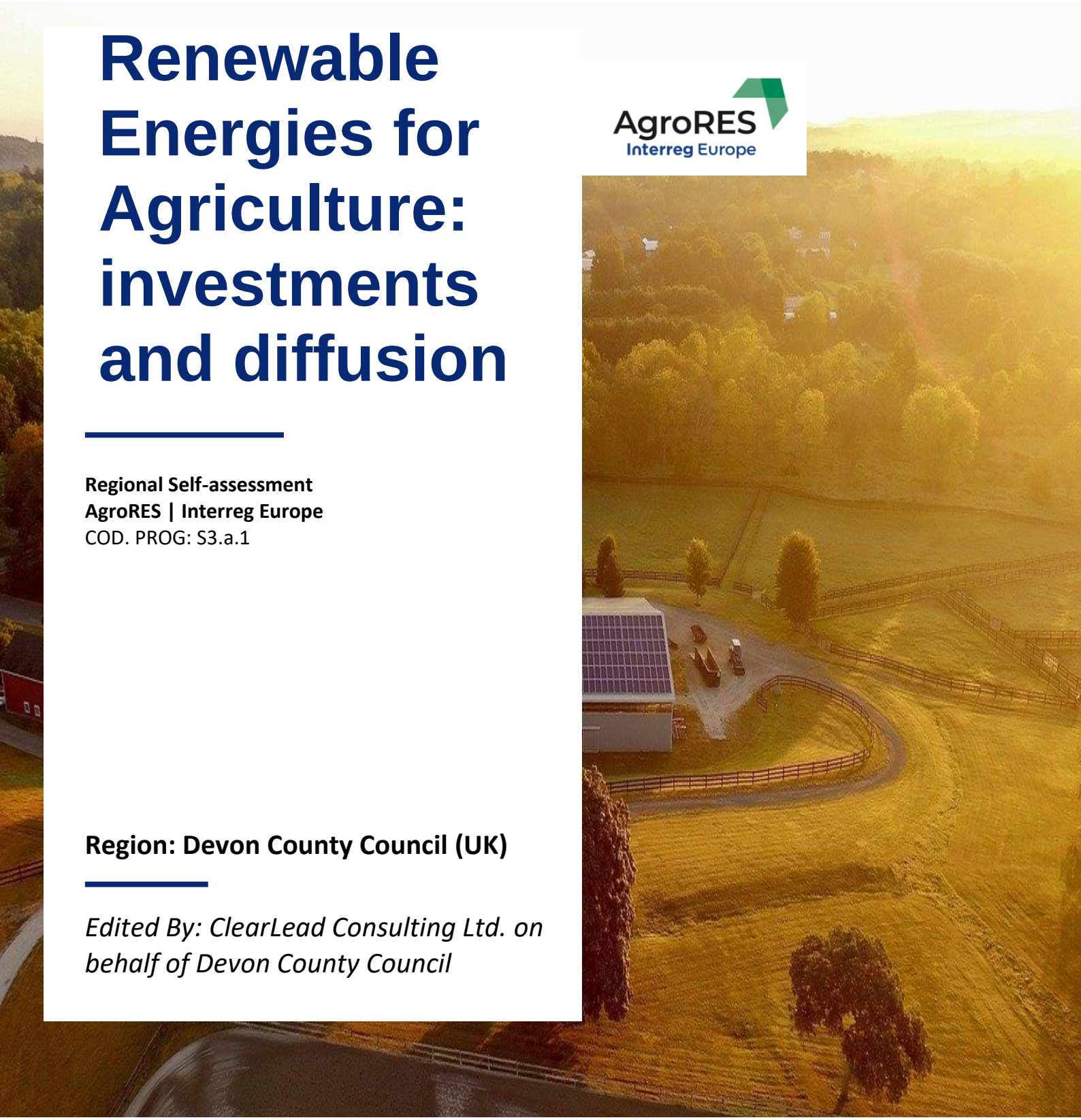
Renewable Energies for Agriculture: investments and diffusion



Regional Self-assessment
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1. Introduction to the document

Introduction

This document forms the self-assessment report as part of the AgroRES EU project for the Devon County Council (DCC) region. The report follows the format set out in the guidelines for the self-assessment phase of the project in accordance with the quality established by the AgroRES project in semester 3, phase a, point 1.

The report includes the following sections:

- Introduction
- Regional socio-economic framework
- Evolution of the diffusion of Renewable Energies (RE) in agriculture
- Local policies and actions for the pursuit of the European sustainability objectives for 2030
- Risks and opportunities associated with the spread of RE in agriculture

A concluding summary is provided, including a SWOT analysis that assesses the strengths, weaknesses, opportunities and threats to the diffusion of RE developments in the region. Concluding comments aim to provide insights to guide public policy to further incentivise the investment in RE within the DCC agricultural sector.

This summary report provides key information for the AgroRES project. An in-depth report has been provided alongside this report to add more information to guide RE developments and policy within DCC.

Scope

Due to the scope and timeframe of the project, no primary data was collected. All data contained within this report comes from a desk-based review of data sourced from third parties, data is clearly referenced. Key organisations, such as Regen SW and the National Farmers Union (NFU) were also contacted for information.

The most current available data has been provided and the year of the data stated. All assumptions that have been made during the production of this report have also been noted. Data is for the DCC Local Authority (LA) area where available, however, where data for this region was unobtainable, data for the geographic county of Devon or at a larger scale has been provided and noted. Where quantitative data was unavailable, suitable alternative data or descriptive information has been provided. Financial information has been obtained in British pounds and converted into Euros using InforEuro, January 2021 exchange rates[1].

[1] InforEuro, 2021. *Jan. 2021 exchange rates*. Available: https://ec.europa.eu/info/funding-tenders/how-eu-funding-works/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en.

I. Regional socio-economic framework

1.1 Socio-economic indicators

Key socio-economic indicators for DCC are shown in Table 1.

Table 1: Socio-economic framework of DCC

Socio-economic framework of DCC			
Indicator			
Territory	Devon County Council		
Surface (ha)	663 610 ha[2]		
Population (% of total)	Female	51%[3]	
	Male	49%[3]	
Regional GDP (million)	£19 974[4]	€22 118	
Pro-capita GDP	£25 116[4]	€27 812	
Average net household income	£29 497[4]	€32 663	
GVA by main economic sectors	Economic sector	£	€
	Agriculture; mining; electricity; gas; water and waste	£1 232 000 000[5]	€ 1 367 520 000
	Construction	£1 473 000 000	€ 1 635 030 000
	Distribution; transport; accommodation & food	£3 174 000 000	€ 3 523 140 000
	Financial and insurance activities	£371 000 000	€ 411 810 000
	Information & communication	£904 000 000	€ 1 003 440 000
	Manufacturing	£1 456 000 000	€ 1 616 160 000
	Professional & administrative services	£1 458 000 000	€ 1 618 380 000
	Public administration; education; health	£4 009 000 000	€ 4 449 990 000
	Real estate activities	£3 104 000 000	€ 3 445 440 000
	Recreation, other services & household activities	£537 000 000	€ 596 070 000

1.2 Territory under analysis

[2] ONS, 2016. *Total extent of the realm*. Available: https://ons.maps.arcgis.com/home/item.html?id=a79de233ad254a6d9f76298e666abb2b.
[3] ONS, 2019. *Nomis Labour Market Profiles-Devon*. Available: https://www.nomisweb.co.uk/reports/lmp/la/1941962901/report.aspx?town=devon#tabrespop.
[4] ONS, 2018. *Regional gross domestic product all NUTS level regions*. Available: https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions.
[5] ONS, 2018. *Output by Industry*. Available: https://www.devonomics.info/data/output/sector-composition/ [all GVA data].

DCC is the largest local authority region in terms of surface area in the South West (SW) and the third largest in England[3]. It is comprised of eight districts, with Exeter being the largest urban area. Plymouth and Torbay are covered by independent unitary authorities and are excluded from the DCC administration.

The region is rich in natural capital with 35% of the geographic area of Devon being covered by landscape designations[6]. The region contains two National Parks and five Areas of Outstanding Natural Beauty and is characterised by diverse landscapes including high moors, heathlands, valleys and rolling farmland[6].

1.3 Regional social characteristics

DCC's population was 802,400[3] in 2019, having grown by 8.2% over the last decade (Figure 1). The regional working age population is declining, driven by an increase in over 65s[7].

The average person in DCC has a disposable income of £20 461 (€22 657), 3% lower than the national average[8]. Employment rates are 4% higher than national averages at 79.2%[7].

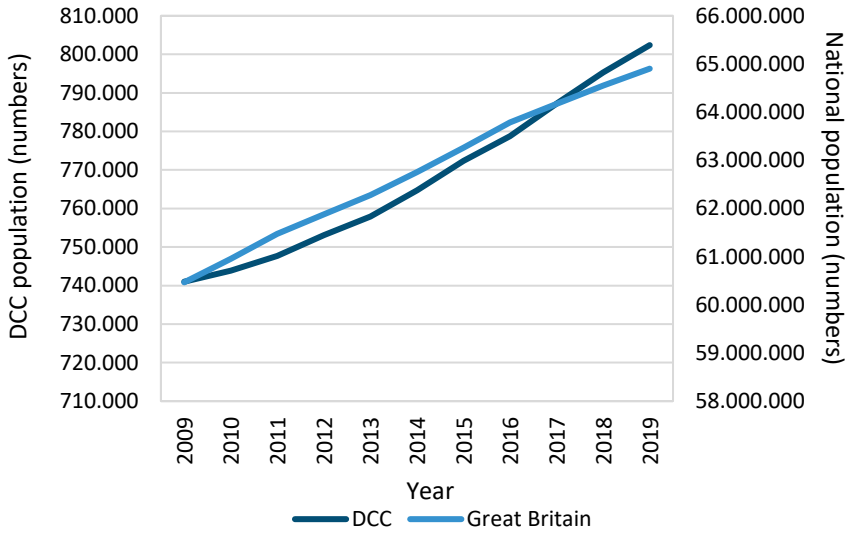

Figure 1: Population of DCC and the UK [3]

1.4 Regional economic characteristics

[6] DBRC, 2009. *Sites and Habitats.* Available: https://www.dbrc.org.uk/information/sites-and-habitats/.
[7] Devon County Council, 2019. *Economic Overview.* Available: https://www.devonomics.info/overview/.
[8] ONS, 2018. *Regional GDHI*. Available: https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/1997to2018/relateddata.

DCC's economy is varied in terms of sector, with the public administration, education and health making the largest contribution to GVA in 2018 (23%), followed by real estate activities (18%). Agriculture combined with other primary activities such as mining, water and waste, contributes to 7% of DCC's GVA.

DCC's GDP growth has been in line with the national average, although the DCC economy is reported to be growing faster than the national average in terms of output. Labour productivity however is 77.4% of the national average[7].

1.5 Regional agricultural characteristics

1.5.1 Overview of regional agricultural sector

Table 2 provides key indicators of the agricultural sector in the geographic region of Devon.

Table 2: Overview of Devon agricultural sector

Overview of Devon agricultural sector	
Indicator	
Total agricultural area (ha)	485 751.5 ha[9].
Total area used (% of total)	72.4% of the total area of the geographic county[10].

Table 3 shows production by agricultural sector for the wider SW region. SW agricultural production in 2019 was estimated to be worth £3 629 million[9], 30% of which came from dairy production. Support and secondary activities relating to farming are not formerly recorded, however, diversified activities were of comparatively low value, contributing 6% to overall production[11].

Table 3: Production by agricultural sector (2019)[9]

Production by agricultural sector within the South West	
Macro category	**Production (£ million)**
Combinables & sugar beet	539
Vegetables, Horticulture & potatoes	782
Pigs & poultry	464
Dairy	1 105
Beef & sheep	523
Diversification	215

1.5.2 Number and size of farms

[9] Food, Farming & Countryside Commission, 2019. *Devon Locally Led inquiry; Grasslands and Livestock Production in Devon.* Available: https://ffcc.co.uk/assets/downloads/FFCC-Devon-grasslands-and-livestock.pdf.
[10] Devon Strategic Partnership, 2014. *Feeding Devon's Future' Devon Food Strategy and Action Plan 2013-2016*. Available: https://democracy.devon.gov.uk/Data/Cabinet/20141008/Agenda/supplementary%20information-CS-14-36.pdf.
[11] DEFRA Agriaccounts, 2020. *NYTS1 Datasets for 'Total Income from Farming for the Regions of England*. Available: https://www.gov.uk/government/statistics/total-income-from-farming-for-the-regions-of-england.

8 541 farms were recorded in the geographic county of Devon in 2016[12]. Figure 2 shows how these were distributed by size, showing that DCC is characterised by smaller farms.

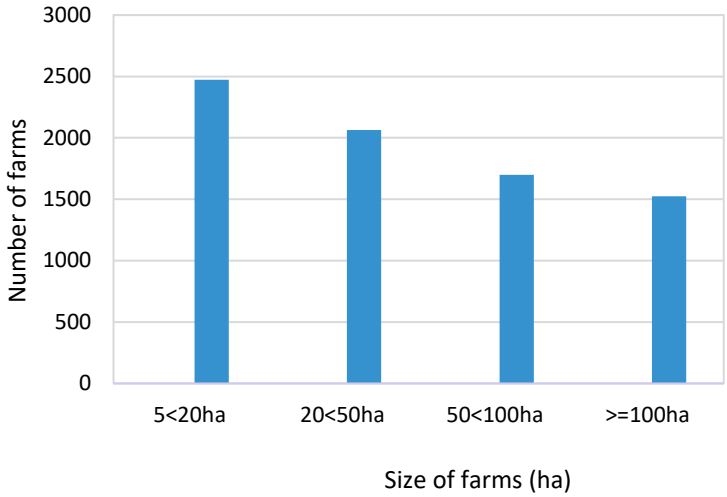

Figure 2: Size distribution of farms within Devon (2016)[12]

1.5.3 Farm labour

In total there were 19 650 farm workers in 2019, a further breakdown is provided in Figure 3. The majority of farm labour (73%) is made up of "farmers, partners, directors and spouses", suggesting that farm owners predominantly make up the agricultural workforce.

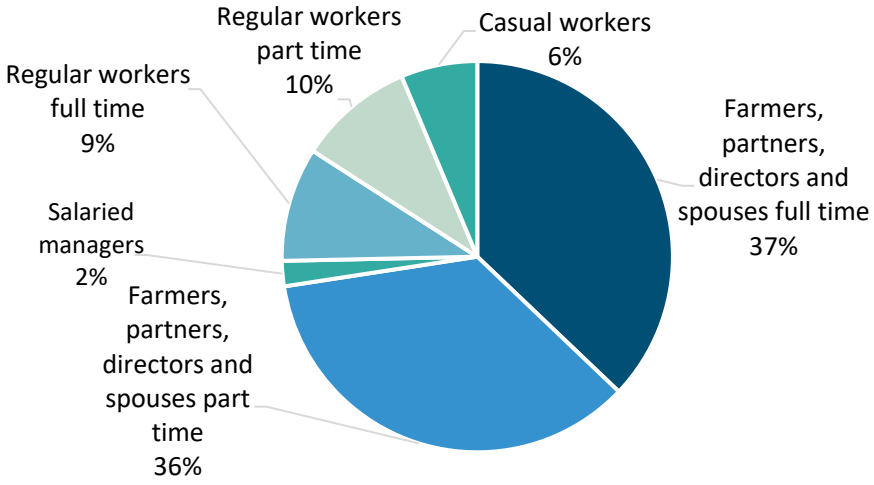

Figure 3: Farm labour breakdown for Devon[12]

1.5.4 Livestock units

[12] DEFRA, 2016. *June Survey of Agriculture*. Available: https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june.

7 063 538 farmed animals were recorded in the county in 2016[12]. Figure 4 provides a breakdown of the total number of animals converted to livestock units. Dairy dominates, making up 62% of total livestock units, with sheep farming being the second largest category (22%).

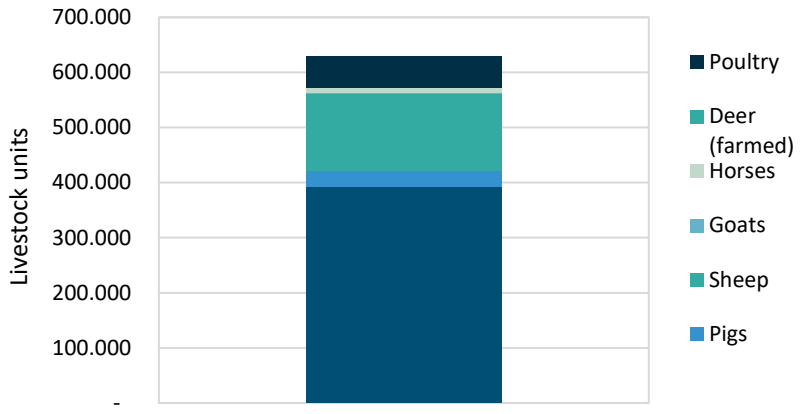

Figure 4: Breakdown of livestock units in Devon[12]

1.5.5 Use of agricultural land

Figure 5 shows agricultural land use. The majority of land is used for grazing (77%), due to the presence of Dartmoor and Exmoor National Parks. There is a strong history of open moorland grazing, with local farmers given rights to graze livestock. 16% of the Devon's agricultural land is used for arable farming, which equates to around 81 000 ha, only 17.4 km^2 is used for vegetable crops (Figure 5)[12].

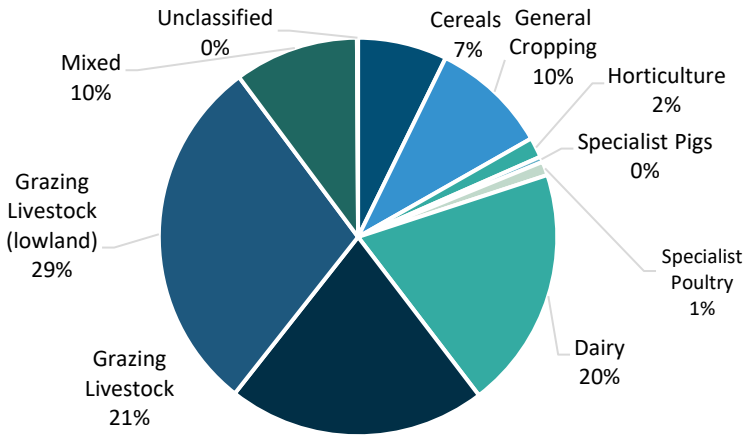

Figure 5: Use of agricultural land in Devon[12]

1.5.6 Farmhouse holiday

Tourism is a large sector within Devon, bringing in an estimated £2.4 billion (€2.65 billion) in 2016[13]; and many farms have diversified to capitalise on this. A review of tourism accommodation providers shows

[13] The South West Research Company Ltd, 2018. *The Economic Impact of Devon's Visitor Economy, 2016*. https://mk0devonxbk65t3kfl.kinstacdn.com/wp-content/uploads/sites/132/2018/07/Devon-districts-2016.pdf.

numerous high quality properties available to let within Devon. Accommodation is mainly self-catering, B&B accommodation and campsites. Many farms also provide food direct to consumers through farm shops or farmers markets.

1.6. Regional energy characteristics

1.6.1 Overview of regional energy characteristics

Key indicators to characterise the region from an energy perspective are shown in Table 4.

Table 4: Regional energy characteristics

Regional energy characteristics				
Indicator	**Electrical (GWh)**	**Thermal (GWh)**	**Transport (GWh)**	**Total (GWh)**
Regional energy production	8 587	0	0	8 587
Regional energy consumption	3 339	8 060	6 577	17 976
Regional energy consumption mix	**Renewable sources**		**Non-renewable sources**	
	%	GWh	%	GWh
Electrical	45	1 507	55	1 832
Thermal	0	0	100	8 060
Transport	0	0	100	6 577
Total	8	1 507	92	16 469
Energy consumption by socio-economic characteristics	11.6% of the DCC population live in fuel poverty			

1.6.2 Regional energy production

DCC electrical production can be inferred from the combination of RE energy generation and the output from non-renewable sources. Within DCC there one non-renewable power plant, a 885 MW Combined Cycle Gas Turbine power station at Langage; RE generates 1 507 GWh[14] and the Langage plant is calculated to generate 7 080 GWh annually, therefore, total DCC electricity production is estimated to be 8 587 GWh.

1.6.3 Regional energy consumption

[14] Regen, 2018. *Devon Renewable Energy Progress Report.*
Available: https://www.devon.gov.uk/energyandclimatechange/renewable-energy.

As of 2018, DCC's overall energy consumption was 17 976 GWh[15] (including energy for road transport and rail), gas and electricity, as shown in Figure 6.

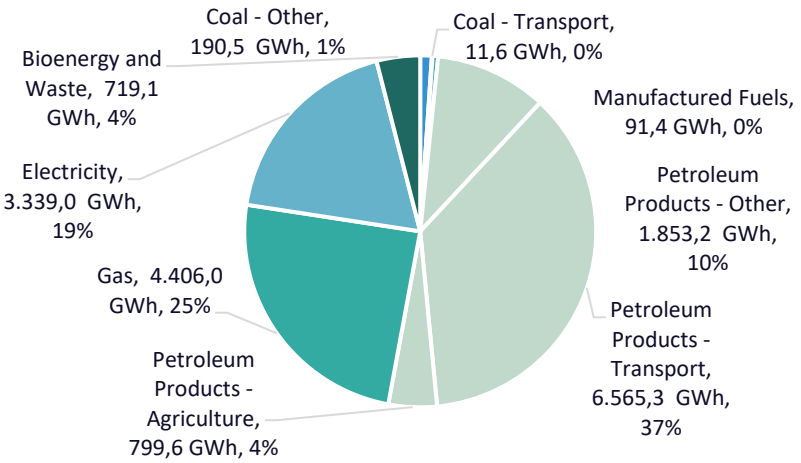

Figure 6: DCC total energy consumption per fuel type (2018)[15]

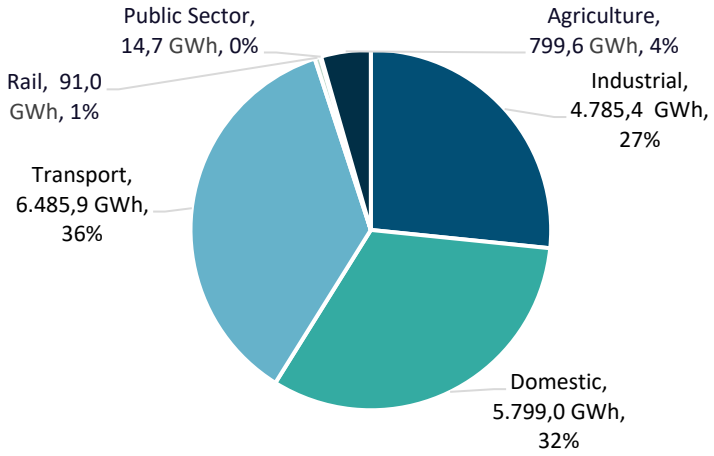

Figure 7: DCC total energy consumption by sector (2018)[15]

1.6.4 Regional energy mix (thermal and electrical)

As of 2016, 8% (1 507 GWh) of DCC energy consumption was obtained from RE. DCC's regional energy mix by local authority area is presented in Figure 8, showing that this value ranges from 23% in Torridge to 3% in Exeter. Torridge's high proportion of RE is assumed to be due to the rural nature of the area and preferrable location for solar PV and wind turbines.

[15] ONS, 2020. *Total final energy consumption at regional and local authority level 2005 to 2018.* Available: https://www.gov.uk/government/statistics/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2018.

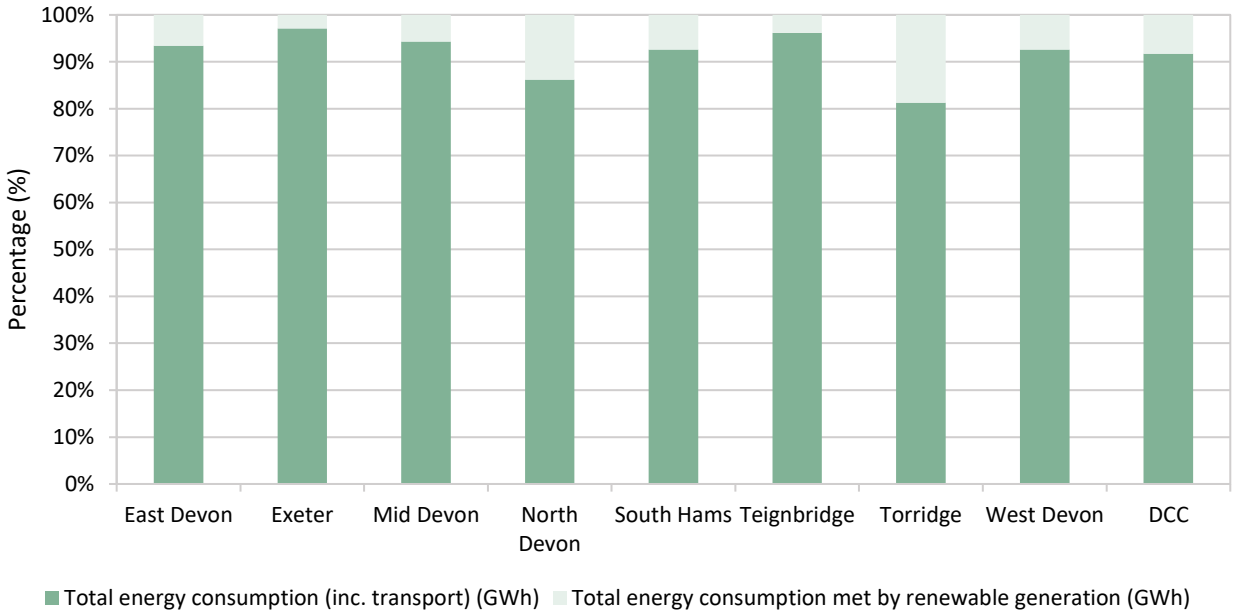

Figure 8: Percentage of total energy consumption met by renewable energy generation[16]

1.6.5 Energy consumption by socio-economic sector and percentage breakdown

A key measure of energy consumption in relation to socio-economic sector is the number of households that are in fuel poverty, as assessed using the Low Income High Cost (LIHC) indicator. The LIHC considers a household to in fuel poverty if fuel costs are above the national median level and, if they were to spend that amount they would be left with a residual income below the poverty line. 11.6% of the DCC population live in fuel poverty[17].

[16] Regen, 2018. *Devon Renewable Energy Progress Report.*
Available: https://www.devon.gov.uk/energyandclimatechange/renewable-energy.
[17] ONS, 2019. *Fuel poverty sub-regional tables 2019*. Available: https://www.gov.uk/government/collections/fuel-poverty-sub-regional-statistics.

II. *Evolution of the spread of renewable energies in agriculture*

2.1 History of regional RE

RE in DCC has markedly increased since 2010 (Figure 9), but, still only contributes 8% of RE consumption, illustrating the large potential to increase RE use.

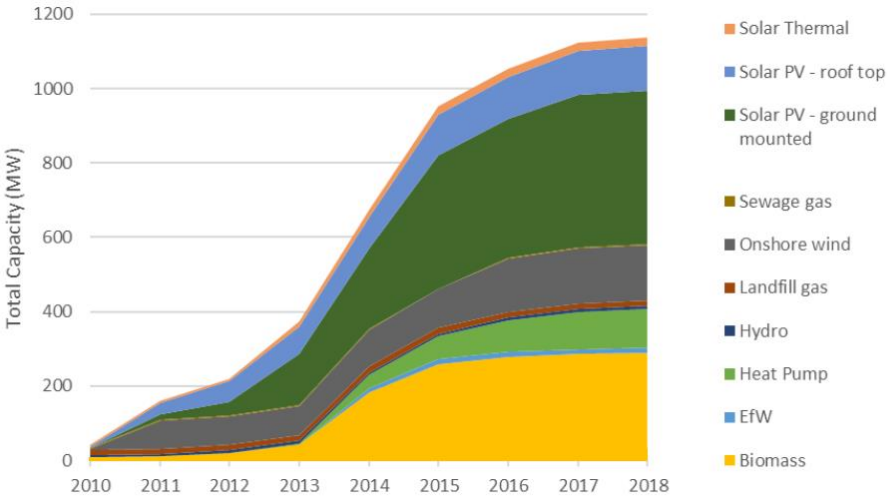

Figure 9: DCC RE[16]

2.2 RE Incentive policies

Key RE incentive policies are shown below, including whether they apply to the agricultural sector:

- **Feed in Tariff**
  Incentive paid per kWh generated and exported from certified renewable electricity installations (<5MW).
  Timescale: 2010-19
  Location: National

  Agricultural sector ✓ | Energy efficiency | Energy sale ✓

- **Renewable Heat Incentive**
  Incentive paid per kWh of renewable heat based on type/size of installation.
  Timescale: 2011-Mar 21
  Location: National

  Agricultural sector ✓ | Energy efficiency | Energy sale

- **Smart Export Guarantee**
  A guaranteed payment per kWh exported to the grid from RE >5MW.
  Timescale: 2020-Present
  Location: National

  Agricultural sector ✓ | Energy efficiency | Energy sale

- **Renewable Obligation**
  Support scheme for >5MW RE.
  Timescale: 2002-17
  Location: National

Agricultural sector	✓	Energy efficiency		Energy sale	✓

- **Resource Efficiency for Farmers**
  Resource efficiency advice and grants for farms.
  Timescale: 2009-13
  Location: Devon

Agricultural sector	✓	Energy efficiency	✓	Energy sale	

- **Contract for Difference**
  A guaranteed fixed price for exported renewable electricity based on wholesale rates over 15-20 years.
  Timescale: 2021-35
  Location: National

Agricultural sector	✓	Energy efficiency		Energy sale	✓

2.3 RE in the DCC agricultural sector

Large scale RE installations in the DCC agricultural sector are shown in Table 5[18]. Only 41 farms have RE installations over 150 kW in DCC. Data for small-scale RE installations is not publicly available.

Table 5: RE >150kW in DCC within the agricultural setting[18]

RE >150kW in DCC within the agricultural setting		
No. of farms with operational RE (>150 kW)		41
Type	**No.**	**Capacity (MW)**
Wind	1	5
Solar PV	37	209
Biomass	0	-
Anaerobic Digestion (AD)	3	4.3
Hydro	0	-
Other	0	-

2.4 RE in DCC

Table 6 shows total number of installations and electricity production from RE in DCC across all sectors.

[18] REPD, 2020. *Renewable Energy Planning Database quarterly extract, September 2020*. Available: https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract.

Table 6: No. of RE installations and electricity production for DCC (all installations)[19]

No. of RE installations and electricity production for DCC (all installations)			
RE	**Capacity (kW)**	**Production (GWh)**	**No.**
Solar PV	537 062	526.3	25 515
Onshore Wind	136 936	287.6	252
Hydro	7 717	18.7	48
AD	13 166	65.0	17
Sewage Gas	900	3.5	4
Landfill Gas	15 480	58.1	4
Biomass	4 700	4.5	3
Low Enthalpy Geothermal			
Solar Thermal (elect.)		0	

Off grid RE installations in DCC are shown in Table 7.

Table 7: Off grid RE installations in DCC[20]

Off grid RE installations in DCC	
RE	**Capacity (kW)**
Solar PV	266
Wind	33
Hydro	5
AD	499

Key areas of energy use by farm type are shown in Table 8.

Table 8: Energy use by farming type[21]

Energy use by farming type	
Farm type	**Use**
Arable	Crop storage/cultivation
Dairy	Milk production process; water heating; lighting & pumping; refrigeration
Beef	Cattle feed delivery
Poultry	Maintenance of environmental conditions for stock rearing
Pigs	Waste/manure management; feeding systems; maintenance of ambient conditions for stock
Horticulture	Greenhouse heating

[19] BEIS, 2019. *Regional Renewable Statistics*. Available: https://www.gov.uk/government/statistics/regional-renewable-statistics

[20] REF, 2020. *FIT generation* (data last updated Sep, 2020). Available: https://www.ref.org.uk/energy-data.

[21] Carbon Trust, 2019. *Energy efficiency in agriculture.* Available: https://www.carbontrust.com/resources/energy-efficiency-in-agriculture-guide.

III. Local policies and actions for the pursuit of Sustainable Development Goals by 2030

This section provides an analysis of the local policies relevant to the DCC region which promote RE in agriculture.

3.1 General framework of policies

- In the UK there is currently no statutory framework of policies related to RE sources from agriculture. Instead, there are national policies and legislation relating to sustainability and climate change across all sectors, including the agricultural, to meet its Greenhouse Gas (GHG) emissions targets by 2030[22]. For example, the Climate Change Act 2008, the 2017 Clean Growth Strategy[23] (CGS) and the National Planning Policy Framework (NPPF)[24].
- All Local Planning Authorities (LPAs) in Devon have Local Plans (LP) that contain policies which promote RE as required by the NPPF, but they do not relate explicitly to RE in agriculture and this is where the policy gap lies.
- An example of an action which has promoted renewables in the agricultural sector is the launch of the GHG Action Plan[25] in 2011 by a coalition of agricultural industry partners.
- The agricultural sector is promoted within the CGS where it states "we want our land and agriculture sectors to play a significant role in low carbon growth supported through a system of incentives", but currently there is little incentive for investment in renewables in this sector.

3.2 Strengths

- There are policies within the region that promote energy production from renewable sources.
- There is also recognition at a national policy level of the need to support the agricultural sector more to help it address climate change (see Policy 38 of the CGS).

3.3 Weaknesses

- The current policies are generic and not sector specific to agriculture.
- There is no quota within LP policies across the region to deliver RE development.
- Many of the LPAs in the region have not assessed the potential RE resource in their area which means policy support cannot be specifically targeted.
- Some local policies limit support to certain technologies of renewable development.

[22] UK Government, 2020. *United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution*. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Kingdom.pdf
[23] BIES, 2019. *The UK's Integrated National Energy & Climate Plan (NECP).* Available: https://www.gov.uk/government/publications/uk-national-energy-and-climate-plan-necp
[24] MHCLG, 2019. *National Planning Policy Framework.* Available: https://www.gov.uk/government/publications/national-planning-policy-framework--2.
[25] BEACON, 2018. *The Greenhouse Gas Action Plan for Agriculture in England Study.* Available: https://www.adelphi.de/en/publication/greenhouse-gas-action-plan-agriculture-england

- The presence of environmental designations across the region and subsequent policies constrains what level of RE development can be achieved.

3.4 Coherence of policies

- The existing policy framework has a diffusion of polices that promote RE development, but this is not specific to agriculture.
- The Dartmoor Local Plan does recognise that "agricultural buildings may also be able to incorporate renewable energy development" and "often this does not need planning permission". This shows policy support for the use of agricultural buildings to incorporate renewable energy and is one of the few areas where this review has found recognition of this.

3.5 Conclusion

- The absence of RE policies specific to agriculture makes it difficult to monitor carbon targets in this sector.
- To change this there needs to be a clearly defined and robust policy framework with supporting incentives which promote renewable sources in agriculture. The UK's exit from the EU and from the Common Agricultural Policy (CAP) presents an opportunity to do this.

IV. Risks & opportunities from policies and market for the spread of renewable energy in agriculture

This section provides an analysis of the factors that affect the spread of RE in agriculture and the risks and opportunities posed to future uptake of RE from economical scenarios following the Covid-19 pandemic and the UK's exit from the EU.

4.1 Regional factors and limitations

4.1.1 Overview

A high proportion of the DCC's land is used for agriculture and there are a large number of farms, resulting in significant land and potential for RE. Data suggests larger RE installations (>150MW) on agricultural land are predominantly owned by investment companies, suggesting that farm owned installations should be incentivised. There is a threat that small scale RE installations may not be economically feasible without incentives and, despite the recent upsurge in RE in the last ten years, only 8% of total energy consumption is met be RE generation in DCC.

4.1.2 Regional farm characteristics

Volatile cash flow is cited as a key barrier to growth for farm businesses[26], with the availability of capital a key factor in determining investments. The DCC agricultural sector is characterised by small family owned farms, traditionally associated with modest income levels. The number of small farms is declining in the SW[27], posing a risk to the DCC agricultural sector as a whole. RE does offers small farms an option to diversify their income and increase future resilience.

4.1.3 RE technologies

The high proportion of livestock and grazing farms suggests there may be opportunities for anaerobic digestion (AD) plants within larger dairy farms to create renewable electricity. With increasing food waste collections, farmers also could partner with local authorities to add food waste into AD plants providing a service to the local community[28].

Other options include ground mounted solar PV on unplanted areas (e.g. field margins) or PV deployed across fields[29]. Ground mounted PV across entire fields allows some agricultural activity to continue (e.g.

[26] Farmers Weekly, 2019. *Farmers blame market uncertainty for lack of growth*. Available: https://www.fwi.co.uk/business/markets-and-trends/farmers-blame-market-uncertainty-for-lack-of-growth.
[27] Winter, M. and Lobley, M. 2016. *Is there a future for the small family farm in the UK?* Report to The Prince's Countryside Fund, London: Prince's Countryside Fund. Available: https://www.princescountrysidefund.org.uk/downloads/research/is-there-a-future-for-the-small-family-farm-in-the-uk-report.pdf.
[28] Farmers Weekly, 2019. *Where now for renewable energy on farms?* Available: https://www.fwi.co.uk/business/diversification/farm-energy/where-now-for-renewable-energy-on-farms.
[29] NFU, 2013. *Solar photovoltaic electricity in agriculture – on your roofs and in your fields.* Available: https://www.nfuonline.com/solarpv_nfubriefing4/.

sheep grazing or free-range poultry) and can provide space for "environmental stewardship" measures[29]. PV on livestock housing roofs is also an option, best suited to buildings with high electricity use (e.g. dairy parlours[29]). DCC is ideally placed for PV as the SW receives some of the highest levels of solar irradiation in the UK[30].

Wind power and hydropower installations are also feasible but location dependent. DCC receives strong prevailing westerly winds making large commercial wind farms, small clusters of turbines or single, small wind energy systems[31] viable, these also allow for continuation of agricultural activity but can be harder to obtain planning permission for. Local wind speeds of at least 5m/s, proximity to properties, nearby radar and airport installations and visual impact are key considerations for wind power[32]. Hydropower can be a very efficient form of RE, however, steep hills and fast flowing water are required[33].

The demand for renewable heat within DCC farms is low, however, heating water can account for 23% of energy costs on typical dairy farms[34], so there are opportunities to install heat generating RE such as solar thermal or biomass to provide hot water. Farms that have diversified into tourism may have higher heat demands. There are limited RE opportunities from geothermal heat in DCC[35].

Further information on typical RE costs and payback periods is shown in Table 9, however, financial returns will be determined by local parameters.

Table 9: RE costs and payback periods [36]

RE costs and payback periods	
RE technology	**Cost and payback period**
AD	Price varies dependent on the complexity of the system Relatively high initial costs but payback periods of 5-10 years Additional costs savings through reduced cost of waste disposal
Solar PV	Site issues determine costs Potentially 5-8 year payback times
Wind	Wind speed dependent
Hydro	Water speed and volume dependent Capital costs vary due to site specific conditions
Solar thermal	Strong economic case where there is a high demand for hot water

[30] The World Bank, 2019. *Solar resource maps of United Kingdom*. Available: https://solargis.com/maps-and-gis-data/download/united-kingdom.
[31] NFU, 2015. *Wind power in agriculture – small, medium and large scale*. Available: https://www.nfuonline.com/assets/46020.
[32] Farm Carbon Cutting Toolkit, 2021. *Energy Generation*. Available: https://www.farmcarbontoolkit.org.uk/toolkit/energy-generation.
[33] CAT, 2021. Micro-Hydro Power. Available: https://www.cat.org.uk/info-resources/free-information-service/energy/micro-hydro/.
[34] Farmers Weekly, 2019. *Guide to water heating options for your dairy parlour*. Available : https://www.fwi.co.uk/livestock/dairy/guide-to-water-heating-options-for-your-dairy-parlour.
[35] Cornwall Council. *Geothermal.* Available: https://www.cornwall.gov.uk/business/economic-development/geothermal/.
[36] Carbon Trust. Available: https://www.carbontrust.com/resources/renewable-energy-guide.

	More economically viable in larger systems
Biomass	Capital cost varies due to size, fuel type and level of automation Payback periods can be relatively short (differs per project) Dependent on cost of fuel (may be zero if using a combustible bi-product)

4.1.4 Planning constraints

Solar PV makes up 99% of total RE installations in DCC and 90% of large installations on DCC farms. The high uptake of solar PV is partly due to planning constraints within the region making other technologies hard to obtain planning permission for. Strict planning constraints pose a threat to future installations, particularly wind power. Out of 20 applications for wind turbines over 150 kW on agricultural land, only 4 are operational, planning permission was either refused or applications were withdrawn for the remaining 16[18].

4.1.5 Changing attitudes and commitment to act on climate change

Planning constraints, protected areas and historic public opposition to RE developments highlight the need for RE installations that do not negatively impact on natural capital. Attitudes towards RE are however changing due to an increased awareness of the climate emergency and focus on decarbonisation[37]. The national commitment to be net zero by 2050[38] and sectoral net zero commitment by the NFU to become net zero by 2040[39] represent a significant opportunity for the installation of RE in agriculture. Clean growth and the energy sector are also highlighted as a key priority in the Local Industrial Strategy[40]. There is also significant local commitment from DCC to act on climate change[41] and the region benefits from a wide-ranging RE sector, with the University of Exeter having RE specialisms[42].

4.1.6 Grid constraints

Grid capacity availability in the SW is a limitation to the spread of renewable electricity within agriculture in DCC. Due to the rapid growth of regional distributed RE projects, there are extensive constraints on the grid network as exporting limits, mainly through the "F route", the Western Power Distribution

[37] Farmers Weekly, 2019. *Where now for renewable energy on farms?* Available: https://www.fwi.co.uk/business/diversification/farm-energy/where-now-for-renewable-energy-on-farms.
[38] Gov.uk, 2019. *UK becomes first major economy to pass net zero emissions* law. Available: https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law.
[39] NFU, 2019. *Achieving NET ZERO Farming's 2040 goal*. Available: https://www.nfuonline.com/nfu-online/business/regulation/achieving-net-zero-farmings-2040-goal/.
[40] https://heartofswlep.co.uk/wp-content/uploads/2019/07/6.1-HotSW-LIS-Full-draft-17-07-2019-LEP-Board-Jul19.pdf
[41] Interreg Europe, 2021. *DCC*. Available: https://www.interregeurope.eu/agrores/news/news-article/8078/devon-county-council/.
[42] SQW, 2018. *Local Economic Assessment (2018) and Strategy for Growth Discussion Paper*. Available: https://mk0devonxbk65t3kfl.kinstacdn.com/wp-content/uploads/sites/132/2018/09/Local-Economic-Assessment-2018.pdf.

(WPD) line that runs out of the region, being reached[43]. This has historically led to delays of 3-6 years for connection of works at high voltage (i.e. above 6.6kV or 11kV)[37].

Grid capacity constraints may however promote the installation of smaller scale, low voltage renewable electricity installations[37], where generation and demand can be closely matched to maximise self-consumption and minimize export to the grid. Alternatively, there are opportunities to install RE installations which are not connected to the grid at all and where all electricity generated is used onsite, stored or supplied to a local community through a private wire[44].

WPD have committed to upgrading the "F route"[44], potentially as part of the connection of the Hinkley C nuclear power plant, however, considerable uncertainty remains. Capacity is likely to be freed up in the future when older projects fail and technology evolves to more accurately match supply and demand[37].

4.2 Scenarios for future economic development

4.2.1 The economic consequences of Covid-19 and Brexit

The economic impact of the Covid-19 pandemic is unprecedented[45]. National GDP was 25% lower in April 2020 than two months earlier, with GDP reaching 9% of pre-pandemic levels in by November 2020[45]. GDP forecasts point to a large decline in 2020, with central scenarios forecasting a reduction of 12.4% in 2020 and recovery of 3.7% in 2021[45]. Even when the economic shock of the pandemic dissipates, lasting damage may result and potential structural shifts in the economy are likely[37].

The impact of the UK's exit from the EU must also be considered alongside the Covid-19 pandemic, the combination of the two potentially leading to economic downturn and significant uncertainty across all sectors[46]. The London School of Economics estimated in July 2020 that Brexit had already reduced GDP by 2.1% and refer to the government's own assessment that leaving the EU with a deal will lead to a long term 4.9% reduction in GDP[47].

4.2.2 Impact on the spread of RE in agriculture

As a result of Covid-19, the agricultural sector experienced a sustained reduction in output in 2020 compared with February 2020 levels[48]. Forced closures and social distancing restrictions impacted farm

[43] RegenSW, 2016. *Grid Constraints in the South West: Options for connection.* Available: https://heartofswlep.co.uk/wp-content/uploads/2016/09/HoSW-LEP-Grid-constraints-guidance_0.pdf.
[44] WPD, n.d. *Distributed generation EHV constraint maps*. Available: https://www.westernpower.co.uk/our-network/distributed-generation-ehv-constraint-maps.
[45] Harari, D. and Keep, M. 2021. *Coronavirus: Economic impact*. Available: https://commonslibrary.parliament.uk/research-briefings.
[46] TUC, 2020. *Impact of Covid-19 and Brexit for the UK economy*. Available:https://www.tuc.org.uk/sites/default/files/2020-12/BrexitBrief.pdf.
[47] De Lyon, J. and Dhingra, S. 2020. *Covid-19 and Brexit: Real-time updates on business performance in the United Kingdom.* Available: https://cep.lse.ac.uk/pubs/download/cepcovid-19-006.pdf.

output and uncertainty continues around the length of the pandemic[48]. The impact of this is high level uncertainty within the sector stifling investment. Conversely, the Covid-19 pandemic has heightened public awareness of the need to protect the environment, with the "climate emergency" being reported as also a "health emergency"[49]. This renewed focus on tackling climate change may increase governmental focus on climate change and encourage investment.

The UK's exit from the EU may disproportionately affect rural communities leading to a lack of capital to invest in RE. Farms will be impacted through the changing agricultural support regime, loss of migrant workers and the economic impacts from changes in tariffs and terms of trade[50]. In October 2019, a third of farmers surveyed listed market uncertainty as the biggest reason for lack of investment[51].

Almost 40% of the EU's budget is related to agriculture and rural development through the CAP, which provides a framework for the regulation of direct payments to farmers, market support measures and rural development programmes to support the wider rural economy[52]. In addition, many UK farms rely on seasonal migrant labour from the EEA, the loss of which is cited as a particular concern for farmers[53]. Furthermore, whilst there is confidence in the UK government's long term commitment to RE, UK Energy Policy is linked to the EU Renewable Energy Directive and there is a lack of clarity around future policy and incentives to encourage the uptake of RE. The NFU does argue however that Brexit offers an opportunity for change and to revise agricultural subsidies, which may in the long term help to ensure a thriving farming sector post-Brexit[53], presenting opportunities for RE investment.

Uncertainty associated with the economic implications of Covid-19 and the wider impacts of the UK's exit from the EU is expected to continue for some time, many farmers may therefore choose to delay significant investment in RE unless advances in technology and reductions in costs result in RE being financially viable, highlighting the need for targeted incentives.

4.3 Increased focus on Environmental, Social, and Corporate Governance

The global risks of climate change and poverty pose significant challenges to policy makers, the potential implications of projects should not be considered in isolation and increasingly investments are being considered from a financial, social and environmental perspective. Investor preferences are shifting towards interest in financial products that incorporate Environmental, Social and Governance (ESG) with more than 80% of mainstream investors now considering ESG information when making investment

[48] Marsh Commercial, 2020. *How the Coronavirus has affected UK farming*. Available: https://www.marshcommercial.co.uk/articles/farming-the-coronavirus-impact/.
[49] SDU, 2021. *The climate emergency is a health emergency*. Available: https://www.sduhealth.org.uk/news/682/the-climate-emergency-is-a-health-emergency.
[50] The SW Rural Productivity Commission, 2017. *Evidence Report 2017*. Available: https://heartofswlep.co.uk/wp-content/uploads/2017/10/Evidence-Report.pdf.
[51] Farmers Weekly, 2019. *Farmers blame market uncertainty for lack of growth*. Available: https://www.fwi.co.uk/business/markets-and-trends/farmers-blame-market-uncertainty-for-lack-of-growth.
[52] Potton E., Garton Grimwood, G., Booth, L. and Sutherland, N. 2017. *Effect of the UK leaving the EU on the rural economy.* Available: https://commonslibrary.parliament.uk/research-briefings/cdp-2017-0018/.
[53] NFU, 2021. *Brexit News.* Available: https://www.nfuonline.com/news/latest-news-rh-panel/brexit-news/.

decisions[54], and sustainability factors increasingly affecting the risks, returns and values of investments[55].

Within the EU, ESG is receiving considerable attention from regulators and policy drivers, being particularly prominent in the European Commission's 2020 Work Programme[56]. The increased focus on ESG within investments poses an opportunity for the spread of RE within agriculture as increasingly investors will be looking to support projects that have a positive impact. There are opportunities for investors and pension funds to provide capital for sizable RE developments, far larger than may be possible if the installation was funded through farms themselves. These investments may also offer the opportunity to bridge the gap in renewable and agricultural subsidies.

Key to future RE investments, is ensuring that any investment has net positive impacts and does not negatively impact local natural capital, food security, biodiversity and farm profitability in the long term.

[54] Faversham House Group Ltd, 2020. *Edie Explains: Carbon Offsetting.* Available: https://www.edie.net/downloads/edie-Explains--Carbon-offsetting/475.
[55] ESMA, 2020. *Strategy on Sustainable Finance*. Available: https://www.esma.europa.eu/sites/default/files/library/esma22-105-1052_sustainable_finance_strategy.pdf.
[56] Factset, 2020. *ESG Regulation – Where to start?* Available: https://insight.factset.com/esg-regulation-where-to-start.

V. Conclusions

5.1 SWOT analysis

Table 10: SWOT analysis

SWOT analysis	
	
• Policies support energy production • National policy support for RE and carbon reduction and recognition of the need to support the agricultural sector to address climate change • Previous policy incentives for RE have had success especially wind turbines and field-scale solar PV.	• Policy wording could be stronger and sector specific • Policy aims to maximise RE development, but no defined quota • Unknown RE potential across Devon • Some policies limit support to certain RE technologies • Environmental designations may present a barrier • Little incentive for investment in RE.
	
• Land available for RE with only a small proportion of farms investing • Ideal geographical location for solar PV and wind power • Develop farm owned installations • Opportunity to diversify, increase resilience and address climate crisis • AD plants within dairy sector and adding food waste • Provision of hot water in dairy sector • Solar PV on livestock housing and dairy parlour roof space • Private wire RE installations matching local supply and demand • Opportunity to revise agricultural subsidies post-Brexit • Increased focus on ESG within investments with potential for capital for sizable RE developments.	• Small scale RE installations may not be economically feasible without incentives • Declining farm income - lack of capital to invest • Modest income and volatile cash flow • Number of small farms declining • Strict planning constraints • Availability of grid capacity • Economic downturn and uncertainty due to Covid-19 and Brexit.

5.2 Conclusion

There is a significant opportunity for the investment and diffusion of RE across the DCC agricultural sector due to the rural nature of the region, strong commitment to action on climate change, ideal geographic conditions of the region and latent potential for investment amongst farms.

National incentives and policies over the past decade have significantly encouraged investment in RE, however, local and sector specific policies are lacking. Despite the increase over the past 10 years, only 8% of total regional energy use is met through RE.

Anaerobic digestion cost-effective for larger dairy farms and roof mounted solar PV on dairy parlour roofs could offer a financially viable solution for smaller dairy farmers. In the wider grazing/livestock sector, there are opportunities for ground mounted solar PV. Wind power is also viable in the right location, however, planning constraints can create challenges to installation.

Investments in RE are at risk due to the Covid-19 pandemic and the UK's exit from the EU, however, certainty remains over long-term commitment to act on climate change. A challenge exists as to how to fund investments, whether through investment schemes focusing on ESG factors for larger investments or incentive schemes that make small scale on-farm investments financially viable.