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ESB Networks Dingle Project: Activating energy citizenship through collaboration, participation, and technological trials

MaREI – 2021

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Executive Summary

MaREI developed this report to draw out findings related to the *Dingle Project,* the ESB Networks flagship energy citizen initiative on the Dingle Peninsula. This research was jointly funded by ESB Networks and Science Foundation Ireland (SFI) through MaREI, the SFI Research Centre for Energy, Climate, and Marine [Grant No: 12/RC/2302_P2].

As part of the *Dingle Project*, ESB Networks undertook an Ambassador Programme and an EV Trial with low-carbon technologies integrated into households on the peninsula. This report provides findings on the experiential dimensions of participation in the different aspects of the project to highlight mechanisms and barriers to widespread **technology adoption** in the Irish context, using qualitative research and secondary desk research, supported by quantitative data provided by ESB Networks. In addition, ESB Networks has been working in collaboration with several organisations on the peninsula as part of Corca Dhuibhne/*Dingle Peninsula 2030*, a regional low-carbon transition initiative. This report also outlines the wider impact brought about through *Corca Dhuibhne/Dingle Peninsula 2030* through the **diffusion of sustainability**, highlighting the potential of community-wide approaches to stimulate and deliver active energy citizenship.

Across the three years of the research (December 2018-August 2021), MaREI developed a range of different methods to provide insights into the *Dingle Project.* In relation to the Ambassador Programme, the participants were followed throughout the three-year process. Interviews were conducted at regular intervals. Alongside this, MaREI analysed media content and quantitative information provided by ESB Networks to support the qualitative analysis. On the EV Trial, MaREI administered a survey to all participants at the beginning of the research, followed by in-depth interviews towards the end of the process. Quantitative data has again been provided to support the qualitative findings. Finally, concerning the diffusion of sustainability, MaREI attended regular events and meetings to build a profile of different diffusions of sustainability that have occurred throughout the timeframe.

This research report provides findings with relation to energy citizenship both at the individual and societal level and brings forward knowledge with relation to the social dimensions of low-carbon technologies.

Findings

Ambassador Programme

- Significant emissions reductions (up to 50%) are achievable for homes, businesses and transport from retrofitting and deployment of heat pumps, solar PV and electric vehicles.
- Integrating low-carbon technologies into households and businesses facilitates the emergence of active energy citizenship.
- Active participation in demand management can be supported using interactive software programmes.

EV Trial

- Electric Vehicles can be used for daily driving in rural communities without disruption to normal patterns.
- Range, cost to charge, and performance are perceived more positively following user experience.
- For long-distance driving, EV's are deemed to be less practical than internal combustion engine alternatives.

Diffusion of Technology

- Solar PV installations on the Dingle Peninsula in 2020 were two and a half times higher than the national average, illustrating the impact of demonstration projects on technological uptake.

Diffusion of Sustainability

- A wide range of energy-related initiatives, beyond the initial remit of the Dingle Project, have emerged on the peninsula.
- Working collaboratively with communities represents a favourable opportunity to enable the diffusion of sustainability, increasing local capacity to meet decarbonisation targets.

Recommendations

- National organisations and public bodies should be encouraged and supported to work in collaboration with other groups within the local community to increase local capacity to develop decarbonisation initiatives. This can be facilitated via the employment of dedicated community engagement staff in organisations.
- Further supports (financial, technical, administrative, guidance) are needed to ensure positive experiences and outcomes for homeowners and businesses when undertaking retrofits.
- Local champions should be supported to empower them to mobilise action within a community. They can support collaborative, community-led approaches to energy citizenship over individualist consumer-based alternatives.
- The successful roll-out of EVs nationally requires an increase in public charging facilities.
- Further research is needed on the societal and behavioural interactions with energy technologies, using research on long term engagement with trial participants coupled with data collection.

Introduction

ESB Networks Dingle Project

In 2021, The Intergovernmental Panel on Climate Change 6th Assessment Report outlined the urgent and immediate need for global action on decarbonisation, to avoid catastrophic climatological changes in the decades ahead. Within this context, there is a pressing need for Ireland to deliver strong climate action to match the recent increase in climate ambition.

The Climate Action Plan (2019) set forward a range of measures to achieve decarbonisation with relation to electricity, enterprise, the built environment, transport, and agriculture, forestry and land use. While the Plan's ambition is to be welcomed, it will require far-reaching and transformative systemic changes to energy generation, infrastructure development and behaviour. Ireland currently emits roughly 40 million tonnes of carbon dioxide per annum from electricity, heat and transport. The Climate Action Plan seeks to reduce average annual energy-related emissions by 4% every year until 2030. Within the Plan, citizen engagement and community leadership have been given an important role. It outlines the importance of "engagement, feedback and learning, including providing information to existing networks and further developing their capacity to act" and the "evaluation of evolving technologies, promoting innovation, and developing the capacity to realise opportunities" (DCCAE, P.136). The revised Climate Action Plan (2021) retains the key targets with relation to the electrification of heat and transport. Following on from the initial Climate Action Plan, the 2020 Programme for Government emphasised the importance of climate governance, emission reductions and building stronger communities. The 2021 Budget announced an increase in the carbon tax, increased support for retrofit programmes, and a holistic approach to sustainable travel across walking, cycling and public transport.

In October 2020, the Government published new climate legislation that commits Ireland to net-zero greenhouse gas emissions by 2050. The enacting of the Climate Bill (2021) established, on a statutory basis, a 'national climate objective' for a climate-neutral economy, placing an obligation on public bodies to align their functions with national climate plans and strategies and to assist in furthering the achievement of the national climate objective. The short term target is to achieve a 51% reduction in GHG emissions by 2030 relative to 2018, effectively doubling the ambition contained in the 2019 Climate Action Plan.

The Electricity Supply Board (ESB) has a long history in the Irish context of being at the forefront of energy transitions within the country. The rural electrification of Ireland from the 1940s onwards successfully brought electricity to rural Ireland, revolutionising daily life for homes and families across the country. It is noted that "the design and development of the rural scheme was probably the largest capital investment program undertaken by the Irish state in the 20th century and became a model for similar schemes worldwide in the developing world in the past thirty years" (Duffy, 2011, P.1885). Parallels can be drawn between rural electrification and the current demand for increased electrification coupled with the decarbonisation of the electricity supply. On from this, there has been increased ambition from political leadership. However, this alone does not mean success will be achieved. Currently, Ireland is off-target in meeting national and EU decarbonisation goals and widespread changes are needed across the country in a manner perhaps never seen before. The transition requires political leadership, industry innovation, systemic change, and societal buy-in. While we must be mindful of the scale of the transition, there is also cause for optimism in recent decades. Ireland has been "very successful over the past 20 years in reducing electricity-related emissions while continuing to meet increasing electricity demands. Ireland's electricity-related carbon dioxide emissions reduced by 42 per cent in this period, while electricity demand increased by 40 per cent" (Ó Gallachóir & Deane, 2021). In facing up to decarbonisation we must be earnest concerning the magnitude of the challenges, yet optimistic about achieving the goal.

The ESB has set out to play a leading role in decarbonisation in Ireland through their 'Brighter Future Strategy', which puts sustainability at the centre of their strategic objectives. The organisation seeks to pioneer the transition to reliable, affordable, low-carbon energy. ESB has two core targets within this overall vision. Firstly they are seeking to reduce carbon intensity by 50% by 2030; and secondly, to increase renewables to 50% of generation capacity (generating 40% electricity) by 2030. ESB Networks (the distribution system operator within ESB) in aligning with the overarching 'Brighter Future Strategy', has developed a flagship project seeking to generate learnings on the societal dimensions of the energy transition through trialling new technologies in homes and businesses in a rural region in the south-west of Ireland.

In September 2017, former chief executive Pat O' Doherty and former Managing Director of ESB Networks Marguerite Sayers appeared on RTÉ (Irish national broadcaster) from the Dingle Peninsula to announce plans for a pilot project, where the company would trial smart grid infrastructure and technologies in the region. Following the initial announcement, a formal launch was undertaken on 3rd April 2018. The trialling of smart grid infrastructure on the peninsula was to include updates to the pre-existing network, alongside the deployment of technologies such as EVs, EV chargers, solar panels, smart meters, battery storage, energy monitoring devices and residential and business retrofits. The project team from ESB Networks consisted of a project manager, a community engagement manager, an asset manager and a communications and I.T. manager. The announcement of the initiative, with a central focus on heat and transport, foreshadowed later policy developments as outlined through the Climate Action Plan (2019).

As part of the Dingle Project, ESB Networks established the Ambassador Programme whereby local people applied to integrate new technologies into their homes and businesses to investigate the lived experience and to share learnings from their participation in the project. Alongside this, ESB Networks established an EV trial whereby 17 EVs were distributed across the peninsula, with 15 being trialled by households (including the 5 Ambassadors) over 12 months and two being made available as share-car options for people in the area. ESB Networks (although not under investigation within this report) also led the distribution of 20 solar panels to individuals chosen through a random selection process on the peninsula.

As part of the ESB Networks Dingle Project, ESB Networks's community engagement manager also acted as a member of the collaborative committee for the Corca Dhuibhne/Dingle Peninsula 2030 project. Dingle Peninsula 2030 or Corca Dhuibhne 2030 (Irish translation), is a collaborative initiative aiming to transition the region to a low-carbon, sustainable community by 2030. The initiative was formalised in early 2018. It is a multi-stakeholder collaboration working across scales, including grassroots community organisations, national agencies and research bodies, in developing and delivering a range of sustainability projects across the sectors of marine, agriculture, energy, tourism and transport. The collaboration consists of the Corca Dhuibhne/Dingle Creativity and Innovation Hub, North East West Kerry Development (NEWKD), ESB Networks, and MaREI, the Science Foundation Ireland Centre for Energy, Climate and Marine.

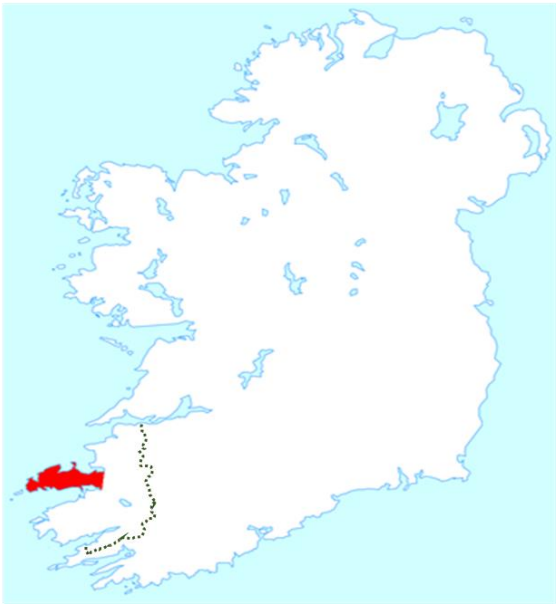
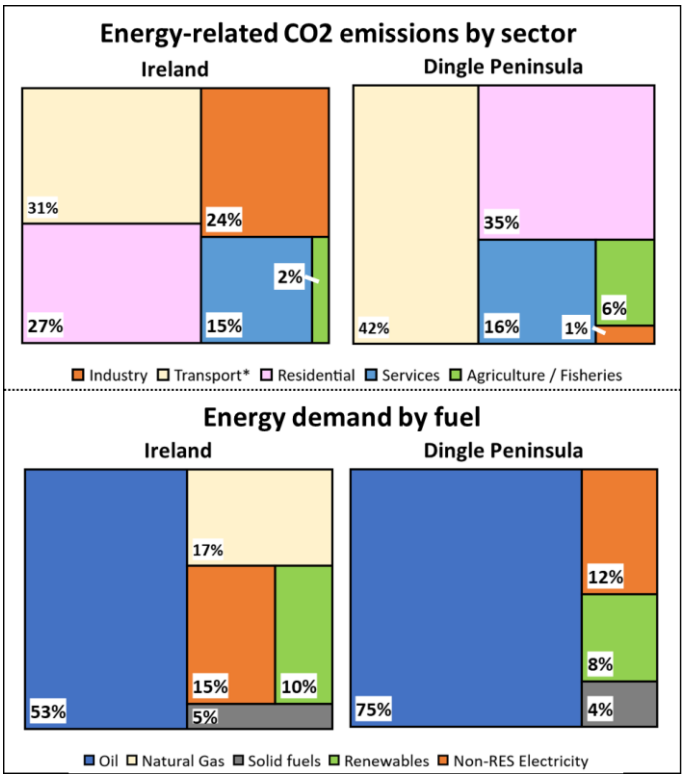


Figure 1. Map of Ireland with Co. Kerry highlighted to the West of the dotted line and the Dingle Peninsula in red.

Energy and Transport on the Dingle Peninsula



On the Dingle Peninsula, we see a significantly different pattern of energy demand from the national average. As outlined through the Corca Dhuibhne/Dingle Peninsula 2030 initiative (McGookin et al., 2021a), this can be attributed to the rural and isolated nature of the area, which results in above-average residential and transport demand, as well as the high dependence on tourism, farming and fishing within the economy and a lack of industry in the area. The top of Figure 2 shows that about 77% of energy use on the peninsula is associated with residential and transport, compared with a considerably lower share (58%) nationwide.

*Figure 2. Energy-related CO2 emissions per sector and energy demand by fuel source in Ireland and the Dingle Peninsula (*Transport sector is excluding aviation, rail and navigation).*

Due to the lack of connection to the natural gas grid and the dependence on private car travel, the peninsula is heavily dependent on imported oil, as shown in the bottom half of Figure 2. Oil accounts for nearly three-quarters of energy use on the peninsula, compared with just over half nationwide.

The total cost of energy across the five sectors outlined in Figure 2 is estimated to be in the region of €36.5 million per year. The Dingle Peninsula is heavily dependent on private transport for mobility, with 67% of commuters travelling less than half an hour to work or school. Public transport links across the peninsula are very limited. Some small private bus services are in operation, but not at a sufficient level for the whole peninsula, due to the dispersed nature of dwellings (McGrath, 1998). MaREI estimates that 43% of the energy use in the area is taken up by transport, aligning with national figures. There are about 702 cars per 1,000 of the adult population on the peninsula, which exceeds both the national (558 per 1,000) and county figures (622 per 1,000).

Energy Citizenship

Within the transition to a low-carbon society, renewable energy sources play a central role and within this citizens are reimagined as moving from passive energy consumers to active energy citizens (Ines et al., 2020). The standard classification of energy users as customers at the margins of centralized systems is beginning to be challenged with the production of energy citizenship through public participation in low carbon energy transitions (Ryghaug et al., 2018). Whilst the establishment of energy citizenship at the individual level is a useful mechanism through which to get people engaged, it "should not only be conceived of individually – the concept must also support and promote collective citizen action. Policymakers need broader metrics - not just kWh savings on a year to year basis – which include the capacity of local groups and longer-term planning" (Watson, 2015, P.3).

The call for energy citizenship emerged in Irish policy through the 2015 publication of The Energy White Paper Ireland's Transition to a Low Carbon Energy Future 2015-2030. The establishment of the Paper acted to outline the national mitigation plan. Included within were discussions on pathways to 2050, the active energy citizen and community energy projects, technological choices, regulatory frameworks and market considerations, and innovation and enterprise opportunities. The implementation of the strategy set out across the three pillars of sustainability, security of supply and competitiveness gave a central role to citizens within the transition process, and called for the emergence of the active energy citizen. The White Paper acknowledged the national collective undertaking necessary for the transition. The importance of citizens and communities was outlined as central to this process. After the failings of top-down approaches to transition Ireland to a low carbon society, the White Paper offered an invitation for civil society involvement in the matter, acknowledging the necessity of social inclusion in the process. As Sovacool notes "the success of any new technology owes less to its technological virtues and more to being 'built into society'" (2009, P.4503).

To ground the concept of energy citizenship, we may start with the notion of public participation in low carbon energy transitions (Ryghaug et al., 2018) as foundational. Within this, the channel to allow public participation must be open. The need for collaboration between different scales can operate to enable participation at the citizen level.

Dingle Project Ambassador Programme
Introduction

Electrification is set to play a key role in the decarbonisation of household energy use. In the Irish context, the 2019 Climate Action Plan set targets for 50,000 deep energy efficiency retrofits per annum from 2021. To achieve this target a commitment was made to design a new retrofit delivery model which would group large numbers of houses to achieve economies of scale, leverage smart finance, and ensure achievable pay-back methods. Meeting such targets would result in the retrofitting of 500,000 houses (including 400,000 heat pumps) by the end of the decade (30% of the national housing stock). Projected uptake indicates policy target shortfalls of 53% for retrofitting (Mac Uidhir et al., 2020). In light of this projected failure to meet targets, considerable work is needed across policy, industry and communities to move closer to the stated goal. Innovative or experimental projects seeking to highlight the experience and value of undertaking retrofits could prove useful in building buy-in within the residential sector.

To better understand the challenges faced by individuals and households in transitioning away from solid fuels, the ESB Networks *Dingle Project* initiated their Ambassador Programme on the peninsula, whereby local people applied to integrate new technologies into their homes and businesses, to investigate the lived experience and to share learnings from their participation in the project. The Ambassador Programme was launched on 17th December 2018 in a local pub in Dingle town. At this event, the five Ambassadors, who had been selected from the open call, were presented to the audience. They consisted of four families and one family business. As previously noted, demonstration projects, such as the Ambassador Programme;

> *"Have proven to be an important instrument for policy-makers, researchers and firms in helping to reduce uncertainty and to facilitate learning about the acceptance, desirability and adaptation of new technology in society. Interaction with societal actors, monitoring experiences with governance of such projects and policy leaning are important issues"* (Klitkou, 2016, P.97).

The participative approach applied to the demonstration project sought to facilitate active engagement with, and adoption of, future energy technologies and to learn from the experiences of those involved.

As part of the trial three retrofits were completed, two domestic and one commercial. The deep retrofits included internal and external insulation, the installation of new doors and windows, air-source heat pumps, and ventilation systems. Two Ambassadors already had heat pumps in their homes and received replacements six months before the end of the trial. All five Ambassadors had seven solar panels installed alongside a residential scale battery. All five Ambassadors were also part of the EV Trial (outlined later in the report) receiving the use of an EV for 12 months and a smart EV charger. All five also received home energy monitoring systems. Some of the technical installations were delayed due to the impact of Covid-19.

Name	Solar PV	Air Source Heat Pump	Residential Scale Battery	EVs	Retrofit Start	Retrofit Complete
Ambassador 1	Feb-19	Oct-20	May-21	Feb-21	Oct 19	Dec 19
Ambassador 2	Feb-19	Oct-20	May-21	Feb-21	Oct 19	Dec 19
Ambassador 3	Feb-19	Jun-21	May-21	Feb-21	n/a	n/a
Ambassador 4	Feb-19	Jun-21	May-21	Feb-21	n/a	n/a
Ambassador 5	Feb-19	Dec-20	May-21	Feb-21	Oct 19	May 21

Figure 3. Dates of technological installations for Ambassadors

Local champions have been acknowledged within the literature as having a key role in facilitating the emergence of energy sustainability within community contexts. Hall et al. (2013) suggest that trust-based relationships can be supported by local champions within a community who can use their social capital to assist in ensuring successful relationships emerge between actors within a project. Within energy transitions, and the deployment of renewable energy technologies, champions have been seen to play a role in garnering social acceptance for projects (Simpson, 2018; Ruggiero et al., 2014). The notion of 'neighbourhood champions' has been suggested as playing a role in energy reduction projects (Parkhill et al., 2015). This combination of social acceptance and individual behaviour change is critical to the socio-technical transition and highlights the important role which champions can play concerning both dynamics.

In the Irish context, it has been noted that community champions and energy champions have a key role to play, acting as trusted and respected members of the local community who can engage people in the energy transition. These champions must, however, be supported. The responsibility and time required to take on a champion role may contribute to the difficulty in finding suitable individuals. The capacities of champions represent a considerable resource within a community, but one which can be depleted. Caution must be given to the potential for burn-out, disillusionment and overreliance on individuals and volunteers. Champions are often conceived of as individuals, but it may also refer to the collective organizational capacities of groups, associations and co-operatives (Watson et al., 2020).

Methods

This study investigates Ambassador participation in the Dingle Project, whereby a range of new technologies has been integrated into five homes/businesses on the peninsula. Through undertaking a series of interviews throughout the trial, coupled with analysis of media interaction by the participants, this research outlines how the Ambassadors experienced the trial. The responses solicited through the interviews have been anonymised throughout to avoid potential recognition due to the small sample size. Alongside this, quantitative data taken from the trial has been used to support the discussion, where relevant.

Figure 4. Map showing locations of five ESB Networks Ambassadors.

Twenty interviews were conducted over four rounds from 2018-2021. After each round, following transcribing the recordings of interviews, the data was analysed thematically (Braun & Clarke, 2006) using the constant comparative analysis method (Hewitt-Taylor, 2001) to code data into themes. Once coded, categories were created around different themes where similarities and overlaps were present across different interviews. Questions for each round of interviews was

informed by the previous round with supporting insight from ESB Networks and media outreach undertaken by the ambassadors.

The information presented was collected from December 2018 to 31st August 2021. Limitations are placed on this investigation due to the small sample size under investigation, the impact of Covid-19 on the timeframe of the investigation, and the lack of capital investment from participants themselves.

Findings and Discussion

Based on the analysis of McGookin et al. (2021b, 2021c) (outlined in the Appendix), the average household on the Dingle Peninsula emits roughly 9 tonnes of CO_2 per year. Driving and heating each account for around 40% of energy related-CO_2 emissions, with electrical appliances and lighting making up the remaining 20%. Similarly, both the installation of a heat pump and switching to an electric vehicle can each result in savings of around 2 tonnes CO_2 per year, while a 1.8 kW Solar PV array has the potential to provide power equivalent of up to 40% of the annual electricity demand depending on the alignment of demand.

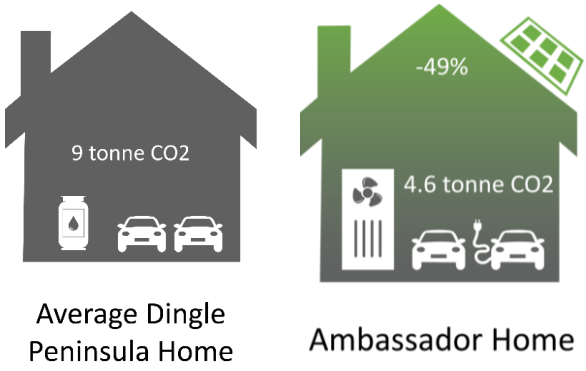


Figure 5. Illustration of the CO2 emission savings in a household with the ambassador technologies versus average Dingle Peninsula household

Throughout the trial, during the regular interactions with the Ambassadors through qualitative interviews, a general feeling of gratitude was evident across the participants. Coupled with this, their experience of engaging with ESB Networks throughout the trial was viewed favourably with all the Ambassadors having a positive experience. The project has afforded ESB Networks greater visibility on the peninsula with an increased awareness of their role in the national electricity system.

ESB Networks and Participation

"It feels like winning the lotto".

"I know how lucky I am to have been picked".

"I wouldn't say no to ESB Networks if they asked me to build a tunnel under the sea. I would say thanks!"

"They were brilliant (ESB Networks), they really were".

*"The *community engagement manager* as always is brilliant".*

"I was saying, look in ten years I will still be an Ambassador for ESB Networks if people want to come to the house I would certainly have no problem."

"Obviously they are involved in the [Energy] *Master Plan work and the other aspects of Dingle Peninsula 2030. I think they have been a lot more visible down here. People are a lot more aware of what they are doing".*

Throughout the project, several positives have been listed by the Ambassadors across their homes and businesses. The benefits for residents in retrofitted homes has long been established within the literature (Iversen et al., 1986; Fisk et al., 2020). For the individuals within this programme, there were clear benefits and improvements made to their homes and businesses throughout the trial.

Positives for Homes and Businesses

"There is a big difference in the house without a doubt".

"Certainty in terms of the aesthetics getting new solid windows that aren't drafty, having insulation through the house. Certainly, the heat pump hasn't missed a beat, I have no qualms about recommending a heat pump, 'always on' hot water, not having to worry about immersions and all of those sides of things".

"The heating, the hot water, the cosiness of the house, the PV panels everything has come good".

"In a house where there is teenage girls hot water and a shower are an important thing".

On from the immediate benefits felt by individuals through participation in the trial, the notion of energy citizenship has been central to the *Dingle Project*. The traditional energy system of Ireland is a complex system hidden from the view of the general citizen. Within this complexity, a relationship of trust is developed between the citizen and the expert (Giddens, 1990). The citizen in this context is perceived in policy discourse as a passive consumer, leaving the complexity of

the energy system to the expert knowledge of others. Within community-based energy systems and bottom-up smart grids, the citizen must move beyond a policy classification as a consumer to gain an active role in the process. While a neoliberal technocratic outlook would suggest that the energy system should be left to these experts, others suggest a more nuanced relationship can exist. The *Dingle Project* has sought to investigate the emergence of this more engaged relationship where individuals are actively involved in energy supply and demand.

The ESB Networks Ambassadors, throughout the three-year process, have emerged as examples of energy citizenship, becoming more versed in energy-related topics and engaging publically through media outreach and public presentations to share their experiences of participation in the trial. These Ambassadors now see themselves as having a voice within the community in relation to energy. Through understanding these technologies, through implementing them in their homes and lives, they have gained a first-hand experience that can be shared with others. It has long since been found in attitude studies that such first-hand experiences shape the formation of more extreme attitudes towards technologies (Smith & Swinyard, 1983). Two individuals within the trial have gone on to suggest that they would be interested in using their own land for energy generation, illustrating the move from passive consumer to active energy citizen throughout the trial period. All of the Ambassadors were keen to remain involved with ESB Networks in some capacity following the project.

Energy Citizenship

> *"People would sort of see you as a source of info, mining you for information and understanding what your experience has been".*
>
> *"Yes for sure. I am much more confident to talk about it or understand it. The experience of having done it has definitely helped me to understand it better".*
>
> *"My whole mindset has changed a lot… it is not little steps anymore we really have to look at massive big steps".*
>
> *"You have to see stuff to see how it works".*
>
> *"You wouldn't believe the number of times it comes up, not a day goes by that someone doesn't talk about it or ask about it or express an interest in it. It is a really big thing in the community. It's bigger than you would probably think it is. People are really interested. I get asked an awful lot of in-depth questions to a point where at the beginning I could not answer them myself but now I am beginning to... I am a bit more up with what I am meant to know".*

Throughout the trial, the Ambassadors have been able to track the kWh generated through their solar panels. Each Ambassador has had 7 panels installed. Through tracking the generated kWh, the Ambassadors have been actively following their performance when compared with others, sharing data between themselves and with the research team. The kWh generated by each Ambassador can be shown in the table below, with each anonymised (#1-#5).

Ambassador	#1	#2	#3	#4	#5	Total
Solar Production (kWh)	4,869	3,892	5,249	3,735	3,951	21,696
CO_2 emissions avoided (kg)	1,508	1,206	1,626	1,157	1,224	6,721

Figure 6. Solar production in kWh (February 2019-August 2021) with CO2 emissions avoided and an equivalent litre of oil displaced.

There has been a desire within the trial for greater quantitative data (see: *Issues Faced* below). With the availability of further data related to demand response, energy efficiency and self-consumption, a process of gamification, whereby game design elements are applied to non-game contexts, could be used to drive engagement and energy-related behaviour change (AlSkaif et al., 2018). While significant financial barriers exist to integrate low-carbon technologies into the home, engagement with said technologies once installed is an important aspect of energy-related behaviour change. During the research period, participants tracked their solar generation, comparing and contrasting with others. Solar production across the peninsula is not uniform, with this instead acting as passive gamification. The engagement with energy, however, highlights the potential of more active forms of gamification. Since the integration of the app, the ambassadors have been enthusiastically interacting with the software. To encourage the emergence of active energy citizenship on a national scale, the use of a gamified approach could be applied to encourage active participation, using information provision, rewarding systems, social connection and performance status to drive behaviour change and engagement.

Active Participation

"We won't call it a competition but we have a WhatsApp group and I am head of the posse. It is driving them all bananas so it is gas".

"People put up their solar kWh figures every now and again to see how everyone is getting on".

"That is the bit I am looking forward to. I guarantee I will be good at that, getting the best out of everything. I was even driving the kids mad I wouldn't let them put the dishwasher and washing machine on during the day".

"I am creating that (solar) but it is going out to the grid there now. I am creating that but it is going straight out".

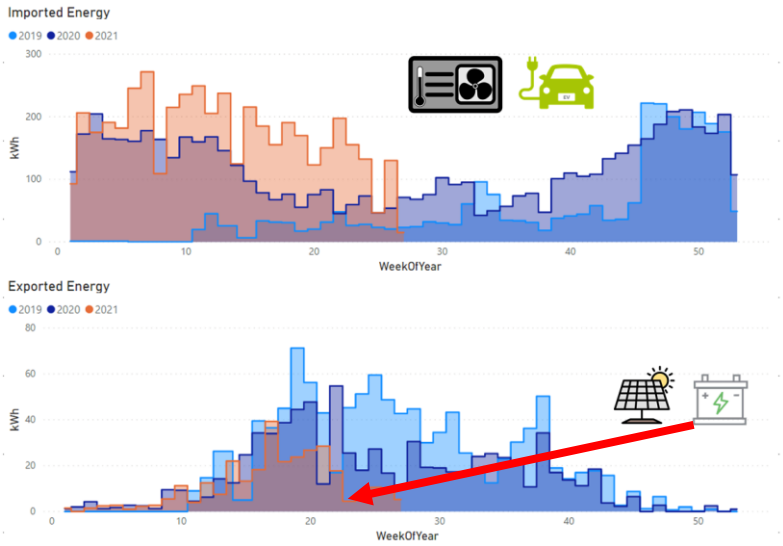


Figure 7. Imported and exported energy for one Ambassador over the programme period.

The final quotation above highlights an issue with relation to the integration of an app-based system without a mechanism for home energy producers to sell power back to the grid. This has been referenced within the programme as a need for national policy around feed-in tariffs. As illustrated below, there is a mismatch between the electrified heating with a heat pump and the generation of electricity with solar PV. In 2019 / 2020 (blue bars on bottom graph Fig.7), during the summer when solar PV generation is highest (bottom half of the picture), the demand from the heat pump is lowest (top half of the picture). This means some of the electricity from the solar PV is lost to the grid. However, in 2021, the addition of EV charging during the day and installation of a battery reduced this spillage and, most significantly, the impact of the battery can be seen in week 23. Active participation and the integrated and optimised operation of these technologies can assist in reducing spill.

While outlining the positive outcomes of the trial for the Ambassadors it is also important to note some of the issues faced. One concern listed by participants has been the lack of availability of quantitative data for the Ambassadors to assume a role as energy citizens throughout the trial and to be a trusted voice in the community. The COVID-19 pandemic delayed the implementation of technologies with knock-on effects around the rollout of an app for participants to have direct interaction with the quantitative information. This, however, has improved in the final months of the project as the app rollout has taken place and is heavily used by participants.

Some smaller issues arose related to the noise of vents and also their durability in extreme weather conditions. This was rectified by ESB Networks with new vent systems being implemented where necessary. Also, the reliability of oil over electricity was presented as a concern for one participant due to the isolated location in which they are based. A participant noted an issue with relation to their confidence in managing the system by themselves once the ESB Networks programme has ended. At the level of project management, it was suggested that there could be one technical expert or project manager overseeing the whole project. With this, it was also suggested that the use of local contractors would be favourable to have more immediate contact should anything go wrong. At a practical level, it was noted that the process of retrofitting a home or business can bring considerable stress. In the context of businesses, this can cause

considerable strain on operating hours, with the need for supports to enable businesses to undertake the work in off-peak hours, something previously missing within the established SEAI grant structures. These minor challenges were often representative of moments in time throughout the ambassadors' journeys.

Minor Challenges

"When people ask me about it (range of new technologies) *I can tell them a certain amount and then it starts to sound like I don't know what I am talking about because what they really want to know is the quantitative information". (*Need for quantitative information on different technologies)

"The vent, it doesn't quite whistle but it is that sort of noise, from a liveability perspective they have been a little problematic so we are hoping to work through those a little bit". (Vents involved in retrofit)

"I guess one question forming in my mind would be if the project closes in December will we feel confident enough to manage the system ourselves". (Operating system alone)

"I think having one technical oversight as part of the project could be useful". (Need for technical oversight)

"There is stress and strain involved in the inconvenience of it all. It was a nightmare initially to declutter the house". (Preparing for major home retrofit)

"We were a bit surprised at how high it was (electricity bill)". (Cost of Heat Pump)

There were some wider challenges, beyond the remit of ESB Networks, represented by participants throughout the study. Questions were asked of participants around barriers to undertaking such work for citizens, potential issues for financing low-carbon technology deployment, and raising public awareness on low-carbon measures. Participants noted the need for more long term engagement to investigate the benefits of the trial over the coming years and the challenge of making a financial case for undertaking such work for people not supported by ESB Networks and the *Dingle Project*. This gap around the long-term economics of the project will become clearer over the coming years as the participants get a better sense of the costs and savings associated with the changes undertaken. While some useful tools have been developed by SEAI on calculating savings on heat pumps, retrofits etc. greater work is needed to communicate payback clearly and concisely for the public.

A recent study has shown that information on comfort-related benefits makes tenants more likely to choose retrofits, while inversely, information on the financial consequences of retrofits reduces support (Ossokina et al., 2021). This relates to another wider challenge presented by a participant with relation to getting people interested in undertaking such work. There is a need to communicate the bigger picture with relation to the need to decarbonise household energy use, particularly in light of the urgent and pressing need for action as outlined through the 2021 IPCC

report. Finally, a wider challenge was presented with relation to grant funding. Firstly, it was felt that current grant structures alone are not enough to encourage people to undertake retrofit work. Secondly, the support the Ambassadors received in accessing grant funding potentially represents a gap when compared to the experience of an individual trying to get grant support alone.

Wider Challenges

"I think it would be very important to see the learnings to see if they are positive or negative. I think it would be nice in some ways to keep it alive to do a check-in in a couple of years".

"The big question anyone will want to know is it worth the cost and I can't answer that at the moment".

"And in a lot of cases I think people would struggle to make their own personal business case for it and I certainly would hope that there would be case studies and data that comes out of the ESB project which would help to quantify the benefits and the payback period and things like that".

"I have not necessarily converted people at this point. I think certainly seeds have been sown. I would not feel comfortable recommending anything yet until I have a fuller picture of the costs and the savings".

"It is really hard to get that stuff in the public domain without it actually interesting them in the first place".

"I am not sure people think about the bigger picture".

"I don't think the grants alone at the moment are enough for people".

"Given the way this Ambassador programme is set up, completely removed from any of the SEAI work, it might be a bit of a gap in the overall Ambassador program".

The Covid-19 pandemic ran in parallel to a significant portion of the trial and had a significant impact. In a positive sense, through moving online, the project has been able to use webinars to target different audiences. Several online events have been held in the form of the Dingle Adapts Energy Series, a mini-series across five weeks where different Ambassadors were invited to speak on different topics related to the overall trial. The organising of public events has, however, been impacted by Covid with one Ambassador noting the difficulty in engaging people in conversations on energy and the trial within their business due to the immediacy of the pandemic on people's daily lives. As the Ambassadors can further learn from their experiences, coupled with the end of heavy restrictions related to Covid-19, there is potential for more face-to-face engagements moving forward, with the Ambassadors keen to stay involved in the process if possible.

Covid Impact

"You are probably getting a chance to reach different people now because some people are more into webinars".

"We would have had far more public get-togethers and everything and we would have had a few meetings where people could ask us questions and we would probably be sitting at a top table and we would be able to talk directly back to the people".

"It has had a big impact. After the ESB going through all the trouble in fairness to deploy their technologies and to educate us as Ambassadors and to educate the rest of the public, it has just put an awful dampener on it".

"I had all these grand ideas… I had plans to push it out there more this year but it all went pear-shaped. I would hope that it will become important again at some stage but just at the moment because of Covid, nobody wants to talk about how you are heating the home or where you are getting your energy from. Hard to think about the other stuff at the moment".

"It is only now that we are going to start educating the ESB and each other and hopefully over the next two or three years if they want to get us together for a chin wag, I will certainly be available".

Within the ESB Networks *Dingle Project,* a focus has been given to moving from customer to citizen and engaging directly with individuals as part of the process. Within this, the Ambassadors have been allowed to meet with different individuals within organisations and government and hold conversations about their experiences as part of the process. This has been viewed positively by them and has given them the ability to influence organisational changes through their participation.

Engagement

"I met every commission in the country (CRU, Department of Agriculture etc.). *I had dinner with people and you turn on the TV the following evening they are in the Oireachtas".*

"We had the whole group from ESB down for lunch. Two (senior staff members) came down and they had lunch and it was a fabulous day. They got to see it as it was in the middle of the mess upstairs (retrofit) so they got to see how much chaos it causes so it was good for them".

The Ambassadors' have acted both within their local communities and also beyond this to wider institutional actors to represent their experiences of participation within the trial. This sharing of experience is fundamental to raising awareness about the lived experience of integrating low-carbon technologies into homes and businesses.

Dingle Project EV Trial
Introduction

In meeting the urgent need to decarbonize the Irish economy, in line with the targets set out through the European Union's climate and energy framework, considerable action is needed across numerous sectors. Private cars account for 20% of energy-related CO2 emissions in Ireland (SEAI, 2020). A range of solutions are being pursued to meet the need to reduce the emissions related to private transport. These include investment in public transport, the development of shared mobility schemes, and the scaling up of public infrastructure for transport alternatives such as cycling. The deployment of electric vehicles is a solution that is being prioritized within the All-of-Government *Climate Action Plan* (DCCAE, 2019), whereby aspirations have been set to get 840,000 electric vehicles on Irish roads by 2030, alongside the expansion of charging infrastructure across the country.

While this policy aspiration towards large scale deployment of electric vehicles in Ireland is commendable and may prove effective in reducing emissions related to car transport, there are some associated challenges for EV users and potential users which must be noted. The perception of limited driving range for electric vehicles is at odds with the established user experience of getting fuel at a petrol station. The charge times are vastly longer than the standard experience of fueling your car at a petrol pump, even with relation to superchargers. These two factors lead to what has been referred to as 'range anxiety' (Rauh et al., 2015; Neubauer & Wood, 2014). To date, the ESB has developed 1,100 public charge points across the country, but to facilitate the scale-up represented through government ambition this number must be greatly enhanced. Currently, the infrastructure is not sufficient to deal with such ambition, furthermore, wider problems with relation to the impact, such an increase of charge points, will have on the power system must be considered (see: Calnan et al., 2013). The limited vehicle choice of EVs on the market has also been presented as a challenge for their uptake (Mulholland et al., 2018).

In recent years, however, an increase in consumer adoption has coincided with the availability of a wider range of models. Despite this, however, the upfront costs are often greater. Maximum grant incentives of €5,000 are currently available for privately purchased new EVs in Ireland. A final associated challenge for users is the lack of qualified mechanical support. A recent study in the U.K. found that 97% of mechanics were not qualified to work on electric vehicles (Borrás, 2018). Employment opportunities exist to reskill people towards this area, with electric motors having fewer components than their combustion engine counterparts.

While these challenges are noted, innovative solutions to facilitating the scaling up of electric vehicle deployment in Ireland are needed. As part of the *Dingle Project,* ESB Networks has deployed 17 EV's across the peninsula for a one year trial, given to individuals and families selected through an application process. Two of the seventeen vehicles were shared cars, outside

of the remit of the qualitative research process. Within this trial, research has been conducted on the lived experience of participants in taking on EV's and the benefits and challenges within this. Although outside the remit of this piece of research, the findings from the overall trial will help ESB Networks to investigate the impact of EV's on the electricity grid. This piece of research seeks to draw out findings on the experiential dimensions of transitioning to EV's for private transport. These driver experiences can provide insights for policymakers to assist in actualizing the aspiration for 840,000 EV's by 2030 set out in the Climate Action Plan.

Studies have previously been conducted to investigate the integration of EV's into a household's transport mix (Jensen & Mabit, 2017). Findings within this research suggested that factors related to the distance of journey and charging availability influence EV travel behaviour. EVs are predominantly used for well-planned transport and are not used in the same manner as conventional vehicles within two vehicle homes. Earlier research (Krause et al., 2013) highlighted the misconceptions of consumers around price, fuel and maintenance savings for EV's, suggesting that clearer consumer information about the advantageous aspects of making the switch could provide considerable benefit in the mass commercialization of EV's. Here a trial approach may draw out useful findings with relation to communication of experiences, both beneficial and challenging. The deployment of EVs in the public domain, such as the approach taken in the ESB Networks trial project, has been shown to positively affect the stimulation of private EV sales (Liu et al., 2020). Strong future diffusion of EVs has been suggested due to the investments made by big car manufacturing companies, government incentives, and infrastructure developments (Viola & Longo, 2017). Beyond the practical considerations with relation to usage, and the positivity found with relation to strong future diffusion, there is a need to understand consumer behaviour and ethics (Adnan et al., 2017). Subsidies and 'ecological ideology' will not sustain the stimulation of the EV market indefinitely, and a greater understanding of user perceptions with relation to comfort and performance must be considered (Viola & Longo, 2017).

Methods

For this research, a one hour survey was administered to trial participants at the beginning of the process (February 2021). These drew out baseline information across several topics with relation to motivations, benefits, challenges, performance, practicality, usability, social norms and diffusion. A follow-up interview was then undertaken at the close of the research project (August

2021) to revisit the participant experience of integrating an EV into their lives. Interview respondents have been numbered 1-15 (i.e. EV1-EV15). The fifteen trial participants, of which five were the Ambassadors and ten were selected from an open call process, were given EV's and home charging units. The cars consisted of 10 Hyundai Konas & 5 Nissan Leafs. The survey and interviews have been cross-referenced to draw out findings. A WhatsApp group was established by ESB Networks for participants to discuss their involvement in the trial with their peers. This group has been followed throughout the research period to keep informed on developments within the trial. Alongside this, quantitative data has been gathered on each participant vehicle through the use of a telematics data monitoring system. This has been used here to supplement the qualitative findings. All the information presented from the telematics data is dated from 1st February 2021 to 31st August 2021.

Limitations are placed on this investigation due to the small sample size under investigation, restricted geographical spread, the lack of capital investment from participants, and the self-selected nature of the individuals involved. However, through studying this pilot trial, using a small sample size of 15 users, empirical findings of user perceptions with relation to motivations, benefits, challenges, performance, practicality, usability, social norms and diffusion are outlined.

Findings and Discussion

Here we present some findings from the undertaking of the methods outlined above. The findings are centred on direct quotations taken from participants in the trial, supported by the qualitative data gathered. Alongside this, we provide a discussion on the findings in light of the established literature on Electric Vehicle uptake and behaviour change.

Below we see the breakdown of total distance travelled, total journeys, longest journey and total charging in kWh. Based on the most recent grid CO_2 intensity figure (2020) compared to an average car user from the area that would equate to roughly 19.3 tons CO_2 saved, which is equivalent to 3,002 litres of diesel.

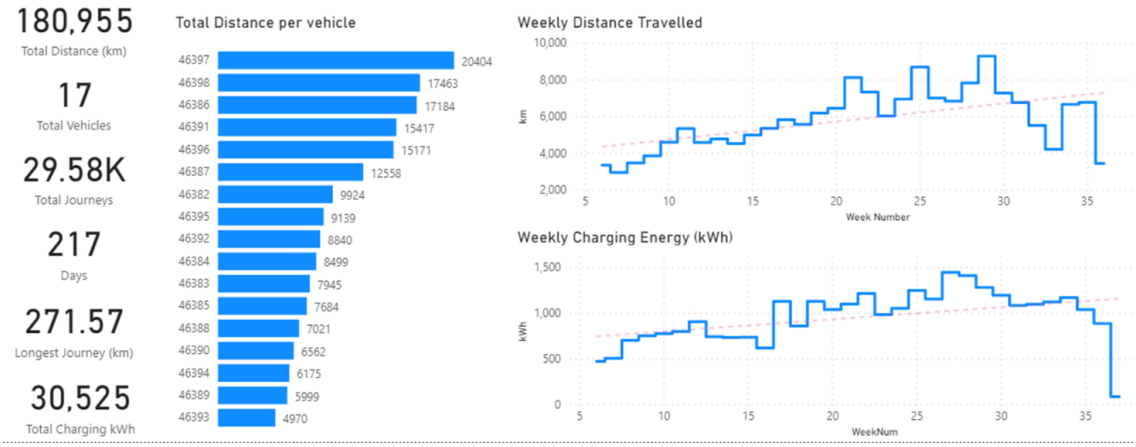


Figure 8. Data related to the overall EV Trial for all 17 vehicles.

As noted in the Introduction, residents of the Dingle Peninsula heavily rely on private car travel, with 1.45 cars per household, which is 20% above the national average of 1.2 cars per household (Central Statistics Office, 2016). As a result, private car travel represents around a quarter of the Dingle Peninsula's energy related-CO_2 emissions (McGookin et al., 2021b, 2021c). For the average Dingle Peninsula household, cars represent 40% of annual CO2 emissions. The switch to an electric vehicle offers significant savings at an estimate of around 2 tons per year, which will get even better in future as the share of renewable sources on the electricity grid grows.

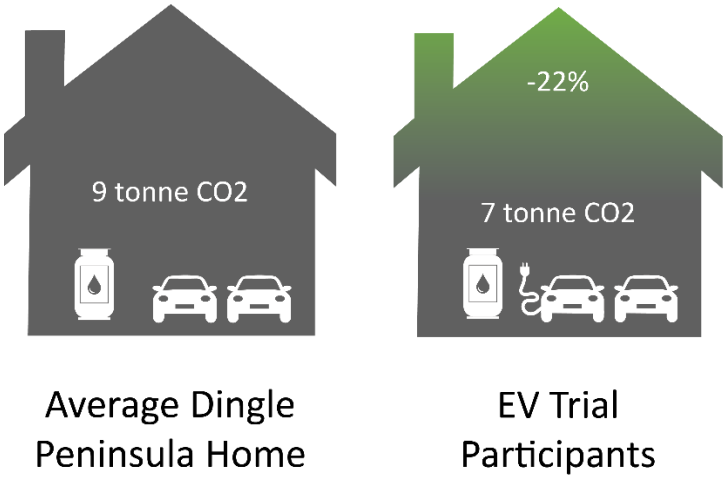


Figure 9. Energy-related CO2 emissions for average Dingle Peninsula Home and EV Trial Participants.

The majority of participants viewed the experience of using an electric vehicle as part of the trial favourably, with several participants considering the future purchase of an EV. This, however, was not seen by many as a practical next step due to financial considerations. Of the participants, one missed the mechanical process of driving a mechanical combustion engine vehicle, whilst another who had some technical issues with the vehicle throughout the trial felt that the upfront cost of converting to an EV would not be something they would be happy with if they had purchased the vehicle. EV's in and of themselves may not present a more desirable consumer choice when compared with traditional modes of private transport. Despite this, the general feeling about the experience of the trial was favourable.

Keeping an EV

"We are going to do our best to get an EV following this and we will look to try and trade in one of the petrol cars by the end of the year to get a second-hand EV". (EV9)

"We would definitely go electric from here on in. It is not an issue it is just another way to get a car moving. It is like anything in life people want to tell the negative stories the whole time and people don't talk about the positives. It is very straightforward". (EV8)

"It is way too expensive for most people at the moment". (EV13)

"In the future yes, but not straight away". (EV15)

"I am happy that it was free for the year but 48k is a lot of money and if you are investing in it you would want it to be really really good if you think of the cars you could get for 50k". (EV11)

A central facet of the ESB Networks *Dingle Project* is to investigate how energy citizenship can be established through the integration of low-carbon technologies into people's lives. Within the trial, some participants represented this emergent notion of "energy citizenship" through increased awareness of energy use through their experience of driving in an energy-efficient manner. Energy has become a topic of conversation for participants in daily life.

Energy Citizenship

"There have been some days that I have four or five discussions with people throughout the day (about the EV)". (EV2)

"We are all obsessed with electricity now. We send pictures from the app to the family WhatsApp group. If something is using a lot (of energy) on the app everyone is running around the house turning things off. You become really obsessed with it". (EV5)

The idea of energy citizenship, and within this behaviour change related to energy efficiency, can be facilitated through real-time feedback of energy usage and the gamification of energy previously discussed with relation to the Ambassador Programme outlined above. Eco-driving and efficiency prompts have been shown previously to be viewed as favourable by drivers (Kreußlein & Gauglitz, 2016) bringing about higher recovery kilometres attained through efficient driving practices. Increased awareness of efficiency was referenced within the EV trial as being carried over to other non-EV cars within the home.

Gamification to Behaviour Change

"I generated 7km coming down the Connor Pass that was such a thrill". (EV1)

"That instant feedback on the dashboard is a real eye-opener for me and how it drives behaviour". (EV3)

"Definitely a much slower and calmer driver... You get obsessed with the kWh. It definitely changes the way you drive". (EV5)

"You are watching the screen to make sure you are not burning up too much energy, you don't drive the car too hard. I follow that when I am driving". (EV7)

"I find it interesting putting the regenerative braking back into the battery". (EV15)
"I find that I am taking it on to the other cars as well. I go a steady 80-100km/h, you are definitely more conscious". (EV7)

The participants within the trial were asked to outline three positive and three negative things which come to mind when thinking about electric vehicles. This was done both at the beginning and end of the trial. A mind map has been developed to illustrate participant responses. Aspects referenced numerous times were given greater weight. Overall, participants brought forward more positive responses than negative with some participants not offering any negative aspects and only a few offering the requested three. Environmental benefits were referenced most regularly as a positive, as highlighted previously (Ghasri et al., 2019).

Figure 10. Mind map of positives and negatives of Electric Vehicles from trial participants. Green used for positives and red for

On from this, cost efficiency and driving experience were referenced most regularly as positives. With relation to negatives, public charging infrastructure, range (Broadbent et al., 2021), cost of purchase and battery manufacturing were referenced most regularly.

The environmental positives of non-polluting EV's have been widely represented through advertising and the media (Malik & Yadav, 2021). However, trial participants maintained that other benefits, such as the cost-effectiveness, the suitability of range for daily driving, and the use of regular home charging to ensure range must be more clearly communicated to the public. The many misconceptions about EVs (Burgess, 2013) can be overcome through direct experience. Below (fig.11) we can see total kilometres driven per week, indicating an increased trust in the technology, coupled with changing Covid restrictions. Also, highlighted is the maximum journey distance per week. A journey is from ignition on to ignition off. If someone stopped off to go to the shop along a trip, it would end one journey and start another.

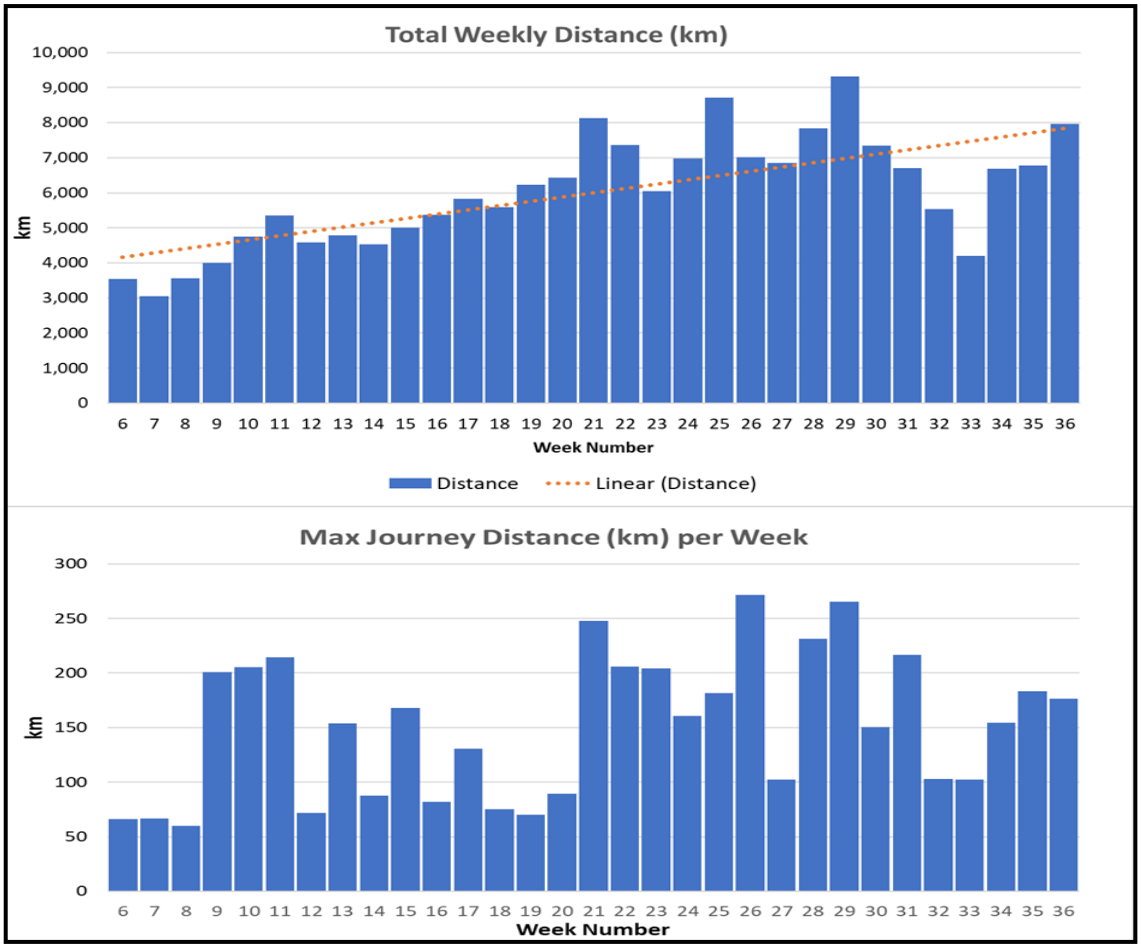


Figure 11. Total distance travelled and maximum journey distance over in 2021 (week 6-36).

The importance of clearer communication around the reality of using an EV was brought forward several times within this trial based upon participant experience of using the technology. A hesitancy or scepticism towards emergent technologies is a general trend that in light of the timely need to decarbonise private transport in the Irish context should be addressed through a broader communication strategy with relation to EVs.

Communication Recommendation

"Everything needs to be clear". (EV2)

"Somebody needs to shout about the fact the batteries need to be constantly topped up. I would be really happy to plug in my car the same way I would lock it in the evening and always have it topped up, to have that flexibility. I would be telling them to push that". (EV3)

"People find it hard to believe that you could get that kind of range out of them. When you tell them it costs €5 to get that 450 km or so, then they start listening". (EV4)

"Advertise how efficient they are. Everyone thinks they have an extremely short range". (EV5)

"The main perception people have is the range is too limited". (EV6)

While the positives must be more effectively communicated there is still a need to address the negative aspects of EVs. Within the trial, the primary negative factor brought forward by participants was the public charging infrastructure available across the country. Due to Covid-19 limitations have been placed on participants' ability to interact regularly with the national network. The vast majority of charging has taken place at home which has been represented below by highlighting energy used for charging at home divided by vehicle type.

There has, however, been some instances through holidays or work trips whereby participants have felt under-serviced with regards to the public charging infrastructure. This is not an absolute trend with some participants facing no trouble when charging outside of the home, yet still must be acknowledged as an important concern due to the regularity with which it has been referenced.

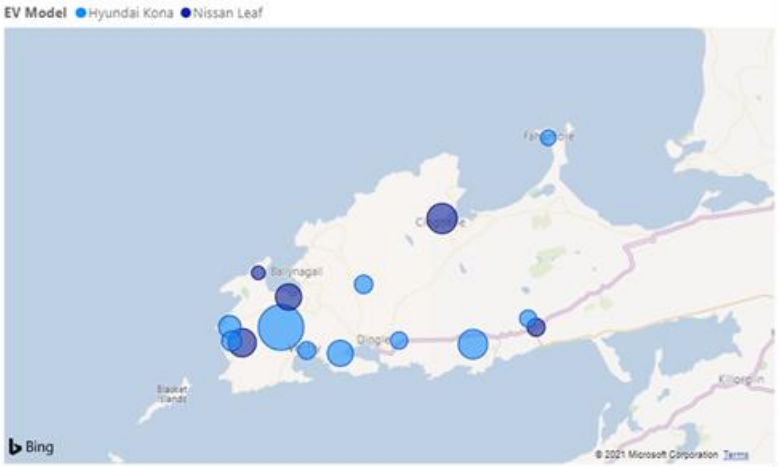


Figure 12. Energy used for charging at home, divided by vehicle type.

Public Charging

"The big thing that needs to be brushed up on is chargers around the country, people need to know they can pull up to any town in the country and get a charge". (EV2)

"Two-thirds of the population lives within 100 miles of Dublin so range anxiety should not really be a thing if there are enough chargers". (EV6)

"If Kerry reach an All-Ireland final, 20,000 Kerrymen and only one charger in Croke Park. We will all have to spend a month above in Dublin waiting for a charge". (EV7)

"On longer journeys, the infrastructure is poor when looking to find somewhere to charge… they have given us the cart but no horse". (EV7)

"With any policy, it has to be supported by infrastructure. Just having a robust network of chargers. You should not have to plan a trip in Ireland with military precision. I think you should hop in the EV and go to Galway or Donegal with the same level of concern you would have with finding a petrol station" (EV9)

As part of the research process, a survey was undertaken at the beginning (February 2021) and end (August 2021) of the trial. This sought to investigate factors of importance for participants when purchasing an Electric Vehicle. Each factor was given a score on a scale of 1-10, with 10

being of greatest importance. The two scores have been added together to highlight which aspects are of greatest importance to consumers when thinking about buying an electric vehicle. With a small sample size (15 participants) there is very little variation between the two surveys. The upfront cost of purchase has been represented here as of greatest importance alongside environmental benefits and range. Of least importance was the preferential tax cost, the availability of second-hand options, and how the car looks.

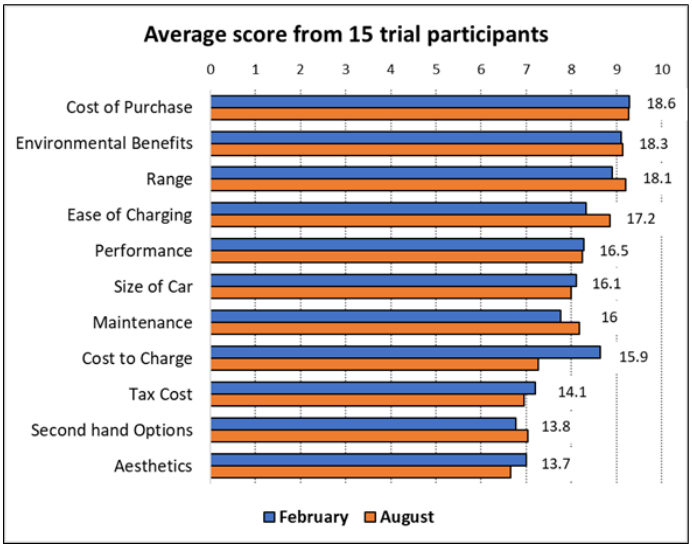


Figure 13. Factors of importance for purchasing an Electric Vehicle.

ESB Networks, in undertaking the *Dingle Project,* is seeking to build upon the initiative on the Peninsula to draw out lessons for further electrification initiatives nationally, to enable the emergence of energy citizenship. In asking participants several questions about wider uptake, we outline findings beyond the remit of ESB Networks to look at EV deployment at a national level. The need to communicate the efficiency (as referenced above) was referenced alongside the need for a more robust national charging network. Alongside this, one participant felt there was a need for ESB Networks to educate individuals on how to drive cars efficiently. A thirty-minute training session was delivered to each participant on the day of the handover. The transition to night rate electricity, which the majority of participants undertook, was felt to be overly complicated and in need of simplification for consumers. Finally, it was felt that a longer time scale for investigation could lead to richer findings with relation to both the user experience and the impact of charging on the grid.

Suggestions for Electric Vehicle Uptake

“There is a need for more fast chargers”. (EV4)

"A bit more detail on how to drive the cars properly. It wasn’t their fault because of Covid. But it was just hand over the keys and figure it out yourself. And there is a way to drive the car to get the most out of it. You had to figure that out yourself and I think some people in the group still have not figured that out. No point getting an electric car and not optimizing it". (EV5)

"Advertise how efficient they are. Everyone thinks they have an extremely short range". (EV5)

"More chargers, build it and they will come”. (EV6)

"They were really professional it would be more the car itself that let me down. I was really happy with them". (EV11)

"Within 12 months you are not going to get a real handle on the running costs, other than fuel costs. We haven't got it serviced or had any issues with it. Something that may be difficult for them to infer is what impact do older generation EVs have on the patterns of usage. If we had a smaller capacity battery we probably would have been charging much more regularly". (EV9)

Finally, participants offered some policy recommendations for the uptake of electric vehicles. These were related to improvements of charging infrastructure with incentives for petrol stations and businesses (e.g. supermarkets) to integrate superchargers within their current services. Incentives as a policy approach were viewed as preferential for the uptake of EVs for individuals.

Policy Recommendations

"If you are to sway people to electric vehicles you need some sort of carrot to sway them across". (EV15)

"An improvement of the charging services"... "Incentivise petrol stations to make up losses from petrol and diesel. They are already raising their prices to make up for losses from last year". (EV1)

"They are too dear... there are so many incentives they could bring in. Even parking for electric cars, people should be able to do their shopping and plugin". (EV2)
"Communication piece, I think the economics are going to sort themselves out". (EV3)
"Incentivize it through tax breaks". (EV4)

"Not more tax for everything, they should be incentivizing. Also to put in more charging points" (EV7)

Following an outline of both the Ambassador Programme and the EV Trial, we now move towards further findings with relation to diffusion. Firstly, with the *diffusion of technology* stimulated through both the Ambassador Programme and the EV Trial; and secondly, concerning the wider *diffusion of sustainability* arising from both the ESB Networks *Dingle Project* and the wider *Dingle Peninsula 2030* initiative.

Technological Diffusion

The ESB Networks *Dingle Project* has provided learning with relation to the lived experience of integrating new technologies into the home, their impact on the electricity grid, and their contribution to CO_2 emissions reduction. Path dependency and technology "lock-in" can be seen as central features which hinder the scaling up of innovations (Foxon, 2014). Social norms, education and knowledge have been referenced alongside physical infrastructure, legislation, and finance as contributors to path dependency (Lovio et al., 2011). Despite the challenges faced with relation to the development of innovations, the early adopters take on technologies through investment, playing a key role in the creation of knowledge around the innovation (Lehtonen, 2003) and innovating themselves around the creation of new practices through interacting with and building upon the innovation (von Hippel, 2005). The Ambassadors and EV participants could be considered in this regard as *early adopters*. Diffusion of innovations, as an area of academic study, seeks to analyse and explain how innovative ideas and practices spread within and between communities once taken on by early adopters (Valente, 2005, P.98).

Diffusion can be seen to occur through three mechanisms; internal influence, external influence and mixed influence (Valente, 1993). At a most cursory level, internal influence for the diffusion of innovation is concerned with the spread of new ideas and practices through communication between interpersonal contacts (Valente & Rogers, 1995). External influence is diffusion through external sources not related to interpersonal relationships. The media plays an important role in external influence alongside private sector triggers and policy developments. Finally, mixed influence involves both internal and external influence principles whereby both the wider landscape and interpersonal relationships impact the adoption of innovations.

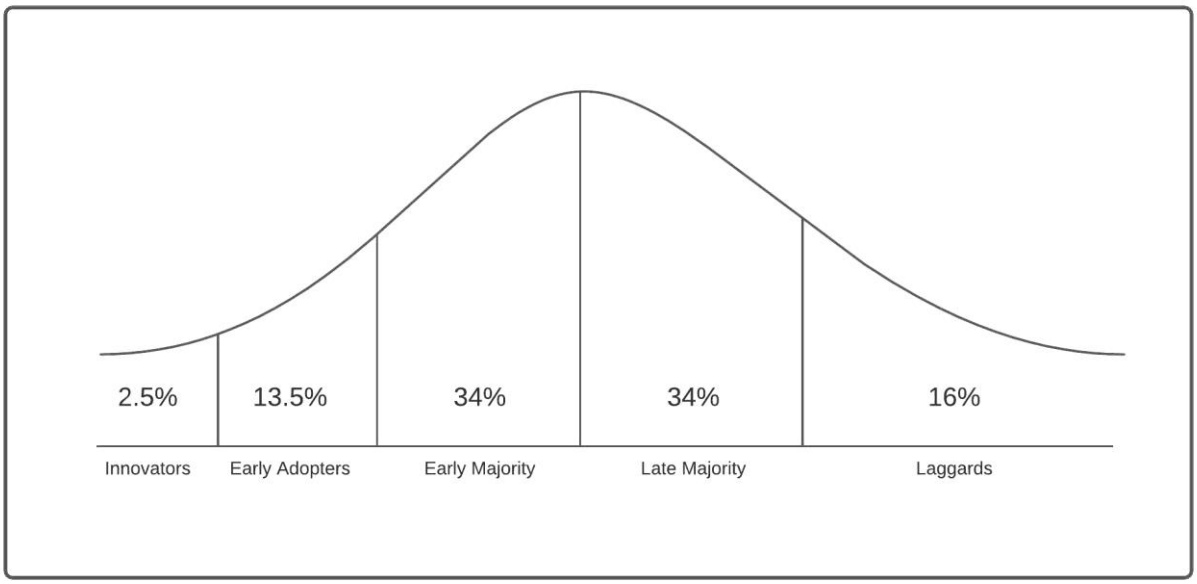


Figure 14. Sample diffusion curve.

Some key areas of interest within the diffusion of innovations literature concern the uptake of new practices (i.e. early adopters, laggards etc.) and trying to understand why some individuals adopt an innovation while others do not. The relevance here to climate action, and more specifically the energy transition, is clear. In the Irish context, through the publication of the Climate Action Plan as previously noted (DCCAE, 2019), a pathway has been developed which aims to retrofit 500,000 homes and for there to be 890,000 electric vehicles on the road by 2030. While some grant aid may be available, widespread diffusion must occur to achieve these goals. Alongside this, lessons must be learned at the policy level about previous attempts to engage society on climate change and the energy transition. By way of example, the Power of One campaign (Diffney et al., 2009) aiming to encourage consumers to develop more energy-efficient practices at the individual level led to short term increases in awareness but failed to have any long term impact (Diffney et al., 2013). The importance of collective conscience (Deane-Drummond, 2011) has been highlighted as a useful alternative to the individualist logic of the Power of One campaign.

In recent years, concerning consumer behaviour, there has been a move towards social models, moving beyond traditional individualist approaches, established through 20th-century figures such as Bernays (Suarez, 2016) and expressed in campaigns such as the Power of One. Through disciplines such as neuroscience and social psychology, it has been suggested that humans should rightfully be defined through their true essence, as herd animals (Earls, 2003). This insight can be combined with the diffusion of innovation theory to move towards an understanding of how the solutions offered through climate policy may be implemented and spread amongst the public. Some factors have been outlined which affect the rate at which innovations are taken up: 1- relative advantage of innovation, 2- compatibility with values, 3- complexity, 4- trialability, 5- observability (Rogers, 1995).

Diffusion of Technology on the Dingle Peninsula

Through the EV trial, many participants have gained interest from family and friends in the purchasing of EVs, with one participant having bought their own based on the experience of participation. Similarly, the Ambassador Programme has led to a wider interest in undertaking similar work with one participant noting that “my mom and dad did, they got more insulation. My uncle has had his walls pumped. Our next-door neighbours over towards our house had a whole retrofit done. I don’t know if that was because of it being done here… but they have had it done and there are plenty of people doing work”. Through a data request submitted to SEAI, the diffusion of PV panels emanating from the *Dingle Project* can be illustrated (fig. 15).

As previously outlined, *Dingle Peninsula 2030,* is a collaborative initiative aiming to transition the region to a low-carbon, sustainable community by 2030. ESB Networks has acted as a key partner within the collaborative committee for the initiative. While it is too early in the transition process to clearly see the impact of the *Dingle Project* and *Corca Dhuibhne/Dingle Peninsula 2030*, a closer look at the Solar PV installations in the area may show an indication of some technology diffusion. However, it is acknowledged that this does not prove that the *Dingle Project's* collaboration with *Corca Dhuibhne/Dingle Peninsula 2030* has had an impact, due to the following issues:

- The dataset is incomplete – houses built after 2011 or with a BER lower than C rated cannot access the grant and thus are not accounted for in the data provided by SEAI. In the case of the Dingle Peninsula, 15 installations were added to the grant number as it was known how many ESB Networks had installed. However, it would be very difficult to repeat this exercise for the national dataset.
- There is no proof – what motivated the eleven households to install Solar PV in 2020 has not been verified by asking them.
- A single year does not represent a trend – the increased activity seen in 2020 may not continue, this might just be a once-off spike rather than representing a long-term trend.
- External factors – factors such as household savings incurred due to COVID-19 restrictions may in part explain the spending in 2020.

	2018	2019	2020	Total
No. installs	4	25	11	40
kW	8	55	36	98.4
kWh	7,709	52,902	34,208	94,818
Tonne CO2 saving	2,894	17,167	10,091	30,152

Figure 15. Solar PV installation on Dingle Peninsula 2018-2020.

A data request submitted to the Sustainable Energy Authority of Ireland (SEAI) in mid-2021 on Solar PV grants to date, along with known installations as part of the ESB Networks *Dingle Project,* provided the following figures.

A significant portion of these installations can be attributed directly to the ESB Networks *Dingle Project,* which saw 25 households receiving Solar PV panels in 2019. It is no surprise then that the total Solar PV installed in the area between 2018 and 2020 is above what might be expected, at just over twice the national average. However, looking at the per capita installations for the year 2020, occurring after the *Dingle Project* installations had taken place, it is interesting to see an above-average installation rate on the peninsula.

W installed / capita	2018-2020	2020
Ireland	2.7	1.1
Dingle Peninsula	7.9	2.8

Figure 16. Solar PV installed nationally and on the Dingle Peninsula per capita (2018-2020)

Alongside this, a general interest in the area of low-carbon technologies can be suggested as arising through the running of the *Dingle Project*. This is seen through the expressions of interest

related to the initial Ambassador trial and the later EV trial. There were roughly 65 expressions of interest for the Ambassador Programme with 450 expressions of interest for the EV trial. Anecdotally, it could be suggested that this increase represents an increased awareness of the technological changes required for the low-carbon transition highlighted through ESB Network's engagement on the peninsula.

The Diffusion of Sustainability

Introduction

In discussing the diffusion of innovation, the importance of a collective approach has been outlined when compared to more individualistic modes. Within the *Dingle Project*, through collaboration with *Corca Dhuibhne/Dingle Peninsula 2030*, a wide range of sustainability and decarbonisation initiatives have emerged on the Dingle Peninsula which can support the energy transition. Diffusion, as referenced previously, can be viewed as a process through which an innovation can be communicated using certain mediums or channels over time to members of a social group or system. Diffusion can be understood as a "cascading mechanism that leads to cumulative adoption of behaviours by some individuals even while their social position, or the resources associated with them, changes only trivially or remains unaltered" (Palloni, 2001, P.68). Borrowing from Clough et al. sustainability can be defined as:

> "*A process that helps create a vibrant economy and a high quality of life, while respecting the need to sustain natural resources and protect the environment. It expresses the principle that future generations should live in a world that the present generation has enjoyed but not diminished."* (2006, P.30).

The diffusion of sustainability is understood to be aligned with the definitions of both Palloni and Clough et al., whereby initiatives, projects or actions which support the creation of a vibrant economy and high quality of life, whilst respecting natural resources and the environment are cumulatively developed or adopted. The importance of community-level actions and initiatives for the delivery of climate action and sustainability more broadly has been acknowledged within policy (DDCAE, 2019). Through the initiation and establishment of both the *Dingle Project* and *Corca Dhuibhne/Dingle Peninsula 2030*, the potential for diffusion throughout the community, to other communities, and to nationally led initiatives can be acknowledged as a mechanism through which to assist in the delivery of the socio-technical transition to a low-carbon society.

Method

Throughout the three year trial period, regular events and meetings have been attended to build a profile of different diffusions of sustainability that have occurred throughout the timeframe. They have been graphed into a network map illustration to highlight growing societal infrastructure. The network map outlines energy-related diffusions and wider diffusions to illustrate the influence of the *Dingle Project* beyond the immediate impact of the Ambassador programme and the EV trial.

Findings and Discussion

The core diffusions emanating from the *Dingle Project* and *Corca Dhuibhne/Dingle Peninsula 2030* related specifically to energy are outlined here. A graph has been developed which highlights both the diffusions related directly to energy and also the wider diffusions. These wider diffusions have an impact on building local capacity for climate action and energy citizenship, the communication of the project to national and international audiences, and the inclusion of diverse actors in conversations on energy and sustainability.

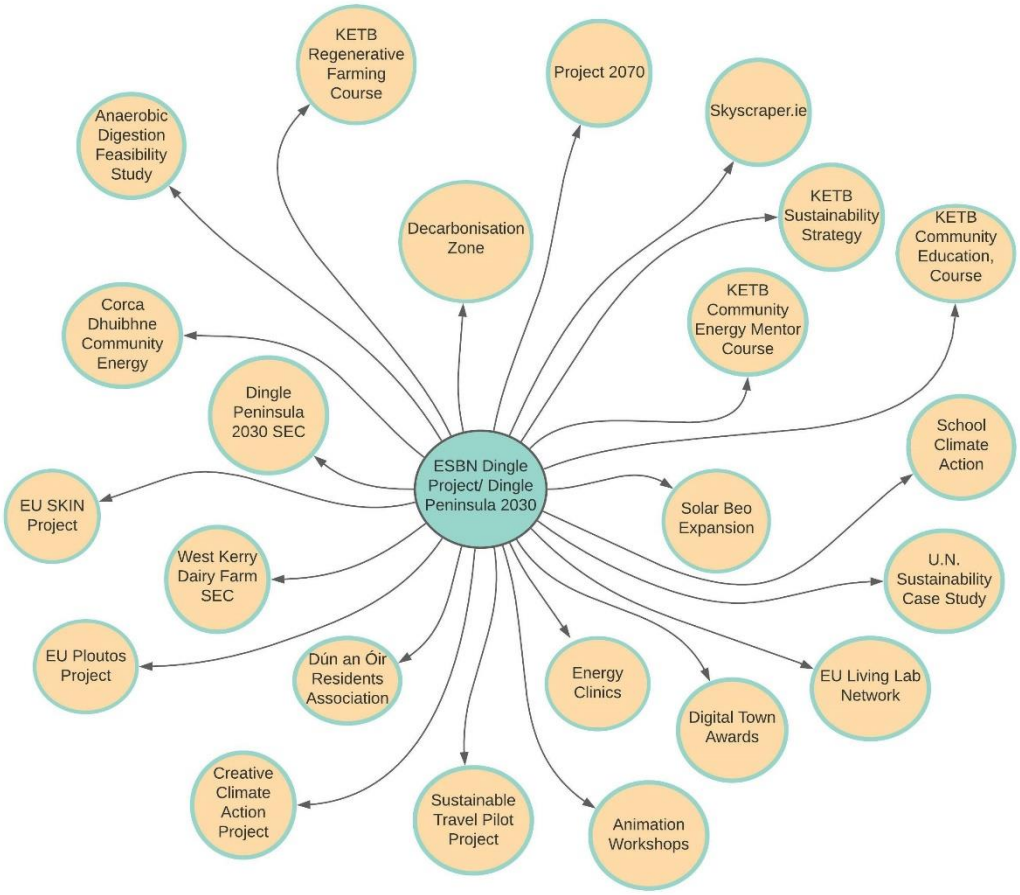


Figure 17. Diffusions of Sustainability emanating from the ESB Networks Dingle Project and Dingle Peninsula 2030.

Corca Dhuibhne Community Energy: In its initial stages, this group has been formed to work on different energy-related initiatives on the peninsula for community benefit. They have submitted a proposal to SEAI's RD&D call and are awaiting its announcement. Members within this group are very active in aligned initiatives across the peninsula. They are all linked by a common interest in community-owned energy.

Decarbonisation Zone: The Dingle Peninsula has been selected as a Decarbonisation Zone by Kerry County Council. As outlined in the Climate Action Plan (2019), a Decarbonisation Zone is a spatial area where different climate mitigation, adaptation and biodiversity measures and action owners are identified to address local low carbon energy, greenhouse gas emissions and climate needs to contribute to national climate action targets. Monitoring progress is central to the approach with a need to build in community decision making and to highlight impact.

Dingle Peninsula SEC: The creation of the Dingle Peninsula Sustainable Energy Community (SEC), through the SEAI SEC Programme, has facilitated the creation of an Energy Master Plan for the peninsula which provides a foundation for future energy projects in the region by outlining current energy use. Within the register of opportunities, pathways for decarbonisation were outlined concerning residential, transport, services and industry.

KETB Community Energy Mentor Course: As part of Dingle Peninsula 2030, a Community Energy Mentor Course was established and administered on the peninsula through the Kerry Education and Training Board (Kerry ETB), training 10 local people as energy mentors. SEAI, MaREI, Sacred Heart University (SHU), Kerry Sustainable Energy Co-op and ESB Networks all contributed to material throughout the course. One Ambassador and one of the Ambassadors' family members took part in the course.

Energy Clinics: Facilitated through the Dingle Hub, and following on from the KETB Community Energy Mentor Course, 'Energy Clinics' were held where residents of the peninsula were given online advice on the possible low carbon technological solutions to their own home upgrades.

Solar Beo Expansion: Through tendering for the installation of solar panels on the peninsula, as part of ESB Networks's involvement in the IERC "Storenet Project", Solar Beo was established to provide clean energy upgrades and retrofits to buildings in Kerry, Cork and Limerick. Since then the company has installed over 150 solar PV installations in Munster and provided businesses and farms with energy upgrades to commit to a clean, reduced carbon, sustainable future in their industry. The *Dingle Project* has played a role in Solar Beo's establishment and responds to the need for local contractors as outlined by participants in the Ambassador Programme.

Sustainable Travel Pilot Project: A steering group has been developed by *Dingle Peninsula 2030* Local Link Kerry, and representatives from the Dept. of Transport to investigate several initiatives related to the decarbonisation of transport on the peninsula. Initiatives under investigation include; new bus services on the Dingle peninsula, transitioning to low carbon emission buses, integrated online booking system and real-time passenger information systems for public

transport, commuter buses from Dingle to and from Tralee (the largest town in the County), and the construction of an EV parking and charging scheme. The EV parking and charging scheme align with some challenges presented to participants in the EV Trial regarding public charging infrastructure. This project will also explore the facilitation of multi-modal mobility - bike racks for buses, areas to lock bikes, storage facilities at bus shelters. It will also seek to scope walkway, cycleway and full greenway development on the peninsula. Car sharing schemes will also be encouraged.

West Kerry Dairy Farm SEC: Initiated and led by an ESB Networks Ambassador & Community Energy Mentors, the West Kerry Dairy Farm SEC has been established to investigate options for decarbonisation of up to 100 dairy farms across the peninsula. A second community energy mentor is the secretary of this group. Solar generation and heat recovery are included in early ideas been explored by the group through the SEAI Energy Master Plan format.

Dún an Óir Residents Association: The residents association with 55 members consisting of holiday homeowners have come together to explore the potential of working together on energy efficiency upgrades.

Conclusion

Sustainability can be coupled with the digital age as organisational macro trends in the 21st century. Both can be aligned with the need for rural development. The emergence of the digital age has significant implications concerning sustainability. With this in mind, in the flux of an energy transition, it is important to equate both the 'digital revolution' and socio-technical transition to a low-carbon society as part of the same development. This is not to suggest a purely complementary application of the two to each other, as there is a potential conflict between these two developments, but rather to make explicit the reality that they are occurring in parallel.

The ESB Networks Dingle Project is aligned with the digital age, where the technological approach involves open networks and platforms, and highly scalable and flexible systems. The process approach is centred on moving from customers to citizens, with an importance placed on engagement. Finally, the decision-making, actionable insights are based on citizen (or participant) input (Lewis & Maslin, 2018). In aligning with the macro trends of the digital age and the transition to sustainability ESB Networks is positioned to play a crucial role in the energy-related societal changes of the 21st Century, just as they have previously done with the rural electrification of Ireland (Sheil, 1984). As part of the ESB Networks Dingle Project, the Ambassador Programme and the EV Trial have provided insights on citizen experiences when adopting low-carbon technologies. These insights can inform strategy moving forward to stimulate widespread adoption and sustainable practices.

With relation to the widespread uptake of residential retrofits, aligning with the targets outlined through the Climate Action Plan (2019), the "retrofitting of homes is unlikely to happen until large-scale peer-to-peer examples displace the perception of retrofitting as a costly and disruptive event with limited benefits" (Mac Uidhir et al., 2020, P.28). Trial projects such as the Dingle Project Ambassador Programme can assist in building an evidence base to outline the benefits of upgrades, which, when paired with effective payback schemes, financial supports, and communicative mechanisms, could move the residential housing stock closer to the stated targets.

The Dingle Project EV Trial has indicated a generally favourable user experience when compared with traditional fuel alternatives. The use of electric vehicles for daily driving practices within a rural area of dispersed settlement was viewed positively. While participant experience was positive it also highlighted the need for more public information with regards to the range of current EV models and the increased range now available, alongside the cost savings when compared with traditional energy sources.

By collaborating with several partner organisations through the *Corca Dhuibhne/Dingle Peninsula 2030* initiative, ESB Networks has been able to take a wider approach to stimulate energy citizenship than what may have been facilitated through an independent strategy. *Corca*

Dhuibhne/Dingle Peninsula 2030 and the *Dingle Project* have both acted in support of one another, with *Corca Dhuibhne/Dingle Peninsula 2030* acting in an intermediate role to some of the diffusions of sustainability outlined within this report. Projects such as *Corca Dhuibhne/Dingle Peninsula 2030*, whilst acting within their own agenda and vision, can operate as intermediaries between top-down policy and bottom-up initiative with relation to the diffusion of sustainability. The implementation of a comprehensive community engagement strategy, as part of the *Dingle Project*, has had a considerable impact beyond the technical trials.

Looking beyond the project timeframe, the local capacity has been developed for the Dingle Peninsula to establish itself as an active energy community in the years ahead. The development of the societal infrastructure required to decarbonise Irish society in the next ten years can be facilitated through the implementation of collaborative engagement strategies such as the one deployed by *Corca Dhuibhne/Dingle Peninsula 2030* and the *Dingle Project.*

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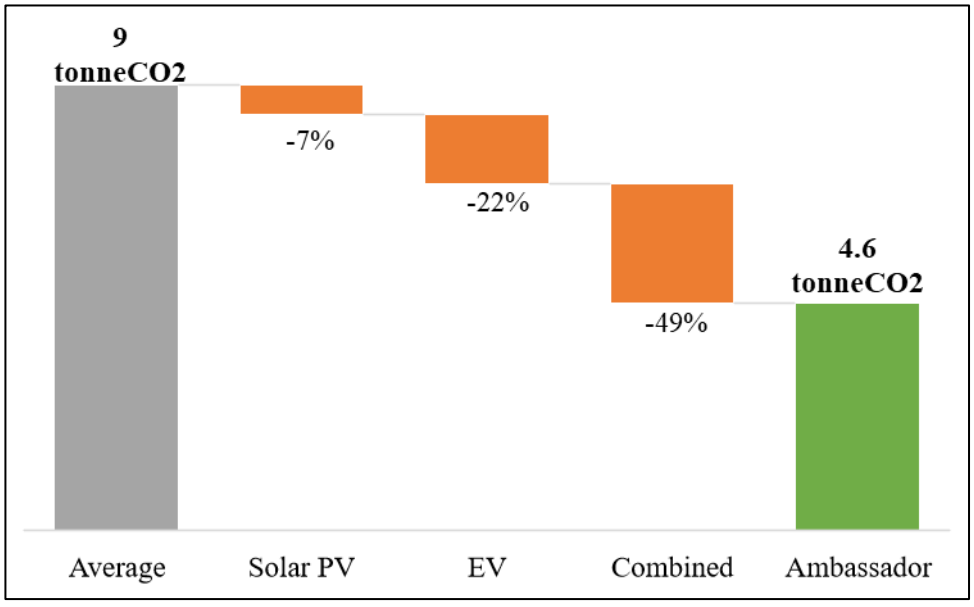
Appendix

Energy by sector and fuel Ireland / Dingle Peninsula (McGookin et al. 2021a, b & c)

ktonne CO2	Ireland		Dingle Peninsula	
Industry	8,637	24%	1.2	1%
Transport*	10,932	31%	36.9	42%
Residential	9,663	27%	30.9	35%
Services	5,316	15%	14.0	16%
Agriculture / Fisheries	816	2%	5.7	6%
	35,364		88.7	
GWh				
Oil	64,143	53%	231.2	75%
Natural Gas	21,263	17%	0.0	0%
Solid fuels	5,658	5%	13.2	4%
Renewables	11,952	10%	25.6	8%
Non-RES Electricity	18,542	15%	36.4	12%
	121,558		306.4	

Overview of energy / CO_2 emission calculations

A comparison of the CO_2 emission savings for each of the trails against an average household on the Dingle Peninsula is shown below.



	tonne CO2 / year						
	avg.	Solar PV		EV		Ambassador	
Heating	3.9	3.9	0%	3.9	0%	2.1	-46%
Appliances, etc.	1.4	0.8	-40%	1.4	0%	0.8	-40%
Travel	3.7	3.7	0%	1.7	-53%	1.7	-53%
	9.0	8.4	-7%	7.0	-22%	4.6	-49%

In the absence of access to recorded energy data, an estimate for potential CO_2 savings as a result of the ambassador programme was determined using the Dingle Peninsula energy system model developed by (McGookin et al., 2021b, 2021c). The estimate of heating was determined by combining data on the Dingle Peninsula housing stock from the 2016 Census (Central Statistics Office, 2016), performance of buildings in Co. Kerry from the Building Energy Rating Database (Sustainable Energy Authority of Ireland, 2020) and CO_2 emission factors from SEAI (Sustainable Energy Authority of Ireland, 2021).

For example in the case of the average D rated house with an oil boiler:

Annual primary heat demand = Avg. energy D-rated x Avg. size D-rated

Annual primary heat demand = 92.2 kWh/m^2 x 128.2 m^2 = 11,818 kWh

Annual primary heat CO_2 emissions) = Heat energy demand x Emission factor

Annual primary heat CO_2 emissions = 11,818 kWh x 0.257 $kgCO_2/kWh$ = 3,037 kg CO_2

Heating		
Annual primary heat demand (D rated / oil boiler)	11,818	kWh
Annual primary heat demand (B rated / heat pump)	4,021	kWh
Annual secondary heat demand (D rated / solid multi-fuel)	2,476	kWh
Annual secondary heat demand (B rated / solid multi-fuel)	2,612	kWh
Kerosene CO2 intensity	0.257	kgCO2 / kWh
Solid fuel CO2 intensity	0.348	kgCO2 / kWh
Grid CO2 intensity (2020)	0.295	kgCO2 / kWh
Annual primary heat CO2 emissions (D rated / oil boiler)	3037	kgCO2
Average primary heat CO2 emissions (B rated / heat pump)	1186	kgCO2
Average secondary heat CO2 emissions (D rated / solid multi-fuel)	862	kgCO2
Average secondary heat CO2 emissions (B rated / solid multi-fuel)	910	kgCO2

Annual heating CO2 emission (D rated)	3900	kgCO2
Annual heating CO2 emission (B rated)	2096	kgCO2
Retrofit / Heat pump savings	1804	kgCO2

For Solar PV, the calculation is quite simple:

Solar PV Generated = Installed capacity x Hours in a year x Capacity factor

Solar PV Generated =2.1 x 8,760 x 0.11 =2,024 kWh

CO2 savings = 1,734 kWh x 0.295 $kgCO_2$/kWh = 597 $kgCO_2$

The approach for private cars was different as data on the performance of the electric vehicles was available and due to the average car per house being 1.45. To get the initial estimate of the average Dingle Peninsula household, instead of working out the contribution of half a car is based on total private car demand divided by the number of homes. This also helps to capture the fact that the car stock doesn't use one fuel but rather is around 65% diesel and 35% petrol. The estimate for the private car sector was generated with the number of cars (Central Statistics Office, 2016), share by emission category in Co. Kerry, and performance values (km driven per year and kWh per km) based on the Irish Car Stock Model (O'Riodan et al., 2021).

Private car	
Total GWh	73.13
Total ktonne CO_2	18
avg. kWh / car	10,277
avg. CO_2 / car	2.5
avg. CO_2 / house	3.7
avg. km / house / year	27,688

The data from ESB Networks on the trial performance to date and cost/emission factors from the SEAI are provided in the table below.

EV trial - Input data		
Number of cars	15	
Distance travelled to date	180,955	km
Number of journeys	29,580	
Average journey	6.12	km
Diesel car share of distance travelled	65%	
Petrol car share of distance travelled	35%	
Diesel engine efficency	0.59	kWh / km
Petrol engine efficency	0.63	kWh / km
EV efficiency	0.17	kWh / km
Diesel CO2 intesity	0.264	kgCO2 / kWh
Petrol CO2 intesity	0.252	kgCO2 / kWh
Electricity grid CO2 intensity (2020)	0.295	kgCO2 / kWh
Cost of diesel	0.11	€ / kWh
Cost of petrol	0.14	€ / kWh
Unit price of elec (household / night rate)	0.10	€ / kWh

The calculation of CO2 savings to date can be seen in the table below. Based on this an expected annual saving was determined as follows:

EV Trial - Calculation		
Diesel km replaced	117,621	km
Associated energy demand	69,360	kWh
Associated CO2 emissions	18,304	kgCO2
Associated cost	7,844	
Petrol km replaced	42,602	km
Associated energy demand	26,708	kWh
Associated CO2 emissions	6,728	kgCO2
Associated cost	3,657	

Average km per car = 180,955 / 15 = 12,063.7 km

Share of annual average driving $= \frac{12{,}064}{18{,}500} = 65\%$

Savings associated with 12 months =

EV energy demand	20,533	kWh	
Associated CO2 emissions	6,059	kgCO2	
Associated cost	€2,053		
CO2 savings (total)	18,973	kgCO2	
	19.0	tonneCO2	
CO2 savings (per car)	1.3	tonneCO2	
Cost savings (total)	€9,448		
Cost savings (per car)	€630		

$$\frac{Savings\ per\ car\ during\ trial}{Share\ of\ annual\ average\ driving}$$

Savings associated with 12 months = $\frac{1.3}{0.65}$ *= 1.9 tonne* CO_2