Dingle HUB

MaREI
Energy · Climate · Marine

Dingle Sustainable Energy Community

Energy Master Plan

Baseline Energy Balance, Renewable Energy Potential and Register of Opportunities

February 2020

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Executive Summary

In April 2018, the Dingle Sustainable Energy Community (SEC) was established under the aegis Mol Teic (Dingle Creativity and Innovation Hub). The SEC network is coordinated by SEAI with the aim of encouraging and supporting the involvement of communities in the transition to a low carbon future. It offers a number of sharing and learning opportunities, as well as providing access to grant support.

A vital first step in the development of an SEC is to understand the community's current energy consumption. In October 2018, the Dingle SEC commissioned the production of an Energy Master Plan for the Peninsula. The work was completed in June 2019, providing the basis for this report along with supporting analysis from the MaREI Centre.

This document provides an overview of the anaylsis undertaken, highlighting the relevant findings on the community's current energy demand, as well as the options available for reducing energy usage and switching to renewable energy sources. The purpose of this document is to begin a conversation about our energy usage and the necessary changes set to take place over the next decade if we are to meet the targets outlined in the Government's *Climate Action Plan* published in May 2019.

Mol Teic/Dingle SEC are active partners in the 'Dingle 2030' Working Group, collaborating with ESB Networks, the MaREI Centre and North, East and West Kerry Development (NEWKD). This diverse group is actively working with the local community, schools, business and the farming sector to explore, support and enable the broader societal changes required for the low carbon transition.

The narratives around climate change provide a very stark warning of the potential challenges that will be faced.. However, here on the Dingle Peninsula, there is plenty of which to be proud of, with a wide range of sustainability and energy initiatives already underway and a very solid basis on which to build in the future. To learn more about what is happening and how you can be involved in climate action, please click on the following link ; https://dinglehub.com/projects/.

Study Area

The area considered under this study is highlighted by the red line in Figure 1. From the point where the Peninsula meets the mainland, the area is defined as everything west of Castlemaine and Blennerville.

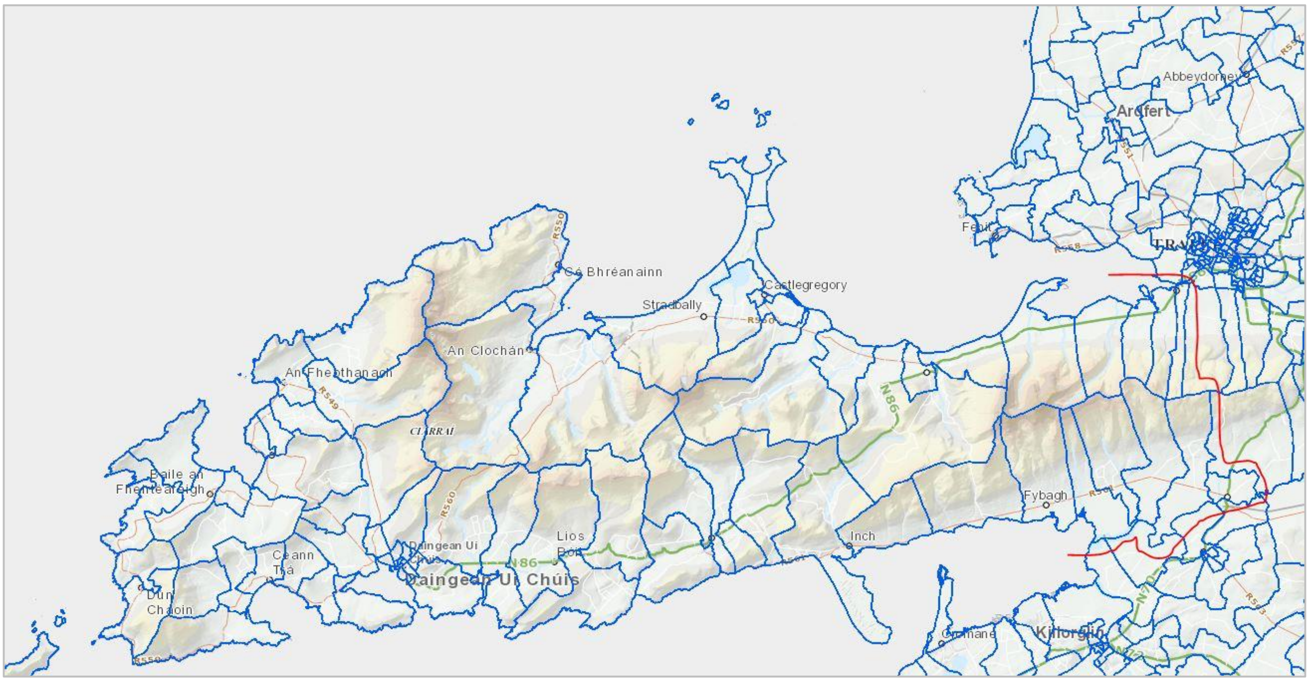

Figure 1 - Map of Dingle Peninsula highlighting area covered by this study

Dingle Peninsula Baseline Energy Balance

Dingle Peninsula Energy Balance in 2016

The energy usage across the Dingle Peninsula differs significantly to the national pattern for a number of reasons. Firstly, the rural and isolated nature of the area contributes to higher than average residential and transport demand. Secondly, the economic activity of the region is highly dependent on tourism, farming and fishing.

	Ireland		Kerry		Dingle	
	GWh	%	GWh	%	GWh	%
Industry	28,435	23%	442	13%	3.51	1%
Transport*	43,265	36%	1,436	43%	150.3	48%
Residential	31,448	26%	992	30%	99.2	32%
Services	15,782	13%	343	10%	37.7	12%
Agriculture / Fisheries	2,628	2%	136	4%	19.5	6%
Total	**121,558**		**3,348**		**310.2**	
kWh/capita	25,527		22,669		24,799	
kWh / capita (Transport)	9,086		9,722		12,014	
kWh / home** (Residential)	18,524		18,265		20,523	

Table 1 - Energy balance in 2016; Ireland, Co. Kerry and the Dingle Peninsula
**Transport excluding aviation, rail and navigation. **Home refers to permanently occupied dwelling*

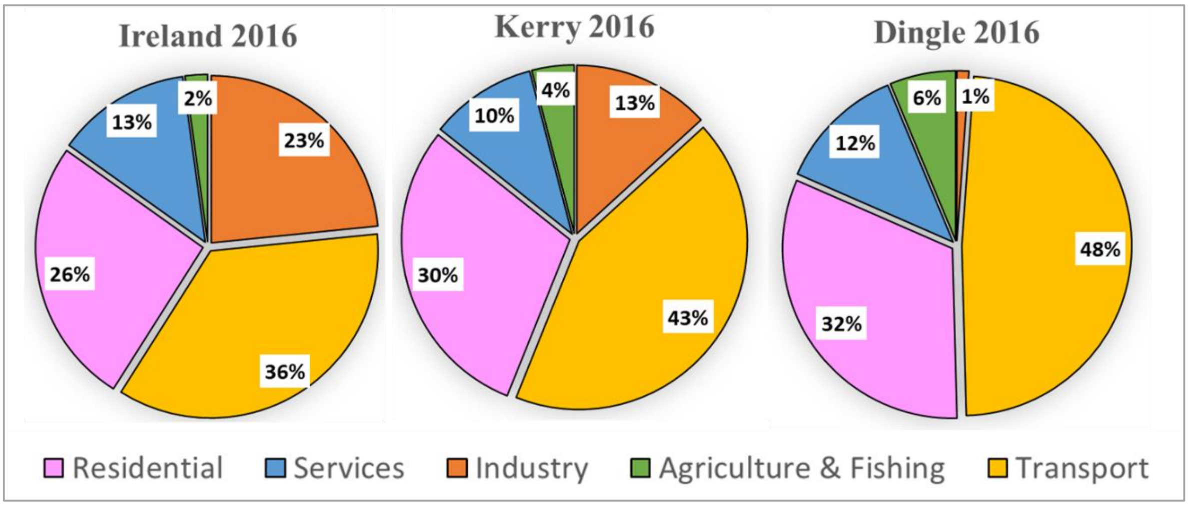

Figure 2 - Energy balance in 2016; Ireland, Co. Kerry and the Dingle Peninsula

As highlighted below in Figure 3, the key areas of concern on the Dingle Peninsula are private car travel and residential heating. This is primarily due to the Dingle Peninsula's geographical location as an isolated and sparsely populated rural area. Kerry is Ireland's fourth least densely populated county at 30.7 people/km^2, while the Dingle Peninsula is even lower, at 21.5 people/km^2. This is significantly lower than the national average of 70 people/km^2 [1] As a result, car ownership on the Dingle Peninsula is significantly above the national average at 547 cars / 1,000 people [2] compared to 428 cars / 1,000 people [3], a difference of almost 28%. Heating also presents a challenge, with the area currently heavily reliant on the import of oil with LPG (liquid petroleum gas) and kerosene boilers representing 71% of central heating systems compared to 41% nationally. Likewise, solid fuel use is higher than average, with 17% of houses relying on coal, peat and wood compared to 6% nationally. In addition, given the rural nature of Kerry, the percentage of one-off houses is above the national average at 75% compared to 71%. [4] This means that the energy related CO2 per house (permanently occupied) is higher than the national average at 10.8 tonnes/house compared to 8.1 tonnes/house.

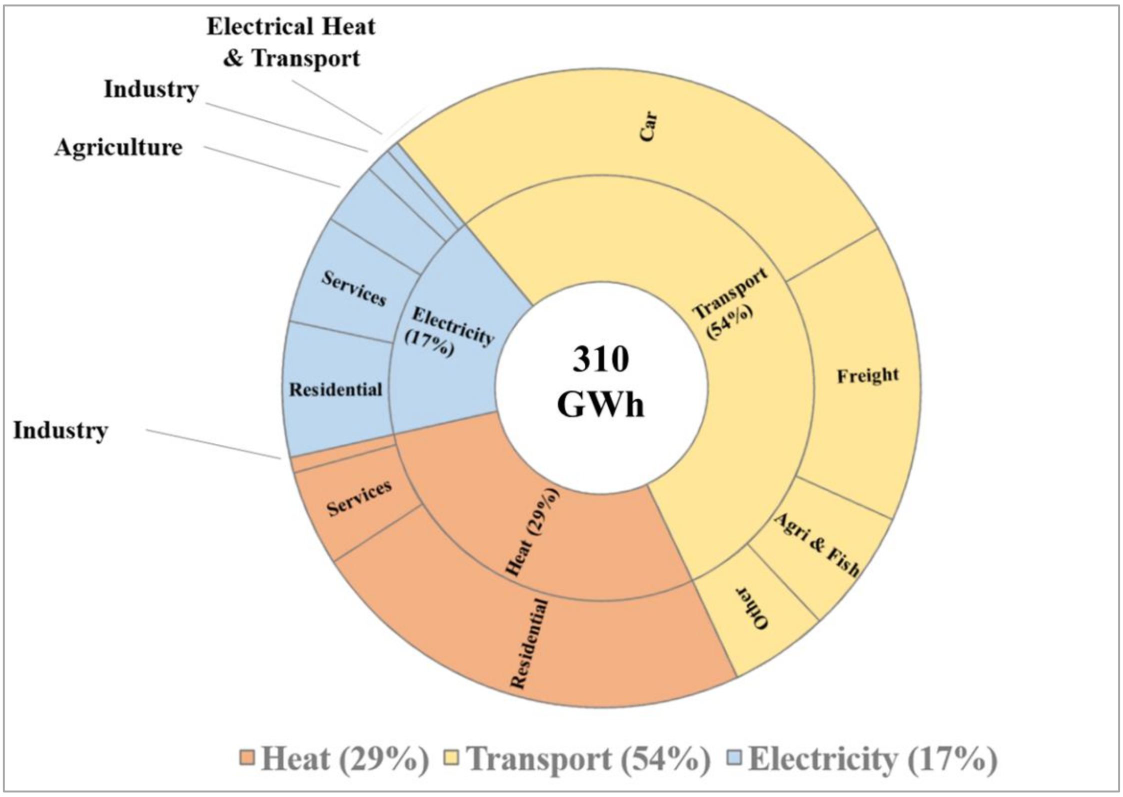

Figure 3 - The Dingle Peninsula's energy use by mode in 2016

Dingle Peninsula's fuel share and emissions in 2016

The absence of a natural gas grid and dependence on private car travel means that the area is heavily reliant on the import of oil.

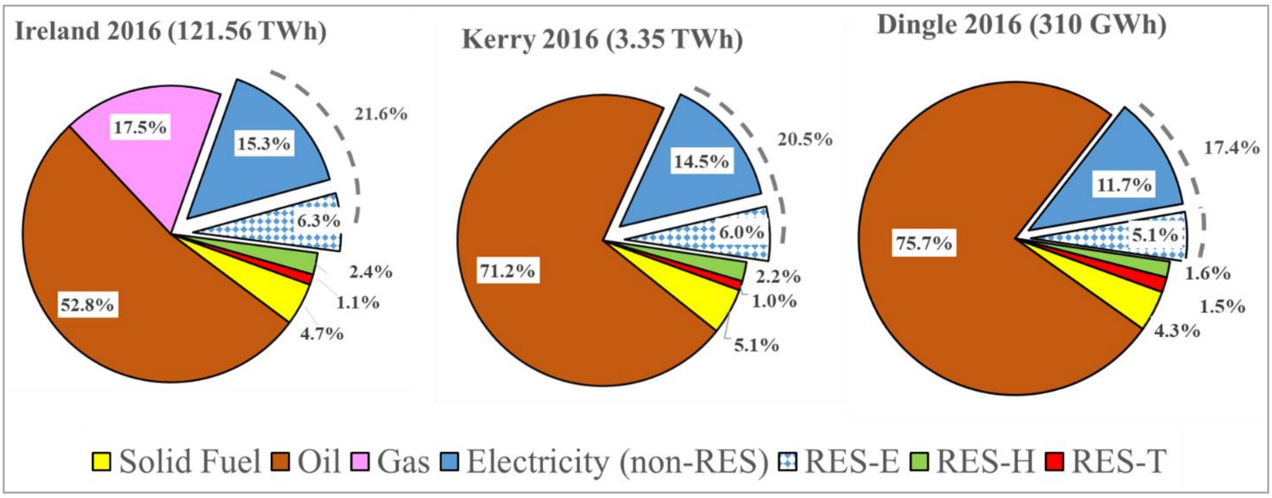

Figure 4 - Final energy consumed by fuel source in 2016; Ireland, Co. Kerry and the Dingle Peninsula

The subsequent energy related CO2 emissions can be seen in Table 3. With regards energy related CO2 emissions, the Dingle Peninsula has a below average tCO2 per capita, at 7 tonneCO2/capita compared to 7.4 tonneCO2/capita nationally. This is likely due to the lack of industry in the area. However, it should be noted that energy is not the only source of GHG emissions. Nationally, non-energy related agricultural emissions accounted for over 30% of total GHG emissions in 2016. [5] Based on the number of cattle on the Dingle Peninsula [6], it was estimated that this figure could be as high as 49%, with farming emitting an additional 78-ktonne CO2 equivalent non-energy related emissions.

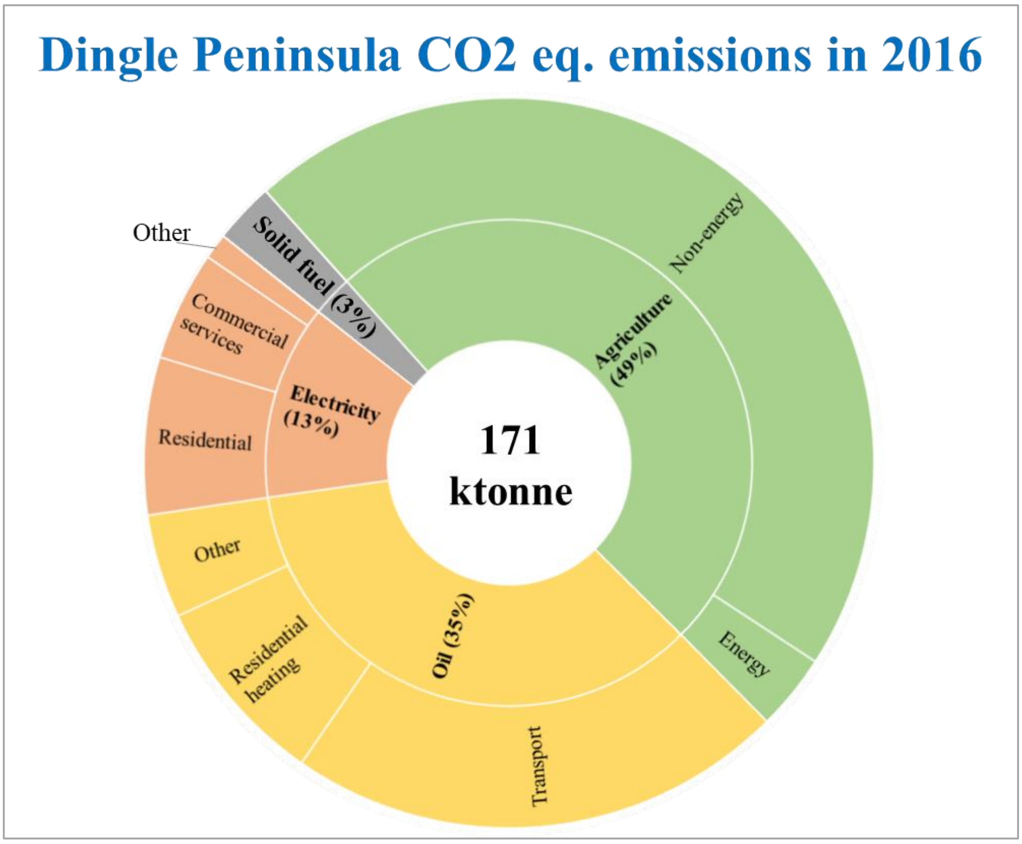

Figure 5 - ktonne CO2 equivalent emissions on the Dingle Peninsula

Cost of energy in 2016

	Peat	Coal	Wood	Heating Oil	LPG	Petrol	Diesel	Electricity	Total
Industry	€ -	€ 2,618	€ 16,660	€ 96,417	€ 27,956	€ -	€ -	€ 186,177	€ 329,827
Agriculture									
Farming	€ -	€ -	€ -	€ -	€ -	€ -	€ 509,105	€ 306,000	€ 815,105
Fishing	€ -	€ -	€ -	€ -	€ -	€ -	€ 429,883	€ -	€ 429,883
Services									
Commercial	€ -	€ -	€ 37,195	€ 429,933	€ 894,624	€ -	€ -	€2,041,668	€ 3,403,420
Public	€ -	€ -	€ 2,673	€ 282,138	€ -	€ -	€ -	€ 458,796	€ 743,608
Residential									
excl. holiday homes	€288,388	€479,785	€801,724	€4,363,714	€ 506,562	€ -	€ -	€4,867,115	€11,307,287
incl. holiday homes	€ 15,101	€ 25,123	€ 41,981	€ 228,497	€ 26,525	€ -	€ -	€ 987,441	€ 1,324,667
Transport									
Private Car	€ -	€ -	€ -	€ -	€ -	€6,196,712	€ 4,739,724	€ 13,684	€10,950,120
Freight	€ -	€ -	€ -	€ -	€ -	€ 13,808	€ 5,348,204	€ 1,289	€ 5,363,301
Public	€ -	€ -		€ -	€ -	€ 101,962	€ 350,026	€ 12	€ 452,000
Unspecified	€ -	€ -		€ -	€ -	€ 481,655	€ 934,922	€ 350	€ 1,416,927
Total	€303,488	€507,526	€900,232	€5,400,699	€1,455,667	€6,794,137	€12,311,864	€8,862,533	€36,536,146

Table 2 - The Dingle Peninsula's fuel costs in 2016

Household energy spending

Figure 5 below shows a comparison of household energy spending across the Dingle Peninsula. As a whole, households on the Peninsula spends 12.5% more on energy than the national average. However, in areas of the Peninsula with higher levels of car ownership and older homes, households may be spending up to 20% more than the national average.

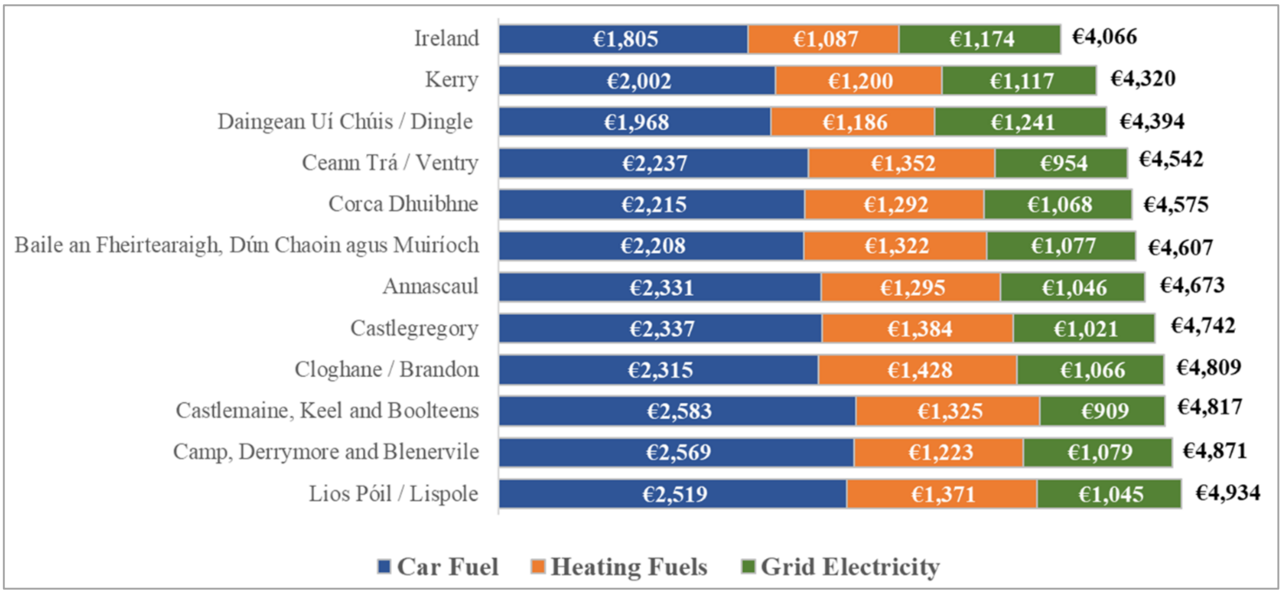

Figure 6 - Average annual spend per household; Ireland, Co. Kerry and the Dingle Peninsula

Register of Opportunities

Targets from the Government's Climate Action Plan 2019

The Government's Climate Action Plan, published in May 2019, contains 183 measures to be taken in order to ensure that Ireland meets its legally-binding CO2 reductions targets by 2030. [7] The following sections will discuss what these targets mean for the Dingle Peninsula's energy system, examining what each sector must do and the steps towards meeting, as well as exceeding, the targets set.

Residential

The overall target for the residential sector is to reduce CO2 equivalent emissions by 40–45%. [7] This will be achieved through the following changes by the year 2030:

- 30% of existing houses will be retrofitted to a Building Energy Rating (BER) of B2
- 23.5% of existing houses will upgrade to a heat pump system

The BER is a measure of how well a home retains heat, scaled from A (well-insulated homes requiring very little heating) down to G (poorly insulated homes requiring a lot of heating). For example, the average BER on the Dingle Peninsula is a C3. Upgrading to a BER of B2 would reduce the amount of heat energy required by around 55 – 60%. Meeting the Government's target on the Dingle Peninsula would require 1,450 homes being retrofitted to a BER B2 level and 1,136 of these would also be required to install a heat pump.

Four retrofitting scenarios were explored in the Energy Master Plan, firstly to meet this target and then secondly to go beyond it.

1. Even share – An even share (41%) of all houses built before 2000 are retrofitted to a BER B2 meeting the minimum of 1,450 homes, of which the minimum of 1,136 homes will be required to install a heat pump.
2. Pre 1970 – All houses built before 1970 are retrofitted to a BER B2, which would equate to 1,528 homes, with the minimum of 1,136 homes being required to install a heat pump.
3. Increasing ambition – 75% of houses built before 1970 (1,145 homes) are retrofitted to a BER B2 with a heat pump installed and 75% of houses built between 1970 – 2000 (1,434 homes) are retrofitted to BER A3 with a heat pump installed.
4. Serious ambition - 75% of houses built before 2000 (2,629 homes) and 50% of houses built between 2000-2010 (617 homes) are retrofitted to a BER A3 with heat pump installed.

In addition, the reduction in electricity use as a result of the switch to LED lighting was also investigated. In 2018, the European Commission banned the sale of incandescent bulbs, so it was assumed that by the year 2030 almost all lighting would come from LEDs. [8]

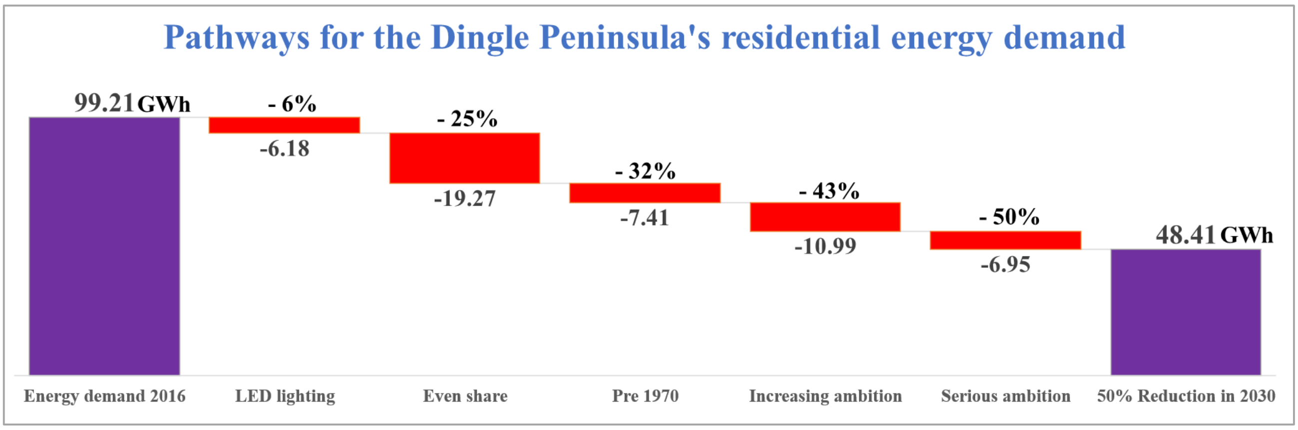

Figure 7 - Pathways for the Dingle Peninsula's residential energy demand

The emissions savings from the various retrofit scenarios are quite significant. This is primarily due to the reduction in energy demand, but is also due to the switch from oil / solid fuel heating sources to an electric heat pump. Heat pumps are extremely efficient machines; the average domestic heat pump can offer a coefficient of performance (COP) of 2.5. This means only 1 unit of electricity is needed to produce 2.5 units of heat. However, to operate effectively heat pumps require that the buildings are very well insulated and almost completely sealed, meaning that most houses will require a retrofit as a prerequisite to the installation of a heat pump system.

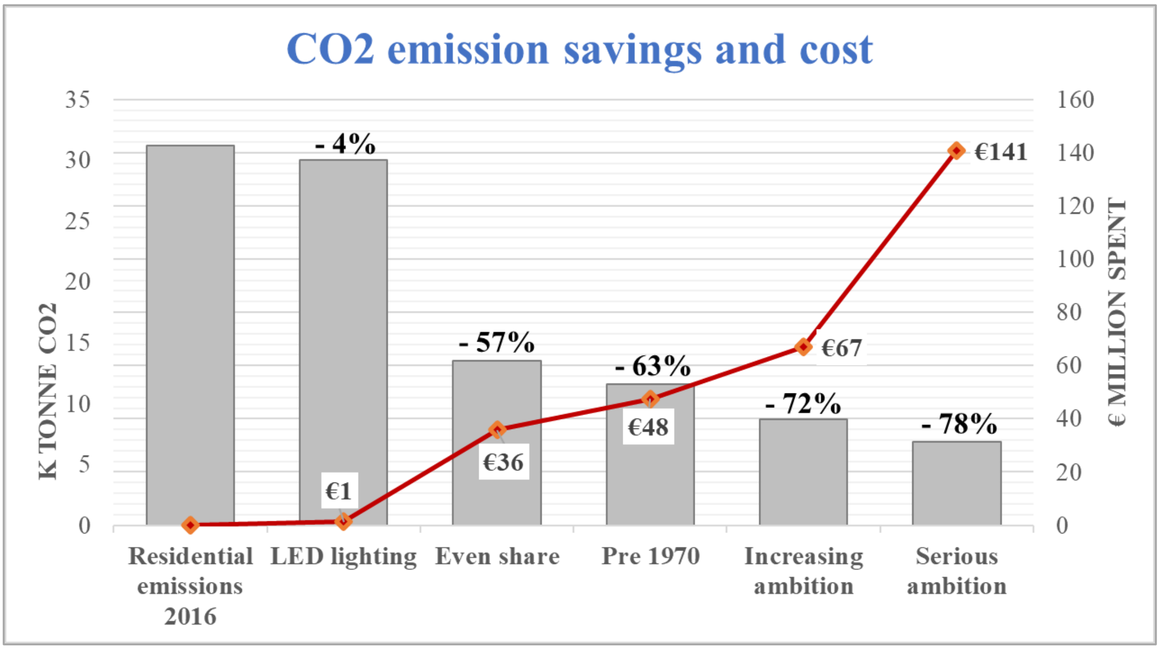

Figure 8 - CO2 savings and cost of measures in the residential sector

Transport

The overall target is to reduce CO2 equivalent emissions from the transport sector by 45–50%. [7] The targets set to deliver this are;

- Increase the number of electric vehicles (EV's) to 936,000, comprised of:
    - 840,000 passenger EV's
    - 95,000 electric vans and trucks
    - 1,200 electric buses
- The blend proportion of biofuels in road transport will be raised to 10% in petrol and 12% in diesel

In addition to this, the *"Alternative Fuels Infrastructure for Transport in Ireland: 2017 – 2030"[9]*, sets the ambition that there would be 4,500 compressed natural gas trucks by 2030.

Meeting this target would mean that are 2,738 out of the 6,845 cars on the Dingle Peninsula would be EV's. Five different measures were explored to meet this target and also to go beyond it.

1. 20% PHEV & 20% EV – 20% of cars are electric vehicles and 20% are plug-in electric hybrids (PHEV)
2. 40% EV – 40% of cars are fully electric vehicles
3. Work from home – 10% of people working in the services and industry sectors no longer commute to work as they are working remotely
4. Modal shift – 5% reduction in overall distance travelled by cars as people use alternative modes like cycling, walking and public transport
5. EV & CNG freight – 28% of trucks are electric and 1% are compressed natural gas

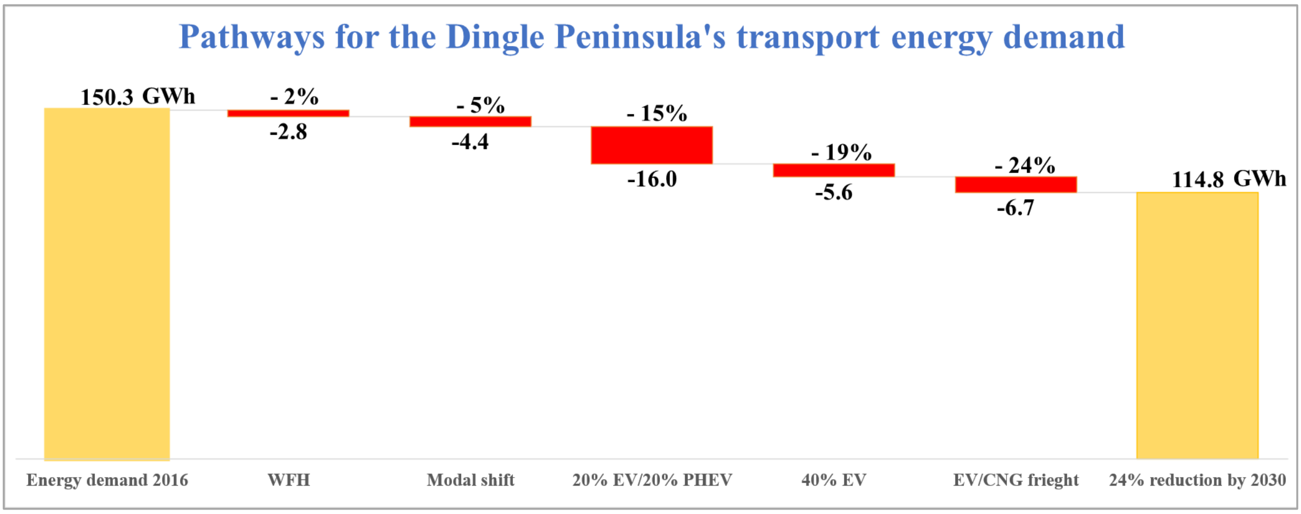

Figure 9 - Pathways for the Dingle Peninsula's transport sector energy demand

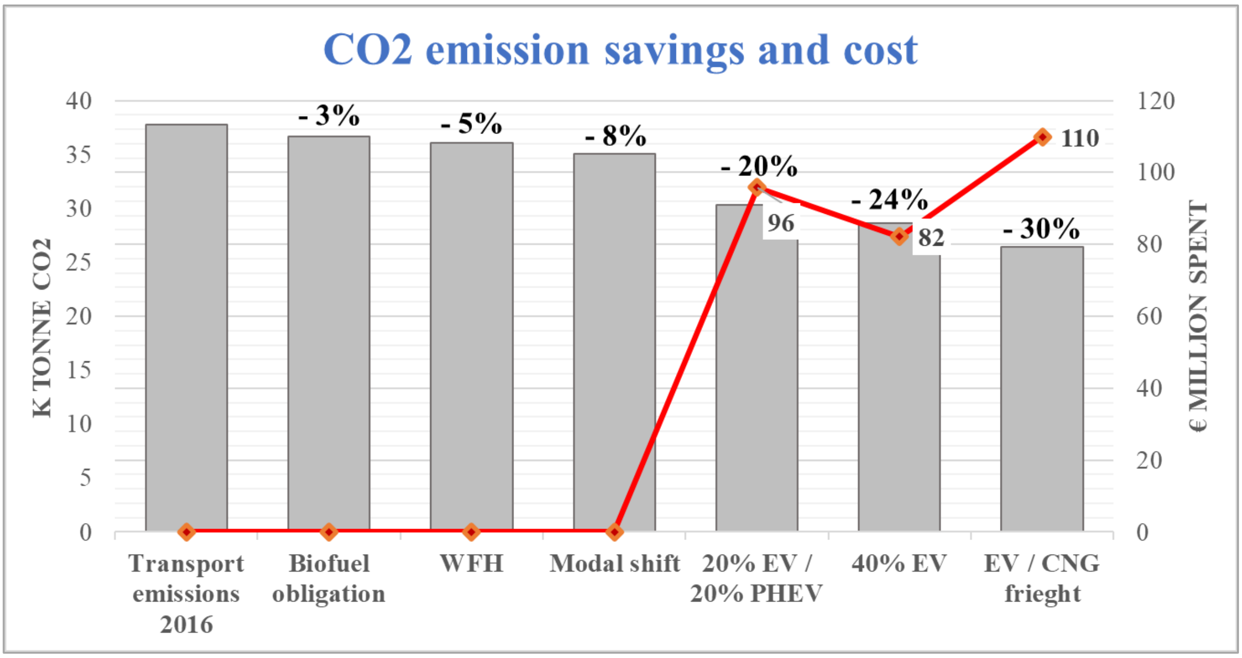

Figure 10 - CO2 savings and cost of measures in the transport sector

Services

The overall aim is to reduce CO2 equivalent emissions from the services sector by 30%. [7] Within this, the public sector is expected to lead the way, with a number of ambitious targets;

- Improve the energy efficiency of public sector buildings by 50%
- Set a target to demonstrate leadership in the adoption of low emission transport options
- In 2019, a Climate Mandate was adopted by every Public Body, making the sector a catalyst for climate action
- In 2019, a Climate Action Charter was agreed with Local Authorities
- All Public Buildings to reach at least BER 'B' by 2030

The commercial sector is somewhat neglected in the *Government's Climate Action Plan*, with much less coverage than the other sectors. The targets set is that enterprise must contribute to a 20-25% reduction in building CO2 emissions and 45-50% reduction in transport.

The steps explored include the following;

1. Local authority pledge – 50% improvement in the energy efficiency of public sector buildings, in addition it was assumed all public lighting will be LED.
2. Big business – 30% reduction across large retailers (Supervalu and Lidl), bars/restaurants (The Seven Hogs, An Droichead Beag, Dick Mac's, etc.) and hotels (Dingle Skellig, Benners, Dingle Bay and Dingle Peninsula).
3. Small business – 30% reduction across small to medium sized retailers (>250 m^2) and pubs/restaurants (>200 m^2)
4. B&B upgrades – retrofit for all 18 small B&Bs (50 - 100 m^2), half of medium-sized B&Bs (100 - 300 m2) retrofitted and half of remaining large B&Bs, guesthouses and hotels retrofitted.

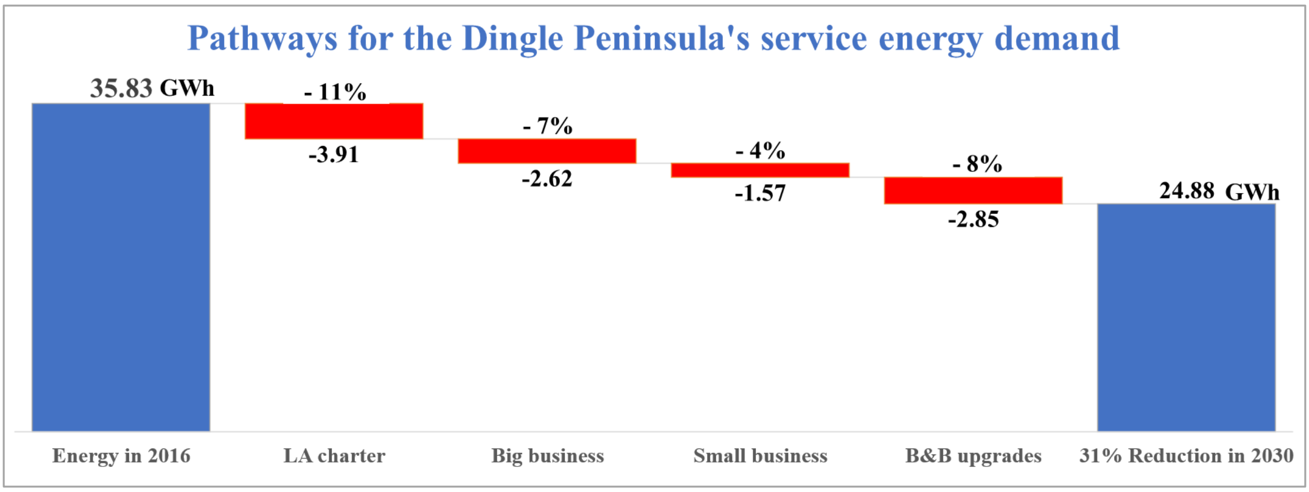

Figure 11 - Pathways for the Dingle Peninsula's service sector energy demand

Industry

Industry is arguably the toughest sector to decarbonise due to the extreme heat required for some processes; as a result, this sector has the least ambitious targets with Ireland's ETS (emission trading scheme) industry expected to reduce CO2 equivalent emissions by 10-15% by 2030, relative to 2030 projections. [7]

There is a limited amount of industrial activity on the Dingle Peninsula, with the estimated energy demand for 2016 representing just over 1% of total energy demand, at 3.51 GWh. Meeting the above target would reduce this to a figure of between 3 – 3.2 GWh.

Energy Balance in 2030

The energy balance shown below in Figure 11 is based on pursing the most ambitious pathways in each sector. This will result in an overall reduction in energy demand of 29% and a subsequent reduction in energy related CO2 emissions of 43%.

The most notable change to how energy is used on the Peninsula is the growth in electrical heating and transport, with the introduction of technologies, such as heat pumps and electric vehicles. In 2030, electricity could make up 38% of the area's energy demand, compared to only 17% in 2016.

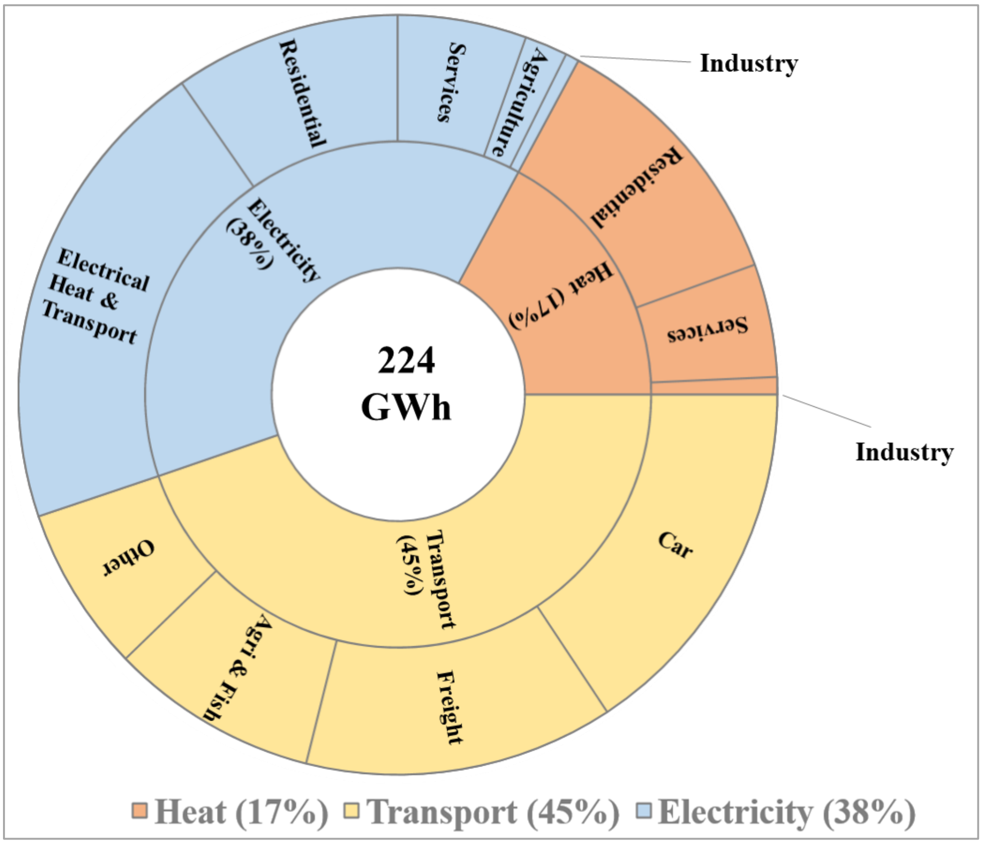

Figure 12 - The Dingle Peninsula's energy balance in 2030

Renewable energy options

Anaerobic Digester Feasibility Study

In March 2019, a consortium led by XD Consulting, was commissioned to investigate the options for anaerobic digestion on the Peninsula. The preliminary findings from their analysis indicate that the variety of feedstocks available in the area have the potential to match almost the entire energy demand. Work is still underway to develop a roadmap; firstly on the most economically viable system design and, secondly, recommendations on community-owned business models as well as suitable locations.

The analysis to date has highlighted that the most valuable feedstock is silage, which may provide up to 280 GWh of biogas per year, if some practical changes occurred, such as:

- Increase yearly silage yield by 25%
- Turn 10% permanent pasture to silage production (improved land and grass management)
- Change in farming enterprise from dry cattle for beef to silage for biogas (30% of permanent pasture)

The following additional feedstocks may deliver a further 25 GWh of biogas per year:

- Slurry
- Food waste
- Sewage sludge
- Fish waste
- Offal

Solar PV

In this section, we compare a 4MW ground mounted solar PV farm to the equivalent number of panels installed on rooftops. As can be seen in the Table 4 below, larger-scale projects can deliver a cheaper cost per kW installed. According to KPMG's report on Ireland's Solar PV potential, the cost of a domestic installation in

2017 was roughly €2,000/kW compared to €1,200/kW for a commercial size project. [10] This means that it would make greater economic sense for households to collaborate to build a community project rather than individual households installing solar PV systems by themselves.

	Ground mounted	Rooftop
Install capacity	4 MW	4 MW
Annual output	3,900 MWh	3,900 MWh
	Equivalent to 872 homes	Equivalent to 872 homes
Capital cost (€/kW)	€1,200	€1,750*
Total cost	€4,800,000	€7,800,000
Area required	25 acres [11]	2,000 domestic roofs 10 m² each
	8 GAA pitches	+ 50 commercial roofs 27m² each

Table 3 - Options for the development of Solar PV on the Dingle Peninsula
*€2,000/kW domestic and €1,500/kW commercial

There are 4,834 homes on the Dingle Peninsula. This means putting the panels on rooftops would require that 40% of homes be involved in the project and all of those interested would require to have 10m² south-facing roof space available. The cost would be €3,600 per household for a 1.8kW installation and €12,150 per commercial property for an 8.1 kW installation. Alternatively, by collaborating together and investing in a solar PV farm, the same amount of electricity could be generated if 2,000 shares were sold at a price of €2,400 each.

Wind energy

In terms of resource, the Dingle Peninsula would be a suitable location for developing on-shore wind. However, the majority of the area is a Special Area of Conservation, highlighted in red in Figure 11 below. In addition, due to the region's reputation as a beautiful rural landscape and its heavy dependence on the resultant tourism, it is deemed unlikely that the local community would support the development of wind energy.

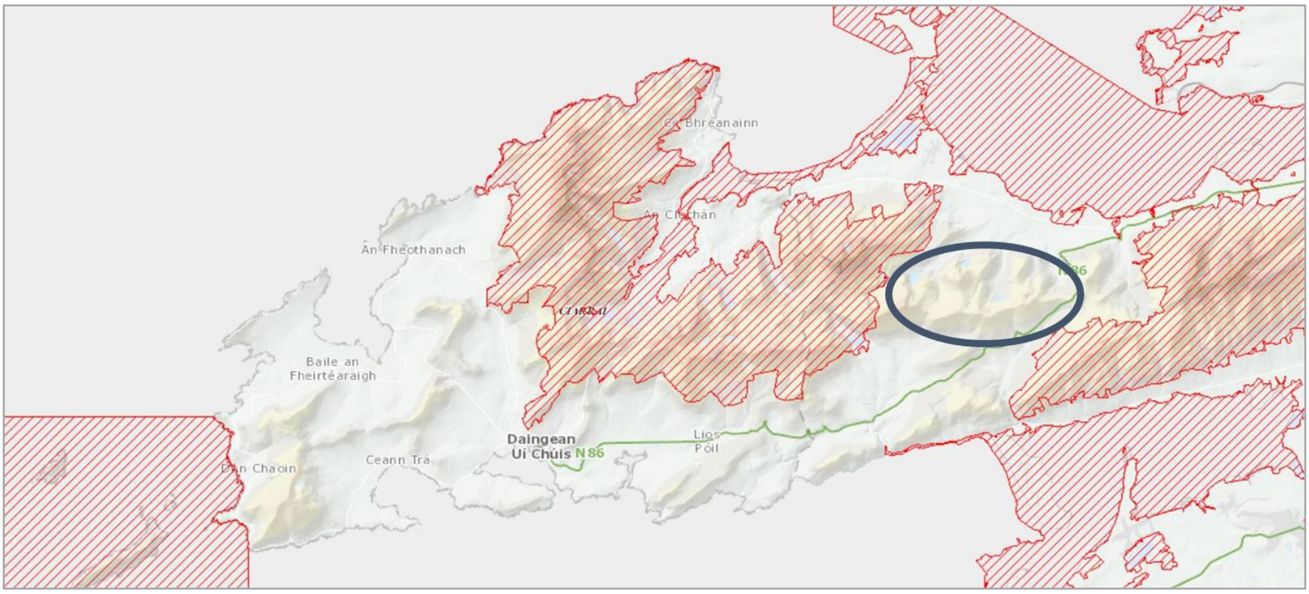

Figure 13 - Special areas of conservation within the Dingle Peninsula

There is one potential location that could be further investigated for development, contained within the grey circle in Figure 11. An initial assessment indicates that the wind conditions here would be suitable, with average wind speeds at 75m around 10 m s^{-1}. [12] A single large commercial turbine (70m tall [13]) placed here could generate up to 9.8 GWh / year, which is the equivalent of the power needed for approximately 2,200 homes. That is 2.5 times more energy than the solar PV options discussed in the previous section. The primary reason for this difference is the availability of the resource. In Ireland, onshore wind energy has a capacity factor of around 30%, whereas for solar PV it is only 10%. In other words, the wind is available c. 30% of the year but sun is only available c. 10%. [14] However, the difficulty with wind energy is agreeing placement of the turbines. The significant amount of local opposition in the past has resulted in strict planning regulations, for example, a large commercial turbine would have to be at least 500m from any nearby houses. [15] To address this challenge, smaller scale turbines could be used, such as the Norvento nED-100 100kW wind turbine with a hub height of 25m. [16] At an estimated capital cost of €350,000 [17], it could produce the equivalent of the power needed for approximately 60 homes.

Wind energy does not have to be so large. In Ireland, domestic-scale wind turbines are not readily available but examples from the UK show that it might be an important option for homeowners looking to invest in renewable energy. As can be seen in Figure 14 below, the average wind speeds at 20 metres are around 5 m/s for the majority of the area, making it an ideal spot for the placement of a small stand-alone wind turbine.

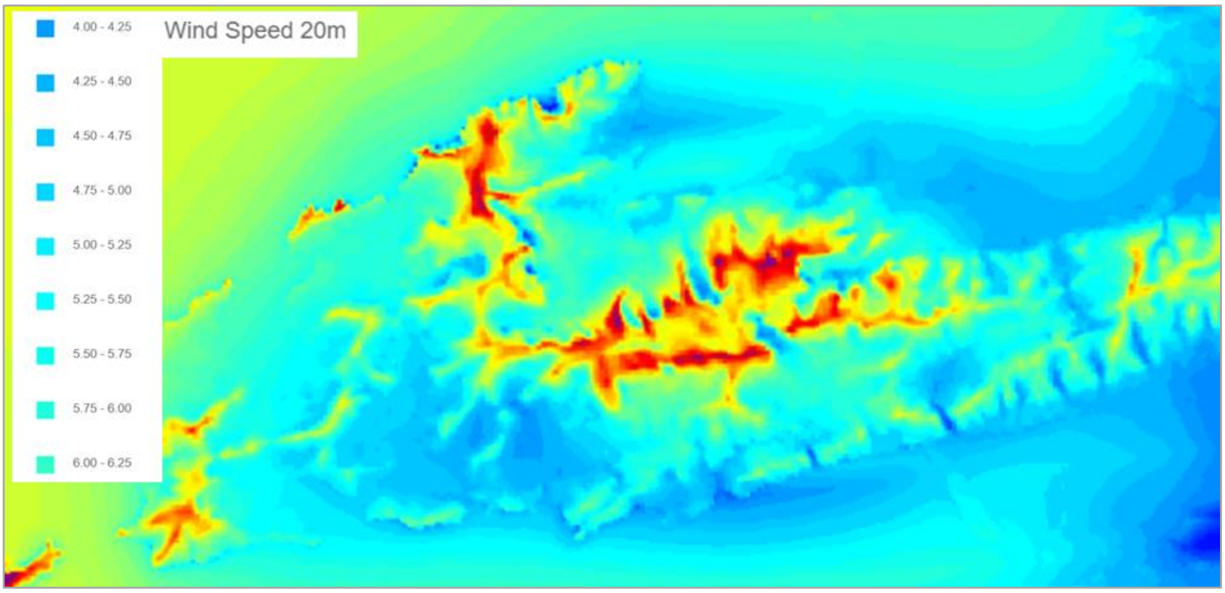

Figure 14 - Map of average annual wind speeds at 20m for the Dingle Peninsula

	Rooftop-mounted	Stand alone	
Install capacity	500 W	1.5 kW	2.5 kW
Annual output	1,100 kWh	3,900 kWh	6,600 kWh
Share of annual household usage	25%	90%	150%
Capital cost [18]	€3,000	€7,000	€12,500
Payback	~19 years*	~12 years*	~14 years**

Table 4 - Options for the domestic-scale wind turbines

*if all electricity consumed by household **same as * for first 4,470kWh and 0.072c/kWh [19] thereafter exported to the grid

Hydropower

Hydropower is a fantastic resource, as unlike wind and solar, it can provide a constant supply of electricity. According to SEAI's small-scale hydro map, shown below in figure 14, there are six suitable sites on the Peninsula. [20]

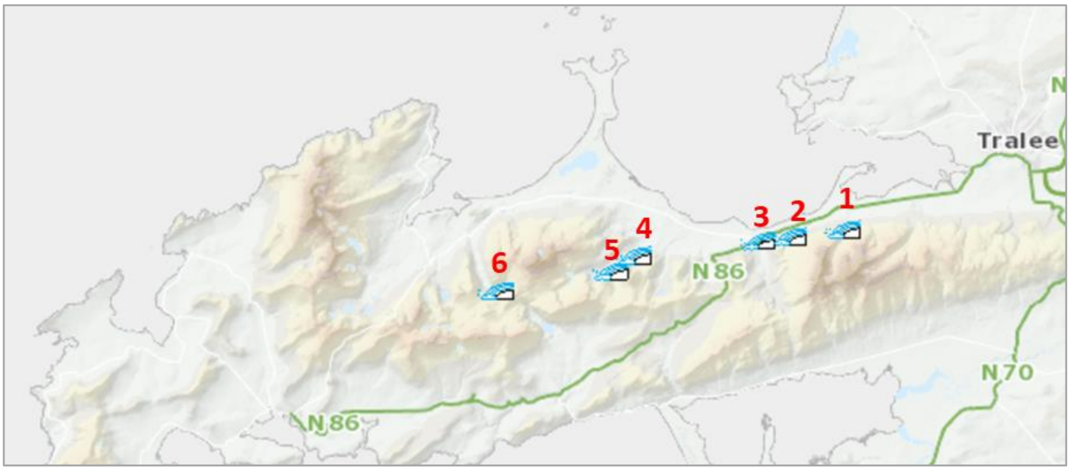

Figure 15 - Map of potential sites for the development of small-scale hydropower on the Dingle Peninsula

Site No.	**1**	**2**	**3**	**4**	**5**	**6**
River	Derrymore	Unnamed	Finglas	Unnamed	Drishoge	Unnamed
Mean flow (m/s)	0.27	0.08	0.85	0.07	0.16	0.21
Head (m)	100	60	16	100	90	120
Install capacity (kW)	184	27	73	32	78	136
Annual output (MWh)	764	112	351	149	372	645
Annual output (homes)	171	25	79	33	83	144
Annual output (€)*	67,232	9,856	30,888	13,112	32,736	56,760
Capital cost (€) [21]	765,000	187,500	401,500	187,500	412,500	686,000
O&M (€)	5,000	1,000	2,500	1,000	2,500	5,000
Payback (years)	12	21	14	15	14	13

Table 5 - Potential small-scale hydropower sites on the Dingle Peninsula

*assuming export to the grid at 8.8 c/kWh [19]

In addition to the six sites listed above, there are likely a number of other locations that would be suitable for the development of micro-generators, with installations of 5 or 6 kW.

Ocean energy

The oceans around Ireland and, in particular, the Atlantic Ocean can offer Ireland a significant renewable energy resource. However, as this report focuses on development over the next decade out to 2030, ocean renewables are not considered a viable option in that timeline. This is reflected at a national level in the Climate Action Plan, which has omitted targets for developing ocean resources over the next 10 years, instead opting to focus on more proven technologies like on/off –shore wind energy and solar PV. [7] Moving beyond 2030, it is expected that the cost of ocean energy technologies, like wave and tidal, will become comparable to existing renewable sources, such as wind and solar PV and, therefore, will undoubtedly play a part in the future energy mix.

The mouth of the Dingle Harbour may offer some opportunities for tidal energy, as it is quite similar to the opening at Strangford Lough in Co. Down, which was the site for the world's first commercial-scale tidal energy project back in 2008. In September 2012, the Strangford Lough project hit an important milestone, with the developers, SeaGen, producing 5GWh of tidal power since its commissioning, which is equivalent to the annual power consumption of 1,500 households. [22]

Appendix

This section provides an overview of how the energy demand was estimated for each sector. It is based on detailed analysis carried out by McGookin et al. [23], as well as supplementary work carried out by Curtin and Kavanagh. [24] In the interest of replicability and accessibility, the majority of figures are determined using publicly available data sources, primarily relying on SEAI's *Energy in Ireland 2016* report [25] and a number of reports from the Central Statistics Office, in particular the small area statistics data from the *2016 Census*. [2]

Residential

Residential energy demand can be determined using a bottom-up approach, by taking an average energy consumption per age group from the BER database [26] combined with the age profile of the housing stock. [2]

$$Energy\ Usage = No.\ of\ Dwellings \times Avg.\ m^2 \times Avg.\ kWh / m^2$$

Period Built	**Households**	**kWh/m2**	**m2**	**GWh**
Pre 1919	522	402	118	24.8
1919 - 1945	456	409	100	18.7
1946 - 1960	294	365	104	11.2
1961 - 1970	256	328	104	8.7
1971 - 1980	603	250	109	16.4
1981 - 1990	551	240	108	14.3
1991 - 2000	622	225	110	15.4
2001 - 2010	1233	187	113	25.9
2011 or later	91	78	140	0.99
Not stated	206	253	122	6.6
Total	**4,834**			**142.95**
		Corrected		**91.39**

However, the BER data is not suitable for use for this purpose. It is a useful indication of energy efficiency but does not, necessarily, reflect actual energy usage. The BER is determined by measuring how well a home retains heat but cannot represent how homeowners will behave. It assumes that all rooms in a house are constantly being kept at a comfortable temperature, however, in reality, lower energy efficient homes tend to leave the heating off in favour of wearing additional clothing such as a sweater. This means it will tend to overestimate the energy usage in lower rated homes, which can be seen when applying the method to the national housing stock, as it significantly overestimates the energy demand by 56%. This issue was addressed by deriving a correction factor from the national BER estimate as follows;

$$\frac{31{,}448}{49{,}191} = 0.6393$$

This results in a revised estimate for permanently occupied homes of 91.4 GWh, with an additional 7.8 GWh from the holiday homes, determined using visitor volume statistics, to give a total of 99.21GWh.

Transport

Private Car

Using a bottom-up method, the private car energy demand may be determined by multiplying the distance travelled by cars from the area [27] and the kWh / km for each fuel source. [25]

For example;

Km travelled = No. of cars x Fuel share x Average km per year

Energy Usage = kWh / km x km travelled

However, a number of studies have shown that the fuel efficiency figures for new cars sold do not match the actual performance of cars on the road. Dennehy and Ó Gallachóir, by looking at the changes in labelled l/100km versus the actual fuel consumed in Ireland, showed that the improved efficiencies in test values were cancelled out by the 'on road' factor. [28] The bottom-up estimate for the Irish car fleet underestimated the amount of fuel consumed by roughly 30%. In other words, the cars only perform better during tests and are still consuming the same amount of fuel on the road. This is line with another study from the International Council on Clean Transportation, which highlighted that in Europe the difference between test values and actual on the road consumption has increased from roughly 9% in 2001 to 42% in 2015. [29] To address this issue, the private car energy demand was determined using the share of km travelled by cars owned by people living on the Dingle Peninsula, as a proportion of the national energy demand.

Km travelled by Dingle residents = average km travelled (Co. Kerry) x No. of cars on Dingle Peninsula

Km travelled by Dingle Peninsula residents = 18,726 [27] *x 6,817 [2] = 127.7 million km*

% share of national car travel = 128.2 / 36,690 [27] *= 0.349%*

Energy usage = % share x national energy demand

Energy usage = 24,970 [25] *x 0.00348 = 87.23 GWh*

Freight

The road freight energy demand was determined using a top-down proportioning using an estimate of the tonne km travelled by vehicles going to/from the Dingle Peninsula based on the gross income generated in the area.

Co. Kerry tonne km = South West tonne km x % share km travelled by vehicles from Co. Kerry

Co. Kerry tonne km = 1,615 [30] x (261.5 / 1,229) [27] *= 344 million tonne km*

Dingle Peninsula tonne km = Co. Kerry tonne km x %share of GVA generated on the Dingle Peninsula

Dingle Peninsula tonne km = 344 x (570 / 4,373) [31] = 44.8 million tonne km

Energy usage = 12,255 [25] *x (44.8 /11,564) [30] = 26.06 GWh*

Public service and unspecified

The public service vehicles were determined using a simple top-down proportioning, using the number of vehicles registered at a county level [32] and the number of public sector employees. [2, 33]

Dingle Peninsula PS vehicles 2016 = 949 x (711 / 8,657) = 78 vehicles

Energy usage = 1,553 [25] *x (78 /31,516) = 3.84 GWh*

The final piece to consider in the transport sector is what SEAI classify as unspecified; this covers vehicles such as ambulances, taxis and hearses. For this estimate, a simple population-based proportioning was used.

Energy usage = 4,488 [25] *x (12,508 / 4,761,865) [2] = 11.79 GWh*

Services & Industry

The services and industry sector estimates are based on a bottom-up estimate, similar to the residential energy demand, combining floor area estimates and standardised figures for energy consumption per metre squared based on the use of the properties. Consultants who carried out a detailed survey of the area compiled a profile of commercial, public and industrial buildings. [24] In addition, some data was available from Kerry County Council on the consumption from lighting, public buildings, housing, water and sewage.

Agriculture & Fishing

Agriculture

The agricultural energy demand was determined using a combination of income at a county level and the hectares of farmland within the Dingle Peninsula.

Kerry GVA 2016 = % share of South west farming income = 375.6 [31] x 0.28 [34] = €103.7 million

Dingle Peninsula GVA in 2016 = 103.7 x (32,362 / 347,241) [6] = €9.7 million

Energy usage = 2,407 [25] *x (9.7 / 1,968 [31]) = 11.8 GWh*

Fishing

The fishing energy demand is based on the value of fish landed in Dingle port.

Gross Boat Tonnage in Dingle Fishery Harbour Centre = Weighted of boats in South West x % share of value landed in Dingle port

Gross Boat Tonnage in Dingle Fishery Harbour Centre = 16,322 [35] x (23,576 / 170,819) [36] = 2,240

Energy Usage = 221 [25] *x (2,240 / 64,548 [35]) = 7.7 GWh*

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