energy saving trust

Community and locally owned energy in Scotland

2021 report

30 May 2022

Report produced on behalf of the Scottish Government

Executive summary

1. An estimated 896 MW of community and locally owned renewable energy capacity was operational in Scotland at the end of December 2021, up 44 MW (5%) from the 853 MW which was previously reported to be in operation at the end of December 2020.[1]
2. The Scottish Government has therefore progressed 45% towards their 2030 target of having 2 GW of operational renewable energy capacity in community and local ownership.
3. At least 31 MW of the new capacity reported was in operation prior to the 2021 reporting year, with the remaining 12 MW attributed to 2021.
4. The largest proportion of community and locally owned renewable energy capacity is found under farm and estate ownership (41%, 366 MW), which is mostly from wind and biomass installations. This is followed by local authorities (16%, 147 MW) and local businesses (13%, 115 MW).
5. The reported operating capacity comes from 29,000 installations, up by 3,170 (12%) in comparison to the previously reported 25,830 for 2020.[2]
6. The largest numbers of installations are under housing association (40%) and local authority (34%) ownership which are predominantly found in social let domestic properties. A further 17% of the total number of installations are in social let properties where the exact ownership category cannot be determined. The vast majority of installations in social let domestic properties are heat pumps, solar PV and solar thermal.
7. The 896 MW in operation is estimated to produce 1,921 GWh of renewable energy. This is composed of:
    a. 450 MW of electrical capacity, producing an estimated 1,029 GWh of electricity
    b. 388 MW of thermal capacity, producing an estimated 687 GWh of heat
    c. 59 MW of combined heat and power (CHP) capacity, producing an estimated 205 GWh of energy which is a mixture of heat and electricity
8. The two local authorities with the greatest share of operational capacity are Aberdeenshire (25%, 225 MW) and Highland (12%, 107 MW). Both are rural local authorities where the majority of the capacity in these areas is attributable to farm and estate ownership.
9. In addition to the 896 MW of operational capacity, there is an estimated 1,328 MW in various stages of development. The in-development capacity can be broken down into:[3]
    a. 61 MW in scoping
    b. 99 MW in planning[4]
    c. 128 MW consented, but not yet under construction[4]
    d. 37 MW under construction
    e. 1,002 MW where an element of shared ownership is under discussion[5]
    f. 2 MW where the development status is unknown
10. There are 270 projects recorded in the database which include an element of shared ownership, 47 of which were operational and accounted for 67 MW (8%) of the total reported capacity.
11. At the end of December 2021, there was an estimated 9.36 MWh of operational energy storage capacity in community and local ownership in Scotland with a further 0.6 MWh in development.

[1] Please note that summed figures may not precisely equal reported totals due to rounding.
[2] Numbers of installations have been rounded to the nearest ten throughout this report.
[3] 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.
[4] Applies only to installations that would require planning permission.
[5] 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 shared ownership under discussion status into the true development status of the project or, if an agreement is not reached, removed from the database.

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1. Introduction

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 and to produce a short report on the information it contained. The objective of this work was to monitor progress towards the target set by the Scottish Government of having 0.5 GW of operational renewable energy capacity in community or local ownership by 2020.[6]

This target was exceeded in 2015 and subsequently the Scottish Government doubled the target to 1 GW of operational community and locally owned renewable energy capacity by 2020 and set a further target of 2 GW by 2030.

As per the 2020 community and locally owned energy report, the Scottish Government progressed 85% towards their 1 GW 2020 target by the 31 December 2020 deadline. The reporting series is now focussed on tracking progress towards the 2 GW target with a deadline set for 31 December 2030.

This database has been updated annually 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 2021.

Since 2016, and as storage technologies have become more common, we have also included findings on the capacity and type of community and locally owned energy storage systems. 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 systems.

In this report, and as per previous reports of the series, the figures presented on the accumulative changes in community and locally owned renewable energy capacity are based on the differences between this year's analysis and the figures which were reported last year.

[6] www.gov.scot/policies/renewable-and-low-carbon-energy/local-and-small-scale-renewables/

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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[7]

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.

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

2. Methodology summary

A full methodology is provided in Appendix A. The following section provides a summary of the main points.

2.1. 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 technologies producing heat and/or electricity from a renewable source, where the owner of the installation is in one of the following categories:

- A community group
- A local Scottish business
- A farm or estate
- A local authority
- A public sector or charitable organisation, including:
    - Charities, including faith organisations and those found on the Scottish Charity Regulator (OSCR) website[8]
    - Public bodies or publicly owned companies
    - Further education establishments including colleges and universities
- Social housing where it is not possible to identify if the owner is a local authority or housing association, hereafter referred to as 'undetermined social housing'[9]

'Ownership' has not been restricted to cases where the organisation owns the entire renewable installation as 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 renewables system in return for some benefit, such as a share in the income generated. In such cases, only the 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 is a land rental payment from the owner or developer of the installation, or installations that generate community benefit payments but that are fully owned by another organisation (for example a utility company). Renewable developments where an element of shared ownership is under discussion are included within our pipeline estimates.

2.2. Renewable energy technologies included

The following renewable energy technologies are included in the database:

- Wind
- Biomass primary combustion (including for district heating)
- Heat pumps (ground source, air source, water source and wastewater source) including air source heat pumps incorporating exhaust air heat recovery (EAHR)
- Solar photovoltaics (solar PV)
- Energy from waste technologies, including:
    - Waste incineration (organic or putrescible fraction) for production of heat or heat and electricity
    - Primary combustion for heat or heat and electricity of biogases produced by:
        - Anaerobic digestion

[8] https://www.oscr.org.uk/

[9] These are properties that according to the Scottish domestic energy performance certificate (EPC) register are socially let and have renewable energy systems installed but we do not know if they are owned by a housing association or local authority because EPCs do not distinguish between the two.

        - Gasification or pyrolysis
        - Landfill
- Solar thermal panels (providing solar heated hot water)
- Hydroelectric
- Wave and tidal (marine)

The following energy storage systems are included in the database:

- Electrical battery storage
- Heat battery storage (using phase change materials)
- Hydrogen storage
- Pumped hydroelectric storage

Full descriptions of these technologies are provided in Appendix B.

2.3. Approach taken and datasets used

The approach taken for data collection and processing for this version of the database and report was broadly in line with the approach taken for the previous reports. A full methodology is provided in Appendix A.

For this year's report a full database update was carried out for the period from 1 January 2021 to 31 December 2021.

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

2.4. 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 Section 2.1)
- 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 Section 2.2
- The number of installations and the installed operational capacity
- The operational status as at the end of December 2021, selected from:
    - Operating
    - Under construction
    - Consented, not built
    - In planning
    - In scoping
    - Shared ownership under discussion[10]

[10] 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.

  - Completed but non-operational[11]
  - Decommissioned[11]
  - Cancelled[11]
- The date on which generation commenced (for operational projects)
- 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

2.5. 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. Further information on the methodology can be found in Appendix A.

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 of the data we require. We are also aware that there are some potentially very useful datasets, such as the FiTs register, that we do not have access to.

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, when considering the distribution of renewable energy installations across Scotland, as well as temporally, because it is often not until several years after an installation becomes operational that we may secure data about it. Regular reviews are carried out to improve the amount or quality of data received, for example recently we started using EPC data to supplement the surveys we undertake. 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 the "Intended changes to research and reporting for the 2022 report" section of Appendix A for more information on what is being considered for the next reporting year.

[11] These statuses are not reported on as the installations are no longer operational and are therefore excluded from our operational or in-development metrics.

3. Community and locally owned renewable energy operational in 2021

At the end of December 2021 an estimated 896 MW of community and locally owned renewable energy capacity was operational in Scotland. This means that at the end of 2021, the Scottish Government has progressed 45% towards their target of having 2 GW of operational community and locally owned renewable energy capacity by 2030. The capacity in operation is from a total of 29,000 individual renewable energy installations.

3.1. Total operational capacity and number of installations by ownership category

A breakdown of operational capacity by ownership category is given in Table 1 and illustrated in Figure 1. A breakdown of the number of operational renewable energy installations by ownership category is given in Table 2 and illustrated in Figure 2.

Table 1. Operational capacity by community or local ownership category, 2021

Ownership category	Operational capacity (MW)	Percentage of operational capacity	Absolute change from December 2020 (MW)	Percentage change from December 2020
Farm and estate	366	41%	17	5%
Local authority	147	16%	11	8%
Local business	115	13%	5	5%
Community	92	10%	3	3%
Public sector and charity	77	9%	8	12%
Housing association	74	8%	3	4%
Undetermined social housing[12]	25	3%	-3	-10%
Total	**896**	**100%**	**44**	**5%**

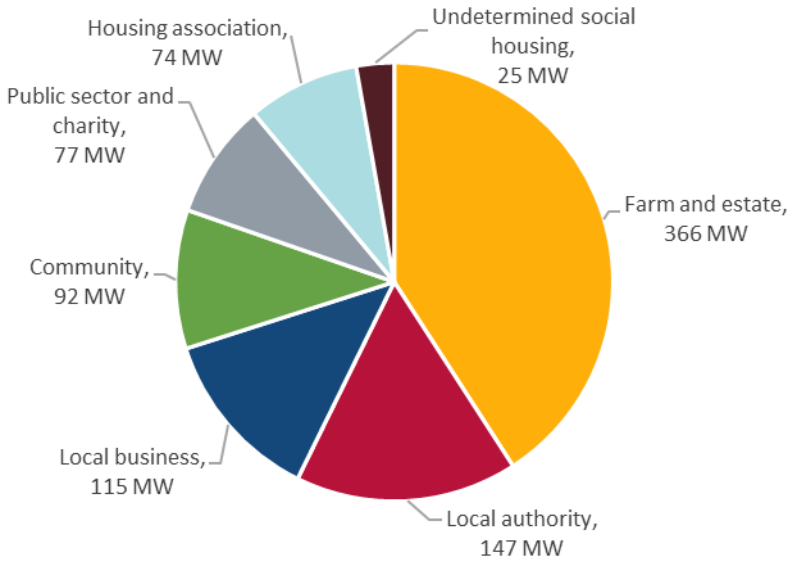

Figure 1. Operational capacity by community or local ownership category, 2021

[12] Reduction in capacity is due to methodological improvements rather than a genuine decrease in renewable energy capacity. Please see the "Operational capacity in social housing" section of appendix A for more info on what methodological changes were made.

Table 2. Number of operational installations by community or local ownership category, 2021

Ownership category	Number of installations	Percentage of installations	Absolute change from December 2020	Percentage change from December 2020
Farm and estate	900	3%	60	7%
Local authority	9,860	34%	600	6%
Local business	690	2%	100	16%
Community	600	2%	30	5%
Public sector and charity	520	2%	30	7%
Housing association	11,540	40%	110	<1%
Undetermined social housing	4,890	17%	2,250	85%
Total	**29,000**	**100%**	**3,170**	**12%**

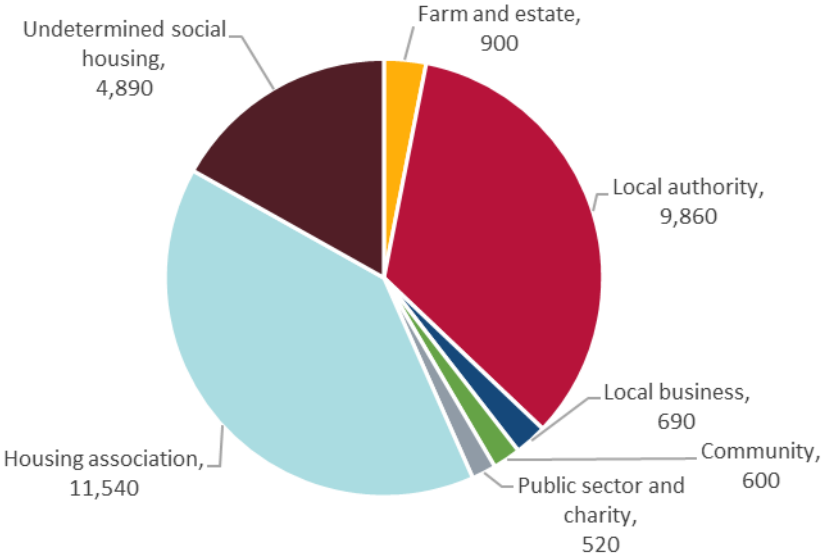

Figure 2. Number of operational installations by community or local ownership category, 2021

The largest proportion of operational capacity was on Scottish farms and estates (41%) despite making up a small proportion (3%) of the total number of installations. Farm and estate installations have on average much larger capacities than the other ownership categories because they are often used for larger scale non-domestic purposes. Local authorities have the next largest share of total capacity (16%) but also own a considerable share of the total number of installations (34%). Housing associations have the largest share of the total number of installations (40%) but a relatively low share of the total capacity (8%). Local authority and housing association owned installations have on average much smaller capacities because they are mostly found in social let properties where they are used to meet domestic space heating, hot water and electrical demands.

The two ownership categories to have shown the most reported growth in capacity since December 2020 were public sector and charities (12%) and local authorities (8%).

The ownership category to have shown the greatest growth in number of installations was the undetermined social housing category (85%). This reflects that a large number of renewable energy installations are newly recorded in domestic Energy Performance Certificate (EPC) data, but which are not yet being captured by the other data sources we have access to for our analysis.

The factors influencing the share of capacity and installation totals comprised of by each of the ownership categories is discussed in more detail in Section 3.3.

3.2. Operational capacity and number of installations by technology

A breakdown of operational capacity by technology is given in Table 3 and illustrated in Figure 3. A breakdown of the number of operational renewable energy installations by technology is given in Table 4 and illustrated in Figure 4.

Table 3. Operational capacity by technology, 2021

Technology	Operational capacity (MW)	Percentage of operational capacity	Absolute change from December 2020 (MW)	Percentage change from December 2020
Wind	333	37%	3	1%
Biomass	279	31%	19	7%
Heat pump	86	10%	15	20%
Solar PV	74	8%	3	5%
Energy from waste	65	7%	2	4%
Hydroelectric	43	5%	<1	<1%
Solar thermal	16	2%	<1	1%
Total	**896**	**100%**	**44**	**5%**

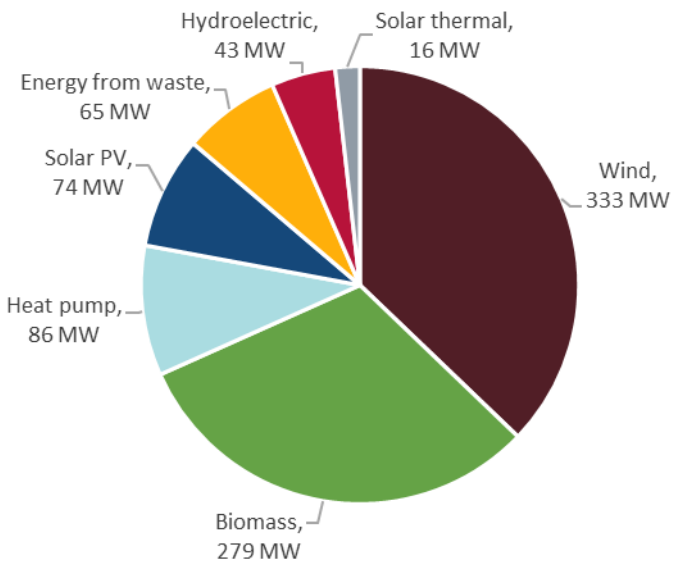

Figure 3. Operational capacity by technology, 2021

Table 3 shows that wind installations are responsible for the greatest share of reported operational capacity (37%) followed by biomass (31%). However, both technologies are responsible for relatively small shares of the total reported number of operational installations, at 3% and 5% respectively (see Table 4). Wind and biomass installations tend to have larger capacities relative to the other technologies reported on. Most wind installations recorded in our database are of the very large variety found in wind farms across Scotland. Similarly, while there are some micro-sized biomass installations held within our database, most commonly in domestic properties, the majority of biomass installations in community or local ownership are installed to meet high space heating or industrial demands and are therefore of quite large capacities.

In comparison, the technologies comprising the greatest percentages of the number of installations, solar PV at 46% and heat pumps at 32% (see Table 4). However, these make up relatively small percentages of the

total capacity, at 8% and 10% (see Table 3). This is because the majority of solar PV and heat pump installations in our database are found in domestic properties, where smaller capacities are installed to meet relatively small domestic space heating or electrical demands.

Biomass was the technology which had the greatest increase in capacity reported in 2021, with an additional 19 MW (7%) over the 2020 reported figure. Heat pumps were the technology which had the largest percentage increase of capacity, increasing by 20% (15 MW) over the 2020 reported figures.

There was a 15% increase in the number of installations of solar PV and heat pumps between 2020 and 2021 (1,780 and 1,230 respectively; see table 4). This bought the total number of installations of solar PV to 13,460 and heat pumps to 9,200.

Table 4. Number of operational installations by technology, 2021

Technology	Number of installations	Percentage of installations	Absolute change from December 2020	Percentage change from December 2020
Wind	1,000	3%	40	4%
Biomass	1,590	5%	90	6%
Heat pump	9,200	32%	1,230	15%
Solar PV	13,460	46%	1,780	15%
Energy from waste	40	<1%	<10	9%
Hydroelectric	180	<1%	<10	2%
Solar thermal	3,520	12%	40	1%
Total	**29,000**	**100%**	**3,170**	**12%**

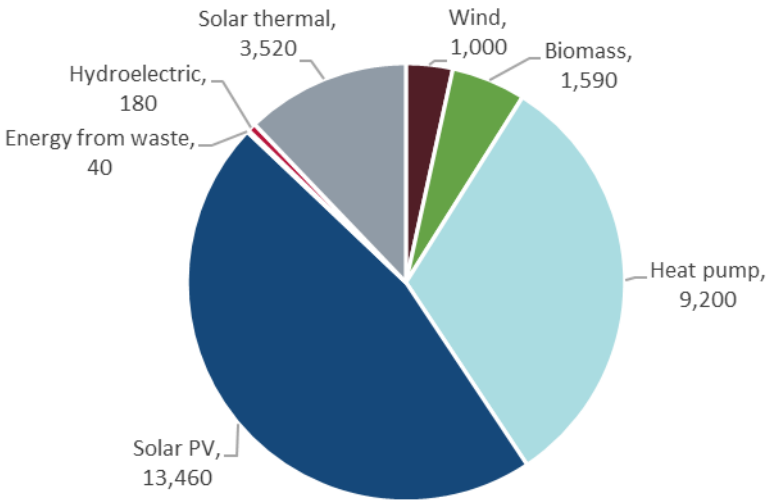

Figure 4. Number of operational installations by technology, 2021

3.3. Operational capacity by ownership category and technology

Figure 5 shows the breakdown of operational renewable energy capacity by both ownership category and technology. There are several reasons why some technologies are more prevalent in some ownership categories over others.

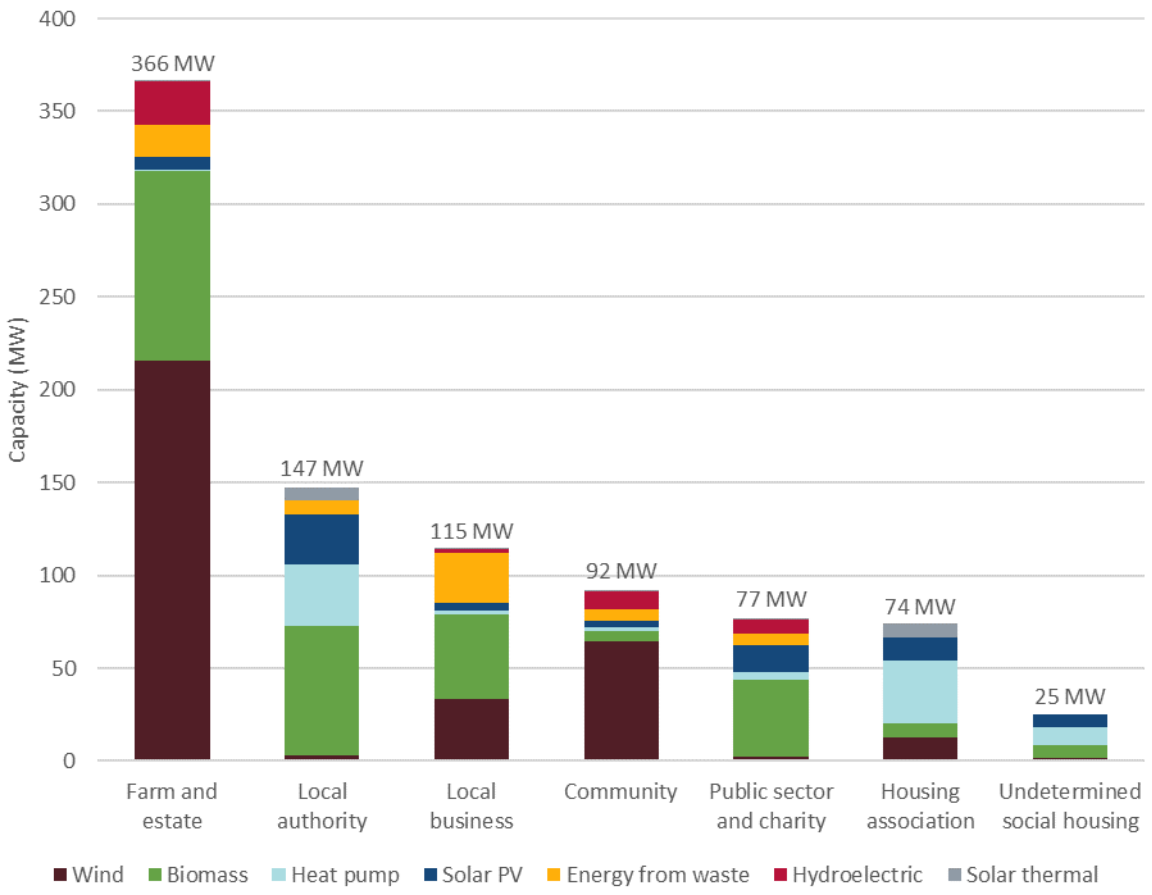

Figure 5. Operational capacity by ownership category and technology, 2021

Farm and estate capacity totals tend to be dominated by wind (59%) and biomass (28%) with some hydroelectric (6%) and energy from waste (5%) capacity as well. These technologies may be desirable on farms and estates where the natural resources required to produce electricity, such as suitable bodies of water or areas of high speed, unobstructed wind, may be more readily available. Moreover, farms and estates are typically in rural and off-gas grid areas so there may be significant appeal for biomass installations through a combination of wishing to move from more expensive fossil fuels to using local woodchip or agricultural waste from on site to generate heat with. Energy from waste installations may also have further uses beyond generating renewable energy, such as the production of fertiliser which is often a co-product of the anaerobic digestion process used to produce biogas for combustion.

The capacities of farm and estate installations tend to be quite large which means that the impact of relatively few installations can be a more significant increase in capacity. For example, much of the biomass installed by farms and estates will be to meet quite large heat demands related to agricultural activities, such as drying grain or heating greenhouses. Farm and estate biomass capacities will therefore typically be larger than biomass installations commonly found in other non-domestic and domestic settings.

Local authorities also own a significant amount of biomass capacity, contributing 47% of the total local authority owned operational capacity. These biomass installations can have relatively large capacities where they are used to meet the high and relatively steady heat demands of non-domestic properties such as schools, or where they feed into heat networks. Local authority owned biomass installations are concentrated in the more rural local authorities where there is likely to be better access to locally produced

woodfuel. More rural local authorities also have a greater proportion of the building stock not on the mains gas grid and biomass could be an attractive solution to heat such properties.

Local authorities also have a large amount of their capacity coming from heat pumps (23%) and solar PV (18%). Installations of these technologies are located in both non-domestic and domestic properties but with the majority in domestic settings. Local authorities, along with housing associations, are registered social landlords, and part of their responsibilities is to meet the Energy Efficiency Standards for Social Housing (EESSH) as set out by the Scottish Government.[13] These standards encourage the retrofit installation of energy efficiency and renewable measures in existing properties. Renewable technologies are also common in new build social let properties where the installation of such technologies is often an efficient way to meet the current Scottish building standards for new builds.[14] Standard 6.1 of the building standards technical handbook states that the potential carbon dioxide emissions of a new build property must be below a maximum threshold defined by the size, type and main heating fuel (e.g. mains gas) of a notional property, something which may be achieved by installing a suitable renewable technology. These regulations are thereby an additional driver of installing renewable energy in social let properties.

Within local authority ownership, 5% of the renewable energy capacity is from energy from waste technologies. As local authorities have responsibility for waste management in their areas, some councils also own energy from waste installations which make use of by-products from landfill or recycling centres to produce heat or CHP output.

The greatest contributing technologies to the **local business** capacity totals are biomass (40%), wind (29%) and energy from waste (23%). Similar to farms and estates, the majority of local business operational capacity can also be found in rural and off-gas grid areas where there are good wind resources or where biomass may be an attractive alternative to existing fuels used. The relatively large percentage of energy from waste capacity in local business ownership, in comparison to the other ownership categories, can be attributed to businesses who are involved in the management of waste and therefore have a readily available supply of waste to generate energy from.

The majority of **community** owned renewable capacity uses wind (70%) and hydroelectricity (10%) 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. Although making up a less significant share of total community owned capacity, small scale solar PV arrays (3%) and heat pumps (2%) can often be found installed to meet smaller space heating and electrical demands, such as that of local community halls or other public properties in community ownership.

The **public sector and other charitable** organisation category capacity total has a significant biomass technology contribution (53%) with smaller contributions coming from solar PV (19%), hydroelectricity (10%), energy from waste (8%), heat pumps (6%) and wind (3%). The mixture of technologies is largely attributable to the wide variety of organisations that can be found within this ownership category. For example, biomass installations tend to be owned by the public sector or charitable organisations with the greatest and most consistent heat demands such as in NHS hospitals. Other biomass installations can be found in ownership of universities and other further education establishments. The majority of solar PV and energy from waste capacity is largely coming from Scottish Water, Scotland's publicly owned water company, which installs a considerable capacity of these technologies at their various premises throughout the country, including at several of their wastewater treatment sites.

Housing associations have a mixture of technologies making up their total capacity which are mostly installed in domestic settings. Heat pumps (45%), solar PV (17%), biomass (11%) and solar thermal (10%) installations make up the majority of their installed capacity. These technologies are well suited to providing heat or electricity to meet domestic heating, hot water and electrical demands. However, due to the low space heating and electrical demands of domestic consumption, relative to non-domestic use cases, each installation typically has a very small (<10 kW) capacity. As per the local authority ownership category, the installation of renewable energy technologies in social tenure properties owned by housing associations will in part be driven by the needs to meet EESSH and other energy efficiency related housing regulations.

[13] https://www.gov.scot/policies/home-energy-and-fuel-poverty/energy-efficiency-in-social-housing/
[14] https://www.gov.scot/publications/building-standards-technical-handbook-2020-domestic/

3.4. Operational capacity by local authority area

Figure 6 shows the operational community and locally owned renewable energy capacity for the top ten local authority areas broken down by ownership category. The accompanying maps (Figures 7 to 13) illustrate, by local authority area and ownership category, the distribution of operational community and locally owned renewable energy capacity throughout Scotland as at the end of December 2021.[15]

The local authority areas which are contributing the most capacity are Aberdeenshire and Highland. The majority of capacity in the former is mostly from farm and estate ownership, with the latter being a relatively more even mixture of all the ownership categories reported on.

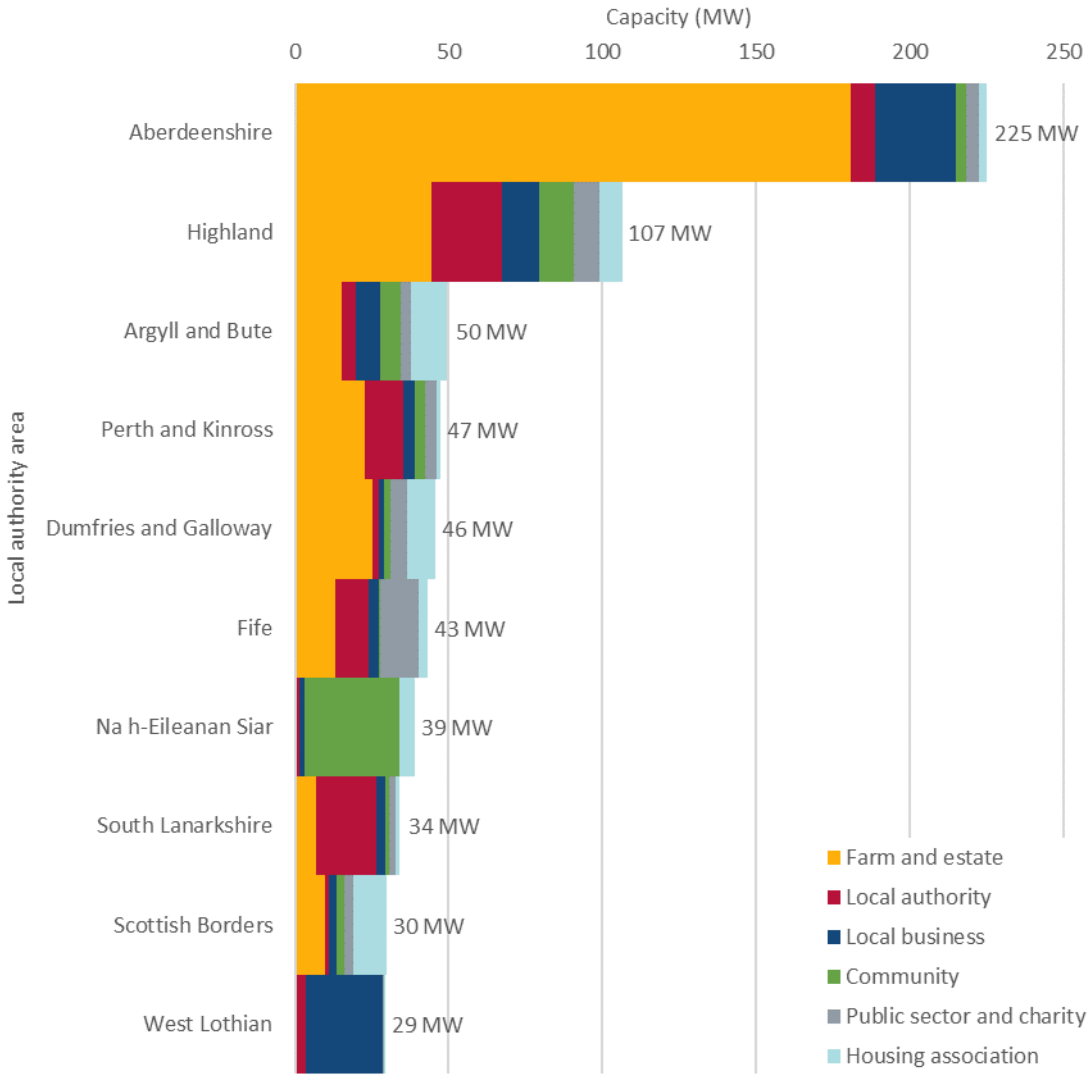

Figure 6. Operational capacity by local authority area and ownership category

[15] Please note that these maps show more than 99% of the reported total capacity. A small percentage has been omitted because we cannot allocate it to specific local authority areas.

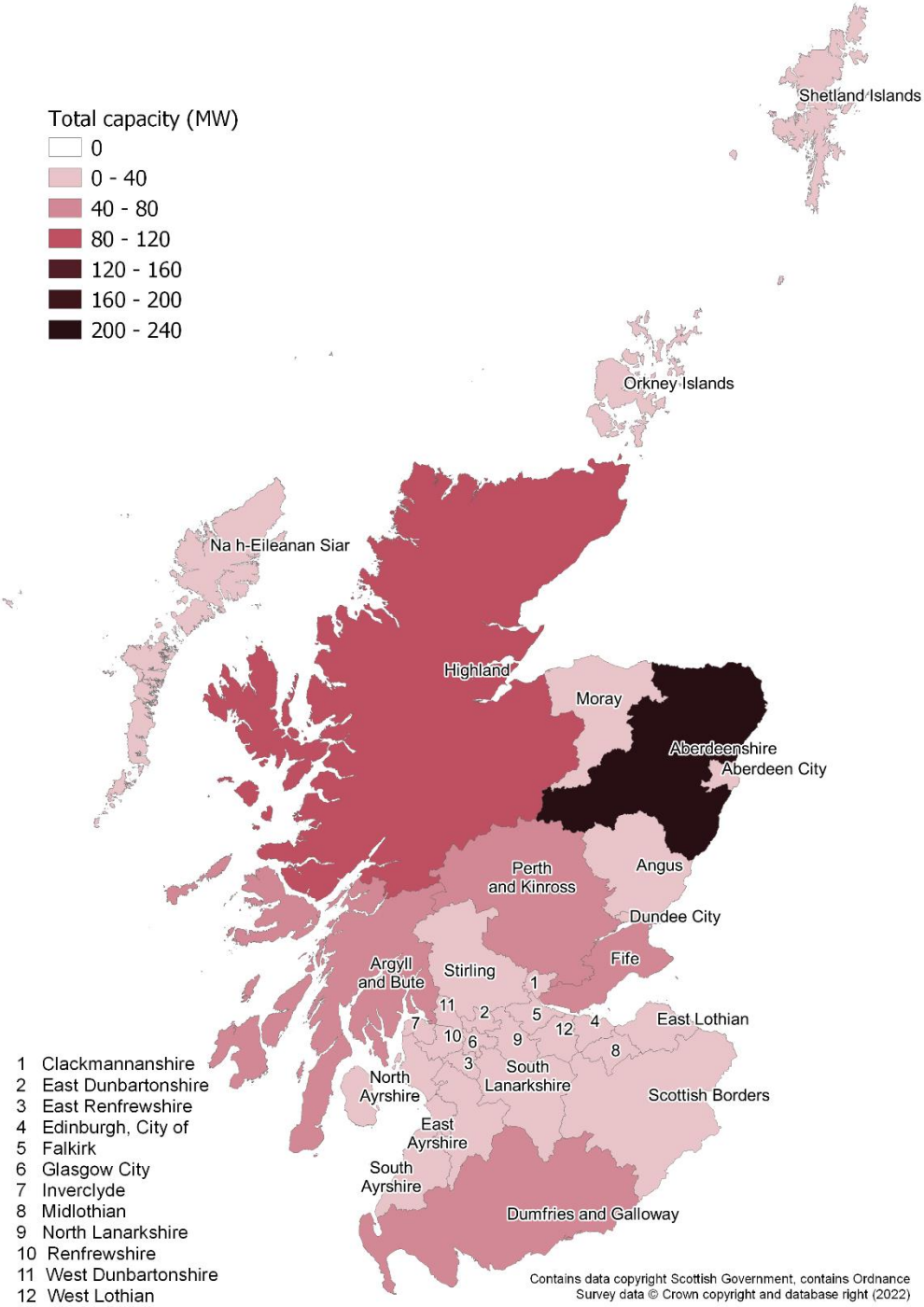

Figure 7. Total operational renewable energy capacity in community or local ownership, 2021

Figure 7 shows that the majority of community and locally owned renewable energy capacity is found in the more rural local authorities. This is likely to be because the rural local authorities typically have more natural resources available from which to generate renewable energy, including higher and more consistent wind speeds due to upland or exposed coastline areas, and greater availably of locally produced wood fuel for use by biomass systems. More rural local authorities may also have more properties off the mains-gas grid which can be a driver to install biomass or heat pump heating systems. These local authorities also typically have lower population densities which means more space for the development of larger renewable energy projects, such as wind farms.

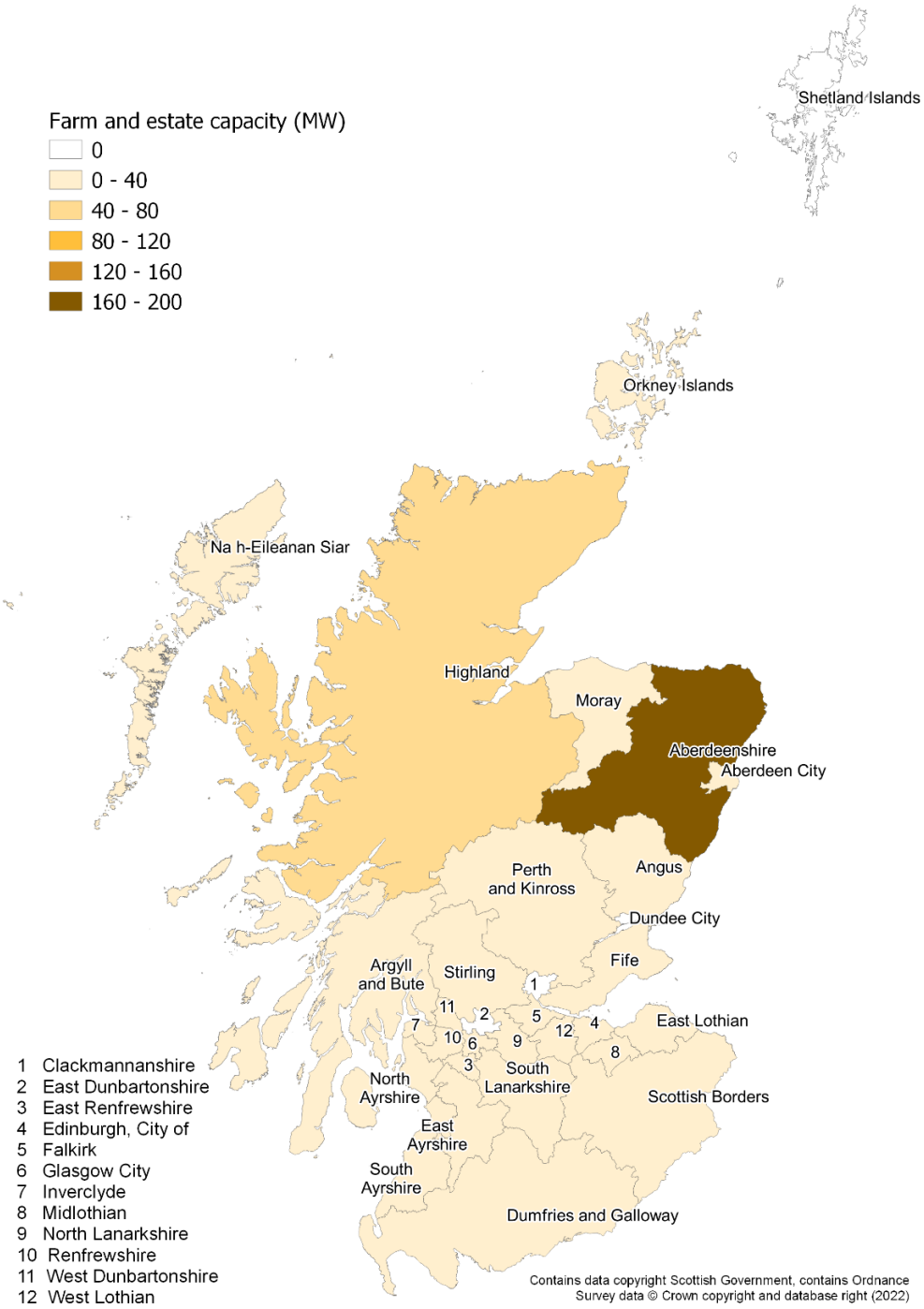

Figure 8. Operational capacity in farm and estate ownership by local authority area, 2021

Figure 8 shows that there is a clear concentration of known farm and estate capacity in Aberdeenshire, followed by Highland. This suggests that a greater number of farms and estates have taken advantage of renewable energy in these areas to support or as part of their core business strategies.

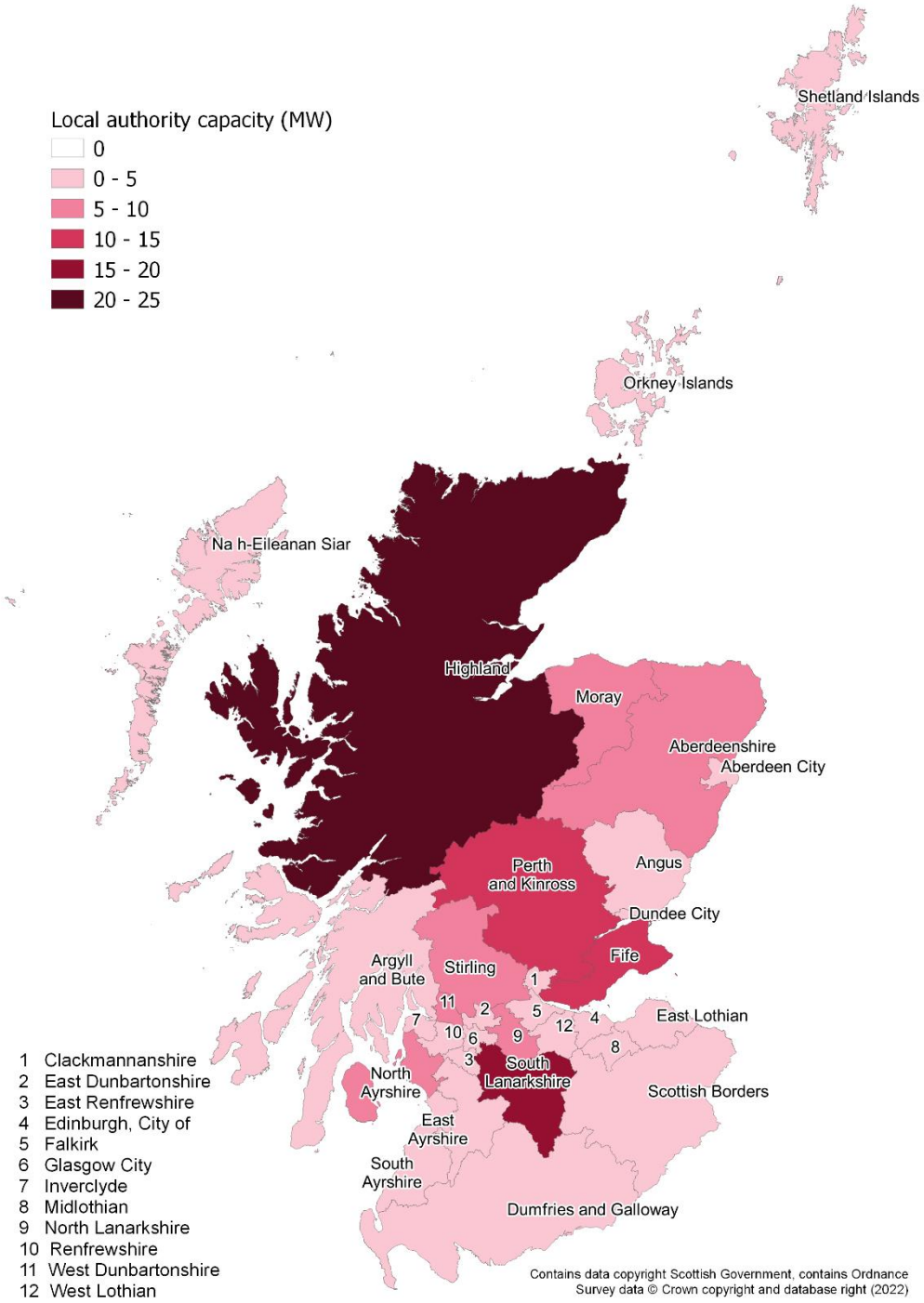

Figure 9. Operational capacity in local authority ownership by local authority area, 2021

As seen in Figure 9, Highland (23 MW), South Lanarkshire (20 MW), Perth and Kinross (12 MW) and Fife (11 MW) are the local authorities which own the most renewable energy capacity, together contributing 37% of the total local authority owned capacity recorded. The technologies installed by each of these local authorities are quite different to one another. In the Highland area, capacity is heavily dominated by biomass (92%) which are often relatively large systems in non-domestic properties such as schools. In South Lanarkshire, the capacity is mostly from heat pumps (52%) with smaller proportions coming from biomass (35%) and solar PV (12%). The heat pumps owned by South Lanarkshire are predominantly in social let properties reflecting large retrofit programmes for their social housing stock. Fife, on the other hand, has significant contributions to their total capacity from energy from waste (57%) followed by solar thermal (15%) and biomass (13%). The energy from waste installations are situated on or near waste management sites, which the council are responsible for, and the installations are being used to feed heat networks.

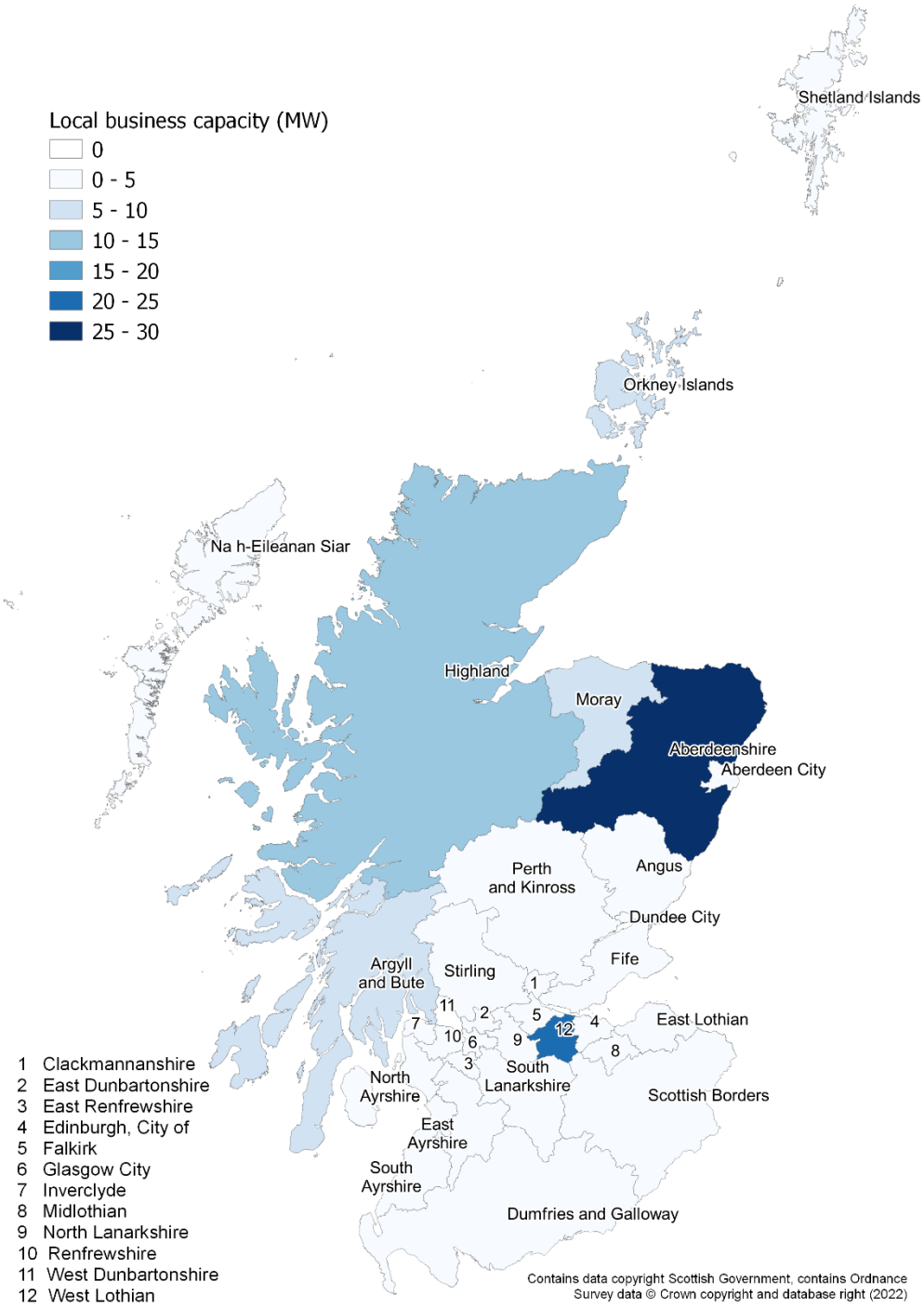

Figure 10. Operational capacity in local business ownership by local authority area, 2021

Figure 10, showing the distribution of local business capacity, shows a clear concentration of capacity in Aberdeenshire. There is a second large concentration of capacity in West Lothian which is tied to a small number of very large energy from waste installations.

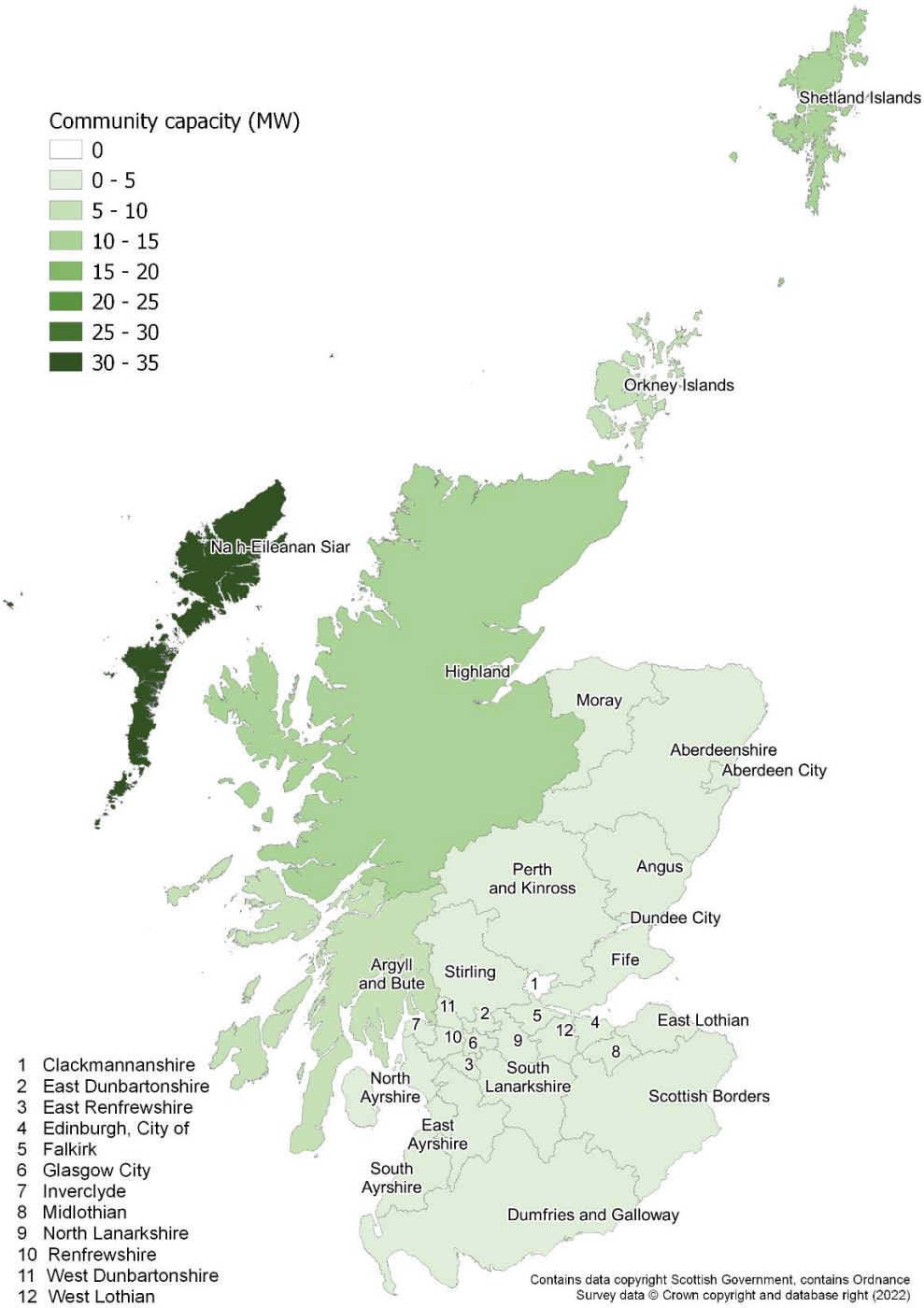

Figure 11. Operational capacity in community ownership by local authority area, 2021

The distribution of community owned renewable energy capacity, in Figure 11, shows that this is mostly found in the Highlands and Islands. Community capacity is comprised mostly from wind installations, and secondarily from hydroelectric installations, which the Highlands and Islands are well suited for. In some cases, the community capacity also reflects economic development in the area, particularly on islands not connected to the national electricity grid where communities are installing renewable electricity generating systems alongside electric batteries. Due to the particular challenges and opportunities in rural and island areas, there has traditionally been more targeted support available to help enable community owned renewable energy installations.

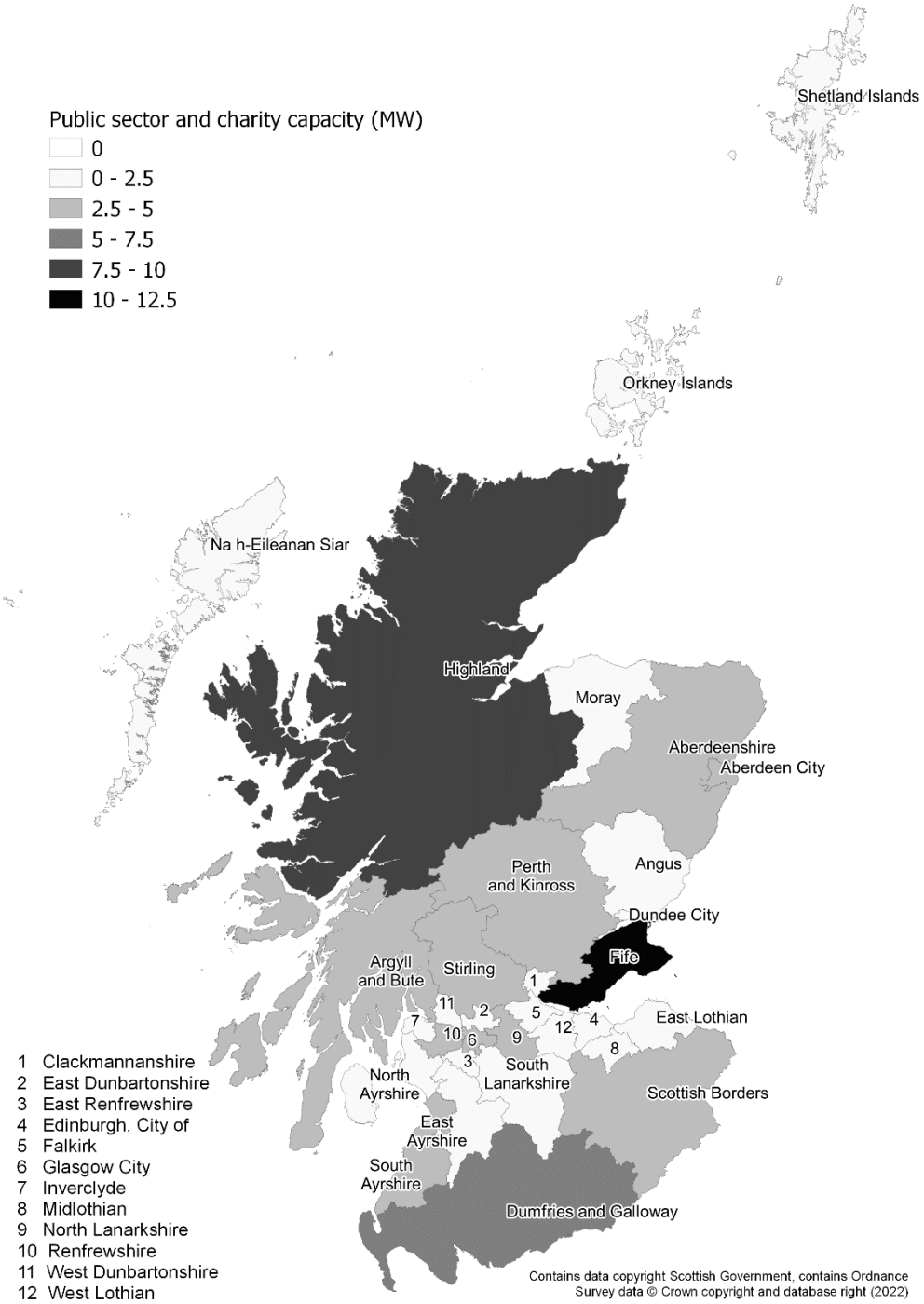

Figure 12. Operational capacity in public sector and charity ownership by local authority area, 2021

Figure 12 shows the distribution of renewable energy capacity in public sector and other charitable organisation ownership. Noting the much tighter minimum and maximum scale of the map legend, you can see that the distribution of capacity across Scotland relative to the other ownership categories is much more evenly spread. Where a local authority area has a greater contribution of public sector capacity, it tends to be from a small number of very large installations owned by a small number of organisations. For example, the majority of public sector capacity in Fife is from a large biomass heat network operated by a university.

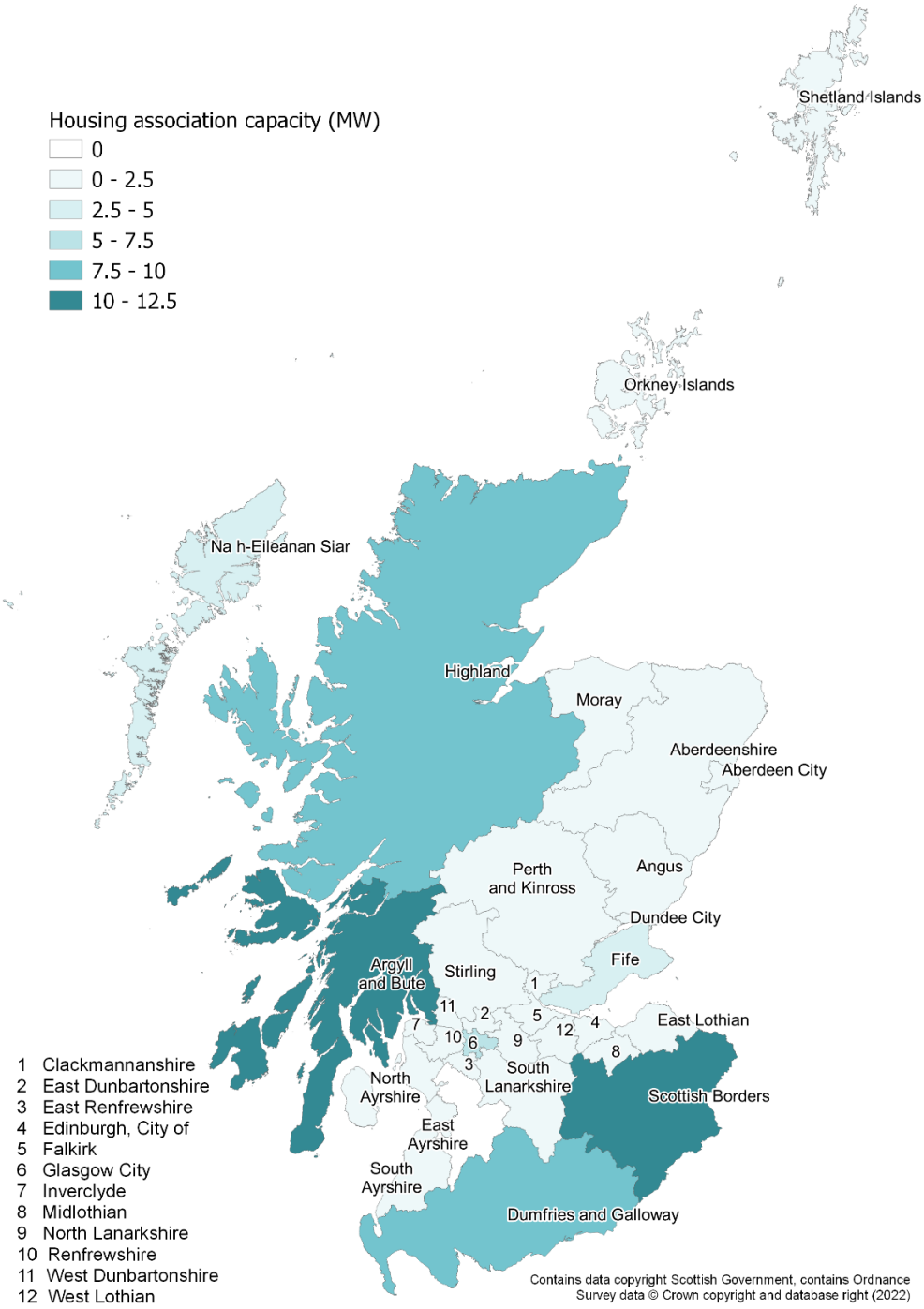

Figure 13. Operational capacity in housing association ownership by local authority area, 2021

Figure 13 shows that housing association owned capacity is most commonly found in the larger, more rural local authorities. Since the majority of housing association installations are domestic, their distribution will therefore be less driven by the availability of large wind and hydro resources. Domestic installations are more driven by the suitability and need of smaller scale electricity generating and renewable heating systems for the local housing stock, especially in areas not on the mains gas grid. However, it should be noted that the housing association distribution will also trend towards the housing associations who most regularly respond to our survey. As most housing associations in Scotland tend to operate in a specific geographic area, the local authority areas that these housing associations operate in may have higher operational capacities as a result.

3.5. Estimate of annual output from reported total capacity

Over a year, the 896 MW of operational community and locally owned renewable energy capacity is estimated to produce 1,921 GWh of renewable energy. This consists of around 1,029 GWh of electricity, 687 GWh of heat and 205 GWh of energy from CHP installations.

The breakdown of total output into electrical, heat or CHP output is shown in Table 5 and Figure 14.

Table 5. Operational output by energy type, 2021

Energy type	Operational output (GWh)	Percentage of operational output	Absolute change from December 2020	Percentage change from December 2020
Electricity	1,029	54%	47	5%
Heat	687	36%	38	6%
CHP	205	11%	<1	<1%
Total	**1,921**	**100%**	**85**	**5%**

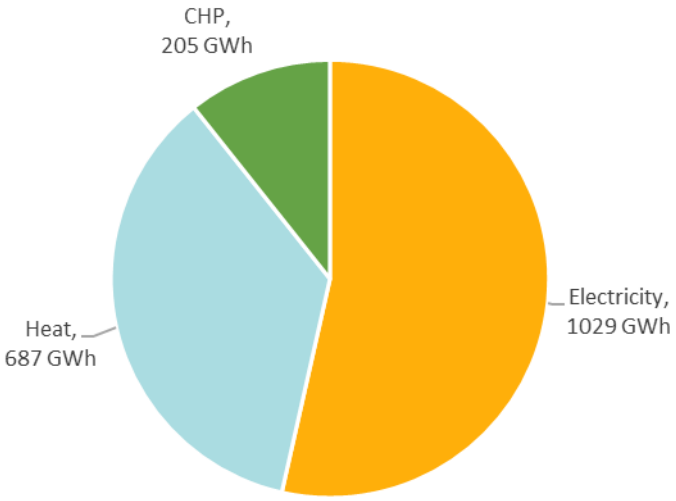

Figure 14. Operational community and locally owned renewable output by energy type, 2021

4. Progress towards the 2 GW target

At the end of December 2021, the Scottish Government has progressed 45% towards their goal of having 2 GW of capacity in community or local ownership by the end of 2030, see Figure 15.

Assuming that progress will be evenly distributed across every future year until 2030, which is not necessarily how the growth in community and locally owned renewable energy should be expected to happen, in order to reach the 2 GW target the total capacity in operation would need to increase by 123 MW each year for the next 10 years.

As the growth in capacity reported for 2021 was 44 MW, a faster rate of annual capacity gain is required in order to reach the target in time. Some of the support currently, and previously, offered by the Scottish Government to help achieve the 2 GW target is given in section 4.1.

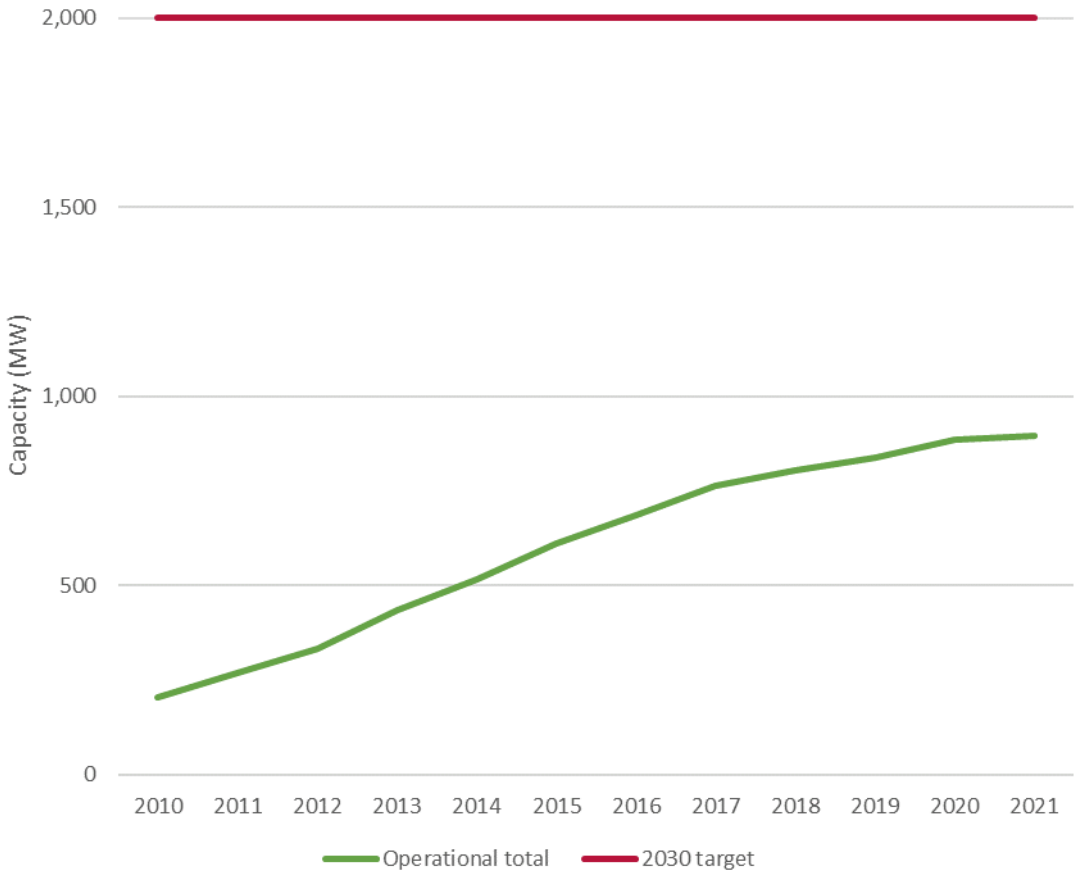

Figure 15. Total operational capacity and the 2030 2 GW target

4.1. Community and locally owned renewable energy time series

To assist with tracking progress towards the 2 GW target, we have produced the following time series of community and locally owned capacity and number of installations. The key difference between the figures presented in this section and those discussed elsewhere in the report is that we have updated the statistics for historical reporting years where possible. These revisions were made to accommodate new information found on historical installations not previously known to us, or where a more accurate operating year could be attributed to installations already known to us.

Figure 16 shows the time series of operational capacity from 2010 to 2021 by ownership category. Figures 17 and 18 show the growth in the number of operational renewable energy installations by ownership category.

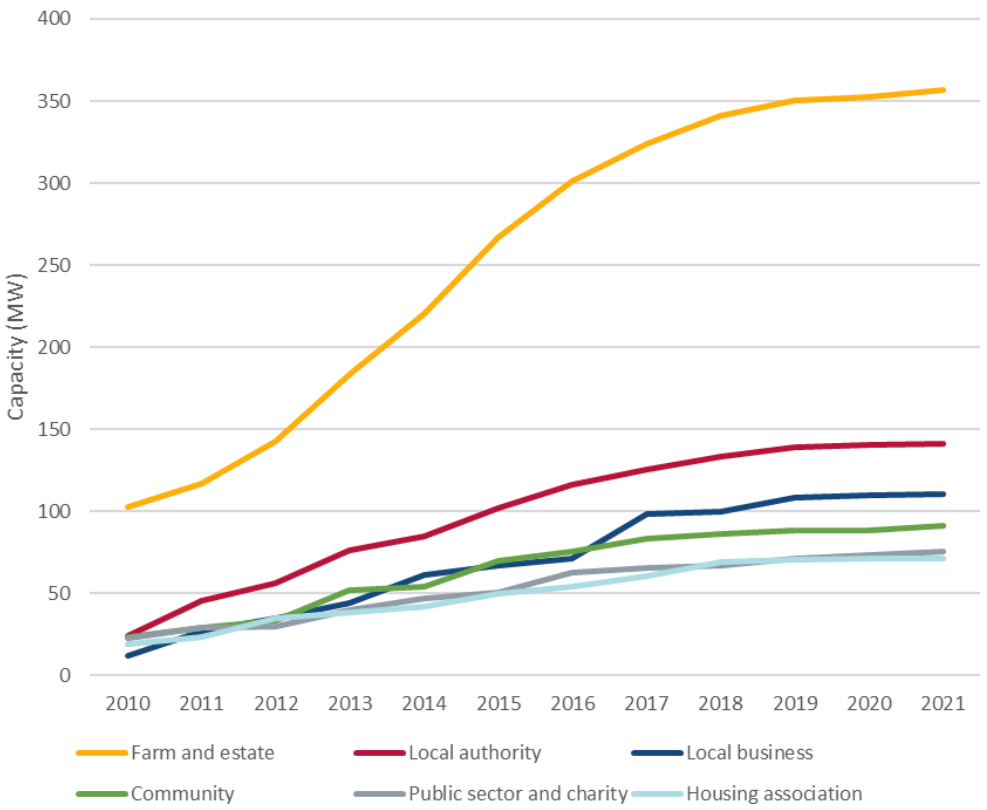

Figure 16. Operational capacity by ownership category, 2010 to 2021

The growth in capacity has generally been steady across all of the ownership categories between 2010 and 2021 but with some plateauing occurring from 2017 onwards. 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.

Uptake of renewable energy capacity was highest between 2013 and 2016 which coincides with significant number of accreditations to the UK Government's Renewable Heat Incentive (RHI) and Feed in Tariff (FiTs) schemes, which subsidised renewable heat and renewable electricity respectively. During this period, the scheme tariffs were at their highest, but have gradually decreased thereafter. On 1 April 2019 the FiTs scheme closed to new applications, limiting the financial feasibility of potential new electricity generating installations. In 2020, the Smart Export Guarantee (SEG) scheme was launched by the UK Government which guarantees that small scale electricity exporters will be paid greater than £0.00 per unit exported to the grid. However, the financial returns from the SEG are lower than from the FiTs scheme. The reduction, and temporary removal, of tariff subsidies for generated renewable electricity is likely one of the most significant causes of the slowing uptake of new renewable capacity between 2016 and 2020.

The non-domestic RHI scheme closed to new applications in 2021. While in operation, the scheme had a degression mechanism where the RHI tariffs were gradually reduced as more of a particular technology was installed, in line with the total amount of funding available for each technology. As a result, the number of new non-domestic accreditations for biomass, the renewable technology with the greatest contribution to renewable heat in Scotland,[16] gradually decreased between 2010 and 2021; although there was an increase in biomass accreditations with capacities greater than 200 kW between 2016 and 2018 when RHI biomass tariffs were simplified, and installations of this size became more incentivised as a result. The increased uptake of medium and large sized biomass installations coincides with the peak in uptake of new capacity seen for farms and estates between 2016 and 2018, where a number of these biomass installations would have been installed for agricultural use.

[16] https://energysavingtrust.org.uk/report/renewable-heat-in-scotland-2020/

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:[17]

- Community and Renewable Energy Scheme (CARES)
- District Heating Loan Fund (DHLF)
- Small and Medium Enterprise (SME) loan and cashback scheme and the Energy Efficiency Business Support scheme
- Low Carbon Infrastructure Transition Programme (LCITP) – the scheme closed to new applications in 2021.
- 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, the Scotland's Heat Network Fund,[18] opened to applications on the 21 February 2022, and will support the development of new zero emission heat networks. The Scottish Government also announced the opening of applications to the Social Housing Net Zero Heat Development Fund,[19] which will provide financial support to registered social landlords to help install renewable heating systems in their housing stock.

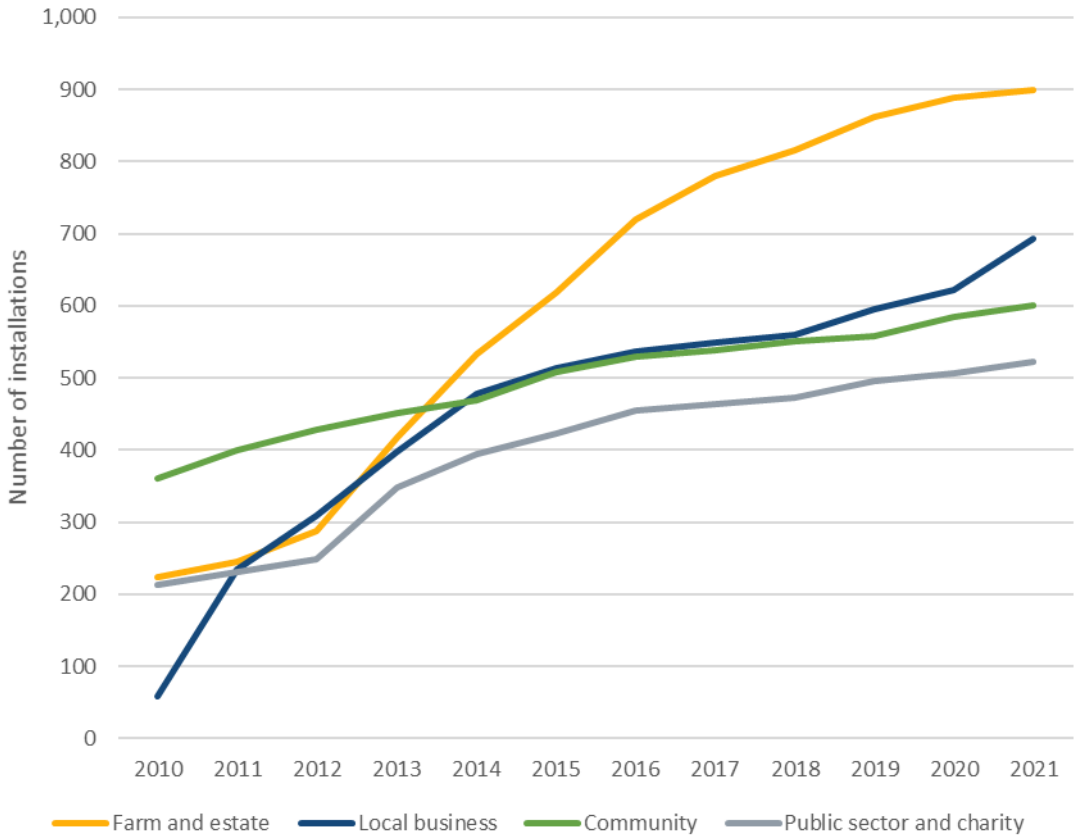

Figure 17. Number of operational installations by community, farm and estate, local business and public sector and charity ownership categories, from 2010 to 2021

[17] 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).
[18] https://www.gov.scot/publications/heat-network-fund-application-guidance/
[19] https://www.gov.scot/publications/social-housing-net-zero-heat-fund-development-funding-invitation/

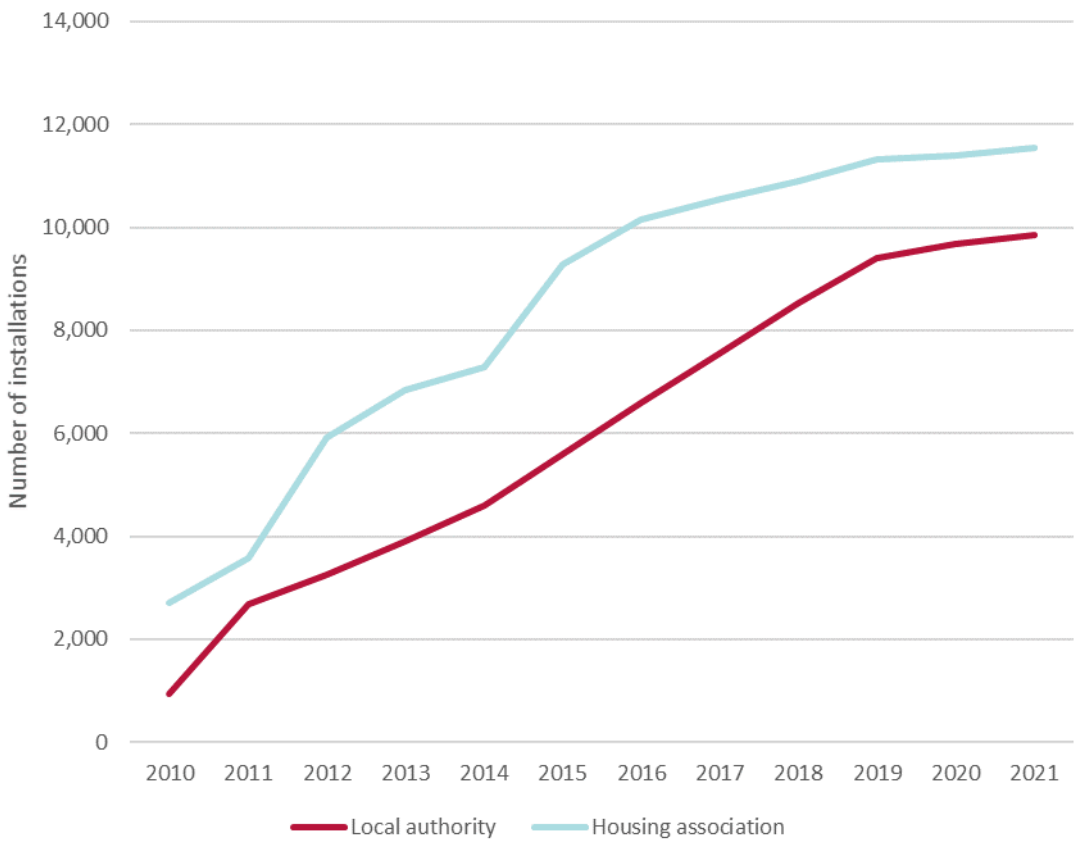

Figure 18. Number of operational installations by housing association and local authority ownership categories, from 2010 to 2021

As discussed earlier in the report, the uptake of renewable energy installations are also encouraged through the minimum Energy Efficiency Standards for Social Housing (EESSH) regulations, enacted by the Scottish Government in 2014. These regulations stipulate that where feasible to do so, all social let properties should reach an EPC band of D or C (average energy efficiency or above) by 2020 and an EPC band B (high energy efficiency) by 2032. While it may be possible to meet the 2020 standards in a large number of properties without installing renewable technologies, because an efficient fossil fuel heating system and good levels of insulation may be sufficient to meet the more immediate targets, installing renewable technologies is one way of reaching the minimum standards set. Renewable technologies are also very likely to be needed in most of the existing housing stock in order to meet the stricter 2032 standards. We therefore expect to continue to see the steady uptake of renewable technologies in social housing over this timeframe.

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. These models are specific to a property's size, detachment and main heating fuel and an efficient way to meet these standards is to install renewable energy technologies. 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.

4.2. Impact of the Covid-19 health emergency

It is difficult to ascertain the impact of the Covid-19 health emergency upon the rate of installation of new community and locally owned renewable energy capacity from the data we have collected. To some degree, and depending upon the source of data, there is a lag between when an installation becomes operational and when it becomes known to us for reporting. As a result, many of the installations we hear about in a reporting year are installations found to be in operation historically. This means that any stronger impacts of the Covid-19 health emergency may not be detectable in our analysis until one or more years later.

Looking elsewhere for the potential impacts, according to the publicly available non-domestic and domestic RHI datasets for Great Britain,[20] the rate of accreditation under the RHI schemes has been slower in 2021 than in previous years. However, as discussed earlier in the report, the rate of accreditation under the RHI schemes was already slowing, largely due to reducing tariff rates and the non-domestic RHI scheme closed to new applications in 2021. The slow rate of accreditation under the schemes in 2021 is therefore not unexpected.

An examination of Microgeneration Certification Scheme (MCS) data on the number of renewable energy accreditations occurring between 2019 and mid-2021 in Scotland does show a sharp drop during spring 2020, which coincides with the first UK national lockdown. MCS is an accreditation standard for micro-sized renewable energy installations in the UK and certifies capacities of typically less than 45 kW for renewable heat installations and less than 50 kW for renewable electricity installations. As certification is required to access a number of financial support schemes, including the domestic RHI scheme (closed to new applicants on 1 April 2022) and the Scottish Government's Home Energy Scotland loan scheme, MCS data is considered one of the most complete indicators on smaller scale renewable energy installations. However, the remainder of 2020 shows a near immediate bounce back to pre-pandemic levels of new accreditations, and the rate of MCS accreditation in the first six months of 2021 is higher than the same period of either 2020 or 2019. This suggests that the impact of Covid-19 on micro-sized renewable energy installations was not significant in the longer term.

Due to Covid-19 impacts on the supply chain it is likely that there will have been some slowing of the rate of renewable installations and thereby the figures presented in this report. However, from the data we currently have available, any impacts currently recognisable appear fairly limited in scope.

[20] www.gov.uk/government/collections/renewable-heat-incentive-statistics

5. Further community and locally owned capacity in development

In addition to the 896 MW of community and locally owned renewable energy capacity estimated to be operational at the end of December 2021, a further 1,328 MW was estimated to be in various stages of development.

Of the renewable energy capacity estimated to be in development:

- 61 MW was in the scoping stage
- 99 MW was waiting for a planning decision to be made ('in planning')[21]
- 128 MW had been granted planning permission, but construction had not yet started ('consented, not built')[21]
- 37 MW was under construction
- 1,002 MW is under discussion for potential shared ownership between a renewable developer and a local or community group ('shared ownership under discussion')
- 2 MW was in 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 19, and a breakdown by technology type is given in Table 6.

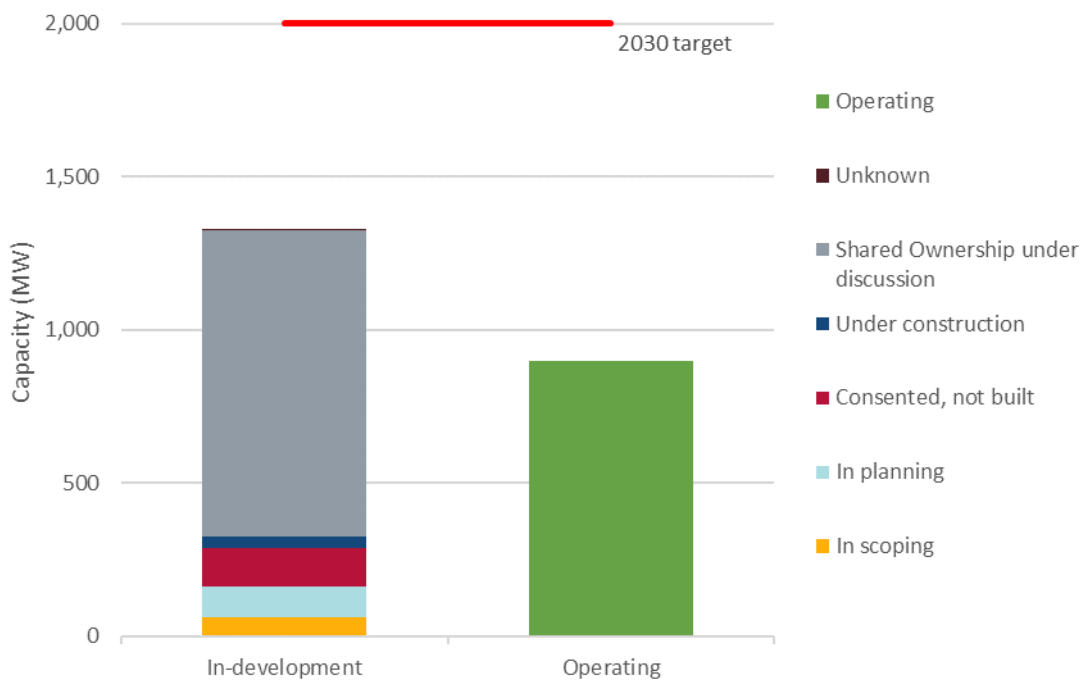

Figure 19. Capacity in each stage of project development, 2021

[21] Applies only to projects that would require planning permission.

Table 6. Capacity (MW) in each stage of development by technology[22]

Technology	In scoping	In planning	Consented, not built	Under construction	Shared ownership under discussion	Total
Wind	21	65	67	8	996	1,157
Solar PV	27	5	18	4	3	58
Tidal	<1	20	10	0	0	30
Energy from waste	<1	0	18	11	<1	29
Heat pump	<1	3	5	8	0	18
Hydroelectric	5	2	7	3	3	19
Biomass	3	3	3	2	0	12
Geothermal	4	0	0	<1	0	4
Solar thermal	<1	<1	<1	<1	0	<1
Grand total	**61**	**99**	**128**	**37**	**1,002**	**1,328**

5.1. Shared ownership projects

A number of projects have ownership which is either shared between a community or local owner and a developer, or where multiple community or local owners have come together to share ownership.

We have included projects where shared ownership is under discussion but where any partnership has not yet been formalised between renewable developers and local community groups. This information is included to better capture in-development community and locally owned energy as well as to indicate the progress made towards the Scottish Government's ambition to ensure that by 2020, at least half of newly consented renewable energy projects had an element of shared ownership. The Scottish Government have continued with this ambition and at least half of all newly consented renewable energy projects have an element of shared ownership with communities.[23] Projects were identified as being 'under discussion' through CARES engagement with local groups and developers.

As shared ownership agreements are finalised, those projects currently classed as under discussion will move into the other stages of development. Where any such agreements do not come to fruition, the projects 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.

At the end of December 2021, there were 270 unique projects recorded in the database with either shared ownership or where shared ownership is under discussion; out of which 47 were operational at the time of reporting. These operational projects accounted for 67 MW of community and locally owned capacity between them. The remaining 223 projects were in various stages of development and account for 1,003 MW of the in-development capacity. There are a number of factors that will impact the proportion of 1,003 MW that's realised as community and locally owned and the attrition rate for the remaining 223 projects is expected to be high. This is because some projects will not be consented, some projects will not be built, some shared ownership stakes will be reduced, and some projects will eventually fail to agree shared ownership.

Tables 7 and 8 show the breakdown of shared ownership projects in development split by ownership category and technology. The numbers recorded in the 'number of records' and 'number of projects' columns in Tables 7 and 8 are different because each 'community or local' owner (see Appendix A for ownership

[22] For ease of reading, the 2 MW of capacity classed as being in an unknown stage of development has been omitted from this table.
[23] https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/pages/14/

category descriptions) is recorded individually in the database. This is to allow for appropriate allocation of capacity between the ownership categories. For example, a project may be owned by a number of different organisations that fall into different ownership categories. This means that there will be multiple records in the database for that particular project. As such, there are 280 records in the database covering 270 unique projects.

Wind turbines make up the vast majority of the shared ownership operational capacity in operation (63 MW) and under development (996 MW).

Table 7. Number of projects in the database with shared ownership and where at least one of the owners is a community or local organisation

Development status	Number of projects
Operational	47
In scoping	1
In planning	1
Consented, not built	1
Under construction	0
Shared ownership under discussion	220
Total	**270**

Table 8. Number of records in the database with shared ownership by ownership category and development status

Technology	Operating	In scoping	In planning	Consented, not built	Under construction	Shared ownership under discussion
Farm and estate	14	0	0	0	0	0
Local authority	2	0	1	0	0	0
Local business	2	0	0	1	0	0
Community	26	0	0	0	0	220
Public sector and charity	2	0	0	0	0	0
Housing association	11	1	0	0	0	0
Total	**57**	**1**	**1**	**1**	**0**	**220**

6. Community and locally owned energy storage in 2021

At the end of December 2021, there was an estimated 9.4 MWh of installed energy storage capacity in community or locally owned ownership in Scotland. This was spread over approximately 1,080 installations.

Of the 9.4 MWh of energy storage capacity known to be installed there was an estimated:

- 2.4 MWh of electrical storage capacity
- 5.6 MWh of heat storage capacity
- 1.4 MWh of hydrogen storage capacity

The growth in energy storage capacity since December 2020 was all attributable to electrical storage (0.3 MWh). The ownership of the new electrical storage capacity is split between community groups (0.2 MWh) and public sector and other charitable organisations (0.1 MWh).

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 electricity supply and demand.

6.1. Further energy storage capacity in development

In addition to the 9.4 MWh of community and locally owned energy storage capacity estimated to be installed in Scotland at the end of December 2021, a further 0.6 MWh was estimated to be in development. Of this 0.6MWh of energy storage capacity in development:

- 0.1 MWh was under construction. This is all electricity storage capacity
- 0.5 MWh was in planning. This is mostly heat storage capacity with a very small amount of electrical storage capacity

Appendix A 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.

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 technologies producing heat and/or electricity from a renewable source,[24] where the owner of the installation is in one of the following categories:

- A community group
- A local Scottish business[25]
- 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[26]
    - 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 projects[27] 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 information has been used to establish whether estate owners are normally resident on the estate

[24] A full description of each eligible technology is given in Appendix B.
[25] 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).
[26] https://www.oscr.org.uk/
[27] www.localenergyscotland.org/view-the-register/

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,[28] 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)[29] or Universities Scotland.[30] 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,[31] and churches and other religious organisations.
- The **local business** category are small or medium-sized enterprises (SMEs) registered with Companies House[32] 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 projects at a location significantly removed from their registered office, and where the business does not own the land where the installation will be built.[33]
- 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 projects, or types of energy storage, such as electricity, heat and hydrogen, which fell into the ownership categories listed above were included in the database.

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 electricity-producing technologies is usually measured in kilowatts of electricity (kWe) or megawatts of electricity (MWe), depending on the size of the installation. The capacity of heat-producing technologies is measured in kilowatts-thermal (kWth) or megawatts-thermal (MWth), again depending on the size of the installation. For ease of reading, the capacity totals presented in this report are all given in gigawatts (GW). One gigawatt is equal to one thousand megawatts or one million kilowatts.

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 (MWe + MWth) is recorded. However, the supporting database attempts to also record both figures (electrical capacity and heat capacity).

Solar PV capacity can be referred to in kilowatt-peak, or kWp, which is interchangeable with kWe.

[28] www.scotland.gov.uk/Topics/Government/public-bodies/about/Bodies
[29] www.collegesscotland.ac.uk/about-us
[30] www.universities-scotland.ac.uk/
[31] Leisure trusts supply sports facilities to local communities, often on behalf of unitary authorities.
[32] www.companieshouse.gov.uk/
[33] 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.

"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 kilowatt hours (kWh) or megawatt hours (MWh).

Approach taken and data sets 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 2021 to December 2021. The figures reported in this publication are correct as of 31 December 2021.

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.

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 Scottish domestic Energy Performance Certificate (EPC) register**

As the housing association and local authority surveys are voluntary, they are likely to provide an incomplete picture of renewable energy measures installed in social let properties. We have extracted a list of EPCs for all social let properties in Scotland, that had at least one renewable technology listed, for analysis. Please see the later 'Operational capacity in social housing' appendix section for more information.

- **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),[34] which is maintained on their behalf by Eunomia. The REPD tracks the progress through the UK planning system of all renewable electricity-generating technologies with an electrical generation capacity of 0.01 MWe (10 kWe) 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 10 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 projects that had received support from the Renewable Energy Investment Fund (REIF). While the majority of the projects 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.

- **Data from the Community Energy: State of the Sector report[35]**

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. For the first time this year their latest survey also covered Scotland. Community 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 projects 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[36] and in its newsletters
- Individual community group, charity or housing association websites

[34] www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[35] https://communityenergyscotland.org.uk/wp-content/uploads/2021/06/UK-SOTS-Full-Report-reduced-file-size.pdf
[36] www.communityenergyscotland.org.uk/

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 2021 (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 projects
- 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)
- 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

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 projects that were under development as of 31 December 2020 has remained the same if no evidence has been found that the project has progressed as of 31 December 2021.

The quality of data provided varied considerably. In particular, installed capacity was often not provided, and operational status was sometimes unclear.[37] 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

[37] 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.

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 projects still in scoping, location had not always been decided at the time of data collection.

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 projects, 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 projects, 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. However, analysis of the Scottish domestic EPC register was conducted to get an idea of how many renewable energy installations in social housing may be missing from the collated surveys. Please see the later 'Operational capacity in social housing' appendix section for more information.

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

It is difficult to gain information on projects 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 projects until they enter the planning process. Therefore, the figures presented here for installations in scoping are highly likely to be an underestimate.

- **Projects 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 projects greater than 1 MW of capacity. For our own checks, only a sample of local authority planning portals can be checked each year in time due to resource constraints., Therefore, the figures presented here for installations in planning are likely to be an underestimate.

- **Projects 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 projects 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 projects in development are likely to be missing from the database altogether due to not being found in the sources used.

- **Energy storage projects**

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[38] 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 projects not in local authority or housing association ownership are much less likely to have been captured in the data collection process.

Operational capacity in social housing

We have already discussed the operational capacity in local authority and housing association ownership which is primarily collected through surveys. Since we are aware that a number of housing associations and local authorities do not respond to our survey each reporting year, it was deemed highly likely that our social housing estimates were significantly undercounting the amount of renewable energy installations in social let properties. In order to fill in this gap, we have for the second time this year analysed data from the Scottish domestic EPC register. This involved extracting EPC information for every social let property with at least one renewable technology being listed as present in the property.

The result was a count of 23,930 different renewable technologies being installed in all Scottish social let properties. We subtracted our own count of renewable energy installations, gathered through our surveys, from this number to estimate that there were 4,890 installations we were not aware of.

Unfortunately, EPC data does not give an indication of the capacity of the installed renewable technologies, so we have multiplied the number of each technology found from the EPC data by our assumed capacities for each technology in domestic settings (please see Appendix D for more information on these assumptions). The result was that these 4,890 newly found installations are estimated to add a further 25 MW of operational capacity to the reported totals.

There are, however, some potential issues with this analysis worth exploring to put the reported figures in best context:

- Domestic EPCs indicate the tenancy of the property as owner occupied, private rented or social rented. The social rented classification on a domestic EPC does not distinguish whether the social landlord is a local authority or a housing association, and we are therefore unable to breakdown this 25 MW of operational capacity into the exact community or local ownership categories used in this report.
- Some of the older EPCs may no longer be up to date and there is a risk that some of the social housing with renewable technologies installed are now in private ownership or demolished, or the

[38] www.sandia.gov/ess-ssl/gesdb/public/projects.html

renewable energy installation has been decommissioned. Hence, there may be some degree of overcounting.

- We have not been able to verify the installation totals derived from the EPC register data at address level by cross-checking them against any other datasets, including our community and locally owned renewable energy database. Therefore, there may be a risk of some double counting occurring.
- As we are assuming the capacity of the renewable installations found on the EPCs using the average capacities of installations known to us through the local authority and housing association surveys, we are therefore assuming that the installations from the domestic EPC analysis are similar to those collected through the surveys.
- The domestic EPCs list each renewable technology present but do not give an indication of how many installations of each technology there may be within a property. We have therefore assumed that there is only one of each technology listed on an EPC in the premises, however, in a small number of cases this may be incorrect.

The social let EPC analysis underwent several methodological changes between the 2021 and 2020 reports. These methodological changes are important because the drop in capacity reported for undetermined social housing (see Table 1) is due to methodological reasons rather than from genuine change in the sector.

The most significant methodological change were revisions to the assumed capacities for domestic installations. For the 2020 report, our assumed domestic capacities were calculated from any installations in our database which were local authority or housing association owned, had a capacity of less than 45 kW and were in a property known to be not non-domestic (i.e. domestic or unknown whether it was domestic or non-domestic). For the 2021 analysis, we have restricted the basis of our assumed domestic capacities to just the installations confirmed to be in domestic properties, and so excluding those properties which are unknown whether they are domestic or non-domestic. This led to a reduction in the assumed capacities for several technologies in social let domestic settings, namely:

- Assumed domestic solar PV capacities fell from 4.0 kW to 2.4 kW
- Assumed domestic air source heat pump capacities fell from 8.0 kW to 7.1 kW
- Assumed domestic biomass capacities fell from 25.3 kW to 20.0 kW

When multiplying the above capacities by the number of each of these technologies installed, as identified from the EPC analysis, the impact is a drop of 8.1 MW compared to what would have been calculated if the assumed capacities for the 2020 report had instead been used for the 2021 report. The -3 MW change reported for undetermined social housing in Table 1 would instead be a 5 MW gain if the 2020 assumed values had been used, which would be in line with the 2,250 new installations found in EPCs for social let properties as part of our 2021 analysis.

We will continue to refine this methodology over the next reporting year to better integrate the undetermined social housing figures within the community and locally owned energy database and accompanying report.

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,[39] 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).

[39] fintrydt.org.uk/about/

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.[40] 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.

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 D.

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 9. 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[41]

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 10.

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).

[40] energy4all.co.uk/
[41] Scottish average calculated using data from: www.pvfitcalculator.energysavingtrust.org.uk/

Table 10. 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[42]
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[43]
Biomass	Annual peak loads	Not disclosed[44]	Hours/year	Analysis of unpublished non-domestic RHI data
Heat pumps	Annual peak loads	Not disclosed[44]	Hours/year	Analysis of unpublished non-domestic RHI data
Solar thermal	Annual peak loads	Not disclosed[44]	Hours/year	Analysis of unpublished non-domestic RHI data
Biogas	Annual peak loads	Not disclosed[44]	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

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

[43] 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
- Scottish Hydropower Resource Study for FREDS, Aug 2008, www.british-hydro.org/wp-content/uploads/2018/03/A-Guide-to-UK-mini-hydro-development-v3.pdf

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

[44] 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/

Intended changes to research and reporting for the 2022 report

In this report, and as per previous reports of the series, the figures presented on the accumulative changes in community and locally owned renewable energy capacity are based on the differences between this year's analysis and the figures which were reported last year.

In order to improve the community and locally owned renewable energy reporting, we intend to move to reporting on a revised time series each year which allocates the amount of renewable energy installed to the year of installation rather than the year in which it became known to us. To some extent the methodology for this has already been achieved, see Figures 14 and 15 of this report, but any new reports in the series will focus on the revised time series figures rather than commenting on the change in capacity previously reported.

The advantages of this approach will be to allow more detailed commentary on the timing and reasons for trends seen in community and locally owned renewable energy capacity. What will remain a potential limitation is that any commentary on the change in capacity within the most recent reporting year will likely be an underestimate for that year due to the delay in latest installations becoming known to us.

Appendix B 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).

- **Biomass primary combustion**

Biomass is burnt to directly produce heat or both heat and electricity (CHP). Here 'biomass' has been taken to mean woodfuel, such as wood chips, pellets or logs, or other plant matter including straw and energy crops. It is also possible (as in the Lerwick district heating scheme in Shetland) for other organic or putrescible matter, such as food waste, to be burnt to produce heat, but in these cases the installation has been classified as 'energy from waste' (EfW).

- **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.

- **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.

- **Energy from waste technologies:**
  - **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 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 to generate electricity and heat.

- **Waste primary 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.[45]

- **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.

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

- **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.

[45] 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

- **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 C List of main data sets used

Table 11 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 11. 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[46]
Energy Saving Trust, on behalf of the Scottish Government	District Heating Loan Fund (DHLF); Scottish EPC register	Local authority; housing association; community;[47] 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

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

Appendix D Capacities assumed for individual installations where not known

Table 12 shows the assumed capacities that were used in the community and locally owned renewable energy database where information on capacity was not available.

Table 12. Assumptions for capacity by technology and building type

Ownership category	Building type	Technology	Assumed capacity (kW)	Source
Community	Non-domestic	Air source heat pump	16	Average of known community air source heat pump capacities held in the database
	Non-domestic	Hydroelectricity	362	Average of known community hydroelectric capacities held in the database
	Non-domestic	Biomass primary combustion	109	Average of known community biomass primary combustion installations recorded in the database
	Non-domestic	Ground source heat pump	29	Average of known community ground source heat pump installations recorded in the database
	Non-domestic	Solar PV	66	Average of known community solar PV capacities held in the database
	Non-domestic	Solar thermal	6	Average of known community solar thermal capacities held in the database
	Non-domestic	Wind	769	Average of known community wind capacities held in the database[48]

[48] 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.

	Non-domestic	Energy storage (electricity)	38	Average of known community energy storage(electricity) capacities held in the database
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	Biogas produced by anaerobic digestion primary combustion	1,108	Average of known farm and estate biogas produced by anaerobic digestion primary combustion capacities held in the database
	Non-domestic	Biogas produced by gasification primary combustion	140	Average of known farm and estate biogas produced by gasification primary combustion capacities held in the database
	Non-domestic	Biomass primary combustion	244	Average of known farm and estate biomass primary combustion capacities held in the database
	Non-domestic	Ground source heat pump	78	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	314	Average of known farm and estate wind capacities held in the database

Local authority	Non-domestic	Air source heat pump	16	Average of known local authority air source heat pump capacities held in the database
	Non-domestic	Biomass primary combustion	15	Average of known local authority biomass primary combustion capacities held in the database
	Non-domestic	Ground source heat pump	22	Average of known local authority ground source heat pump capacities held in the database
	Non-domestic	Solar PV	9	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
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 primary 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	19	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 primary combustion	232	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
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 primary combustion	259	Average of known public sector and other charity biomass primary combustion capacities held in the database
	Non-domestic	Ground source heat pump	35	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 PV	22	Average of known public sector and other charity solar PV capacities held in the database
	Non-domestic	Solar thermal	71	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 primary combustion	1,157	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 primary combustion	134	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	40	Average of all school air source heat pump capacities held in the database
	School	Biomass primary combustion	232	Average of all school biomass primary combustion capacities held in the database
	School	Ground source heat pump	83	Average of all school ground source heat pump capacities held in the database
	School	Solar PV	25	Average of all school solar PV capacities held in the database
	School	Solar thermal	11	Average of all school solar thermal capacities held in the database