CIRCULÉIRE

CIRCULÉIRE'S CIRCULAR ICT AND EEE GOOD PRACTICE SECTORAL GUIDE

IRISH MANUFACTURING RESEARCH

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About CIRCULÉIRE

CIRCULÉIRE, the National Platform for Circular Manufacturing seeks to accelerate Ireland's transition towards a net-zero carbon circular economy. A key objective of the programme is to demystify, de-risk and deliver circular business model innovation for Irish industry.

Want to learn more about CIRCULÉIRE? Visit our website at www.circuleire.ie or contact circuleire@imr.ie

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Acronyms

AI – Artificial Intelligence

B2B – Business to Business

B2C – Business to Consumer

CE – Circular Economy

CRM – Critical Raw Materials

EEE – Electrical & Electronic Equipment

EU – European Union

EPA – Environmental Protection Agency

ELV – End of Life Vehicle

EV – Electric Vehicle

ICT – Internet & Communication Technology

IDA – Irish Development Authority

ITAD – Information Technology Asset Disposition

MNC – Multinational Company

OECD - The Organization for Economic Cooperation and Development

SME – Small & Medium Enterprise

Executive Summary

The Electronics and ICT sectors have played a major part in the success of the Irish economy and has been a key driver in the initial industrialisation of Ireland. This success has enabled the current Irish landscape where the world's pre-eminent technology and electronics firms have manufacturing facilities, logistics hubs, European headquarters and an array of other hardware and software related functions call Ireland home.

The initial surge in Electronics and manufacturing in the early 70's lasted until the late 1990's and early 2000's with the offshoring of many manufacturers relocating to Eastern Europe and Asia. Ireland was left with several high-profile manufacturers such as Apple and Intel. The government of Ireland and its development agencies succeeded in transitioning the core of Electronic & ICT sector activities to a services-based sector whilst creating niche expertise in manufacturing and research for multinational companies. For example, the current ICT sector employs 37,000 people and generates €35bn in exports each year.

This guide on the Electronics and ICT sectors presents case studies on how companies in Ireland are transitioning to the systems change required in manufacturing and services to reduce emissions and meet our targets in the coming years. The transition to a sustainable and circular sector is being led by many actors nationally and in Europe. The case studies presented in this guide, demonstrate the activities taking place nationally and internationally in the shift to more circular practices and opportunities.

The guide identifies key enablers in how we can transition to a more circular economy by building capacity through education and training, by funding companies to de-risk their transition through research and by incorporating policy, regulations and legislation that encourage and change existing behaviours in how we manage our resources.

The guide presents an example of the key barriers that may prevent or reducing our effectiveness in transitioning to circular practices. These are based on a lack of strategic or decision making in organisations based in Ireland. For example, materials or design decisions may be made outside of Ireland and the EU which may have a negative impact. The current targets set by the WEEE Directive for the Extended Producer Responsibility model requires review and better targets for more circular strategies on the waste hierarchy needs to be established.

The final section of the guide outlines some of the key recommendations that will enable more circularity in Ireland. Improving the collection, takeback and treatment of WEEE in Ireland can enhance our targets and build in better quality

and efficiencies in our waste sector. Increasing value chain cooperation and innovation in this sector to provide specialised services and circular solutions through research and partnerships between stakeholders can benefit the current ecosystem. Another key recommendation is understanding our post-industrial waste in the form of B2B activities in Ireland. By measuring repair, reuse and refurbishment activities we can quantify the Co_2 savings. A key recommendation that is key to future manufacturing activity in Ireland is the development of a remanufacturing strategy that can enhance existing industrial activity and may be vital in positioning Ireland as a mass producer of renewable energy.

Cluster	Case Study name	Region covered	Top CE Strategies	TRL
Capacity building for CE	**CESI** - Circular Economy Skills Initiative: Capacity Building for the White Goods Repair Technicians	Ireland	Training for Repair	9
	LLLB - Lithium Long Life Battery Project: Dismantling, Recovery & Reuse of EV batteries	Ireland	Dismantling, Recovery & Reuse	8
Design for Circularity	**Framework** - Closing the loop for Laptop computers	Worldwide	Design for Disassembly, Modularity, Repair	9
	Fagerhult - Circular Innovation in Lighting	Europe	Product & Materials Innovation	9
Product Service Systems	**Urban Volt** - Solar & Lighting as a Service	Ireland & UK	Solar as a Service & Lighting as a Service	9
Reuse & Shared Use	**Homie** - Appliances as a Service/Pay per Use	Europe	Pay per Use	9
Remanufacturing	**Cisco** - Refresh: Certified Remanufactured Equipment	Worldwide	Remanufacturing	9
Repair & Refurbishment	**Wisetek** - IT Asset Disposition, Reuse & Manufacturing	Ireland, Worldwide	Reuse, Refurbishment	9
	Glen Dimplex - Repair & Spare Parts Availability Initiative	Ireland & EU	Repair, Refurbishment	9
	TriREUSE - Trialling the Preparation for Reuse of Consumer ICT	Ireland	Preparation for Reuse	7
Recycling, Takeback & Reverse Logistics	**KMK Metals Recycling** - Electrical, Electronic & Metals Waste Solutions	Ireland	Takeback, Recycling, Materials Recovery	9
Industrial Symbiosis	**Tallaght District Heating Scheme (TDHS)** - Waste heat from Datacentres for District Heating	Dublin, Ireland	Waste Energy, Feedstock	9

Figure 1 Case Study Matrix

Section 1 – The Electronics & ICT sector in Ireland

The purpose of this section of is to map out the evolution of Ireland's Electronics & ICT Sector which has contributed significantly to much of Irish economic growth over the last 4 decade(s).

The Electronics and ICT sector in Ireland has adapted to many of the economic challenges it has faced over the past 50 years and the current climate crisis is no different. The focus of the core of this sector has become more niche and diversified into new and emerging technologies.

Section 1 presents the history and background of the Electronics & ICT Sectors in Ireland and how they have become key factors in Ireland's economic success. The next stage of this success will be based on embracing circularity to continue this growth and to lead through innovation and sustainability.

1.1. Background

The ICT Sector in Ireland currently employs over 106,000+ people and generates €35 billion in exports annually(IDA Ireland, 2022). According to IDA Ireland, Ireland is home to the Top 5 Global Software companies and 9 of the Top 10 US Technology Companies have a presence in Ireland.

Ireland has developed into one of the pre-eminent locations for the world's top Electronics and ICT companies. The Electronics & ICT sectors were initially concentrated on manufacturing in the early years, but this has changed due to the evolving transformation of Electronics and ICT sectors due to the offshoring brought about by high labour costs and supply chain difficulties.

The Electronics and Internet and Communications Technology (ICT) sectors have undergone rapid change in the past 40 years in Ireland. The manufacturing of Electronics & ICT was the dominant sector initially, but this has become more focused on the professional services industry with Ireland being a key location for operational, logistics, support and software development activities for the many of the world's largest multinational companies, primarily due to having an English-speaking population, a good education system providing a well-educated workforce and government incentives providing a fertile ground for foreign direct investment (FDI).

The Electronics and ICT sector is a major employer in Ireland and the education sector in Ireland has been aligned from its inception to providing skilled

technicians and engineers to its current incarnation by providing skilled software engineers and developers, cyber security expertise and project management roles. The demand for these specialized skillsets and the concentration of multinationals in the Dublin area has created an increased demand which is being met by employees from all over the world.

1.2. Electronics / ICT Manufacturing in Ireland

The Industrial Development Authority (IDA) in Ireland was setup in 1949 to stimulate, support and develop export-led business and enterprise in Ireland. It was not until 1958 with the introduction of the first Programme for Economic Expansion that Ireland ended its protectionist policies. In 1969 the IDA was made responsible for all aspects of industrial development and from here the IDA was tasked to develop a strategy of searching out emerging growth sectors and to seek inward foreign direct investment (IDA Ireland, 2022).

IDA Ireland sought out new opportunities and targeted the electronics and computer manufacturing with a specific focus on minicomputers, peripherals and subassemblies (van Egeraat and Jacobson, 2004). In 1971 one of the leaders of the minicomputer industry, Digital Equipment Corporation (DEC) or Digital for short setup a large-scale manufacturing plant in County Galway, Ireland. Many other minicomputer manufacturers followed suit due to incentives from the Irish government and an educated work force with relatively low wages.

Digital's presence had a strong demonstration effect among many of the other companies such as Nixdorf (Co. Wicklow) and Wang (Co. Limerick) setup production facilities Ireland in 1978 and 1979. Several other companies' setup in Ireland as can be seen from the timeline in Figure 1.

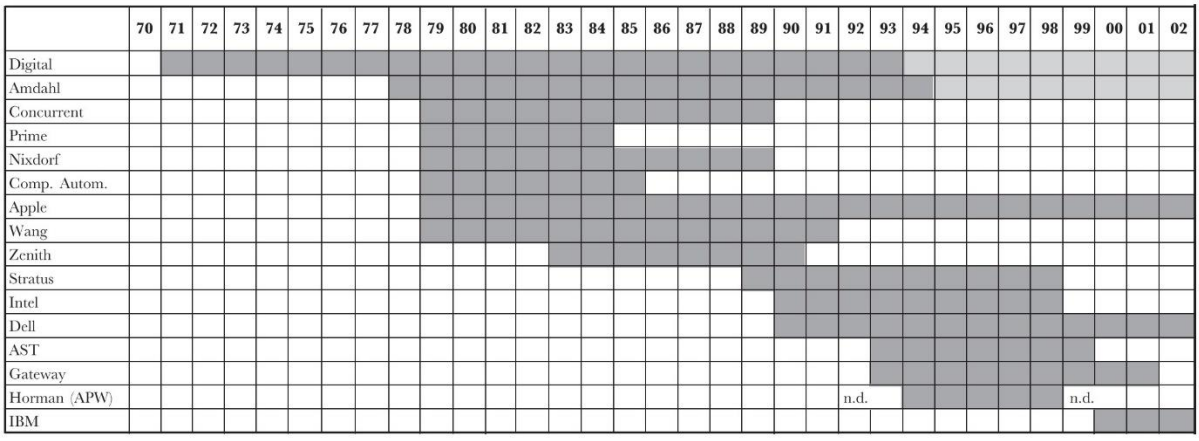

Figure 2 Main computer assemblers in Ireland 1970-2002 (van Egeraat, C. and Jacobson, D., 2004)

The initial manufacturing presence was focused on minicomputer hardware and components. The advent of the personal computer in the 1980's had a global impact on minicomputer manufacturing with many companies leaving the industry or diversifying to meet the needs of the burgeoning microcomputer industry. The IDA identified the microcomputer subsector as an emerging trend and sought to attract these computer & component manufacturers and suppliers. Apple arrived in 1980 as the first personal computer (PC) assembler in Ireland followed by Zenith. Digital and Centronics had opened facilities to produce components for the personal computer assembly sector. In 1989 Intel setup a component manufacturing presence in Ireland for the manufacture of its motherboards and network cards. During the early 90's companies such as U.S companies such as Gateway, Dell and AST setup personal computer assembly plants. Seagate opened facilities for its hard drive production in Tipperary and Derry in 1994.

However, the late 1990's the personal computer assembly sector experienced plant closures and job losses due to increased global competition and more favourable low-wage economies in the east. By 2002 only Dell and Apple were assembling computers in Ireland (van Egeraat and Jacobson, 2004).

The increase in labour and operating costs in Ireland in the 1990's and early 2000's saw a massive reduction in activities in the personal computer manufacturing and the relocation and offshoring of operations further east from locations such as Poland and China. The Digital Equipment Corporation (DEC) or Digital as it was then known is a good example of how companies adapted through takeovers and mergers and still retain a presence in Ireland. Digital began operations in Galway in 1971 and at its peak employed 1200 people from the region. In 1993 Digital announced that it was ceasing to manufacture hardware in the Galway facility with the loss of 700 jobs. Digital continued to operate its European Software Centre at this location. In 1998 Digital was eventually bought out by Compaq who in turn were taken over by Hewlett Packard (HP) in 2002. In 2017 HP was split to create HPE (Hewlett Packard Enterprise), Microfocus and DXC Technology with many of the employees having started out with Digital initially. To this day HPE still operate a Software Development Centre in Galway and have recently named Galway as a European hub for Cyber Security operations with the largest headcount of cyber security professionals in HPE being based in Galway.

The story of Dell Technologies Inc. shares a similar path to that of Digital. Having taken over the Atari manufacturing facility in Raheen, Co. Limerick in 1991, Dell moved to expand computer assembling operations in the facility. Dell assembled its products in Limerick for over 18 years but in 2009 Dell laid off 2500 employees with the decision to transfer manufacturing from Ireland to Poland. Dell continues to have a strong presence in Limerick after the manufacturing arm moved abroad. The Dell campus is home to several Global and EMEA wide operations with the Applications Solution Centre, the Enterprise Command Centre and Finance.

The current ICT & Electronics manufacturing sector is Ireland dominated by semiconductor manufacturers by Intel in Leixlip, Co. Kildare and Analog Devices in Co. Limerick. The only remaining multinational computer manufacturing plant that is still in operation is Apple's facility in Holyhill, Cork City. As previously stated, 9 of the top 10 technology companies in the world have a presence in Ireland, but these facilities tend to be involved in services such as Finance, Operations, Logistics and Research & Development with manufacturing having been phased out and operations relocated to other parts of the globe.

Although Ireland is home to a number of large-scale global players, almost 95 per cent of manufacturing firms employ less than 50 people

(Forfas, 2020)

The current landscape for electronics in Ireland is represented by many Small to Medium Enterprise (SME) as independent entities or as part of Multinational (MNC) organisations. These companies have been in operation for many years and have diversified from the initial electronics manufacturing operations for ICT to adjacent sectors such as automotive, consumer products and specialised electronics manufacturing services. The services on offer vary from component design, building sensors for IoT applications , refurbishment of electronic products or surface-mount technology (SMT) assembly. Presented in Figure X is an example list of some of the current companies in Ireland.

Company	Services	Location
Alps Alpine	**Electronics for Automotive, IoT, White Goods**	**Millstreet, Co. Cork**
Ei Electronics		**Shannon, Co. Clare**
Emdalo Technologies	**IIoT, Firmware**	**Shannon, Co. Clare**
iQuTech	**Electronics Refurbishment, Software**	**Annacotty, Co. Limerick**
Macom	**RF, Optical & Networking**	**Little Island, Co. Cork**
Microchip	**Embedded control applications & semiconductors**	**Ennis, Co. Clare**
Smart Electronics	**SMT & Prototype Assembly**	**Shannon, Co. Clare**
Taoglas	**Antenna & RF design**	**Wexford & Dublin**
Valeo	**Powertrain Systems Comfort & Driving Assistance Systems**	**Tuam, Co. Galway**

Figure 3 Sample of Electronics companies & activities in Ireland

1.3. ICT Services sector

Ireland's technology landscape can be divided up into the following core groups; Software, Global Business Services, Engineering & Industrial Technology, Fintech, Semiconductor & Communications Technology, Artificial Intelligence and Cyber Security (IDA Ireland, 2022).

In 2019, the largest ICT services subsector in the EU, 'Computer programming, consultancy and related activities', employed 10 times more persons than the largest ICT manufacturing subsector, 'Electronic components and boards'. Eurostat

The move towards ICT Services has seen employment and opportunities increase in Ireland. The third-level education sector has been quick to respond to the new opportunities created by the move to a more services-based ICT sector. Most third-level colleges offer courses in Software, Engineering, AI and Cyber Security to fill the gap left by the Manufacturing sector. The recent departure of the United Kingdom from the European Union has solidified Ireland's place as the prime English-speaking location for doing business in the EU.

1.3.1. Infrastructure

The cloud is a term for ICT infrastructure that stores data offsite in in centralized locations. The transition to ICT Services that exist in the cloud has seen the growth of many datacentre-based services such as Amazon Web Services (AWS) and Microsoft Azure. There are several reasons why Ireland is suitable as a data centre location.

- our electricity grid system has large amounts of renewable energy supplemented with connections to the UK and future connections to France.
- Ireland has a temperate climate which requires less cooling infrastructure for the heat generated from these data centres.

- Ireland has a skilled work force in the terms of data centre operations and the construction industry.

The data generated by social media apps such as Facebook and Twitter are based on cloud architecture to provide resilience and security for this infrastructure. Ireland has used the benefits of having a large wind powered renewable energy sector to provide clean energy to these data centres. The Irish Grid regulator EirGrid has highlighted that the increasing the number of datacentres in Ireland may have a negative effect on meeting our own domestic energy needs in the coming years. It has been estimated that there are over 50 operational data centres in Ireland with 8 more in the construction phase and planning approval has granted for over 20 others.

1.3.2. Social Media

The biggest global social media companies from Meta/Facebook, TikTok, Twitter and LinkedIn have their European Headquarters in Ireland. These presences range from operations to software development to datacentre hosting.

1.3.3. Business Services

Ireland is well served by the largest worldwide online business services providers and it the location of many operations including software engineering, customer support, finance and logistics. Companies such as Google, eBay, PayPal, Amazon, SAP and Oracle all have considerable presences throughout Ireland.

There is also growing digitization of the Medical and Pharma sectors in Ireland with software development centres being opened by Becton Dickinson and Johnson & Johnson (Vision Care) in Limerick. There is also a burgeoning tech start-up ecosystem in Ireland with many young companies providing niche services to and for the Electronics & ICT sectors.

1.4. Circularity in the Irish Electronics & ICT sector

The challenge for the Electronics and ICT Sectors in Ireland in the current climate crisis and supply chain disruptions caused by world events is the transition to more sustainable operations. The race to Net Zero in terms of carbon footprint will require a change in current practices and the pivoting to alternative solutions.

The transition is already underway with the move to renewable energy, water reuse, waste treatment and waste heat. The transition to a low carbon economy has been embraced by most multinationals based in Ireland with many locations

using renewable energy provided by the main electric utility companies and in some instances Solar PV is used to supply power to locations.

In addition, the circular economy has become more prevalent in business given recognition that it is integral to decarbonisation – as it is estimated that circa 45% of emissions are attributable to products (EMF & Material Economics, 2019). The change in practice from the linear model of business to a more circular model is driving innovation and presenting opportunities for better more efficient uses of materials and products. Circular economy business models are becoming part of standard practice in organizations and helping to drive change by enabling companies to make informed decisions based on sustainability and their products value proposition.

1.4.1. Methods

The report is based on information gathered using the following methods. An initial two-part scoping desktop review was conducted on:

1. The literature on circular economy in the Electronics & ICT sectors
2. Policies and public-sector led initiatives aimed at supporting circular Electronics & ICT

The findings of the desktop review were used to refine our Sectoral Guide objectives and were used to develop key criteria to select our case studies, using purposeful sampling, and to develop our analytical framework. Key circular economy databases were identified and used to identify a long list of circular innovations in the fashion and textiles sector.

In the final stage of our research, we identified and selected case studies according to the following criteria:

Circularity of the company, project or initiative	In order to enable comparative analysis of the processes enabling different kinds of innovation, we sought to select projects which explicitly presented themselves as a circular innovation, pursued one or more circular economy strategies (CIRCULÉIRE, 2022), and which illustrated circularity under on or more of the following 'layers': 1. Capacity building for the Circular Economy 2. Design for Circularity 3. Product Service Systems 4. Reuse & Shared Use 5. Remanufacturing 6. Repair & Refurbishment 7. Recycling, Takeback & Reverse Logistics 8. Industrial Symbiosis

Impact of the project/ initiative (proven or high potential)	"Circularity" in and of itself does not guarantee positive social, economic, and environmental performance (i.e., sustainability) (Blum, Haupt and Bening, 2020). Case studies were shortlisted on the basis that they overtly self-identified as circular innovations and have demonstrated an effort to create impact(s) against different social, economic and environmental impact indicators. Consideration was given to ensure projects and initiatives profiled demonstrated positive performance (proven or high-potential if scaled) against material waste and carbon emission reductions. While we targeted examples of potential or established good practices, the aim of the case studies was not to evaluate projects or organisations - since even less 'successful' cases can yield important insights about existing barriers to implementing or scaling circular innovations.
Technological Readiness Levels (TRLs) of the Initiative	To gather information on both emergent / cutting-edge innovations and more established, 'market ready' circular electronic and ICT innovations, we selected case studies that were judged to range from TRL 6 – 9. This enabled us to gather insights about the opportunities and challenges (such as regulatory, scaling and replication challenges) from circular electronics and ICT innovations at different stages of maturity.
Geographic variety	To analyse the processes associated with supporting circular electronics and ICT innovations in different socio-economic and policy contexts, and in the context of different market and sectoral conditions, we select cases from a variety of regions (with a particular focus on European regions). Particular attention has been given to spotlight good practices originating or operating in other regions, nonetheless, the Guide also endeavours to highlight good practice examples of circular innovations identified within Ireland too.

Figure 4 Methodology for Case Studies

Comparative analysis was undertaken to understand processes and approaches that have been adopted and the insights gathered around the opportunities and gaps were used to inform the recommendations presented in section 3 about how the Electronics & ICT Sectors can be supported to transition to a circular economy in the Irish context.

1.4.2. Structure of the Guide

This Guide is structured as follows:

- Section 2 builds on desk research and summarises good practices of circular Electronics & ICT innovations in action from Ireland, Europe and Worldwide.

- Section 3 draws on the lessons learnt from the case studies and from other contexts that have made good progress in advancing circular electronics and ICT. It offers recommendations about what's needed to advance a circular economy for the Electronics & ICT sector here in Ireland.

Section 2 – Circular Economy Innovations in the Electronics & ICT Sector

Ireland has been home to many electronics and electrical manufacturing companies since the 70's and while the manufacturing sector is much reduced, these companies still retain a presence owing to our proximity to the United Kingdom and the European Union and also due to status as an English language country. The offshoring of manufacturing operations took place with many multinationals moving these bases lower labour countries in Eastern Europe and China. Companies such as Dell, HP, IBM and Logitech maintain a presence in Ireland with specialities in logistics, operations, software and sustainability. In this section we will present case studies that highlight circular economy practices that are being undertaken in Ireland, the European Union and globally.

2.1. State of the Art in Ireland

The policy and regulatory frameworks for the Circular Economy in Ireland have undergone a rapid change since 2019. In the past two years we have seen the Waste Action Plan for a Circular Economy (2020), the All of Government Circular Economy Strategy (2021) and the Circular Economy Act (2022) being introduced to enable the circular economy to move forward. The Circular Economy and its principal strategies have been developed by government funding through the Environmental Protection Agency (EPA). Recycling activities have been the main activity for the Metals, WEEE and Packaging industries in Ireland mainly due to two reasons, a valuable end of waste commodity (Steel, Copper, Aluminium etc.) and the presence of Extended Producer Responsibility schemes being in operation and formalising takeback and recovery of materials (WEEE and Packaging). Ireland has two compliance schemes in the WEEE sector, WEEE Ireland which accounts for around 80% of the sector and ERP Ireland which represents 20% and both schemes have similar values geographically in Ireland.

The largest metals and WEEE recycling/recovery facility is operated by KMK Metals Recycling in Co. Offaly. KMK Metals Recycling are a WEEELABEX certified facility. Much of the waste electronics and electrical equipment is sent for further processing in the UK and Europe.

The Repair strategy has become more noticeable in recent years with initiatives such as the Repairmystuff.ie website which lists local repair companies throughout Ireland. Remanufacturing and Refurbishment has seen increasing activity especially in the ICT and Electronics and Electrical sectors.

The lack of heavy manufacturing in Ireland has been a barrier to some of the better-known remanufacturing activities that takes place in the Automotive and Medical industries globally and this coupled with our close proximity to the United Kingdom means that these activities tend to happen elsewhere.

There are however opportunities for many companies to understand the value chain of their products and what future opportunities may be available by undertaking remanufacturing to recover value in used products and parts.

Product Service Systems have enabled many companies to add value to their offering by offsetting the capital cost for their customers. The product service system allows companies to retain ownership by means on a rental model that helps reduce initial cosy outlay. These new circular systems have seen growth in the areas of Car Rental, White Goods and Lighting to name a few.

Case Studies will be presented on UrbanVolt and Fagerhult who both operate in the lighting sector and have developed innovative circular economy business models that have transformed the way these businesses are operated and added value through sustainable actions.

This Sectoral Guide is intended for those involved in Ireland's Electronics & ICT industry, including economic operators in the value chain (such as retailers), and key decision-makers, such as funders and policymakers. It aims to provide industry stakeholders with an overview of good circular economy practices from the electronics and ICT sectors to inspire, increase knowledge & awareness and encourage replication and adoption of good practices from across Europe to the Irish context. For policymakers, the Guide is intended to draw attention to some of the key policy enablers which supporting the advancement of circular Electronic & ICT sectoral activity in other jurisdictions.

In this guide, the following clusters which are driving circular innovations in the Electronics & Textile sectors are given particular attention:

1. Capacity building for the Circular Economy
2. Design for Circularity
3. Product Service Systems
4. Reuse & Shared Use
5. Remanufacturing
6. Repair & Refurbishment
7. Recycling, Takeback & Reverse Logistics
8. Industrial Symbiosis

2.2. Emergent vs Established practices (EU & Worldwide)

The EEE & ICT sector have developed and transformed at a rapid pace. Innovation and design have created what we consider essential products for consumers and businesses. The rapid pace of innovation however comes at a cost, much of the gains of the electronics industry has come in the areas of miniaturisation and energy efficient equipment which have aided the development of smart products (smartphones, smart watches etc.) but this innovation has created products that contain "critical" materials from lithium to gallium and many more.

These critical raw materials are critical due to an increased demand from other sectors such as the Clean Energy (Renewables) and Electric Vehicle sectors. These materials are also critical as the supply chain for these materials are characterised as being sensitive to geopolitical events e.g. China has reduced the availability for some critical raw materials to be used internally and this has created volatility in the market for supply.

Accessing raw materials that contain the valuable building materials of our modern technology industries is labour intensive, causes environmental damage and has a large carbon footprint. Many of these raw materials are located in specific regions that may or may not be accessible to outside markets and depend on the political will in that country or region as to who and how they do business. The demand for these materials has created a perfect storm with many countries reopening older mines to maintain supply chain security.

The Urban Mine has been proposed as an alternative method to source raw materials needed for the technology sectors. The Urban Mine is the supply of devices and products that have already been produced and are in use or storage in our homes and businesses. There is much research being undertaken on how we recover these products and recycle them. The current recycling processes and technologies have been in existence for many years and are only focused on the recovery of large fractions and mostly for precious metals (gold, silver, copper).

End of life strategies are vital to make the technology sector more sustainable, in Europe the prevailing strategy has focused on recycling which is the lowest R on the Waste Hierarchy pyramid. Recycling has achieved many targets as set out by the EU but due to falling collection rates, there is now a consensus that we now need to examine how we calculate how these targets and introduce new methods and use an all-actors approach. There has been a growing movement that aims to introduce the Repair strategy to increase a products lifetime. The Right to Repair movement and organisations like iFixit have popularised this strategy among consumers and created an awareness that has incentivised businesses to introduce more favourable repair options that adds value and maintains customer loyalty. The Reuse strategy has met with limited success but companies have developed economic and environmental savings by reusing repaired products which are then classified as refurbished and which then are used to supply products for warranty replacement items. Apple and Glen Dimplex are examples of one of many companies who operate this model successfully.

Technology company Google has based its operating model on circularity in its products, buildings and datacentres. 27% of upgrade components for their datacentres were sourced from refurbished inventory and across their consumer products range, they have prioritised to using 50% recycled or renewable content by 2025.

The Platform for Accelerating the Circular Economy (PACE) in partnership with Accenture developed the Circular Economy Action Agenda for Electronics and stated that there are 10 action points that are vital to advancing circularity: incentivise & support product design for circularity, increase supply of recycled content, change consumer behaviour, implement new circular business models, increase takeback, create better collection systems, formalise transboundary movement, improve recycling processes, invest in better and more efficient recycling technologies and provide decent work in the transition to a circular economy (PACE and Accenture, 2021).

The consensus is building among companies in the technology sector that there are many rising challenges that will affect this sector in the coming years and that action needs to be taken to secure supply chains, develop substitute materials, innovate with new materials, increase the uptake in more favourable end of life strategies and improve recycling processes and technologies.

2.3. Case Studies

This section will present case studies that build on the innovative circular practices that have been developed and are being used in the Electronics & ICT industry. The case studies will outline the circularity of these strategies and present how these practices have improved existing processes.

The circular strategies being presented in this sectoral guide will highlight the following:

- Capacity building for the Circular Economy
  - CESI
  - LLLB
- Design for Circularity
  - Framework
  - Fagerhult
- Product Service Systems
  - Urban Volt
- Reuse & Shared Use
  - Homie
- Remanufacturing
  - Cisco
- Repair & Refurbishment
  - Wisetek
  - Glen Dimplex
  - TriREUSE
- Recycling, Takeback & Reverse Logistics
  - KMK Metals Recycling
- Industrial Symbiosis

- Tallaght District Heating Scheme

The case studies highlighted in this chapter are in many cases, built on the back of previous research and collaboration in the EEE & ICT sector between government, academic research and representative organisations.

Table 2.1 Overview of the Electronics & ICT CE Case Studies

Cluster	Case Study name	Region covered	Top CE Strategies	TRL
Capacity building for CE	**CESI** - Circular Economy Skills Initiative: Capacity Building for the White Goods Repair Technicians	Ireland	Training for Repair	9
	LLLB - Lithium Long Life Battery Project: Dismantling, Recovery & Reuse of EV batteries	Ireland	Dismantling, Recovery & Reuse	8
Design for Circularity	**Framework** - Closing the loop for Laptop computers	Worldwide	Design for Disassembly, Modularity, Repair	9
	Fagerhult - Circular Innovation in Lighting	Europe	Product & Materials Innovation	9
Product Service Systems	**Urban Volt** - Solar & Lighting as a Service	Ireland & UK	Solar as a Service & Lighting as a Service	9
Reuse & Shared Use	**Homie** - Appliances as a Service/Pay per Use	Europe	Pay per Use	9
Remanufacturing	**Cisco** - Refresh: Certified Remanufactured Equipment	Worldwide	Remanufacturing	9
Repair & Refurbishment	**Wisetek** - IT Asset Disposition, Reuse & Manufacturing	Ireland, Worldwide	Reuse, Refurbishment	9
	Glen Dimplex - Repair & Spare Parts Availability Initiative	Ireland & EU	Repair, Refurbishment	9
	TriREUSE - Trialling the Preparation for Reuse of Consumer ICT	Ireland	Preparation for Reuse	7
Recycling, Takeback & Reverse Logistics	**KMK Metals Recycling** - Electrical, Electronic & Metals Waste Solutions	Ireland	Takeback, Recycling, Materials Recovery	9
Industrial Symbiosis	**Tallaght District Heating Scheme (TDHS)** - Waste heat from Datacentres for District Heating	Dublin, Ireland	Waste Energy, Feedstock	9

Figure 5 Overview of Electronics & ICT CE Case Studies

Case Study#1 - Circular Economy Skills Initiative (CESI) Project
Capacity building for White Goods Repair Technicians

Website: https://fit.ie/circular-economy-skills-initiative/
Partner(s) involved: WEEE Ireland, Fasttrack into Information Technology (FIT), Louth Meath Education & Training Board (LMETB)
CE Strategies used: Repair, Reuse, Disassembly
Type of CE innovation: System Innovation
Region(s) it's based in: Ireland
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- The CESI project was developed to address the need for suitably qualified repair technicians to service white goods appliances.
- The initiative aims to address the current shortfall in new technicians in this sector by training which will help maintain, repair, reuse and recycle appliances.
- The syllabus was developed to address and educate trainees on the sustainability and circular economy practices.

Background of the initiative

- The CESI project is a collaboration between WEEE Ireland, FIT, the Louth Meath Education Training Board, the White Goods Association and funded by CIRCULÉIRE's Innovation Fund.
- WEEE Ireland are an extended producer responsibility (EPR) scheme in Ireland who represent 96% of the Irish battery industry and 74% of the household electrical and electronics industry.. WEEE Ireland are one of the founding members of CIRCULÉIRE network.
- Fasttrack Into Technology (FIT) is a representative organisation for the technology sector and is committed to growing skills and capacity for the tech workforce in Ireland.
- White Goods Association (WGA) are a trade association and part of IBEC, who are Ireland's largest business representative group. The membership of the WGA, contain companies such as Beko, B/S/H, Miele and Whirlpool among others.
- The Louth Meath Education Training Board (LMETB) is the largest education and Training provider in Louth & Meath providing education and training to over 30,000 students each year.
- The CESI initiative was created to address the chronic shortage of skilled technicians in the White Goods Repair sector and To build capacity and skills in the repair industry.

Impact and maturity of the initiative

- The CESI project began its first intake of students in March 2022 and was subsequently oversubscribed.
- The majority of trainees completed their training and received full offers of employment by industry sector partner.
- 45 white goods appliances were repaired during the first course.
- 10 participants were trained as Repair technicians.
- The benefit of this initiative is that the stakeholders joined forces to understand the issues that may stifle the circular economy strategy of repair and reuse for White Goods Appliances and sought to address the skills gap and provide a solution that can be replicated in other sectors.

Case Study#2 - Lithium Long Life Battery (LLLB) Reuse Project
Building capacity for the recovery and reuse of EV Batteries

Website: https://www.weeeireland.ie/close-the-loop-initiatives/long-life-lithium-batteries-lllb-centre-of-excellence/
Partner(s) involved: WEEE Ireland, KMK Metals Recycling, Wisetek
CE Strategies used: Product & Material Recovery
Type of CE innovation: Reuse & Disassembly skills
Region(s) it's based in: Ireland
TRL: 8

What circular challenge / opportunity is the case study trying to address?

- The rise in Electric Vehicles (EV) has created an opportunity on the island of Ireland to increase circularity through recycling and reuse while also reducing the costs of lithium battery recovery.

Background of the initiative

- The project has been funded by CIRCULÉIRE (the National Platform for Circular Manufacturing) Innovation Fund Demonstrator Project.
- The LLLB project is a collaboration between WEEE Ireland, Wisetek and KMK Metals Recycling.
- WEEE Ireland is the largest Extended Producer Responsibility scheme in Ireland and
- Wisetek are an IT Asset Disposition company headquartered in Cork and with facilities globally.
- KMK Metals Recycling are Irelands largest processor and recycler of e-waste and are based in Tullamore, Co. Offaly.
- The project aimed to demonstrate a pilot on how to build capacity and skills to allow the disassembly and reuse of EV battery modules in Ireland.

Impact and maturity of the initiative

- The LLLB project has successfully demonstrated how a circular system to process end of life & damaged EV batteries by removing damaged modules and recovering valuable resources would work.
- The project has demonstrated that the weight of exported batteries can be reduced by 50% and reduces the carbon footprint as well as recovering valuable resources.
- The LLLB project is at a mature level and is being deployed as a service offering by KMK Metals Recycling in Co. Offaly
- This initiative is a TRL 8 and is mature.
- Take a look at the recording of the LLLB pilot project dissemination webinar as well as 10 key lessons from the innovation pilot here: https://circuleire.ie/10-things-we-learnt-from-the-long-life-lithium-battery-lllb-re-use-pilot/

Case Study#3 – framework - Closing the loop for laptop computers

Website: https://frame.work/ie/en
Partner(s) involved: framework
CE Strategies used: Design for Disassembly, Modularity, Design for Reparability, Design for Upgradability.
Type of CE innovation: Product Innovation
Region(s) it's based in: USA (Shipping worldwide)
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- The consumer electronics industry has been slow in understanding the needs of consumers in terms of extending a products lifetime and therefore has neglected the potential for repairing, replacing or upgrading components or parts of computers etc.
- Laptop computers can be easily damaged but not easily repaired. framework designed a slimline laptop that allows components to be replaced, repaired, upgraded and recyclable thus extending a products lifetime and reducing e-waste.
- framework is showing the consumer electronics industry that design and sustainability can be a winning idea for modern laptops.

Background of the initiative

- Framework was founded in 2020 and has had significant funding success in the past two years.
- The framework laptop is available to order in the US, Canada, UK, Germany, France, Ireland, the Netherlands and Austria.

Impact and maturity of the initiative

- Framework estimates that each laptop emits 1/3 of a metric ton CO_2eq through manufacturing and logistics.
- As framework does not produce the individual components, it is reliant on manufacturers to reduce their emissions but they are aiming to make their laptop carbon neutral by offering customers the ability to purchase carbon capture & sequestration in their online marketplace.
- The business is at TRL 9 and is operating successfully and exports to several overseas marketplaces.
- The framework laptop is OS neutral which allows the customer to have a choice on their favoured operating system.
- iFixit have awarded the framework laptop a reparability score of 10/10.
- framework have been awarded a red dot "best of the best design award".
- The arrival of framework and their unique selling point has seen several other large manufacturers of laptops re-design their products to incorporate design for repair, modularity and upgradability.

Case Study#4 – Fagerhult – Circular innovation in Lighting

Website: https://www.fagerhult.com/about-fagerhult/
Partner(s) involved: N/A
CE Strategies used: Design for Refurbishment ,Design for Repair, Design for Disassembly,
Type of CE innovation: Product & Materials Innovation
Region(s) it's based in: Europe
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- Fagerhult has introduced the concepts of refurbishing and material innovation to its luminaire products to incorporate sustainable and circular economy practices in its portfolio.
- Fagerhult has develop the Whitecroft Vitality product range to concentrate on a circular approach to its materials and products.

Background of the initiative

- Fagerhults as it was originally known was formed over 75 years ago in Sweden by Bertil Svensson.
- Fagerhults were one of the first luminaire manufacturers to develop a plastic housing fitting for the Fabian range of lighting products. The Lucifer light was the first luminaire's to be made completely from plastic and since become a design icon.
- Fagehults also developed the modular interconnected light fittings for offices and workplaces called the Trimtube 2000.
- Innovation has been a key driver in Fagerhult products leading to the current range of Re:Furbish and Re:Think initiatives to drive innovation in sustainability.
- The Re:Furbish initiative integrates a circular mindset to reuse and recycle resources in a more sustainable way. This initiative provides a method of renewing and reusing existing lighting solutions with more sustainable materials and better energy efficiency.1
- The Re:Think initiative has developed and created innovation in materials use for Fagerhult products reducing luminaire housing and packaging.1
- Fagerhult are a leading manufacturer in the luminaire/lighting industry, they have continued to innovate with their materials use, energy efficiency and to develop sustainable products that are driving the transition to a circular economy.

Impact and maturity of the initiative

- Fagerhult through its Whitecroft Lighting division have been able to save 2000kg worth of new materials and reduce energy usage to 23W per fitting and save 1.5 t of packaging for a project for the Cheshire Police Authority by adopting circularity principles and practices.1
- Fagerhult as an organisation have managed to reduce plastic in their products by 67%.
- This case study is at a high TRL (9) level as it has been adopted and deployed among its customers.
- Fagerhult's Whitecroft division has developed a Vitality ReLight project to regenerate lighting systems to reduce waste and decarbonise facilities.

Case Study#5 - UrbanVolt - Solar & Lighting as a Service

Website: https://urbanvolt.com/
Partner(s) involved: N/A
CE Strategies used: Product as a Service (PaaS)
Type of CE innovation: System Innovation
Region(s) it's based in: EU/Worldwide
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- UrbanVolt have developed a no-cost model to help companies to install solar and led lighting.
- UrbanVolt have used the PaaS to create a Solar as a Service (SaaS) and Lighting as a Service (LaaS) offering.
- UrbanVolt cover the upfront cost of installing or changing the Solar or Lighting through a monthly service fee.

Background of the initiative

- UrbanVolt was founded in 2015 by Kevin Maughan, Declan Barrett and Graham Deane in Dublin, Ireland.
- UrbanVolt has offices in Ireland, the US and Germany to service their growing client base.
- They have created a sister company called Dataful to capture energy usage data and to help clients make informed decisions to help with the transition to a more sustainable business.
- UrbanVolt have borrowed €30m from The Irish-Swiss climate-action investment group Solas. This will fund further expansion of solar panel installs and lighting solutions.
- UrbanVolt customers include Heineken, Pfizer, Zimmer Biomet and Syncreon.
- UrbanVolt became Irelands first certified B Corporation in 2018.

Impact and maturity of the initiative

- UrbanVolt's solar as a service offering has installed over 3MW's of Solar Panels which is enough to produce 960 MWh of energy which equates to removing 460t of Co_2 from the atmosphere each year.
- In August 2022, UrbanVolt were able to produce 60% of their clients' needs through solar energy.
- UrbanVolt's solar as a service solution has been in operation in materials and hardware supply company TJ O'Mahony's thirteen locations and has created savings of €325,000 a year on energy bills.

Case Study#6 -HOMIE: **Appliances as a Service/Pay per use**

Website: https://www.homiepayperuse.com/en/our-story/
Partner(s) involved: Homie
CE Strategies used: Pay per use
Type of CE innovation: Product Service System
Region(s) it's based in: Europe
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- The current ownership model for white goods appliances can be restrictive to people renting or requiring short stays.
- Ownership of appliances can be expensive with maintenance and servicing being required to sustain operation.
- Homie have identified an opportunity to provide a product service system (PSS) to appliances through a subscription-based model.
- Homie aim to stimulate lowering energy usage while saving money for customers. Homie repair, replace and relocate your appliance.

Background of the initiative

- Homie was created from academic research in TU Delft in the Netherlands. The research posed the question, **how can we stimulate sustainable usage of home appliances?**
- The Pay-per-Use concept was trialled in 2017 and the results indicated that the concept resulted in more sustainable behaviours, which led to fewer washes and at lower temperatures.

Impact and maturity of the initiative

- Homie have collected data from a study they undertook and found that Homie users are able to reduce their energy consumption for washing by up to 25%.
- Homie increases the product lifetimes through a preventative program of repairs and maintenance.

Case Study#7 - Cisco Refresh - Certified Remanufactured Equipment

Website: https://www.cisco.com/c/en/us/products/remanufactured.html
Partner(s) involved: N/A
CE Strategies used: Remanufacturing
Type of CE innovation: Process/Product Innovation
Region(s) it's based in: Ireland/EU/Worldwide
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- Cisco have developed an initiative to reuse their equipment through remanufacturing. The initiative is called Cisco Refresh.
- Cisco are creating a Lifetime Extension strategy through remanufacturing which allows equipment to be reused.
- To complement this initiative Cisco, have their own Takeback and Reuse Program, this allows Cisco to receive used goods which can be feedstock for their remanufacturing program.
- The Cisco Refresh program is backed up with ISO 9001/14001 certification for remanufacturing.

Background of the initiative

- Cisco employs 79,500 people across 95 countries and generates revenues of approximately US$50bn.
- Cisco has been selling its high-quality remanufactured products since 2001 under the Cisco Certified Refresh Equipment (CCRE) program.
- Cisco has developed the Send IT Back app for the US, German & Dutch markets which saw a 156% increase in items being returned via the app.
- The Cisco Takeback and Reuse program reuse and recycle 99.9% of returned equipment.
- Cisco provides a free takeback service for its products.
- The example of Cisco's Refresh program is that they can add value to their end-of-life products by extending the lifetime but also providing availability of products which may have legacy customer requirements. By addressing their end-of-life products, Cisco are able to create a value chain which bolsters their environmental credentials while optimising their product range for specialised and budget constrained customers.

Impact and maturity of the initiative

- Cisco has been selling its high-quality remanufactured products since 2001 under the Cisco Certified Refresh Equipment (CCRE).
- Cisco Refresh is available in over 70 countries.
- Cisco Refresh products are ideal for customers who may have a constrained budget, need better product availability or require compliance with environmental goals.
- Remanufacturing uses less energy than manufacturing and also extends the product lifetime.
- Cisco Refresh carry over 6,500 active and end of sale products (no longer available) and provide at least 1 year of support. The products range from switches, routers, wireless, IP telephony and security.
- Cisco's remanufacturing program has been in operation since 2001.

Case Study#8 – Wisetek - IT Asset Disposition, Reuse & Manufacturing

Website: https://wisetek.net/
Partner(s) involved: DELL EMC, HP
CE Strategies used: Reuse, Refurbish, Lifetime Extension
Type of CE innovation: Process Innovation
Region(s) it's based in: Cork, Ireland & Worldwide
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- Wisetek are a solution provider for end-of-life business ICT equipment.
- Wisetek enable businesses to dispose of their end-of-life ICT equipment by providing the following services such as data sanitisation, decommissioning, data destruction & shredding.
- Wisetek seek to make their business model circular by either reusing or refurbishing the product or the parts of the equipment that handle.
- Once the equipment has been processed, Wisetek repair, refurbish and reuse this equipment for other markets. This enables a longer life for equipment which has high embodied energy from its manufacture.

Background of the initiative

- Wisetek have been in operation for 12 years and were founded by ex-employees from EMC in Cork, Ireland.
- Wisetek are headquartered in Cork, Ireland and have facilities in Milton Keynes (UK), Northborough, Virginia, Austin, Sacramento (US) and Thailand.
- Wisetek are holders of the R2 – Responsible Recycling certification, the e-Stewards EMS as well as ISO 9001, 140001 & 45001. They are also a WEEELABEX certified facility in Cork.

Impact and maturity of the initiative

- Wisetek are based in Cork but have a worldwide presence and service some of the biggest brands in ICT.
- 162Kt of IT equipment has been received by Wisetek and 13.2k rack systems have been refurbished with 525k Laptops and Desktops being processed and 6.3 million pounds of toxic materials being diverted from waste.

Case Study#9 Glen Dimplex Ireland: **Repair & Spare Parts Availability initiative**

Website: https://www.glendimplexireland.com/about
Partner(s) involved: N/A
CE Strategies used: Repair, Refurbish & Spare Parts availability
Type of CE innovation: Lifetime Extension
Region(s) it's based in: Ireland/EU/Worldwide
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- GDI have developed a Circular Economy Strategy through Product Lifetime Extension and have created a repair, refurbishment and spare parts to service their users and repair technicians.
- GDI offers repair services for their portfolio of appliances.
- Any items that are returned are refurbished for re-sale.
- Spare Parts are made available for internal and external use with many spare parts being sourced from returned appliances.

Background of the initiative

- Glen Dimplex Ireland are a distributor of electrical equipment for many major brands such as Belling, Toshiba, Morphy Richards, Roberts and Xpelair. GDI distribute consumer electronics, domestic and heating appliances, white goods and heat pumps, solar and other smart solutions.
- Glen Dimplex Ireland are part of the Glen Dimplex Group which have manufacturing and development centres in Ireland, the UK and China.
- GDI's Product Lifetime Extension strategy has been in operation for several years.
- While GDI are mainly operate as a distributor for their portfolio of products they have built up a strong presence in the Repair and Field Service sectors.
- The circularity of their spare part offering is a good example of how to increase product lifetimes through repair, refurbishment and reuse to a high standard of quality. The high quality of these processes creates an important value chain and helps to mitigate potential supply chain issues by creating an alternative source of spare parts.

Impact and maturity of the initiative

- GDI have repaired in 2021 >12,000 products in their portfolio such cooking appliances, electric fires, renewables, water heaters, televisions and white good appliances.
- GDI uses the spare parts from returned appliances that cannot be refurbished and this reduces the requirement to purchase and transport spare parts by 10%.
- All returned items are inspected & refurbished to a high standard. These refurbished items are used to replace products that require repair when field service is not required, the returned damaged products follow the same process to become the next source of supply.
- GDI have developed local partnerships to source spare parts when they are not available due to supply chain challenges.
- In 2020, the GDI repair team undertook over 14,000 repairs in Ireland, this includes around 1000 inhouse workshop repairs.
- The Lifetime Extension strategy has been in operation and is at a high maturity level.

Case Study#10 - TriREUSE: Trialling Preparation for Reuse of Consumer ICT Equipment

Website:
https://www.epa.ie/publications/research/waste/Research_Report_333.pdf
Partner(s) involved: University of Limerick, Phoenix RM (Green IT)
CE Strategies used: Preparation for Reuse
Type of CE innovation: Disassembly skills
Region(s) it's based in: Ireland
TRL: 7

What circular challenge / opportunity is the case study trying to address?

- The TriREUSE Project was developed to address the willingness of consumers to return their laptops, tablets and smartphones for reuse with the added incentive of free data sanitisation on all returned items.
- Preparation for Reuse is where end-of-life devices are collected as WEEE but segregated to be tested for its suitability for reuse.

Background of the initiative

- The TriREUSE Project was funded by the EPA (Environmental Protection Agency) in Ireland under its STRIVE program.
- The University of Limerick's Electronic & Computer Engineering department led the project and have extensive experience in WEEE and End-of-Life strategies.
- Phoenix RM (trading as Green IT) are an IT Asset Disposition and Refurbishment company based in Naas, Co. Kildare.

Impact and maturity of the initiative

- The TriREUSE project created several takeback events both public and private throughout Ireland to measure the appetite for takeback of consumer ICT equipment.
- 283 kg of laptops, smartphones and tablets were collected from 10 events in Ireland.
- 60 kg or 28% were suitable for preparation for reuse using technical and economic criteria.
- 308 kg of WEEE which were outside of the scope of the project was also collected and recycled during the events.
- The potential for creating a preparation for reuse sector in Ireland has been hampered by a lack of licensed operators and access to good quality equipment.

Case Study#11 – KMK Recycling: Electrical, Electronic & Metals Waste Solutions

Website: https://www.kmk.ie/
Partner(s) involved: WEEE Ireland, ERP Ireland
CE Strategies used: Recycling, Product & Material Recovery
Type of CE innovation: Material & Process Innovation
Region(s) it's based in: Ireland
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- KMK Metals Recycling are Ireland's largest recycler of metals and Waste Electrical & Electronic Equipment (WEEE) and services both compliance schemes in Ireland.
- KMK collect, recycle and dispose of WEEE and these materials are feedstock for new products. KMK also undertake the collection and recycling of Batteries.
- The urban mine i.e., the electrical and electronic equipment that we do not dispose of has the potential to be the largest reserves of precious and critical raw materials.

Background of the initiative

- KMK Metals Recycling was established in 1979 in Tullamore, Co. Offaly in Ireland. In 1985 KMK set up their first recycling facility in Tullamore.
- With the advent of the WEEE Directive in 2002, KMK were awarded contracts by Ireland's two compliance schemes to collect and recycle WEEE.
- KMK provide a fully compliant collection and processing facility for hazardous and non-hazardous metals.
- KMK became the first WEEELABEX certified recycling facility in Ireland in 2015.
- KMK are responsible for the collection and processing of WEEE from retailers and recycling centres throughout Ireland on behalf of WEEE Ireland.
- KMK are responsible for the collection of batteries from retail outlets, businesses and schools on behalf of WEEE Ireland.
- KMK have developed their business model from being initially a recycling focused offering to a service focused model and provide WEEE, Battery, Metals and ITAD services.

Impact and maturity of the initiative

- In 2020, KMK recycled 1,012t of Metals, collected 42,818t of WEEE, recycled 1,089t of Batteries which had the impact of avoiding 200,000t of Co_2 (approx..)
- KMK established the first disassembly and recovery service for damaged EV batteries in Ireland with the LLLB Project which was led by WEEE Ireland and funded by CIRCULÉIRE (see above).
- KMK have installed Votechnik's ALR 3000 which is a fully automated thigh through put technology for the safe dismantling of LCD screens. The ALR 3000 can process up to 60 LCDs per hour. This technology enables the recovery of critical raw materials that would have been lost using existing practices.

CaseStudy#12 – Tallaght District Heating Scheme (TDHS)
Using waste heat from Datacentres for district heating

Website: https://www.codema.ie/projects/local-projects/tallaght-district-heating-scheme/
Partner(s) involved: Codema, AWS & South Dublin County Council (SDCC), Fortum eNext, TU Dublin.
CE Strategies used: Renewables and Waste Heat
Type of CE innovation: Process Innovation
Region(s) it's based in: Dublin, Ireland
TRL: 9

What circular challenge / opportunity is the case study trying to address?

- This project is using waste heat from a datacentre to provide heating to residents in Tallaght, Co. Dublin.
- Waste energy is the main source of waste from datacentres and the increasing prevalence of datacentres in Ireland has created an opportunity to capture this waste.
- The waste heat energy from datacentres has been used in many other countries in Europe but this is a first for Ireland.

Background of the initiative

- Waste heat is the heat energy which is a by-product of industrial processes and datacentres which is not captured and is released to the environment. When this heat is captured or recycling it by means of a district heating system, it eliminates this waste.
- The main customers of this scheme will be SDCC and TU Dublin.
- The scheme is being funded the government of Ireland's Climate Action Fund, Interreg North-West Europe and Science Foundation Ireland (SFI)
- The scheme is run by Heatworks which is Ireland's first not-for-profit energy utility.

Impact and maturity of the initiative

- The project is a collaboration between Codema, South Dublin County Council and Amazon Web Services. Codema is the Energy Agency for Dublin.
- The benefits of a district heating scheme are to provide lower emissions, hot water on demand, no boiler required, improved air quality, better energy ratings, lower costs and the flexibility to source heat from other sources.
- The scheme will connect 1,962 homes in Tallaght, Co. Dublin.
- 58% of heat delivered will be zero carbon from a local data centre.
- The scheme will save 1,441 tonnes of CO_2 annually.
- 47,000m^2 of public buildings connected.
- The district heating system began construction in 2021.
- Estimates state that there is enough waste heat and renewable resources to heat the equivalent of one million households.

Section 3 . What's needed to circularise Ireland's Electronics & ICT sector?

The 12 case studies selected for this ICT & Electronics Sectoral Guide give a good overview of circularity in the ICT & Electronics sector and represent a good cross-section of circular innovations happening at different parts of the value chain: such as capacity building, circular innovation, circular design, product service systems, shared use, remanufacturing and recycling, repair, refurbishment and reuse.

While this study is not a comprehensive assessment of the maturity of circularity within the sector, the case studies profiled demonstrate that the adoption of circular economy practices is at an advanced stage. The ICT & Electronics sector has pioneered many innovations in design and innovative systems to incorporate circular economy principles. The case studies are all at a relatively high technological readiness level (TRL 8-9).

This section summarises the key enablers and lessons learnt based on our analysis of the case studies and the wider literature about what's needed to initiate and scale circular ICT and Electronics innovations in Ireland. It then presents some of the current barriers that are hampering the transition to a circular ICT and Electronics system. Finally, it concludes with 4 recommendations for policymakers and industry leaders about what's needed to pave a future pathway for Ireland's ICT & Electronics sector premised on circularity, sustainability and innovation.

3.1. Key enablers/lessons learnt

The ICT/EEE sector covers a broad and complex range of products and services and the Irish case studies profiled highlight that there are circular economy activities already underway in the ICT / EEE sector in Ireland. However, the case studies from further afield provide examples of how we can continue the journey to scale circularity. Moreover, cross comparative analysis of the case studies reveals important cross-cutting lessons that can help overcome the competing challenges the sector faces in Ireland related to; 1) Capacity Building, 2) Funding and 3) Policy, Regulation and Legislation.

3.1.1. Theme 1: Capacity Building

The Circular Economy is not a new concept and has been in use in some sectors for a long time however this sustainable business model has been gaining in popularity but the complex nature of ICT and EEE products has stalled wider adoption. Investment in capacity building is required to scale up circular implementation. This will allow companies to test their ideas and investigate how they can be applied to their business to change from linear to circular models. A

key enabler of transitioning to a circular economy is the provision of funding for research and innovation as well as financial support for repair practices among others (Rizos and Bryhn, 2022).

Capacity building is required for all stakeholders in the ICT & EEE sector in order to develop a better understanding of circular economy models and to accelerate the level of knowledge to allow this transition. The ICT & EEE sector encompasses many industries under the technology umbrella and covers all areas from datacentres, computer manufacturing, consumer goods and many others in between. Consumers, manufacturers and distributors all need to understand the implications of their actions and need to be advised on what options are more environmentally sound. For example the Right to Repair movement has created awareness among consumers of the need to be able to repair consumer electronics instead of disposing of damaged items and this in turn has created pressure on manufacturers to examine how they design their products and increase reparability.

The www.repairmystuff.ie website was created by several stakeholders such as WEEE Ireland, ERP Ireland, Local Authorities and the EPA to create a directory service of repair providers for electronics, large and small appliances in Ireland.

CIRCULÉIRE, the National Platform for Circular Manufacturing in Ireland has rolled out the Innovation Fund Demonstrator projects for the Circular Economy to build capacity circular economy practices. An example of this funding the Circular Economy Skills Initiative (CESI) project which developed a curriculum and training program to increase the quantity of new repair technicians entering the White Goods repair industry. The Lithium Long Life Battery project is another example of building capacity in the disassembly and reuse for damaged electric vehicle battery packs and modules. A training program was created to enhance the knowledge in the recycling sector to overcome environmental and economic issues.

There are many opportunities to build in circular economy business models into existing businesses which add value to the business. Glen Dimplex is a large distributor in Ireland for many household brand name home appliances and they have added value to their offering by providing offsite and onsite warranty repair which allows them to create products with longer lifetimes while also providing a ready supply of stock for refurbished products which are provided as warranty replacements.

By understanding the circular economy, businesses can potentially unlock new sources of revenue while being more circular and building more sustainability in their business.

3.1.2. Theme 2: Funding

The availability of funding has been highlighted as a key enabler for companies to adopt circular economy practices and the provision of grants both EU and nationally is a key factor in diversifying companies core operations to a more circular process. (Rizos and Bryhn, 2022). The presence of funding initiatives by Government enables companies to test the water and gain a better understanding of circular economy practices and innovation. Grant funding can allow companies to de-risk their circular experimentation.

SME's may be resource constrained to investigate fully the potential of their business to transition to more circular practices. The availability of funding allows the creation of testbeds and demonstrators which have the potential to scale up and be presented as valuable use cases for other companies and sectors to follow or replicate.

The funding landscape in Ireland is well developed with several government departments running and overseeing initiatives to finance sustainable and circular innovation. The Green Enterprise funding is overseen by the Environmental Protection Agency (EPA) and is an annual funding call to support innovators in Ireland to develop, demonstrate and implement circular economy approaches in their business models. This fund is worth €650k in total with allocations of between €50k-€100k for applicants. The Department of Environment oversee the Circular Economy Innovation Grants scheme which is directed at social enterprises, voluntary and community groups and businesses with less than 50 employees and provides up to €100k of funding.

IDA Ireland operates an innovation voucher scheme which allows companies to carry out research by Irelands publicly funded knowledge providers. The vouchers are worth €5k which allows entities to make the first steps in innovation. Enterprise Ireland runs the Green Start/Plus Programmes which aims to allow companies develop sustainable business models and undertake short term assignments. The funding available is €5k. The Department of Business, Enterprise & Innovation oversees the Disruptive Technologies Innovation Fund and provides €500m in funding since 2017 and is aimed at research organisations, SMEs and multinationals.

There are several European Union level grants schemes in operation such as the EU LIFE Programme and Horizon Europe. The issue of sustainable finance has been at the forefront of EU discussions on funding the European Green Deal

CIRCULÉIRE has funded 10 Innovation Fund Demonstrator projects over the past 2 years. Four of these innovation funded projects have been based in the areas of Training (CESI), Batteries (LLLB), WEEE (MEDAL) and Recycling (RoboCRM). For example the RoboCRM project which was undertaken by CIRCULÉIRE member FPD Recycling/Peregrine Technologies, the University of Limerick and Robotics &

Drives and they were successful in accessing funding from the Department of Business & Innovations Disruptive Technologies Innovation Fund (DTIF) partly based on the work they had undertaken in the Innovation Fund. The availability of different tiers of funding allows the financing of research at various stages and can lead to better scalability which in turn can lead to the creation of more opportunities.

3.1.3. Theme 3: Policy, Regulation and Legislation

Policy, Regulation and Legislation have enabled the transition of the waste management sector to a more sustainable and circular model by implementing legislation on how we dispose or treat waste from all sectors.

The end-of-life disposal of ICT & Electronics products have been under the auspices of the EU WEEE Directive since 2002. The Directive was implemented by the EU and transposed to each member countries national legislation in various iterations. The success of the WEEE Directive in ensuring that electronic products did not go to landfill and instead were collected and treated in recycling facilities helped to create value and enabled materials to be reused.

The model of Extended Producer Responsibility that was implemented by businesses to serve requirements of the WEEE Directive has created a system that has operated successfully and has enabled a more circular approach and mindset among the ICT & Electronics sector.

In recent years the European Commission has adopted a set of proposals to align the EU's climate, energy, transport and taxation with the reduction of greenhouse gas emissions by 50% for 2030. This action has been called the European Green Deal. Within this policy is the Circular Economy Action Plan (CEAP), which will introduce legislative and non-legislative measures to target areas such as increase the amount of sustainable products and focus on sectors that have a high resource use and where the potential for circularity may be high such as electronics and ICT among others. The CEAP will address policies for Plastics, Waste & Recycling, Critical Raw Materials and Sustainable Products. The Sustainable Products Initiative which will seek to improve measures like the Ecodesign directive and develop a Digital Product Passport which will create a digital thread of all the data associated with a product from bill of materials to composition to repair and recycling options.

The Government of Ireland has recently passed the Circular Economy Bill to strengthen waste and circular economy legislation. This bill is part of the government's commitment as set out in 2020 Waste Action Plan for the Circular Economy and the 2021 Whole of Government Circular Economy Strategy. The OECD report "The Circular Economy in Ireland" stated that there are three main

obstacles to a CE transition, that is CE is viewed as based on waste and not resources and a more holistic approach to leverage opportunities in terms of economic, environmental and social wellbeing. Our current approach focuses on recycling and recovery over prevention, repairing and reusing. The final obstacle is that by creating a National Waste Management Plan it may fail to account for local issues such as income, population and economic activities.

These range of policies, regulation and legislation aim to address current gaps and inefficiencies by creating a more substantive framework to support businesses to address their transition to a circular economy business model. The opportunity provided by these will help enable and become a driver for the Circular Economy in the ICT & EEE sectors. Regulations and other policy instruments have been identified as important drivers for more advanced recycling and circularity in place of a lack of economic incentives (Aminoff and Sundqvist-Andberg, 2021).

In Ireland the lack of industry's understanding of End-of-Waste criteria and By-product legislation has been cited as hampering the adoption of circular economy innovations in the recycling sector. Steel has been the primary material that has added value as an end-of-waste product. This is due to the demand for steel and the relative ease at which it can be recycled.

3.2. Key barriers to the Circular Economy Transition?

Analysis of the case studies and wider literature highlights the following barriers as impeding the implementation or scaling of circularity in Ireland's ICT and Electronics sector : 1) a lack of decision-making capabilities locally, 2) end-of-life treatment based on recycling, 3) increasing demand for critical raw materials.

3.2.1. Theme 1: Lack of local strategic and decision making capabilities

While Ireland has a small manufacturing base which employs around 260k people which represents 12% of the total workforce we do however achieve notable success in many areas of manufacturing in the medical, pharmaceutical and food & drink sectors (Ibec, 2022). Much of our manufacturing base in the ICT & EEE sectors is conducted by multinational companies in the semiconductor (Analog, Intel), computer manufacturing (Apple) and technology services (Amazon, Apple, Google) and with some local electronics manufacturing (Ei Electronics).

Multination Companies (MNC'S) that manufacture or place products on the market in Ireland may have limited ability to make key decisions that are made around design, materials and supply as many of these decisions are made outside of Ireland in many instances. While there are exceptions such as Logitech whose

Sustainability team is located in Cork. Circular economy strategies such as product lifetime extension need to be addressed in the design phase but this decision may be made in another jurisdiction with different drivers.

A key factor in an Irish setting is that the majority of Extended Producer Responsibility members in Ireland tend to be distributors of ICT & Electronics rather than manufacturers. This role can limit the autonomy of organisations to make changes in relation to localised regulations. The geographical proximity to the United Kingdom has meant that many manufacturers and distributors based the European operations in the UK and Ireland was considered as part of the same market. The recent exit of the United Kingdom from the European Union has changed Ireland's role as an English-speaking nation in terms of corporate influence in the EU.

3.2.2. Theme 2: The Extended Producer Responsibility model in the EU

One of the main obstacles to transitioning to a circular economy in Ireland is that our current approach focuses on recycling and recovery over prevention, repair and reuse (OECD, 2022). WEEE or e-waste is one of the fastest growing waste streams throughout the world and especially in more developed regions such as Europe. The UNU Global E-waste Monitor reported that in 2019, 53.6Mt of e-waste is generated worldwide and this equates to around 7.3kg per capita (Forti et al., 2020). The current system in Europe has worked well but needs to change with rising challenges in the increasing WEEE and falling collection rates.

- Recycling is at the bottom of the waste hierarchy and the EU has been very successful in the adoption of the WEEE Directive to initiate mass recycling of WEEE.
- The focus on recycling as the main treatment of WEEE has created a very efficient system with Ireland meeting or exceeding the targets set by the EU. This focus has however come at the expense of the remaining waste management approaches of the waste hierarchy (repair, reuse, reduce).
- There are no registered Preparation for Reuse providers for ICT/Electronics currently in Ireland.
- In Ireland the Extended Producer Responsibility Schemes are based on Business to Consumer (B2C) products and do not account for any Business to Business (B2B) products even though these products can be disposed of in Local Authority Civic Amenity sites.
- There are several large Information Technology Asset Disposition (ITAD) companies that refurbish and reuse ICT equipment that are not reported due to being operated by private companies that operate in the B2B market.
- Many B2B products tend to be high value items that can be refurbished or remanufactured for further reuse. These types of products vary from medical equipment (MRI machines) to office equipment (Multi-function Printers).

- There is also a thriving second hand market for electronics consumer goods such as smartphones and laptops on high streets all over Ireland that accelerate reuse and lifetime extension.

3.2.3. Theme 3: Supply Chain Challenges for Critical Raw Materials

The raw materials required for many ICT and Electronic equipment have been deemed critical by the European Commission and are also essential for the development of strategic sectors such as renewable energy, electric mobility, aerospace and digital technology (European Commission, 2020). These critical raw materials (CRMs) are identified as such due to the fact that the EU is dependent on these materials to be imported into Europe and in some circumstances these materials are subject to supply chain challenges due to geopolitical events (Bobba *et al.*, 2020).

Moreover, the Clean Energy sector will be placing huge demand on these critical raw materials for the production of wind turbines and PV panels.. The E-Mobility sector is also heavily reliant on access to lithium reserves to transition from ICE to EV as well as many other materials (Vahle *et al.*, 2022).

In the coming years security of supply/ access to these critical raw materials is likely to become a considerable challenge for Ireland's ICT & Electronics sector. An alternative source of supply that has been put forward as a potential solution is the concept and practice of "Urban mining". An Urban Mine is the stock-pile of waste raw materials from WEEE, ELV's, Batteries and Mining waste and the ProSUM project (2015- 2017) is / has measured the quantities of products placed on market and waste generated in Europe.

Urban mining has been highlighted as an opportunity to unlock the potential critical raw material supply in Waste Electrical and Electronic Equipment. However, urban mining requires there to be efficient and readily available processes developed for recovering these metals. Advances in recycling technology through automation and artificial intelligence have the potential to unlock how we treat our Waste Electrical & Electronic Equipment. For example CIRCULÉIRE member FPD Recycling are developing automated recycling equipment that utilise AI to create greater efficiencies through sorting and dismantling.

3.3. Key recommendations to unlock circularity in the Electronics & ICT sector

Wider literature and case studies, highlighted in this guide, provide key insights which can play an important role in supporting the circular transition in the ICT & Electronics' sector. Below, 4 key recommendations are outlined which could help support the transition to a circular Electronics & ICT system in Ireland and are aligned with PACE's ten action points for the Circular Economy Action Agenda in Electronics as mentioned in section 2.2.

3.3.1. Waste management of WEEE

The current system for the collection, takeback and treatment of WEEE needs an overhaul to reduce our dependence on recycling as our only treatment option. Consideration needs to be given to a Preparation for Reuse strategy for certain products which will enhance circular offerings for waste electronics such as White Goods Appliances and ICT equipment and an increase in Reuse and Repair activity for EEE.

The 65% collection rate of WEEE collected in Ireland still leaves 35% of products not being collected and being hoarded. The WEEE Forum which represents many of the EU's EPR and Compliance Schemes has stated that the current target rate of 65% is not sustainable due to issues with an increasing number of products being placed on market and the reduction in collection and recovery of products. This is due to become a key topic of discussion for the upcoming evaluation of the WEEE Directive (WEEE Ireland, 2021).

The reduction in collection rates is exacerbated by hoarding of EEE/WEEE, products not being placed in the correct waste streams and transboundary shipments (Baldé, Iattoni and Yamamoto, 2022). The falling collection rates may be addressed by providing secure reverse logistics for data bearing devices and the operation of kerbside to door-to-door collections and access to Civic Amenity sites in cities to increase the takeback of the 35% of items not collected. The treatment of WEEE needs to be assessed and the types of materials originating in Ireland need to be mapped for future understanding of material supply for the European Union.

3.3.2. Value chain cooperation and experimentation

Examining the value chain through cooperation and experimentation can lead to potential opportunities to create circular processes (CEP, 2022). As we have seen previously the case study of District Heating by using waste heat from a datacentre to heat residential and business premises in the adjacent local area is a prime example of cooperation among entities (Codema, 2021). There are other

opportunities to roll out similar district heating schemes adjacent to datacentres in other parts of Ireland. Sustainability and the circular economy have begun to harness the current advances in technology through automation, artificial intelligence and software to enable opportunities to facilitate the transition to circular business models. The advances in digitalisation have created an ecosystem of software and services which aim to build databases of information containing all aspect of the product lifecycle from design to end of life (Bressanelli *et al.*, 2020). An example of this is the Horizon 2020 funded CircThread project which is building the digital infrastructure for the circular economy based on open-source principles. The intersection of digitalisation and the circular economy will play an important role in the future of products and the upcoming EU Digital Product Passport legislation is proposed to be introduced in products in the ICT & EEE sectors in the near future.

As has been mentioned previously the building of capacity through education and training can present opportunities to upskill and prepare companies for a more circular future. The LLLB and CESI project overseen by WEEE Ireland has led the way in enabling businesses and organisations to gain training and experience to increase the skill base in Ireland. The cooperation of different stakeholders to achieve a common goal, there can be a successful outcome. The success of the CESI Project and its curriculum has created interest from other training centres throughout Ireland.

Ireland is a vibrant economy that has worked to create an innovation ecosystem through the successful collaboration of academia, research and business to develop solutions to many technological and engineering problems. We need to harness our joint expertise across the Electronics and ICT Sectors to develop and create innovative solutions for the circular economy. Ireland is an island economy that is home to two separate jurisdictions, the Republic of Ireland and Northern Ireland. The need to cooperate for a shared future of resources and a more circular way of thinking is imperative to the economic and environmental health of both countries.

3.3.3. Post-industrial activities and measurement (B2B)

The current Extended Producer Responsibility model that is prevalent in the European Union has served the Business to Consumer market very well. It has enabled an efficient and functioning takeback mechanism for electronic goods. However the Business to Business (B2B) sector has created the Individual Producer Responsibility model which allows B2B operators to manage their own collection and takeback activities. The Government of Ireland have stated in “A Waste Action Plan for the Circular Economy” policy document that they will remove individual producer self-compliance as an option and that they will build on the success of the EPR schemes to capitalise on the circularity potential (DCCAE, 2020). The document also adds that the government will review end-of-waste and by-products regulation to remove barriers to circular economy developments.

Post-industrial or B2B equipment has a high potential for reuse, repair and refurbishment. It often referred to as professional equipment and this type of equipment is generally not counted by Producer Responsibility Organizations (PRO) (WEEE Forum, 2020). UNITAR have estimated that there could be as much as 1.7 kg/inhabitant of professional equipment in Northern & Western Europe (Forti et al., 2020). B2B presents an opportunity to capture the quantities of EEE & ICT going for repair, reuse and refurbishment but with little to no measurement taking place which means that this potential is being missed. For example, the Information Technology Asset Disposition (ITAD) industry creates economic and environmental benefits by repair, reusing and refurbishment to extending product lifetimes of Servers, Laptops and Desktop computers.

The measurement of the activity in this sector would provide a vital baseline for insights in how these activities have environmental and economic benefits for Ireland. A voluntary disclosure system in the B2B sector will allow the capture of data to highlight these activities and add to how we transition to Net Zero by 2030 and beyond.

3.3.4. Development of an All-Island Remanufacturing Strategy

The Centre for Remanufacture and Reuse have identified several areas where remanufacturing can provide a solution from several perspectives from circular economy, standards, EPR, new business models and re-shoring. China has developed a strategy for the remanufacturing of automobile parts as part of its overall Circular Economy strategy (Ellen Macarthur Foundation, 2019).

Remanufacturing is considered one of the most valuable industrial scale value-retention processes (VRP) along with refurbishment (Arnold *et al.*, 2021). Remanufacturing is defined as returning a used product to its original state from a quality, performance and warranty perspective (Sitcharangsie, Ijomah and Wong, 2019). Remanufacturing is often the preferred end-of-life option for high value products such as machinery (plant), prime movers (engines), medical (MRI) and office equipment. These types of equipment can be disassembled and reconditioned and eventually remanufactured into perfectly working products which can be resold while retaining their value. The remanufacturing strategy has an important part to play in the circular economy in ICT and Electronics and Electrical equipment. Canon, who make photocopiers and multi-function printers have successfully implemented a remanufacturing strategy to reduce costs and their environmental footprint. A key recommendation from this guide would be the quantification and development of a remanufacturing strategy in Ireland to encourage indigenous businesses to invest in and implement remanufacturing activities and reverse logistics infrastructure and foreign direct investment to help them purse this strategy. We have a low manufacturing base in Ireland but this still contributes 12% of total employment and is responsible for €12.5bn in wages and employment taxes and is a huge contributor to the success of the Irish economy (Ibec, 2021). Ireland has many niche manufacturers that make high value items

from Machinery & Equipment to Medical Technology. There are a number of areas in which a remanufacturing strategy can play a key role in Ireland.

- Support manufacturers and distributors of equipment to develop remanufacturing bases in Ireland
- Build competencies in supporting remanufacturing through applied research for Design for Manufacturing (3D Printing), Digitalisation and Traceability.
- Potential to support remanufacturing in Ireland in the transition to Renewables e.g. onshore and offshore Wind Turbine manufacture.

4. Further Resources: Electronics & ICT Sectors

Ireland's EPA provides environmental data, assessments and evidence to inform decision making and implements effective regulation and environmental compliance systems and also provides funding for research into the Circular Economy and Waste.

EPA funded research provides insightful data into current practices in Ireland and helps the circular economy by determining data on how much waste is being created and where it is going. There have been several reports examining the area of Waste Electrical & Electronic Equipment (WEEE) and Materials which are listed below.

- STRIVE 110: Re-Evaluate - Re-use of Electrical and Electronic Equipment (Evaluation and Mainstreaming)
- Research Report 186: The Development of a Model to Ascertain Future Levels of Historic WEEE Arising (Historic WEEE)
- Research 201: Investigation of Liquid Crystal Displays as a Source of Indium
- Research 241: Research of Upcycling Supports to Increase Re-use, with a Focus on Waste Electrical and Electronic Equipment (UpWEEE)
- Research 262: A Community Based Social Marketing Approach for Increased Participation in WEEE Recycling (ColectWEEE)
- Research 294: Investigation of Indium Recovery from End-of-life LCDs
- Research 333: TriREUSE – Trialling the Preparation for Reuse of Consumer Laptops, Tablets and Smartphones
- Research 366: An Investigation into WEEE Arising and Not Arising in Ireland (EEE2WEEE)
- Research 388: Circular Economy Opportunities – Raw Materials Ireland Project
- Research 393: Estimating the Quantity of Electrical and Electronic Equipment (EEE) Exported from Ireland as Used EEE

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