St. Ives Energy and Carbon Audit:

2020 Report for St. Ives Climate Action Group

St. Ives Plus Rainbow. Photo: Kim Nicol

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Abbreviations

AONB	Area of Outstanding Natural Beauty
AGLV	Area of Great Landscape Value
BEIS	UK Government Department for Business, Energy and Industrial Strategy
DEFRA	Department for Environment, Food and Rural Affairs. DEFRA factors (released annually) provide standardised conversion into tCO_2e
HHD	Half-hourly data - Consumption data collected by a half-hourly meter, which, every half-hour, records how much energy was
used	in the previous half-hour.
kW	Kilowatt: unit of power
kWh	Kilowatt-hour: unit of energy consumption
LPG	Liquified Petroleum Gas: bottled gas fuel

LSOA	Lower Super Output Area: sub unit of MSOA Eg: *Cornwall 054C St Ives Alexandra Road and Porthmeor*
MSOA	Middle Super Output Area: geographical area used by the ONS. The MSOA *Cornwall 054 and Cornwall 058* (used in this report) represents St. Ives town (see Appendix I)
MW	Megawatt: unit of power equivalent to 1000 x 1kW
MWh	Megawatt-hour: unit of energy equivalent to a thousand kWh
ONS	(UK Government) Office for National Statistics
OREC	Offshore Renewable Energy Catapult
PV	Photovoltaic - type of solar panels used to generate energy using sunlight
tCO_2e/ tCO2e	Equivalent Tonnes of Carbon Dioxide
toe	Tonnes of Oil Equivalent: unit of energy defined as the amount of energy released by burning one tonne of crude oil

Contents

0 Executive Summary

The annual energy consumption and associated carbon emissions for St. Ives town area are estimated to be 238,829 MWh with an associated 56,078 tCO2e.

Achieving a zero-carbon future requires first a reduction in energy consumption, followed by a switch to renewable energy (achievable in the form of local community energy projects), a transition to public transportation and an increase in local food production to reduce the demand on transported goods.

Energy demand in St. Ives (MWh)

Type	Domestic	Non-Domestic	Transport	**Total**	%
Electricity	31,916	36,702		68,619	28
Gas	62,926	20,423		83,349	34
Oil	7,221	-	83,056	90,277	37
Coal, LPG	3,045	-		3,045	1
Totals	105,109	57,125	83,056	245,290	100
%	43	23	34	100	

Based on 2018 data, the largest energy consumption of a single category can be attributed to oil used for transport followed by domestic gas. This highlights the need to reduce our reliance on fossil-fueled transportation and to address insulation in homes and any other factors that lead to excessive consumption.

Electricity accounts for nearly a third of all energy consumed: switching to zero-carbon options such as renewable energy would mean almost a third of St. Ives' energy consumption is carbon neutral.

Carbon emissions by type in St Ives

Energy source	Total energy use MWh	%	Emissions coefficient kg CO2e/kWh	Carbon emissions: Emissions t CO2 e	%	Methodology
LPG	1627.5	1%	0.21448	349	1%	using 2018 figures and 2018 DEFRA factors
Petrol	35,578	15%	0.23377	8,317	14%	using 2018 figures and 2018 DEFRA factors
Diesel	47,478	20%	0.24768	11,759	20%	using 2018 figures and 2018 DEFRA factors
Electricity	68,619	29%	0.28307	19,424	34%	using 2018 figures and 2018 DEFRA factors
Gas	83,349	35%	0.20437	17,034	30%	using 2018 figures and 2018 DEFRA factors
Coal	1417.9	1%	0.36288	515	1%	using 2018 figures and 2018 DEFRA factors
Total Energy	**238,069**			**57,398**		

The estimated single largest contributor to St. Ives' energy carbon footprint is found to be electricity at 34%, followed by gas at 30%. However, petrol and diesel sum to 35%. This tells us that our consumption of electricity, gas and fuel oil are equally important to address.

For perspective, scaled Cornwall estimates of the carbon emissions of Large Industrial Installations, Agriculture and Diesel Railways can be shown to represent less than 7% of the projected total carbon footprint of the town.

Energy source	Carbon emissions: Emissions t CO2 e	%	Methodology
Large Industrial Installations	261	0.43%	scaled 2013-2017 Cornwall average
Agriculture	2,991	4.97%	scaled 2013-2017 Cornwall average
Diesel Railways	814	1.35%	scaled 2013-2017 Cornwall average
Subtotal	**4,066**	**6.76%**	
Total	**60,143**	**100%**	

These findings highlight the importance of an enhanced local food production which will steer away from generating a higher carbon footprint via importing food. The findings also support an enhanced use of railways in order to reduce the significant emissions generated by road transportation. Trains are one of the most environmentally friendly forms of mass transport available[1].

Renewable energy generation in St Ives

Projections for renewable projects in St. Ives are explored with example calculations. The main renewable resources in Cornwall are solar and wind energy, but land issues may present an issue for wind power in St. Ives as it is surrounded by land classifications Area of Outstanding Natural Beauty (AONB) and Area of Great Landscape Value (AGLV).

It was found that about 2.4% of homes in St. Ives have domestic solar panels and there are currently no wind turbines in the St. Ives area. This is likely because of the AGLV/AONB regions. However, these classifications do not apply in certain areas of Carbis Bay and Penbeagle according to Cornwall Council's operational wind turbine map. Therefore, it is thought that there is scope for smaller wind energy projects in the local area and a large increase in solar power generation in the town.

Wind

A small wind farm that may be suitable for the St. Ives is modelled on the combination of wind turbines found in Pendeen, another location with AONB/AGLV classification, where similar wind conditions to St. Ives are present. It was found that wind projects on this scale would be able to cover the annual demand of 33 St. Ives homes (less than 1%). Therefore, larger scale wind projects are deemed as a more viable solution for the town in terms of harnessing the area's wind energy, which would likely need to seek greater approval, given the land classifications surrounding St. Ives.

To contrast, an estimated 32MW off-shore wind project using the existing foundations of the Wave Hub project in St. Ives bay is referenced. It is concluded that because plans have not been released that the scheme is many years off and may not occur. These outlines should therefore not be used in any decision-making related to the town's acting on the climate emergency.

Solar

The estimated price of a small retrofit domestic installation is scaled up to create an absolute maximum cost of offsetting St. Ives' electricity supply. It was

[1] UK rail: where are the electric-diesel hybrids, hydrogen, battery trains? - https://energypost.eu/uk-rail-where-are-the-electric-diesel-hybrids-hydrogen-battery-trains/

found that the cost of installing solar panels that generate the town's current electricity demand is less than £57.5m.

Realistically, a more efficient procedure to achieve this would be to install solar farms around the town, such as the solar array at Polmanter. It was found that 50 arrays identical to Polmanter would generate enough power to offset the entire town's electricity supply. The Polmanter array alone is estimated to power between 152 and 273 typical St. Ives homes. This suggests that such projects might be conducted via community energy. Community energy is defined in the conclusion of this report.

Introduction

This report was initiated by the St. Ives Climate Action Group as a response to its interest in reducing the town's carbon budget as a contribution towards addressing the global climate emergency.

The climate emergency was declared in 2019 by the UK government[2] to symbolise the mobilisation of the country (as a part of the greater world movement) to act with sufficient scale and in sufficient time-frame to protect civilisation, the economy, people, species, and ecosystems[3]. The United Nations says we could have just 11 years left to limit a climate change catastrophe.

Long recognised as a primary cause of anthropogenic climate change, our society's carbon dioxide emissions must be continually and rapidly phased out until we are no-longer reliant upon these processes. A key part of this means reducing energy consumption to essential and converting the resources for remaining consumption to carbon-neutral technology. Such a dramatic change in habits on a society-wide scale must happen locally, at a global scale.

Cornwall Council have committed to becoming Carbon Neutral by 2030[4] and have commissioned Exeter University to write a report on the carbon projections for Cornwall that includes what they must do to achieve their goal[5].

Clear actions towards carbon neutrality on a local scale such as new local renewable power generation also helps to build a public awareness, which acts as a positive feedback loop towards taking actions on a larger scale. If the public doesn't recognise the emergency, then it will not be able to take necessary action to address the emergency.

St. Ives town carries the benefit of being a highly touristic location and, as such, carries greater influence than the average british town when climate awareness is made plain to see.

This report provides a transparent preliminary analysis of the best available data relating to the present energy consumption in St. Ives, Cornwall, including:

- Domestic and commercial electricity
- Domestic and commercial gas
- Oil demand (road/public transport and space heating)

2 BBC: 'Climate change: What is a climate emergency?' - https://www.bbc.co.uk/news/newsbeat-47570654

3 The Climate Emergency Declaration and Mobilisation - https://climateemergencydeclaration.org/about/

4 Cornwall Council's action plan to become carbon neutral by 2030 - https://www.cornwall.gov.uk/environment-and-planning/climate-emergency/our-action-plan/

5 Cornwall Climate Emergency: Pathways to "Net Zero" - https://www.cornwall.gov.uk/media/42296194/uoe-cornwall-climate-emergency-scenario.pdf

The implications of fuel poverty in the area are then summarised.

A breakdown of the estimated annual carbon footprint of the town is presented and discussed.

Several renewable sources of energy are discussed in relation to the St. Ives area presented with example calculations.

Finally, the report recommends a number of additional areas for further investigation, including:

1. Examining the experience of existing successful community energy projects that could be relevant/feasible in the St.Ives context.
2. The development of specific recommendations to the St. Ives Area.

1 Energy Demand and Supply for St. Ives

The annual electricity and mains gas demand is presented for St. Ives. These two sources of CO_2 emission are the sources most able to be reduced by actions taken on an individual/household level.

The carbon dioxide emitted [tCO2e, tonnes of Carbon Dioxide Equivalent emitted] generated by electricity use is adjusted to convey how ‘green’ the energy supply is. Due to an increase in UK renewable power generation, this is reflected in the changing DEFRA factors that convert the electrical consumption units kilowatt hours [kWh] and megawatt-hours [1 MWh = 1000 x 1kWh] to tCO2e. DEFRA factors are updated each year.

The most accurate source of information on the energy demand (electricity and mains gas) is by the Office of National Statistics for the Department for Business, Energy & Industrial Strategy (BEIS). The tables below show the demand information available for electricity and mains gas in St. Ives, by local area ward.

Domestic consumption of electricity and gas is available on an annual time-resolution to the nearest postcode from the domestic energy map[6].

6 Domestic Energy Map http://www.domesticenergymap.uk/

1.1 Electricity Demand

Domestic Electricity

Table 1 shows the variation by area in individual household annual demand for electricity, based on 2018 data. The median average is shown because it is less influenced by extreme outliers than the mean.

St. Ives area wards		**Total demand**	**Meters**	**Median demand**
Code	**Name**	**MWh**	**Number**	**kWh/meter**
Cornwall 054A	St Ives Higher Stennack Nanjivey	2,277	699	2,628
Cornwall 054B	St Ives Hellesvean, Halsetown and Penbeagle	3,073	725	3,239
Cornwall 054C	St Ives Alexandra Road and Porthmeor	2,219	681	2,626
Cornwall 054D	St Ives Treloyhan and Carbis Bay Counthouse	4,134	1,069	3,057
Cornwall 054E	St Ives Town Centre and Island	6,009	2,150	3,867
Cornwall 058A	Lelant	4,992	1,237	3,080
Cornwall 058B	Carbis Bay	3,482	1,080	2,361
Cornwall 058C	Castle Gate and Nancledra	5,730	1,005	4,235
Totals		**31,916**	**8,646**	

Table 1: BEIS domestic electricity consumption data split by St. Ives LSOA area ward

Commercial Electricity

Commercial (non-domestic) electricity information is not presently available at the same temporal or spatial resolution as domestic electricity. An estimate of the annual consumption was made using 2018 data from the MSOA non domestic electricity 2010-2018[7].

Cornwall 054 (St. Ives)	**Number of meters**	**Consumption (kWh)**
Non HHD	800	8,128,497
Estimated HHD	77	20,172,643
Total	877	28,301,140

7 MSOA non domestic electricity 2010-2018 - https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption

	Number of meters	Consumption (MWh)
Non-HH St. Ives (Cornwall 054)	800	8128.497
Non-HH St. Ives (Cornwall 058)	260	2412.9
Estimated HH St. Ives	103	26161
St. Ives Total	**1163**	**36,702.18**

Table 2: Scaled BEIS non-domestic electricity consumption for St. Ives MSOA

The data used to make this estimate consists of non-half-hourly data for the St. Ives MSOA area ward (Cornwall 054 and Cornwall 058) and the half-hourly data (HHD) over the whole of Cornwall in 2018.

An estimate was made of the HHD totals for St. Ives by using the fraction of St. Ives non HHD meters and total consumption compared to that of the whole of Cornwall (~2% and 3% respectively).

Conclusion

Combining the consumption estimates for domestic and commercial demands predicts St. Ives's annual electricity demand is approximately **68,619 MWh.**

Year-on-year tracking of St. Ives Electricity consumption is possible using the resources used above, however it is outside the scope of this report.

1.2 Gas Demand

Domestic Gas

Table 3 shows the variation by local area of household mains gas demand based on 2018 data.

St. Ives local area		Demand MWh	Number of meters	Median consumption (kWh per meter)	% homes not on the gas grid
Cornwall 054A	St Ives Higher Stennack Nanjivey	426	644	7,648	7%
Cornwall 054B	St Ives Hellesvean, Halsetown and Penbeagle	4,650	500	8,135	30%
Cornwall 054C	St Ives Alexandra Road and Porthmeor	6,748	615	9,665	5%
Cornwall 054D	St Ives Treloyhan and Carbis Bay Counthouse	12,356	865	12,078	9%
Cornwall 054E	St Ives Town Centre and Island	14,476	1,554	7,358	11%
Cornwall 058A	Lelant	12,576	992	11,324	16%
Cornwall 058B	Carbis Bay	9,503	865	9,194	10%
Cornwall 058C	Castle Gate and Nancledra	2,191	165	11,549	84%
Totals		**62,926**	**6,200**		

Table 3: BEIS domestic gas consumption data split by St. Ives LSOA area ward

The domestic gas demand figures show a higher proportion of 30% households not on the gas grid in St Ives Hellesvean, Halsetown and Penbeagle area and majority 84% Castle Gate and Nancledra area. Such homes do not contribute to these gas consumption figures - they are likely to be heated using another source of energy, which is examined in section 1.3.

Commercial Gas

Commercial gas consumption was estimated based on data from the MSOA non domestic gas 2010-2018 dataset.

MSOA Name	Gas demand /MWh	Number of meters	Mean demand (MWh per meter)	Median demand (MWh per meter)
Cornwall 054	13,962	67	208	125
Cornwall 058	6,461	24	269	175
Total St. Ives	20,423	91	224	

Table 4: BEIS non-domestic gas consumption in St. Ives MSOA

Despite only 91 meters (<2%) representing commercial consumption, the commercial gas demand is about 25% of the domestic demand, indicating that most commercial energy demand is consumed as electricity.

There may also be some commercial gas demand which is counted in the domestic sector statistics as it is under the expected cut-off point for commercial operations.

Conclusion

The total annual mains gas consumption for St. Ives is **83,349 MWh.**

1.3 Oil Demand

The term oil in this section is defined as any liquid fuel substance derived from fossil fuels which releases CO_2 at the point of usage when they are consumed.

Oil is primarily used in the St. Ives area for transport (Petrol/Diesel) and for heating in both domestic and non-domestic buildings that are not on the gas grid.

The major use of oil in the UK is for road transport. Statistics for transport energy use is aggregated at the local authority (Cornwall) level.

1.3a Road Transport

Table 5 presents estimates of the annual energy consumption by various road vehicles in St. Ives. This has been based on an average of BEIS Road Transport fuel consumption tables 2005-2017. Energy consumption is given first in the units of the data source, Tonnes of Oil Equivalent (toe) with a conversion into MWh.

St. Ives:		
Type of Vehicle	**TOE**	**MWh**
Buses	255	2,962
Diesel Cars	1,785	20,757
Petrol Cars	2,932	34,104
Motorcycles	53	619
HGV	813	9,450
Diesel LGV3	1,230	14,310
Petrol LGV3	73	855

Table 5: Scaled BEIS energy consumption data from road transport for the St. Ives MSOAs split by vehicle type

The data from BEIS was available as annual figures at a local authority level. The above figures for St. Ives are scaled down using the mid-2018 population estimates for St. Ives and Cornwall pro-rata. The population figures used are in Appendix I.

The figures are then split into diesel and petrol consuming vehicles to produce the following figures in Table 6 which can be converted into tCO_2e using the petrol and diesel conversion factors.

Road Transport Oil	Demand (MWh)
Petrol	35,578
Diesel	47,478
Total	83,056

Table 6: Energy consumption from road transport in the St. Ives MSOA split by fuel type

Conclusion

Road transport in St. Ives has an annual demand of **83,056 MWh**.

1.3b Space Heating Homes Off the Gas Grid

Most homes on the gas grid are heated via the consumption of natural gas. However, there are a significant number of homes off the gas grid in the St. Ives MSOA that were not included in the BEIS figures used in section 1.2.

An estimate of the energy consumption for these homes is required to estimate the carbon footprint for the town.

Since no specific survey is available to assess the heat energy consumption of these homes, the energy consumption of homes on the gas grid presented in section 1.2 is extrapolated to estimate the energy consumption of the homes off the grid, as summarised in Table 7.

St. Ives local area (LSOA)		% homes not on the gas grid	Estimated heating consumption of homes off the grid (MWh)
Cornwall 054A	St Ives Higher Stennack Nanjivey	7%	32
Cornwall 054B	St Ives Hellesvean, Halsetown and Penbeagle	30%	1,993
Cornwall 054C	St Ives Alexandra Road and Porthmeor	5%	355
Cornwall 054D	St Ives Treloyhan and Carbis Bay Counthouse	9%	1,222
Cornwall 054E	St Ives Town Centre and Island	11%	1,789
Cornwall 058A	Lelant	16%	2,395
Cornwall 058B	Carbis Bay	10%	1,056
Cornwall 058C	Castle Gate and Nancledra	84%	11,502
Total			20,344

Table 7: Annual energy consumption via heating of homes off the gas grid in the St. Ives LSOAs

To obtain a slightly more accurate carbon footprint, a 2009 OFT survey is used to apportion the energy consumption shown in table 7 into several types of fuel. Table 8 contains the percentage of homes that are considered to use each fuel type in the two classifications 'Rural' and 'Urban' according to the survey.

Fuel type	**Rural**	**Urban**	**Total (MWh)**
Heating Oil	53%	1%	1090
LPG	8%	8%	431
Coal	10%	1%	233
Electricity	29%	90%	3637

Table 8: Percentages of homes off the gas grid heated by various fuels according to the OFT survey.

As an approximation, the LSOA Cornwall 054B and Cornwall 058C were classified as Rural and the others classified as Urban when accessing these percentages. Energy consumption from homes that are heated using electricity are accounted for in their electricity consumption in section 1.1.

Conclusion

Of the estimated annual **5,391MWh** used by homes off the gas grid, **1090MWh** is attributed to heating oil, **431MWh** to LPG, **233MWh** to Coal. The remaining **10,078MWh** attributed to electric heating has already been accounted for in section 1.1.

1.4 Total Energy Demand

Table 8 summarises the estimated annual energy demand in MWh in the St. Ives MSOAs. This is a total electricity, gas, oil, and LPG/coal. The consumption is broken into Domestic, Non-domestic and Transport.

Type	Domestic	Non-Domestic	Transport	**Total**	Percentage
Electricity	17,712	28,301		46,013	30%
Gas	43,656	13,962		57,618	38%
Oil	-	-	44,443	44,443	29%
LPG	5,391	-		5,391	4%
Totals	66,760	42,263	44,443	153,465	100%
%	44%	28%	29%	100%	

Table 9: Annual energy consumption in MWh by type in the St. Ives MSOA

Gas is the largest contributor of the energy sources which is thought to be due to the need for heating. As a fossil fuel which directly contributes to greenhouse emissions, gas consumption must be reduced and eventually rendered obsolete to reach carbon zero. As the primary method of heating homes, these figures emphasise a need for homes to be thoroughly insulated and heated using a less carbon intensive method.

1.5 Fuel Poverty

In considering the issues around reaching carbon neutrality the area authority may also wish to address equity issues, which shows as fuel poverty in relation to energy.

A household is considered to be fuel poor if they have required fuel costs that are above average (the national median level) and, were they to spend that amount, they would be left with a residual income below the poverty line.

Table 9 contains the BEIS estimates of the number of fuel poor households in the St. Ives MSOA, broken into LSOAs.

LSOA Name		Estimated number of households	Estimated number of fuel poor households	Proportion of households fuel poor (%)
Cornwall 054A	St Ives Higher Stennack Nanjivey	696	132	19
Cornwall 054B	St Ives Hellesvean, Halsetown and Penbeagle	649	100	15
Cornwall 054C	St Ives Alexandra Road and Porthmeor	611	63	10
Cornwall 054D	St Ives Treloyhan and Carbis Bay Counthouse	681	87	13
Cornwall 054E	St Ives Town Centre and Island	1,097	183	17
Cornwall 058A	Lelant	1123	146	13
Cornwall 058B	Carbis Bay	820	82	10
Cornwall 058C	Castle Gate and Nancledra	994	169	17
Total		6671	962	14

Table 10: BEIS estimated fuel poor households in the St. Ives MSOA

According to BEIS, an average of 15% of households in St. Ives are considered fuel poor.

1.8 Data Comments

Electricity and Gas

- St. Ives has a highly seasonal population. A time resolution of 6 or 3 monthly data would be useful to monitor seasonal variation in domestic electricity and gas.
- LSOA Region of Cornwall 054 and Cornwall 058 do not perfectly match the TR26 area (see appendix).
- Most domestic usage data in the St. Ives MSOAs Cornwall 054 and Cornwall 058 were available (very few postcodes were listed as having missing data) according to the domestic energy map.
- Known percentage of properties off the gas grid properties was useful to estimate consumption of all homes in the area. It only allows an estimate of these homes because there are no known statistics for fuel consumption of the off grid households in the St. Ives area.
- The domestic energy map interface has potential for residents to monitor their postcode's energy usage with ease. Along with Western Power's Carbon Tracer[8], such tools might be compiled and presented to the public to help achieve a greater understanding of their implications for electricity consumption and conservation.
- Commercial demand needed to be estimated based on MSOA statistics because no data was available.
    - It was not made clear on the website what qualifies a commercial installation.
        - Hayle's carbon report alludes to a minimum level of consumption, however this figure is not stated. This is possibly because half-hourly metering is mandatory for all electricity customers with a maximum power demand (peak load) greater than 100 kW[9]
        - Half-hourly customers are referenced in relation to commercial consumption of electricity. Half-hourly metering is a form of automated metering that does not necessarily relate to commercial supplies, other than that it may correlate well to commercial supplies who install them as part of regulation. This should be further investigated and declared with more transparency.

8 Carbon Tracer tool https://carbontracer.westernpower.co.uk/

9 Half-hourly data information https://www.energylens.com/half-hourly-data

Oil

- These estimates are the best source we have to cover St. Ives as a resident population of Cornwall. However, more interesting figures might take into account the tourism industry.
- How much petrol is burned by tourists who travel to St. Ives on holiday? This might be compared to the equivalent in train travel.

Fuel Poverty

- These estimates are the best source we have to cover St. Ives as a resident population of Cornwall. However, more interesting figures might take into account the tourism industry.

2 Carbon Footprint

The carbon footprint for St. Ives' energy consumption is presented for scope 1 and 2 emissions.

Table 10 contains the energy consumption in the St. Ives MSOA of each energy source discussed in this report with the associated carbon emission in tCO2e. In addition, the carbon emissions of several key industries are placed in the table for comparison.

The carbon footprint of each energy source is calculated using 2018 usage data and thus 2018 DEFRA conversion factors for consistency.

The 'UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2017' provides the estimated carbon footprint for the industries: Large Industrial Installations; Agriculture; Diesel Railways at the Cornwall level. They have been extrapolated using MSOA population statistics to represent St. Ives to provide an idea of scale.

	Total energy use		**Emissions**	**Carbon emissions**		
Energy source	**MWh**	**%**	**coefficient kgCO2e/kWh**	**Emissions t CO2 e**	**%**	**Methodology**
LPG	1627.5	1%	0.21448	349	1%	using 2018 figures and 2018 DEFRA factors
Petrol	35,578	15%	0.23377	8,317	15%	using 2018 figures and 2018 DEFRA factors
Diesel	47,478	20%	0.24768	11,759	21%	using 2018 figures and 2018 DEFRA factors
Electricity	68,619	30%	0.28307	19,424	35%	using 2018 figures and 2018 DEFRA factors
Gas	76,888	33%	0.20437	15,714	28%	using 2018 figures and 2018 DEFRA factors
Coal	1417.9	1%	0.36288	515	1%	using 2018 figures and 2018 DEFRA factors
Subtotal	**231,608**			**56,078**		
Large Industrial Installations				261	**0%**	based on 2013-2017 Cornwall average
Agriculture				2,991	**5%**	based on 2013-2017 Cornwall average
Diesel Railways				814	**1%**	based on 2013-2017 Cornwall average
Totals				**60,143**	**100%**	

Table 11: Carbon footprint in tCO2e associated with the St. Ives MSOA energy consumption (MWh) compared with BEIS scaled estimates of the carbon footprint associated with key industries: Large Industrial Installations, Agriculture, Diesel Railways

3 Renewable energy supply for St. Ives

3.1 Present renewable energy supply in St. Ives

The Renewable Energy Foundation (REF) database was used to determine the number of local wind and PV systems installed in the TR26 area.

The following figures are an overestimate of the total potential output of current renewable energy when compared to the electricity demand figures presented in section 1.1. This is because:

1. The capacity is the maximum output for the renewable generators.
2. The TR26 postcode covers a greater area than the MSOAs Cornwall 054 and Cornwall 058.

It was found that there are no large-scale renewable generators in the TR26 area. Small-scale installations consisted entirely of solar PV, as shown in the table below.

Solar PV installations in TR26 AREA	Number	Capacity (kW)
Domestic	207	726
Community	4	36
Commercial	2	47
Industrial	1	4
Total	**214**	**812**

Table 12: Solar PV installations in the TR26 area split into classifications Domestic, Community, Commercial and Industrial and associated capacity

The database returned 214 solar photovoltaic systems in St. Ives that total a maximum output of 0.81MW.

Of these, around two thirds of the installed systems are under 4kW installed capacity[10].

10 Defined as <3.9kW

Approximately 2.4% of homes in St. Ives have domestic panels.

There are currently no operational wind turbines installed in the TR26 area. Figure 1 is an adapted version of Cornwall Council's operational wind turbine map[11] which displays up-to-date information for the area.

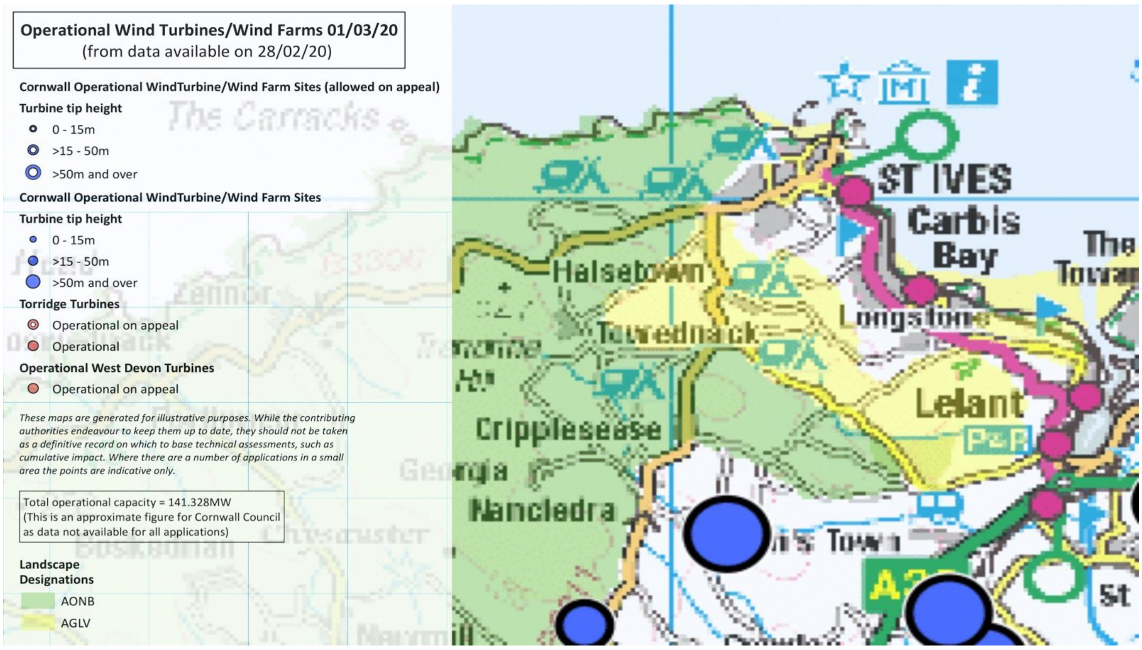


Figure 1: Adapted Cornwall Council map showing operational wind turbines in the St. Ives area (blue dots not to scale). Land classifications AONB and AGLV are coloured in green and yellow respectively

Figure 1 shows the nearest turbine to be a 50m+ turbine in Cannons town in an area neither designated AONB (Area of Outstanding Natural Beauty nor AGLV (Area of Great Landscape Value).

A similar area can be seen that extends from St. Ives Hellesvean and Town Centre to Carbis Bay, which may be suitable for a turbine. Given that it is a domestic area, it is likely that a preference would be strongly towards domestic PV installations here.

The map also shows several nearby AONB to the west where turbines have been put in place. An example calculation will be made in section 3.2.1 to examine the impact of installing a modest wind farm.

11 Map of Cornwall's operational wind turbines found at https://www.cornwall.gov.uk/renewableenergy

3.2 Potential for renewable energy supply in St. Ives

The potential for renewable energy generation in St. Ives is discussed and presented with several calculations.

3.2.1 Wind

A calculation of the estimated generation of wind power in the St. Ives area is presented using the best available data and reasonable estimates.

Onshore

The potential for the suitability of wind turbine installations of turbines in the St. Ives MSOA is considered.

As seen in the operational turbine map, much of the land in and around the St. Ives MSOA is classified as AONB or AGLV. These are not requirements for wind generation, however they do present obstacles to obtaining planning permission for wind turbines. A stretch of land between St. Ives town into Carbis Bay domestic areas of land where turbines might be installed more easily, subject to local planning. As such, the net merits of any domestic wind turbine installation should be considered against a solar PV installation within a property.

Of course, another key factor in installing turbines is the average wind speed at the prospective height of any turbine being considered. This is of critical importance for the planning and engineering stages but since wind speed is extremely localised in domestic areas, it is outside the scope of this report.

Small, domestic-scale turbines are modelled on existing turbines in West Penwith in the table below.

There are open rural areas located around the outskirts of St. Ives and along the coast to the West of the town which may serve as possible locations for onshore wind generation, despite being located in an AONB. Wind turbines located in Pendeen are an example of this (as seen in the operational wind turbines map).

The turbines installed in Pendeen are useful examples of the kind of turbines that might be installed in the St. Ives area. The table below contains the 5 turbine installations in Pendeen and their generation capacities in kW, according to Egerton (2015)[12].

12 West Cornwall operational wind turbine dataset- http://www.bobegerton.info/windandsolarinco.html

Description	Capacity (kW)
Tregaminion Manor, Morvah, Pendeen	11
Carn Farm, Morvah, Pendeen	11
Stone Farm, Bojewyan, Stennack, Pendeen	10
Chypraze Farm, Morvah, Pendeen	5
Calartha Farm, Pendeen	5
Total	**42**

Table 13: Wind turbines installed in the Pendeen area and their capacities in kW

The five turbines have relatively small capacities when compared to a typical commercial installation. The capacity of the turbines varies with the smallest capacity at 5kW and the larger turbines at 11kW. The total capacity for the onshore wind generation in Pendeen is 42kW.

The installations in Pendeen provide an example of a range of small scale turbines in the West Penwith area, as cited in table 14.

Offshore Wind Potential

Plans are in preparation for off-shore turbines to be installed in St. Ives Bay using the existing foundations of the Wave Hub project. A report by the Offshore Renewable Energy Catapult (OREC) states that a four-turbine scheme placed 16km off the coast may operate at 32MW, providing power for up to 23,000 homes. This should be considered the upper-estimate of potential offshore wind power generation in the area, as no specific plans have yet been released. This serves as a key example for the purposes of his report and is included in table 14.

Estimated power generation in St. Ives

The wind turbines in Pendeen and prospective offshore turbines are presented in comparison to the electricity consumption of the St. Ives MSOA.

Pendeen is only a small village so the combined generation of the turbines is considered to be equivalent to that of a small-scale wind farm located in the outskirts of St. Ives.

The table below compares several capacities of wind power generation that are likely in the St. Ives area based on the above references. Energy generated per year [MWh] is calculated as the Capacity [MW] multiplied by 24 [hours] multiplied by 365 [days] multiplied by the capacity factor. A typical capacity factor for a wind turbine of 30% has been used here[13]. Energy generated is then compared to the town's electricity consumption from section 1.1.

Scale of Turbine	Capacity (MW)	Annual Energy Generated (MWh)	Equivalent Households in St. Ives	% St. Ives Households
Small single turbine	0.005	13	4	0.07%
Medium single turbine	0.011	29	9	0.16%
Small local wind farm	0.042	110	33	0.62%
OREC Wave Hub Projection	32	84,096	25254	474.34%

Table 14: Estimated power generation of single small / medium wind turbines and a small local wind farm compared with St. Ives' electricity consumption

3.2.2 Solar

Solar PV is currently the only source of renewable electricity that is currently generated in the St. Ives TR26 area, according to the REF database (see section 3.1).

Domestic Solar

An estimate is made of the potential for solar PV electricity generation in the town and how this compares to the current domestic electricity demand.

Although there are 207 domestic installations in the TR26 area, this represents less than 2.4% of homes in the St. Ives MSOA[14] (which renders this figure an overestimate). This suggests that there is ample scope for more domestic buildings to be generating solar energy to reduce the town's carbon footprint where available rooftop space is concerned. The following estimate does not consider the direction of rooftop face: it is intended to gain perspective on how typical domestic solar PV installations could influence the town's self-sufficiency of power consumption.

The average domestic installation in St. Ives has a generation capacity of 3.5kW. Using a scaled up example from The Renewable Energy Hub[15], such a system would cost £6650[16] including installation (excluding battery storage options) and generate 2975kWh per year.

Scaled up, this kind of solar power generation would meet the demand of between 70% and 126% of the median annual domestic electricity consumption

13 Typical wind turbine and solar capacity factors; Conversion of capacity into MWh - http://www.bobegerton.info/windandsolarinco.html

14 One home is assumed to be represented by one electricity meter

15 The Renewable Energy Hub - How Much Do Solar Panel Systems Costs in 2020 - https://www.renewableenergyhub.co.uk/main/solar-panels/the-cost-of-solar-panels/

16 Cost scaled in proportion to generation capacity - this is highly inaccurate and presents an absolute overestimate of cost

in section 1.1, depending on which LSOA is being considered) for the cost of £57.5m for the whole town. Scaling up the cost in proportion to the generated power is highly inaccurate because it is far more cost effective to make large-scale installations.

This estimate does not include the cost savings of installing panels with a higher generation capacity than 3.5kW, nor the labour costs saved by installing panels into newbuilds when compared to retrofitting, nor the costs saved by installing solar panels onto a group of rooftops at the same time.

This estimate only examines domestic rooftop installation and does not account for auxiliary solar farms in St. Ives that could support domestic generation, should St. Ives hypothetically be powered purely by solar energy. Larger solar arrays are examined in the next section.

This calculation demonstrates that possibly the most inefficient method of achieving zero carbon electricity for St. Ives is still achievable. It indicates that solar arrays are the most likely solution for reducing the town's electricity footprint to zero, but that small-scale retrofit installations are costly.

Solar Farms

The solar array at Polmanter is examined as an example of a typical solar farm that can be installed in the St. Ives Area. It's energy production is then compared to the electricity consumption of St. Ives.

According to pers comm Phillipp Osborne (2020), the site's total generation capacity is 250kW and has been measured to generate 645MWh per year. This is equivalent to 2% of the town's annual electricity consumption, or powering between 152 and 273 typical St. Ives homes, depending on which St. Ives LSOA is being considered.

It is important to note that solar energy must be stored in order to be consumed on demand (typically, more electricity is used at night when no solar energy is being generated). This means some energy must be lost in transfer and that further costs would be incurred installing essential storage infrastructure that is required for nighttime demand.

More solar projects on a scale similar to Polmanter would reduce the reliance on fossil fuels via electricity consumption in the town. In isolation, it would only take 50 solar farms with identical output to the solar array at Polmanter to provide the equivalent power demand of the whole of St. Ives. This might be achieved via community funded projects, complementing other renewable energy projects.

Community energy schemes would allow the cost to be reduced for such a site that meets the demand of over 150 St. Ives homes. Encouraging projects like this is a clear way to offset St. Ives' electricity carbon footprint. Some community energy resources are mentioned in the conclusion.

Conclusion

To act on the climate emergency, a transition involving the reduction of energy consumption in St. Ives combined with the conversion to renewable energy sources on the scale of the whole town is immediately required .

This can be achieved via efforts towards educating the public on improving consumption habits on an individual basis and town investment in community renewable energy projects. This will ultimately reduce the cost of the transition.

St. Ives' annual electricity and gas consumption is trackable via government statistics. Such a resource might be used to track the progress of the town and influence local policy.

It is vital that a change in consumption habits is brought about. Then, the essential energy consumption should be reallocated to renewables to reach carbon neutrality most quickly and cost-effectively.

Wind and solar power are, at present, the most significant and standard forms of local renewable energy. Therefore this report focused on the benefits of initial investment in these most recognised forms.

Penwith already contains examples of successful private renewable energy projects which are relevant to St. Ives, which are already making a positive impact on the area's carbon budget.

In addition to offsetting the carbon footprint of local energy consumption, high profile renewable installations are effective in opening public conversations about the future of energy, carbon neutrality and consumption patterns.

Changes to infrastructure such as building renewable energy generators incur costs. New infrastructure is limited by lack of funding and contributing opposition from the surrounding AONB / AGLV.

A solution to this lies in the role of community energy. Community energy projects which developed through public consultation could play an important role in harnessing local interest and resources on a smaller scale.

Community Energy England is one of many schemes and resources to learn about community energy projects. Their website[17] summarises the concept as "... the delivery of community led renewable energy, energy demand reduction and energy supply projects, whether wholly owned and/or controlled by communities or through partnership with commercial or public sector partners".

17 Community Energy England Website - https://communityenergyengland.org/pages/what-is-community-energy

Members of the public can support UK community energy schemes using investment platforms. An example of this Abundance Investments[18] who currently have two (soon to be more) investments projects open where West Berkshire and Warrington Council (targets of carbon neutral 2030) are raising funds to build council owned solar farms.

This is a viable step for Cornwall Council. With sufficient publicity and public interest, communities all over the UK could own their own source of publicly owned renewable energy.

It is true that St. Ives, as a tourist destination, has pressure to maintain its high landscape and amenity values. Though current planning legislation and public opinion may presently deter certain forms of development, in a climate emergency judicious trade-offs must be continually sought and applied.

Recent plans have been released to utilise the Wave Hub platform for renewable generation. This could make a substantial impact on the local renewable energy sector and developments should be carefully monitored. Although the Wave Hub is situated close to St. Ives, this project does not have a confirmed start date and should not encourage complacency in launching local community energy schemes.

New technologies are continually becoming available to improve energy efficiency. A balance must be struck between waiting for new technology and acting now.

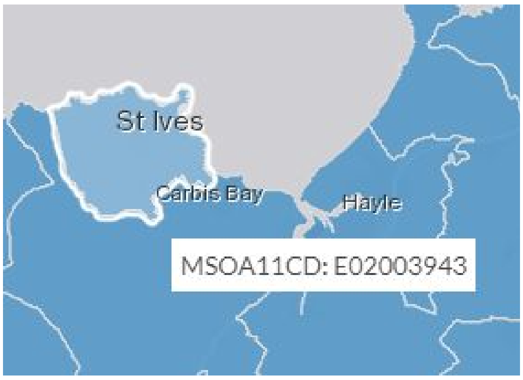
Newbuild homes should also be the target of new policy. This is because, despite technological advances, retrofitting is always less cost-effective than sustainable design implementation. Therefore, where new-build homes are necessary, a high build quality that is well insulated with solar PV rooftops should become the standard. Other efficiency technologies such as ground and air source heat pumps may be considered in new-build homes, but details are outside the scope of this report.

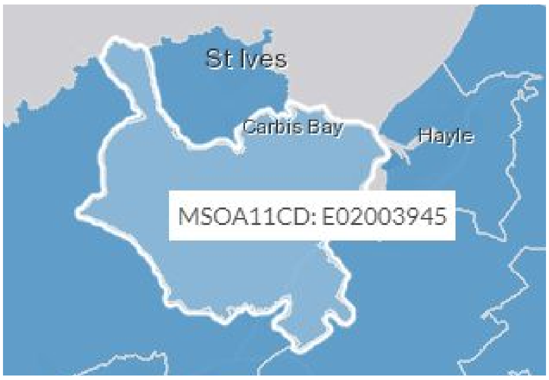
18 Abundance Municipal Investments - https://www.abundanceinvestment.com/invest-now/municipal-investments

Appendix I - Maps and Area Codes for statistics

St. Ives Medium Super Output Areas (MSOA)

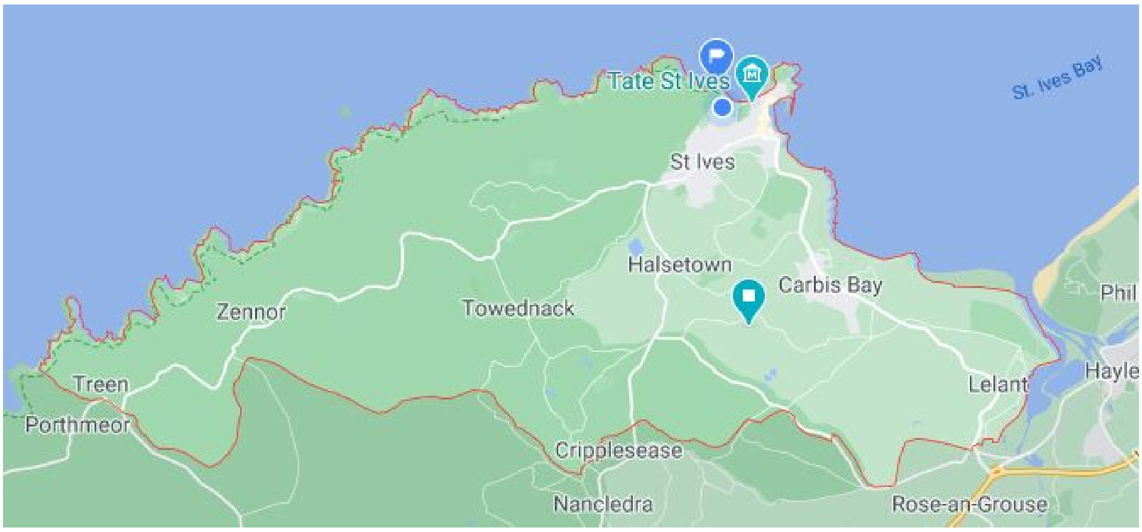
E02003943	Cornwall 054
E02003945	Cornwall 058





Source: https://geoportal.statistics.gov.uk/datasets/826dc85fb600440889480f4d9dbb1a24_0

Map of TR26, as shown on Google Maps



St. Ives Lower Super Output Areas (LSOA)

2011 LSOA Code	2011 LSOA Name	2011 Local Name
E01019008	Cornwall 054A	St Ives Higher Stennack Nanjivey
E01019009	Cornwall 054B	St Ives Hellesvean, Halsetown and Penbeagle
E01019010	Cornwall 054C	St Ives Alexandra Road and Porthmeor
E01019011	Cornwall 054D	St Ives Treloyhan and Carbis Bay Counthouse
E01019012	Cornwall 054E	St Ives Town Centre and Island
E01018985	Cornwall 058A	Lelant
E01018986	Cornwall 058B	Carbis Bay
E01018987	Cornwall 058C	Castle Gate and Nancledra

Population Statistics

Population Estimates taken from Lower layer Super Output Area population estimates (supporting information)[19].

Table SAPE21DT1a: Mid-2018 Population Estimates for Lower Layer Super Output Areas in England and Wales by Single Year of Age and Sex, Persons - Supporting Information

Cornwall, All Ages:

565,968

St. Ives:

Area Codes	LSOA	All Ages
E01019008	Cornwall 054A	1,319
E01019009	Cornwall 054B	1,525
E01019010	Cornwall 054C	1,216
E01019011	Cornwall 054D	1,547
E01019012	Cornwall 054E	1,453
E01018985	Cornwall 058A	2,499
E01018986	Cornwall 058B	1,528
E01018987	Cornwall 058C	2,107
	Total	13,194

19 Lower layer Super Output Area population estimates (supporting information): https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates