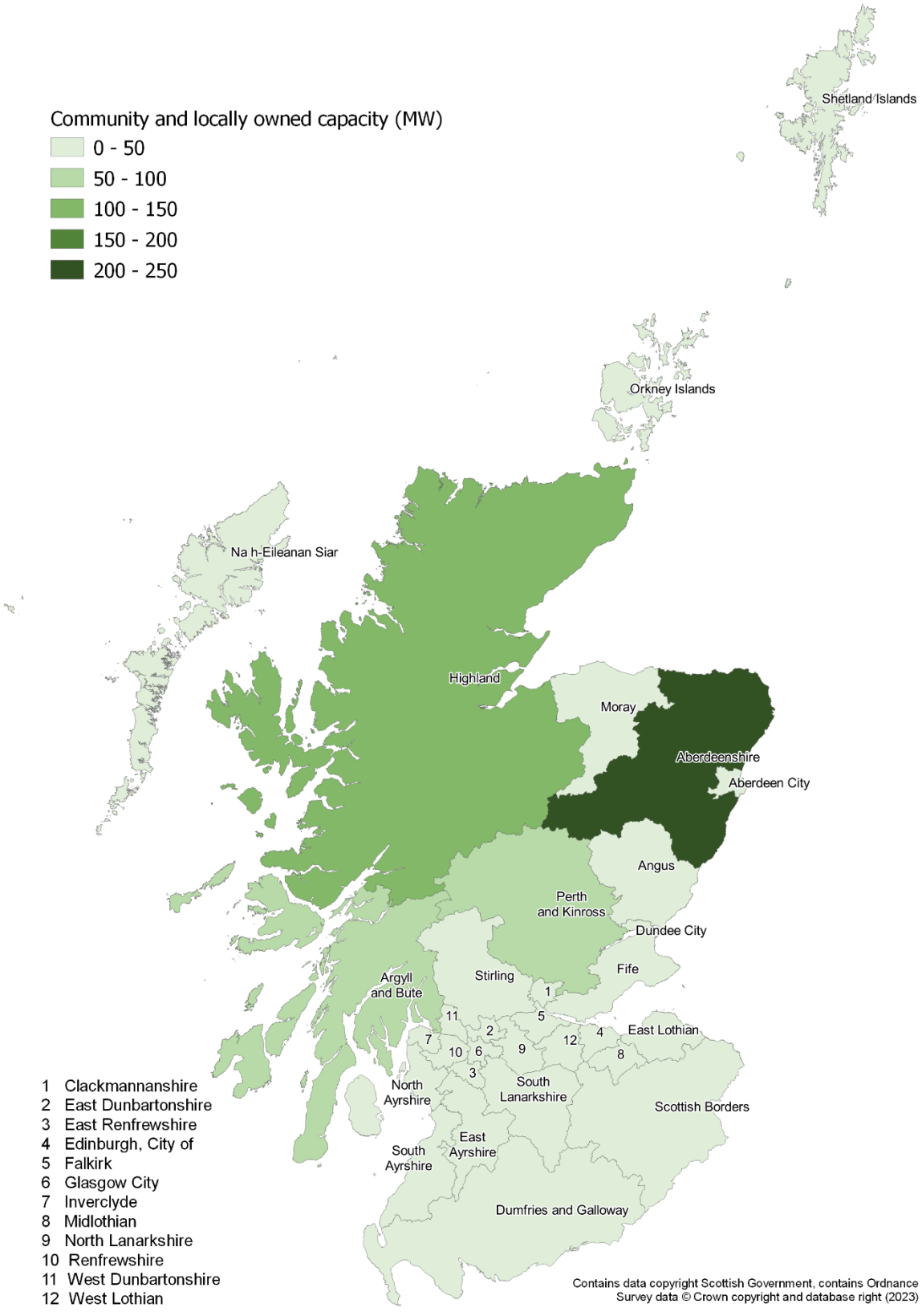

Figure 6. Total operational renewable energy capacity in community and local ownership, 2022

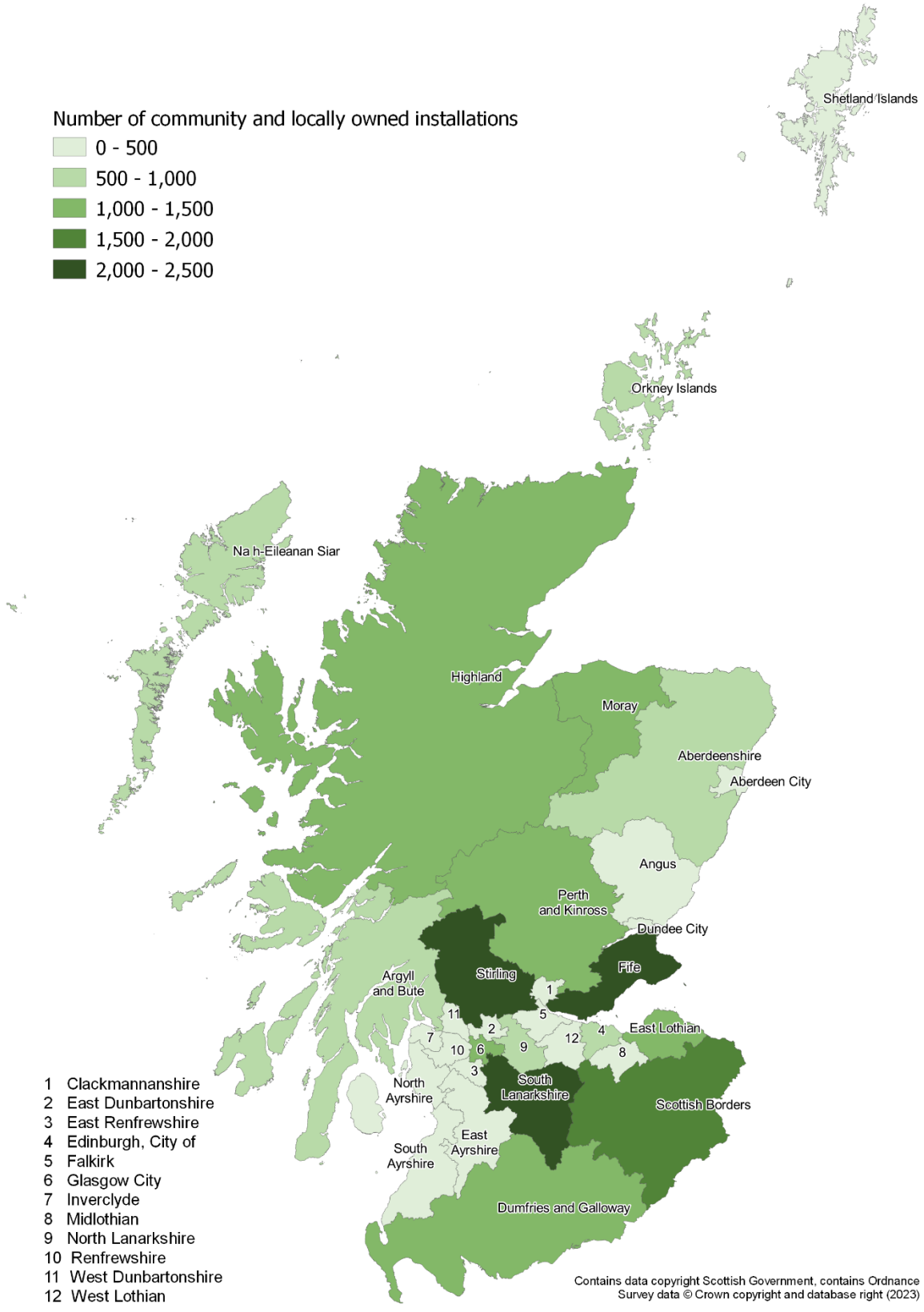

Figure 7. Total number of operational renewable energy installations in community and local ownership, 2022

The patterns between ownership category and technology

To understand the trends and growth of community and locally owned renewable energy, it is important to consider which technologies are being installed by the different ownership categories and why. Figure 8 shows the distribution of operational capacity for each technology by ownership category.

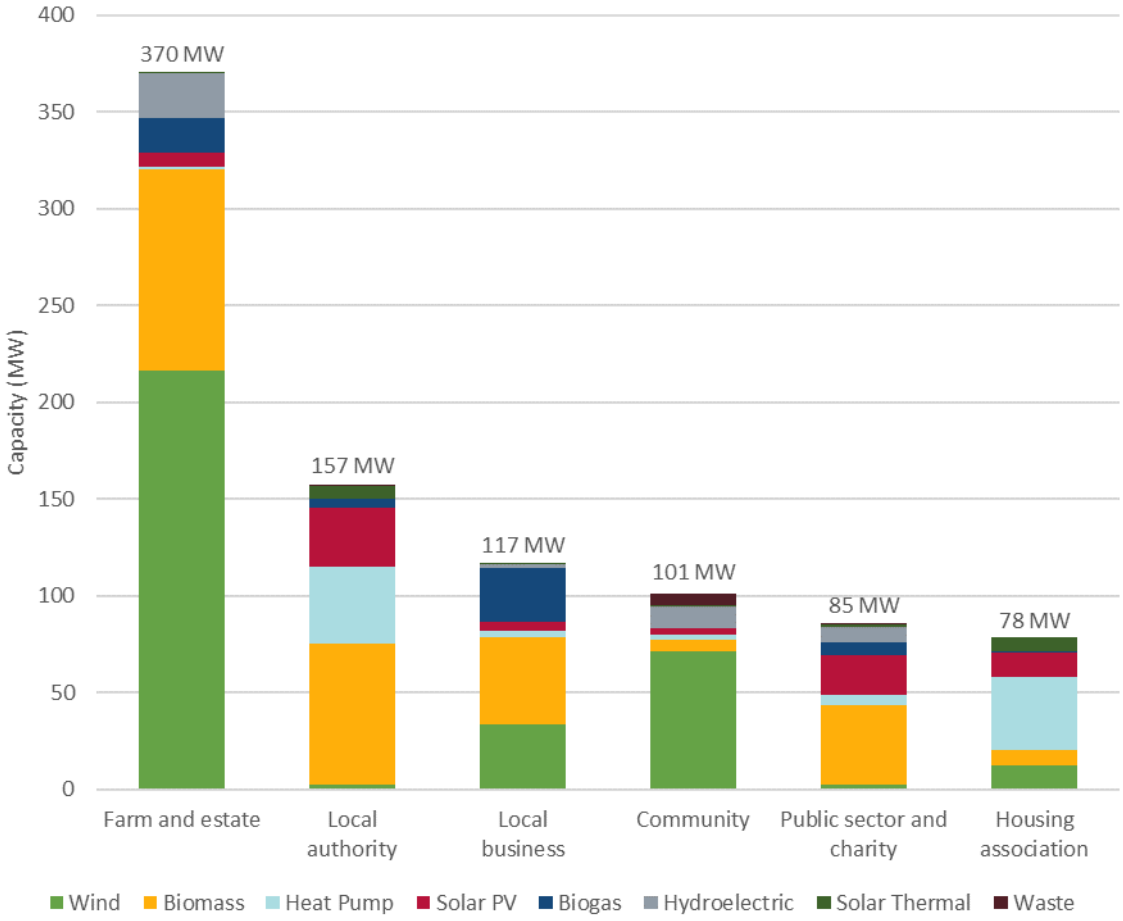

Figure 8. Operational capacity by ownership category and technology, 2022

Figure 8 shows that wind, biomass and hydroelectric technologies are most commonly installed on farms and estates. These technologies may be more suitable on farms and estates where the natural resources are abundant, such as suitable bodies of water or areas of higher speed, unobstructed wind. Moreover, farms and estates are often in rural and off-gas grid areas so there can be significant appeal for biomass installations to replace more expensive fossil fuels or using local woodchip or on-site agricultural waste to generate heat. Farm and estate installations have on average much larger capacities than the other ownership categories. This may be because they are scaled to offset higher business-related energy consumption or to generate electricity for export to the grid.

Local authorities and housing associations have most often installed heat pumps, solar PV and solar thermal technologies. These technologies are well suited for providing space heating, hot water and electricity to domestic properties. This is why local authority and housing association owned installations have on average much smaller capacities compared to the other ownership categories. Local authorities also own a considerable amount of biomass capacity, contributing 26% of the total biomass operational capacity. These are typically used to meet the high and relatively steady heat demands of non-domestic properties such as schools, or feed into heat networks.

The majority of community owned renewable capacity is from wind and hydroelectricity technologies. Both can be attractive investments to local community groups either to directly make use of natural resources within their local area or as part of shared ownership offers from renewable developers.

The public sector and other charitable organisation category makes use of a wider mixture of technologies compared to most other ownership categories. This may be because this ownership category covers a wide variety of organisations, such as NHS facilities, further education institutions and public bodies, which are likely to have very different energy end uses. Some individual organisations also operate a wide range of technologies tailored to meet or make use of site-specific demands and opportunities. For instance, Scottish Water, Scotland's publicly owned water company, have installed biogas combined heat and power (CHP) units using anaerobic digester and sewage produced gasses, heat pumps to extract heat from waste water and solar PV to generate electricity at their waste water treatment sites.[12]

The local business category also owns a wide variety of different technologies and, similar to the public sector and other charitable organisation category, this may be due to the variety of local businesses in Scotland which own renewable energy installations. Of particular note is that the local business ownership category has a relatively high share of capacity coming from biogas compared to the other ownership categories. This can be attributed to waste management businesses having a readily available supply of waste to generate energy.

3.2. Estimate of annual output from reported total capacity

Over a year, the 908 MW of operational community and locally owned renewable energy capacity is estimated to produce 1,933 GWh of renewable energy. This consists of around 1,054 GWh of electricity, 686 GWh of heat and 189 GWh of energy from CHP installations. Please see Appendix B9 for the methodology for estimating output.

The breakdown of total output into electrical, heat or CHP output is shown in Table 3 and Figure 9.

Table 3. Operational output by energy type, 2022

Energy type	Operational output (GWh)	Percentage of operational output
Electricity	1,054	55%
Heat	686	35%
CHP	189	10%
Unknown	3	<1%
Total	**1,933**	**100%**

[12] https://www.scottishwater.co.uk/about-us/energy-and-sustainability/renewable-energy-technologies

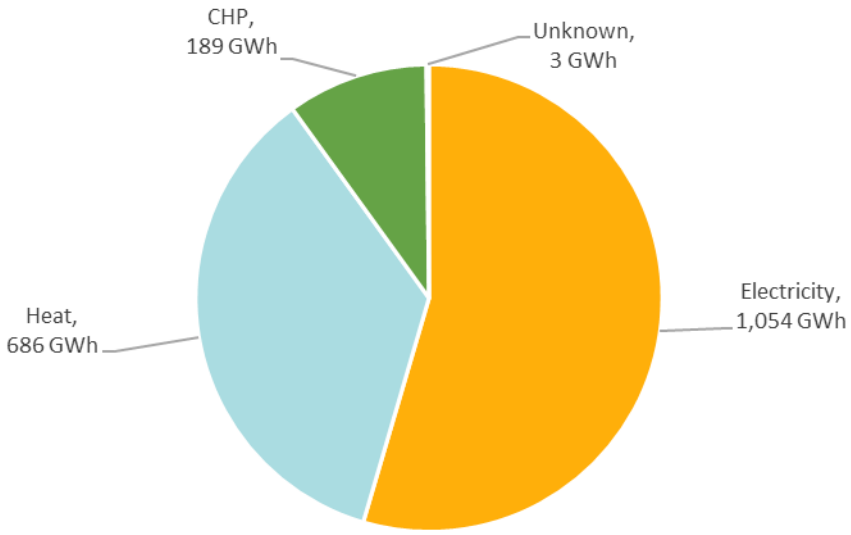

Figure 9. Operational community and locally owned renewable output by energy type, 2022

3.3. Community and locally owned energy shared ownership installations

Some installations have more than one owner and this information is recorded to better capture in-development community and locally owned energy. This also provides additional context to the Scottish Government's ambition to ensure that at least half of newly consented commercial renewable energy installations have an element of community ownership by 2030.[13] The Scottish Government encourage developers to offer shared ownership opportunities on all new renewable energy projects, including the repowering of existing sites and extensions to existing projects.[14,15] Installations were identified as being 'under discussion' through Community and Renewable Energy Scheme (CARES) engagement with community groups and developers. The full definition of different shared ownership is presented in Appendix B7.

At the end of December 2022, there were 550 installations with either shared ownership or where shared ownership is under discussion.[16] Of these, 440 were reported as operational. These operational installations accounted for 74 MW of community and locally owned capacity between them. The remaining 110 installations were in various stages of development and accounted for 1,082 MW of the in-development capacity. Wind turbines make up the vast majority of the shared ownership operational capacity in operation (70 MW) and under development (1,070 MW).

The 1,082 MW of in development capacity from 110 installations contrasts with the 78 MW of operational capacity from a much larger number of installations at 440. This is due to very large capacity wind farms forming most of the 110 installations. Even a relatively small share of a large capacity wind farm can bring significant step changes in community or locally owned renewable energy capacity. However, it is expected that not all of the projected 1,082 MW of community and locally owned capacity will be achieved due to some installations not being consented, not being built, the percentage of shared ownership will be reduced or will fail to agree shared ownership.

[13] https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/pages/14/
[14] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/pages/4/
[15] https://www.gov.scot/publications/onshore-wind-policy-statement-2022/pages/5/
[16] We have moved away from using "projects" to describe shared ownership activity for consistency of the report and better clarity as the definition of a "project" can be subjective.

4. Community and locally owned renewable energy time series

As part of our continual improvement of the data, we have produced the following time series of community and locally owned capacity and number of installations. Please refer to Chapter 2 and Appendix A for the methodology changes made for this time series.

There was 37 MW of operational capacity newly reported to us this year. Approximately 20 MW of this capacity became operational in the 2022 reporting year, with the remaining 17 MW attributed to previous reporting years. The 2011, 2015, 2016 and 2021 reporting years have shown the most change due to these revisions. Please refer to Appendix A for the changes to each historic year.

Revisions to the most recent reporting years can be significant because it can take a year or more for operational installations to become known to us after their operating date. For instance, out of the 17 MW that was added to historic years, 8 MW was added to 2021. This increased the reported growth in operational capacity for 2021 by 52% from the 2021 report. Therefore, we expect that the growth in operational capacity for 2022 may be revised in future reporting should installations not currently known to us become identified.

Figure 10 shows the latest time series of total operational capacity from pre-2010 to 2022, and Figure 11 shows the time series for total operational number of installations.

The growth in capacity was generally steady between 2010 and 2017 before slowing down (Figure 10). The number of installations also shows a similar steady growth (Figure 11).

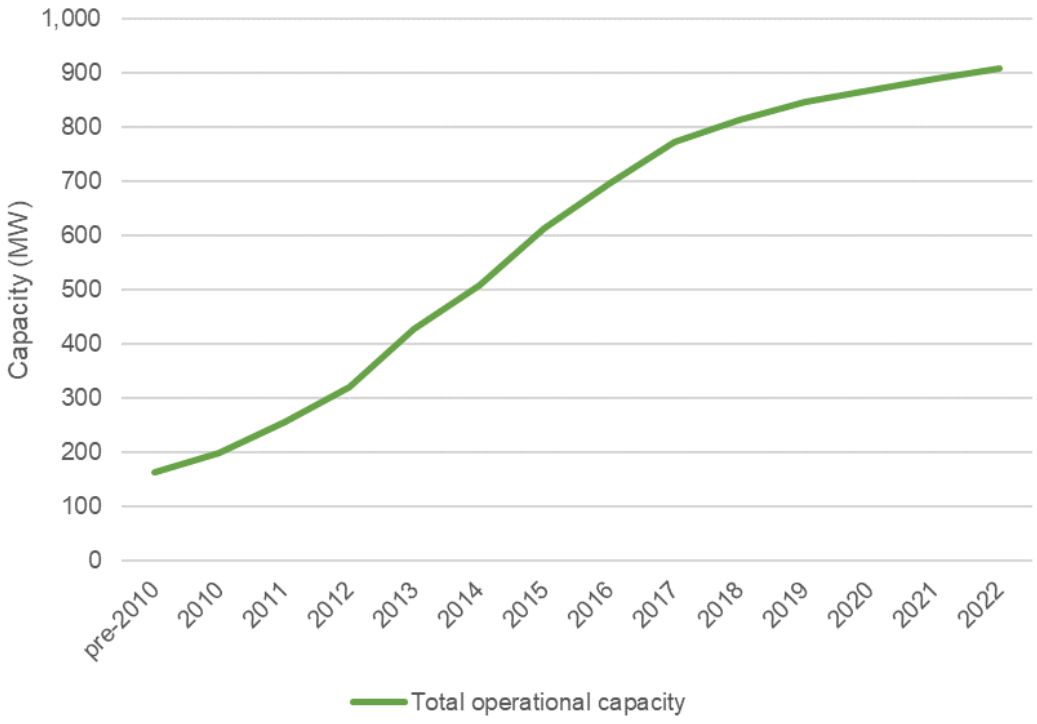

Figure 10. Total operational capacity, pre-2010 to 2022

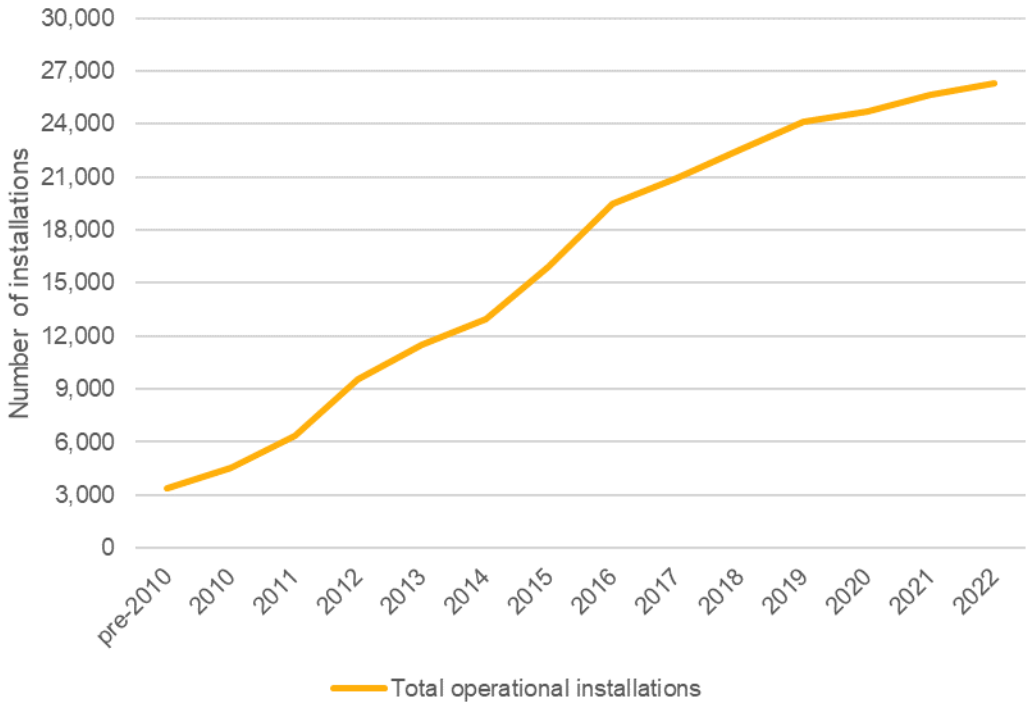

Figure 11. Total operational number of installations, pre 2010 to 2022

From 2011 to 2017, the average annual growth in operational capacity is 82 MW, which is much higher compared to the average annual growth of 27 MW from 2018 to 2022. This trend is heavily correlated to the technologies which typically have larger capacities, such as wind and biomass. Before 2017, wind and biomass were more frequently installed and then less so after 2017. The installation rates of heat pumps and solar PV did also decrease after 2017 but to a lesser extent; and as these technologies typically have much smaller capacities this is overall less impactful on the total capacity trends.

In the beginning of the time series, the likely key contributors to the rapid growth in capacity were the UK Government's Feed in Tariff (FiTs) scheme[17] and Renewable Heat Incentive (RHI) schemes[18], which subsidised renewable electricity and renewable heat respectively. The level of subsidies paid under these schemes decreased over time and eventually closed to new applicants towards the end of our time series. The UK Government's Smart Export Guarantee (SEG) scheme launched in 2020 to subsidise renewable electricity but it provided a lower level of subsidy than what was available under FiTs. The reduced or removed UK Government subsidy support for electricity and heat are likely the most significant causes of the slowing uptake of new renewable capacity between 2017 and 2022.

As well as UK government subsidy support, we recognise there are a full range of factors that influence renewable energy installations uptake, including but not limited to original equipment manufacturer (OEM) price, supply chain resilience, economic conditions, and Scottish Government policy and regulations. Although we have limited information to comment on all the factors above, we have provided information about the Scottish policy and support environment below for further context.

Scottish policy perspective

The uptake of renewable energy installations was encouraged in Scotland through the Energy Efficiency Standard for Social Housing (EESSH), enacted by the Scottish Government in 2014. The standard mandated that social let properties must reach certain energy efficiency standards by set dates, with the first milestone being to reach EPC band E, D or C (average efficiency or above) by 2020, with the specific target EPC band depending on the property type and heating fuel in use. It may have been possible to meet the 2020 required standard in many properties without installing renewable technologies because good levels of

[17] The Feed in Tariff (FiTs) scheme launched in 2010 and closed in 2019.
[18] The non-domestic Renewable Heat Incentive (RHI) scheme launched in 2011 and closed to new applicants in 2021. The domestic RHI scheme launched in 2014 and closed to new applicants in 2022.

insulation and an efficient fossil fuel system may have been sufficient, but some social landlords would have opted for renewables where it was efficient or cost effective to do so.

The post-2020 Energy Efficiency Standard for Social Housing (EESSH2) required from December 2025 for any social let property to be EPC band D or above before it could be relet, subject to specific temporary exemptions, and for all social let properties to meet an EPC band B (high energy efficiency) by 2032. These requirements are currently suspended while EESSH2 undergoes a review to bring the standard in line with the Scottish Government's net zero targets. This review is due to be complete in 2023 and although the details are not yet confirmed, the standard is likely to continue to encourage or require the installation of renewable energy technologies. We therefore expect to continue to see the steady uptake of renewable technologies in social housing.

For new build properties, similar regulations enacted by the Scottish Government in 2016 stipulate that property developers must show carbon dioxide emission reductions for new build properties relative to baseline property models. An efficient way to meet these standards can be to install renewable energy technologies and as a result, the regulations have encouraged, and will continue to encourage, the uptake of renewable technologies in a considerable number of new build properties, of which a proportion will be social tenure.

As the financial viability of renewable energy installations and the financial support available are key drivers in the growth of renewable energy, we expected to see some degree of slowing in the uptake of installations in line with significant changes to the availability and size of UK Government renewable energy subsidies.

The Scottish Government has maintained financial support for community and locally owned renewable energy throughout the last decade through various funding and support schemes, including:[19]

- Community and Renewable Energy Scheme (CARES)
- District Heating Loan Fund (DHLF)
- Small and Medium Enterprise (SME) loan and cashback scheme
- Low Carbon Infrastructure Transition Programme (LCITP) – the scheme is now closed to new applications.
- Energy Investment Funding (EIF) / Renewable Energy Investment Funding (REIF)

Of the above schemes, CARES is due to run until at least 2025, and the SME loan and cashback scheme and other support for small businesses are also expected to continue. The successor to the LCITP, Scotland's Heat Network Fund,[20] opened to applications on the 21 February 2022, and will support the development of new zero emission heat networks and communal heating systems as well as the expansion and decarbonisation of existing heat networks across Scotland. The Scottish Government continues to support the social housing sector through the Social Housing Net Zero Heat Fund,[21] which provides capital support to registered social landlords to help install zero emission heat systems and energy efficiency works in their housing stock.

[19] These programmes constitute some of the best data available on the growth in community and locally owned renewable energy in Scotland and the majority of installations funded through them can be found in our database (excluding any organisations not considered to be community or local organisations by the definitions set out in this report).
[20] https://www.gov.scot/publications/heat-network-fund-application-guidance/
[21] https://www.gov.scot/publications/social-housing-net-zero-heat-fund-development-funding-invitation/

5. Further community and locally owned capacity in development

In addition to the 908 MW of community and locally owned renewable energy capacity estimated to be operational at the end of December 2022, a further 1,505 MW was estimated to be in various stages of development.

Of the renewable energy capacity estimated to be in development:

- 62 MW was in the scoping stage
- 131 MW was waiting for a planning decision to be made ('in planning')[22]
- 186 MW had been granted planning permission, but construction had not yet started ('consented, not built')[22]
- 42 MW was under construction
- 1,082 MW was under discussion for potential shared ownership between a renewable developer and a local or community group ('shared ownership under discussion')
- 2 MW was at an unknown stage of development

The total capacity in each stage of development held within the community and locally owned renewable energy database is shown in Figure 12, and a breakdown by technology type is given in Table 4.

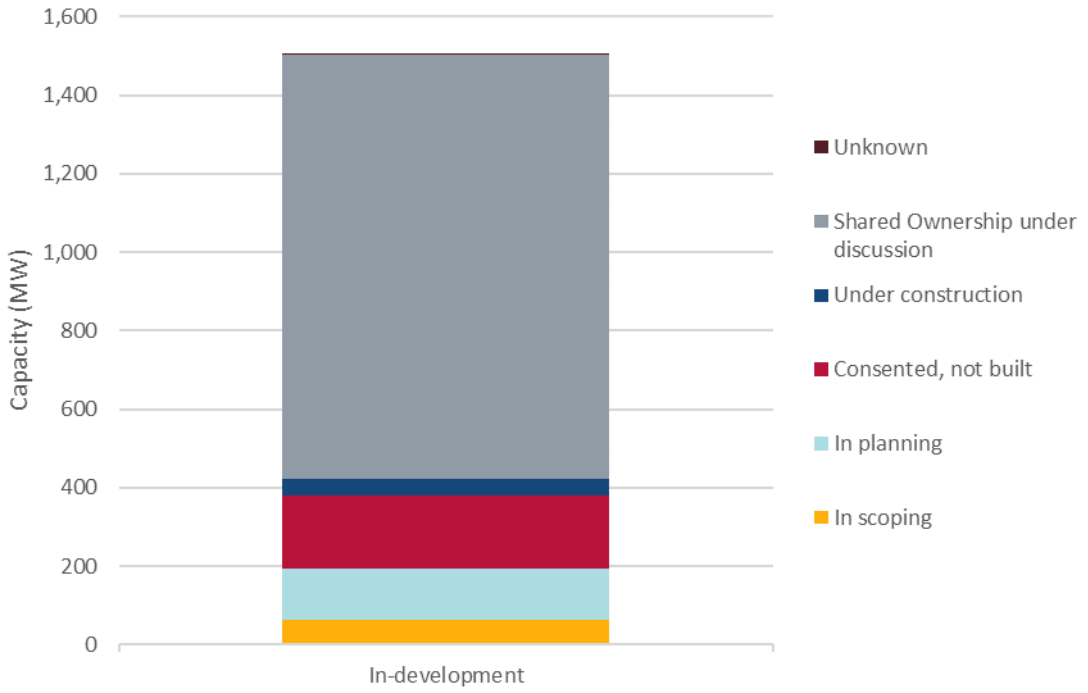

Figure 12. Capacity in each stage of project development, 2022

[22] Applies only to installations that would require planning permission.

Table 4. Capacity (MW) in each stage of development by technology[23]

Technology	In scoping	In planning	Consented, not built	Under construction	Shared ownership under discussion	Total
Wind	21	96	127	8	1,070	1,324
Solar PV	28	6	22	5	7	68
Biogas	<1	0	20	11	<1	32
Heat pump	<1	3	6	12	0	23
Tidal	<1	20	1	0	0	21
Hydroelectric	5	2	6	3	4	20
Biomass	2	4	3	3	0	13
Geothermal	4	0	0	<1	0	4
Solar thermal	<1	<1	<1	<1	0	<1
Grand total	**62**	**131**	**186**	**42**	**1,082**	**1,505**

[23] For ease of reading, the 2 MW of capacity classed as being in an unknown stage of development has been omitted from this table.

6. Community and locally owned energy storage in 2022

We have included commentary on energy storage technologies since 2016 as the technologies became more common in the sector. The Scottish Government also considers energy storage to be a potential contributor as part of the just transition to a net zero energy system.[24] We will continue to report on the energy storage development in the sector, albeit energy storage capacity does not contribute to the community and locally owned renewable energy target. At the end of December 2022, there was an estimated 10 MWh of installed energy storage capacity in community or locally owned ownership in Scotland. This was spread over approximately 1,090 installations.

Of the 10 MWh of energy storage capacity known to be installed there was an estimated:

- 3 MWh of electrical storage capacity
- 6 MWh of heat storage capacity
- 1 MWh of hydrogen storage capacity

The growth in energy storage capacity since December 2021 was all attributable to electrical storage (<1 MWh, 20 installations).[25] The ownership of the new electrical storage number of installations is split between community with 10 installations (<1 MWh); and local authority, local business and farm and estate each with less than 10 installations (<1 MWh) respectively.

The community owned electrical storage includes seven individual storage installations across six Scottish islands not connected to the mainland UK electricity grid. The islands rely on generators and renewable energy systems for their electricity and the installed battery storage systems allow communities to better manage discrepancies between periods of renewable electricity supply and demand.

6.1. Further energy storage capacity in development

In addition to the 10 MWh of community and locally owned energy storage capacity estimated to be installed in Scotland at the end of December 2022, a further 2 MWh was estimated to be in development. Of this 2 MWh of energy storage capacity in development:

- <1 MWh was under construction. This is all electricity storage capacity
- 1 MWh was in planning. This is mostly heat storage capacity with a very small amount of electrical storage capacity
- 1 MWh was consented, not built. This increase is mostly hydrogen storage and some electrical storage.

[24] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/pages/3/
[25] Due to data sensitivity reasons, all storage capacity less than 1 MWh will be displayed as <1 MWh.

Appendix A Changes for the 2022 time series and future considerations

The 2021 report was the first year that we introduced a revised reporting time series, and we have once again provided a fully revised time series for this iteration of the report. We make changes to the time series as part of our continual improvement of the data and from access to updated or improved datasets that we may not have had access to at the time of previous reporting.

Some of the key changes to the revised time series concern our review of installation operating dates, where more precise operating dates become known to us for particular installations, or where operating dates are found for several installations where they were previously unknown to us.

In addition, we have included records within the time series that became decommissioned or began or ended being community or locally owned during the time frame of the reporting series. As an example of the latter, some community delivered projects were sold into non-community and non-local private ownership sometime after completion of the project. This means that such projects should be present in our time series from the point of completion but be removed from the time series from the point of sale. Decommissioned or sold-out-of community or local ownership installations are not counted towards the 2,000 MW target in 2030, because they will not be operating or under eligible ownership by the target deadline; they are included only to better reflect the genuine changes in the sector over time.

The revised time series can be considerably different to the figures published in previous editions of the report. This is because historical reports in the series reported on the growth in capacity between publications. Such an approach is limited because some of the growth seen between reports was historical and should not be confused with the growth seen within the present reporting year. Commenting on the difference in capacity and number of installations between two years using the revised time series allows us to better report on the growth seen in any particular reporting year. It is important to note that it can be years before the total growth for a particular reporting year can be confirmed because it can take a considerable amount of time for some installations to become known to us either through survey or other data collection. Any comments on the trends in community or locally owned renewable energy within the last one or two reporting years may therefore be limited to an extent.

We will continue to improve the time series in the future by incorporating an analysis of renewables installed in social let properties found in the domestic EPC register of Scotland. This was not possible to achieve as part of this year's revised time series due to difficulties in cross-checking the available EPC data with records held within our own database. The risk of double counting was considered too high and more time is required to carry out this additional analysis.

Table 5 shows the non-cumulative capacity (MW) in each reporting year for both the 2021 and 2022 time series and their difference. Table 6 shows the cumulative capacity (MW) in each reporting year for both the 2021 and 2022 time series and their difference.

Table 5. Non-cumulative capacity (MW) by revised and unrevised time series

Report Year	Pre-2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2021 time series (MW)	NA	205[26]	66	62	103	79	97	75	77	41	33	19	15	NA
2022 time series (MW)	163	37	57	64	107	80	104	84	75	41	34	20	23	20
Difference (MW)	NA	NA	-8	1	4	1	6	9	-2	<1	1	<1	8	20

Table 6. Cumulative capacity (MW) by revised and unrevised time series

Report Year	Pre-2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2021 time series (MW)[27]	NA	205	270	332	435	514	611	686	764	804	837	856	871	NA
2022 time series (MW)	163	200	257	321	428	508	612	696	771	812	846	866	889	908
Difference (MW)	NA	-4	-13	-11	-7	-6	0	9	7	8	9	10	17	NA

[26] The 2010 non-cumulative totals for this year's and last year's time series are not directly comparable because last year's time series included operational capacity before 2010 within the 2010 totals whereas this year we have split them.
[27] The 2021 time series excludes the undetermined social housing category from the analysis to make comparisons consistent with the revised 2022 time series. Some 2021 cumulative capacity totals are therefore different from the previous report.

Appendix B Full methodology

The actions taken and assumptions used to try to ensure minimal gaps in the information contained in the community and locally owned renewable energy database are described below.

B1. Definition of 'community and locally owned'

As with previous versions of the database, the Scottish Government has requested that 'community and locally owned renewable energy' be defined as those which generate electricity, heat or both from natural sources that are replenished at a higher rate than they are consumed.[28] where the owner of the installation is in one of the following categories:

- A community group
- A local Scottish business[29]
- A farm or estate
- A local authority
- A housing association
- A 'Public sector or other charitable organisation', including:
    - Charities, including faith organisations and those found on the Scottish Charity Regulator (OSCR) website[30]
    - Public bodies or publicly owned companies
    - Further or higher education establishments such as universities and colleges

'Ownership' has not been restricted to cases where the organisation owns the entire renewable installation. It also includes cases where, for example, a community group or farmer has helped to meet part of the cost of developing and installing a renewable system in return for some benefit, such as a share in the income generated. In such cases, a percentage of the installation's capacity equal to the share owned by the community or local owner is counted towards the target.

'Ownership' does not include cases where the only benefit to the farmer or community group is a land rental payment from the owner or developer of the installation, or installations that generate community benefit payments but are owned by another organisation (for example a wind farm developer). The Scottish Government has established a register of community benefits from renewable energy installations[31] in order to help communities and renewable energy developers negotiate appropriate levels of community benefit payment.

There is naturally some overlap between the different categories of owners. For example, some community groups have charitable status, as do many housing associations; and farms and estates could also be considered local Scottish businesses. For the purposes of this report, the following definitions have been used to determine which category each installation belongs to:

- The **community** category has been defined as communities of place, i.e. based around a sense of shared location. They often have charitable status. In some instances, the renewable technology and/or income from it may be owned by a trading subsidiary, which may be registered as a separate company; but in all such cases the installations have been treated as under community ownership.
- The **farm or estate** category includes organisations where the renewable technology is installed on land currently used for agricultural or other farming purposes, or on buildings that are part of a farm or estate layout; and (where the installation needs planning permission) where the person or organisation listed as the applicant in the planning application gives their address as being in Scotland. Estate ownership is often difficult to establish, but where possible publicly available

[28] A full description of each eligible technology is given in Appendix C.
[29] Note this excludes Scottish businesses whose purpose is to develop renewable energy projects when the installation is at a distance from their own properties or where ownership and management of the installation is provided as an energy service company (ESCO).
[30] https://www.oscr.org.uk/
[31] https://localenergy.scot/community-benefits-register/

information has been used to establish whether estate owners are normally resident on the estate where the installation is to be built. Estate ownership is sometimes connected to or maintained through a charitable trust or a local business, but in such cases any related renewable energy installations have been included under farm and estate ownership.

- The **public sector and other charitable organisation** category cover publics bodies and charities. Public bodies are those listed in the National Public Bodies Directory,[32] including health bodies such as NHS health boards and public corporations such as Scottish Water. Other publicly owned organisations such as the fire and rescue services and the police forces are also included in this category, although they are not strictly public bodies. This category also includes further or higher education establishments who are members of Association of Scotland's Colleges (ASC)[33] or Universities Scotland.[34] Charities have been defined as charitable organisations found on the Scottish Charity Regulator website, which are not also a community group, housing association or estate owned charitable trust. This category has also been taken to include leisure trusts,[35] and churches and other religious organisations.
- The **local business** category is defined as small or medium-sized enterprises (SMEs) registered with Companies House[36] at an address in Scotland. The businesses must have fewer than 250 employees and not be a subsidiary of another business which has more than 250 employees or is registered outside of Scotland as per Companies House. Businesses receiving funding through CARES or through Resource Efficient Scotland (RES) SME loans have been included. Note that this definition excludes Scottish SMEs whose purpose is to develop renewable energy installations at a location significantly removed from their registered office, and where the business does not own the land where the installation will be built.[37]
- The **local authority** category includes all 32 unitary local authorities of Scotland.
- The **housing association** category includes all registered providers of social housing within Scotland other than local authorities. Although some housing associations are registered charities and others are community groups, any renewable energy installations owned by a registered social landlord is recorded under the housing association ownership category.

Any source of renewable energy generation, such as electricity, heat, combined heat and power or other unspecified energy categories, i.e. energy from waste installations, or types of energy storage, such as electricity, heat and hydrogen, which fell into the ownership categories listed above were included in the database.

B2. Approach taken and datasets used

The approach taken to collect data from each source is broadly in line with that taken to produce the previous versions of the database and accompanying report and is outlined below.

The data collection period was from January 2022 to December 2022. The figures reported in this publication are correct as of 31 December 2022.

A significant amount of time has been spent reviewing records for which detailed information has been previously hard to find and checks have been undertaken to assure quality and accuracy of data. To further improve quality, the final dataset used to compile the figures detailed in this report have been through an internal quality check. Despite the measures taken to ensure the accuracy of the data there are still uncertainties associated with the methodology used to compile the data. These are discussed later in this section.

[32] www.scotland.gov.uk/Topics/Government/public-bodies/about/Bodies
[33] https://collegesscotland.ac.uk/about-us
[34] www.universities-scotland.ac.uk/
[35] Leisure trusts supply sports facilities to local communities, often on behalf of unitary authorities.
[36] https://www.gov.uk/government/organisations/companies-house
[37] For example, an SME established to build and operate a renewable energy project could count as a 'local Scottish business' for the purposes of the Scottish Government's target if it was registered with Companies House at an address in Scotland, and either a) owned all the land where the installation was to be built, or b) if it did not own all the land, if its registered address indicated that it was physically located close to the address of the proposed installation.

Due to the large number of different organisations and different technologies covered by the Scottish Government's definition of 'community and locally owned renewable energy', information is sought from a variety of sources. This includes organisations administering Scottish Government or other public funding streams, local authorities and planning authorities, public bodies (e.g. NHS and Highlands and Islands Enterprise) and other groups of organisations which we believe are likely to be renewable energy owners themselves. In some cases, organisations were able to provide information about installations in more than one ownership category and for each ownership category there were a number of different information sources used:

- **Data from funding and delivery organisations**

There have been a variety of funding sources available in recent years to promote the uptake of renewable energy generation among different groups, such as communities and farms. Therefore, an important source of information for this database was information on the organisations who have received such funding, which was provided either by the funding organisation themselves (e.g. Scottish Government) or delivery and administration organisations (e.g. Local Energy Scotland, Energy Saving Trust and Ofgem).

- **Data from local authorities**

A survey was sent by email to all 32 Scottish local authorities enquiring about renewable energy and energy storage technologies fully or partly owned by local authorities. As this survey has now been undertaken as part of several annual updates of the community and locally owned database, we now have some information from all 32 local authorities.

- **Data from housing associations**

A survey was sent by email from the Scottish Federation of Housing Associations (SFHA) on behalf of Energy Saving Trust and the Scottish Government to all SFHA members. This survey asked about renewable technologies fully or partly owned by housing associations.

- **Data from the UK Renewable Energy Planning Database**

The UK Department of Business, Energy and Industrial Strategy (BEIS) publishes the Renewable Energy Planning Database (REPD),[38] which is maintained on their behalf by Eunomia. The REPD tracked the progress through the UK planning system of all renewable electricity-generating technologies with an electrical generation capacity of 0.01 MW (10 kW) and greater, and of some heat-generating installations. However, it does not record details of ownership. From October 2014 the REPD ceased tracking installations that are smaller than 1 MWe. This has made the tracking of smaller installations more challenging and means the number of smaller installations in operation and in various stages of development may now be further underestimated.

- **Data from planning authorities**

As part of this year's data collection, information was collected from 12 of the 32 Scottish local authority planning portals for any planning application which involved a renewable technology being installed after 31 December 2018, and where the applicant could be confirmed to be a community or local organisation and the owner of said installation(s).

- **Data from Scottish Enterprise**

Scottish Enterprise provided information on renewable installations that had received support from the Renewable Energy Investment Fund (REIF). While the majority of the installations listed were already recorded in the database from other sources, the data from Scottish Enterprise provided updates on key details such as operating status and capacity.

- **Data from Scottish Water**

Data on any Scottish Water owned renewable energy installations are provided directly to us by Scottish Water each year. The dataset includes information on the location, capacity and output of each installation. As Scottish Water are a publicly owned company, this dataset solely contributes to the public sector and other charitable organisation totals of the community and locally owned renewable energy database.

[38] www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

- **Data from the Community Energy: State of the Sector report**[9]

Community Energy England, Scotland and Wales jointly conduct a survey of community organisations, collecting data on the number, capacity, output and operating date of renewable energy installations in their ownership. Energy Scotland shared an extract of their survey responses with us, and this has been used to populate our database with additional records, and to validate existing ones. Please note that there are methodological differences between the State of the Sector report and this publication series which means that the community owned capacity results from both do not precisely align with one another.

- **Low Carbon Infrastructure Transition Programme (LCITP)**

The Scottish Government provided data on installations that had received funding through the Low Carbon Infrastructure Transition Programme (LCITP). The programme which was launched in 2015 and closed to new applications in 2021.

Further information sources included:

- Information from individual installation owners, where necessary to confirm details such as capacity or ownership in response to telephone or e-mail contact
- Information available on Community Energy Scotland's website[39] and in its newsletters
- Individual community group, charity or housing association websites

Wherever possible, the information sought included:

- Name of the project
- Ownership (organisation and type of organisation)
- Where appropriate, the name of the subsidiary trading company owning the renewable technology on behalf of the community group or charity
- Location, including local authority area, address, and a postcode and/or grid reference
- Technology type
- Number and installed capacity of the technologies installed
- Operational status as at 31 December 2022 (operating / under construction / consented not built / in planning / in scoping / shared ownership under discussion / non-operational / decommissioned / cancelled), including, where possible, the date on which generation commenced for operational installations
- Percentage ownership by the community or local organisation in cases where the organisation did not have full ownership of the installation
- Where appropriate, the building type associated with the renewable energy or storage installation, to aid cross-checking with other sources and to better estimate yearly energy output
- Whether public grant or loan funding was received, to aid cross-checking with information received from bodies administering those funds

Other data sources not used in this update of the database

The information sources listed below were investigated for the first version of the database and report, but the publicly available information on these was found to contain either information captured elsewhere, insufficient detail for this project or were unavailable for access.

- Carbon Reduction Commitment (CRC) Energy Efficiency Scheme (administered in Scotland by the Scottish Environmental Protection Agency (SEPA) on behalf of BEIS)
- The Feed-in Tariff (FIT) scheme (administered by Ofgem on behalf of BEIS)
- The Renewable Heat Incentive (RHI) (administered by Ofgem on behalf of BEIS)

[39] www.communityenergyscotland.org.uk/

- Installations registered for the Climate Change Levy, and Renewable Energy Guarantees of Origin (administered by Ofgem on behalf of BEIS)
- Scotland's Climate Change Declaration

A full list of the main data sources used, and the organisations that provided them, is given in Appendix D.

Data quality

Not all the required information was available from all sources. Given the large number of installations covered by the community and locally owned renewable energy database, it was not possible to contact each project individually, or to track down all missing details from other sources. Priority was given to ensuring the database contained the correct information with regards to technology type; operational status; installed capacity; and percentage community or local ownership share. The status of installations that were under development as of 31 December 2021 has remained the same if no evidence has been found that the project has progressed as of 31 December 2022.

The quality of data provided varied considerably. In particular, installed capacity was often not provided, and operational status was sometimes unclear.[40] Technology type was sometimes also unclear (for example 'solar', which does not indicate whether the installation is a solar PV panel generating electricity, or a solar thermal panel generating hot water). In these cases, we have recorded as much information as has been provided by the data source but have not made assumptions on the technology or size of system. In some cases, a known capacity has been recorded, but the technology type is unknown. As the annual output assumptions used are dependent on technology type, the annual output for these systems cannot be estimated.

Data received from BEIS's REPD provided very good location data and operational status, but did not contain information on ownership, which had to be sought from other sources (mostly the planning authorities).

Location data was often missing or incomplete. In the case of installations still in scoping, location had not always been decided at the time of data collection.

B3. Information collected

Wherever possible, the information collected for each installation includes:

- Name of the project
- The owning organisation (including the category of community or local ownership as per the list set out in Appendix B1)
- Where appropriate, the name of the subsidiary trading company owning the renewable technology on behalf of the community group or charity
- Location, including the local authority area, address, postcode and national grid coordinates
- Technology type as per the list set out in Appendix C
- The number of installations and the installed operational capacity
- The operational status as at the end of December 2022, selected from:
    - Operating
    - Under construction
    - Consented, not built
    - In planning
    - In scoping

[40] For example, grant and loan schemes frequently record the stage of the application for funding (loan offered or paid), but not the stage of the renewable technology itself e.g. under construction or operational.

- Shared ownership under discussion[41]
- Completed but non-operational[42]
- Decommissioned[43]
- Cancelled[44]

- The date on which generation commenced (for operational installations)
- The date on which the installation started or ceased to be community and locally owned
- The percentage of ownership by the community or local group in cases where ownership of the installations is shared with another organisation
- Where appropriate, the building type associated with the renewable energy installations
- Where public grant or loan funding was received to support the installation

B4. Methodological limitations

In order to present the figures of this report in the best context, we have included some information on the key limitations of the methodology used to produce them.

A significant issue with reporting on community and locally owned renewable energy is that owners, installers, certifiers and many funders of these renewable energy systems do not have a mandatory requirement to report that these systems are in community or local ownership. As such, much of the data we report on is voluntarily provided or is sourced from public datasets that do not include all the data we require. There is a risk that this introduces a degree of bias into the results. For example, our local authority and housing association totals will be skewed towards those organisations which respond to our surveys. We are aware that there are some potentially very useful datasets which may reduce this risk, such as the FiTs register or the Scottish domestic EPC register, that we do not currently have access to or were not able to analyse for this year's report.

Although we have built the time series to better reflect the growth in each reporting year and trends of the sector, it can however take years before the total growth for a particular reporting year can be confirmed. This is because it can take a considerable amount of time before an installation becomes known to us through surveys or other data collection. Any comments on the trends in community or locally owned renewable energy within the last one or two reporting years may therefore be more limited.

We strongly believe that the data we have collected does not form a fully complete picture of renewable energy in community and local ownership because there are very likely to be gaps in the information. These are gaps both spatially, due to the voluntary nature of some of the data reported to us, as well as temporally, due to the delay of an operational installation becoming known to us. Regular reviews are carried out to improve the amount or quality of data received. We pursue access to new datasets and review and, where necessary, revise the assumptions we use to fill in some of the data gaps.

Despite our best efforts, it remains possible that the interpretations made using our results may be biased towards the trends in the data collected rather than trends in the installation of renewable energy in community or local ownership. However, due to the extensive data collection that we do carry out, the depth of data collected and from Energy Saving Trust's experience in the sector and from over a decade of data collection, analysis and reporting on the Scottish Government's target, we consider the results presented here to be the best available on community and locally owned renewable energy in Scotland to date. We endeavour to continually improve the methodology and access to data sources, see Appendix A for more information on what is being considered for the next reporting year.

[41] Note that the majority of projects which are included in the 'under discussion' status are in various stages of development, including a small proportion which are already operational. Once an element of shared ownership has been agreed, installations will move from the shared ownership under discussion status into the true development status of the project.
[42] These statuses are not reported on as the installations are no longer operational and are therefore excluded from our operational or in-development metrics.
[43] These installations are only included in the reporting year that they are operating as community and locally owned renewable energy and removed from the decommissioning reporting year onwards.
[44] This status is not reported on as the installations are cancelled during development and are therefore excluded from pipeline estimates of in development capacity.

B5. Note on the units used in the report

When referring to renewable energy installations *"capacity"* refers to the maximum instantaneous power output of the system, in either electricity or heat. The capacity of technologies is usually measured in kilowatts-thermal (kW) or megawatts-thermal (MW), depending on the size of the installation. For ease of reading, the capacity totals presented in this report are all given in megawatts (MW), except when we were referring to the 2 GW target at the beginning of the report. One gigawatt is equal to one thousand megawatts.

Combined heat and power units have figures for electrical capacity and heat capacity. Where such installations are recorded in the database, the total installed capacity in MW is recorded. However, the supporting database attempts to also record both figures (electrical capacity and heat capacity).

"Energy output" is total energy of any type (electricity, heat or both) produced during a particular time. In the database, energy output is estimated for each technology on an annual basis. Energy is recorded in the database in megawatt-hours (MWh) and given in the report as gigawatt-hours (GWh). One gigawatt-hour is equal to one thousand megawatt-hours.

When referring to energy storage systems *"capacity"* refers to the maximum amount of energy that the system can store at one time and is measured in megawatt hours (MWh).

B6. Uncertainty levels associated with the methodology

In any analysis of this kind where data is gathered from a variety of different sources, total data coverage may be incomplete. This is for a number of reasons, for example:

- Incomplete information may be received on some installations
- The number of sectors and technologies that the database covers means there is a chance that some installations may have been missed altogether

Large capacity renewable energy installations are typically higher profile installations, and more likely to require planning permission (and planning records are a very good source of reliable information). Issues with data collection are therefore more likely for smaller capacity installations such as heat pump, solar thermal and solar PV installations.

The double-counting of installations is also a potential issue, although efforts have been made to avoid this. Due to the large number of data sources and the varying level of detail provided by different organisations there remains a risk that some double-counting of installations or their capacity may have occurred. Again, as large capacity renewable energy installations are typically higher profile installations, and more likely to require planning permission, double-counting is most likely to occur for smaller capacity installations such as heat pump, solar thermal and solar PV installations, and are therefore less likely to significantly affect the overall figures.

Some points for particular consideration in relation to data coverage and data quality are:

- **Information received from local authorities**

Due to the large numbers of different building types for which councils have responsibility (for example: social housing, council offices, schools, waste collection facilities) and the large number of different council departments which are involved in maintaining these, we could not always guarantee that the response received provided a full picture of all council-owned stock. As renewable capacity reported for local authority stock varied greatly, no attempt was made to scale up known capacity to account for non-respondents, meaning that the local authority capacity totals presented in this report are likely to be underestimates.

- **Information received from housing associations**

The SFHA sent an email survey on behalf of Energy Saving Trust and the Scottish Government to all members of the SFHA. Again, given the range of reported installed capacity per housing association, no attempt was made to scale up known capacity to account for non-respondents.

- **Installations in the scoping phase of development**

It is difficult to gain information on installations which are still in the early development stages, particularly if the applicants are not eligible for financial support from the funding organisations we contacted while compiling the database. This will be particularly true of farms and estates intending to install wind turbines or biomass systems, which typically have large capacities, as we would not be aware of these installations until they enter the planning process. Therefore, the figures presented here for installations in scoping are highly likely to be an underestimate.

- **Installations in the planning phase of development**

In compiling the database, the majority of in planning information comes from BEIS's REPD as well as our own checks of local authority planning portals. However, the REPD is now only updated with installations greater than 1 MW of capacity. For our own checks, only a sample of local authority planning portals can be checked each year due to resource constraints., Therefore, the figures presented here for installations in planning are likely to be an underestimate.

- **Installations in all stages of development**

Best efforts are made to identify the development status of the project upon initial entry into the database and this is often possible using the sources and methodology described above. However, after entry into the database there is no guarantee that there will be a subsequent update on the status of the project through any of the sources used. As a result, some installations can remain in an in-development limbo and recorded as in scoping, in planning, consented not built or under construction for a considerable, and perhaps unrealistic, amount of time. As such, we may be over-estimating the amount of renewable energy capacity in the various stages of development to some extent, although, this may be negated by the fact that some installations in development are likely to be missing from the database altogether due to not being found in the sources used.

- **Energy storage installations**

When compiling the database, it was difficult to collect data on energy storage systems because very few data sources that hold this information were found. The majority of the energy storage data has been sourced from surveys completed by local authorities and housing associations and from the Global Energy Storage Database[45] which tends to hold information on larger scale energy storage systems. It is therefore highly likely that the energy storage figures presented in this report are underestimates. In particular, small scale energy storage installations not in local authority or housing association ownership are much less likely to have been captured in the data collection process.

B7. Share of capacity in community and local ownership

As noted earlier, the definition of 'ownership' used in this analysis was not restricted to cases where the organisation owns the entire renewable installation. It also included cases where, for example, a community group or farmer helped to meet part of the cost of developing and installing a renewable energy system in return for some benefit, such as a share in the income generated. In such cases, a percentage of the installation's capacity equal to the share owned by the community or local owner is counted towards the target.

Such instances are normally wind energy developments, where perhaps the best-known example is the wind turbine 'owned' by Fintry Renewable Energy Enterprise, the trading subsidiary of Fintry Development Trust,[46] which is part of the larger Earlsburn Wind Farm. In this case, the turbine owned by Fintry has a capacity of 2.5 MW, so Fintry Development Trust's entry in the community and locally owned database lists one turbine of 2.5 MW, although the full capacity of Earlsburn wind farm is much larger (around 35 MW).

Energy4All wind farms were a special case for consideration. Energy4All works to help establish wind energy co-operatives in the UK, and this work has included the establishment of operational wind farm co-operatives in Scotland.[47] Members of the local community can buy shares in the developments. In these cases, information on the percentage of community ownership was received from Energy4All, and the percentage applied to the total installed capacity of the site to estimate the MW in community and local ownership.

[45] www.energystorageexchange.org/
[46] fintrydt.org.uk/about/
[47] energy4all.co.uk/

As shared ownership agreements are finalised, those installations currently classed as under discussion will move into the other stages of development. Where any such agreements do not come to fruition, the installations will be removed from the database. Note that the 'under discussion' status also includes a small number of sites which are already operational but where the owners are looking to refinance to include a component of shared ownership. We will continue to work closely with all groups involved to monitor the active shared ownership pipeline and the progress will be reported here annually.

B8. Capacity estimates where values were not available

As previously noted, not all required information was available for all renewable energy installations. In some cases, the installed capacity was one of the figures that were unavailable.

Every effort was made to confirm capacity with the owners of installations. However, because of the large number of installations covered in this work it was not always possible to obtain this information for all installations within available resources.

For installations where a value for capacity was not provided, an estimate was made for likely installed capacity based on technology type, ownership category and building type (where appropriate). These were derived from similar installations where capacity was known, or by using other assumptions as given below. A note of the values assumed for capacity is given in Appendix E.

Information on solar thermal panels and solar PV panels was sometimes provided in area (m^2) of panel. In such cases, the conversion factors used to estimate capacity are given in Table 9.

Table 7. Assumptions used to estimate capacity of solar thermal and solar PV panels from array size

Technology	Value used	Unit	Information source
Solar PV	0.14	kWp/m^2	Solar Trade Association
Solar thermal	0.7	$kWth/m^2$	Energy Saving Trust Solar Energy Calculator tool assumptions[48]

B9. Annual energy output

The assumptions used to estimate yearly output in MWh of energy from community and locally owned renewable energy sources, where the output was is unknown, are given in Table 8.

For solar thermal panels and solar PV panels, annual energy output was estimated using the following method:

Total installed capacity (kW) multiplied by estimate of output per kW of capacity (kWh/kW/yr) = annual energy output (kWh).

For all other renewable technologies, the following formula used was:

Total installed capacity (kW), multiplied by estimate of peak load hours per year (h) = annual energy output (kWh).

[48] Scottish average calculated using data from: www.pvfitcalculator.energysavingtrust.org.uk/

Table 8. Assumptions used to estimate annual energy output

Technology	Assumption	Value used	Units	Information source
Solar PV	Annual energy output per kW	807	kWh/kW/year	Derived from MCS calculations recreated using Energy Saving Trust standard assumptions for occupancy and panel size
Solar thermal	Annual energy output per kW	630	kWh/kW/year	Energy Saving Trust Solar Energy Calculator tool assumptions[48]
Wind	Annual peak load for small (<10 kWe) wind turbines	1,664	Hours/year	Energy Saving Trust field trial of domestic small-scale wind turbines
Wind	Annual peak load for large (>=10 kWe) wind turbines	2,365	Hours/year	Scottish Renewables
Hydroelectric	Annual peak load	3,500	Hours/year	Various[49]
Biomass	Annual peak loads	Not disclosed[50]	Hours/year	Analysis of unpublished non-domestic RHI data
Heat pumps	Annual peak loads	Not disclosed[50]	Hours/year	Analysis of unpublished non-domestic RHI data
Solar thermal	Annual peak loads	Not disclosed[50]	Hours/year	Analysis of unpublished non-domestic RHI data
Biogas	Annual peak loads	Not disclosed[50]	Hours/year	Analysis of unpublished non-domestic RHI data
CHP (All technology)	Annual peak loads	3,902	Hours/year	Digest of UK Energy Statistics (DUKES) CHP chapter
Tidal	Annual peak loads	3,066	Hours/year	Scottish Renewables

[49] The following sources were used, which indicated that a reasonable assumption to use would be 3,500 peak hours per year, equivalent to a 40% load factor.

- Garrad Hassan report on renewable energy potential for Scottish Renewables
- The British Hydropower Association's mini hydro guide (V3), www.british-hydro.org/wp-content/uploads/2018/03/A-Guide-to-UK-mini-hydro-development-v3.pdf
- Nick Forrest Associates Ltd et al, Scottish Hydropower Resource Study, August 2008

However, estimates of output from hydroelectric installations should be treated with caution because it is highly site specific.

[50] We have not disclosed the running hours assumptions for these technologies because they have been calculated from unpublished non-domestic RHI data provided by BEIS for the Renewable Heat in Scotland Report https://energysavingtrust.org.uk/report/renewable-heat-in-scotland-2020/

Appendix C Individual technology descriptions

The following renewable technologies have been included in the database:

- **Wind**

Wind turbines have blades which are turned by the wind. When the wind blows, the blades are forced round, driving a turbine which generates electricity. They may be pole-mounted or building-mounted, and may be connected to the national electricity grid, a local distribution grid, or stand-alone.

- **Hydroelectric**

A flow of water falling from a higher altitude to a lower altitude (and not from waves or tides) is used to drive a turbine which generates electricity.

- **Wave and tidal (marine)**

The action of waves or tides is used to drive a turbine, which generates electricity.

- **Solar photovoltaics (PV)**

Panels or modules, normally fixed to the roofs of buildings, which produce electricity when exposed to light (either direct or indirect).

- **Biogas combustion**
    - **Biogas produced by anaerobic digestion (AD)**

      Organic matter is broken down in the absence of oxygen to produce a mixture of combustible gases. The biogas is then burnt to produce heat or burnt in a combined heat and power unit to generate both heat and electricity. In some applications, the heat produced is used solely to maintain the anaerobic digestion process which requires some heat input. The feedstock is typically some form of waste such as food and garden waste or agricultural waste.

      Biogas that is produced by AD and then processed into biomethane for injection into the gas grid is not included under biogas combustion as no fuel is consumed on site. Any renewable heat output produced in this way is found under the biomethane technology class.

    - **Biogas produced by landfill**

      Landfill gas (methane from rotting organic matter in landfill) is captured and burnt to produce heat or used in a combined heat and power unit.

    - **Biogas produced by pyrolysis or other advanced conversion methods**

      Treatment of waste at high temperatures either in the complete absence of oxygen (pyrolysis) or a limited amount of oxygen (gasification) to produce gases which can be burnt to generate heat or heat and electricity.

- **Biomass combustion**
    - **Biomass heat only**

      Solid biomass is burnt to directly produce heat for space or water heating, or to provide heat for an industrial process. Woodfuel is the most common type of solid biomass used to produce heat in Scotland, usually in the form of woodchip, pellets, or logs. Large biomass boilers installed for generating heat in the wood processing industries will normally be fuelled with as much on-site produced co-products as possible such as bark, offcuts and saw dust, supplemented by virgin fibre or woodfuel when required. A small proportion of biomass installations may be using other solid biomass fuels instead of or in addition to woodfuel, such as straw or energy crops.

- **Biomass combined heat and power (CHP)**

  Solid biomass is burnt to generate electricity. Heat is produced as a co-product, which can then be used for process heat, supplying space or water heating or exported to another user. Biomass CHP installations tend to be very large in capacity and will predominantly use a variety of woodfuel types including any wood co-products produced on site, recycled wood and virgin fibre.

- **Solar thermal**

Panels normally fixed to the roofs of buildings, which produce hot water using the sun's heat. Occasionally these systems are designed so that the hot water produced also contributes to space heating demand (solar space heating).

- **Heat pumps**

Technologies to extract low-grade heat from the external environment through a compression system. Typically used to produce heat for space heating, water heating or both and are therefore most common in domestic properties although specific heat pump set ups may also be capable of meeting industrial process heat demands. Although heat pumps rely on electricity to operate, their high co-efficient of performance (COP) means they extract more heat energy from the environment than they use in electricity.

Heat pumps can be used with air or water distribution systems but only heat pumps using a wet distribution system are eligible for RHI payments. For this reason, the vast majority of heat pumps installed use wet distribution systems.

'Exhaust air heat pumps' (which, in addition to extracting heat from the external air, also draw warmth from warm stale air leaving a building) have been included under the air source heat pump technology. Units which are purely exhaust air heat recovery, without also extracting heat from the air outside, have not been included as these do not include any element of renewable heating. Cooling provided by heat pumps has also not been recorded in the database.

- **Air source heat pump (ASHP)**

  Heat from outside air is absorbed at low temperature into a fluid. This fluid passes through a compressor, increasing the temperature, and transfers that higher temperature heat to the heating circuits.

- **Ground source heat pump (GSHP)**

  Ground source heat pumps circulate a mixture of water and antifreeze through pipework buried in the ground. Heat from the ground is absorbed into the fluid, the fluid is compressed, and then the heat passes through a heat exchanger into the heat pump. The pipework can be buried horizontally, referred to as a ground loop, or vertically in a borehole. The length of buried pipework is dependent on the amount of heat required.

- **Water source heat pump (WSHP)**

  Water source heat pumps function the same as ground source heat pumps except the pipework is submerged in a body of water such as a river or lake, or a water filled borehole rather than the ground. Due to needing a substantial body of water available, the number of installed water source heat pumps is considerably lower than the number of installed air or ground source heat pumps.

- **Waste combustion**

Heat energy produced from burning waste not considered as solid biomass or bioliquids, such as municipal solid waste. For installations burning municipal solid waste, a proportion of the heat capacity and output is estimated to be renewable based on the biodegradable proportion of the waste burnt.[51]

Another technology which could have been included in the database if examples had been found was:

[51] The percentage of municipal waste assumed to be renewable is 50% in line with the latest BEIS RESTATS methodology. https://www.gov.uk/government/collections/renewables-statistics

- **Fuel cell biomass**

Fuel cells running on biomass could be used to produce electricity and useful heat. However, none were identified in Scotland for this version of the database.

- **Deep geothermal**

Heat from deep underground is extracted by pumping water into a deep well, allowing it to heat up using the heat of the rocks, then abstracting the water via another well.

Technologies which have not been included in the database, as they do not produce energy from renewable sources, are:

- **Non-biomass CHP**

CHP units fuelled by fossil fuel gas (or other fossil fuels) to produce electricity and heat. CHP (or tri-generation) units can represent an efficient use of fuel as they achieve high efficiencies. However, as the energy from such units is generated from fossil fuel sources, it has not been counted towards renewable energy targets in this report.

- **Exhaust air heat recovery (EAHR) only**

Systems which recover the heat from warm stale air leaving a building and use it to warm incoming air. This can help to reduce space heating requirements. However, because the heat being recovered for the building will normally have been generated by fossil fuels in the first instance, these systems do not provide renewable heat. Some heat pumps have been included which are classed as 'exhaust air heat recovery', but only where it was possible to ascertain that they also provided heat taken from the air outside the building (which is renewable heat) via a heat pump component.

- **Passive renewable heating or cooling**

The building design is used to ensure heating or cooling without relying on mechanical means, for example through features such as solar gain through large areas of south-facing glazing, or 'natural ventilation'. Such design features can successfully help a building meet its heat demand, however they have not been included in this report or in the database as the heat resource is very difficult to estimate.

The following energy storage solutions have been included in the database:

- **Electricity battery storage**

Deep-cycle batteries that store electricity when it is generated and provide power when it is needed. The most common types of battery storage are lead acid batteries and lithium-ion batteries. Batteries can be charged from a range of technologies including wind turbines, solar PV panels, hydroelectric systems and diesel generators.

- **Heat batteries**

Heat batteries take generated electricity or heat and use phase change materials (PCMs) to store this energy. This energy can later be used to heat water on demand.

- **Hydrogen storage**

Hydrogen can be stored as either a gas (at a high pressure) or a liquid (at a low temperature) before being used as a fuel.

- **Pumped Hydroelectric storage**

Water can be pumped up to a higher elevation and then allowed to flow downwards at times of high electrical demand. The water is used to drive a turbine which generates electricity as per other hydroelectric installations which do not have pumped storage capabilities.

Appendix D List of main data sets used

Table 9 lists the main data sources used in this update of the community and locally owned renewable energy database, by ownership category and data provider. Details of the data sources used for previous versions of the database can be found in the relevant reports.

Table 9. Main datasets used

Organisation(s) contacted/providing data	Dataset(s)	Ownership category
Local Energy Scotland, on behalf of the Scottish Government	Community and Renewable Energy Scheme (CARES); Local Energy Challenge Fund (LECF)	Community; farm and estate; local business[52]
Energy Saving Trust, on behalf of the Scottish Government	District Heating Loan Fund (DHLF); Scottish EPC register	Local authority; housing association; community;[53] farm and estate; local business
Resource Efficient Scotland, on behalf of the Scottish Government	Resource Efficient Scotland Small and Medium-sized enterprise loan	Local business
Scottish Forestry (previously Forestry Commission Scotland)	Wind and hydroelectric schemes on the National Forest Estate (publicly available information)	Community; public sector and other charity; farm and estate; local business
NHS National Services Scotland	Operational renewable energy installations on the NHS Scotland estate	Public sector and other charity
Individual local authorities via survey	Responses to an Energy Saving Trust email survey	Local authority
Individual housing associations via SFHA	Responses to an SFHA email survey	Housing association
Eunomia, on behalf of BEIS	Extract from the Renewable Energy Planning Database (REPD)	Local authority; housing association; community; public sector and other charity; local business; farm and estate
Ofgem	Renewables and CHP register (publicly available)	Public sector and charity; community; local business; farm and estate
Scottish Enterprise, on behalf of the Scottish Government	Energy Investment Fund (EIF) and Renewable Energy Investment Fund (REIF)	Community
Community Energy England, Community Energy Scotland and Community Energy Wales	Community Energy: State of the Sector report	Community
Scottish Water	Renewable installations owned by Scottish Water	Public sector and other charity
Local authorities, collected by Energy Saving Trust	Planning applications on local authority planning portals which include renewables	Local authority; housing association; farm and estate; local business; public sector and other charity; community

[52] Local businesses must also be rural businesses to be eligible for CARES funding.
[53] Communities must be legally constituted community groups to apply for the district heating loan fund.

Appendix E Capacities assumed for individual installations where not known

Table 10 shows the assumed capacities that were used in the community and locally owned renewable energy database where information on capacity was not available.

Table 10. Assumptions for capacity by technology and building type

Ownership category	Building type	Technology	Assumed capacity (kW)	Source
Community	Non-domestic	Air source heat pump	15	Average of known community air source heat pump capacities held in the database
	Non-domestic	Hydroelectricity	465	Average of known community hydroelectric capacities held in the database
	Non-domestic	Biomass combustion	105	Average of known community biomass primary combustion installations recorded in the database
	Non-domestic	Ground source heat pump	28	Average of known community ground source heat pump installations recorded in the database
	Non-domestic	Solar PV	49	Average of known community solar PV capacities held in the database
	Non-domestic	Solar thermal	10	Average of known community solar thermal capacities held in the database
	Non-domestic	Wind	923	Average of known community wind capacities held in the database[54]
	Non-domestic	Energy storage (electricity)	25	Average of known community energy storage(electricity) capacities held in the database

[54] This average excludes large-scale wind developments and was used as the assumed capacity for wind turbines installed under SCHRI or CARES grant schemes (where this information was not provided), and in cases where other information provided indicated that the turbine was associated with a community hall or other small building, rather than being part of a larger development. Revenue-generating wind projects (which are typically not grant funded) are more variable in size. However as these tend to be large in size (typically 800 kW and over), effort has been made to determine the exact size of each installation for non-grant funded community wind projects.

Farm and estate	Non-domestic	Air source heat pump	16	Average of known farm and estate air source heat pump capacities held in the database
	Non-domestic	Anaerobic digestion and biogas combustion	1,680	Average of known farm and estate biogas produced by anaerobic digestion primary combustion capacities held in the database
	Non-domestic	Biomass gasification and combustion	134	Average of known farm and estate biogas produced by gasification primary combustion capacities held in the database
	Non-domestic	Biomass combustion	251	Average of known farm and estate biomass primary combustion capacities held in the database
	Non-domestic	Ground source heat pump	64	Average of known farm and estate ground source heat pump capacities held in the database
	Non-domestic	Solar PV	57	Average of known farm and estate solar PV capacities held in the database
	Non-domestic	Water source heat pump	60	Average of known farm and estate air source heat pump capacities held in the database
	Non-domestic	Wind	193	Average of known farm and estate wind capacities held in the database
Local authority	Non-domestic	Air source heat pump	17	Average of known local authority air source heat pump capacities held in the database
	Non-domestic	Biomass combustion	15	Average of known local authority biomass primary combustion capacities held in the database

	Non-domestic	Ground source heat pump	25	Average of known local authority ground source heat pump capacities held in the database
	Non-domestic	Solar PV	10	Average of known solar PV capacities held in the database
	Non-domestic	Solar thermal	5	Average of known solar thermal capacities held in the database
	Non-domestic	Water source heat pump	40	Average of known local authority water source heat pump capacities held in the database
Local authority and housing association	Domestic	Air source heat pump	7	Average of known local authority and housing association domestic air source heat pump capacities held in the database
	Domestic	Biomass combustion	20	Average of known local authority and housing association domestic biomass primary combustion capacities held in the database
	Domestic	Ground source heat pump	7	Average of known local authority and housing association domestic ground source heat pump capacities held in the database
	Domestic	Solar PV	2	Average of known local authority and housing association domestic solar PV capacities held in the database
	Domestic	Solar thermal	4	Average of known local authority and housing association domestic solar PV capacities held in the database
Local business	Non-domestic	Air source heat pumps	16	Average of known local business air source heat pump capacities held in the database

	Non-domestic	Ground source heat pumps	50	Average of known local business ground source heat pump capacities held in the database
	Non-domestic	Biomass combustion	220	Average of known local business biomass primary combustion capacities held in the database
	Non-domestic	Heat pump (unknown source)	12	Average of known local business heat pump (unknown source) capacities held in the database
	Non-domestic	Hydroelectricity	80	Average of known local business hydroelectricity capacities held in the database
	Non-domestic	Water source heat pump	150	Average of known local business water source heat pump capacities held in the database
	Non-domestic	Solar PV	27	Average of known local business solar PV capacities held in the database
Public sector and charity	Non-domestic	Air source heat pump	15	Average of known public sector and other charity air source heat pump capacities held in the database
	Non-domestic	Biomass combustion	345	Average of known public sector and other charity biomass primary combustion capacities held in the database
	Non-domestic	Ground source heat pump	42	Average of known public sector and other charity ground source heat pump capacities held in the database
	Non-domestic	Heat pump (unknown source)	12	Average of known public sector and other charity heat pump (unknown source) capacities held in the database

	Non-domestic	Solar thermal	64	Average of known public sector and other charity solar thermal capacities held in the database
	Non-domestic	Water source heat pump	65	Average of known public sector and other charity water source heat pump capacities held in the database
	Hospital and health centres (Medium and large sized installations)	Biomass combustion	1,100	Average of known medium and large hospital and health centres biomass primary combustion capacities held in the database
	Hospital and health centres (Micro and small sized installations)	Biomass combustion	137	Average of known micro and small hospital and health centres biomass primary combustion capacities held in the database
All categories	School	Air source heat pump	36	Average of all school air source heat pump capacities held in the database
	School	Biomass combustion	241	Average of all school biomass primary combustion capacities held in the database
	School	Ground source heat pump	65	Average of all school ground source heat pump capacities held in the database
	School	Solar PV	31	Average of all school solar PV capacities held in the database
	School	Solar thermal	10	Average of all school solar thermal capacities held in the database