Appendix B.1 - LEAP energy system model documentation

A copy of the Dingle Peninsula LEAP energy system model and associated data are available for download from the MaREI Centre, Energy Policy & Modelling Group GitHub repository - https://github.com/MaREI-EPMG/LEAP_Dingle_Peninsula

Scenario Descriptions

Table B.1.1. Overview of energy system scenarios modelled for the period 2010-2030.

Name		Description
Reference	REF	Business as usual reference scenario with COVID-19 impact • COVID-19 impact over 2020/21 • 2022 onward return to business as usual • Population growth is significantly less than national projection for the period 2019-2030 at an annual average rate of 0.45% compared to 1.1% nationally
Current Policy Mid-Range Emissions (Reference Scenario Variant)	REFPOL1	Mid-range emission scenario for national 2030 targets under the 2019 Climate Action Plan [1] • 30% of homes retrofitted to B rating, spread across housing stock. 80% of retrofitted homes get a heat pump. • Private car Internal Combustion Engine (ICE) sales go to zero in 2030, battery electric vehicles make up 50% of sales by 2030 and 20% of car stock, with hybrids and plugin hybrids likewise accounting for 50% of sales in 2030 and 20% of car stock • Retrofitting and switch to heat pumps in 20% of Hotels and Bed & Breakfasts • Industrial lighting switched to LEDs, and improvements in space heating (kWh/m2) by 20% • 28% of light goods vehicles electric by 2030 • Biofuel share by energy content increased to 10.6% for petrol and 12.5% for diesel by 2030
Current Policy Low Emissions (Reference Scenario Variant)	REFPOL2	Low emission scenario for national 2030 targets under the 2019 Climate Action Plan [1] • Retrofitting targets lowest rated homes (E, F and G), which account for roughly 30% of homes, eliminating this portion of the housing stock by 2030. 80% of retrofitted homes get a heat pump. • ICE sales go to zero in 2030, battery electric vehicles grow to 100% of sales by 2030 and 40% of car stock • Retrofitting and switch to heat pumps in 20% of Hotels and Bed & Breakfasts • Retrofitting and switch to heat pumps in 20% of Hotels and Bed & Breakfasts • Industrial lighting switched to LEDs, and improvements in space heating (kWh/m2) by 20% • 28% of light goods vehicles are electric by 2030 • Biofuel share by energy content increased to 10.6% for petrol and 12.5% for diesel by 2030

Additional measures co-produced (Reference Scenario Variant)	REFCOPROD	Additional measures based on local dialogues
		• Reduced car dependence by 2030:
		  o Improved public transport replaces 2% of private car kms
		  o Active modes replace 5% of private car kms
		• Retrofitting targets lowest rated homes (E, F and G), which account for roughly 30% of homes, eliminating this portion of the housing stock by 2030. In addition, minimum post-works energy efficiency target raised from B rated to A rated homes. 80% of retrofitted homes get a heat pump.
		• Solar PV (4MW farm & 4.5 MW rooftop) installations equivalent to 15% of electricity demand by 2030
		• Small-scale wind turbines equivalent to 1.05 GWh installed by 2030
		• Solid fuel is banned from 2027 onward, replaced with biomass, which over time comes from local native woodlands
		• Biomethane from anaerobic digestion replaces LPG and natural gas use in industry, services and homes

Build Forward Better	BFB	Build forward better after COVID-19 impact
		• COVID-19 impact over 2020/21
		• 2022 onward build forward better
		  o 10% of holiday homes remain permanently occupied from 2022 onward
		  o By 2030, 25% of holiday homes have become permanently occupied
		  o Population grows around 14% between 2019-2030, in line with County/National projections for that period

Current Policy Low Emissions (Build Forward Better Scenario Variant)	BFBPOL2	As above in POL2 under reference scenario

Additional measures co-produced (Build Forward Better Scenario Variant)	BFBCOPROD	As above in COPROD under reference scenario but with additional:
		• Reduced car dependence by 2030:
		  o Improved public transport replaces 5% of private car kms
		  o Active modes replace 7.5% of private car kms
		  o Work from home 2 days a week for employees that this would be suitable, around 40% of the workforce. Replaces 7% of private car kms.
		• Retrofitting target left at B rating for lowest rated homes undergoing works. To reduce impact of holiday homes becoming permanently occupied, 520 C/D rated homes upgraded to A

Key Assumptions

Table B.1.2 - Historical population change between 2002-2016

	Dingle Peninsula	**Co. Kerry**	**Ireland**

Population 2002	11,679	132,527	3,917,203
Population 2016	12,508	147,707	4,761,865
Change 2002-2016	829	15,180	844,662
Growth (%)	7.1%	11.5%	21.6%
Yearly average growth (%)	0.51%	0.82%	1.54%

Table B.1.3 - Population, homes and cars for the historical years (2002, 2006, 2011, 2016, 2019) and scenario end year (2030)

	Historical years				**Scenarios**	
					REF	**BFB**
	2002	**2006**	**2011**	**2016**	**2030**	**2030**
Population	11,679	12,268	12,549	12,508	13,489	14,675
Homes	4,337	4,669	4,623	4,712	5,079	5,523
People / household	2.69	2.63	2.71	2.65	2.66	2.66
Cars	5,392	6,251	6,696	6,815	7,429	8,179
Cars / household	1.24	1.34	1.45	1.45	1.46	1.48

Data sources

The process to acquire data and filter it for the case study region was previously outlined in McGookin et al. [2]. Table 1 provides an overview of the model variables by sector and the relevant source.

Table B.1.4 - Energy usage indicators and other key data sources by sector

Sector	**Variables**	**Unit**	**Source**
All	Population, number of homes, cars, and other Census data (see McGookin et al. [2])	NA	Census of Ireland 2016, Small Area Population Statistics [3]
	Energy demand and supply by sector	toe	Sustainable Energy Authority of Ireland, National Energy Balance 1990-2018 [4]
	Gross value added by sector	€ million	CSO County Income and Regional GDP 2016 [5]
	Employees by sector	Employees	CSO Business Demography [6]
Industry & Services	kWh/m^2 for energy service demands (electricity, heating, etc.) and associated fuel share by business type	Multiple	Sustainable Energy Authority of Ireland, National Building Energy Rating Register [7]
Industry & Services	Floor area by business type in the case study region	m^2	Consultant's building survey prepared for Dingle Peninsula Sustainable Energy Community [8]
Agriculture	Hectares of land	ha	Census of Agriculture [9]
Fishing	Weight of fish landed	tonne	CSO Fish Landings 2007-2018 [10]
Residential	By energy rating – the no. of houses, average size, and fuel shares for	Multiple	Sustainable Energy Authority of Ireland, National Building Energy Rating Research Tool [11]

	primary / secondary / water heating		
Residential	Number of new houses built 2011-2019	Homes	CSO, New Dwelling Completions [12]
Residential	Breakdown of energy demand by use in households	NA	SEAI, Energy in the Residential Sector 2018 [13]
Transport	Number of public service and freight vehicles	NA	Irish Bulletin of Vehicle and Driver Statistics 2016 [14]
Transport – private car	Km/year and kWh/km by engine size	Multiple	Irish Car Stock Model 2.0 [15]
Transport - Road freight & Private car	Distance travelled	Km	CSO Transport Omnibus 2016; Road traffic volumes [16]
Transport - Road freight	Weight carried	Tonne km	CSO Transport Omnibus 2016; Road freight transport [17]

Appendix B.2 - Renewable energy potentials

As previously outlined in McGookin et al. [8], the renewable energy potential from each source was determined as follows.

Solar PV

Ireland's recent Programme for Government set the target to have 700,000 homes install solar PV panels by 2030 [18], which is around 40% of the current stock. This would equate to 2,208 homes on the Dingle Peninsula. There were also opportunities identified with businesses, farm sheds (from roughly 100 farmers that have formed the West Kerry Dairy Farming Sustainable Energy Community) and public buildings as outlined below. The capacity factor was taken to 11% [19].

Building	No. of roofs	Avg. Installed Capacity (kW)	Total Installed Capacity (MW)	Annual Output (MWh)
Homes	2,208	1.8	3.974	3,830
Farm sheds	80	6	0.48	463
Businesses				
Small B&Bs	16	2.8	0.045	43
Large hotels	4	5.6	0.022	22
Large retailers	2	3.6	0.007	7
Public buildings	10	3.6	0.036	34
Total			**4.565**	**4,399**

With the addition of a 4MW solar farm providing 3,854 MWh/year, the total annual output from solar PV would be 8.25 GWh of electricity.

Wind energy

Located in along Ireland's west coast makes the Dingle Peninsula a suitable location for developing onshore wind. However, the majority of the area is a Special Area of Conservation, highlighted in red in Figure 1 below. In addition, due to the region's dependence on tourism that in a large part stems from its reputation for natural beauty, it is deemed unlikely that the local community would support the development of wind energy.

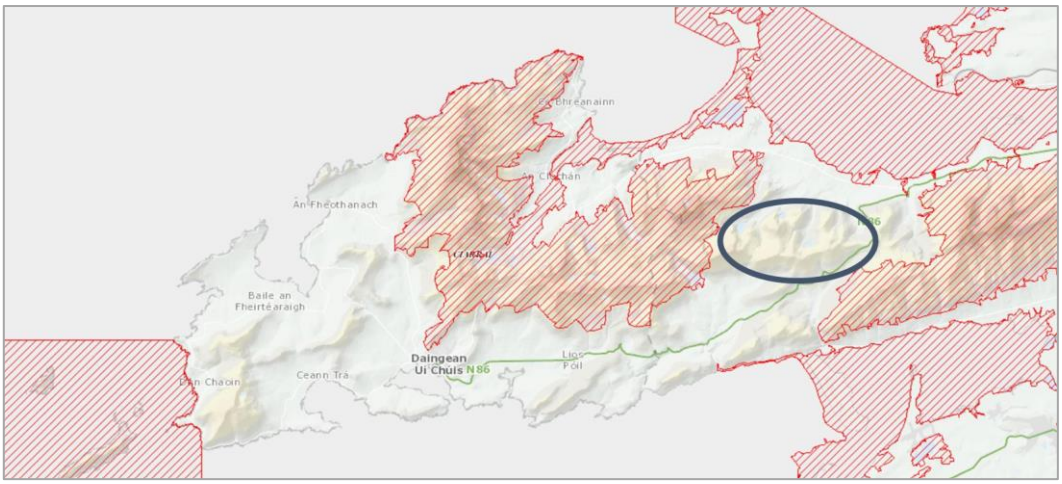


Figure 1 - Special areas of conservation within the Dingle Peninsula

There is one potential location that could be further investigated for development, contained within the grey circle in Figure 1. An initial assessment indicates that the wind conditions here would be suitable,

with average wind speeds at 75m around 10 m s^{-1}. [20] A single large commercial turbine (70m tall) placed here could generate up to 9.8 GWh / year [8]. However, a large-scale installation was ruled out by our local partners. There was a clear preference for a series of smaller scale (5kW) turbines. At a capacity factor of 30%, 80 installations could yield 1.05 GWh/year.

Hydropower

According to the Sustainable Energy Authority of Ireland's small-scale hydro map, shown below in the Figure 3, there are six suitable sites in the region [21].

Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
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	530
Annual output (MWh)	764	112	351	149	372	645	2,393

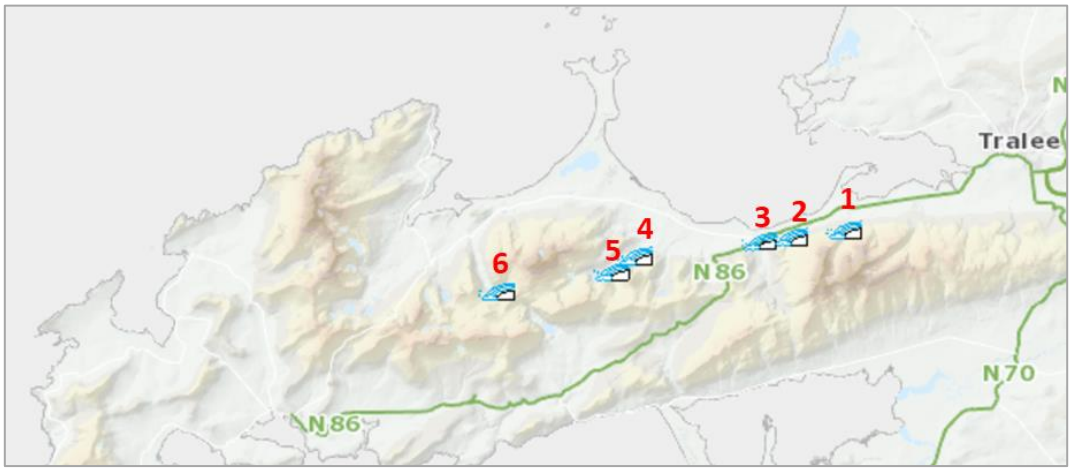


Figure 2 - Map of potential sites for the development of small-scale hydropower on the Dingle Peninsula

Anaerobic digestion

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 equate to 305 GWh in potential [22], which would be almost an exact match for the total energy demand in the region [23]. 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 current plant design being explored is outlined in the Figure 3 below.

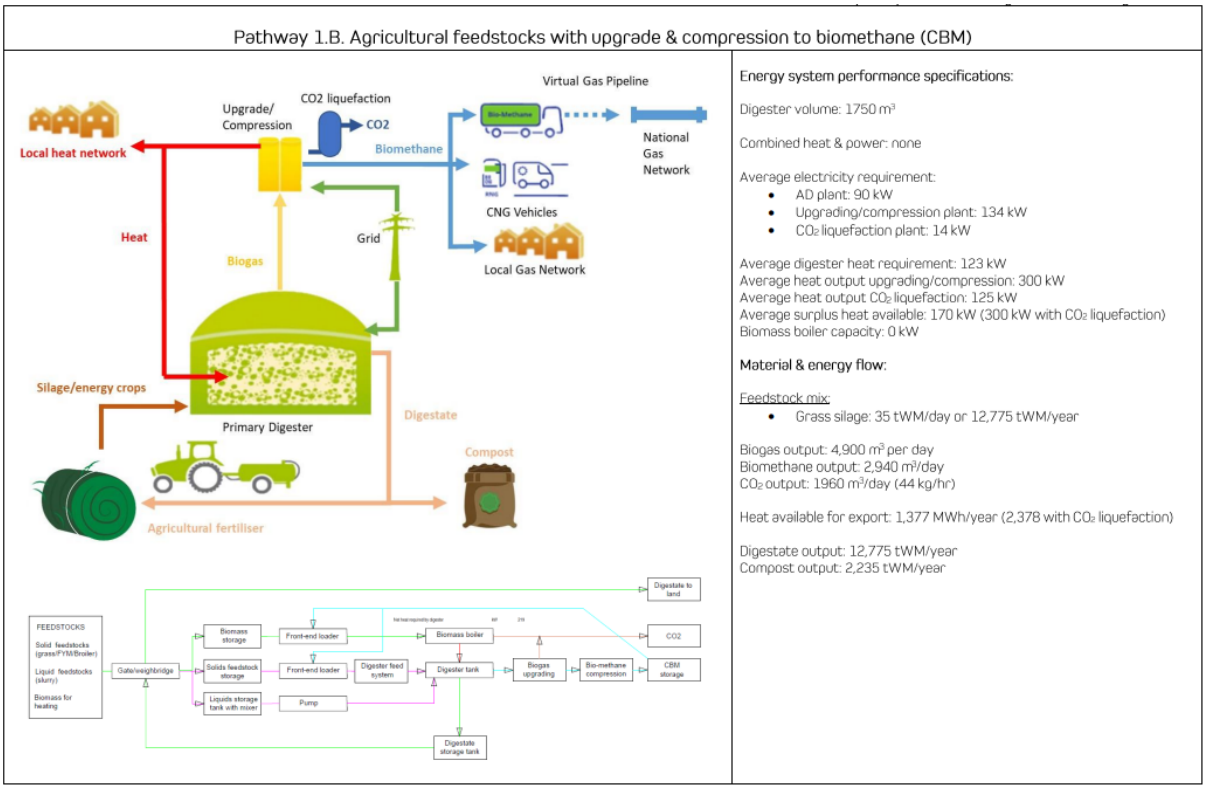


Figure 3. Potential anaerobic digestion plant design.

Biomass

According to a recent review of Ireland's bioenergy potential, biomass could provide 6.3 TWh/year if 11% (or 770,000 ha) of the national land area was afforested [24]. From this a energy yield per hectare was determined to be 8.182 MWh / ha (6,300 / 770,000). This would give a potential resource of 8.2 GWh/year from 1,000 hectares of farmland being planted on the Dingle Peninsula, which would be roughly of 3% of what is current available.

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